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Aeronautical Engineering A Continuing Bibliography with Indexes NASA SP-7037 (116) December 1979

National Aeronautics and SEFILE Space Administration

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## NASA SP-7037(116)

# AERONAUTICAL ENGINEERING

## A Continuing Bibliography

### **Supplement 116**

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 1979 in

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

## **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 550 reports, journal articles, and other documents originally announced in November 1979 in Scientific and Technical Aerospace Reports (STAR) or in International Aerospace Abstracts (IAA).

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

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*. in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included. An annual cumulative index will be published.

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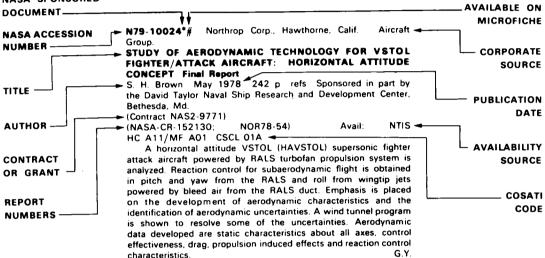
viii

## TABLE OF CONTENTS

AA Entries	
STAR Entries	
Subject Index	A-1
Personal Author Index	
Contract Number Index	<b>C</b> -1

## TYPICAL CITATION AND ABSTRACT FROM STAR

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## TYPICAL CITATION AND ABSTRACT FROM IAA

NASA SPONSORED	A79-10266 * # An experimental study of three-dimensional	AVAILABLE ON MICROFICHE
NUMBER	turbulent boundary layer and turbulence characteristics inside a turbo machinery rotor passage. A. K. Anand and B. Lakshminarayana (Pennsylvania State University, University Park, Pa.). (American	AUTHORS
	Society of Mechanical Engineers, Gas Turbine Conference and Products Show, London, England, Apr. 9-13, 1978, Paper	AUTHOR'S
TITLE OF PERIODICAL	78-GT-114.) ASME, Transactions, Journal of Engineering for Power, vol. 100, Oct. 1978, p. 676-687; Discussion, p. 688-690. 19 refs. Grant No. NGL-39-009-007.	
	Three-dimensional boundary layer and turbulence measurements of flow inside a rotating helical channel of a turbomachinery rotor are described. The rotor is a four-bladed axial flow inducer operated at large axial pressure gradient. The mean velocity profiles, turbu- lence intensities and shear stresses, and limiting stream-line angles are measured at various radial and chordwise locations, using rotating triaxial hot-wire and conventional probes. The radial flows in the rotor channel are found to be higher compared to those at zero or small axial pressure gradient. The radial component of turbulence intensity is found to be higher than the streamwise component due to the effect of rotation. Flow near the annulus wall is found to be highly complex due to the interaction of the blade boundary layers and the annulus wall resulting in an appreciable radial inward flow, and a large defect in the mainstream velocity. Increased level of turbulence intensity and shear stresses near the midpassage are also observed near this radial location. (Author)	PUBLICATION DATE

## AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 116)

#### DECEMBER 1979

## IAA ENTRIES

A79-46995 Surface-effect components of aerodynamic characteristics of air-cushion vehicle with ram pressurization. M. A. Gur'ianov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 17-29.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 10-19, 8 refs. Translation.

In the present paper, the general laws of gasdynamics (laws of total pressure, flow rate, and momentum conservation in the gas stream) are used as a basis to derive formulas which relate the skirt components of the aerodynamic characteristics to the parameters defining the geometry and position of the skirts. The interaction force of the oncoming flow is taken into consideration only at the inner surface of the skirts. The latter are configured as a pi-shaped half-tunnel. It is shown that this geometry is characterized by a high L/D ratio and high stability with respect to pitch.

A79-46996 Statistical diagnostics of aircraft engines. Iu. V. Kozhevnikov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 30-35.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 20-25. 5 refs. Translation.

The present paper deals with the linear statistical problem of aircraft engine parametric diagnostics for a given set of stable modes of operation. Some diagnostics problems with respect to one or more parameters are analyzed and solved. V.P.

A79-46997 Optimal thermogasdynamic design of gas turbine engines using element prototypes. I. lu. V. Kozhevnikov, V. O. Borovik, V. S. Ivanov, V. A. Talyzin, I. N. Agliullin, and Iu. V. Meluzov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 36-43.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 26-32. Translation.

The problem of optimal thermogasdynamic designing on the basis of a mathematical model of a gas-turbine engine, containing the characteristics of prototype engine elements in similarity parameters is analyzed. Optimality criteria are derived for a two-spool bypass turbojet engine, making allowance for the engines modes of operation. V.P.

A79-46999 Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I. A. I. Matiazh, V. A. Sterlin, V. A. Popov, V. V. Isaev, and G. A. Cheremukhin. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 49-54.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 37-41. 5 refs. Translation.

A79-47000 Analytic formulas for wing profile aerodynamic characteristics in incompressible flow. N. M. Monakhov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 55-61.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 42-47. Translation. In the present paper, conformal mapping is applied to the derivation of equations for calculating the lift coefficient, the moment coefficient, and the coordinates of the aerodynamic center and center of pressure for a wing profile in incompressible flow and the velocity at the wing surface. The high accuracy of the formulas is illustrated by examples. V.P.

A79-47001 On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics. V. A. Ovchinnikov, V. D. Osorgin, V. G. Pavlov, and E. Ia. Fedorov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 62-65.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 48-51. Translation.

A79-47002 Solution of the inverse aerodynamics problem by the random search method. G. D. Peshatov and Iu. N. Novoselov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 68-73.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 54-58. 7 refs. Translation.

A computer-aided method is proposed for designing subsonic and supersonic wing profiles for a given pressure distribution. An optimization procedure for designing a simply connected contour from the constraints on its shape is outlined, and its block diagram is discussed. V.P.

A79-47009 Harmonic oscillations of annular wing in steady ideal fluid flow. Z. N. Shesternina. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 115-121.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 93-98. 7 refs. Translation.

Existing methods of solving problems concerning the harmonic vibrations of wings in translational flow are based on the substitution of a system of attached ring vortices for the wing. The methods reduce to the solution of a system of Fredholm integral equations of the first kind. In the method proposed in the present paper, use is made of the same substitution, however, by using the properties of the single-layer potential and a somewhat modified impermeability condition, the problem is reduced to a system of Fredholm integral equations of the second kind with respect to the density of the attached vortices. The detailed formalism of these equations made it possible to prove the uniqueness of the solution, to satisfy the Chaplygin-Joukowski condition, and to determine the influence of the wing profile configuration on the convergence of the iterations.

A79-47012 Overall aerodynamic characteristics of caret and delta wings at supersonic speeds. Iu. P. Gun'ko and I. I. Mazhul'. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 129-132.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 107-110. 6 refs. Translation.

A79-47014 Selecting the passenger airplane fuselage. Iu. N. Egorov. (Aviatsionnaia Tekhnika, vol. 21, no. 2, 1978, p. 135-138.) Soviet Aeronautics, vol. 21, no. 2, 1978, p. 114-116. Translation.

Weight and drag criteria are presented for the fuselages of passenger aircraft, with consideration of the space required for passenger accomodations. An expression is obtained relating the surface area, diameter and length of a fuselage for purposes of weight- and drag-optimal design. Relationships between weight and aspect ratio are also examined. B.J. A79-47093 \* Some observations on four current subjects related to aeroelastic stability. H. Ashley (Stanford University, Stanford, Calif.). (Israel Annual Conference on Aviation and Astronautics, 20th, Tel Aviv and Haifa, Israel, Feb. 22, 23, 1978.) Israel Journal of Technology, vol. 16, no. 1-2, 1978, p. 3-22. 63 refs. Grants No. AF-AFOSR-74-2712; No. NGL-05-020-243.

After introductory comments on the literature and the purposes of this paper, a table is presented summarizing the author's views on some currently solved vs partially unsolved problems related to aeroelastic stability. The term 'solved' is used in the practical sense that engineers are able to cope confidently with that problem during the process of structural design. Selected entries in the table are reviewed, partially to motivate the topics in the rest of the paper. The 'four current subjects' are chosen both for timeliness and because they are among the ongoing interests of the Stanford group. The first involves the prediction of linearized unsteady aerodynamic loads due to arbitrary motions of streamlined shapes. Some contributions by Edwards are refined, which were motivated by the requirements of active control system design. The second subject is nonlinear unsteady aerodynamics for the transonic regime. After describing a few useful developments from locally-linear theory and computational fluid dynamics, there is suggested an empirical procedure for interim-analysis purposes. The third and fourth subjects concern recent discoveries regarding the aeroelastic stability of large-aspect-ratio wings and wind turbines. The former work is mainly that of Petre and Boyd. The latter includes some of the author's own preliminary discoveries about the performance and dynamics of vertical-axis machines. (Author)

A79-47098 Analysis of optimal loop and split-S by energy state modeling. J. Shinar (Technion - Israel Institute of Technology, Haifa, Israel), D. Yair, and Y. Rotman. (*Israel Annual Conference on Aviation and Astronautics, 20th, Tel Aviv and Haifa, Israel, Feb. 22,* 23, 1978.) Israel Journal of Technology, vol. 16, no. 1-2, 1978, p. 70-82, 13 refs.

Maneuverability in the vertical plane has great importance in performance assessment of high-thrust aircraft. In the paper two basic vertical turning maneuvers are analyzed as minimum-time optimal control problems with terminal constraint. To avoid the complexity of the solution of a TPBVP a reduced order model, based on energy-state approximation, is proposed. This approach is the implementation of the 'maximum maneuver concept' in the vertical plane and leads to the solution of a more simple initial value problem. Moreover, the solution can be expressed in a feedback form, calling for an eventual real-time airborne application. The results of the approximation compare very well to the solution of the original TPBVP. Though the reduced order model identifies only a part of the admissible optimal trajectories, it provides a useful tool to performance comparison and an important insight into the problem of optimal vertical turning maneuvers. (Author)

A79-47099 The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow. C. R. Zorea and J. Rom (Technion - Israel Institute of Technology, Haifa, Israel). (Israel Annual Conference on Aviation and Astronautics, 20th, Tel Aviv and Haifa, Israel, Feb. 22, 23, 1978.) Israel Journal of Technology, vol. 16, no. 1-2, 1978, p. 83-96. 32 refs. Grant No. AF-AFOSR-71-2145.

The paper presents a method for calculating the nonlinear characteristics of wings of rectangular and delta planforms for high down to low aspect ratios in the subsonic speed range. This method can be used to calculate the characteristics of the wings and its wake as a unified system. The numerical calculations are based on the discretization of the vortex sheet into line vortices, and the numerical problems due to this discretization are discussed. Calculations are performed for rectangular wings with aspect ratios of 5.33, 1.0, and 0.25 and for triangular wings with ratios of 1.0, 1.5, and 2.0. The results obtained for the aerodynamic coefficients, the center

of pressure position, the load distribution and the wake characteristics are in good agreement with the experimental results particularly for the rectangular wings. Finally, it is noted that the computer time required is a function of the number of cells into which the wings are divided. M.E.P.

A79-47119 # A method of the theory of airfoil profiles with a jet flap (Ob odnom metode v teorii profilia so struinym zakrylkom). I. T. Selezov and I. E. Kornilov (Akademiia Nauk Ukrainskoi SSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR). *Gidromekhanika*, no. 39, 1979, p. 3-6. In Russian.

Sato (1973) has proposed a discrete vortex method for calculating flows past jet-flapped wings, which is based on classical conformal mapping of the wing into a unit circle. In the present paper, Sato's method is subjected to a rigorous analysis. It is shown that introduction of a certain correction term leads to a shift in the position of the jet and a redistribution of the pressure over the wing, which provide a better agreement with the experiment. V.P.

A79-47302 # High-performance reinforced plastic structures for civil aviation (Les structures hautes performances en plastiques renforcés pour l'aviation civile). M. E. Heitz. *Verre Textile, Plastiques Renforcés,* vol. 17, Mar. 1979, p. 37-45. In French.

A79-47341 \* # Experiments of shock associated noise of supersonic jets. J. M. Seiner and T. D. Norum (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1526. 16 p. 17 refs.

The paper examines the aeroacoustics associated with model nozzles operating supersonically. In particular, the shock structure and radiated shock noise of Mach 1.5 and 2.0 nozzles are compared with those of a convergent nozzle over a wide nozzle pressure ratio range corresponding to a fully expanded Mach number between unity and 2.37. The nozzles were operated unheated both with and without a tab for screech tone suppression. The measurements show differences between the shock cell spacing of convergent and convergent-divergent nozzles, and the scaling relation appears to be a function of the exit-to-throat velocity ratio of each nozzle type. The acoustic measurements indicate the extent of the pressure ratio range where a C-D nozzle achieves a noise reduction benefit. At the design point of the Mach 1.5 nozzle, the total integrated sound power from this nozzle is 6 dB less than a convergent nozzle operating at the same pressure ratio and thrust. (Author)

A79-47342 # Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils. R. Chipman (Grumman Aerospace Corp., Bethpage, N.Y.) and A. Jameson (New York University, New York, N.Y.). American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1555. 10 p. 19 refs.

Numerical difference schemes are presented for the computation of unsteady transonic flows about airfoils. A first-order system of equations in conservation form is developed for irrotational (full potential) flow and solved by finite difference methods. To enable the boundary conditions to be imposed directly on the airfoil surface, a time-varying sheared-rectilinear coordinate transformation is used. Explicit differencing schemes are used to solve both lifting and non-lifting cases. Additionally, an alternating direction implicit (ADI) scheme has been coded for efficient solutions in the non-lifting case. Calculated time-accurate solutions for several cases are compared with the results of other unsteady transonic codes. Good correlation is shown with results produced by the more exact but computationally slower Euler-equations codes. Shock location is demonstrated to be better predicted than by small-perturbation or quasi-conservative schemes. (Author)

A79-47345 # Experimental measurements of shock/ boundary-layer interaction of a supercritical airfoil. K. P. Burdges (Lockheed-Georgia Co., Marietta, Ga.). American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1499. 11 p. 12 refs.

A recent investigation of the shock/boundary-layer interaction region of a state-of-the-art supercritical airfoil in the Lockheed-Georgia Compressible Flow Wind Tunnel is summarized. The test apparatus is a half airfoil model mounted on the floor of the tunnel which provides a boundary layer with proper upstream history from stagnation point through the shock wave to the trailing edge. A four-tube probe traversed the boundary layer in the vicinity of the shock wave. Measurements were made at all flow boundaries to provide boundary conditions for Navier-Stokes calculations of the entire flow field. (Author)

A79-47346 \* # Wing aerodynamic loading caused by jetinduced lift associated with STOL-OTW configurations. U. von Glahn and D. Groesbeck (NASA, Lewis Research Center, Cleveland, Ohio). American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1664. 38 p. 5 refs.

Surface pressure distributions were obtained with model-scale STOL-OTW configurations using various nozzles designed to promote flow attachment to the wing-flap surface. The nozzle configurations included slot-types and both circular and slot nozzles with external flow deflectors. The wing aerodynamic loading caused by the jet-induced lift is presented in conventional terms of delta p/q as a function of chordwise surface distance in the nozzle centerline plane as well as outboard of the nozzle centerline. Included in the geometric variables affecting the wing loading are nozzle roof/ deflector angle, chordwise location of the nozzle, wing size, and flap deflection angle. (Author)

A79-47347 \* # Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control. A. L. Johns, R. C. Williams (NASA, Lewis Research Center, Cleveland, Ohio), and H. C. Potonides (Grumman Aerospace Corp., Bethpage, N.Y.). A/AA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, A/AA Paper 79-1163. 11 p. 5 refs.

A scale model of a V/STOL tilt nacelle fitted to a 0.508 m single stage fan was tested in the NASA Lewis low speed wind tunnel to determine the effect of diffuser blowing on the inlet aerodynamics and aeromechanical performance. The test was conducted over a range of freestream speeds (up to 120 knots) and angles-of attack (up to 120 deg). In general, diffuser blowing had a beneficial affect on all performance parameters. The angle-of-attack range for a separation-free flow substantially increased, and the fan face distortion reduced with a corresponding increase in total pressure recovery. Discrete narrow band blade stress peaks which were common to the nonblowing (baseline) configuration were eradicated with diffuser blowing. V.T.

A79-47348 # New versus existing engines for new helicopter systems - A life cycle cost view. G. I. Walker (General Electric Co., Aircraft Engine Business Group, Lynn, Mass.). AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1316. 6 p.

The use of life cycle cost analysis as a tool for decision making in system selection with respect to new helicopter system development and acquisition is examined. The tradeoff in choosing an existing engine or a completely new engine as a power plant for a new helicopter is studied. Emphasis is given to the analysis of derivative twin versus new twin engines using parameters for disk loading, rotor solidity ratio, rotor tip speed, and equivalent flat plate areas. C.F.W.

A79-47349 # The application of multiple swirl modules in the design and development of gas turbine combustors. B. Jones

(Rolls-Royce, Ltd., Combustion Research Dept., Derby, England). AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1196. 11 p.

The possibility of reducing emissions from gas turbine engines, by means of small swirl modules, is investigated. Attention is given to combustor design variables and the conflicts which arise between factors such as operating cost, engine integrity, short length, and altitude restarting. Design constraints for low emission combustors discussed are: (1) rich primary zone followed by rapid quench, (2) lean primary zone, and (3) fuel staging between two zones each optimized for opposite extremes in the range of operation. Other areas covered are multiple fuel injection modules, and the economic advantages of modular combustors which include simplified test procedure and design modification. In addition, as an example the development of a staged combustor for the Rolls Royce RB.211 engine is described. M.E.P.

A79-47428 # Nozzles for vectored thrust jet engines (Sopla vozdushno-reaktivnykh dvigatelei s otkłoniaemym vektorom tiagi). K. N. Popov, V. D. Sokolov, and N. I. Khvostov. Moscow, Izdatel'stvo Mashinostroenie, 1979. 144 p. 25 refs. In Russian.

The book deals with the gasdynamic design of nozzles for gasturbine-driven VTOL aircraft. The effectiveness of vectored thrust in vertical takeoff and landing is demonstrated. Some representative powerplant systems for VTOL aircraft are examined. V.P.

A79-47433 # Fuels, lubricants and other fluids used in aviation (Aviatsionnye goriuche-smazochnye materialy i spetsial'nye zhidkosti). I. N. Shishkov and V. B. Belov. Moscow, Izdatel'stvo Transport, 1979. 248 p. 18 refs. In Russian.

The properties of fuels, lubricants and other fluids are examined, and their fundamental applications in aviation and groundbased technologies are discussed. Chemical and physical characteristics, production methods and quality control techniques of hydrocarbon fuels for piston and gas turbine engines, including piston engines with spark ignition, piston engines with ignition from compression and jet engines, are considered. The production and properties of motor oils are discussed, with attention given to oils for aircraft piston engines, turbojet engines, turboprop engines, carburetor engines and diesel engines. Consistent greases and solid lubricants are discussed, and cooling, hydraulic, anti-icing and cleaning fluids are examined. A.L.W.

A79-47520 The inner regions of annular jets. N. W. M. Ko and W. T. Chan (University of Hong Kong, Hong Kong). *Journal of Fluid Mechanics,* vol. 93, Aug. 14, 1979, p. 549-584. 31 refs.

Further experiments on the detailed study of annular jets are described in which the mean and fluctuating properties in the inner region have been measured. The experiments in the conical let have shown, besides the jet vortices in the outer mixing region, another train of vortices in the inner region. This train of vortices is due to the wake formed by the boundary layer on the surface of the conical bullet. The experiments in the inner region of the basic annular jet have similar mean velocity profiles to those in the internal recirculating region. Good correlation is found for the location of the vortex center, the location of reattachment, the minimum and maximum mean static pressure and their locations with the nondimensional available pressure Mo/AiPatm for entrainment behind the interface. A train of wake vortices is generated in the internal recirculating region and a train of jet vortices is found in the inner mixing region. Both types of vortices in the inner region seem to decay fairly rapidly within a distance of one outer diameter Do downstream. The disturbances associated with the wake vortices in the inner region seem to excite the outer mixing region. (Author)

A79-47535 # Some early experiments in the development of a flying platform for aerodynamic testing. S. M. Ramachandra (Hindustan Aeronautics, Ltd., Bangalore, India). *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée*, vol. 24, Jan.-Feb. 1979, p. 109-117. The flying aerodynamic platform reported in this paper offers an attractive method of interference free aerodynamic testing using a suitably instrumented airplane or glider as the model carrier. The low cost of glider operation coupled with reasonable operating times and satisfactory model scales makes the flying platform inexpensive for aerodynamic testing and is liable to considerable development.

(Author)

A79-47606 Development of V/STOL aircraft - 1950 to 1970. J. P. Campbell (Joint Institute for Advancement of Flight Sciences, Hampton, Va.). American Helicopter Society, Journal, vol. 24, June 1979, p. 7-16, 14 refs.

In the period from 1950 to 1970 many significant V/STOL aircraft were built and flown and important advances were made in the development of V/STOL technology. This chronological account of V/STOL aircraft starts with the early work on propeller and turbojet vertical-attitude VTOL concepts, and then covers the much more extensive work on horizontal-attitude concepts in separate sections devoted to propeller, turbojet and turbofan, lift-fan, ejector augmentor and rotor V/STOL aircraft. B.J.

A79-47607 V/STOL Technology - Where do we stand. R. F. Siewert (U.S. Navy, Naval Air Systems Command, Washington, D.C.). American Helicopter Society, Journal, vol. 24, June 1979, p. 17-29. 16 refs.

A broad survey of those aspects of the basic airframe technologies that directly impact V/STOL aircraft configurations is presented. Configurations, aerodynamics, structures, propulsion and flight control are addressed. The dominant problem in developing any V/STOL aircraft is to optimally integrate the propulsion system and the airframe to achieve performance consistent with the aircraft mission requirements. Therefore, focus is on hover and low speed flight characteristics including propulsion induced effects, flight control requirements, and the characteristics of propulsion systems as lifting and/or control devices. Based on this survey, and recognizing that while there are still problems that must be solved, it is concluded that in light of the many technological solutions which exist and are constantly being expanded and improved, V/STOL technology is adequate to permit the development of viable and useful V/STOL aircraft. (Author)

A79-47608 \* Recent- V/STOL aircraft designs. W. H. Deckert (NASA, Ames Research Center, V/STOL Aircraft Technology Div., Moffett Field, Calif.). American Helicopter Society, Journal, vol. 24, June 1979, p. 30-37.

The paper reviews the V/STOL aircraft designs pursued by industry from 1971 to 1978, with emphasis on the 1975-1978 period. Consideration is given to those designs pertaining to vertical-attitude and horizontal-attitude V/STOL types. These are divided into such concepts as tilting jet engine, lift/cruise engine, lift/cruise fan, ejector augmentor, tilt rotor, stowed rotor, and rotor wing.

A79-47654 # Developments in gear analysis and test techniques for helicopter drive systems. C. Albrecht (Boeing Vertol Co., Philadelphia, Pa.). American Society of Mechanical Engineers, Design Engineering Conference and Show, Chicago, III., May 7-10, 1979, Paper 79-DE-15. 16 p. 16 refs.

Improvements in helicopter transmission gearing analysis and test techniques have been developed for the high-precision, lightweight gears used on the Heavy Lift, UTTAS and CH-47C and D helicopter drive systems. The use of finite element analyses for performing gear stress and natural frequency calculations: transmission vibration/noise methodology; damage tolerance concepts and failure detection methods are discussed. (Author)

A79-47750 Lifting-line theory for a swept wing at transonic speeds. L. P. Cook (California, University, Los Angeles, Calif.). *Quarterly of Applied Mathematics*, vol. 37, July 1979, p. 177-202. 13 refs. The boundary value problems are derived describing first-order corrections of two-dimensional transonic small disturbance equations to two-dimensional flow about a lifting swept wing at freestream Mach number less than unity. The method of matched asymptotic expansion of the transonic small disturbance equations for x determining the correction is used. The three-dimensional transonic small disturbance theory boundary value problem for a lifting yawed wing is formulated and the methods of Van Dyke and of Cook and Cole for high aspect ratio are examined.

A79-47844 The principles of hovercraft, powering and propulsion. Hovering Craft and Hydrofoil, vol. 18, June-July 1979, p. 10-14.

The principles, history and development of hovercraft are outlined, together with design aspects, resistances, powering and propulsion. Some types of hovering craft are discussed, as well as the historical development of amphibious and nonamphibious craft, and their sealing arrangements such as skirts and sidewalls. In addition, some basic theory is provided for understanding the hovering principle, and the mechanisms by which this is achieved. Finally, lift and propulsive devices are reviewed, as well as their design aspects, resistances acting, and trends.

A79-47845 Gas turbines for ACV's and hydrofoils. Hovering Craft and Hydrofoil, vol. 18, June-July 1979, p. 17-20. Attention is given to the principles of marine gas turbines and their applications in hydrofoils and hovercraft. The turbine gas cycle is discussed along with design features such as single or two shaft

machines, heat exchangers, open or closed cycle preheating, and axial or rotary compressors. Fuels are also covered. Finally, applications for naval boost propulsion, merchant ship propulsion and naval ship propulsion are considered. M.E.P.

A79-47847 Jet propulsion for ACV's and hydrofoils. Hovering Craft and Hydrofoil, vol. 18, June-July 1979, p. 30, 31.

Attention is given to the basic theory and design of waterjet propulsion. Formulas are presented for thrust, waterjet propulsive efficiency, specific speed, and suction specific speed for cavitation. Inlets for waterjets are also discussed, noting three types: (1) ram inlets or scoops, (2) scoop or variable area inlets, and (3) flush inlets (normally on planing hulls). Waterjet applications discussed include the Boeing Jetfoil, the Italian Swordfish, and the American Enterprise. Finally, air jet propulsion is covered, noting that while high velocity turbojets are not suitable for hovercraft speeds and are too noisy, ducting air from the fans to propulsive nozzles at the rear has advantages such as low noise level and the fact that one powerplant serves both lift and propulsion.

A79-47873 # Experimental investigation of helicopter flight modes on helicopter-generated noise (Ersperimental'nye issledovaniia rezhimov poleta vertoletov na sozdavaemyi imi shum). B. N. Mel'nikov (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR). Akusticheskii Zhurnal, vol. 25, May-June 1979, p. 450-453, 5 refs, In Russian.

The establishment of a theoretical relationship between helicopter flight velocity and noise is highly complicated by the complexity of the mechanism of excitation and propagation of helicopter noise and by the multitude of factors that affect the noise. In the experiments described, an attempt is made to establish the noise characteristics and the relationship of velocity to noise for the Mi-2, Mi-6, Mi-8, and Ka-26 helicopters. V.P.

A79-47876 \* # The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane. H. P. Stough, III and J. M. Patton, Jr. (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1786. 13 p. 9 refs.

A fully instrumented, low-wing, single-engine general aviation airplane has been spin tested. Several tail configurations, wing leading-edge modifications, fuselage modifications, moment-ofinertia variations, center-of-gravity positions, and control inputs have been tested to determine their effect on spinning and spin recovery. Results indicate that wing airfoil design can significantly influence airplane spin and recovery characteristics and can overpower the effects of tail design. Results also point out a need to determine limitations of such factors as Reynolds number in model spin test techniques and high angle-of-atack aerodynamics. (Author)

A79-47878 \* # Flight control systems development of highly maneuverable aircraft technology /HiMAT/ vehicle. K. L. Petersen (NASA, Flight Research Center, Edwards, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1789. 20 p. 5 refs.

The highly maneuverable aircraft technology (HiMAT) program was conceived to demonstrate advanced technology concepts through scaled-aircraft flight tests using a remotely piloted technique. Closed-loop primary flight control is performed from a ground-based cockpit, utilizing a digital computer and up/down telemetry links. A backup flight control system for emergency operation resides in an onboard computer. The onboard systems are designed to provide fail-operational capabilities and utilize two microcomputers, dual uplink receiver/decoders, and redundant hydraulic actuation and power systems. This paper discusses the design and validation of the primary and backup digital flight control systems as well as the unique-pilot and specialized systems interfaces. (Author)

A79-47879 \* # Some results from the use of a control augmentation system to study the developed spin of a light plane. T. C. O'Bryan, K. E. Glover (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.), and T. E. Edwards (U.S. Army, Structures Laboratory, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1790.* 9 p.

A control augmentation system consisting of hydrogen peroxide rockets mounted on the wing tips of a light airplane has been developed and used to study spin recovery characteristics. Recovery from spins that were unrecoverable with aerodynamic controls was accomplished in less than one turn at maximum thrust in about three turns at minimum thrust. The rocket system at maximum thrust produced spin recovery characteristics similar to those obtained using a parachute. An advantage of using the control augmentation system on any airplane being used in a spin test program is its capability to demonstrate configuration effects on stall/spin characteristics at very high angles of attack and clearly determine the existence of all possible spin modes. (Author)

A79-47880 # Flight testing the circulation control wing. A. J. Pugliese (Grumman Aerospace Corp., Flight Test Dept., Bethpage, N.Y.) and R. J. Englar (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Bethesda, Md.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1791. 18 p.

The Grumman A-6A was modified and flight tested to demonstrate the high lift and STOL capability of the Circulation Control Wing (CCW) concept, which employs a circular trailing edge blown by engine bleed air. The test program included a ground test series for calibration, adjustment, and checkout of the blowing system, followed by a limited duration flight program to measure blown lift enhancement and resulting STOL improvements. The paper describes the test program, emphasizing flight safety considerations and application of recently developed flight test techniques to accomplish the program's optimistic objectives. Test results are discussed, including the successful demonstration of lift augmentation and significant STOL performance. (Author)

A79-47881 # Compass Cope airframe design history. R. B. Brown (Boeing Commercial Airplane Co., Product Development Div., Renton, Wash.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1792. 10 p.

Preliminary design decisions on the project phase (1971-1973) and flight tests (1973-1974) of the Compass Cope remotely piloted vehicle are discussed. Mission-related decisions are presented along with engine and power plant, wing, landing gear, body, empennage, and flight control design decisions. Wind-tunnel and flight-test results are discussed. It is noted that the podded single-engine airplane arrangement utilized can be considered as a potential standard for future single-engine high-altitude surveillance designs, manned or unmanned. The airframe design features discussed also include a composite and bonded primary structure with maximum use of honeycomb and fiberglass as well as integral wing fuel containment within a honeycomb basic structure. V.T.

A79-47882 # Manned strategic system concepts 1990-2000. C. D. Wiler and D. P. Raymer (Rockwell International Corp., North American Aircraft Group, Los Angeles, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1793. 15 p. Contract No. F33615-77-C-0115.

Manned strategic system concept designs are discussed, requiring the development of new technologies in the areas of aerodynamics, propulsion, structures, controls, and stealth. A total of 34 innovative concepts were prepared using the advanced technologies. Concepts were designed to a strategic 'high-low-low-high' missions, with several exceptions, and can be grouped into four major categories: (1) low-cost simplistic, (2) minimum weight, (3) supersonic penetration, (4) laser defended. The concepts were qualitatively rated to select the best two or three concepts in each category. These remaining candidate concepts were then subjected to a preliminary sizing exercise to select one baseline per category. The baselines were sized, configurated, analyzed, and reconfigurated. V.T.

A79-47883 # Identifying desirable design features for the C-XX aircraft - A systems approach. W. T. Mikolowsky, S. G. Thompson, and E. W. Caldwell (Lockheed-Georgia Co., Marietta, Ga.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1796. 11 p. 14 refs. Contract No. F33615-78-C-0122.

The paper describes Lockheed's approach to the development of information needed to assess pertinent design features of an advanced technology military/commercial transport known as C-XX. The first element is a qualitative assessment that focuses on identifying the most significant features and associated design options, such as basic performance, ground interface, airfield compatibility, cargo compartment, inflight refueling, etc. A quantitative analysis examines the configurational effects of the selected design options as well as their military cost-effectiveness and commercial economics. The results of the analysis were incorporated into the LGA-144-400, the latest version of the baseline aircraft, which serves as a point of departure for the analysis of cargo-compartment height, passenger provisions, service life specification, and other design features. V.T.

A79-47884 # Recent progress in aircraft sink rate measurement. G. E. Clarke and K. L. Merson (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1798. 5 p. Efforts to reduce dependency on manually read emulsion film for determination of aircraft sink rate have resulted in test development of faster and more consistent techniques. The two methods undergoing more extensive development are: (1) onboard doppler radar and (2) laser theodolite tracking. These two methods have been tested concurrently with existing sideline and centerline ballistic camera systems with emphasis on accuracy and time correlation of the various methods. The doppler radar appears to give the best instantaneous sink rate information at touchdown although location on the aircraft can affect overall accuracy. The laser theodolite increases the number of significant parameters that can be monitored in real time by the test engineer permitting immediate confirmation of the most significant landing parameters. (Author)

A79-47885 # An improved method for load survey flight testing. A. Rosende, Jr. (Lockheed-Georgia Co., Marietta, Ga.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1799, 5 p.

In the conduct of load survey flight testing, two methods are generally used to obtain inflight load variations: (1) trims, turns and pushdowns, or (2) roller-coaster maneuvers. In either case, maneuver requirements call for smooth, quasi-static load factor variations with minimum variations in airspeed and altitude. The conduct of these maneuvers often exceeds pilot capability to provide the necessary data quality, and substantial re-flying becomes necessary. A new mechanical method has been developed which produces roller-coaster maneuvers with minimum variation in airspeed and altitude. This paper presents the results achieved using this new system. (Author)

A79-47886 # Dutch roll excitation and recovery techniques on a C-141A Starlifter. R. E. Hart (USAF, Flight Test Center, Edwards AFB, Calif.) and D. G. Picha (U.S. Air Force Academy, Colorado Springs, Colo.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1801. 5 p.

The Air Force has experienced several incidents of severe C-141A Starlifter dutch roll problems at cruise altitude. A test program was implemented to develop dutch roll recovery procedures for use by low time C-141A pilots in all weather conditions. The flight test program consisted of evaluating over 100 dutch roll maneuvers. Pilot ratings using Cooper-Harper scale were used to evaluate various recovery techniques. Procedures arrived at can be used safely by low time pilots. C-141A flight restrictions at high cruise altitude/gross weight combinations were lifted as a result.

(Author)

A79-47887 \* # Some flight data extraction techniques used on a general aviation spin research aircraft. S. M. Sliwa (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1802, 9 p. 11 refs.

Some methods for obtaining flight data from a highly instrumented general aviation spin research aircraft are developed and illustrated. The required correction terms for the measurement of body accelerations, body velocities, and aircraft orientation are presented. In addition, the equations of motion are utilized to derive total aerodynamic coefficients for comparison with model tests and for analysis. Flight test experience is used to evaluate the utility of various instruments and calculation techniques for spin research.

(Author)

A79-47888 # AFFTC parameter identification experience. D. P. Maunder (USAF, Performance and Flying Qualities Branch, Edwards AFB, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1803. 6 p. 5 refs.

An overview of the Air Force Flight Test Center experience with automated parameter identification is presented along with the major results of this with respect to accuracy, contributions of otherwise unobtainable information, cost effectiveness, and problems encountered. During the evaluation of several prototype and production aircraft, classic stability and control maneuvers and stability derivative extraction (STABDEX) maneuvers were conducted. It is noted that test planning can effect a reduction in flight test time, while the total flight test time can be reduced nearly 75% by the application of STABDEX techniques. The ability to model relatively small changes in the aircraft's response characteristics due to changes in the aircraft's shape or configuration is outlined. V.T.

A79-47889 # New materials for future commercial aircraft. D. T. Lovell and R. V. Carter (Boeing Commercial Airplane Co., Seattle, Wash.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1804. 5 p.

New structural graphite-epoxy composites and aluminum alloys will be used on new model commercial airplanes built during the 1980's. The graphite-epoxy composite system will be used for the principal flight control structures; i.e., elevators, rudder, and ailerons, with weight savings exceeding 30% in some components. The new aluminum alloys will be used for primary structures; i.e., upper and lower wing skins and stiffeners with strength improvements from 5% to 12%. The graphite-epoxy composite system will be reviewed with emphasis on design for environmental durability. A review of the aluminum alloy material and durability characteristics will be given. (Author)

A79-47890 # Design of advanced titanium structures. C. A. Paez and R. Gordon (Grumman Aerospace Corp., Bethpage, N.Y.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1805, 12 p. Contract No. F33615-77-3109.

An application of. superplastic forming/diffusion bonding (SPF/DB) techniques to a Mach 2.0-class aircraft (ATS/BLAST) is discussed. Consideration is given to high-temperature environment due to aerodynamic and engine heating; loads and dynamic analyses; fracture mechanics analyses of SPF/DB structures; detail design of major components; and concept evaluation. Emphasis is placed on maintainability and reliability assessment and weight and cost analyses of advanced concepts. Optimization techniques, joint details, and design/process/tooling interactions are outlined. Attention is given to potential problem areas and future applications of this new design/fabrication method.

A79-47891 \* # Design development of an advanced composite aileron. C. F. Griffin (Lockheed-California Co., Burbank, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1807. 8 p. Contract No. NAS1-15069.

This paper summarizes the design development of an advanced composite inboard aileron for the L-1011 commercial transport aircraft. Design details of the composite aileron are reported. Results of tests which substantiate the structural integrity of the design are also presented. The composite aileron is a multi-rib assembly with graphite/epoxy tape-syntactic core sandwich covers, a graphite/epoxy tape front spar, and graphite/epoxy fabric ribs. This structure is a direct replacement for the current metal aileron with a weight savings of 28.7 percent (40.3 lb.). Engineering cost estimates indicate that the composite structure will be cost competitive with the metal structure it is replacing. (Author)

A79-47892 # Simplified analysis spectrum for joints exposed to complex continuously varying stresses. B. M. Shah (Lockheed-Georgia Co., Marietta, Ga.). American Institute of Aero-

nautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1808. 6 p. 9 refs. USAF-supported research.

The stress response of aerospace structures to continuous in-flight turbulence is a complex series of axial/shear stress timehistories which have random phasing relationships. Analytically simplified simulation to obtain durability estimates of 'real-world' experience has been a challenge in-so-far as obtaining reasonably accurate representation. Due to the complexity of this phasing problem no unified analytical simulation spectrum has been testverified as representative for durability evaluations of the actual experience. An available empirical procedure of defining discrete axial-shear stress phasing relationships is utilized in this paper to develop an equivalent analytical representation spectrum that can be utilized for flight-by-flight durability analyses and tests of structural joints. The essential features of the equivalent spectrum are: axial-shear stress phasing relationships; lo-hi sequence within a mission segment; application of infrequently occurring stresses; and mission segment-to-segment transitions. Test verification in terms of rate of crack growth demonstrates excellent correlation between the real-world axial-shear stress histories and the derived equivalent analytical representative stress spectrum. (Author)

A79-47893 \* # The nonaxisymmetric nozzle - It is for real. F. J. Capone (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1810. 18 p. 82 refs.

A review is made of the current status of the nonaxisymmetric nozzle from a technology standpoint. Some of the potential payoffs attributed to this class of nozzles installed on twin-engine high performance fighter aircraft are addressed. These payoffs include a reduction in cruise drag through improved integration and an increase in aircraft maneuverability and agility through the application of thrust vectoring and reversing. Improved takeoff and landing characteristics also are expected through the use of thrust vectoring and reversing. Stealth and survivability aspects of the aircraft can be increased through a reduction of nozzle infrared signature and radar cross section. (Author)

A79-47894 # Performance evaluation of an air vehicle utilizing non-axisymmetric nozzles. J. A. Laughrey (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), D. J. Drape, and P. E. Hiley (McDonnell Aircraft Co., St. Louis, Mo.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1811, 12 p. 5 refs.

An extensive non-axisymmetric nozzle design and performance data base was utilized to evaluate the performance of a vehicle designed for an air-to-air mission. Performance was evaluated through comparative sizing analysis for selected non-axisymmetric nozzle installations versus a baseline axisymmetric nozzle installation. The non-axisymmetric nozzle/vehicle with a single external expansion ramp was found to be lighter in takeoff gross weight (TOGW) than the axisymmetric baseline. The lighter TOGW was due primarily to the low weight and low installation drag of the non-axisymmetric nozzle, plus the use of thrust vectoring for reduced drag at the transonic maneuver condition used for engine sizing. (Author)

A79-47895 \* # Historical development of worldwide supersonic aircraft. M. L. Spearman (NASA, Langley Research Center, Aeronautical Systems Div., Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1815. 15 p.

Aerodynamic problems in the development of supersonic aircraft, their solutions, and innovative design features are presented. Studies of compressibility, introduction of jets, supersonic phenomena, transonic drag and lift, longitudinal and directional stability, dynamic pressure fields, and advent of the supersonic fighter are discussed. The flight research aircraft such as the Bell X-1 and the Douglas-558, the century series models, reconnaissance aircraft, the multimission tactical fighter, and the current generation fighters such as F-16 and F-18 are described. The SCAT program is considered, along with supersonic developments in Great Britain, France, and USSR. It is concluded that the sonic boom still appears to be an inherent problem of supersonic flight that particularly affects overland commercial flight, and efforts continue for increased efficiency for economic and performance gains and increased safety for military and civilian aircraft. A.T.

A79-47896 # From HiMAT to future fighters. M. R. Robinson and S. M. Silverman (Rockwell International Corp., North American Aircraft Div., Los Angeles, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1816. 8 p. 6 refs.

The NATO/U.S. Air Force requirements call for highperformance aircraft, in substantial numbers, and at a low unit cost. The objectives of the HiMAT (Highly Maneuverable Aircraft Technology) program are to investigate and demonstrate in-flight high-risk interdisciplinary technologies as applied to a high-performance fighter design at the lowest possible price. These technologies form the basis for other advances in high-performance aircraft design. Forward swept wing (FSW) is one of the more promising concepts in this category. Several technologies that are common to both programs are outlined: aerodynamics and aeroelastic tailoring, advanced structures, and close-coupled canards. These and control systems and low observables will dictate the specific concepts and combat characteristics that can be attained for future fighters. V.T.

A79-47898 \* # Radar cross section fundamentals for the aircraft designer. H. A. Stadmore. American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1818. 10 p. 8 refs. Research supported by the Grumman Aerospace Corp. and NASA.

Various aspects of radar cross-section (RCS) techniques are summarized, with emphasis placed on fundamental electromagnetic phenomena, such as plane and spherical wave formulations, and the definition of RCS is given in the far-field sense. The basic relationship between electronic countermeasures and a signature level is discussed in terms of the detectability range of a target vehicle. Fundamental radar-signature analysis techniques, such as the physical-optics and geometrical-optics approximations, are presented along with examples in terms of aircraft components. Methods of analysis based on the geometrical theory of diffraction are considered and various wave-propagation phenomena are related to local vehicle geometry. Typical vehicle components are also discussed, together with their contribution to total vehicle RCS and their individual signature sensitivities. V.T.

A79-47900 \* # Full-scale wind tunnel study of nacelle shape on cooling drag. V. R. Corsiglia, J. Katz (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 Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1820, 10 p. 7 refs.

Tests were made in the NASA-Ames 40- by 80 Foot Wind Tunnel of a wing semispan with a nacelle (no propeller) from a typical, general aviation twin-engine aircraft. Measurements were made of the effect on drag of the cooling air flow through the nacelle. Internal and external nacelle pressures were measured. It was found that the cooling flow accounts for about 13% of the estimated airplane drag and about 42% of the cooling flow drag is associated with the internal flow. It was concluded that improvements could be made by relocating both the inlet and the outlet of the cooling air.

(Author)

A79-47901 # Real time weather display in the general aviation cockpit. G. M. Kirkpatrick (GMK Consulting Services, North Syracuse, N.Y.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1821. 4 p.

Weather radar is currently available for installation in many general aviation aircraft including the single engine category. The voice channels of the VOR navigation facilities might be used for narrow-band digital transmission. Airborne radar can be expected to be complementary to the relayed radar charts, since the airborne units are partially able to overcome the limitations created by the curvature of the earth and can provide a closeup view of severe weather for penetration flight paths. The cost of digital storage and processing circuitry has decreased in recent years to the extent that the display, when used with an existing VOR receiver should cost less than an airborne weather radar. S.D.

A79-47902 # A cheap, effective icing detector for general aviation aircraft. J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.) and D. Manor. American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1823. 6 p.

A icing detector device that measures near instantaneous ice buildup on aircraft wings is presented and various wind tunnel and flight tests are studied. Existing de-icing techniques and ice detectors such as a differential pressure type sensor, a beta radiation detector, and vibrating rods are examined and it is found that these devices are not only expensive but, due to their mechanical or electrical systems, they are very undependable. A probe, consisting of a streamlined extruded tubing, with a 1 inch width, 2.4 inch chord and 6 inch height, was tested at the VPI wind tunnel and then on a flight in 8000 ft during rime icing conditions. Results showed that the ice detector system employing a pilot-static device was found to be accurate, reliable and inexpensive. C.F.W.

A79-47903 # Engine-aircraft afterbody interactions -Recommended testing techniques based on YF-17 experience. A. E. Fanning (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and E. J. Lucas (ARO, Inc., Arnold Air Force Station, Tenn.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1829. 12 p. 8 refs.

The fundamental technical aspects of interactions between propulsion system flows and external aerodynamics are discussed. Installation losses are identified as deviation of these interactions from idealized values. The objectives and approach of an effort to reduce the uncertainties introduced by the methods used to predict these losses are presented. The test techniques used during this effort are presented with data to substantiate their validity. The results of testing two different scale, wind tunnel models are used to define the effects of characteristic Reynolds number and model scale. The techniques used to correct wind tunnel data to free flight conditions are presented and the results compared to flight test data. Comparisons of surface static pressure distributions and integrated axial pressure forces are included. Based on these comparisons, recommendations are made. (Author)

A79-47904 # Benefits of aerodynamic interaction to the three surface configuration. J. W. Agnew and J. R. Hess, Jr. (McDonnell Aircraft Co., St. Louis, Mo.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1830. 9 p.

The three-surface configuration and active flight controls will permit the next generation of fighter aircraft to capitalize on the performance and maneuverability benefits of horizontal canards while retaining the stability and control advantages of horizontal tails. Recent wind tunnel data for a contemporary fighter, with a close-coupled horizontal canard added, are presented with emphasis on demonstrating the beneficial aerodynamic interaction of the canard with the wing, empennage, and other aircraft control surfaces. These data show that a properly configured three-surface configuration can provide significantly increased performance and an effective six-degree-of-freedom maneuvering capability. (Author)

A79-47905 # Winglet toe out angle optimization for the Gates Learjet Longhorn Wing. N. E. Conley (Gates Learjet Corp., Wichita, Kan.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1831. 8 p. 9 refs.

The Gates Learjet Model 28 Longhorn was the first turbojet to be certified with winglets. It has now been joined by the stand-up cabin Model 55 in applying NASA advanced technology to American business jet aircraft. This paper describes the effect of tailoring toe out (incidence) angle for best winglet performance. A winglet with little or no twist must be toed out to reduce separation at the root on the upper surface because of the large inflow angles near the upper surface of the wing at the tip. The need for toe out disappears rapidly with radial distance from the chord of the wing tip due to the reduction in local flow angles to free stream flow angles. Results of wind tunnel testing, computational aerodynamic methods and flight testing will be presented and their relative merits weighed. Some criteria for useful winglet design will be suggested. (Author)

A79-47906 # All electric subsystems for next generation transport aircraft. J. W. Phillips (Lockheed Georgia Co., Flight Sciences Div., Marietta, Ga.) and N. E. Wood (AiResearch Manufacturing Company of California, Torrance, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1832, 12 p.

A technology assessment study conducted to evaluate the applicability of an all-electric airplane concept to transport aircraft is presented. The study compared two all-electric variations of the Lockheed medium advanced transport aircraft (ATA) with the existing ATA that utilizes advanced structures, aerodynamics, and engines, but conventional secondary power systems. The results of reconfiguration tradeoff studies conducted on the primary and secondary plower generation and distribution, and the landing-gear brakes are considered. Maintainability, reliability, and weight analyses are outlined. V.T.

A79-47907 # The Beech Model 77 'Skipper' spin program. M. L. Holcomb (Beech Aircraft Corp., Wichita, Kan.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1835. 7 p. 7 refs.

An economical 2-place general aviation airplane has been developed for pilot training, including developed spins up to 6 turns. The aerodynamic design of the airplane incorporates many features aimed at providing for adequate spin and spin recovery characteristics. To verify early in the development program that the airplane would have acceptable spin characteristics both free flight radiocontrol model and spin tunnel tests were employed. This was followed by comprehensive full scale airplane flight tests which resulted in certification for the FAA 6-turn acrobatic spin requirement. (Author)

A79-47908 \* # Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane. D. J. DiCarlo and J. L. Johnson, Jr. (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1837. 15 p. 11 refs.

A wide variety of model and airplane tests were conducted to explore the effects of wing leading-edge modifications on the stalling and spinning characteristics of a low-wing general aviation research airplane configuration. The results presented herein discuss the effects of leading-edge airfoil modifications applied to the full wing span and to partial-span locations. The results obtained in the study indicate that the wing modifications can produce large effects (both favorable or unfavorable) on spin resistance, developed spin characteristics, and spin recovery. (Author)

A79-47909 # Design of the circulation control wing STOL demonstrator aircraft. R. J. Englar, R. A. Hemmerly (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Bethesda, Md.), W. H. Moore, V. Seredinsky, W. Valckenaere, and J. A. Jackson (Grumman Aerospace Corp., Bethpage, N.Y.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1842. 12 p. 9 refs.

A testbed aircraft design and modification and a flight demonstration program have been conducted to confirm the short takeoff and landing characteristics of the circulation-control-wing (CCW) concept on an A-6A flight demonstrator. Wind tunnel, engine bleed, and flight tests investigations have verified that the test aircraft can double the lifting capabilities of the A-6A by using existing bleed flow. A trimmed lift coefficient of 3.60 produced a 67-knot airspeed for the demonstrator, and indicated that maximum lift coefficients predicted by tunnel results were obtainable by the manned aircraft. The program's proof-of-concept objectives are accomplished, and the potential payoffs of a CCW-configurated high-performance naval aircraft are identified. S.D.

A79-47910 # Geometric data transfer. W. L. Howard (Rockwell International Corp., El Segundo, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1844. 5 p.

Coordination of an engineering-manufacturing agreement as to data format, procedures, and schedules for geometric data transfer within two separate companies is shown. Consideration is given to the methods used in gaining agreement, examples of problems overcome, and procedures used to document and implement solutions. Sample model drawings were constructed and then redrawn several times in accordance with requirements of design management and manufacturing. Manual drawing release and automated drawing release are discussed with emphasis placed on the use of the CADAM model. V.T.

A79-47911 # Engineering and manufacturing communication via the computer data base. E. N. Nilson (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1845. 8 p. 12 refs.

The most substantial reductions in lead time and cost to be realized across the design/manufacturing interface come from integrated interactive CAD/CAM. The computer data base performs the fundamental communication function. The present status of this technology, the extent of its utilization, its implementation, examples of applications, potential benefits to be derived, implementation, roblems and solutions, and the developing CAD/CAM technology are the subject of this paper. (Author)

A79-47912 # CADAM data handling from conceptual design through produce support. S. J. Smyth (Lockheed California Co., Burbank, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1846. 8 p.

The use of interactive computer graphics for data handling in aircraft design, manufacturing, and product support is discussed. The

software used is the Lockheed Computer-Graphics Augmented Design and Manufacturing (CADAM) system and the IRAD program CADATA. CADAM provides a common data base of the selected vehicle design for all user disciplines: preliminary design, loft, production design, tool design, numerical control part programming, quality control, and product support. Examples of the use of CADAM and CADATA are given to illustrate the cost savings and reduced time spans achieved. V.T.

A79-47913 \* # The characteristics of a lift cruise fan V/STOL configuration in near proximity to a small deck with finite edge positions. V. R. Stewart (Rockwell International Corp., Columbus, Ohio). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1854. 8 p. NASA-supported research.

Two V/STOL model configurations utilizing lift-cruise-fans for the propulsion system have been tested in the presence of a small landing platform with finite deck edge positions. Results and analysis of these tests are presented. The model was tested at both static (zero velocity) and forward speed conditions with several heights and deck edge positions. Configurations utilizing three fans and four fans were investigated. Incremental forces and moments induced by the various deck edge positions are analyzed as relating to the model height above the ground and the thrust velocity relationships. The test and analysis show the induced forces to be relatively unaffected by deck edge. (Author)

A79-47914 \* # Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system. M. D. Betzina (NASA, Ames Research Center, Moffett Field, Calif.) and R. Kita (Grumman Aerospace Corp., Bethpage, N.Y.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1855, 11 p.

One possible technique for obtaining longitudinal control on a tilt-nacelle V/STOL aircraft is the use of a variable attitude vane assembly mounted in the propulsion system exhaust. Deflecting the vane produces large forces and moments without depending on forward speed of the aircraft. Tests are carried out in the Ames 40 by 80 ft wind tunnel on a large-scale tilt-nacelle V/STOL propulsion system with and without a variable attitude control vane assembly. Aerodynamic characteristics are analyzed in terms of nacelle aerodynamics, vane aerodynamics, and vane-induced effects on the nacelle aerodynamics. It is shown that the aerodynamic forces due to the nacelle without the vane can be a significant part of the total forces produced by the propulsion system. The control vane effectively produces large changes in pitching moment which are accompanied by significant changes in total lift and drag. The vane has a substantial effect on the propulsion-system aerodynamics. Other pertinent results are also given. S.D.

A79-47918 \* # Energy efficient aircraft engines. R. Chamberlin and B. Miller (NASA, Lewis Research Center, Energy Conservative Engines Office, Cleveland, Ohio). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1861. 11 p.

The three engine programs that constitute the propulsion portion of NASA's Aircraft Energy Efficiency Program are described, their status indicated, and anticipated improvements in SFC discussed. The three engine programs are: (1) engine component improvement, directed at current engines, (2) energy efficient engine, directed at new turbofan engines, and (3) advanced turboprops, directed at technology for advanced turboprop-powered aircraft with cruise speeds to Mach 0.8. Unique propulsion system interactive ties to the airframe resulting from engine design features to reduce fuel consumption are discussed. Emphasis is placed on the advanced turboprop since it offers the largest potential fuel savings of the three propulsion programs and also has the strongest interactive ties to the airframe. (Author) A79-47919 # Air buoyant vehicles - Energy efficient aircraft. V. H. Pavlecka (Airships International, Inc., Tustin, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1862. 7 p.

Energy and overall economic considerations of airplane and two airships in terms of a cost intensity parameter indicate that Metalclad airships can now be constructed and operated with an economic superiority to wide-body jet transports. Comparisons are based on computer printouts of actual flights of 747F and on design studies of MC-80 and MC-100. B.J.

A79-47920 # Laminar flow stabilization by surface cooling on hydrogen fueled aircraft. J. G. Theisen (Lockheed-Georgia Co., Marietta, Ga.), G. D. Brewer, and L. R. Miranda (Lockheed-California Co., Burbank, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1863. 12 p. 30 refs. Research supported by Lockheed-California Independent Research and Development Funds.

The feasibility of delaying the transition from laminar to turbulent flow over aerodynamic surfaces by cooling those surfaces, to decrease friction and increase fuel economy of aircraft, is discussed. For the 'energy crisis', hydrogen is being considered as an alternate fuel, so its cryogenic properties may be used for cooling below the 280 deg R known to stabilize boundary layers. Equations for the stability analysis of a two-dimensional, compressible, laminar boundary layer are presented, including heat transfer and adverse pressure gradient effects which constitute the principal new technological contribution of this study, for near-cruise flight. Preliminary systems analysis for an advanced commercial transport shows drag reductions near 27% and lower direct operating costs (DOC) by over 21%. (Author)

A79-47921 \* # The aerial relay system - An energy-efficient solution to the airport congestion problem. A. C. Kyser (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1865. 23 p. 7 refs.

The aerial relay system concept, which was developed as a means of exploiting inflight transfer, utilizing large 'cruise liner' aircraft that fly continuously along their routes and dock periodically with short-haul 'feeder' aircraft for payload exchanges, is discussed. The system employs two distinctly different kinds of aircraft, one for takeoff and landing and one for cruising, with provisions for the routine inflight transfer of passengers, baggage, fuel, etc. The liner design consists of a module of 320 ft span and 80 ft chord with an 800 seat capacity and capable of cruising at 0.75 M, while the feeder is a relatively conventional short-haul transport aircraft with a modified fuselage to accommodate special docking and transportation operations. It is concluded that this concept could alleviate present inadequacies in an extremely cost-effective and fuel-efficient way, and could be expanded indefinitely to become a high-quality, high-capacity national system. C.F.W.

A79-47923 # F-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives. W. A. Moch (General Dynamics Corp., Fort Worth, Tex.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1868. 7 p.

The paper surveys the F-16 Avionics Interim Contractor Support (AICS) and the Avionics Intermediate Shop (AIS) which it supports. Aspects of the AIS discussed include the maintenance concept, a hardware description, F-16 AIS integration testing, and an F-16 AIS development/production plan. Attention is given to the AICS background and program objectives which address the needs of concurrent development and support in the face of such problems as schedules, avionics configuration changes, changing customer requirements, etc. Other areas covered include the planned phase-in of customer personnel, and the reliability improvement warranty (RIW). M.E.P.

A79-47924 \* # High-performance wings with significant leading-edge thrust at supersonic speeds. A. W. Robins and H. W. Carlson (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1871. 6 p. 11 refs.

A new class of curved-leading-edge wings with which significant levels of leading-edge thrust may be achieved at moderate supersonic speeds is suggested. A recent analysis of the factors limiting such leading-edge thrust has led to a new method for the prediction of attainable leading-edge thrust from subsonic through supersonic speeds for wings of arbitrary planform. Recent supersonic tests of a new wing shape, which largely meets design criteria given by the new prediction method, give evidence of significant levels of leading-edge thrust. The consequent unusually high levels of aerodynamic performance should renew interest in supersonic-cruise vehicle design in general and in cruise-speed selection in particular. (Author)

A79-47925 # Aerodynamics of spoiler control devices. M. D. Mack, H. C. Seetharam, W. G. Kuhn, and J. T. Bright (Boeing Commercial Airplane Co., Flight Controls Technology Research Group, Seattle, Wash.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1873. 19 p. 28 refs.

Experimental and computational studies of the aerodynamics of spoilers are discussed. Aerodynamic nonlinearities and dead bands are described, scale effect problems shown, and a preliminary design method reviewed. Two-dimensional experimental data for single- and multi-element airfoils with spoilers is presented. Details of the wake behind a spoiler and spoiler induced tail buffet are discussed. Computational results for an airfoil with deflected spoiler are presented. The separation of the turbulent boundary layer ahead of the spoiler's hinge line and reattachment on the face of the spoiler, and calculation of the flow around a multi-element airfoil with a spoiler are discussed. (Author)

A79-47926 # Boundary layer control on wings using sound and leading edge serrations. F. G. Collins (Tennessee, University, Tullahoma, Tenn.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1875. 11 p. 25 refs. NSF Grant No. GK-42133.

Three techniques for improving the lifting characteristics of low speed wings were experimentally examined in a wind tunnel, namely leading edge serrations, external sound, and sound emitted through periodically spaced holes near the wing leading edge. Serrations increased the lift curve slope by 12% for an NACA 0015 airfoil and 22% for an NACA 2412 airfoil (chord Reynolds numbers to 6 x 10 to the 5th). Drag was not measurably increased by the serrations. Sound of certain frequencies emitted from periodically spaced holes could reattach stalled flow and suppress stall-flutter. External sound also improved the airfoil stall characteristics. (Author)

A79-47928 # Flow patterns and aerodynamic characteristics of wing with strake. L. Mou-Jie (Peking Institute of Aeronautics and Astronautics, Peking, Communist China). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1877. 12 p. 14 refs.

Surface oil flow visualizations, force tests and pressure measurements were conducted at low, transonic and supersonic speeds. Four flow types of a wing with strake at low speed have been found. The surface flow is affected and controlled mainly by the formation, development and breakdown of the strake vortices. The differences in flow patterns are reflected in the force and moment results. The lift increment comes from the effect of the strake vortex not only on the inner panel but also on the outer panel. The causes of the nonlinear variation of the pitching moment and ways of reducing it are discussed. The lift increment is decreased with an increase in Mach number at transonic speeds, primarily because the flow over the wing without strake changes from leading-edge separation to leading-edge attached flow with shock-induced separation. An increase in the lift-drag ratio is due to the lift increase at low speed and the drag decrease at supersonic speeds. (Author)

A79-47939 Predictive guidance for interceptors with time delays. C. Hecht (Aerospace Corp., Guidance Analysis Dept., El Segundo, Calif.) and A. Troesch (Southern California, University, Los Angeles, Calif.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 88-94. 5 refs. Contract No. F4701-77-C-0078.

Predictive guidance equations for systems with time delays are developed using optimal control theory to obtain interceptor steering gains. Previously, predictive guidance and proportional navigation, which are essentially the same, employed a steering policy based on instantaneous interceptor response. In this paper the time response of the interceptor is approximated by a linear first order time lag, and the optimal steering gain is evaluated using a quadratic penalty function. The optimal control for interception is determined to be a linear function of the predicted position error and the acceleration error. The gains are functions of only the time-to-go and the interceptor time constant. An application with computer simulations is included for interception of a non-maneuvering target. The simulations demonstrate a significant improvement of interceptor performance using the optimum gains in comparison to the conventional gain of proportional navigation. (Author)

A79-47943 Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack. R. K. Mehra and J. V. Carroll (Scientific Systems, Inc., Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 186-192. 15 refs. Contract No. N00014-76-C-0780.

Aircraft dynamic behavior at high angles of attack is highly nonlinear and, in the past, there has been a lack of suitable techniques for analyzing the global behavior of nonlinear systems. In this paper, an approach based on bifurcation analysis and catastrophe theory methodology (BACTM) has been applied to specific jump, hysteresis and limit cycle phenomena such as roll-coupling, pitch-up, wing rock, buffeting, departure and divergence. Four different aircraft have been considered for comparison purposes, and it has been shown how different types of instabilities and families of limit cycles arise as the control variables are varied. A complete representation of the aircraft equilibrium and bifurcation surfaces is given in a nine-dimensional space consisting of velocity, roll rate, pitch rate, yaw rate, angle-of-attack, sideslip angle, elevator, aileron and rudder deflections. The use of BACTM for understanding spin entry, spin prevention, spin recovery and stability augmentation at high angles of attack are also discussed. (Author)

A79-47957 Estimation for advanced technology engines. F. A. Farrar and G. J. Michael (United Technologies Research Center, East Hartford, Conn.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 342-347. 8 refs. Contract No. N00014-76-C-0710. An estimation algorithm for nonlinear transient operation of multivariable gas turbine engines was developed and evaluated. Kalman methodology and model-mismatch compensation procedures were employed in defining the filtering logic. The estimation algorithm was evaluated by application to noise-corrupted measurement data generated by a nonlinear digital dynamic F100/F401 engine simulation. Estimation of unmeasurable as well as measurable key engine variables from (1) nominal-engine data, (2) degraded-engine data, and (3) engine data with off-nominal noise statistics was evaluated. Results obtained indicate that the nonlinear estimation algorithm provides a viable approach to estimating key engine variables under realistic operating conditions. (Author)

A79-47959 \* Nonlinear decoupled control synthesis for maneuvering aircraft. S. N. Singh (Santa Maria, Universidade Federal, Santa Maria, Brazil) and A. A. Schy (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 360-370, 14 refs.

A control law for decoupling roll rate, angle of attack and sideslip in rapid, nonlinear airplane maneuvers is derived. For simplicity, only moments caused by ailerons, rudder and elevator are considered, and control forces are neglected. Simulated responses of the closed loop system, including the control forces, show that the neglected forces have no significant effects and that large, simultaneous lateral and longitudinal maneuvers can be precisely performed. The violent divergences which occur in open-loop maneuvers of this type are eliminated by the decoupling. The control law showed little sensitivity to 20 percent perturbation in three important stability derivatives. (Author)

A79-47960 Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft. E. Y. Shapiro and H. E. Decarli (Lockheed California Co., Burbank, Calif.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 371-376. 5 refs.

The implementation and flight test results of an analyticredundancy approach employing operational sensors to reconstruct signals of failed sensors is described. This method evolves from the concept of Luenberger Observers. The system is intended for use in a dual or triple redundant environment, and takes maximal advantage of all existing functional and dynamic relationships among the variables sensed by dissimilar sensors. In this paper a brief discussion on the use of Luenberger Observers as a means for the attainment of analytic redundancy is provided. The structure and parameters of the failed sensor signal-reconstructor is developed. Flight test data of the Lockheed L-1011 aircraft are exhibited. (Author)

A79-47961 The enhancement of aircraft parameter identification using linear transformations. K. S. Govindaraj and E. G. Rynaski (Calspan Advanced Technology Center, Buffalo, N.Y.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 377-384. Research supported by Calspan Corp.

An approach is developed to identify the equations of motion of an aircraft using linear transformations. The equations of motion are transformed into the phase variable form, the identification is carried out in the phase variable domain and transformed back into the equations of motion form to get the stability and control derivatives. This identification procedure is very useful for the identification of the stability and control derivatives of an aeroelastic airplane. The accuracy of stability and control derivatives obtained through a phase variable transformation is verified by comparing the results of this procedure with the results obtained from the identification in the equations of motion form for the same data on the USAF Total In-Flight Simulator (TIFS). The phase variable method of identification was felt to yield results as accurate as the results obtained from the identification in the equations of motion form. (Author)

A79-47962 \* A multiple objective optimization approach to aircraft control systems design. D. Tabak, A. A. Schy, K. G. Johnson (NASA, Langley Research Center, Hampton, Va.), and D. P. Giesy (NASA, Langley Research Center; Vought Corp., Hampton, Va.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 385, 386.

The design of an aircraft lateral control system, subject to several performance criteria and constraints, is considered. While in the previous studies of the same model a single criterion optimization, with other performance requirements expressed as constraints, has been pursued, the current approach involves a multiple criteria optimization. In particular, a Pareto optimal solution is sought.

(Author)

A79-47971 Failure detection in signal processing and sensing in flight control systems. R. Onken and N. Stuckenberg (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 449-454.

For the signal processing part of a flight control system a definition of the system integrity function is given in order to enable comparative evaluation of different design approaches with respect to the system integrity and mission survival. Two main failure detection methods are analytically investigated, the passive failure detection. And the selfdiagnosing active failure detection. For the sensing part of a flight control system a sensor failure detection and elimination concept is presented, based on doubled sensors and deterministic observers. This system equals the fail-operational properties of a triplex-system. (Author)

A79-47987 # Estimation of aircraft target motion using pattern recognition orientation measurements. J. D. Kendrick (USAF, Technical Applications Center, Patrick AFB, Fla.), P. S. Maybeck, and J. G. Reid (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics

Engineers, Inc., 1979, p. 953-959. 16 refs.

A new approach to estimating motion of a highly maneuvering aircraft target in an air-to-air tracking scenario is presented. An interactive filter system is developed which provides an improved estimate of target motion states by conditioning kinematic filter estimates upon target aspect angle data. Pattern recognition techniques used with an electro-optical tracker are presumed to provide this target aspect information. A target orientation filter processes the aspect angle measurements by statistically weighting measured aspect angles with the current best estimate of target kinematics. The aerodynamic lift equation is used to relate approximate angle of attack to target velocity and acceleration. A novel statistical model for aircraft target normal acceleration is also developed to better represent unknown target accelerations. Simulation results of realistic three-dimensional scenarios are presented to evaluate the performance of the interactive filter system. (Author)

A79-47991 \* Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization. R. B. Washburn, R. K. Mehra, and S. Sajan (Scientific Systems, Inc., Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 983-990. 13 refs. Contract No. NAS1-15113. The singular perturbation theory (SPT) approximation of optimal feedback control laws is presented and methods for on-line application of these approximations are discussed. It is demonstrated that SPT control laws break down when the current state is near the terminal target state. The use of continuation methods to improve the accuracy of the SPT approximation and to obtain global solutions of two-point boundary value problems is also discussed. As an illustration, consideration is given to the minimum-time control of a supersonic aircraft for a three-dimensional intercept problem. B.J.

A79-48000 \* Digital adaptive control laws for VTOL aircraft. G. L. Hartmann and G. Stein (Honeywell Systems and Research Center, Minneapolis, Minn.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1103, 1104. Contract No. NAS1-14921.

Honeywell has designed a digital self-adaptive flight control system for flight test in the VALT Research Aircraft (a modified CH-47). The final design resulted from a comparison of two different adaptive concepts: one based on explicit parameter estimates from a real-time maximum likelihood estimation algorithm and the other based on an implicit model reference adaptive system. The two designs are compared on the basis of performance and complexity.

B.J.

A79-48051 A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements. R. L. Pope and R. E. Dudley (Weapons Research Establishment, Salisbury, Australia). Aeronautical Journal, vol. 83, June 1979, p. 224-229. 6 refs.

A free flight testing technique for missiles is presented, together with the results of a preliminary test. The technique consists of firing a projectile across a field and monitoring the trajectory with three ballistic cameras sited downrange. The simplicity and low cost are stressed, noting that the output from the experiments repays the resources used to carry out the trial and data analysis. It is concluded that results from the initial test of the trial technique and the data analysis show that the method is feasible and accurate estimates of aerodynamics parameters can be obtained. M.E.P.

A79-48052 Aircraft longitudinal motion at high incidence. A. W. Babister (Glasgow, University, Glasgow, Scotland). *Aeronautical Journal*, vol. 83, June 1979, p. 230-232.

The paper studies longitudinal symmetric motion of constant speed and height and determines simple control laws for an autopilot which would prevent a superstall occurring. An equation is presented for pitching motion and analysis with fixed elevator and T-tailed aircraft is made. Finally, the prevention of superstalled flight is discussed and it is concluded that a simple linear feedback control can be used to prevent superstalled flight. M.E.P.

A79-48311 # Handbook on aircraft materials and their application technology (Spravochnik po aviatsionnym materialam i tekhnologii ikh primeneniia). V. G. Aleksandrov and B. I. Bazanov. Moscow, Izdatel'stvo Transport, 1979. 263 p. 18 refs. In Russian.

The handbook covers characteristics and properties of steels, nonferrous materials, bearings, plastics, adhesives, elastomeric and textile materials, and leather. Sealing and gasketing materials, fuel filters, varnish coatings, fuel, lubricants, and hydraulic fluids are covered. Various materials used in aircraft and safety methods are described. A.T.

A79-48495 Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics. P. P. Grigorenko, Iu. A. Spiridonov, and A. V. Talantov. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 30-37.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 20-24. 6 refs. Translation. In the experiments described, the mixing of hot gas jets injected into a cross-flow of cold air was studied as a function of some chamber parameters. It is shown that the flow rate increases and the quality of mixing improves when the mixer aperture and number of holes is increased. A diagram is proposed for selecting optimal mixer parameters with respect to the minimization of temperature-field nonuniformity. V.P.

A79-48497 On the question of selecting the characteristic quantity governing fuel self-ignition in a stream. V. N. Gruzdev, N. A. Malishevskaia, and M. D. Tavger. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 42-45.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 28-30. Translation.

In the experiments described, the self-ignition of kerosene TS-1 in a flow of nonequilibrium combustion products was studied to determine the degree to which the ignition delay characterizes the process as a whole. The ignition time is found to decrease with increasing flow temperature and increasing density of active centers. It is proposed to use the critical flow velocity (which forms the upper bound of the possible range of self-ignition) as the criterion of self-ignition. V.P.

A79-48498 Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface. O. N. Emin, I. I. Kutysh, and P. I. Shvartsman. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 46-53.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 31-36. 8 refs. Translation.

A79-48500 Determination of turning angle of a jet impinging on a bucket with visor. L. M. Kotliar, S. G. Margulis, and E. D. Nesterov. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 58-62.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 40-43. 6 refs. Translation.

The flow inside a symmetrical target-type thrust reverser is analyzed under the assumption of an imponderable fluid. The reverser ejection angle is calculated by Chaplygin's method of singular points. A technique for determining the ejection angle as a function of the deflector parameters is proposed. V.P.

A79-48501 Most rational linearization of nonlinear unsteady heat conduction problems. N. L. Men'shikh. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 63-67.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 44-47. 5 refs. Translation.

A proof is obtained for the correspondence between nonlinear and linearized unsteady heat-conduction problems from the point of view of similarity theory. This correspondence is used as a basis to develop a 'most rational' method of linearizing nonlinear unsteady heat conduction problems, owing to a dependence of the thermophysical properties on the temperature and radiant transfer. The method is illustrated by some practical examples. V.P.

A79-48503 On the influence of relative pitch in the subsonic turbine cascade. V. G. Nesterenko and G. L. Podvidz. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 75-80.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 53-56. 8 refs. Translation.

The influence of varying the pitch/chord ratio from 0.8 to 1.5 on the performance of a subsonic cascade of turbine airfoils is analyzed for large flow angles. The flow of an ideal compressible fluid in the aperture between two blades is calculated and compared with the experiment. Two types of separated flow are identified which may arise at pitch/chord ratios above the critical value. V.P. A79-48505 Analysis design of complex systems. II. T. K. Sirazetdinov and A. I. Bogomolov. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 85-91.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 61-65. 16 refs. Translation.

In the present paper, the problem of analytically designing complex systems is formulated and is placed in proper perspective with respect to the general process of systems design. An approach, based on control theory, is proposed to the analytical designing of complex systems. The application of this approach is demonstrated by examples. V.P.

A79-48507 Experimental study of the turbulent wake downstream of a fan jet. O. A. Khachaturian. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 100-107.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 72-77. 10 refs. Translation.

The velocity and temperature distributions in developing wakes of fan-shaped jets were studied in a cylindrical wind tunnel. It is shown that the wake flow is analogous to the wake behind bluff bodies of revolution. Relations for calculating the temperature and velocity in any wake cross section from the initial parameters of a fan-shaped jet are proposed. V.P.

A79-48517 Long-life GTE operation based on technical condition. A. A. Mukhin, A. A. Kovalev, and A. A. Kornoukhov. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 153-156.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 116-118. Translation.

The service life of a gas-turbine engine depends primarily on the endurance of the turbine blades, which depends on the gasdynamic and centrifugal stresses, the nonuniformity of the temperature field, the gas temperature, the atmospheric conditions, and seasonal effects. In the present paper, the endurance of first-stage blades prepared from ZhS6KP alloy is analyzed for the actual operating conditions of a modern long-range airliner, involving temperature variations ranging from -55 to +45 C and pressure variations from 725 to 775 torr. Methods of evaluating the technical state of turbine blades are discussed. V.P.

A79-48518 Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades. A. M. Poliakov, V. S. Petrovskii, and V. I. Krichakin. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 156-160.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 119-122. Translation.

In the present paper, an economical scheme of integrating over two space variables is applied to the solution of the unsteady-state thermal problem for an axial-flow turbine disk with blades having elongated roots. The problem is reduced to a system of twodimensional unsteady-state heat equations for the blades and disk. The disk profile is defined by means of arbitrary functions which delimit the contour of the lateral surfaces. By means of linearfractional transformation, the curvilinear contour of the disk is transformed into a rectangle. The problem then can be solved for coupled rectangular blade and disk regions connected by the boundarv conditions. V.P.

A79-48519 Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber. B. D. Fishbein. (Aviatsionnaia Tekhnika, vol. 21, no. 3, 1978, p. 160-164.) Soviet Aeronautics, vol. 21, no. 3, 1978, p. 123-126. 6 refs. Translation.

In the present paper, the thermodynamic effectiveness of thrust augmentation by supplying oxygen to the afterburner of a turbojet bypass engine is calculated for various modes of flight. The thermodynamic characteristics of air, air-oxygen mixtures, and combustion products of kerosene in air and in air-oxygen mixtures are tabulated. It is shown that for minimum excess oxidant (air-oxygen) ratio, an oxygen supply of 10 to 20 percent of the rate of airflow results in thrust augmentation by factors of 1.18 to 1.2 at M = 0, and by factors of 1.8 to 2.2 at M = 3.2. The total specific fuel consumption increases by factors of 2.4 to 4.4 at M = 0, and by factors of 2.0 to 2.8 at M = 3.2. V.P.

A79-48572 Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of interference from nearby cascades (Aerodynamische Erregungskräfte von Schaufelschwingungen in axialen Turbomaschinen infolge der Interferenz benachbarter Schaufelgitter). W. Lienhart. *Ingenieur-Archiv*, vol. 48, no. 4, 1979, p. 239-258. 17 refs. In German.

The paper presents the calculation of the unsteady blade forces and moments caused by the interaction of adjacent cascades by means of an approximation of incompressible plane unsteady potential flow. The results of vibration stimuli for a number of double cascade configurations are presented as examples. Attention is given to the influence of the axial clearance between the cascades, of the profile shape, of the different pitches of adjacent cascades, and of the ratio of peripheral speed to isentropic stage velocity. Finally, a simple formula is given for the influence of axial clearance between the blade rows. M.E.P.

A79-48596 Multiband antenna. F. W. Vortmeier (McDonnell Aircraft Co., St. Louis, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 35-42. Contract No. N62269-77-C-0138.

With the introduction of a new generation of radio communication equipment which is capable of operating at VHF-FM (30-76 MHz), VHF-AM (108-156 MHz) and UHF (225-400 MHz) from a single radio unit, the requirement existed to develop an antenna to match this capability. Such an antenna was developed for conformal mounting on tactical Naval aircraft with the approach being to add capability to an existing antenna. This makes it possible to provide with one antenna the capability formerly provided with two or three antennas. This paper describes the work performed, the successful results obtained and substantiating data. Data measured consisted of impedance measurements on a full scale model, pattern measurements of fourth and fifth scale models, power measurements and gain comparison measurements. (Author)

A79-48597 Small lightweight electronically steerable cylindrical antenna successfully utilized in an air traffic management system. J. A. Acoraci (Bendix Corp., Communications Div., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 43-49. Grant No. DAAB07-77-C-2176.

Bendix Communications Division has designed, fabricated and tested a brassboard model lightweight electronic scan interrogator antenna for use in air traffic management. The antenna is a Butler matrix-fed multimode electronically scanned cylindrical array. A brief description of the total system and a detailed technical description of the antenna are presented. S.D.

A79-48598 Adaptive array tradeoffs for existing airborne UHF radios. D. A. Sweeney (E-Systems, Inc., St. Petersburg, Fla.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 50-57.

Present-day UHF airborne communications links are susceptible to jamming interference. Frequency hopping, spread spectrum signals, and adaptive antenna arrays are among the methods that can be used to provide antijamming capabilities. The adaptive antenna approach is the only one that can be implemented without replacing or modifying the existing UHF radios. The requirements, tradeoffs, and hardware configurations involved in an adaptive array design are discussed. S.D.

A79-48602 Preprocessing for advanced image matching techniques. J. E. Berry and J. K. Yoo (Goodyear Aerospace Corp., Akron, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 86-91. Grant No. DAAK40-77-C-0107.

Preprocessing that enables accurate matching of two images taken by range measuring sensors located at different points in space and at different times is presented. Separation between the sensors results in perspective changes that appear as geometric distortion. There are also variations in image element intensities as a result of changes in position and time. The preprocessing used to remove position dependent distortion and to circumvent the effect of intensity variations are described. This includes descriptions of the sensor data format, the rationale for the preprocessing approach and transformations used to implement the approach. Examples comparing images before and after preprocessing are shown. (Author)

A79-48603 Synthetic aperture radar map matching for navigation. E. R. Hiller (Raytheon Co., Missile Systems Div., Bedford, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 92-100. Contract No. F04701-76-C-0002.

The location of preselected features in synthetic aperture radar (SAR) images by map matching with reference templates can provide fix data for navigation. A procedure for map matching has been developed that encodes the reference feature shape in a binary reference template which is utilized to provide an adaptive normalization and slicing of the radar image, followed by simple binary correlation. The procedure offers a significant reduction in computational complexity compared to traditional cross correlation processing and has the capability to acquire reference features with high probability in the presence of other competing features. Analysis of the theoretical performance characteristics of this map matching procedure is presented. Examples of results obtained with the procedure utilizing SAR imagery are also included. (Author)

A79-48606 Microcomputer applications in strapdown heading and attitude reference system. A. Halamandaris and E. N. Jackson (Litton Industries, Guidance and Control Systems Div., Woodland Hills, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979, Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 145-151.

Recent developments in LSI technology have made a very dramatic change in the digital system design of an all-attitude strapdown heading and reference system. With the advent of microcomputers it is now possible to design a system with distributed processing techniques. The purpose of this paper is to present the design approach of two microcomputer controlled modules within the Litton Heading Attitude Reference System (HARS). The HARS is a single unit containing inertial sensors, instrument support electronics, BITE electronics, power supply, system I/O electronics and distributed microcomputers. (Author)

A79-48608 # Microprocessor-based digital autopilot development for the XBQM-106 Mini-RPV. O. D. Koger, D. E. Tietz, and G. B. Lamont (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 157-167. 52 refs.

Contemporary integrated circuit technology permits the employment of microprocessors in the design of small remotely piloted vehicles. The development of a microprocessor based autopilot for the XBQM-106 Mini-Remotely Piloted Vehicles (RPV) is described in this paper. With ultra-low component cost as a primary goal, the autopilot design uses the RCA CDP-1802 microprocessor. The digital autopilot was developed through the breadboard state with performance testing accomplished via hybrid simulation. Aircraft transfer functions were first derived from aerodynamic wind tunnel data. Then a complete control analysis was made of the existing analog autopilot, sensors, actuators, and aircraft dynamics. This was followed by synthesis of the digital control algorithms from the digitization of the analog control laws. Hardware was selected based on system requirements, and software to execute the digital algorithms was developed. The results of testing by hybrid simulation indicates that the performance of the digital autopilot is very comparable to the existing analog autopilot. Sources of minor discrepancies are discussed. (Author)

A79-48609 A status report on the advanced FIREFLY assessment program. D. E. Longmire (Northrop Corp., Avionics Systems Analysis Dept., Los Angeles, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 170-175.

FIREFLY studies have shown the potential for significant increases in aircraft effectiveness and survivability offered by integration of the fire and flight control functions during weapons delivery. A modularized characterization of an integrated fire/flight control system eliminates the costly and extensive analysis that has heretofore resulted from conventional, separate, fire and flight control logic. FIREFLY has as its primary goal the design, development and utilization of a digital simulation of such an integrated fire/flight control system that would yield meaningful tactical versatility when used for the analysis and evaluation of a specific aircraft and weapon. (Author)

A79-48610 Multisensor integration for defensive fire control surveillance. C. L. Bowman (VERAC, Inc., San Diego, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 176-184. 8 refs. Contract No. F33616-78-C-1576.

This paper develops a multisensor integration (MSI) concept for defensive fire control surveillance. Multisensor, multitarget, maximum likelihood track correlation and minimum variance MSI track filtering algorithms are designed. Due to computational and timing requirements, as well as system reliability and flexibility considerations, sensor-level track files are selected to provide the measurements for MSI algorithms. The benchmark algorithm derivations therefore differ from those standard in the multitarget tracking literature, because of the autocorrelations in the track file errors which arise from the sensor track filters. Candidate suboptimal MSI algorithms are derived in accordance with the sensor characteristics and tracking requirements of a high energy laser (HEL) fire control. (Author)

A79-48614 Electric power system control techniques. J. R. Perkins, D. E. Lautner, A. J. Marek (Vought Corp., Dallas, Tex.), and D. Fox (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 237-245. Contract No. F33615-78-C-2018.

This paper presents the Phase I results of a two phase study program which addresses the integration of advanced power system control technologies into a reliable and fault tolerant system. The advanced control technologies integrated include electric engine start, automatic load management, microprocessor control implementations, design techniques for providing 'no-gap' power and an all 'solid state' electric power distribution system. Electric system performance requirements are established and preliminary designs of an integrated 'baseline' control system for single and a multiengine aircraft for the 1990 operational time period are presented. Finally, stability analysis requirements and procedures are established for each of the two designs. (Author)

A79-48615 Advanced RPV electrical systems. F. L. Miller (Teledyne Ryan Aeronautical, San Diego, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 246-253.

The paper surveys the possible improvements that can be made in the electrical power systems (EPS) of remotely piloted vehicles (RPV). It is noted that off the shelf hardware, which is commonly used due to cost considerations, is becoming inadequate for the tasks and is causing operational difficulties. Attention is given to the EPS design philosophy and some specific problems such as the lack of adequate generated power, interconnection difficulties, reliability and maintainability problems such as those associated with batteries and high life cycle costs. Several types of RPVs are described such as the HALE RPV, the mini RPV, and the TEDS. Technological improvements considered include: rare earth permanent magnets, flat wire and printed circuit cable, and fiber optics.

A79-48616 Electrical power system for new-technology transport power-by-wire airplane. E. T. Reiquam (Boeing Aerospace Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 254-261.

A design of the electrical power system for a new-technology aircraft in which the electrical system is the only secondary power system extracting power from the engines is presented. All flight control surface actuation is accomplished by electro-mechanical actuators and hydraulic systems are eliminated. The air conditioning system prime mover is an electric motor that drives a bootstrap air-cycle pack which permits more efficient engine shaft power extraction than less efficient bleed air extraction. The power generation system has quadruple redundancy established for the flight control system. Power for the flight control actuator system is at 270 V dc, and avionics, lighting, engine controls, and instrumentation are powered from 115/200 V 400-Hz, 28 V 400-Hz, and 28 V dc buses. A.T.

A79-48617 E-4B mission electrical power. M. E. Kleinmann and A. A. Stewart (Boeing Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics

Engineers, Inc., 1979, p. 262-269.

An overview of the mission power distribution system designed for the E-4B version of the Boeing 747 aircraft is presented. The requirements and criteria established for mission power distribution are given along with a general description of the system, including interfaces with the basic 1200-kVA electrical power generation system. The E-4B power system is characterized by the ability to automatically shed selected mission loads in the event that multiple generator failures require a reduction in load. Mission power distribution control and monitoring is provided at the mission technical control station. From this station 32 dedicated-load and general-purpose mission buses are controlled, and their status monitored. The system also provides 28-V dc; 10-V dc; and 115-V, single-phase, 60-Hz power to mission loads throughout the plane.

V.T.

A79-48618 Digital simulation of a three-phase generator. P. J. Leong and I. S. Mehdi (Boeing Aerospace Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 270-278.

A technique is presented for dynamically modeling a brushless three-phase ac generator on a digital computer. A simplification in the mathematical description of the generator is obtained by using the Park's transformation which defines a new set of variables in terms of the actual winding variables. The model equations are set up in the state-space method and the flux linkages are the state variables. One of the problems encountered in the digital simulation of synchronous generators is the determination of saturation. In this model, a table lookup routine handles the nonlinear saturation effect. The generator model is part of a complete system simulation of an aircraft generating system. The simulation determines stability and power quality during steady-state and transient operating conditions. (Author)

A79-48620 # Avionics computer software operation and support cost estimation. D. V. Ferens and R. L. Harris (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 296-300. 9 refs.

This paper describes many current models and methods available for predicting computer software operational and support costs and discusses the limitations of available models and methods as useful tools. This paper also discusses in detail the Air Force Avionics Laboratory's current effort to develop a model that will help the engineer or cost analyst accurately predict operational and support costs of avionics systems computer software being maintained at Air Force Air Logistics Centers. (Author)

A79-48621 Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness. R. J. McCabe (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 301-307.

This paper treats the problems of developing effective BIT approaches for A/D converters to be used in airborne radar systems, and recommends new directions for improving the effectiveness of A/D BIT. Present A/D approaches are comprised of one or more of three basic types of BIT: critical circuit verifications, end-to-end system level tests, and front-to-back hardware level tests. Each of these approaches is described and the merits and shortcomings of each approach are summarized. New requirements for processing of radar target data and the introduction of new hardware technologies motivate a shift toward hardware level A/D BIT. Recommendations for improved BIT effectiveness are given, and include improved test parameters, microprocessor-based measurement techniques, and further development of A/D system modeling techniques. (Author)

A79-48622 Flight test verification of the ASSET system. S. T. Donley (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.) and R. D. Solomon (Grumman Aerospace Corp., Bethpage, N.Y.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of

Electrical and Electronics Engineers, Inc., 1979, p. 311-318, 8 refs. The ASSET (Advanced Skewed Sensory Electronic Triad) system flight test configuration consists of two sets of six skewed rate sensors. One set consists of conventional spring-restrained rate gyros, while the other is composed of vibrating beam rate sensors. Flight test results are presented for a redundant arrangement of skewed angular rate sensors and associated failure detection and isolation algorithms designed for digital fly-by-wire control applications. The separation of the sensors in the skewed array demonstrated the concept of survivability through sensor separation. The redundancy data management software demonstrated that computer technology can reliably perform isolation and signal selection which can be processed within the iteration time constraints of aircraft control laws. Specific conclusions are drawn. S.D.

A79-48623 A microprocessor system for flight control research. J. C. Seat (USAF, Williams AFB, Ariz.), G. E. Miller, and R. F. Stengel (Princeton University, Princeton, N.J.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 319-326. Contract No. N00014-78-C-0257.

A digital flight control system based on microprocessor technology has been designed, developed, and flight tested in Princeton's Variable-Response Research Aircraft (VRA). The Micro-DFCS works in conjunction with the VRA's existing fly-by-wire control system, and it is programmed to provide command and stability augmentation control laws formulated through modern control theory. The Model 1 Micro-DFCS hardware and software are described, and initial flight test results are presented. (Author)

A79-48625 # Synthesis of digital flight control tracking systems by the method of entire eigenstructure assignment. J. J. D'Azzo and T. A. Kennedy (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 343-347. 12 refs.

The paper is concerned with the use of entire eigenstructure assignment (Moore, 1976; D'Azzo, 1978) in the synthesis of tracking systems which are required to track a command input vector containing piecewise constant signals. The method is demonstrated by application to a digital aircraft flight control system required to produce a constant climb rate at constant velocity. The controllable system is represented in the continuous-time domain by linear multivariable matrix state and output equations. S.D.

A79-48629 Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for advanced architectures using MIL-STD-1553B. C. R. Turner and M. B. McCall (Boeing Aerospace Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 426-432.

This paper is presented in two major sections. The first section presents a comparison of current MIL-STD-1553 multiplex systems. These systems are compared as to their application areas, architectures and system control approaches. The second section is a discussion section which presents the conclusions drawn from our study of current systems, as well as presenting areas identified as needing further study. The areas discussed are: problems of MIL-STD-1553(USAF) and MIL-STD-1553A which were solved by -1553B, predicting the future from the past, what advances are needed, and what the payoff is. (Author)

A79-48630 F/A-18 Homet display system. R. A. Juergens (McDonnell Aircraft Co., St. Louis, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 434-442.

The F/A-18 cockpit display system consists of a Head Up Display (HUD), two Multipurpose Display Indicators (MDIs), and either a Multipurpose Display Repeater Indicator (MDRI) or a Horizontal Situation Display (HSD). The MDI, MDRI, and HUD were developed by Kaiser Electronics while the HSD was developed by Bendix/Ferranti. These four units provide an integrated display system with the functional redundancy necessary to provide a high probability of mission success. Each MDI is able, under aircraft computer direction, to provide all necessary display information to itself and to either the MDRI/HSD, the HUD, or both. With the exception of the optics, the HUD, HSD and MDRI are functionally similar. Internally, the MDIs consist of the MDRI modules plus a processor comprised of an input/putput (I/O) section, a central display processor, and two independent but identical symbol generators. This paper discusses the display system organization and (Author) details the processor operation.

A79-48640 A simple integrated navigation based on multiple DME. U. Brokof (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). (Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-041.) In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 591-599. 5 refs. Translation.

A simple integrated navigation system is described, consisting of a dead reckoning system using the intrinsic velocity and the compass heading. The system is supported by range measurements to various DME ground stations by means of a Kalman filter. The state vector contains, besides the elements for dead reckoning, the systematic errors of the ground stations. The operation of the system is discussed in the light of test flight results with an HFB 320. P.T.H.

A79-48641 Ouaternion matching in transfer alignment for SAR motion compensation. D. J. Schmidt and G. A. Bendor (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 600-604. If seef.

The paper presents the initial results of an on-going study to develop a system for motion compensation in SAR signal processing. In the proposed configuration, a high cost, high performance, low data rate master IMU is located at a convenient vehicle station; also a low cost low performance, high data rate, strapdown slave IMU is located at a remote station. It is noted that despite structural deformation and large slave IMU errors, adequate accuracy is achieved in the slave by Kalmanized transfer alignment with the master. Finally, covariance analysis indicates that accelerometer attitude matches (i.e., quaternion matches) are needed along with other types of matches if slave strapdown inertial sensors of tactical guidance quality are to be used in this application. M.E.P.

A79-48648 The effect of standardization of avionics software quality assurance. R. J. Rubey (Softech, Inc., Waltham, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 656-662. The paper summarizes existing military standards and Air Force regulations applicable to both inhouse quality assurance (QA) efforts and independent verification and validation (V&V) activities. The need for additional QA and V&V standards are discussed and some potential standards are suggested. An effective software quality assurance plan describing the important parts of a developer's quality assurance activities is described and the major sections of the plan are analyzed including scope, applicable documents, and organization.

C.F.W.

A79-48652 Power hybridization - Key to reducing avionics power supply weight and volume. R. C. Newton, Jr. and D. G. Frey (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 698-703.

It is shown that the use of power hybrid packages (PHP) for both linear series regulators and switching power supplies results in large savings in the system power supply weight (over 30 percent) and volume (over 46 percent). The use of PHP technology has other advantages, such as improvements in reliability, producibility, and maintainability. It is apparent that the potential for commonality of the PHP building blocks is large for both linear and switching regulators. In addition, there is evidence to support the prediction that life cycle costs will be significantly reduced. V.P.

A79-48656 Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation. V. S. Samant, B. G. Gardner (Orincon Corp., La Jolla, Calif.), and R. Akita (U.S. Navy, Naval Ordnance Systems Command, San Diego, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p.

726-737. The paper considers the problem of accurately determining position and velocity of naval ships using GPS signals. An extended Kalman filtering algorithm was adequate for achieving 10 m and 0.2 m/sec accuracies in ship position and velocity in the absence of disturbing sea motion, but this filter is divergent in moderate and stormy sea-state environments. Inertial navigation configurations to measure the ship motion, algorithms for estimating the disturbance rnotion, and a disturbance motion compensation technique are discussed. The disturbance sea motion estimates are used to compensate GPS measurements to maintain the filter performance within desired limits, and was shown that actual at sea results confirmed the simulation results of velocity error sensitivities due to sea motion. A.T.

A79-48657 A real-time sequential filtering algorithm for GPS low-dynamics navigation system. T. N. Upadhyay (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.) and J. N. Damoulakis (Texas Instruments, Inc., Dallas, Tex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 739-749. 20 refs. Contracts No. F04701-78-0181; No. F33615-78-C-1430.

This paper describes the design, implementation, and performance of a real-time estimation algorithm, referred to in this paper as the Sequential Piecewise Recursive (SPWR) algorithm, for the Global-Positioning System (GPS) low-dynamics navigation system. The SPWR algorithm is based on the extended Kalman filter. It, however, differs from the conventional Kalman filter in that it computes error covariance and filter gains at a slower rate than the state measurement update, and it uses U-D factor formulation to perform covariance computations. Thus, the SPWR algorithm saves real-time processing requirements without appreciable degradation of filter performance, and it alleviates the numerical accuracy problems generally associated with the Kalman filter. Another important feature of the SPWR algorithm is that it incorporates range and range-rate data from each GPS satellite sequential for navigation solution. Numerical results are presented. (Author)

A79-48664 Radar signal processing development for application of VHSI, J. D. Grimm and G. L. Bair (Texas Instruments, Inc., Radar and Digital Systems Div., Dallas, Tex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 796-805.

Advances in component technology leading to the development of very high speed integration promise revolutionary progress in the next decade of radar signal processing. The paper examines mission requirements that place demands on future equipment design. To quantify future signal processing requirements, a baseline is established by describing a current developmental signal processor for an airborne coherent multimode radar. Operational requirements for future processor development are outlined consistent with projected mission capabilities. Signal processor parameters are derived from these operational requirements. Equipment mechanization to meet projected requirements is accomplished by developing architectures that lend themselves to application of revolutionary device technology. (Author)

A79-48665 Millimeter airborne radar target detection and selection techniques. L. M. Novak and F. W. Vote (MIT, Lexington, Mass.), In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 807-817. 12 refs. USAF-DARPA-Army sponsored research.

Results of a study of candidate target detection and selection techniques for use in millimeter airborne radar systems are presented. Improved target and ground clutter models are developed and the implications of these mathematical models on target detection and selection performance is discussed. (Author)

A79-48666 An analysis of SAPPHIRE image parameters as a function of processing parameters. R. E. Morden (Goodyear Aerospace Corp., Litchfield Park, Ariz.) and R. L. Withman (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics

Engineers, Inc., 1979, p. 818-824. Contract No. F33657-74-C-0604. SAPPHIRE (Synthetic Aperture Precision Processor, High RE-

liability) is a special-purpose digital processor capable of synthetic aperture processing of data from an AN/APD-10 coherent sidelooking radar at real-time rates with full resolution. The processor was designed to perform a variety of parameter tradeoff experiments to aid in determining performance requirements for future systems. The paper presents an analysis of clutter return in imagery produced by SAPPHIRE from two passes over a specified site, with special emphasis on an analysis of radar image parameters as a function of processing parameters. The two passes represent a moderate (16 deg) and a relatively low (5 deg) depression angle. The results compare measured clutter histograms with those predicted by theory and also compare two different methods of performing parameter tradeoffs. S.D.

A79-48667 Verification of operational flight programs by simulation. C. D. Williams and C. Nemec (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 826-828.

Avionics software and their support packages have progressed to the point where verification of onboard computations can be accomplished totally by computer simulation. A test method is proposed which provides dynamic inputs, via the off-line simulation, to a support software package capable of executing onboard code and comparing results of the onboard algorithms with anticipated results. It is now possible to modify and verify onboard computations without the facilities of a software bench. Generation of the test inputs to the support software is achieved by a FORTRAN program that uses a two-tier approach to simulate flight paths for an interceptor and up to 10 maneuverable targets. After simulating the onboard code, the FORTRAN interface routine gathers outputs of the operational flight program and returns to the upper tier. This allows accurate assessment of nonlinearities, parameter uncertainties, and modeling errors. S.D.

A79-48670 Computer Monitor and Control - A flexible, cost-effective implementation. J. A. Rey and R. K. Thompson (Northrop Corp., Aircraft Group, Hawthorne, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 840-844.

This paper describes the Performance and Design Requirements Analysis for a test set, often referred to as a Computer Monitor and Control Unit (CMAC) to be used during verification and validation of Operational Flight Programs (OFP) of Tactical Aircraft. Discussed are the requirements for data acquisition, methods of capture and post-processing of acquired data. The intent of this CMAC is to allow the test operator/OFP programmer to set a breakpoint, loop, monitor, trace, and otherwise test the OFP in its hosted environment in real-time without any special test-oriented code within the OFP. A specific case of an OFP host processor (AN/AYK-14) will be discussed and its implementation with a laboratory software development situation. (Author)

A79-48671 Evolving methods for reducing avionics data in an AISF environment. C. Bierbaum (USAF, Air Logistics Center, Robins AFB, Ga.), M. Elowitz (TRW Defense and Space Systems Group, Redondo Beach, Calif.), and J. Kennoy, Jr. (TRW Defense and Space Systems Group, Warner Robins, Ga.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 845-852.

The concept and scope of the F-15 data reduction and analysis system (DRAS) are described. Attention is given to the avionics integration support facility (AISF) and its requirement for data reduction, covering such areas as the DSS dynamic simulation system, and flight test support aircraft. The DRAS concept discussion covers the software involved, a timeline summary, timeline analysis, and a parameter listing. Finally, the DRAS state of development is described and the future evolution of the DRAS and the AISF is extrapolated.

A79-48672 # Microcomputer control of a test facility. J. A. Carretto, Jr. (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 853-858.

The paper discusses a unique method of placing the data collection and processing equipment of a test facility under the control of a microcomputer. The specific facility is the AF Avionics Laboratory's Mobile Evaluation Laboratory (MEL), a collection of test and data processing equipment used in the evaluation of navigation systems. The paper includes a general physical and

functional description of the MEL, its development, and the rationale for reorganizing the system under microcomputer control. The advantages of integrating the microcomputer as the system controller are presented from both the hardware and software viewpoints. The modifications necessary for this are presented in detail. Specific problems encountered, and their solutions are also discussed. (Author)

A79-48676 # Operational experience with the AN/ARN-131 Omega Navigation Set. H. W. Underwood and D. W. Keen (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers Inc. 1979 p. 1006-1013

The paper discusses (1) problems encountered in using the AN/ARN-131 Omega Navigation Set on the C-130 Hercules aircraft, (2) the Omega Task Group efforts, and (3) the subsequent follow-on test and evaluation results. It is found that fixes determined as a result of the Omega Task Group effort were effective. To date the fixes which have been approved for implementation by the Air Force are antenna relocation, minimum/maximum range deselect, 15-deg angular deselect, modal interference deselect, and 5-min wind time constant. B.J.

A79-48677 The DG-800 - A rugged, high performance heading reference unit. D. A. Zomick and M. J. Lanni (Bendix Corp., Guidance Systems Div., Teterboro, N.J.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1015-1022.

A directional gyro (DG-800) incorporating a single inertial grade liquid bearing sensor has been designed, fabricated, and tested. The unit is unusually rugged and its hydrostatic bearing and power pivot provide exceptionally good performance for the size of its angular momentum. Considerable interest has been expressed in the concept and the Army has contracted for preproduction units for its CV-HRS program. This paper gives a performance synopsis and discusses design/performance considerations. B.J.

A79-48678 Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities. L. D. Hostetler and R. C. Beckmann (Sandia Laboratories, Albuquerque, N. Mex.), In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1023-1030, 13 refs. Research supported by the U.S. Department of Energy.

The SITAN (Sandia Inertial Terrain-Aided Navigation) system was originally developed to provide continuous updating of an inertial navigation system by using radar altimeter measurements of the terrain in conjunction with prestored topographic data in an extended Kalman filter. The basic algorithm performs satisfactorily for limited initial position uncertainties, but can diverge when the position uncertainty is so great that terrain linearity assumptions are significantly violated. An improvement to the basic system is described which considerably increases the region of convergence. The improvement is accomplished by modelling the terrain nonlinearities as Gauss-Markov measurement noise whose statistics and frequency content are adaptively varied as the uncertainty region evolves with time. Theoretical development of this modification is given and results of flight test experiments are presented which verify the ability of this modification to significantly increase SITAN's region of convergence. (Author)

A79-48679 Transfer alignment for precision pointing applications. J. L. Farrell (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1033-1039. 9 refs.

A transfer alignment formulation is presented and illustrated by the nonrigid case with no unobstructed optical path between master and slave IMU, a full validation of the formulation is also presented. The approach is straightforward; only the interpretation requires some sophistication, since the formulation accounts for an extensive array of strapdown errors not often addressed explicitly in other analyses. B.J.

A79-48680 The alpha-beta-gamma tracking filter in the Z-domain. R. E. Wilcox (Emerson Electric Co., Electronics and Space Div., St. Louis, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979, Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1042-1046. 14 refs.

The classic linear third order tracking filter also known as the alpha-beta-gamma filter will track an accelerating target with a position error which converges to zero. If this filter is implemented in the digital domain, then solutions for the filter output as a function of time must be carried out in the Z-transform formalism not using the continuous s or Laplace transform approach. This paper studies the linear third order tracking filter in the Z-domain with the objective of deriving and documenting the general solutions for the estimated position, position rate and position acceleration outputs as functions of modeling parameters. An algorithmic outline is presented for calculating the noise bandwidths for the filter outputs and the paper includes a numerical example describing the tracking of an incoming accelerating aircraft. (Author)

A79-48681 Complex quaternion notation in coordinate transformations. F. G. Saylor (TRW Defense and Space Systems Group, Redondo Beach, Calif.) and W. A. Jarvinen (USAF, Warner Robins Air Logistics Center, Robins AFB, Ga.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1047-1051. 8 refs.

This paper addresses the use of complex quaternion notation in coordinate system transformations among launch aircraft and simulated missile coordinate systems. Complex quaternion differential equations describing the transformation from the earth to missile coordinate systems are stated. A brief introduction to real quaternions as a lead in to the use of complex quaternions are given. The advantages of using the complex notation over direction cosine techniques are discussed. Complex quaternion solutions to dynamic coordinate system transformations can often reduce time and storage space required for FORTRAN programs when compared to direction cosine methods. (Author)

A79-48682 # Pave Low III. J. E. Clifford (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1054-1062.

Various aspects of the Pave Low III program for night/adverse weather rescue are reviewed. The success of the program is attributed to the people and their philosophy. This is followed by a discussion of the hardware, with emphasis on the equipment selection process for the prototype. Detailed subsystem capabilities, integration requirements, and evolved system capabilities/limitations are also discussed. B.J.

#### A79-48683

A79-48683 # User requirements for future combat search and rescue vehicles. D. H. Sattler (USAF, Military Airlift Command, Scott AFB, III.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electricial and Electronics Engineers, Inc., 1979, p. 1063-1067.

The mission of a combat rescue vehicle is aircrew recovery in hostile territory in daylight or darkness and under visual or instrument meteorological conditions. In order to accomplish this mission, the vehicle must have superior performance, a high degree of survivability, systems reliability, transportability, and easy maintainability. The aircraft must have equipment which allows operation with search and rescue task force or singly in a convert mode. The aircraft must be designed with threat avoidance as the primary method of operation and with threat defeat secondary. B.J.

A79-48684 # H-X combat search and rescue avionics study results. C. L. Zelasco and A. L. Leathan (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1069-1078

The objective of the present study was to perform the necessary tradeoffs required to define an avionics suite which will satisfy U.S. Air Force requirements for a night/adverse weather combat rescue capability in an H-60 class (medium life helicopter). The results of this study showed the practicality of incorporating this type of capability in an H-60 helicopter. The study team arrived at this conclusion by defining a representative point design for the H-X avionics. This design, which evolved from an iterative tradeoff process, identified specific representative avionics equipments which satisfy the performance requirements. B.J.

A79-48685 Multifunction CO2 heterodyning laser radar for low level tactical operations. R. L. Del Boca (U.S. Army, Fort Monmouth, N.J.) and R. J. Mongeon (United Technologies Research Center, East Hartford, Conn.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1079-1088, 8 refs.

Analysis of tactical scenarios indicates that a number of radar requirements are optimally solvable with low power 10.6-micron laser systems. Exploratory development efforts by the U.S. Army and the United Technologies Research Center have been directed at the advancement of the state of the art in airborne CO2 heterodyne laser radar systems. This paper examines the design considerations, hardware configurations, and test results of flyable breadboard models which have demonstrated the feasibility of using CO2 scanning laser systems for wire detection, precision hover, Doppler navigation, and terrain following. B.J.

A79-48686 Terrain-following radar - Key to low-altitude flight. A. C. Woodward and J. B. Lagrange (Texas Instruments, Inc., Radar and Digital Systems Div., Dallas, Tex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1089-1096.

Terrain following radar (TFR) is discussed as a chief factor in aircraft survivability during low-altitude flight. The basic principles of TF techniques applied in current operational radars such as the AN/APQ-126, -146, and -158, are described. Past and current TFR operational environments are compared to examine survivability and cost. Projections are made as to the direction of FTR state of the art to meet operational requirements by the Air Force for fixed and rotary-wing aircraft.

A79-48687 Test implementation through support software - A FIT translator. G. L. Alker and S. M. Stennett (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1098-1104.

The paper considers a hardware environment in which an embedded computer executes fully automated fault isolation tests (FIT) on an airborne radar system. External test equipment is not utilized. Complete FIT of this system requires translation of test designer input into a language that will run on the embedded computer. The information transfer is intricate and prone to error due to weaknesses common to documentation and verbal communication. As a solution to this problem, the paper describes a FIT translator which is easily adapted to a variety of systems. B.J.

A79-48689 Automatic test software for calibrating strapdown systems. L. P. Stave (Rockwell International Corp., Autonetics Strategic Systems Div., Anaheim, Calif.) and A. P. Andrews (Rockwell International Science Center, Thousand Oaks, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics

Engineers, Inc., 1979, p. 1111-1116.

An integrated system of software was developed for calibration of the Rockwell N73 Strapdown Inertial Navigation System. The software includes an interactive monitor for interfacing with production personnel, so that use of the software does not require trained or skilled operators. The calibration software also controls and monitors all test equipment, including the MIL-STD-1553A Data Bus which is the primary link to the navigator. The test computer uses the Data Bus to load and execute special-purpose programs in the navigation computer, for diagnosis and calibration of the navigator. The calibration software also performs data management of all calibration and test data, providing traceability for all calibration parameters. This soft-ware system has been evaluated and modified for human factors in the factory environment, and is now in use in production. (Author)

A79-48690 Automatic test program generation selection. D. B. Day (Support Systems Associates, Inc., Northport, N.Y.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1117-1121.

This paper examines the use of ATE to test electronic devices and the generation of test programs for digital electronic assemblies. Three methods of generating test programs, using manual, simulation, and automatic stimulus generation programs, are presented. The B-1 and F-16 Automatic Test Program Generation (ATPG) selections are studied in detail, noting the difficulties of the selection processes. The results of these processes for both the B-1 and F-16 favored the D-4 LASAR system becuase of its high (80%) fault detection capability. C.F.W.

A79-48691 The impact of software in automatic test equipment. R. G. Slavkin (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics

Engineers, Inc., 1979, p. 1122-1127. The paper examines an automated test tool for the evaluation of

a radar analog to digital converter (A/D). The present manual test method for the A/D is imprecise in identifying pass/fail criteria because any irregularities in the transfer function of a digital to analog converter cause nonlinearities and tend to distort these measurements. To overcome these problems, automated A/D test equipment utilizing quantative statistical analysis in software is developed. The A/D parameters that must be characterized to insure radar system performance such as the linearity of the A/D transfer function, the 'Random Triangle' test included in the automated test set to measure these parameters, and a noise measurement technique known as the 'RMS Noise' test are discussed. The microcomputer hardware is considered, and it is concluded that automatic equipment software allows ease of data handling, complex calculations, efficiency of manipulation, and detailed analysis of the unit in question. A.T.

A79-48692 Guidance accuracy considerations for the microwave landing system L-band precision DME, R, J, Kelly and E, F, C, LaBerge (Bendix Corp., Communications Div., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics

Engineers, Inc., 1979, p. 1130-1141. 26 refs. U.S. Department of Transportation Contract No. FA72WA-2801.

The microwave landing system (MLS) L-band precision distance measuring equipment (PDME) must: (1) satisfy the CTOL Category II decision height and Category III flare maneuver accuracy requirements (100 feet, 2 sigma) when combined with the appropriate elevation data, and (2) for VTOL applications provide accurate range (+ or - 40 feet, 2 sigma) and range information (+ or - 2 knots, 2 sigma) to permit IRF decelerated approaches to within 500-feet range of hover. These specifications must be satisfied in the presence of large signal attenuation caused by ground multipath interference and signal time-of-arrival errors induced by lateral multipath (hangars, etc.). Consideration is given to a consistent accuracy specification suitable for MLS operational requirements and a PDME implementation common for CTOL, STOL, and VTOL. V.T.

A79-48693 The ATCBI-5 beacon interrogator. G. L. Vogt (Bendix Corp., Communications Div., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1142-1146.

A new beacon interrogator has recently been introduced into the nation's air traffic control system by the Federal Aviation Administration. The interrogator, the ATCBI-5 is installed at terminal radar sites, enroute radar sites, and enroute beacon only sites. The ATCBI-5 offers significant improvements over previous interrogators, such as improved reliability, higher output power, improved receiver capabilities, compatibility with military interrogations modes, and others. In its first year of operation, this equipment has demonstrated more than double the mean time between equipment outages as compared to its most recent predecessor.

(Author)

A79-48694 Dynamic simulator test and evaluation of a JTIDS relative navigation system. S. Welt (ITT, ITT Avionics Div., Nutley, N.J.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1162-1169. 5 refs.

The Joint Tactical Information Distribution System (JTIDS) is a spread spectrum command-control-communication system designed to operate in the Lx-Band (960-1215 MHz) and provide the military services with a secure anti-jam communication, navigation and identification capability in the tactical environment of the 1980's. This paper describes the design and implementation of the AN/USM-440 JTIDS Environment Simulator (JES) being developed for the Naval Air Development Center by ITT Avionics Division. The JES is a real time computer controlled dynamic simulator which provides a realistic RF environment and inertial navigation system signals when required which are used to test and evaluate the anti-jam and relative navigation performance of a wide variety of JTIDS user terminals.

(Author)

A79-48695 A deterministic investigation of strapped down navigation system accuracy. P. Motyka (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1172-1178. 5 refs. Contract No. F33615-78-C-1563.

The results of a study which assesses the effects of sensor errors and structural modes upon the accuracy of strapped down navigation systems are presented. These results are significant since the accuracy achieved with state-of-the-art navigation systems is not adequate for present and future high-performance aircraft. The sensors considered are navigation quality laser and two degree-of-freedom gyros and accelerometers. The major sensor errors are considered individually as well as in combination. Time histories of the navigation errors, for a one-hour flight trajectory which includes many features of a typical tactical fighter aircraft profile, are presented and analyzed. (Author)

A79-48696 Application of instrument rotation in the N73 standard inertial navigation system. A. P. Truban (Rockwell International Corp., Autonetics Strategic Systems Div., Anaheim, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1179-1185.

Rotation of inertial instruments for reducing the effect of aircraft flight-profile-dependent error sources on strapdown inertial navigation systems is considered. The N73 strapdown inertial navigation system with electrostatic gyros uses instrument rotation; the effect of rotation on electronic characteristics is considered in the mechanization of the rotational technique. The N73 system, the electrostatic gyro, the system mechanization considerations, and system errors are discussed, noting substantial reduction in the system sensitivity to internal and environmental error sources and the achievement of long-term calibration stability. Error sensitivity are presented which show the improvement in error sensitivity and realibration stability. A.T.

A79-48697 Rapid reaction time techniques for a strapdown navigator employing electrostatic gyro technology. B. E. Bona and R. M. duPlessis (Rockwell International Corp., Autonetics Strategic Systems Div., Anaheim, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1186-1192.

Fast reaction techniques for a strapdown system employing electrostatic gyro technology are described. Induction heating for rotor warmup and accurate gapsetting are used for gyro startup. A scheme for aligning the spin axis and the rotor major principal axis is presented. Gyrocompassing function is accomplished using a staged-gain filter to estimate attitude and drift errors. The filter is designed for rapid detection of large initial errors, especially in heading. The gyrocompass loop is closed through the filter in such a way that the response of the closed loop is precisely as desired. V.T.

A79-48702 A real time video bandwidth reduction system based on a CCD Hadamard transform device. D. J. Spencer and J. M. Anderson (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1218-1231. 7 refs.

A low cost video bandwidth compression system, VIDAP, which operates in real time with standard sensors and displays, is described. The VIDAP is based upon the 8 x 8 Hadamard transform and a full frame (512 x 512 x 6) memory and employs a LSI device

implemented in digital charge coupled device (DCCD) technology. Compression of the video bandwidth is achieved in three ways: (1) frame reduction, (2) statistical redundancy removal, and (3) spatial fidelity reduction (subsampling). These three factors may be traded off to obtain any given data rate at the expense of temporal or spatial distortion. The system provides multiple synchronization modes for use with either sensor-based or modem-based timing and makes it possible to use small (less than 200 parts), low-power (20 W) transmitters for avionics applications. V.T.

A79-48705 # Digital sensor simulation at the Defense Mapping Agency Aerospace Center. M. B. Faintich (U.S. Defense Mapping Agency, Aerospace Center, St. Louis Air Force Station, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1242-1246.

The primary objective of the digital sensor simulation investigations being conducted at the Defense Mapping Agency Aerospace Center (DMAAC) is to establish an editing and analysis capability for digital culture and terrain data bases. These data bases are being produced by DMAAC to support advanced aircraft simulators by providing an improved low level radar training capability offered by digitally generated radar landmass images. As a result of the technology developed for aircraft simulator support, sensor guidance reference scenes, visual, and microwave scenes are also being digitally generated. Currently, intensive studies are underway to generate synthetic input data bases with apparent resolutions finer than in the original data bases, using supportive data base information. Highly realistic sensor simulations have been generated, and the continuing emphasis is on modeling new sensors as well as improving resolution without increasing data base production costs. (Author)

A79-48711 # Integrated CNI avionics. D. G. Botha (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1314-1317. USAF-supported research.

In the context of integrated avionics the concept of multifunction multiband airborne radio system has evolved. This concept recognizes the synergistic relationship between radio navigation and inertial sensor measurements which lead to the designation of an integrated CNI avionics as a subset of integrated avionics. The paper describes a conceptual approach to the airborne CNI function in this higher-level integration context. The findings of a definition phase are discussed, architectural approaches to implementation of the CNI function are described, and further efforts addressing realization of the conceptual goals are postulated. S.D.

A79-48712 Real time compression of video signals. D. Ludington (General Electric Co., Aircraft Equipment Div., Utica, N.Y.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1318-1321. USAF-supported research.

The paper deals with a video bandwidth compression system which uses CCDs to implement a two-dimensional cosine transform in real time at a resolution of 512 pixels per TV line. The system is composed of an airborne encoder and a ground-based decoder. The decoder accepts compressed data from the encoder and converts it back into video. A data frame is first assembled in a memory and is then read out to an inverse quantizer and the inverse cosine transform while a parallel memory is being loaded. The output of the transform is a video signal which, after filtering, is available for display on a standard 525-line monitor.

A79-48713 # Performance of a pulse-decode circuit in the presence of interference. G. S. Douple and S. R. Robinson (USAF,

Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1328-1333.

The performance of a pulse decode circuit is examined through Monte Carlo simulation for various types of signal interference. The received signals represent environments of many non-coherent correct replies with none dominant, many non-coherent friendly replies with one dominant, and noise jamming with no valid reply present. The performance of the receiver was determined by studying the effects of an envelope detected version of the received signal on the decoder circuit, and the results indicate that many types of deterministic pulse formats will cause the decoder to respond at its maximum decode rate. In terms of random, noise-only types of interference, the decoder is most vulnerable to signals whose bandwidths are at least the overall RF bandwidth of the receiver, but for the signal-plus-noise case the simulation results show that once the interference power reaches a certain value, increases in the power of the valid reply will not improve the decoder performance. A.T.

A79-48715 JTIDS relative navigation - Architecture, error characteristics and operational benefits. W. R. Fried (Hughes Aircraft Co., Fullerton, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1344-1349. 7 refs.

The paper examines the relative navigation (RELNAV) function of the joint tactical information distribution system (JTIDS) which provides high-accuracy absolute and relative position information and time synchronization. The RELNAV function is obtained through the addition of software only to the JTIDS terminal's operational computer program. Each member determines his position, velocity, and time offset through sequential passive time-ofarrival measurements with respect to other members, using appropriate source selection algorithms and extrapolation with dead reckoning data by means of a recursive filter mechanization. The basic system architecture, software functions, the error sources, and operational benefits, including the availability of the navigational data in geodetic and arbitrary grid coordinates and operation in a high jamming environment without reliance on critical nodes, are discussed. A.T.

A79-48716 System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function. W. R. Fried (Hughes Aircraft Co., Fullerton, Calif.) and R. Loeliger (Intermetrics, Inc., Long Beach, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1350-1356. USAF-sponsored research.

The system configuration for implementing the Relative Navigation (RELNAV) function in the JTIDS Hughes Improved Terminal (HIT) is presented. The integration options for interfacing the LN-31 Inertial Navigation Set with the HIT are discussed and the selected interface is described. The RELNAV operational modes, control and display requirements, and major software functions are discussed. A description is given of the selected RELNAV filter algorithm and the associated timing and sequencing design. The filter extrapolation, the inertial processing and the source selection algorithms are discussed. Some simulation results are presented. (Author)

A79-48717 # Tactical electronic reconnaissance sensor. P. W. Post (USAF, Tactical Air Warfare Center, Eglin AFB, Fla.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979. 8 p. measured by the iodine number and the increase in vapor pressure due to cracking is demonstrated for the fuels RT, TS-1, T-8B and T-6. Values of the temperature derived from the 'hardness factor' at the iodine number defined as the point of initial thermal decomposition are shown to agree fairly well with thermal decomposition initiation temperatures calculated from kinetic equations and the dependence of iodine number on temperature. It is concluded that the 'hardness factor' allows the prediction of the extent of thermal decomposition at various temperatures and heating times as well as the computation of thermal decomposition initiation temperatures. A.L.W.

A79-48858 # Changes in the quality of T-6 fuel upon prolonged storage (Izmenenie kachestva topliva T-6 pri dlitel'nom khranenii). N. I. Melent'eva, I. V. Malysheva, N. N. Kalitina, and L. N. Savin. *Khimiia i Tekhnologiia Topliv i Masel*, no. 8, 1979, p. 22-24. 7 refs. In Russian.

The values of fuel quality indicators measured at six-month intervals before, during and after the storage of jet fuel T-6 in large steel tanks at elevated pressures are compared. After 20 months of storage, it is found that the acidity, actual tar content, sediment content and dissolved tars exhibit a slight decline in quality, while the remaining technical indicators (density, distillation temperature range, viscosity, aromatic hydrocarbon content, smokeless flame height, iodine number, total sulfur content, ash content, technical impurities and crystallization temperature) remained unchanged. Results of qualification tests, thermal stability tests, corrosion tests and chemical stability tests also indicate that T-6 fuel can be stored for up to two years with no decline in quality.

A79-48859 # Method of determining mechanical-impurity contents in jet fuels (Metody opredeleniia soderzhaniia mekhanicheskikh primesei v reaktivnykh toplivakh). V. N. Zrelov, N. G. Postnikova, L. V. Krasnaia, E. N. Zhuldybin, M. V. Sal'nikova, and I. I. Zimina. *Khimiia i Tekhnologiia Topliv i Masel*, no. 8, 1979, p. 51-53. 7 refs. In Russian.

Two methods based on nitrocellulose filtration for determining the contents of mechanical impurities in jet fuels are presented. The graphical-analytical method which determines impurity content from the slope of the relation of the mass of deposit collected on the nitrocellulose column to the volume of fuel passed through the column after the period of tar adsorption, may require up to 15 I of fuel. The improved method, derived from the GOST 10577-63 and ASTM D 2276 standard test and designated GOST 10577-78 or Method B, requires only 51 of fuel and relies on a coefficient of 0.7 to account for tar accumulation. The results of Method B determinations are shown to agree well with those of the graphical method, and duplicate determinations of jet fuel impurities contents by Method B are shown to differ by no more than 0.06 mg/l, with a mean deviation of 0.02 to 0.03 mg/l. The method, employing on-site filtration by two number 5 filters, is considered suitable for airport as well as laboratory use. A.L.W.

A79-48870 # A Navy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design. F. Liguori (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 24-27.

A79-48873 # E-3A sentry /AWACS/ ATPG. M. S. Martin (USAF, Software Support Center, Robins, AFB, Ga.). In: AUTO-TESTCON '78, International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 39, 40.

The selection of software aids to provide an organic depot capability for certain items of the Air Force E-3A sentry aircraft is

The ALQ-125 tactical electronic reconnaissance (TEREC) sensor detects, identifies, and locates radar emitters and reports them to ground terminals via narrowband data link. The sensor, which is internally mounted in the RF-4C aircraft, uses left and right side interferometer antenna arrays to determine direction of arrival (DOA) of radar emissions. Locations of tactical emitters such as radars associated with surface-to-air missile systems are computed using triangulation techniques as the aircraft flies along a base leg. The TEREC sensor measures the frequency, pulse repetition interval (PRI), pulse width, and (on a preprogrammed optional basis) scan rate, and compares these with the preprogrammed parameters for up to nine priority emitter types in the airborne computer. All TEREC-collected data is stored on magnetic tape for postflight data reduction using the TEREC portable exploitation processor (T-PEP). (Author)

A79-48849 # Subsonic and transonic flows on a variable sweep wing (Ecoulements subsoniques et transsoniques sur une aile a flèche variable). V. Schmitt and F. Manie (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). La Recherche Aérospatiale, July-Aug. 1979, p. 219-237. 24 refs. In French.

Detailed experiments were performed on models of a variable sweep wing emphasizing in particular flow separation and development of vortex structures in the whole speed range and, in addition, the shape of shock waves at transonic speeds. The results of these tests have been compared with those of calculations made with available codes such as an incompressible panel method for unseparated flows and an unsteady method based on a point discretization of the vortex vector for separated flows. Transonic flows were calculated using different relaxation methods: one based on the perturbation theory, two others on the full potential equation.

(Author)

A79-48856 # The tendency of jet fuels to form deposits on a heated surface (Sklonnost' reaktivnykh topliv k obrazovanilu otlozhenii na nagretoi poverkhnosti). E. P. Seregin, V. G. Gorodetskii, N. P. Golenev, and V. N. Prokudin. *Khimila i Tekhnologiia Topliv i Masel*, no. 8, 1979, p. 17-20. 8 refs. In Russian.

The tendencies of various standard commercial jet fuels to form deposits of oxidation products on heated surfaces are investigated. Temperatures at which deposits start to form, relationships between the amount of test deposit formed and a standard (the thermostability index) and thermal stabilities were determined for the fuels T-1, TS-1, RT and T-6 by means of various procedures. The statistical methods employed (LSART and TSRT-2) are found capable of providing information about total oxidation product formation, but are unable to distinguish thermostability indices, while DTS-1 indicates rates of filter obstruction and only DTS-2 is capable of determining deposit-formation and adhesion parameters. The thermostability indices of the fuels, and thus their tendencies to form deposits on heated engine parts, are found to decrease in the order T-1, TS-1, RT to T-6, and temperatures of deposit initiation to range between 85 and 100 C for T-1 and TS-1, 135 and 180 C for RT and 180 and 190 C for T-6. The fuel deposit formation properties obtained are attributed to relative contents of hetero-organic and oxidizable compounds. A.L.W.

A79-48857 # Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness factor' (Otsenka temperatury nachala razlozheniia reaktivnykh topliv po 'faktoru zhestkosti'). A. K. Bukharkin and G. I. Kovalev. *Khimiia i Tekhnologiia Topliv i Masel*, no. 8, 1979, p. 20-22. In Russian.

The application of the pyrolysis 'hardness factor' derived by Linden (1951) as a measure of the extent of cracking in a hydrocarbon and consisting of the product of the temperature and the 0.06th power of the holding time at that temperature, to the calculation of the temperature at which the thermal decomposition of jet fuels begins is examined. A linear correspondance between the 'hardness factor' and the extent of thermal decomposition as examined. Seventeen automatic test pattern generators (ATPG) of digital type were examined and five, including LOGOS and G- and D-LASAR systems, were selected for further examination. In the analog area, thirteen different circuit analysis programs were studied and it was found that SYSCAP-2 would be the most cost effective.

A79-48878 # Air Force modular automatic test equipment development program. C. M. Wheelock (USAF, Washington, D.C.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 119-121.

The paper examines the Air Force modular automatic test equipment (MATE) development program. It is noted that problem areas with automatic test equipment (ATE) are the proliferation of different configurations, software incompatibilities, erroneous test results, late deliveries of new equipment and high development costs. The MATE family will permit interchangeable modules (hardware and software) to be used at all levels of maintenance, thereby reducing the problem of units passing tests at one level of maintenance and failing at another. Attention is given to the objectives of the MATE program which include reducing the life cycle cost of weapon system support, reduce proliferation of ATE, and improve ATE procurement practices. In conclusion it is stressed that a commitment to supply the necessary resources to the program office must be made by the highest levels of the policy-making machinery. M.E.P.

A79-48883 # ATE and aircraft mechanical diagnostics. T. C. Belrose (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 176-181. 12 refs.

The Army is committed to fielding a family of automatic test support systems (ATSS) to support all Army materiel. The current plan is to field the AN/USM-410 'third generation' ATE. The Army has also sponsored a significant amount of work aimed at achieving an 'on condition' maintenance philosophy for major aircraft subsystems by monitoring turbine engine performance, engine mechanical condition, health of various rotating dynamic components, hydraulic systems, and structural integrity of the aircraft. The objective is to investigate the viability of accomplishing the aircraft condition monitoring and diagnostic task using ATE. Significant points are the following: nonintrusive monitoring of aircraft mechanical systems is possible; impressive benefits can be attributed to this approach, but several attempts at fielding such a system have been terminated because of excessive initial investment costs; and mechanical diagnostics is not a simple extension of a measurement capability.

(Author)

A79-48884 of the P3 Orion. P. M. Knapp (AAI Corp., Baltimore, Md.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 235-241.

The update of the AAI 5500 ATE to the AN/USN-449(V) configuration and the extension of the test program to P-3B and ASN-124 TAC/NAV and P-3C configurations are considered. The AN/USN-449(V) introduced the latest computer configuration, updated peripherals, included ATLAS test language, and added a second test port to the 5500 ATE for dynamic digital testing. The planned installations including Conus sites and Naval Avionics Rework facilities are listed, and communications, data systems,

navigation, and update 11 and 111 systems are discussed. The test set hardware station stimulus and measurement capabilities are summarized, and integrated logistics support plan, test program set development, including test program information, program printouts, CAD printouts, and patchcard and cable information are listed. The Atlas impact and test program set production are examined, and it is concluded that the support of the P-3 by automatic test equipment permitted transition from prime equipment manufacturer to depot support, and illustrated the ability of a company specializing in integrated logistics support to produce the ATE and test program.

A.T.

A79-48887 # Can avionic testability requirements be enforced. R. Brocchi (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 282-285.

Theoretically avionic testability can be specified, levied contractually, designed and integrated into hardware, and demonstrated. The intent of this paper is not to identify how it is possible to achieve testability but how it is possible to get the maximum testability that is practical by a methodology of enforcement and control from the time the avionics procurement is envisioned through the design, development, and acceptance. The review and concurrence in testability is accomplished through the data submittals from the avionics supplier. Enforcement is directly related to the type of data required, when it is required, the formats specified, and the ability to get exactly what was contractually required. The optimum method of achieving this end is to have support engineering personnel participate through the stages of data preparation, review, and resubmittal. The participation is via concurrent reviews in conjunction with the avionics design review cycle, and by directing the contractor to include specific testability requirements for each UUT on a case by case basis. (Author)

A79-48888 Avionics design for testability - An aircraft contractor's viewpoint. J. M. Roche (McDonnell Aircraft Co., St. Louis, Mo.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 286-293.

Designing avionics for testability is the inclusion of design provisions in the avionics to enable test of the performance capability of the avionics, to isolate avionic malfunctions to replaceable elements, and to permit adjustment and alignment of the avionics as may be required. The effective implementation of testability provisions in the design of the Air Vehicle Equipment (AVE) and the Ground Support Equipment (GSE) that comprise the avionics can improve equipment reliability and availability while reducing equipment weight and cost. Accordingly, the operational readiness of the weapon system can be improved by effectively designing the avionics for testability. The aircraft contractor's viewpoint of designing avionics for testability is presented along with the methods and techniques employed by the aircraft contractor to effectively include testability provisions in the avionics. (Author)

A79-48889 Avionics design for testability - A vendor's viewpoint. D. C. Byerly (General Electric Co., Binghamton, N.Y.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 294-299. 6 refs.

GE experience with the testability of new avionics systems is reviewed with particular reference to the F-18 program. It is found that testability assessment and enhancement efforts will have minimal adverse impact on the development program for a new avionics system if these efforts are performed at the beginning of the design phase by a separate team of testability/maintainability engineering specialists working in parallel with the system design team. Early generation of test requirement document data submittals provide a highly visible means of measuring and reviewing testability for each UUT in an avionic system.

A79-48890 Testability, the key to economical and operationally effective avionic test software. M. B. Weber (Harris Corp., PRD Electronics Div., Syosset, N.Y.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30. 1978. Conference Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978 p. 300-304.

Testability, in the context of this paper, is defined as the optimum automatic fault detection and isolation capability permitted by the avionic hardware design and economically reflected in the design of the test program set (TPS) for a given automatic test equipment (ATE) system. The paper addresses the major elements of the total avionic/support system (avionic UUT/ATE/TPS, where UUT = unit under test) and the key characteristics of these elements as they relate to and affect the development economics and operational effectiveness of TPSs. The discussion presented reveals how UUT design data derived during the development process of the avionics can be utilized to establish a testability baseline for the UUT/ATE as well as effect-added efficiency in the UUT test software development process.

A79-48891 Techniques for fault isolation ambiguity reduction. R. L. McCollor (Support Systems Associates, Inc., Northport, N.Y.) and N. M. Clark (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electroical and Electronics Engineers, Inc., 1978, p. 305-310.

The specification requirements for avionics testability and test access are reviewed, noting that in general, the requirements are not stringent enough to meet the needs of the ATE operator or avionics repair person. Attention is given to some frequent causes of excess PCOF ambiguities and erroneous PCOF's. Means of eliminating such deficiencies in future equipment designs and test programs are described. Finally, recommendations are made for specification revisions and future vendor and contractor responsibilities. M.E.P.

A79-48894 # F-16 avionics maintenance concept and multinational aspects. G. L. Vickery (USAF, Systems Command, Washington, D.C.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 336-339.

The paper describes the three level avionics maintenance concept for the F-16, organization, intermediate, and depot. This concept has been tailored to the F-16 weapons system by an iterative process. It is shown that decisions are made based on the best economic approach, yet test capability is retained that allows a reversal in those instances where the phased maturation of the weapons system dictates a change. Finally, it is stressed that since the F-16 will carry the defense forces of many countries into the next century, the development of a workable maintenance concept is a critical element of logistics support planning for ensuring that defense capability. M.E.P.

A79-48895 # F-16 depot automatic test equipment. D. B. Day (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 340-345.

General Dynamics Corporation, Fort Worth Division (GD/FW) is currently developing the F-16 depot level Automatic Test Equipment (ATE) system under the direction of the F-16 System Program Office (SPO) located at Wright-Patterson Air Force Base, Ohio. Existing design testers are being extensively utilized through update and improvement modifications, with the vast majority of the development work concentrated in the Test Packages (Interface Test Adapters (ITAs) and test programs). This paper describes the acquisition management techniques used and the various ATE and software development aids selected to date. The test package development effort is described. Our approach to supporting EPROM/PROM ICs is presented. Configuration management is discussed. Finally, a look at the program future is given. (Author)

A79-48896 A new U.U.T./test station interface. M. B. Hosking (General Dynamics Corp., Electronics Div., San Diego, Calif.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record, New York, Institute of Electrical and Electronics Engineers. Inc., 1978, p. 346-350.

The modular UUT/test station interface was designed specifically for a combination of LRU and SRU testing. Its advantages include ease of maintenance, long life, simplified field maintenance, proven high reliability, and a substantial reduction in signal degradation due to excessive lengths of interface cabling. Moreover, interface adapter complexity and weight are minimized. B.J.

A79-48945 Achieving consistency in the production of critical jet engine components by means of press forging. F. Turner (Cameron Iron Works, Ltd., Livingston, Scotland). In: High temperature alloys for gas turbines; Proceedings of the Conference, Liège, Belgium, September 25-27, 1978. Barking,

Essex, England, Applied Science Publishers, Ltd., 1978, p. 893-899. In recent years, manufacturers of aircraft engine components have placed increased emphasis on quality control and inspection procedures. A major reason for this emphasis is the engine builder's requirement of consistency in the fabrication of components. In the present paper, the ingredients of consistency in manufacture are identified as a combination of good quality control and the nature and reliability of the manufacturing equipment. Two examples of how well consistency has been achieved in an industrial plant, as measured by mechanical property data, are presented. V.P.

A79-49052 \* LDV measurements on propellers. J. P. Sullivan (Purdue University, West Lafayette, Ind.). In: Laser velocimetry and particle sizing; Proceedings of the Third International Workshop, West Lafayette, Ind., July 11-13, 1978.

Washington, D.C., Hemisphere Publishing Corp., 1979, p. 531-534. NASA-supported research.

Laser Doppler velocimeter (LDV) measurements of the flow velocity around high-efficiency propeller blades for high disk loading turboprop propulsion systems are reported. The wind-tunnel flow around sets of eight straight and swept propeller blades with the same twist and chord distributions was measured using a conventional two-color dual scatter LDV system. The measurements of the axial flow velocities a small distance in front of the propeller blade, between the blade row, and downstream of the propeller are shown to provide information necessary for the determination of overall performance, swirl angle distribution, blade loading distributions, local lift and drag coefficients, interference effects, shock location, local induced velocities, wake characteristics and stall pattern, A.L.W.

A79-49054 \* # Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover. J. D. Ballard, K. L. Orloff (NASA, Ames Research Center, Moffett Field, Calif.), and A. B. Luebs (Gates Learjet Corp., Wichita, Kan.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. 14 refs. (AHS 79-1)

A laser velocimeter has been used to study the flow surrounding a 2.13-m-diameter, two-bladed, teetering model-scale helicopter rotor operating in the hover condition. The rotor system employed interchangeable blade tips over the outer 25% radius. A conventional rectangular planform and an experimental ogee tip shape were studied. The radial distribution of the blade circulation was obtained by measuring the velocity tangent to a closed rectangular contour around the airfoil section at a number of radial locations. A relationship between local circulation and bound vorticity is invoked to obtain the radial variations in the sectional lifting properties of the blade. The tip vortex-induced velocity was also measured immediately behind the generating blade and immediately before the encounter with the following blade. The mutual influences between blade loading, shed vorticity, and the structure of the encountered vortex are quantified by the results presented and are discussed comparatively for the rectangular and ogee planforms. The experimental loading for the rectangular tip is also compared with predictions of existing rotor analysis. (Author)

A79-49055 Helicopter performance methodology at Bell Helicopter Textron. F. D. Harris, J. D. Kocurek, T. T. McLarty, and T. J. Trept, Jr. (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 48 p. 23 refs. (AHS 79-2)

Forward flight helicopter performance methodology is reviewed with emphasis placed on the two key aspects of the power required calculation, pitch attitude for trim and rotor aerodynamics. The modeling approach to trim is described along with contrasts among airframe component and rotor forces and moments. It is shown that improved correlation results from a more physical treatment of the blade tip loss model used in combination with unsteady, threedimensional blade element aerodynamics. The sensitivity of the performance calculation to airfoil data and blade elastic motion are discussed, and the accuracy of simple momentum theory for prediction of power required in low speed flight is outlined. V.T.

A79-49056 A lifting-surface method for hover/climb airloads. J. M. Summa and D. R. Clark (Analytical Methods, Inc., Bellevue, Wash.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society,

1979. 12 p. 17 refs. Grant No. DAAJ02-76-C-0069. (AHS 79-3)

The development of a lifting-surface method for hover/climb airloads and its application in the prediction of hovering rotor performance are described. The method includes both a prescribed and a relaxed wake representation. Unique features of wake modeling developed for the method include the wake segmentation, a new far-wake model, and a model of the tip vortex shedding across the blade chord. In addition, new techniques for wake relaxation, such as a numerical method for the calculation of wake velocities due to curved vortex filaments, a more representative core model, and a new method of integration for new wake shapes are discussed. Calculated results demonstrate that the fundamental explanation for discrepancies in hovering rotor airloads predicted by lifting-line and lifting-surface methods is the wake shedding model. Finally, hovering performance correlations for converged relaxed wake calculations with experimental data are analyzed. (Author)

A79-49057 The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil. A. O. Saint Hilaire, F. O. Carta (United Technologies Research Center, East Hartford, Conn.), and W. D. Jepson (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 10 p. 10 refs. (AHS 79-4)

An experimental study was conducted to determine the effect of sweep on the unsteady aerodynamic load characteristics of an NACA 0012 airfoil oscillating in pitch about the quarter chord. The unsteady data for these comparisons were obtained from numerical integrations of the unsteady chord-wise pressure distribution. It was found that sweep delays the onset of dynamic stall and generally reduces the magnitude of the unsteady load variation about the mean response as a function of the pitch displacement. A noteworthy aspect of this research program was the ability to estimate the unsteady drag force using only those contributions due to pressure forces. This approximation is especially valid over the stalled portion of the cycle where the viscous drag contribution is relatively small. (Author)

A79-49058 An integrated analytical and experimental investigation of helicopter hub drag. A. H. Logan, R. Marthe (Hughes Helicopters, Culver City, Calif.), D. R. Clark (Analytical Methods, Inc., Bellevue, Wash.), and A. Phelps (U.S. Army, Structures Laboratory, Hampton, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 16 p. 8 refs. (AHS 79-5)

This paper describes an integrated program which uses a viscous wing/body computer code to analyze low drag concepts of a current helicopter. Based on this analysis, full-scale wind tunnel models are fabricated and tested. The resulting experimental data are then compared to predictions and areas of agreement are defined. The viscous wing/body computer code is Program DRAG which includes engine inflow/exhaust modeling and main rotor hub representation. The full-scale experimental model represents the YAH-64 and the testing was conducted in the NASA/Langley V/STOL tunnel. The data presented and discussed indicate that Program DRAG is acceptable for designing hub/pylon modifications. In addition, it is shown that engine air flow has a significant effect on model pylon fairings and the importance of sealing are discussed. (Author)

A79-49059 Helicopter obstacle strike tolerance. L. T. Burrows (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.), J. E. Brunken (Bell Helicopter Textron, Fort Worth, Tex.), and B. P. Gupta (Hughes Helicopters, Culver City, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. Army-supported research. (AHS 79-7)

Design concepts for improving the tolerance of helicopters to in-flight obstacle strikes are derived for the main rotor, tail rotor, fuselage and landing gear (fixed system), and main rotor hub and controls. Selected concepts are comparatively analyzed based on their functional, operational, and aircraft integration characteristics. and on their strike damage cost-reduction potential. Detailed definition of the in-flight obstacle strike problem provided a sound basis for the derivation and selection of the design concepts having the greatest potential for improving helicopter strike tolerance. Problem definition included determination of the types of obstacles struck and frequency; areas of helicopter struck and frequency; cost of strikes; and diameter and type of trees and wires for which current systems have reasonable strike tolerance. Obstacle strike tolerance design criteria for future systems are proposed, as are suggestions for improving the obstacle strike protection of current systems through retrofit. (Author)

A79-49060 # A system for interdisciplinary analysis - A key to improved rotorcraft design. A. W. Kerr (U.S. Army, Research and Technology Laboratories, Moffett Field, Calif.) and J. M. Davis (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 15 p. 16 refs. (AHS 79-8)

Development of the Second Generation Comprehensive Helicopter Analysis System (2GCHAS) is being initiated by the U.S. Army Research and Technology Laboratories. This system provides the capability to model the total helicopter to predict performance, loads, vibration, aeroelastic stability, stability and control, and acoustics characteristics. This interdisciplinary analysis system is a basic tool required to support the rotorcraft design process. Aspects of this system which affect its application as a design tool are addressed. A primary consideration in the development of the system is the manner in which component parts of the helicopter are combined analytically to represent the total vehicle system. The results of a workshop conducted to discuss formulation of equations and related issues are summarized. Requirements to make the system easy to use are explored, including the manner in which it is applicable through all phases of aircraft design and development from conceptual analysis through flight test and detailed modification support. (Author)

A79-49061 Composite helicopter tail booms. H. J. Brown (Fiber Science Corp., Salt Lake City, Utah). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 7 p. (AHS 79-9)

Two different design concepts for helicopter tail booms made from advanced composites are discussed. Cost, structural design and manufacturing factors are presented using the experiences gained from these two tail booms as examples. One tail boom was test flown after extensive static and dynamic testing to prove feasibility. Labor costs using the wet filament winding process plus 1980 material prices for graphic fiber and epoxy resin are presented as justification that production of composite tail booms is reasonable today.

(Author)

A79-49062 Crashworthy armored crewseat for the UH-60A Black Hawk. S. P. Desjardins, D. H. Laananen, R. L. Taylor (Simula, Inc., Tempe, Ariz.), and R. J. Dummer (Norton Co., Industrial Ceramics Div., Worcester, Mass.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. 6 refs. (AHS 79-10)

In addition to the typical operational features of adjustment and comfort, the crewseat for the UH-60A Black Hawk has been designed to provide protection from both ballistic fire during operation and crash hazards during accidents. It is the first production seat to be designed entirely in accordance with MIL-S-58095(AV), the Army specification which specifies the degree of crash protection in terms of structural strength and energy absorption as well as the means for evaluation. This paper includes a discussion of the requirements imposed on the seat design, a description of the seat system with emphasis on its unique features, and a presentation of qualification test results. (Author)

A79-49063 Designing with experimental mechanics. J. Cernosek (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. (AHS 79-11)

Three-dimensional photoelasticity was modified and developed into a relatively inexpensive tool for accurate stress analysis of complicated helicopter parts. The typical design process of helicopter dynamic components is presented along with model methods of experimental mechanics. The method of aluminum-filled epoxy models, stress freezing three-dimensional photoelasticity, and a new model material based on epoxy resin are discussed. Consideration is given to model casting, curing, and loading and evaluation of stress distribution. The main rotor grip of the 412 model was designed using a three-dimensional photoelastic model to evaluate the stress level. V.T.

A79-49064 Agricultural helicopters. H. E. Lemont (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. 5 refs. (AHS 79-60)

Independent investigations, a NASA-funded study on helicopter aerial applications of materials, and flight spraving tests conducted by BHT are discussed. Agricultural (AG) helicopter systems are investigated by computer analysis for parametric effects on swath widths. Standards and productivity indices for a rating system are generated from operational costs, payloads, cruise speeds, and swath widths. Dollar/acre costs are reviewed for establishing Ag helicopter capabilities. The NASA study on the current technology of helicopters, equipment and systems and their inherent limitations form the background for this work. Designs are synthesized from this and other criteria derived in previous studies. These aircraft (three sizes and three missions) are exercised for design potential, cost improvements, and changes in dollars/acre. Advantages of a 'lofted swath' spraying technique and potentials for ultrawide swaths are indicated. Conclusions and recommendations are presented. (Author)

A79-49065 Meeting the challenge of precise navigation during nap-of-the-earth flight. S. P. Rogers and K. D. Cross (Anacapa Sciences, Inc., Santa Barbara, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. 7 refs. (AHS 79-12)

Navigation during nap-of-the-earth (NOE) flight is one of the most demanding tasks ever required of an aviator. The difficulty imposed by a limited view of surrounding terrain is augmented by the complexity of map interpretation. Nevertheless, aviators are expected to navigate to an accuracy of 100 meters. In order to help meet the challenge of such precise navigation, two major efforts are underway. First, special courses in map interpretation and terrain analysis have been constructed to instruct pilots in these vital skills. The lessons include extensive cinematic simulation exercises to teach the interpretation of symbology, effects of map scale, cartographic practices and other critical information. Second, a research program is being conducted to support the development of a computergenerated topographic display. Such a display is capable of providing enormous advantages over conventional maps. The effectiveness of the system depends greatly upon the research performed to adequately define the display content and format. (Author)

A79-49067 Multiplex technology applied to helicopters. L. A. Frazer and J. H. Emery (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 8 p. (AHS 79-14)

A multiplex system is an information transfer system that time-shares a single transmission medium with multiple information sources and receivers. The application of the multiplex technology can greatly enhance the helicopter mission performance, providing more versatility in the design and making possible the optimization of the avionics system. The paper familiarizes the reader with multiplex technology concepts and terminology, and introduces the idea of the multiplex system as a tool with which to integrate helicopter subsystems. The application of the multiplex technology to helicopters has been made possible by the advances in electronics technology, primarily in the area of microprocessors and large-scale integration (LSI) techniques. S.D.

A79-49068 Antennas for the Black Hawk helicopter. M. L. Parent (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 13 p. (AHS 79-15)

The Black Hawk is the Army's troop transport helicopter for the 1980s and beyond. This helicopter incorporates flush antennas with no protrusions on the bottom to be damaged in rough-area landings. The paper outlines the design and development program for these antennas. Attention is given to a discussion of design objectives, initial antenna designs and installation, the antenna test program, and resulting antenna improvements for production. The design objectives for Black Hawk antenna include compliance with overall performance, mechanical, environmental, EMI, reliability, maintainability, and weight requirements, along with meeting design-to-cost requirements. The final development tasks have been successfully completed and the flush antennas are being delivered to the Army on production Black Hawk helicopters. S.D.

A79-49069 Advances in decelerating steep approach and landing for helicopter instrument approaches. P. S. Demko and J. H. Boschma (U.S. Army, Fort Monmouth, N.J.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. (AHS 79-16)

The instrument decelerating steep approach and landing technique which extended the helicopter capability into instrument meteorological conditions (IMC) domain is considered. This capability permits the helicopter pilot to guide it along a precise steep angle approach course and to perform a normal deceleration to a safe approach termination within a confined landing zone, without visual reference to the outside world. This method uses microwave landing guidance system with precision DME, 4-cue/4-axis flight director (FD) and autopilot (AP) system. The deceleration maneuver, approach profile and rate, the microwave landing system controls and equipment, the decelerating steep approach and landing (DSAL) flight director and controls are discussed, and performance of the IMC DSAL maneuver is illustrated by a flight from 1000 and 200 ft intercept altitudes, along 6 and 12 deg glideslopes by the pilot through the FD, or by the autopilot, to a stable hover over the desired landing point. A.T.

A79-49070 Helmet mounted display and sight development. C. J. G. Lewis (Marconi Avionics, Inc., Atlanta, Ga.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 14 p. (AHS 79-17)

Three helmet mounted systems to provide data to the pilot flying head up in nap of the earth (NAP) and at night are examined. The pipelite system avoids the mass, thermal and high voltage disadvantages of mounting a cathode ray tube system directly on the helmet by an airframe cathode ray tube and optics, and data is projected into a coherent fiber optic bundle which brings the light to an optic mounted on the pilot's helmet. The helmet optical position sensing system, HOPS, uses pulsed infrared emitting diodes mounted on the helmet. Their output is detected by airframe mounted, charge coupled devices using V/slit pinhole cameras. The system is free from electromagnetic interference and provides half degree line of sight accuracies. Data for simple sighting and management tasks is provided with a visor projection optics and a high brilliance light emitting diode (LED) addressable matrix with a large viewing aperture. A.T.

A79-49071 \* Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results. B. L. Lee (NASA, Langley Research Center, Hampton, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. 5 refs. (AHS 79-18)

This paper presents results of an experimental program conducted to obtain data which can be used for correlations of rotor blade dynamic analyses. Measurements were made of the rotating frequencies and mode shapes of a representative full-scale, twobladed helicopter rotor in a vacuum. The blades were cantilevered to the hub. Mode shape data were obtained optically using a system of cameras developed specifically for this purpose. Excitation of the rotor was provided by vertical oscillatory motion of the hub. To compare experimental and analytical results, correlations of some experimental measurements with calculations from an existing blade modes computer program based on a Holzer-Myklestad procedure are presented, and the differences between the results are discussed. The experimental and analytical natural frequencies were generally in good agreement as were the principal components of the modal deflections for the flap and lag modes. The torsion mode shape indicated disagreement between the measured and calculated results in regard to the amount of flap and lag motions present in this mode, while the spanwise variations of the measured and calculated torsional components were in agreement. (Author)

A79-49072 Dynamics requirements for an Advanced Scout Helicopter /ASH/. D. P. Schrage and R. A. Wolfe (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 8 p. 9 refs. (AHS 79-19)

The paper presents modified detailed requirements specified for recent helicopter development programs and their potential applicability to the requirements for the Advanced Scout Helicopter (ASH) design. The recommended ASH System Specification (SS) requirements for dynamics are considered, and it is shown how they are and should be verified through the Airworthiness Qualification program (AQP). Attention is given to aeroelastic stability, mechanical stability, engine, shaft, and rotor resonances/instabilities, and air frame vibration. A mast-mounted sight (MMS), true nap-of-the-earth (NOE) flight, and maneuverability are outlined along with their effects on the dynamics requirements discussed. V.T.

A79-49073 Theoretical flap-lag damping with various dynamic inflow models. D. A. Peters (Washington University, St. Louis, Mo.) and G. H. Gaonkar (Indian Institute of Science, Bangalore, India). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society,

1979. 11 p. 13 refs. (AHS 79-20) The effects of dynamic inflow perturbations are incorporated into a flap-lag stability analysis of a rigid blade. The concept of equivalent Lock number, previously, used to model the effect of

equivalent Lock number, previously used to model the effect of quasi-steady inflow for flapping only, is extended to the case of coupled flap-lag motions by the addition of an equivalent profile drag coefficient. Plots of flap and lead-lag damping are presented for various inflow assumptions including: no dynamic inflow, quasisteady momentum theory, unsteady momentum theory, empirical inflow, and equivalent Lock number and drag coefficient. The results show that dynamic inflow has a large effect on blade damping for the regressing mode. In some instances, this effect can be modeled by the equivalent Lock number and drag coefficient. (Author)

A79-49074 Evaluation of the practical aspects of vibration reduction using structural optimization techniques. H. W. Hanson (Bell Helicopter Textron, Fort Worth, Tex.) and N. J. Calapodas (U.S. Army, Aviation Research and Development Command, Fort Eustis, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., American Helicopter Society, 1979. 13 p. 6 refs, Grant No. DAAK51-78-C-0011. (AHS 79-21)

The results of a practical evaluation of two structural optimization techniques for vibration reduction, the Vincent circle method and the forced response strain energy method, are discussed. An elastic line mathematical model of the AH-IG helicopter was used for initial comparison studies of the two methods and for evaluating the Vincent circle method with respect to mass changes and damping effects. The forced response strain energy method was selected for vibration reduction of a large complex built-up Nastran AH-IG model through structural stiffness optimization. It is noted that while the Vincent circle method is useful in predicting optimum locations of dynamic absorbers for vibration reduction, for more detailed analysis the damp forced response strain energy method has the potential benefit of rapid evaluation and optimization of structural vibratory response. V.T.

A79-49075 Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor. J. A. Staley, R. Gabel (Boeing Vertol Co., Philadelphia, Pa.), and H. I. MacDonald (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 14 p. 10 refs. (AHS 79-23)

This paper presents ground and air resonance test results for full scale tests of the Boeing Vertol-Army Bearingless Main Rotor (BMR) flown on a BO-105 helicopter. The BMR has the advantage of simplicity due to elimination of the pitch bearing and the flap and lag hinges used in articulated rotor designs. This results in potential improvements in performance, reliability and life cycle costs. The aircraft was tested for ground and air resonance damping at conditions which were expected to be critical, including level flight, climbs, descents, maximum power dives, and autorotations; in addition, testing during loads evaluations included banked turns, pull-ups, and push-overs. The aircraft encountered no air resonance mode instabilities during any of these flight conditions. Initial testing disclosed that ground resonance mode damping had to be improved by stiffening the existing landing gear skid. Analytical results are also presented which were used in developing the rotor design and in preparing the flight test procedures. Model rotor test results are also shown which gave an accurate preview of what was to have been expected during full scale flight testing. (Author)

A79-49076 Spirit helicopter handling qualities design and development. G. P. Wright and N. Lappos (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. (AHS 79-24)

The design and development of the Spirit (S-76) helicopter are reviewed. A design and development program included preliminary design, developmental model and wind tunnel testing, computer simulation, and a developmental flight test program. Particular design features, such as a fixed, low horizontal stabilizer, main rotor pitch/flap coupling, pitch bias actuator, mechanical control coupling, and stability augmentation are described. It is shown that the helicopter handling quality design depended heavily on simulation model results. Reliance on simulation resulted in few developmental changes after the first flight. Test data accumulated for the simulation model, and simulation correlation with tests are also presented. V.T.

A79-49077 Improved method of predicting helicopter control response and gust sensitivity. F. White and B. B. Blake (Boeing Vertol Co., Philadelphia, Pa.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. 6 refs. (AHS 79-25)

The paper presents the results of studies performed using recently developed analytical models correlated with flight test data to better understand the effects of rotor and aircraft configuration on flying qualities. Attention is given to low speed control trim change, gust sensitivity and interaxis coupling. A theory is given which has been developed to predict rotor trim changes resulting from nonuniform downwash effects. It is shown that the approach combines fixed wing lifting line theory with simple classical rotor equations and allows rapid estimation of parametric effects and trim changes using simple hand calculations. A computer program is discussed which allows the user to select from a variety of helicopter and control system math models and presents output in either the time or frequency domain. Finally, correlation with flight test data is shown, and results of control cross coupling and gust sensitivity studies are presented. M.E.P.

A79-49078 \* # Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight. R. D. Forrest (FAA, Washington, D.C.), R. T. N. Chen, R. M. Gerdes, T. S. Alderete, and D. R. Gee (NASA, Ames Research Center, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 27 p. 12 refs. (AHS 79-26)

An exploratory piloted simulation was conducted to investigate the effects of the characteristics of helicopter flight control systems on instrument flight handling qualities. This joint FAA/NASA study was motivated by the need to improve instrument flight capability. A near-term objective is to assist in updating the airworthiness criteria for helicopter instrument flight. The experiment consisted of variations of single-rotor helicopter types and levels of stability and control augmentation systems (SCAS). These configurations were evaluated during an omnirange approach task under visual and instrument flight conditions. The levels of SCAS design included a simple rate damping system, collective decoupling plus rate damping, and an attitude command system with collective decoupling. A limited evaluation of stick force versus airspeed stability was accomplished. Some problems were experienced with control system mechanization which had a detrimental effect on longitudinal stability. Pilot ratings, pilot commentary, and performance data related to the task are presented. (Author)

A79-49079 Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST. S. W. Ferguson and K. E. Builta (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 19 p. (AHS 79-27)

The Bell 214ST helicopter is an extended version of the single-engine Bell 214 and is powered by two General Electric CT7-2 engines. A fly-by-wire (FBW) elevator system is developed for the 214ST helicopter. Considerable insight is gained in handling qualities, testing techniques, and elevator-related aerodynamics during the development of the 214ST FBW elevator. Significant handling qualities improvements, as compared with those available in Bell helicopters using conventional elevator control systems, are demonstrated in pitch attitude control, longitudinal static stability, trim change with power, and damping of long-period longitudinal oscillations. The availability of a pilot-controlled elevator mode during testing provided the opportunity to acquire previously unavailable static and dynamic stability derivative data. Other valuable data allowed further understanding of the airframe-elevator aerodynamic relationship, as well as the aerodynamic characteristics of the elevator pitching moment. S.D.

A79-49080 Advanced Scout Helicopter flying qualities requirements - How realistic are they. D. M. Pitt and F. E. Heacock (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society,

1979. 14 p. 24 refs. (AHS 79-28)

The proposed mission profile and handling qualities requirements for the Army's Advanced Scout Helicopter (ASH) are examined. The results of the AAH and UTTAS competitive testing are used as a basis to define the state-of-the-art helicopter handling qualities, and what can realistically be expected from the ASH. Results of testing of various Army helicopters in simulated ASH maneuvers are used to justify the ASH postulated handling qualities requirements. Army testing of ASH-type mission equipment and requirements on fielded Army helicopters and their effects on the stability of the known helicopter are used to rationalize expected ASH stability. (Author)

A79-49081 Handling quality and display requirements for low speed and hover in reduced flight visibility. R. H. Hoh and I. L. Ashkenas (Systems Technology, Inc., Hawthorne, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. 24 refs. (AHS 79-29)

A classification scheme has been developed to account for outside visual cues and cockpit displays in determining the required equivalent system forms for low speed and hover. Tentative criteria are presented in terms of a visibility scale which quantifies environmental conditions for the intended mission in a more fine-grained manner than simply specifying IMC or VMC. There are indications that rate and attitude systems may be used for partial IMC conditions but that a translational rate command (TRC) system is required for low speed and hover in zero visibility. In general, most experiments indicate that advanced displays are not a substitute for augmentation. Tentative limiting conditions are defined for rate and attitude systems, but more data are required to define handling qualities for TRC systems. Since the existing data base is primarily oriented toward command/response characteristics, definition of the limiting conditions for turbulence and large discrete wind shears also requires more data. (Author)

A79-49082 Role of Numerical Control Design in the computer aided design/manufacturing interface at Sikorsky. G. O. Pranspill (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C.; American Helicopter Society,

1979. 9 p. (AHS 79-30)

The evolution of Numerical Control Design (Engineering) function from its beginnings in graphic lofting/lines layout/master dimensions to its current pivotal position within the aircraft design/manufacturing process is described. The development and application of many sophisticated computerized hardware and software systems currently in operation are outlined. These include interactive graphics, automated drafting and digitizing, demand batch processing and a greatly enhanced APT III system for design/drafting/lofting. The integration of sheet metal layout and template/tool design within the Numerical Control Design function is shown resulting in the output of a wide variety of tool drawings for downstream manufacturing requirements which are illustrated. How these improved interfaces with preliminary and production design and with manufacturing operations and quality assurance coupled with the increased efficiencies of the above systems have resulted in substantial cost and lead time savings in the development of prototype and production aircraft are demonstrated. (Author)

A79-49083 Model 206L composite litter door. D. Crist (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. (AHS 79-31)

This paper describes a program to design and manufacture a composite door. The door selected was the litter door of the Bell Model 206L, A new manufacturing process was developed for curing the door in a single cure cycle in a closed cavity tool by using air pressure inside the hollow sections, but without an internal pressure bag. The composite door developed is an all-Kevlar/epoxy design which is cured in a Kevlar/epoxy bond tool. The resulting composite door is 37 percent lighter than the baseline aluminum door. Cost, weight, appearance and manufacturing aspects are discussed and compared to the production aluminum door. (Author)

A79-49084 Determining the contour of helicopter rotor blades automatically using electro-optical techniques. A. Pellman (Dreyfus-Pellman Corp., Stamford, Conn.) and T. J. Pojeta (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979.

17 p. Grant No. DAAK50-78-C-0008. (AHS 79-32)

The design of a noncontacting electrooptical system that automatically measures the contour of helicopter blades is presented. An experimental model of an electrooptical range finder was also designed, fabricated, and tested. To test contouring accuracy, measurements were made electrooptically at eighty-seven points on the surface of four sample helicopter rotor blades. In order to check the accuracy of these noncontact electrooptical contour measurements, mechanical-contact gauge measurements were also made on the same sample rotor blades. Contouring test measurements were also made on partially painted translucent fiberglass and blackrubber-coated rotor blades in order to determine how light penetration at the rotor surface and low reflectance would affect contour measurements.

A79-49085 Superplastic forming diffusion bonding of titanium helicopter airframe components. B. A. Burroughs (Rockwell International Corp., Military Aircraft Div., El Segundo, Calif.) and N. J. Mocerino (Hughes Helicopters, Culver City, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington. D.C., American Helicopter Society, 1979. 6 p. (AHS 79-33)

Titanium fabrication combining superplastic forming (SPF) with concurrent diffusion bonding (DB) to reduce fabrication costs and titanium helicopter airframe weight is considered. Superplasticity in titanium which produces large tensile elongations without local thinning is discussed, noting the application of the SPF/DB process for multiple sheet fabrication of the 5 by 8 ft expanded sandwich B-1 aircraft engine access door. The cost and weight savings of this process led to production-type helicopter components for advanced helicopter YAH-64 with a part count reduction up to 30% and proportional cost savings. Three candidates were selected for SPF/DB design evaluation: (1) the aluminum H/C bonded catwalk bridge assembly over the engine driveshaft, (2) the aluminum skin/stringer mechanically fastened engine-nacelle door/work platform, and (3) the primary engine firewall, which is currently a built-up titanium sheet-stiffener assembly with mechanically fastened engine mounts. Further design optimization is expected to increase cost/weight savings, prior to initial production fabrication. A.T.

A79-49086 Metal-matrix composite structures. R. L. Pinckney (Boeing Vertol Co., Philadelphia, Pa.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. 6 refs. Armysupported research. (AHS 79-34)

A design engineering program and fabrication technology development to produce and evaluate complex, high-modulus, fiber-stabilized cast magnesium structure is presented. The introduction of an aluminum oxide, continuous-length, high-modulus fiber and its physical and chemical compatibility with molten aluminum and magnesium alloys made feasible a new direct-casting method of producing high-modulus metal-matrix composite materials. Structural load tests of the CH-47 helicopter main transmission case produced by this method demonstrated that lower deflections under load are achievable. Analysis of the results indicate that better control of component location should provide increased life, reduced vibration and attendant noise. It was shown that new magnesium investment-casting technology can produce void-free composites containing aligned and cross-plied continuous fibers up to 55% by volume, and that direct-cast metal-matrix composite structures can be fabricated and effectively used to stiffen complex helicopter structures. A.T.

Washington.

Automatic scanning inspection of composite A79-49087 helicopter structure using an advanced technology fluoroscopic system. R. H. Porter and B. J. Hunter (Bell Helicopter Textron. Fort Worth, Tex.), In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979. Proceedings. Washington, D.C., American Helicopter Society,

1979, 6 p. (AHS 79-35)

This paper discusses the fluoroscope system that was recently installed at Bell Helicopter Textron (BHT). Included are some of the capabilities of the image intensifying tube and the video image processor that enhances the image signal prior to presentation on three different monitors: a high resolution black and white monitor, a pseudo three-dimension image monitor and a color monitor with variable color density slicing features. This fluoroscope system has all of the video image enhancement features incorporated to compensate for the slight losses of sensitivity and resolution still inherent in the image intensifying tubes of today. (Author)

Computer-assisted high-speed balancing of T53 A79-49088 \* and T55 power turbines. T. J. Pojeta (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.) and T. J. Walter (Mechanical Technology, Inc., Latham, N.Y.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., Washington, May 21-23, 1979, Proceedings. D.C., American Helicopter Society, 1979. 9 p. 9 refs. NASAsupported research. (AHS 79-36)

Standard overhaul procedures for U.S. Army helicopter engines require operational vibration acceptance testing after rebuild. Engines frequently experience vibrations which exceed allowable overhaul work requirement limits. The rework/retest cycle for these engines constitute a significant cost penalty to the overhaul center. This paper reviews both analytical and test data which indicate bending critical speeds within the operating speed range of the low-speed power turbine rotor as the cause of most test cell rejections. High-speed balancing techniques are applicable and are capable of significantly reducing this reject rate. A complete prototype computer-assisted high-speed balancing system for assembled T53 and T55 power turbine rotors is described. (Author)

The influence of engine/fuel control design on A79-49089 helicopter dynamics and handling qualities. W. A. Kuczynski, D. E. Cooper, W. J. Twomey, and J. J. Howlett (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington D.C., American Helicopter Society, 1979. 14 p. 7 refs. (AHS 79-37)

The paper examines the compatibility of the engine/fuel control with helicopter rotor and airframe dynamics in the torsional sense at frequencies below the rotor rotational speed. Consideration is given to the characteristics: torsional stability, transient response (droop) and handling qualities of the helicopter. Studies have shown that the transient response in the rotor speed degree of freedom is affected by the state of the rotor aerodynamics during the condition of high torque demand. It is also shown that the engine/fuel control system can influence the damping in the aircraft handling qualities modes. These interactions are described, drawing upon both flight test experience and analysis. A flight dynamics simulation, GENHEL, is used for this analysis and results are presented which show the potential of using body state feedback to the fuel control to enhance aircraft handling qualities and rotor droop characteristics. M.E.P.

Rotorshaft torquemeter. R. B. Bossler, Jr. A79-49090 (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings, D.C., American Helicopter Society, 1979, 9 p. 8 refs. (AHS 79-38)

This paper discusses the performance benefits and limitations of a rotorshaft torquemeter, surveys some methods of measuring rotorshaft torque and presents some thoughts on using the rotorshaft torque measurement. The performance benefits follow from removing the power penalty imposed by using engine torque measurement to limit rotor torque. Engine torque measurement provides no information on power diversion to accessories or the tail rotor. The greatest performance benefits occur during high-power high-grossweight hover situations, such as pickup and delivery of heavy sling loads. Four currently-used methods of torque measurement in helicopters are reviewed including hydraulic pressure, toothed wheel phase displacement, material property change and telemetered strain gage systems. The pilots' workload and skill requirement can be reduced by using a rotorshaft torquemeter to produce an audible warning signal, to provide maximum continuous power to the rotor. to accumulate torque/time events and to limit the maximum torque that can be applied. (Author)

A79-49091 Self-contained grease lubrication systems for aircraft applications. A. S. Irwin, C. F. Inglee, and J. W. Lenski, Jr. (Boeing Vertol Co., Philadelphia, Pa.), In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings, Washington, D.C., American Helicopter Society, 1979. 7 p. (AHS 79-39)

The need for add-on, self-sufficient systems, together with simplified existing helicopter components that are lighter in weight and require less maintenance, create an effort directed toward ingenious concepts. This paper directs attention toward one such add-on an infrared suppressor and its self-contained bearing/grease lubrication system. Against the requirements for self-contained lubrication systems in helicopter and aircraft bearing support applications, the design principles and concepts, development, and demonstration of grease cavities for antifriction bearings are described (Author)

A79-49092 Ground test vehicle testing. H. D. Jones (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 4 p. (AHS 79-40)

The paper discusses the philosophy behind the requirements for GTV (ground test vehicle) testing and objectives and the value of GTV testing. It is shown that not only is the GTV used for the purpose of qualifying certain subsystems, but also to perform investigative or design support tests on a particular subsystem prior to or during flight testing. It is noted that while bench testing only tests the individual components, GTV testing qualifies the components on the system/subsystem level, thus exposing potential problem areas before actual flight tests begin. Finally, it is concluded that GTV testing is an essential part of the total aircraft qualification effort, MEP

A79-49093 Application of finite-element and holographic techniques in the design of turboshaft engine components. P. S. Kuo (Avco Corp., Avco Lycoming Stratford Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 13 p. 7 refs. (AHS 79-41)

A comprehensive finite element method using various types of elements and approaches to model a vast variety of engine components is described. Illustration includes the vibration and stress analyses of the centrifugal impeller, compressor and turbine blades, mechanical gearing and rotor disk assembly. Facilitated by the automated 2D/3D model generators and the graphic presentation of the results, a rapid evaluation of candidate designs is achieved. Holography has been utilized as an effective means to determine the dynamic behavior, the natural frequency and mode shape of the components; it consequently provides a verification for designs when hardware is available. Examples of holograms are given herein to be compared with the theoretical results. (Author)

A79-49094 Development of a 'no adjustment' turboshaft engine control system. J. J. Curran and A. M. Levine (General Electric Co., Aircraft Engine Group, Lynn, Mass.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. (AHS 79-42)

The paper describes the T700-GE-700 gas turbine engine which has been designed to eliminate the need for traditional adjustments and riggings to provide aircraft/engine/control system matching. Attention is given to the adjustments that have been eliminated; these are: topping, ground idle, power turbine speed governing, load sharing, torque computation, power available spindle, load demand spindle, variable geometry rigging, and specific gravity adjustment. Finally, a review of factory and field experience and acceptability of the 'no adjustment' system is presented. M.E.P.

A79-49095 Certification of composites in civil aircraft. R. Allen and J. R. Soderquist (FAA, Engineering and Manufacturing Div., Washington, D.C.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 7 p. 5 refs. (AHS 79-43)

Certification of composite structure for use on civil rotary wing aircraft involves showing compliance with Federal Aviation Regulations, FAR 29 for transport rotorcraft and FAR 27 for small rotorcraft, with guidance material provided in the FAA Advisory Circular 20-107. The requirements of primary concern in the civil certification of composite rotary wing structure are discussed in detail. The paper provides examples of civil applications of composites and summarizes the overall in-service performance with these applications. S.D.

A79-49096 Qualification program of the composite main rotor blade for the Model 214B helicopter. D. J. Reddy (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. (AHS 79-44)

Extensive fatigue testing of coupons and structural elements and full scale blade testing were accomplished for a composite main rotor blade of the Model 214B helicopter. Data from the coupon and element tests were used to establish S-N curve shapes, environmental effects, and fatigue strength data for such materials as S-glass and E-glass introduced in the blade. Also, a statistical analysis was performed on coupon and element data to find minimum scatter reduction for these materials. The mean S-N curves established by the results of testing the full scale blade fatigue test specimens were reduced for scatter and an additional reduction for environmental effects was taken as indicated by the results of the coupon and structural element tests. It is shown that the coupon tests provided reliable strength values compared with the full scale test data. V.T.

A79-49097 Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter. J. D. Ray (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 12 p. (AHS 79.45)

Tests and operation of a composite horizontal stabilizer for the Sikorsky Spirit helicopter are reviewed. Stabilizer materials and construction are described, noting that the skins are Kelvar/epoxy over Nomex honeycomb, with graphite/epoxy spar caps and a Kelvar/epoxy torque tube. Complete assemblies consisting of a stabilizer assembly, stabilizer support fitting, and intermediate gear support fitting were tested. Following accelerated fatigue testing, stabilizers were loaded statically to failure. During 1050 flight-test hours the stabilizer was exposed to a hot, humid climate and extreme cold temperatures. The test results show that the Spirit stabilizer has an unlimited life with high static residual strengths. V.T.

A79-49098 Design and development of a hybrid composite rotor blade for the circulation control rotor system. G. A. McCoubrey (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 10 p. (AHS 79-46)

The paper presents the design and development of a hybrid composite (graphite and S-glass) circulation control rotor blade (CCR). The CCR system requires rotor blades with a thin slot located on the upper surface near the trailing edge. The blade design characteristics, structural dynamic properties, blade materials, manufacturing process, hybrid composites, and structural testing are discussed. It is shown that by utilizing the additional design freedom provided by the hybrid composite (i.e. fiber orientation, mix ratio, and level of interleaving), it is possible to satisfy strength, bending stiffness, torsional stiffness, weight, and fabrication process constraints. It is concluded that hybrid composite construction permits advances in design optimization for accomodation of engineering and manufacturing constraints. A.T.

A79-49100 The Sikorsky elastomeric rotor. R. C. Rybicki (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 14 p. (AHS 79-48)

The paper surveys the development of the Sikorsky elastomeric rotor. Attention is given to improvements made in the design and analyis techniques employed for elastomeric bearings. It is noted that finite element methods have been developed which can handle the large strain, non-linear material, non-axisymmetric loading problems involved. Developments are the resulting improvements are discussed, as well as testing procedures. Finally it is stressed that initial field problems have been minimal. M.E.P.

A79-49101 Helicopter component environmental vibration testing - The poor man's fatigue test. S. T. Crews (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May' 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 8 p. (AHS 79.49)

It is found that the Army can no longer rely on the current version of MIL-STD-810 for helicopter environmental vibration qualification testing of major helicopter equipment. The Systems Development and Qualification Division of AVRADCOM, in conjunction with several manufacturers, has recently developed specific component environmental vibration qualification tests for major pieces of equipment. These tests were derived from the results of preliminary flight testing of these components. B.J.

A79-49102 Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing. K. Lunn, C. Hutchinson (Boeing Vertol Co., Philadelphia, Pa.), and J. Obbard (Raytheon Service Co., Boston, Mass.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C.,May21-23, 1979, Proceedings.D.C., American Helicopter Society, 1979. 13 p. (AHS 79-50)

A real-time data analysis system currently operational in the helicopter flight test industry is considered. The paper discusses the developments over a 20-year period which culminated in a combination of airborne and ground-based data systems for computational analyses to produce plots, tabulations, and summaries for report purposes. The evolution of the STAR (simulation and test analysis in real time) system, appropriate software, and increases in productivity, and the data base which stores calculated engineering values for a flight test program, and allows merging cross-plotting, and fatigue damage calculations to be performed by an engineer operating from a remote terminal, are described. It is concluded that the real-time data system, combined with an airborne data acquisition system, resulted in improved flight test productivity, data quality, and reduced cost, and used as a multipurpose computer, benefits can be attained in simulation, engineering batch, and terminal job entry. ΔТ

A79-49103 The circulation control rotor flight demonstrator test program. J. B. Wilkerson (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Carderock, Md.), D. R. Barnes, and F. A. Bill (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979, 15 p. 7 refs. (AHS 79-51)

The circulation control rotor (CCR) technology demonstrator, XH-2/CCR, has undergone many phases of structural, pneumatic, and aerodynamic tests, leading to the flight demonstration. A description of XH-2/CCR is provided with brief descriptions of the major tests conducted. Results of pneumodynamic tests of the compressor and control system are presented. Emphasis is placed on performance results from the whirl stand and from the NASA Ames 40- by 80-foot wind tunnel. Correlation between wind tunnel data and theory is also shown. A good agreement was evident over the flight spectrum for the first full-scale CCR. (Author)

A79-49104 \* # Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar. J. S. Bull, D. M. Hegarty, J. D. Phillips, W. R. Sturgeon (NASA, Ames Research Center, Moffett Field Calif.), A. W. Hunting, and D. P. Pate (FAA, Flight Standards National Field Office, Oklahoma City, Okla.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 10 p. (AHS 79-52)

Airborne weather and mapping radar is a near-term, economical method of providing 'self-contained' navigation information for approaches to offshore oil rigs and its use has been rapidly expanding in recent years. A joint NASA/FAA flight test investigation of helicopter IFR approaches to offshore oil rigs in the Gulf of Mexico was initiated in June 1978 and conducted under contract to Air Logistics. Approximately 120 approaches were flown in a Bell 212 helicopter by 15 operational pilots during the months of August and September 1978. The purpose of the tests was to collect data to (1) support development of advanced radar flight director concepts by NASA and (2) aid the establishment of Terminal Instrument Procedures (TERPS) criteria by the FAA. The flight test objectives were to develop airborne radar approach procedures, measure tracking errors, determine accpetable weather minimums, and determine pilot acceptability. Data obtained will contribute significantly to improved helicopter airborne radar approach capability and to the support of exploration, development, and utilization of the Nation's (Author) offshore oil supplies.

A79-49105 \* Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft. R. L. Marr, S. Blackman (Bell Helicopter Textron, Fort Worth, Tex.), J. A. Weiberg (NASA, Ames Research Center, Moffett Field, Calif.), and L. G. Schroers (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. (AHS 79-54)

The XV-15 Tilt Rotor Research Aircraft Project involves design, fabrication, and flight testing of two aircraft. This program is currently in the test phase for concept evaluation and substantiation of design. As part of this evaluation, one of the aircraft was tested in the NASA-Ames 40- by 80-foot wind tunnel. The status of testing to date and some of the results of the wind tunnel and flight tests are presented. (Author)

A79-49106 Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight. C. E. Freeman and W. T. Yeager, Jr. (U.S. Army, Structures Laboratory, Hampton, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. 12 refs. (AHS 79-56)

Experimental investigations were conducted to determine the source of direction control problems of single main-rotor helicopters operating at low speeds and possible means to alleviate them were examined. Tests proved that the V-type empennage presents significant low speed directional control advantages over conventional tail surface arrangements while providing comparable levels of static stability in both high- and low-speed flights. It was concluded that (1) the aerodynamic characteristics of V-tails are affected by low-aspect-ratios and (2) that the nonsymmetric V-tail surfaces decrease the tail rotor power required at low advance ratios by using the rotor-wake swirl to induce a torque counter to the main rotor torque. C.F.W.

A79-49107 Design, analysis, and testing of a new generation tail rotor. K. W. Harvey and C. W. Hughes (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. 8 refs. (AHS 79-57)

The development of a two-bladed teetering tail rotor without pitch-change bearings is described. The design uses a fiberglass twist-strap flexure to accommodate collective pitch control, and features the elimination of the shear-reaction device for counteracting the pitch link load. The design of the rotor was based on the results of earlier model tests and stability analyses. Wind tunnel tests were conducted with the rotor installed on a flightworthy tailboom. The design concept was demonstrated satisfactorily by testing the tail rotor through the entire flight spectrum of the JetRanger test vehicle. (Author)

A79-49108 Ten years of Aérospatiale experience with the fenestron and conventional tail rotor. R. Mouille (Société Nationale Industrielle Aérospatiale, Marignane, Bouches-du-Rhône, France). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.

Washington, D.C., American Helicopter Society, 1979. 10 p. (AHS 79-58)

The improvements which have been made during the past few years in the design of both fenestron and conventional tail rotors are reviewed. For conventional tail rotors, novel airfoils and high twist values have resulted in an increase in figure of merit from 0.5 to above 0.7. For fenestron rotors, higher efficiencies have been obtained, owing to improved aerodynamics, resulting from optimization of airfoils and blade twist angles and revised shroud designs. V.P.

A79-49109 Interactional aerodynamics - A new challenge to helicopter technology. P. F. Sheridan (Boeing Vertol Co., Philadelphia, Pa.) and R. P. Smith (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979, 16 p. 5 refs. (AHS 79-59)

The paper describes the field of interactional aerodynamic phenomena, classifies the problems into categories, such as downstream, localized, ground proximity, external interaction, and wing related category, and establishes a matrix of interactions and problems. Specific interactions are analyzed where sufficient data is available. These include the rotor/hub/fuselage/ empennage, rotor/fuselage, main-rotor/fin/tail-rotor, rotor/ground, rotor/fuselage/ground, and tail rotor/main/rotor/ground interactions. Evident trends such as flow simulation, are discussed and conclusions drawn regarding significant physical mechanisms. Finally, further research is recommended to expand the data base, to foster theory development, and to develop meaningful design guidelines. M.E.P.

## A79-49223 The DC-9 Super 80 - Much more than a simple stretch. J. P. Geddes. *Interavia*, vol. 34, Sept. 1979, p. 865-869.

The general characteristics and design features of the DC-9 Super-80 aircraft are presented. The DC-9-80 has a modified wing, a greatly improved powerplant, and a major redesign in the cockpit using the latest avionic technology. Passenger capacities have been increased from 80 to 155 for economy class passengers and other aircraft versions have been designed, powered by two ten ton engines, capable of carrying up to 170 economy class passengers. Fuselage improvements, like the horizontal stabilizer root extension employing an anti-float tab, increase stabilizer effectiveness when the aircraft is in landing configuration. The layout of the instrument panel is given along with diagrams of the wings and flap setting. Other detailed changes in the compressor, the modular design of the fan, and low pressure rotor are noted and an overall performance report is described. C.F.W.

## A79-49224 Lockheed urges hydrogen fuel. Interavia, vol. 34, Sept. 1979, p. 872, 873.

The use of hydrogen as a future aircraft propellant is discussed and some advantages and disadvantages of using methane as another alternate source are examined. Although hydrogen is seen as a dangerous fuel source, its advantages clearly outweigh its disadvantages. First, it is noted that because hydrogen is lighter than air, a fire ignition would tend to roar upward and not expand sideways like a liquid fuel fire. Second, hydrogen burns cleanly and consistently, providing considerable benefits in the design of future power plants. Last, its exhaust consists mainly of water and therefore a hydrogenfueled engine would create even less air pollution than the cleanest of modern petroleum-burning turbofans. The only disadvantage noted here is the apparent danger because of its high combustibility, and it is concluded that hydrogen may be the best alternative to many present-day energy problems. C, F.W.

## A79-49232 Blown wings from Kiev. Air International, vol. 17, Sept. 1979, p. 140-142, 151.

The Soviet Antonov AN-72 STOL short haul transport aircraft is examined. The aircraft employs a high lift system that resembles the upper surface blowing (USB) system adopted by Boeing for its YC-14 prototypes. Specifications covered include a 16,500 lb payload and a required runway length of 4000 ft. Attention is given to the wing configuration which uses a combination of double-slotted and triple-slotted flaps on the trailing edge and full span leading edge slots. However, it is noted that the primary consideration in locating the engines above the wing was the operation from unimproved runways. Finally, cargo loading arrangements are discussed. M.E.P.

A79-49332 \* # The size and performance effects of high lift system technology on a modern twin engine jet transport. R. L. Sullivan (Boeing Commercial Airplane Co., Seattle, Wash.). *American*  Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1795. 19 p. Contract No. NAS1-14742.

The energy and economic benefits of low-speed aerodynamic system technology applied to a modern 200-passenger, 2000-nmi range, twin engine jet transport are reviewed. Results of a new method to design flap systems at flight Reynolds number are summarized. The study contains the airplane high lift configuration drag characteristics and design selection charts showing the effect of flap technology on the airplane size and performance. The study areas include: wing and flap geometry, climb and descent speed schedules with partial flap deflection, flap system technology, and augmented stability. The results compare the improvements in payload from a hot, high elevation airport. (Author)

A79-49335 # Application of Lagrange Optimization to the drag polar utilizing experimental data. J. S. Kohn (Grumman Aerospace Corp., Bethpage, N.Y.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1833. 15 p. 14 refs.

The Lagrange Optimization, used with linear aerodynamic theory to define optimum aircraft geometry, is shown to have application to the determination of optimum control surface deflections as a function of angle of attack necessary to provide maximum trimmed L/D for a multi-plane aircraft configuration. Linear aerodynamic theory suggests a semi-empirical drag polar equation well suited to the optimization task. The equation is shown to correlate well with experimental data near aircraft cruise conditions. Such correlations are shown for selected aft and forward swept configurations up to 0.9 Mach number both in terms of total drag and drag increments due to control deflections and angle of attack. Optimum trimmed configurations are defined using experimental data and the subject optimization procedure. (Author)

A79-49336 \* # XV-15 flight test results compared with design goals. K. G. Wernicke (Bell Helicopter Textron, Fort Worth, Tex.) and J. P. Magee (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1839. 11 p. 10 refs.

Aircraft No. 2 is presently in the midst of flight envelope expansion. Noise and safety design goals have been demonstrated; preliminary results indicate that performance and component life goals may also be met. Hovering power indicates a standard hover ceiling of 7,000 feet. After 18.0 hours of flight, a true airspeed of 207 knots has been reached. The goal is a 300-knot cruise speed. So far, XV-15 flight tests indicate no reason why the tilt rotor concept should not fulfill its promise to provide a major step forward in air vehicle flexibility and in rotary wing performance. (Author)

A79-49337 # Design criteria for airline operation. W. J. Overend (Delta Air Lines, Inc., Atlanta, Ga.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1849. 7 p.

This paper provides some of the basic airline concepts of design methodology and illustrates how they may be applied to the selection of a new aircraft for service in the 1980's. Two fundamental criteria for aircraft design are noted: (1) the optimization of passenger transportation and (2) predominance of safety over operating economics. Baseline aircraft, performance capability, and engine selection are considered to give the best possible design for providing the public with an aircraft designed for efficient airline operation. C.F.W.

A79-49338 # What the FAA would like in airworthiness standards. C. R. Foster (FAA, Washington, D.C.). American Institute

of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1851. 7 p.

The paper surveys the areas in which the FAA deems future work desirable. These include the development of standards for light transport aircraft used in commuter operations, and for advance types of control configured vehicles. Attention is also given to improved crashworthiness, improved engine capability to resist damage due to ingestion of foreign objects, and the development of standards for operation of helicopters in IFR and icing conditions. Other topics discussed are the development of wet runway stopping criteria, reduction of general aviation accident rate, the development of improved standards for composite and damage tolerant structures, and the development of standards for the verification and validation of digital avionics.

A79-49339 \* # Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft. W. G. Hill, Jr. and R. C. Jenkins (Grumman Aerospace Corp., Bethpage, N.Y.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1856. 13 p. 20 refs. Contract No. NAS2-10097.

The effect of nozzle spacing on ground interference forces was investigated for a two jet V/STOL aircraft design. The need for information on the effect of jet spacing arises because of the tradeoff between mechanical complexity, which calls for close spacing, and roll control moments, which call for wider spacing. The ground interference forces on a two jet V/STOL aircraft model were measured for a range of nozzle spacing. Interference forces showed a complicated behavior with nozzle spacing, fuselage geometry, and height above ground. For some conditions a slight change in nozzle spacing resulted in a fourfold change in the interference force from 3% to 12% of the basic jet thrust. An understanding of the observed aircraft force behavior was developed using detailed measurements of the upwash flow properties, along with force and pressure measurements on a series of two dimensional fuselage representations.

(Author)

A79-49341 # Wing geometry effects on leading-edge vortices. R. M. Kulfan (Boeing Commercial Airplane Co., Seattle, Wash.). American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1872, 38 p. 45 refs.

Leading-edge vortices that form at off-design conditions can profoundly influence the aerodynamic characteristics of highly swept slender wings. A straightforward method that can predict wing geometry effects on the progressive spanwise development of leading-edge vortices is presented. This method, which can account for sweep, camber, twist, airfoil shape, flap deflections, and planform shape, is shown to be a useful tool for aerodynamic design studies. It is shown that suppressing the leading-edge vortex, particularly over the inboard portion of the wing, can cause considerable reduction in drag due to lift. Results of wing geometry parametric studies are shown. (Author)

A79-49343 \* # Evaluation of finite element formulations for transient conduction forced-convection analysis. E. A. Thornton (Old Dominion University, Norfolk, Va.) and A. R. Wieting (NASA, Langley Research Center, Hampton, Va.). National Conference on Numerical Methods in Heat Transfer, College Park, Md., Sept. 24-26, 1979, Paper, 26 p. 13 refs. Grant No. NsG-1321.

Numerical studies clarifying the advantages and disavantages of conventional versus upwind convective finite elements are presented along with lumped versus consistent formulations for practical conduction forced-convection analysis. A finite-element procedure for treatment of negligible capacitance fluid nodes is presented. The procedure is based on procedures used in finite-element structural dynamics to treat nodes with negligible structural mass. Two finite-element programs and a finite-difference lumped-parameter program used in the studies are discussed. Evaluation studies utilizing three convection and two combined conduction-convection problems are then presented and discussed. Additionally, the computational time saving offered by the finite element procedure is considered for a practical combined conduction-convection problem. V.T.

A79-49344 \* # NASA/Princeton digital avionics flight test facility. D. R. Downing, W. H. Bryant (NASA, Langley Research Center, Flight Electronics Div., Hampton, Va.), and R. F. Stengel (Princeton University, Princeton, N.J.). Institute of Electrical and Electronics Engineers and American Institute of Aeronautics and Astronautics, Digital Avionics Systems Conference, 3rd, Fort Worth, Tex., Nov. 6-8, 1978, Paper, 7 p. 10 refs.

This paper describes a general-aviation digital avionics flight-test facility being jointly developed by the Flight Dynamics Laboratory of Princeton University and NASA/Langley Research Center. This facility consists of the Princeton avionics research aircraft (ARA) and NASA/Langley's digital avionics research (DARE) system. The ARA is a fully instrumented five-degree-of-freedom fly-by-wire aircraft. The DARE system contains a state-of-the-art flight computer system and receiving equipment that permits use of the NASA/Wallops Flight Center's position-tracking ground-based display-generation and ground-to-air digital-data-link equipment. The DARE/ARA system will be used for flight evaluation of advanced control, guidance, and display concepts developed as part of NASA/Langley Research Center's general aviation terminal area operations program. (Author)

A79-49345 \* # Characterization of a swept-strut hydrogen fuel-injector for scramjet applications. G. B. Northam, C. A. Trexler, and G. Y. Anderson (NASA, Langley Research Center, Hampton, Va.). Joint Army-Navy-NASA-Air Force, Interagency Propulsion Committee Combustion Meeting, 15th, Newport, R.I., Sept. 1978, Paper. 19 p. 5 refs.

Results of an experimental investigation of a swept-strut hydrogen fuel-injector simulating the center strut of a three strut scramjet module at Mach 6 flight conditions are presented. Detailed wall pressure distributions from over 100 separate tests with overall fuel flow from 0.1 to 1.3 times stoichiometric and test gas stagnation temperature from 1100 to 2400 K were recorded. The distance for pressure rise from the point of injection was found to increase with increasing test stagnation temperature. This trend indicates that chemical kinetics in the immediate region of perpendicular injection are not likely to be the mechanism controlling the onset of pressure rise. A fluid dynamic mechanism is suggested involving separation of the boundary layer downstream of injection which is forced upstream from the trailing edge by pressure rise due to combustion occurring in the base region of the strut. The results obtained indicate that the swept-strut fuel-injector concept can be adapted to a wide range of flight conditions by varying the amount of perpendicular fuel injection. (Author)

A79-49348 Evaluation of airfield pavement materials based on synthetic polymers. C. J. Hilado, D. P. Brauer (San Francisco, University, San Francisco, Calif.), and R. C. Corlett (Washington, University, Seattle, Wash.). (International Conference on Fire Safety, 4th, University of San Francisco, San Francisco, Calif., Jan. 15-19, 1979.) Journal of Fire and Flammability, vol. 10, July 1979, p. 207-215. Navy-supported research.

Two samples of experimental airfield pavement materials were evaluated for ignition, fire spread, smoke, and toxic gas evolution. The materials consisted of fiberglass-reinforced polyester surface sheets laminated to and supported by a high density polyurethane rigid foam core. Both samples exhibited resistance to ignition and fire spread in this limited study. The effect of these pavement materials on the fire spread of a large pool of burning aircraft fuel would appear to be negligible. (Author)

A79-49376 Utilization of alternative fuels for transportation; Proceedings of the Symposium, University of Santa Clara, Santa Clara, Calif., June 19-23, 1978. Symposium sponsored by the U.S. Department of Energy. Edited by M. Newman and J. Grey (American Institute of Aeronautics and Astronautics, Inc., New York, N.Y.). New York, American Institute of Aeronautics and Astronautics, Inc. (AIAA Aerospace Assessment Series. Volume 2), 1979. 244 p. \$15.

This overview of alternative fuel development deals with such issues as energy supply and fuel manufacturing/processing and storage and distribution. Attention is given to fuels for both road vehicles and nonroad vehicles (e.g., aircraft and trains). Finally, discussions on impacts and institutional issues are presented. B.J.

A79-49381 # Alternative fuels in aviation. J. G. Borger (Pan American World Airways, Inc., New York, N.Y.). In: Utilization of alternative fuels for transportation; Proceedings of the Symposium, Santa Clara, Calif., June 19-23, 1978. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 129-142

The state of the art and expected future advances of alternative fuels in aviation are discussed. Consideration is given to uses of liquid hydrogen and methane, broadening of turbine fuel specifications, increased aromatics, decreased flashpoint, increased freeze point, thermal stability, synthetic fuels, and the refinery process. It is noted that major fuel efficiency improvements resulting from the NASA ACEE program probably will not appear before the late 1980s. B.J.

A79-49456 Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave. G. P. Voskresenskii (Akademiia Nauk SSSR, Institut Prikladnoi Matematiki, Moscow, USSR). *Computer Methods in Applied Mechanics and Engineering*, vol. 19, Aug. 1979, p. 257-275, 7 refs.

The object of this paper is to describe a numerical method for the solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave. The velocity vector of the free stream is directed in an arbitrary direction but without flow separation. The problem is formulated for the three-dimensional hyperbolic system of equations of unsteady inviscid chemically reactive gas flow in a mixed subsonic and supersonic domain. It is solved by a finite difference implicit second-order method with the use of the time-dependent stationing principle. A curvilinear coordinate system is introduced in which the numerical domain becomes a simple rectangle. The coordinate system is time-dependent and adapted for the planform of the wing and the free-stream parameters. The planform of the wing and the velocity vector of the free stream may be changed in the timedependent stationing process. The flow field is computed around the front part of wings which have an elliptical planform and an aspect ratio not greater than 2 for selected freestream Mach numbers betweeen 1.5 and 5. (Author)

A79-49478 Helicopter noise rules - Are they appropriate and reasonable. C. R. Cox (Bell Helicopter Textron, Fort Worth, Tex.), Marconi Review, vol. 42, 1st Quarter, 1979, p. 16-21.

Consideration is given to proposed governmental regulations concerning helicopter noise and their effects. Problems with the proposed PAA and ICAO standards are shown to stem from two inadequacies: (1) they are patterned after fixed wing regulations with little or no consideration of differences in operation, and (2) the economic impact of implementing these standards has not been adequately assessed in terms of the cost that must be passed on to the individual user. Other areas discussed include the impact on new designs, on derived and existing designs, on safety and reliability, and on the probability of certification. Different approaches are proposed including operational restraints and flight path control. In conclusion it is stressed that inappropriate regulations could result in serious adverse consequences on an industry composed predominantly of small business operators.

A79-49486 # A design perspective on new technologies for general aviation. J. B. McCollough (FAA, Aircraft Flight Safety Branch, Washington, D.C.). Astronautics and Aeronautics, vol. 17, Sept. 1979, p. 48-53.

Technologies that benefit the design of general aviation aircraft are ranked in terms of safety, performance, utility, and cost. Test criteria in order of importance were: safety, reliability, performance, cost, customer acceptance, efficiency, operational ease and utility, maintenance, weight, and environment. Areas rated were: aerodynamics powerplant, structures, materials, and fabrication, avionics, instrumentation, airframe and system design, and human factors and operations. It is noted that, in many ways, commercial aircraft design is a conservative process, since safety is a first consideration. Among the conclusions is that social and political pressures will also influence the future of the general aviation industry. M.E.P.

A79-49530 \* # Recent applications of theoretical analysis to V/STOL inlet design. N. O. Stockman (NASA, Lewis Research Center, Cleveland, Ohio). U.S. Navy, Workshop on V/STOL Aerodynamics, Monterey, Calif., May 16-18, 1979, Paper. 16 p. 17 refs.

A brief description of the axisymmetric potential flow and boundary layer analysis methods used at the NASA Lewis Research Center, is presented. Application of this method to inlet problems arising from both tilt-nacelle and fixed-nacelle V/STOL aircraft configurations is illustrated. A three-dimensional inlet analysis computer program is described and the preliminary results presented. Finally, a suggested approach to optimum design of inlets for high angle-of-attack operation is discussed. M.E.P.

A79-49541 # The feasibility of modern dirigibles (Faisabilité des dirigeables modernes). J. Bouttes and C. La Burthe (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (Colloque International sur l'Economie et Technologie des Aéronefs Allégés, Paris, France, Mar. 28-30, 1979.) ONERA, TP no. 1979-93, 1979. 17 p. In French.

Through an analysis of the major constraints on dirigible operation and configuration, a design methodology capable of supporting the development of an optimal airship is obtained. Attention is given to the equilibrium properties of the gas compartment at altitude, means of weight compensation, including mooring, vertical lift engines and aerostatic effects, for various dirigible applications (surveillance, cargo, utility operations), steering and control laws and apparatus. Research on interlocking rotors and the thermal balance of a hot-air balloon presently under way at ONERA is outlined, and a weight distribution optimization loop illustrating the design methodology adopted is presented. The importance of a multidisciplinary integrated approach to dirigible design is also noted. A.L.W.

A79-49543 # Aerodynamic interaction on a close-coupled canard-wing configuration (Interaction aérodynamique entre un canard proche et une voilure). Y. Brocard and V. Schmitt (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (NATO, AGARD, Symposium on Aerodynamic Characteristics of Controls, Naples, Italy, May 14-17, 1979.) ONERA, TP no. 1979-95, 1979. 12 p. 14 refs. In French. Research supported by the Direction des Recherches, Etudes et Techniques.

Half-model tests were performed on a close-coupled canard-wing configuration in the low speed, pressurized wind tunnel F1 at the new ONERA Center Le Fauga-Mauzac. The main lifting surface is the rectangular cylindrical, wall mounted, half wing AFV-D in a 60 deg back sweep configuration. The chordwise wing section has a 5 percent thickness ratio and a large leading-edge radius. The canard surfaces are similar in shape and section to the main wing. Experimental results are presented in terms of longitudinal aerodynamic characteristics and pressure distribution on the main wing. The effect of canard deflexion and of Reynolds number variation were investigated. (Author) A79-49554 Airborne microwave ECM. D. J. Steer (Royal Aircraft Establishment, Farnborough, Hants., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 29-38.

The paper examines techniques currently used in airborne ECM. It covers the philosophy of jamming and gives details of the various types of jammers used against specific radar systems. Jammer transmitters are discussed and a brief survey of the power output of travelling wave tubes (TWT) is included. This leads to an assessment of the jammer powers likely to confront Western radar designers. The general design features of a responsive noise jammer are presented and it is suggested that this type of jammer is the basis of selfscreening (SSJ) escort (EJ) and standoff jamming (SOJ). The paper ends with a brief mention of chaff. (Author)

A79-49555 Performance of current radar systems in an EW environment. J. R. Prior and N. Woodward (Royal Signals and Radar Establishment, Malvern, Worcs., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 39-50.

The paper will start by considering the more important ECCMs incorporated into radars. It considers the effects of EW against various types of radar systems. Long range early warning (ADGE) radars, airborne early warning, SAM acquisition tracking radars and airborne intercept radars are considered. For each of these systems typical present day characteristics are defined, their vulnerability to the EW threat discussed and the benefits to be obtained from various ECCMs, both technical and operational, are considered. An indication is given of the future trends in the design of such systems where relevant to their operation in ECM and the role of the more modern antijamming aids arising from new technologies is described.

(Author)

A79-49565 # Combined X/Ka-band tracking radar. L. J. Klaver (Hollandse Signaalapparaten, Hengelo, Netherlands). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 147-156. 6 refs.

The paper surveys the development of the Dutch SIGNAAL combined X/Ka-band tracking radar. Attention is given to the effects of atmospheric conditions, such as rain and sea clutter. It is shown that in this system target detection is performed by a normal search radar, after which the acquisition process is executed with the X-band tracking radar. As soon as video quality permits, target tracking is performed in the Ka-band. Also discussed are the practical problems experienced when tracking low-flying targets by radar and how SIGNAAL overcomes them. M.E.P.

A79-49566 # The A.I. tracking problem. B. B. English (Ferranti, Ltd., Hollinwood, Lancs., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 157-163. Research supported by the Ministry of Defence (Procurement Executive).

Attention is given to the problems arising from using radar to provide target information to other aircraft subsystems such as the weapons aiming computer. The two main problems considered are (1) aircraft motion which disturbs the radar end of the line of sight, and (2) glint, which introduces noise into the measurement of target behavior. A description is given of an approach which treats aircraft motion and glint as independent problems and is then used to generate a set of desirable servo characteristics. An actual radar system is described along with how well it satisfies the ideal requirements. Finally, possible performance improvements provided by the availability of practical airborne digital computing are covered. M.E.P. A79-49567 # A report on the Sperry Dome Radar. L. Schwartzman and P. M. Liebman (Sperry Rand Corp., Sperry Gyroscope, Great Neck, N.Y.). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibi-

tions and Publishers, Ltd., 1979, p. 167-176. The paper describes the Sperry Dome Radar equipment, system

operation, and target tracking experiences to-date. The equipment description includes the dome antenna which design provides capability to scan a volume of 3 pi steradians, and provides maximum gain at an angle of 90 deg with respect to the zenith. For shipboard installations this means continuous radar surveillance and tracking for ship roll and pitch as severe as 30 deg. Automatic multitarget tracking over wide scan angles, which has been demonstrated by the Sperry Dome Radar is described. Radar tracking tests have been performed at various levels, namely simulated target injections, simulated target transmissions from external test towers, live skin tracks of targets-of-opportunity and skin tracks of several controlled aircraft. Some of the track test results are presented.

(Author)

A79-49568 # A new three-dimensional surveillance radar. M. F. Radford (GEC-Marconi Electronics, Ltd., Marconi Research Laboratories, Great Baddow, Essex, England) and A. D. Stevens (Marconi Radar Systems, Ltd., Stanmore, Middx., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 193-200. 6 refs. Research supported by the Ministry of Defence (Procurement Executive).

The paper is concerned with a new fully transportable threedimensional surveillance radar, called Martello, which gives height data with every target plot. It can use its elevation discrimination to separate targets from clutter or from each other. The clutter spectra are narrower, so that the loss of targets in the MTI is minimized. Moreover, a three-dimensional radar is less degraded by jamming, since main beam obscuration is confined to the elevation of the jammer instead of covering the whole elevation sector. The paper shows how the configuration of the Martello radar has been chosen, and describes some of the technological advances incorporated in the design. S.D.

A79-49574 Recent advances in radome design. A. M. Munro (Royal Signals and Radar Establishment, Malvern, Worcs., England), B. V. A. Wickenden, F. S. Ward, and P. H. Dowsett (Plessey Materials, Towcester; Plessey Connectors, Ltd., Kingsthorpe, Northants., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibi-

tions and Publishers, Ltd., 1979, p. 246-258.

The paper deals with aberration caused by A-type sandwich radomes whose shapes may be conical or ogival with high fineness ratios. Three methods for reducing radome aberration are presented. The artificial dielectric approach produces a radome whose performance is comparable to that of a solid laminate. The wire-loading technique is capable of making a marked reduction in aberration, although a slight increase in attenuation results. As yet, the asymmetric design has not been used in a practical case. The use of RP12 polyester resin for the construction of laminate radomes gives an improved bandwidth, due to the near-constant permittivity and low loss over a wide temperature range. It is a unique method of constructing high-performance radomes for high-speed aircraft and missiles.

A79-49580 # Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes. L. Svard and N.-A. Nilsson (L. M. Ericsson Telephone Co., Molndal, Sweden). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 304-309.

This paper describes a computer model for the evaluation of radar proximity fuzes. The target is described by a number of ellipsoids and limiting planes. Cavities are also described by ellipsoids. In this case correction factors are used to adjust the radar cross-section. The contributions from the various ellipsoids are computed by methods of geometrical optics. Shadowing is also considered in this computation. The computer program calculates the received signal with the aid of the radar equation, applies the processing of the fuze and determines the output signal. The output may alternatively be the triggered point in space. A large number of calculations have been performed using this model. The results have been compared with full-scale measurements on a target drone and ultrasonic tank measurements on drone and fighter aircraft models in the X-band. These comparisons show that the standard deviation of the trigger point difference is less than 0.6 m. (Author)

A79-49584 # Distributed TDMA - An approach to JTIDS phase II. J. Rubin (ITT, Avionics Div., Nutley, N.J.). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 341-345. Contract No. N62269-76-C-0105.

A distributed TDMA (DTDMA) system for increased performance to meet expanding multiservice future requirements is presented. In addition to existing Tacan and IFF channels, and the TDMA channel, the joint tactical information distribution system (JTIDS)/DTDMA terminals provide multiple demand access channels for A/J digital voice, and command access channels for command and control communications. The DTDMA technique employs low duty cycle pulses, pseudo-randomly distributed in the timefrequency-phase code domain, and because of its flexible channel design, variable information parameters such as message length and rate, access type, and coding requirements are readily achieved. The JTIDS integrated system, the fundamental signal/channel JTIDS architecture, and performance capabilities are discussed. It is concluded that JTIDS/DTDMA can be used for EW computational burden distribution, RPV based active ECM, real-time reconnaissance data collection, and coordination of communications jamming. A.T.

A79-49587 # Navstar user equipment for civil and military applications. S. G. Allen, P. J. Hargrave, K. Buckley, J. C. Greenwood, and P. K. Blair (Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 405-409.

High performance and basic Navstar receivers are described along with an experimental receiver. The experimental receiver uses a switching-type code tracking loop and is capable of receiving C/A code spread spectrum signals. Pseudorandom measurement was conducted by comparing the difference between 1023 code epochs of the locally generated code with a one-millisecond epoch derived from the 10 MHz stable reference. Signal strength measurement was made of the received signal-to-noise ratio from the Navstar satellites and compared with predictions. The application of Navstar receivers to both civil and military navigation is discussed. V.T.

A79-49589 # The servoed modulation FMCW radar altimeters in military applications. J.-P. Tomasi (Télécommunications Radioélectriques et Téléphoniques, Le Plessis-Robinson, Hauts-de-Seine, France). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978.

Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 421-425.

A method of receiving and detecting a radar signal, by matching the signal to the receiver and adjusting the modulation of the transmission to the target distance so that the signal is perfectly adapted to the receiver is presented. A FMCW radar altimeter is used to transmit a signal with a frequency modulated by a symmetrical or asymmetrical sawtooth and is then reflected, by the ground, and returns with a delay proportional to the aircraft height. The application of this system for military use is examined for three different altitude ranges: 5000, 10,000 and 70,000 ft and its implementation for fighters, missiles, hydrofoils, and helicopter is reviewed.

A79-49590 # The application of pulsed 'G' band radio altimeters to modern military aircraft. R. J. L. Pardoe (Smiths Industries, Ltd., Aviation Div., Basingstoke, Hants., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 426-430. Research supported by the Ministry of Defence (Procurement Executive).

The paper demonstrates the way an assessment can be made of the slant range accuracy of the pulsed altimeter system. Specifications of the G band radio altimeter reviewed include altitude range, accuracy, track rate, search rate, and maneuverability, and total system weight. In addition, the pulse echo function and video pulse shape are covered. The results of this assessment are shown to agree with Ministry of Defence sponsored trials of equipment in a wide range of military fixed wing and rotary wing aircraft and therefore justify the specified performance. M.E.P.

A79-49604 Automated tracking for aircraft surveillance radar systems. R. M. O'Donnell and C. E. Muehe (MIT, Lexington, Mass.). (*NATO*, *AGARD*, *Meeting on Strategies for Automatic Tract Initiation, Monterey, Calif., Oct. 16, 17, 1978). IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-15, July 1979, p. 508-517. 17 refs. U.S. Department of Transportation Contracts No. FA72WAI-242; No. FATO-679; Contract No. F19628-78-C-002.

An improved moving target detector (MTD) (a digital signal processor) has been designed, constructed, and tested which successfully rejects all forms of radar clutter while providing reliable detection of all aircraft within the coverage of the radar. The MTD is being tested on both terminal and enroute surveillance radars for the FAA. This processor has been integrated with automatic tracking algorithms to give complete rejection of ground clutter, heavy precipitation, and angels (birds). (Author)

A79-49605 Small signal compensation of magnetic fields resulting from aircraft maneuvers. S. H. Bickel (Atlantic Richfield Co., Los Angeles, Calif.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-15, July 1979, p. 518-525. 6 refs. Contract No. N62269-75-C-0210.

It is noted that Tolles and Lawson (1950) identified three permanent, five induced, and eight eddy-current fields as sources of magnetic interference associated with airframe maneuvers. The present paper uses small signal approximations to separate the eddy-current terms and thus decouple the sixteen equations into two sets of eight equations. It is found that a singularity exists in the small signal equations for the permanent and induced terms. It is shown that the ambiguity thus caused among three of the coefficients can be resolved mathematically by resorting to large maneuvers. In addition, flight test data are presented which exhibit a large amount of magnetic hysteresis and it is shown that the magnetic anomality detector (MAD) equipped aircraft will not remain compensated from one flight to the next. Finally, it is found that both optimal frequency filtering and altitude compensation can be used to improve the figure of merit (FOM) resulting from pilot maneuvers.

M.E.P.

A79-49608 Multiradar tracking system using radial velocity measurements. A. Farina and S. Pardini (Selenia S.p.A., Rome, Italy). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-15, July 1979, p. 555-563. 14 refs. Multiradar tracking using both position and radial velocity measurements is discussed. The measurement of two or more different radial velocity components allows the calculation of rectangular velocity components. The measurement noise of the velocity components is filtered using a Kalman filter in the same way as the Cartesian position components. Before the conversion of velocity components from radial to Cartesian coordinates, the radial velocities are aligned on a time scale to account for the time shift of the radar measurements. In order to compare multiradar tracking system performance with and without radial velocity, some simulation tests have been performed for typical paths. The simulation results show a significant improvement when radial velocity is used for tracking. (Author)

A79-49718 # An approach for estimating vibration characteristics of nonuniform rotor blades. K.-W. Lang and S. Nemat-Nasser (Northwestern University, Evanston, III.). *AIAA Journal*, vol. 17, Sept. 1979, p. 995-1002, 25 refs. Grants No. DAAG29-77-G-0034; No. DAAG29-78-G-0149.

A method is presented for determining the vibration characteristics of a rotating blade whose cross-sectional dimensions or mechanical properties may vary sharply or even discontinuously along its length. The coupled flapwise bending, chordwise bending, and torsional vibration of the blade is analyzed by the method of the new quotient which is based on a variational statement proposed by Nemat-Nasser. In this approach, the nonuniform blade properties may be approximated by step (piecewise constant) functions. Two illustrative examples are given, and the results are compared with available experimental data and other numerical solutions. The comparison shows that the method of the new quotient yields very good results. (Author)

A79-49806 Fault diagnosis of gas turbine engines by means of component characteristics determination (Fehlerlokalisierung an Einkreis-TL-Triebwerken durch Bestimmung der Bauteilkenngrössen). G. Dahl (Branschweig, Technische Universität, Braunschweig; Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). Zeitschrift für Flugwissenschaften und Weltraumforschung, vol. 3, July-Aug. 1979, p. 216-229. 37 refs. In German.

A method to calculate the component characteristics of single spool jet engine has been developed by using measured engine data. Lacking data are replaced by characteristics of different components of the healthy engine. By comparing the results for these different assumptions the actual conditions of the engine components could be determined. A large number of different faults has been simulated experimentally on a J-65 engine. The application of the present methods led to a correct fault diagnosis in all cases. The method is capable to localize single and multiple faults of arbitrary kind and magnitude. (Author)

A79-49807 Variables characterizing the wind effects on an aircraft (Grössen zur Beschreibung des Windeinflusses auf das Flugzeug). R. Brockhaus (Braunschweig, Technische Universität, Braunschweig, West Germany). Zeitschrift für Flugwissenschaften und Weltraumforschung, vol. 3, July-Aug. 1979, p. 229-234. 6 refs. In German.

A series of Euler angles between the aerodynamic and the flight path coordinates, very similar to those defined by Krauspe and Klenner, is proposed. These angles allow a very comprehensive description of the wind effect on an aircraft. The present definition has the advantage that the Euler angles are related in a positive sense to the components of the wind velocity vector. In addition, exact and approximate relations are presented between the wind velocity components in the principal coordinate systems and those variables which are measurable on board the aircraft. (Author)

A79-49814 Aérospatiale AS.350 and AS.355. J. Boulet (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Marignane, Bouches-du-Rhône, France). (Royal Aeronautical Society, Symposium on A New Generation of Civil Helicopters, London, England, Feb. 7, 1979.) Aeronautical Journal, vol. 83, July 1979, p. 245-249.

The Aérospatiale AS.350 and AS.355 helicopters are surveyed. Attention is given to design features such as the structure made of press stamped parts, and a cabin made up of heat formed polycarbonate shells, the rotor blades and rotor head of fiber glass, showing how the objectives of quality, comfort, performance, and low cost were achieved. Other features discussed include a simplified gearbox, engine availability, the beam type tail rotor. Substantial cost reductions are also shown to have been achieved through the use of high volume production items from the automotive industry, and assembly line production methods. Finally, the introduction of the twin engine AS.355 is noted along with how it differs from the single engine AS.350. M.E.P.

A79-49815 Design and development of the Agusta A 109 helicopter. B. Lovera (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Milan, Italy). (Royal Aeronautical Society, Symposium on A New Generation of Civil Helicopters, London, England, Feb. 7, 1979.) Aeronautical Journal, vol. 83, July 1979, p. 250-256.

The Agusta A 109 helicopter, considered the forerunner of the generation of civil helicopters introduced in the seventies, is examined. The A 109 design objectives and certification basis are discussed. Attention is also given to performance aspects, safety aspects, and passenger comfort aspects. Operational aspects considered include: helicopter loading, external noise, and IFR capability. In addition, auxiliary installations, climatic tests, and operating costs are covered. Finally, future developments are discussed. M.E.P.

A79-49816 The Bell Model 222. J. R. Garrison (Bell Helicopter Textron, Fort Worth, Tex.). (Royal Aeronautical Society, Symposium on A New Generation of Civil Helicopters, London, England, Feb. 7, 1979.) Aeronautical Journal, vol. 83, July 1979, p. 257-268.

The design and performance characteristics of the Bell Model 222 are surveyed. Design details covered include the main rotor hub which is designed for reduced maintenance, safety, and long component fatigue lives, the main rotor blade, the tail rotor, and rotor drive system. Attention is also given to the main transmission, the nodal beam's isolation of drivetrain vibrations, the power reserve provided by the twin Lycoming engines, and the impact resistant fuel cells. It is shown that the cockpit has an instrument panel capable of being equipped with an IFR instrumentation array while retaining good visibility for the VFR operator. Finally, flight tests, fatigue tests and noise measurements are described. M.E.P.

A79-49818 Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics. J. J. Spillman, H. Y. Ratcliffe, and A. McVitie (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal*, vol. 83, July 1979, p. 279-281.

The results of experiments performed with a Paris MS 760 aircraft modified with wing tip sails to reduce vortex drag are presented. Specifications and test procedures are described and it is shown that fuel flow rate and engine speed are uniquely linked. Attention is given to handling characteristics such as the aircraft's ability to take-off up to 10 knots sooner than without sails. In addition there appeared to be increased damping in roll with the roll rate relatively unaffected. It is concluded that the total drag at lift coefficients above 0.22 is reduced because the lift dependent drag is reduced by 27%. The fuel saving is about 4.5% at a typical lift coefficient of 0.35 rising to almost 11% at a lift coefficient of 0.8.

A79-49866\* # Active external store flutter suppression in the YF-17 flutter model. E. Nissim and I. Lottati (Technion - Israel Institute of Technology, Haifa, Israel). Journal of Guidance and Control, vol. 2, Sept.-Oct. 1979, p. 395-401. 22 refs. Grant No. NsG-7072. A single activated trailing-edge (T.E.) control system (spanning 7% of each wing) is applied to the YF-17 flutter model with the object of suppressing the external store flutter of three different store configurations. The control law is derived by the use of the aerodynamic energy concept and its gains are maintained constant for all three configurations. The results obtained show that the activated T.E. control system leads to very significant increases in the flutter dynamic pressures Q(DF) of all three configurations; these increases range between 160-240% increase in Q(DF). These increases in Q(DF) are maintained over a very wide range of flight altitudes and flight velocities. (Author)

A79-49867 \* # On single-degree-of-freedom flutter induced by activated controls. E. Nissim and I. Lottati (Technion - Israel Institute of Technology, Haifa, Israel). Journal of Guidance and Control, vol. 2, Sept. Oct. 1979, p. 402-406. 8 refs. Grant No. NsG-7373.

It is shown that activation of the trailing-edge control of an airfoil leads to single-degree-of-freedom type instabilities which span over a very wide region of reduced frequencies k, including high values of k (unlike the nonactivated system). These instabilities are shown to be sensitive to changes in pitching axis location, control deflection phase angle, and values of the reduced frequency. These sensitivities of the single-degree-of-freedom system cause the activated airfoil to be potentially sensitive to changes in flight conditions, and may be the source of the many difficulties encountered in suppressing classical multi-degree-of-freedom flutter by means of active controls. The results presented herein relate to zero Mach number and to a 20% trailing-edge control surface.

(Author)

A79-49869 \* # Linearization of the boundary-layer equations of the minimum time-to-climb problem. M. D. Ardema (NASA, Ames Research Center, V/STOL Systems Office, Moffett Field, Calif.). Journal of Guidance and Control, vol. 2, Sept.-Oct. 1979, p. 434-436. 6 refs.

Ardema (1974) has formally linearized the two-point boundary value problem arising from a general optimal control problem, and has reviewed the known stability properties of such a linear system. In the present paper, Ardema's results are applied to the minimum time-to-climb problem. The linearized zeroth-order boundary layer equations of the problem are derived and solved. V.P.

A79-49873 # Comment on 'active flutter control using generalized unsteady aerodynamic theory'. R. Vepa (National Aeronautical Laboratory, Bangalore, India). *Journal of Guidance and Control*, vol. 2, Sept.-Oct. 1979, p. 446, 447; Reply, p. 447, 448. 7 refs.

A79-49882 # Solution of a mixed boundary value problem for flow past a thin delta wing (Reshenie smeshannoi kraevoi zadachi obtekaniia tonkogo treugol'nogo kryla). A. M. Antonova and L. I. Dzvonik (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR). *Matematicheskaia Fizika*, no. 25, 1979, p. 74-80. In Russian.

A mapping method is presented for hypersonic flow past a thin delta wing at small angles of attack. A series of transformations makes it possible to formulate a Riemann-Poincare problem for the pressure function. Nontrivial solutions in the form of Fourier series are obtained for the problem along with recursive relations for the flow coefficients, shock profiles, and integral representations for velocity components.

A79-49904 A simulation of amphibious hovercraft overturning. D. M. Waters and R. A. Prasad (Loughborough University of Technology, Loughborough, Leics., England). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25:27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 54-74. 13 refs. The complex motion of an amphibious hovercraft suffering skirt tuck-under, plough-in, and hull contact has been simplified to the beam-on hull contact phase of the roll motion of a craft with a simple flat planing surface at the hull edge. The motion is restricted to two degrees of freedom sideslip and roll, but the nonlinear characteristics are incorporated using the SLAM digital simulation technique. Overturn is assumed if significant roll rate remains after the roll angle has appreciably exceeded that for the deck to submerge (20 to 30 deg). The neutral stability boundary is established as a function of center of gravity height and hull planing surface angle for varying hull thickness/beam, and skirt depth/beam ratios. (Author)

A79-49905 Performance predictions for open ocean air cushion vehicles and surface effect ships. J. A. Tremills (Defence Research Establishment Atlantic, Dartmouth, Nova Scotia, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978.

Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 75-103. 12 refs.

A79-49906 Small hovercraft design - Evolution to simplicity. A. Bliault. In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 104-124, 12 refs.

The paper reviews the development of small amphibious ACVs of capacity 0.1 - 2.0 tons from the early 1960s to the present. Changes in structural design, power train and propulsion systems, together with improvements in skirt technology, enable the design of efficient simple craft at present using a single engine and fan for lift and propulsion. The design developments described result in the capability to produce ACVs equivalent to such vehicles as jeeps and landrovers in their rugged reliability, while having the additional ability to traverse water, marshy, and soft sand terrains. The development of simple, rugged, and inexpensive small ACVs is now possible and has begun in Europe. Design data presented illustrate these modern techniques and the craft designs which result from their use.

A79-49907 Hovercraft skirt design requirements. J. E. Rapson (Hovercraft Development, Ltd., Southampton, England). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978.

Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 125-149. 8 refs.

The reason for using a hovercraft and the duties that it is required to perform are considered as the basis for the work of the hovercraft designer and more particularly, the skirt designer. General skirt requirements are discussed and analyzed in relation to various types of craft. By analyzing the power absorption of several craft, it is shown that a response skirt is of prime importance. The relationship of various skirt configurations is shown and opinions are expressed on their relative performance capabilities. Due to its versatility the open loop and segment system is singled out for special attention and design, and testing techniques are described. Finally the result of work on skirt section stability, nonscooping skirts, and cushion control systems are summarized. (Author)

A79-49909 \* Characteristics of an Air Cushion Landing System incorporating an inelastic trunk. A. B. Boghani, K. M. Captain (Foster-Miller Associates, Inc., Waltham, Mass.), and D. N. Wormley (MIT, Cambridge, Mass.). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 168-189. 8 refs. Contract No. NAS1-12403.

A series of static and dynamic tests performed on an Air Cushion Landing System (ACLS) incorporating inelastic trunk are described. The tests were performed on an apparatus which had provisions to isolate heave-pitch and roll motion on the prototype cushion. The results of the test show that the sides of the trunk behave differently from the trunk ends. The tests also demonstrate that the current ACLS designs suffer from low heave damping, low roll stiffness and fan stall problems. (Author)

A79-49910 Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems, D. Eyre (Saskatchewan Research Council, Saskatoon, Canada) and A. A. Jones (A. A. Jones and Associates, Ltd., La Ronge, Saskatchewan, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 190-213. 5 refs.

The paper summarizes the results of a detailed evaluation of the economics and technical problems of air-cushion-assisted vehicles in on-road applications, conducted from 1977 to 1978. The results show that air-cushion-assisted vehicles are not economically competitive or technically practicable in fleet operations. This indicates the importance of a paper evaluation prior to the development and application of the technology. It is noted that air-cushion-assisted vehicles and cannot satisfy the existing braking regulations. The effect on road maintenance is shown to be minimal, and the energy efficiency to be considerably lower than in the conventional vehicles. V.T.

A79-49911 A combined air-cushion and endless belt transportation system. D. Train and C. Melançon (Hydro-Quebec, Institute of Research, Varennes, Quebec, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 214-224.

The paper describes an air-cushion system for the transportation of loads up to 150 T. The system consists of a pallet and an air-cushion assembly of eight 36-in. castors. Each castor is surrounded by a flexible but impermeable endless belt which enables the air-cushions to be used on floor surfaces having discontinuities such as drains, cracks, and recessed rails. This technique also prevents the compressed air from escaping downward when used on semiporous surfaces such as asphalt, gravel, etc. The system was developed in order to eliminate damage to the floor when using a conventional air-cushion system. A major advantage of the new system is that it is less sensitive to irregularities in the floor surface, and the air castors are less prone to puncture due to swarf, screws, etc. V.T.

A79-49912 Iceater I - Air cushion ice breaker in commercial operations. W. B. Stocking (Arctic Systems, Ltd., Houston, Tex.). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 237-246.

The paper presents the results of full-scale testing of the Arctic System Limited Air Cushion Craft, Iceater I, which was conducted on Thunder Bay, Ontario, during the winters of 1975-76 and 1976-77. Iceater I was initially developed as an overland transporter and work platform. The craft was also adapted to use over water and in almost all aspects it performed satisfactorily when limited to the special operations and close supervision provided by the test environment. In several other aspects, it was deficient as an over-water or in-water craft. Some of the more important of these aspects are discussed: (1) stability in the floating mode; (2) unwatering/deballasting capability; (3) hovering power plant reliability; (4) craft control and security (including anchoring and landing); (5) hovering system maintenance over water; (6) host ship interfaces; a (7) long-range mobility. V.T.

A79-49915 Current Canadian developments related to low-speed heavy lift ACV. R. W. Dyke (Hoverlift Systems, Ltd., Calgary, Alberta, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 358-378.

A method for determining cushion flows over water and over land is discussed, and a new non-dimensional lift-air coefficient is proposed. Propulsion using winched cables, applied to low-speed ACV ferries, is outlined and developments of surface contacting devices are discussed along with the theoretical and experimental prediction of minimum air flows and over-water drags for cushions containing segmented skirts. Emphasis is placed on the development of a modular structure concept which defines a modular system as consisting of rectangular boxes with triangular perimeter, units that can be assembled together to form a series of craft capable of payloads from about 40 to 300 tons. V.T.

A79-49921 # Drag reduction by cooling in hydrogen-fueled aircraft. E. Reshotko (Case Western Reserve University, Cleveland, Ohio). Journal of Aircraft, vol. 16, Sept. 1979, p. 584-590. 28 refs.

Drag reductions are possible for cryo-fueled aircraft by using fuel to cool selected aerodynamic surfaces on its way to the engines. This is because cooled laminar boundary layers in air at subsonic and low supersonic speeds are more stable than adiabatic boundary layers and therefore more resistant to transition to turbulent flow. Calculations for M = 0.85 hydrogen-fueled transport show that drag reductions in cruise of about 20% are within reason. The weight of the fuel saved is well in excess of the weight of the required cooling system. These results suggest that the hydrogen fueled aircraft employing surface cooling is quite attractive as an energy conservative aircraft and warrants more detailed study. (Author)

A79-49922 # Correlation technique for ambient effects on oxides of nitrogen. R. M. Washam and A. M. Mellor (Purdue University, West Lafayette, Ind.). *Journal of Aircraft*, vol. 16, Sept. 1979, p. 626-631. 19 refs. Research supported by the U.S. Environmental Protection Agency.

Aircraft gas turbine engine testing requires large air flow rates and this is accomplished with ambient air. Daily changes in atmospheric air temperature, pressure, and humidity lead to variations in NOxEI (g NOx/kg fuel). A new scheme is proposed to correlate engine data and minimize this scatter due to changes in ambient conditions. The scheme is derivable from first principles; example calculations are shown for several Pratt and Whitney JT9D engines. The correlation technique is explained in detail, and the resulting scaling relations is discussed. (Author)

A79-49925 # Comment on 'Flight test of stick force stability in attitude-stabilized aircraft'. W. O. Breuhaus (Institute for Defense Analyses, Arlington, Va.). *Journal of Aircraft*, vol. 16, Sept. 1979, p. 639, 640; Authors' Reply, p. 640. 6 refs.

A79-49995 Injuries in air transport emergency evacuations. D. W. Pollard (FAA, Protection and Survival Laboratory, Oklahoma City, Okla.). Aviation, Space, and Environmental Medicine, vol. 50, Sept. 1979, p. 943-947. 7 refs.

Eleven accident histories pertaining to air transport emergency evacuations are reviewed because they are representative of types of evacuations. A twelfth history was selected because the passenger load consisted of trained personnel, and hence is unique. Factors influencing survival in emergency evacuations are presented and described in tabular form: configuration, procedure, environment, and biobehavior. The discussion focuses on the configurational and procedural factors. The environmental factor, while significant in high-impact and/or toxic-agent-producing accidents, is relatively unimportant in less severe accidents. The biobehavioral factors cannot be controlled and are therefore not emphasized in this paper. S.D.

A79-50109 Lusaka accident report. J. M. Ramsden. Flight International, vol. 116, Aug. 25, 1979, p. 595, 596, 601-607.

A study of the Lusaka accident of a Boeing 707 is examined in detail with emphasis on the detached stabilizer and the cause of its dislodging. Postaccident tests, a total of nine, using theoretically derived loads were examined over a range of four conditions. Other tests including fatigue and failsafe tests were conducted by US and UK agencies and a failsafe design philosophy is discussed. It was concluded that insufficient consideration had been given to the design and certification stage and to the stress distribution of the horizontal stabilizer spar structure following a top chord failure in the region outboard of the closure rib. C.F.W.

A79-50110 Duct noise radiation through a jet flow. H. E. Plumblee (Lockheed-Georgia Co., Marietta, Ga.) and P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 65, Aug. 22, 1979, p.453-491. 53 refs.

The radiation of internal (or core) noise for aircraft turbojet or turbofan engines is studied analytically. The geometry of a typical engine is simplified for analytical considerations to a hemispherical shell with a jet flow and internal sound emanating through a circular hole on the axis. A linearized theory is used to derive a flow modified spherical wave equation. A forced separation technique is used to produce a modified Legendre equation describing the angular variation of the acoustic radiation field. Then a numerical technique is described for obtaining a general field solution by progressively imposing continuity of pressure across hemispherical shells as the solution is marched from near field to the far field. In a companion paper, numerical results are presented and compared with experimental results from a test configuration identical to that described by the theory. (Author)

A79-50163 High sink-rate landing testing of Navy aircraft. G. E. Clarke (U.S. Naval Air Test Center, Patuxent River, Md.). Society of Flight Test Engineers, Journal, vol. 1, Jan. 1979, p. 2-9.

Sink-rate measurement systems for Navy aircraft are reviewed including photo-optical systems, the Ryan sink-rate radar, a touchdown rate-of-descent indicator (TRODI), and a laser theodolite. The Ryan radar offers a high potential for development into an accurate measuring system. A near-term effort is being made to improve the data readout available from this radar so that the inherent system accuracy might be realized. Goals are to reduce or eliminate reader variability and to generate report quality data. The long-term solution to accurate sink-rate measurement is a laser theodolite with digitized output fed to an onboard minicomputer capable of real-time computation and display of sink rate and engaging speed.

A79-50164 Dynamic test techniques - Concepts and practices. K. Rawlings, III, J. M. Cooper, and D. L. Hughes. *Society of Flight Test Engineers, Journal*, vol. 1, Jan. 1979, p. 10-20.

The concepts involved in dynamic performance testing represent a philosophy of developing a single, coherent performance model using thrust and drag modeling. It is shown that if all thrust drag interactions, maneuver rates, and instrumentation are taken into consideration, it is possible to generate a lift/drag model which is capable of predicting performance from nearly any maneuver. Although this capability is dependent on the ability to calculate gross thrust adequately, the engines can be calibrated through static thrust runs and the thrust computation procedures verified in flight. The capability of generating a consistent lift/drag model in considerably less time than conventional performance methods is demonstrated. V.T. A79-50165 An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack. W. A. Thor (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). Society of Flight Test Engineers, Journal, vol. 1, Jan. 1979, p. 21-25.

The F-104 high-load-factor stability problem was studied with a wind tunnel model. As the angle of attack for the model with a clean wing is increased near the stall, the roll damping drops off abruptly and the yaw due to roll increases negatively (adverse yaw). This characteristic was more pronounced when the wing was in the high-lift configuration of 12 deg leading-edge flap and 13 deg trailing-edge flap, due to the lift-curve slope's decreasing at an earlier angle of attack for the flapped wing. The wing fences, slats, and strakes had a favorable effect on the roll damping and adverse yaw, and they are considered to be the simplest and most effective aerodynamic modification to increase the roll damping at high angles of attack without degrading the longitudinal characteristics. Tack below stall.

A79-50166 Ultrasonic method of gun gas detection. R. L. Grant (McDonnell Aircraft Co., St. Louis, Mo.). Society of Flight Test Engineers, Journal, vol. 1, Jan. 1979, p. 26-32.

Gun-gas sensing systems using ultrasonic sensors are described. Three systems were constructed: two of them employed multiple sensors, whereas the third was a single-sensor prototype system. The control unit, tailored in each case to a particular data system requirement, provided an independent pulse-code modulated output containing the reduced sensor data and various system status indicators. The single-sensor system was tested in an actual flight environment during the F-15 gunfire program. Data were also collected on sensor performance during ground tests of the 20-mm gun used on the F-15. Conclusive test data supporting the quantitative performance of the sensor were limited to laboratory tests although a limited amount of data exists that indicates a correlation with sampling bottle data taken during actual gunfire. It is noted that the response time of the ultrasonic sensor is significantly faster than that of catalytic sensors. νт

A79-50167 Performance modelling methods. W. M. Olson (USAF, Flight Test Center, Edwards AFB, Calif.). Society of Flight Test Engineers, Journal, vol. 1, May 1979, p. 2-12.

Two different directions a performance program can take are discussed. The first is a program in which accelerations are used to generate acceleration performance, etc. The other extreme is a program in which maneuvers are designed solely to generate drag polars and thrust and fuel flow maps. Five basic performance modeling methods which utilize drag and thrust models are outlined: (1) predicted minimum drag method; (2) predicted thrust method; (3) predicted thrust fuel model; (4) complete reliance on the in-flight thrust calculation; and (5) partial reliance on the in-flight thrust calculation. The preferred program should be designed primarily to generate the model, but 'conventional' maneuvers should be used in V.T.

A79-50168 A computer system for identifying aircraft characteristics. T. J. Galbraith, T. J. Petersen, and C. E. Roth (Boeing Commercial Airplane Co., Renton, Wash.). Society of Flight Test Engineers, Journal, vol. 1, May 1979, p. 13-30. 6 refs.

The parameter identification (PI) concept is presented as a mathematical scheme for estimating stability and control derivatives from dynamic flight testing. A parameter identification system composed of six computer programs is described along with a kinematic and sensor-dynamics (KASD) program added to the system for identifying sensor inconsistencies or errors. The PI concept employs the classical six-degree-of-freedom kinematic relations, modeled sensor errors, and an estimator to produce a

V.T.

consistent set of sensor time histories. A flaps-up, lateral-directional flight record for a large subsonic transport aircraft was analyzed to identify the linear stability, control derivatives, and sensor errors. The same record was then processed through KASD. The purpose of this experiment was to determine the impact of more detailed sensor error identification on the estimation of the linear stability and control derivatives. V.T.

A79-50169 The T & E simulator - A comparison with flight test results. J. M. Rebel (U.S. Naval Air Test Center, Patuxent River, Md.). Society of Flight Test Engineers, Journal, vol. 1, May 1979, p. 31-36.

Development of an automatic carrier landing capability for the F-14A aircraft is presented. The models of the aircraft and automatic carrier landing system (ACLS) were constructed with information that included flight test data. The simulator was then 'tuned.' First, standard aircraft maneuvers, such as pitch and bank steps, were run on the simulator, time histories of these maneuvers were compared with flight test data, and corrections to the models were made. Next, a pilot who had recently flown the aircraft was asked to 'fly' the simulator and comment on its fidelity. Based on comparison of measured aircraft frequency response data, touchdown statistics, and the pilot opinion the F-14 ACLS simulation has been shown to be a valid model that is capable of predicting flight test results. V.T.

A79-50206 Derivative engines for the 1980s will help limit acquisition and maintenance costs. J. E. Worsham (General Electric Co., Commercial Engine Div., Cincinnati, Ohio). *ICAO Bulletin,* vol. 34, Apr. 1979, p. 14-17.

It is noted that the projected increase in commercial aviation will lead to greater demand for new aircraft and thus new engines. The industry is shown to be emphasizing derivative engines. Attention is given to the advantages of such development such as rapid maturity of the design resulting in a reduced shop visit rate, and reduced acquisition costs. As an example the CFM56 engine, suitable for re-engineering narrow body aircraft such as the B-707, DC-8, and DC-9, utilizes the core of a high performance engine previously developed for the U.S. Government. It is concluded that meeting costs continues to be a major challenge for the airlines, the aircraft companies, and the engine manufacturers. M.E.P.

A79-50207 Aircraft engine developments centre on improved performance, higher efficiency. W. H. Sens (United Technologies Corp., Commercial Products Div., East Hartford, Conn.). *ICAO Bulletin*, vol. 34, Apr. 1979, p. 18-23.

Improvements that can be made to reduce the fuel consumption of current engines are reviewed as well as for new production versions of current engines. In addition, the potential fuel savings with advanced turbofan engines are discussed. Four ways to improve fuel consumption are covered: improvement in component performance, improved maintenance procedures that reduce the amount of engine performance deterioration with operational use, improvement in the power plant cycle, and by designing the engine to be less sensitive to factors causing performance deterioration. Modification to current engines can improve fuel consumption by 5%. It is concluded that the advanced turbofan configuration has the potential of providing a 20% reduction in fuel burned relative to today's designs for a high bypass ratio turbofan for 1990. M.E.P.

A79-50208 \* OCSEE - The key to future short-haul air transport. C. C. Ciepluch (NASA, Lewis Research Center, Quiet, Clean, Short-Haul Experimental Engine Project Office, Cleveland, Ohio) and W. S. Willis (General Electric Co., Aircraft Engine Group, West Lynn, Mass.). *ICAO Bulletin*, vol. 34, Apr. 1979, p. 24-29.

The paper describes the design and test procedure for the QCSEE (quiet, clean, short-haul experimental engine). The engines designed for the YC-14 and YC-15 STOL aircraft, both use a very low fan pressure ratio to keep jet-flap noise about 3 dB below total

system noise. Other noise reducing features discussed are the low tip speed fans and a carefully selected number of fan blades and vanes with adequate spacing between them. Attention is also given to the development of a low emissions combustor, and reduction of fan frame weight, through the use of graphite/epoxy material. The YC-15 engine also employs variable pitch fans to provide thrust reversal, thus saving weight. Finally, it is noted that the tests have proven that the engines could be configurated to meet the needs of a powered lift system without excessively compromising performance or weight. M.E.P.

A79-50209 Factors controlling stability of swirling flames at diffusers in gas turbines. V. M. Domkundwar, V. Sriramulu, and M. C. Gupta (Indian Institute of Technology, Madras, India). Institute of Energy, Journal, vol. 52, Mar. 1979, p. 17-20. 7 refs.

The paper deals with experimental studies aimed at determining the effect of diffuse angles on flame-stability characteristics and to relate stability data to inlet flow conditions, diffuser angles, and equivalence ratios. The blowoff data obtained for different diffusers show that if diffuser angles are increased, flame stability is improved. The flame-stabilization mechanism is explained by using a recirculation model. It is concluded that the blowoff velocity increases as the diffuser angles increase. V.T.

A79-50236 # The aeroacoustics of advanced turbopropellers. D. B. Hanson (United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.). International Union of Theoretical and Applied Mechanics, International Commission on Acoustics, and AIAA, Symposium on Mechanics of Noise Generation Fluid Flows, Göttingen, West Germany, Aug. 28-31, 1979, Paper. 12 p. 10 refs.

Advanced turbopropellers (prop-fans) are being developed in the United States to improve the fuel economy of future transport aircraft. To study their noise, various noise prediction systems have been developed via the acoustic analogy and a helicoidal source model. A time domain formulation and two frequency domain formulations are presented. Wind tunnel test data are presented to substantiate the theory and to show its limitations. Shadowgraphs and near field microphone signals for straight blades operating at supersonic speeds indicate the presence of detached bow waves that cannot be predicted from the acoustic analogy. Nonlinear effects appear to be confined to a region within two chords of the blade tips and are greatly relieved by blade sweep. It is shown that noise of highly swept blades can be predicted with good accuracy using linear source theory. (Author)

A79-50237 # Supersonic transport aircraft noise, problems of noise reduction and establishment of standards (Shum sverkhzvukovykh transportnykh samoletov, voprosy ego normirovaniia i snizheniia). B. N. Mel'nikov. *Itogi Nauki i Tekhniki, Seriia Vozdushnyi Transport*, vol. 7, 1979, p. 5-37. 42 refs. In Russian.

Noise and sonic boom standards for supersonic transport aircraft are presented. Noise characteristics of supersonic transports equipped with different types of high-temperature jet engines are outlined. Research results and comparative analysis of noise characteristics of first-generation supersonic transports are given along with evaluation of the expected noise characteristics of second-generation supersonic transport aircraft. Consideration is given to methods of noise reduction for the second-generation aircraft, including engine improvement, implementation of exhaust systems for jet suppression, and implementation of specific takeoff and approach techniques.

V.T.

A79-50240 # Current status of airport terminal complex development abroad (Sovremennoe sostoianie razvitiia aerovokzal'nykh kompleksov za rubezhom). V. N. Ivanov and M. G. Piskov. *Itogi Nauki i Tekhniki, Seriia Vozdushnyi Transport,* vol. 7, 1979, p. 159-224, 26 refs. In Russian. Airport terminal complex development before and after 1970 is considered with attention given to finger, drive-in, gate room, and pipe schemes, parking places, and baggage handling and loadingunloading concepts. Five passenger service system approaches are presented: (1) flight check-in, (2) common check-in, (3) gate check-in, (4) drive-in and drive-to-your-gate, and (5) shuttle. Principles of transportation between airport terminals and aircraft are outlined including busing and plane mate techniques. Airport terminal planning and design, curb space planning, and means of passenger access to aircraft are discussed. Emphasis is placed on the use of mathematical models for calculating airport terminal capacities. V.T.

A79-50306 A computer program for aircraft identification and derivative extraction. R. Hector, D. P. Maunder (USAF, Flight Test Center, Edwards AFB, Calif.), and E. M. Cliff (Virginia Polytechnic Institute and State University, Blacksburg, Va.). Society of Flight Test Engineers, Journal, vol. 1, Sept. 1979, p. 8-15.

A computer program developed for the investigation of stability, control and performance derivatives of aircraft from flight test data is presented. The program involves the development of a maximum likelihood technique with greater flexibility and accuracy, the development of a new linearized set of equations of motion, and the use of advanced programming technology for minimizing errors and reducing maintenance costs. The design permits operation in both the batch and interactive graphic mode. Attention is given to parameter identification which provides tools for the efficient use of data in the estimation of constants appearing in mathematical models and for aiding in modeling of phenomena. C.F.W.

A79-50307 Flight testing and simulator flight fidelity. R. T. Galloway (U.S. Naval Air Test Center, Patuxent River, Md.). Society of Flight Test Engineers, Journal, vol. 1, Sept. 1979, p. 22-31. 6 refs.

The paper outlines the role of the NAVAIRTESTCEN in simulator testing, simulator test experience, and fidelity problem areas. The major elements of the Navy test policy are outlined, including assistance in specification preparation, proposal evaluation, participation in in-plant acceptance testing, and adjusting hardware and software to achieve proper flight fidelity. It is shown that the use of NAVAIRTESTCEN flight test expertise has helped to maximize the flight fidelity of recent major aviation training devices within the U.S. Navy and Marine Corps. Furthermore, test experience has shown that meaningful data can be obtained with simple hand-held instrumentation, and that the test pilot must refamiliarize himself with the subtle aircraft characteristics during the evaluation period. C.F.W.

A79-50368 Combined environment reliability test of the common strategic Doppler system. J. F. Wagner, III (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Learning to use our environment; Proceedings of the Twenty-fifth Annual Technical Meeting, Seattle, Wash., April 30-May 2, 1979.

Mount Prospect, III., Institute of Environmental Sciences, 1979, p. 574-577. 6 refs.

A recently completed development program for a new common strategic Doppler system made use of preproduction combined environment reliability testing to provide data for the source selection process. This test was used instead of the previously planned MIL-STD-781B reliability tests in order to subject the vendors' equipment to more realistic environmental conditions. This paper will discuss the effectiveness of the combined environment test in the competitive procurement process. (Author)

A79-50375 Aerodynamics for engineers. J. J. Bertin (Texas, University, Austin, Tex.) and M. L. Smith (U.S. Air Force Academy, Colorado Springs, Colo.). Englewood Cliffs, N.J., Prentice-Hall, Inc., 1979. 424 p. 123 refs. \$28. The book contains an introductory-level discussion of basic fluid mechanics and thermodynamics. The contents are divided among three major areas: flow fields for which the density may be assumed constant; flow fields for which the variations in density are important; and topics with general application both to incompressible and compressible aerodynamics. Discussions of the effects of viscosity, compressibility, shock-boundary layer interactions, turbulence, and other practical aspects of contemporary aerodynamic theory and design are also presented. Attention is given to characteristic parameters for airfoil and wing aerodynamics, two-dimensional incompressible flows around thin airfoils and about wings of finite span, and subsonic and transonic flows. V.T.

A79-50421 # Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ (Gazovye turbiny dvigatelei letatel'nykh apparatov: Teoriia, konstruktsiia i raschet /Third revised and enlarged edition/). V. I. Lokai, M. K. Maksutova, and V. A. Strunkin. Moscow, Izdatel'stvo Mashinostroenie, 1979. 448 p. 42 refs. In Russian.

The book deals with the theory, calculation and projection methods, and designs of gas turbines used in aircraft gas-turbine and liquid rocket engines as well as in auxiliary aircraft power plants. Consideration is given to the physics of gas flows in channels as well as the thermo and gas dynamics of turbines. Emphasis is placed on problems of cooling gas turbines. A classification of cooling systems for gas turbines. Losses in gas turbines, gas turbine characteristics, and operational processes parameters under cooling conditions are evaluated. Typical designs of the major components and units of gas turbines are presented along with strength and vibrational test methods for disks, blades, and shafts. V.T.

A79-50427 The Swedish approach to escape system testing. G. Niss (Saab-Scania AB, Linkoping, Sweden). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 1-1 to 1-12.

The paper deals with methods of obtaining maximum safety in current fighter aircraft escape systems and producing reliable test results. The test aircraft, a modified night fighter version of the Lansen: seat and dummy pilot installation; and the test site where most tests are performed at 500 ft and higher above the ground and in the 270 to 1150 km/h speed range are described. Seat and dummy acceleration during the drive phase, the effect of wind blast on pilot and equipment and effectiveness of the restraint system are evaluated, and initial stability of the man-seat combination, stabilizer chute, the separation between the seat and the pilot, clearance between the dummy-parachute combination and the seat are discussed. Parachute deployment sequence, the trajectory from ejection point till the dummy is in a fully deployed parachute, and inspection of dummy, dress, and equipment are described, and it is concluded that changes required at high speed must be based on full scale flight testing. ΑТ

A79-50428 An evaluation of sidestick force/deflection characteristics on aircraft handling qualities. S. B. Smith and C. M. Miller (USAF, Flight Test Center, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 2-1 to 2-17. 9 refs.

A study of a variable force and motion sidestick controller programmed to simulate the handling characteristics of a highperformance stability fighter aircraft is presented. Precision air to-air tracking of a target aircraft during level and windup turns, gross acquisition and tracking involving large pilot inputs, and landings were evaluated. The ratio of stick force to stick deflection and the ratio of stick force to aircraft response, and the effect of sidestick controller pre-filter characteristics were investigated. It was concluded that for very small displacements the range of stick force/response gradients is restricted, that there is a region of moderate stick displacement where performance is insensitive to variations in force/response gradients, and that moderate stick motion coupled with light to moderate stick force gradients results in the best tracking performance. A.T.

A79-50429 Separation testing of large weapons from the B-1 bomber. R. E. Little (Rockwell International Corp., El Segundo, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978.

Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 4-1 to 4-14.

This paper covers the flight test techniques and data analysis methods in use on the weapon separation test program for the B-1. Weapon trajectory test results together with prediction methods are shown, and the importance of estimating methods and test instrumentation is discussed. Weapon launch and trajectory parameters are covered with comparisons taken from analytical wind tunnel and flight test results. Weapon accuracy error budgets are presented in relation to current capabilities of space positioning equipment, and aircraft/weapon accuracy requirements. (Author)

A79-50430 INACT - Interactive test data analysis. D. R. Halwes (Bell Helicopter Textron, Fort Worth, Tex.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 6-1 to 6-18.

The capability of interactive test data analysis (INACT) for high speed data programs is based on new mini-computers. INACT was developed to provide flight test engineers an on-line computer access during flight and laboratory vibration testing, and to command data acquisition, analysis, and display on a graphics terminal in a telemetry or the vibration control room. INACT can analyze up to 8 channels of analog data from telemetry during flight testing, analog tape playback, or during ground vibration testing. Input command form and conventions, examples of data analysis, and the use of INACT for flight testing are discussed, and it is concluded that INACT provides capabilities for data acquisition, time history displays, harmonic analysis, spectral analysis, damping estimation using the complex exponential approximation, and transfer function computation. A.T.

A79-50432 \* Estimation of longitudinal aircraft characteristics using parameter identification techniques. R. C. Wingrove (NASA, Ames Research Center, Aircraft Guidance and Navigation Branch, Moffett Field, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engi-

neers, 1978, p. 9-1 to 9-24, 22 refs.

This study compares the results from different parameter identification methods used to determine longitudinal aircraft characteristics from flight data. In general, these comparisons have found that the estimated short-period dynamics (natural frequency, damping, transfer functions) are only weakly affected by the type of identification method, however, the estimated aerodynamic coefficients may be strongly affected by the type of identification method. The estimated values for aerodynamic coefficients were found to depend upon the type of math model and type of test data used with each of the identification methods. The use of fairly complete math models and the use of long data lengths, combining both steady and nonsteady motion, are shown to provide aerodynamic coefficient values that compare favorably with the results from other testing methods such as steady-state flight and full-scale wind-tunnel experiments. (Author)

A79-50433 \* Considerations in the analysis of flight test maneuvers, K. W. Iliff, R. E. Maine, and T. D. Montgomery (NASA,

Flight Research Center, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 10-1 to 10-36. 13 refs.

This paper discusses the application of a maximum likelihood estimator to dynamic flight-test data. The information presented is based on the experience in the past twelve years at the NASA Dryden Flight Research Center of estimating stability and control derivatives from over 3,000 maneuvers from 32 aircraft. The overall approach to the analysis of dynamic flight-test data is discussed. Detailed requirements for data and instrumentation are discussed and several examples of the types of problems that may be encountered are presented. (Author)

A79-50434 AFFTC parameter identification experience. D. P. Maunder (USAF, Performance and Flying Qualities Branch, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978.

Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 11-1 to 11-18. 5 refs.

The AFFTC experience with parameter identification and results of this application with respect to accuracy, contributions of otherwise unobtainable information, and cost effectiveness are presented. Parameter identification techniques in aircraft flight testing obtain aerodynamic, structural, and performance characteristics to assess control system performance and establish design criteria. The technique was used to provide mathematical description of aircraft stability and control characteristics such as improved verification of performance criteria and improved dependability of extrapolated flight characteristics. Parameter identification experience including test optimization, accuracy, flight test parameter identification comparisons with wind tunnel, and parameter identification and configuration effects are discussed. It is concluded that parameter identification provided reduction and optimization of flight test programs, better verification of performance criteria, enhanced system development, and optimization of vehicle performance. A.T.

A79-50435 Flight test technology development - A preview of DyMoTech. J. W. Hicks (USAF, Flight Test Center, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978.

Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 12-1 to 12-11. 8 refs.

The scope of dynamic modeling technology (DyMoTech) for instrumentation systems, flight test maneuvers, and performance modeling techniques is presented. The purpose of DyMoTech is to develop dynamic flight test techniques and modeling to define the aircraft performance characteristics, and to conduct an inflight comparison of four methods of extracting flightpath accelerations simultaneously from separate measurement systems on the test aircraft. Four instrumentation systems will be compared during takeoff and landing, climbs, level accelerations, wind-up turns, and split-S maneuvers. It is concluded that DyMoTech seeks to develop a total approach to dynamic flight testing to save flight test time and program cost, provide a more complete definition of the performance envelope, and greater model utility and versatility in which it can predict both standard-day and non-standard day performance data, flight manual preparation, mission analysis, and performance simulation. ΑT

A79-50436 Evaluation of the radar altimeter reference method for determining altitude system positioning errors. J. D. Dinkel (Grumman Aerospace Corp., Calverton, N.Y.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 13-1 to 13-18.

The radar altimeter reference method for determining altitude system position errors which can reduce the number of flights

required to calibrate a system, manpower and supporting equipment is presented. The method has the advantages of instrumentation and equipment in the test aircraft, coverage over a wide range of Mach numbers and attack angles. In addition, it is independent of wind speed and air temperature measurements, has high data productivity per maneuver and flight, and its telemetry compatible system enables determination of answers in real time. The radar altimeter reference method consists of runway flyover, atmosphere calibration, and altitude pressure system calibration. The radar altimeter and pneumatic altimeter, the flight test method, software, and test procedures were evaluated, and computer software was developed. It was concluded that the radar altimeter reference method provides a viable means for determining altitude system position errors. A.T.

A79-50437 ARIA takeoff performance flight test program. H. A. Lebovitz (USAF, Directorate of Flight Test Engineering, Wright-Patterson AFB, Ohio). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 15-1 to 15-13.

The verification and subsequent testing to reduce the impact of the extended takeoff roll on the advanced range instrumented aircraft (ARIA) is presented. Two EC-135N ARIA aircraft experienced a takeoff ground roll greater than predicted by the flight manual. Since in the event of an engine failure at or near the critical engine failure speed, the aircraft would be incapable of aborting the takeoff or continuing it, a hazard report was prepared recommending action to verify the takeoff performance. The verification test indicated that the extended ground roll is due to an interaction of the enlarged nose radome and the ground resulting in a large increase in drag. Ground/radome interaction tests were made, and it was concluded that the EC-135N aircraft exhibit an extended ground run 15% greater than predicted, aircraft subsystems were functioning properly, and the extended ground run appears to be due to a ground/radome interaction. A.T.

A79-50438 The evolution of the high-angle-of-attack features of the F-16 flight control system. C. K. Clark, J. E. Walker, and J. K. Buckner (General Dynamics Corp., Fort Worth, Tex.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 17-1 to 17-21.

'Eyes-out-of-the-cockpit' air combat maneuvering achieved through the use of angle-of-attack and structural-load-limiting features of the flight control system is presented. Spin-tunnel results revealed a fast-flat spin mode that required an unacceptable number of turns to recover, and a no-spin condition resulted when flaperons were deflected to roll in the direction of the spin. A yaw-rate limiter was designed that automatically prevented spins by positioning the flaperon and rudder in the direction defined by the spin tunnel to prevent the spin. Flight testing showed that departures may develop from high angle-of-attack sideslips and rolling maneuvers. A rudder fadeout was designed which prevented yaw departures from fullrudder side-slips, a roll-rate command limiter was installed, pitch-axis modifications were made in the flight control system, and a rudder-pedal command limiter was designed. It was concluded that these systems improved the high angle-of-attack handling qualities of the F-16 and allow the pilot to fly 'eye-out-of-the-cockpit' aircombat maneuvering with maximum command inputs and without fear of departure. A.T.

A79-50439 Evaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Flying Qualities of Piloted Airplanes'. C. C. Withers (Lockheed-Georgia Co., Marietta, Ga.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 19-1 to 19-18. 5 refs.

A comparison of the requirements of the military specification 'Flying Qualities of Piloted Airplanes' with flight test results from the C-5A, L-1011, C-141A, and YC-141B aircraft is presented. A study of the C-5A flight results showed that this specification was too stringent in seven sections which were compared with flight test results in this investigation: phugoid stability, short-period response, elevator control force gradient, lateral directional damping, roll mode time constant, sideslip excursions, and roll control effectiveness. It was shown that: (1) sections dealing with lateral control, roll mode, sideslip excursions, and roll control effectiveness are too stringent for Level 1 conditons; (2) phugoid stability, short period response, and control forces in maneuvering flight warrant adjustment in Level 1 requirement boundaries; and (3) the lateral directional damping section is too restrictive for Level 2 conditions.

A79-50440 \* A simplified gross thrust computing technique for an afterburning turbofan engine. M. J. Hamer (Computing Devices Co., Ottawa, Canada) and F. J. Kurtenbach (NASA, Flight Research Center, Propulsion Controls Branch, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 22-1 to 22-20. 8 refs. Research sponsored by the United States/Canada Defence Production Sharing Program.

A simplified gross thrust computing technique extended to the F100-PW-100 afterburning turbofan engine is described. The technique uses measured total and static pressures in the engine tailpipe and ambient static pressure to compute gross thrust. Empirically evaluated calibration factors account for three-dimensional effects, the effects of friction and mass transfer, and the effects of simplifying assumptions for solving the equations. Instrumentation requirements and the sensitivity of computed thrust to transducer errors are presented. NASA altitude facility tests on F100 engines (computed thrust versus measured thrust) are presented, and calibration factors obtained on one engine are shown to be applicable to the second engine by comparing the computed gross thrust. It is concluded that this thrust method is potentially suitable for flight test application and engine maintenance on production engines with a minimum amount of instrumentation. A.T

A79-50441 J85-CAN-15 compressor stall and flameout investigation. W. L. Macmillan (Department of National Defence, Directorate of Aeronautical Engineering and Simulators, Ottawa, Canada), R. M. McGimpsey (Aerospace Engineering Test Establishment, CFB Cold Lake, Alberta, Canada), and K. D. Nelson. In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4.6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 23-1 to 23-16.

An investigation of the J85-CAN-15 compressor inlet temperature sensing system to prevent compressor stall and flameout during flight operations is presented. Engine testing and stall analysis which demonstrated the compressor inlet temperature sensitivity of the engine, the flight test program to determine engine and sensing system performance, and flight test techniques are described showing that there were errors in the T2 sensing system. It was shown that the compressor inlet temperature (T2) sensing systems on the J85-CAN-15 operate at temperatures warmer than the compressor inlet total temperature (CIT), that the T2 cutback does not occur in accordance with that predicted by the engine CFTO's, T2 cutback can be observed on cockpit instruments, insulating the T2 duct did not significantly reduce the T2 sensing system error, and engine anti-ice provides an effective means of reducing compressor discharge pressure during afterburner initiation. A.T.

A79-50444 Testing the F-18 at the U.S. Naval Air Test Center, J. L. Dunn (U.S. Naval Air Test Center, Patuxent River, Md.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 26-1 to

Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 26-1 to 26-11.

The U.S. Navy is procuring the F-18 as a replacement for the F-4 and A-7 aircraft starting in 1983. The F-18 evolved from the

YF-17 prototype which was a part of the U.S. Air Force Light Weight Fighter Competition in 1974, F-18 design advancements include control-by-wire digital flight control system, cockpit designed for one man operability, state-of-the-art avionics integration by software/multiplex techniques, and a high use of composite materials. From the Navy viewpoint, the unique aspect of the F-18 Full Scale Development (FSD) program is that it will be principal sited at the Naval Air Test Center (NAVAIRTESTCEN), Patuxent River, Maryland, Present plans for the FSD program are based on 11 test aircraft and 3100 test flights with first flight scheduled for late September 1978. NAVAIRTESTCEN involvement to date has consisted of participation in the design review process, Navy Integrated Test and Evaluation Working Group, Aircrew Systems Advisory Panel, and participation in simulation evaluations in St. Louis. The on-site preparation phase has consisted of establishing a management plan, ensuring that adequate facilities, support aircraft, airspace, and data and instrumentation systems are available.

(Author)

A79-50499 # Airport power supply (Elektrosnabzhenie aeroportov). I. S. Gladysh and P. L. Andreev. Moscow, Izdatel'stvo Transport, 1979. 248 p. In Russian.

The book deals with the basic principles and instrumentation of airport power supply. Characteristics of power consumers and techniques for reducing power consumption are discussed. General problems of power supply are considered, including electric network design, methods of design-power selecting, and determining wire and cable cross sections in accordance with heating and voltage-loss requirements. The electric power equipment and relay protection devices for airport transformers and power stations are described along with their design and circuitry. Attention is given to automatics and telemechanics of electric power networks, methods for calculating short-circuit current and selecting power, relay protection, and grounding equipment. The electrotechnic laboratory (ETL-1M) is also described. V.T.

A79-50606 Radiation from quarter-wavelength monopoles on finite cylindrical, conical, and rocket-shaped conducting bodies. M. N. I. Fahmy (Cairo University, Cairo, Egypt; Riyadh, University, Riyadh, Saudi Arabia) and A. Z. Botros (Cairo University, Cairo, Egypt). *IEEE Transactions on Antennas and Propagation*, vol. AP-27, Sept. 1979, p. 615-623. 14 refs.

A theoretical-numerical technique, based on Maue's integral equation, is applied for the determination of radiation patterns of airborne antennas comprising one or more quarter-wavelength monopoles, straight or bent, on finite cylindrical, conical, and rocket-shaped conducting airframes. The induced surface currents on the conducting body are first determined whence the total radiation fields are obtained. In the cases of a single monopole on a conducting body, the surface currents and radiation patterns are studied in view of varying the geometrical parameters of the body as well as the position and relative orientation of the monopole. For the case of two diametrically opposite monopoles on a finite cylinder, the effect of varying the relative phasing is studied. A physical interpretation of the variation with various parameters of the surface currents and the radiation fields is endeavored wherever feasible, and important results are concluded. Experimental investigation of radiation from one of the theoretically treated models, namely that of a bent monopole on a finite frustum of a cone, showed excellent agreement with computed results. This establishes the validity of the theoretical-numerical technique as well as the computed radiation (Author) patterns for various cases.

A79-50920 Aeronautical information data subsystems /AIDS/. F. W. Fischer (Studiengemeinschaft für Flugsicherung, Westerngrund, West Germany). *The Controller*, vol. 18, Sept. 1979, p. 30-33. The aeronautical information data subsystem (AIDS) is presented as a means to help alleviate the problems facing air traffic control at present. The method employs a data base that interlinks radar, flight plan and progress, and information data, and is also capable of simultaneous retrieval for multiple users. It is suggested that this system be implemented as the third vital data category in order to close the air traffic control data processing function loop. Such an implementation would improve air safety by increased responsiveness of the air traffic services to pilots requests for operational flight information availability of vital and important system data to air traffic controllers, and other air navigation services operators. C.F.W.

A79-50921 Modern systems for air traffic control. P. A. Jorgensen (Selenia SpA, Rome, Italy). (International Federation of Air Traffic Controllers' Associations, Annual Conference, 18th, Brussels, Belgium, Apr. 23-27, 1979.) The Controller, vol. 18, Sept. 1979, p. 35-37.

The paper deals with air traffic systems and equipment which can conveniently be put into operation, within a reasonable amount of time in order to upgrade present flaws. Attention is given to distributed intelligence, where the various tasks and functions can clearly be defined and divided to be performed by dedicated computers, each placed where the task or function may best be performed. The typical system structure of a computer and its radar links is shown, depicting the interface between the radar data processor and the display processor, radar head processor, and flight data processor. With this system, it is found that error detection capability is better than 80% within aircraft identification range, and the number of false alarms can be kept to 10 to the minus 8th.

C.F.W.

A79-50925 # Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor. J. Labbe (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (Symposium on Measuring Techniques in Transonic and Supersonic Cascade Flow, Leatherhead, Surrey, England, Mar. 22, 23, 1979.) ONERA, TP no. 1979-30, 1979. 20 p.

In order to investigate the capabilities of laser velocimetry for the study of perturbations due to circular distorsions in an axial compressor, preliminary experiments have been performed on a low speed compressor. The instrument used is a back-scattered Doppler velocimeter designed by ONERA. It is equipped with a 1400 mW argon ion laser used in its green line. Signals, picked up by synchronous sampling, are recorded by a frequency counter. Velocity (average 15 m/sec) and turbulence components are computed off-line. Three locations were investigated, namely upstream, in the mid-interblade channels and downstream of the impeller. Results obtained by LDV show deformations of the velocity vector and are in good agreement with average values deduced from previous experiments performed with pressure probe techniques. (Author)

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STAR ENTRIES

N79-30138\*# Rail Co., Baltimore, Md. MAINTENANCE COST STUDY OF ROTARY WING AIR-CRAFT, PHASE 2 Interim Report Aug. 1979 34 p (Contract NAS2-9143)

(NASA-CR-152291) Avail: NTIS HC A03/MF A01 CSCL 02A

The Navy's maintenance and materials management data base was used in a study to determine the feasibility of predicting unscheduled maintenance costs for the dynamic systems of military rotary wing aircraft. The major operational and design variables were identified and the direct maintenance man hours per flight hour were obtained by step-wise multiple regression analysis. Five nonmilitary helicopter users were contacted to supply data on which variables were important factors in civil applications. These uses included offshore oil exploration and support, police and fire department rescue and enforcement, logging and heavy equipment movement, and U.S. Army military operations. The equations developed were highly effective in predicting unscheduled direct maintenance man hours per flying hours for military aircraft, but less effective for commercial or public service helicopters, probably because of the longer mission durations and the much higher utilization of civil users. A.R.H.

N79-30139\*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif. PERFORMANCE EVALUATION METHOD FOR DISSIMILAR AIRCRAFT DESIGNS

Harold J. Walker Sep. 1979 72 p refs (NASA-RP-1042; H-1064) Avail: NTIS HC A04/MF A01 CSCL 02A

A rationale is presented for using the square of the wingspan rather than the wing reference area as a basis for nondimensional comparisons of the aerodynamic and performance characteristics of aircraft that differ substantially in planform and loading. Working relationships are developed and illustrated through application to several categories of aircraft covering a range of Mach numbers from 0.60 to 2.00. For each application, direct comparisons of drag polars, lift-to-drag ratios, and maneuverability are shown for both nondimensional systems. The inaccuracies that may arise in the determination of aerodynamic efficiency based on reference area are noted. Span loading is introduced independently in comparing the combined effects of loading and aerodynamic efficiency on overall performance. Performance comparisons are made for the NACA research aircraft, lifting bodies, century-series fighter aircraft, F-111A aircraft with conventional and supercritical wings, and a group of supersonic aircraft including the B-58 and XB-70 bomber aircraft. An idealized configuration is included in each category to serve as a standard for comparing overall efficiency. Author

#### N79-30140# Administrative Sciences Corp., Alexandria, Va. NAVAL AIRCRAFT OPERATING AND SUPPORT COST-ESTIMATING MODEL, FY 1977 REVISION

Feb. 1979 199 p refs Revised (Contract N00014-77-C-0180)

(AD-A068175; ASC-R-120; ASC-R-116-Rev) Avail: NTIS HC A09/MF A01 CSCL 05/1

In fiscal year 1974, Administrative Science Corp. developed a parametric cost-estimating model which has been updated and documented several times and used to support numerous Defense

Systems Acquisition Review Council (DSARC) reviews as well as other cost reviews. This report provides a detailed documentation of the cost-estimating relationships (CER's) developed from FY-77 data. In addition, the report has been significantly enhanced in order to serve as a handbook and training aid for Op-96D aircraft analysts. For each cost element in the structure, this report provides: (1) a definition; (2) discussion of the definition and other aspects of how, where, and why these costs are incurred, points of contact including organizational codes and telephone numbers, historical data, and sources for planning data; (3) cost-estimating relationship, including all computational procedures, regression statistics for the CER, and the data base; (4) an alternative CER (in many cases) with the same detail as above; and, (5) an example calculation. GRA

### N79-30141# Information Spectrum, Inc., Warminster, Pa. MAINTENANCE IMPROVEMENT: AN ANALYSIS AP-PROACH INCLUDING INFERENTIAL TECHNICAL DATA Final Report, 27 Dec. 1977 - 15 Mar. 1979

Milton Clyman, Philip S. Grenetz, and Raymond R. Mellott 15 Mar. 1979 322 p

(Contract MDA903-78-C-0176)

(AD-A068382; ISI-W-7958-02C) NTIS Avail HC A14/MF A01 CSCL 01/3

Tables of input information and output data which were used in assessment of the economic impact (cost and downtime) of potentially avoidable maintenance actions are presented for the F-14A fire control, A-7E and S-3A bombing navigation, and the S-3A landing gear. ARH

N79-30143\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

UPPER-SURFACE MODIFICATIONS FOR C SUB I MAX IMPROVEMENT OF SELECTED NASA 6-SERIES AIRFOILS C. A. Szelazek and Raymond M. Hicks Aug. 1979 79 p refs Prepared in cooperation with Computer Information Systems, Cupertino, Calif.

(NASA-TM-78603; A-7889) Avail: NTIS HC A05/MF A01 CSCL 01A

The thickness of the upper surface of 64 airfoils was increased . from the leading edge to the position of maximum thickness. The modifications were generated using a numerical optimization routine coupled with an aerodynamic analysis code. The type of modification presented can be used for aircraft design or for the retrofit of current aircraft to improve the stall characteristics and climb performance. The coordinates of the modified airfoils are presented with plots of the forward 45% of the profiles and pressure distributions for both the modified and unmodified sections at an angle of attack of 14 degrees.

N79-30145\*# Bihrle Applied Research, Inc., Jericho, N. Y. ROTARY BALANCE DATA FOR A TYPICAL SINGLE-ENGINE **GENERAL AVIATION DESIGN FOR AN ANGLE-OF-ATTACK** RANGE OF 8 DEG TO 90 DEG. 1: HIGH-WING MODEL B

William Bihrle, Jr. and Randy S. Hultberg Sep. 1979 497 p. refs

(Contract NAS1-14849)

(NASA-CR-3097) Avail: NTIS HC A21/MF A01 CSCL 01A Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in a spin tunnel are presented in plotted form for a 1/6.5 scale, single engine, high wing, general aviation airplane model. The configurations tested included the basic airplane, various wing leading-edge devices, tail designs, and rudder control settings as well as airplane components. Data are presented without analysis for an angle of attack range of 8 deg to 90 deg and clockwise and counter-clockwise rotations covering an omega b/2V range from 0 to 0.85. Author

N79-30147\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FLOW VISUALIZATION STUDIES OF A GENERAL RE-SEARCH FIGHTER MODEL EMPLOYING A STRAKE-WING CONCEPT AT SUBSONIC SPEEDS

James M. Luckring Aug. 1979 93 p

(NASA-TM-80057: L-12673) Avail: NTIS HC 405/ME 401 CSCI 01A

A systematic wind tunnel study was conducted in the Langley high-speed 7 by 10 foot tunnel to document, by oil-flow photographs, the surface flow patterns for configurations incorporating strake-wing geometries indicative of current and proposed maneuvering aircraft. The configurations employed combinations of strakes with reflexed planforms having exposed spans of 10 percent, 20 percent, and 30 percent of the reference wing span and wings with trapezoidal planforms having leadingedge sweep angles of approximately 30 deg, 44 deg, and 60 deg. Tests were conducted at Mach numbers of 0.3 and 0.5 and at angles of attack ranging from approximately 5 deg to 30 deg in 5 deq increments at 0 deg sideslip. The configurations incorporating the strake-wing geometries exhibited more organized flow patterns with smaller asymmetries to higher angles of attack than the corresponding configurations incorporating the wing-alone aeometries did Author

N79-30148# Northrop Corp., Hawthorne, Calif. Aircraft Group

ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK AERODYNAMICS. VOLUME 1: TECHNICAL DISCUSSION AND ANALYSIS OF RESULTS Progress Report, Jun. 1977 - Apr. 1978 Jack W. Headley Jul. 1978 180 p 2 Vol.

(Contract F33615-77-C-3062; AF Proj. 2404)

(AD-A069646; NOR-78-69-Vol-1; AFFDL-TR-78-94-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 20/4

This report provides a technical discussion and analysis of wind tunnel data obtained from tests conducted on a family of Northrop fighter aircraft. These tests were performed mainly in the Northrop Low Speed Wind Tunnel, and cover the time period between 1966 and 1976. This report concentrates on data in the stall post-stall region, and for convenience is provided in two sections. This volume presents the results of the analysis of wind tunnel data which concentrates on the high angle of attack regime, and on three major aircraft components. These components are the nose and forebody, the wing leading edge extension, and the vertical tail. The effects of geometric changes in these components on the aircrafts' high angle of attack aerodynamics are analysed. Wherever possible design guidelines which identify the sensitivity of aerodynamic characteristics to geometric parameter variations are presented. Geometric changes or effects which were configuration dependent are also discussed. The second volume, Volume 2: 'Data base,' contains summaries of the wind tunnel tests which were selected to provide data for the analysis. GRA

N79-30149# Northrop Corp., Hawthorne, Calif. Aircraft Group.

ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK AERODYNAMICS. VOLUME 2: DATA BASE Progress Report, Jun. 1977 - Apr. 1978

BASE Progress nepot, Jul. 1977 - Apr. 1977 Jack W. Headley Jul. 1978 571 p refs 2 Vol. (Contract F33615-77-C-3062; AF Proj. 2404)

(AD-A069647; NOR-78-69-Vol-2; AFFDL-TR-78-94-Vol-2) Avail: NTIS HC A24/MF A01 CSCL 20/4

This volume presents, in summary form, the geometric and aerodynamic data used as a basis for the design guidelines presented in Volume 1. The summaries have been divided into eight sections, the first seven being the low speed tests, which include almost all the configuration development studies and most of the high AOA testing. Data summaries for the transonic and supersonic testing form the eighth and last section. Because of the considerable quantity of data available from all the testing (some test reports containing as much as thirteen volumes), it is not practical to include the summaries in all the basic aerodynamic data available. In general, only the main aerodynamic effects are presented or summarized, and for more detailed information on a particular configuration, reference should be made to the actual wind tunnel report. All the data summaries are presented in a similar way, and include the following information: a data sheet including the test report title, a summary of the report, and the test conditions; a general three

view of a representative test model configuration; detailed sketches of the pertinent configurations changes; and the relevant aerodynamic data GRA

N79-30151# Naval Ship Research and Development Center, Bethesda, Md. Aviation and Surface Effects Dept.

A FLOW FIELD STUDY FOR TOP MOUNTED INLETS ON FIGHTER AIRCRAFT CONFIGURATIONS Final Report, Oct. 1977 - Sep. 1978

Steven W. Prince Jan. 1979 61 p refs (F41421000)

(AD-A069732; DTNSRDC/ASED-79/03) Avail. NTIS HC A04/MF A01 CSCL 20/4

A flow visualization study was conducted for top mounted inlets on fighter aircraft. A generic fighter model was tested at low speed in a wind tunnel with a tuft grid mounted on the upper fuselage. Tuft patterns were photographed in four longitudinal positions from 0 to 39 deg angle of attack and from 0 to 30 deg sideslip. Various configurations were tested with a high or low delta wing, two leading edge extensions and two canards. The results indicate that the downwash from leading edge extensions or canards can produce fairly smooth and straight flow to high angles of attack and moderate angles of sideslin for an inlet mounted on the upper fuselage surface. GRA

N79-30161# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Aerodynamik.

THEORETICAL ESTIMATION OF NONLINEAR LONGITUDI-NAL CHARACTERISTICS OF WINGS WITH SMALL AND MODERATE ASPECT RATIO BY THE VORTEX-LATTICE METHOD IN INCOMPRESSIBLE FLOW

Wolfgang Schroeder Sep. 1978 82 p refs in GERMAN ENGLISH summary Report will also be announced as translation (ESA-TT-585)

(DLR-FB-78-26) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 31.80

nonlinear vortex-lattice method is described applying a force-free condition to the vortex sheet giving the trailing, sideand leading edges, respectively. In extensive test runs various influences on the numerical stability of the iterative rolling-up process were studied such as the force-free condition of the wake, the number of horseshoe vortices, the panel distribution along span and chord, the representation of the wakes by chains of straight vortex elements of different length and number, and the introduction of an artificial friction parameter. Because of numerical difficulties the slender delta wing itself could not be treated completely. These numerical difficulties resulting from the singular behavior of line vortices are described and ways of overcoming them are suggested. Author (ESA)

N79-30162# National Technical Information Service, Springfield, Va

LIGHTER THAN AIR VEHICLES. CITATIONS FROM THE MTIS DATA BASE Progress Report, 1964 - Mar. 1979 Guy E. Habercom, Jr. May 1979 256 p Supers

256 p Supersedes NTIS/PS-78/0409; NTIS/PS-77/0374 (NTIS/PS-79/0471/7; NTIS/PS-78/0409; NTIS/PS-77/0374)

Avail: NTIS HC \$28.00/MF \$28.00 CSCL 01C

Designs and applications of balloons, dirigibles, and airships are investigated in this Government sponsored research. Passenger or cargo transport, timbering, tethering, and fabric selection are discussed. Meteorological balloons are excluded. This updated bibliography contains 250 abstracts, 16 of which are new entries to the previous edition. GRA

N79-30163# National Technical Information Service, Springfield, Va.

#### LIGHTER THAN AIR VEHICLES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Apr. 1979

Guy E. Habercom, Jr. May 1979 88 p Supersedes NTIS/PS-78/ 0410: NTIS/PS-77/0375 (NTIS/PS-79/0472/5: NTIS/PS-78/0410: NTIS/PS-77/0375)

Avail: NTIS HC \$28.00/MF \$28.00 CSCL 01C

Design and applications of balloons, dirigibles, and airships are investigated. Passenger or cargo transport, timbering, tethering, and fabric selection are discussed. Meteorological balloons are excluded. This updated bibliography contains 82 abstracts, 8 of GRA which are new entries to the previous edition.

#### N79-30164 Fordham Univ., New York, N. Y. FINANCING THE CAPITAL REQUIREMENTS OF THE US AIRLINE INDUSTRY IN THE 1980'S Ph.D. Thesis

Robert William Mandell 1979 245 p Avail: Univ. Microfilms Order No. 7918290

The study presented estimated capital requirements from the close of this decade to the close of the maximum fleet replacement cycle in 1994, under alternative assumptions. It also forecasted internally generated funds and reasonable amounts of additional debt which can be summoned to meet those needs. It was concluded that in order for the industry to approach meeting the projected levels of demand for air travel, the following measures are imminently required: (1) liberalization of the investment tax credit with respect to the purchase of new aircraft; (2) swift deregulation of the industry; and (3) permit mergers between airlines with complementary route structures.

Dissert. Abstr.

### N79-30165\*# Lightning Technologies, Inc., Pittsfield, Mass. THE FEASIBILITY OF INFLIGHT MEASUREMENT OF LIGHTNING STRIKE PARAMETERS

K. E. Crouch and J. A. Plumer Oct. 1978 91 p refs Contract NAS1-15216)

(NASA-CR-158981) Avail: NTIS HC A05/MF A01 CSCL 010

The appearance of nonmetallic structural materials and microelectronics in aircraft design has resulted in a need for better knowledge of hazardous environments such as lightning and the effects these environments have on the aircraft. This feasibility study was performed to determine the lightning parameters in the greatest need of clarification and the performance requirements of equipment necessary to sense and record these parameters on an instrumented flight research aircraft. It was found that electric field rate of change, lightning currents, and induced voltages in aircraft wiring are the parameters of greatest importance. Flat-plate electric field sensors and resistive current shunts are proposed for electric field and current sensors, to provide direct measurements of these parameters. Six bit analog-to-digital signal conversion at a 5 nanosecond sampling rate, short-term storage of 85000 bits and long term storage of 5 x 10 to the 7th power bits of electric field, current and induced voltage data on the airplane are proposed, with readout and further analysis to be accomplished on the ground. A NASA F-106B was found to be suitable for use as the research aircraft because it has a minimum number of possible lightning attachment points, space for the necessary instrumentation, and appears to meet operational requirements. Safety considerations are also presented.

N79-30167# National Transportation Safety Board, Washington, D. C. Bureau of Technology.

### SPECIAL INVESTIGATION REPORT: WING FAILURE OF BOEING 747-131 NEAR MADRID, SPAIN, 9 MAY 1976 6 Oct. 1978 41 p refs (NTSB-AAR-78-12) Avail: NTIS HC A03/MF A01

On May 9, 1976, an Imperial Iranian Air Force Boeing 747-131 crashed as it approached Madrid, Spain. Witnesses observed lightning strike the aircraft followed by fire, explosion, and separation of the left wing. The report includes fire pattern studies, structural failure descriptions, trajectory analysis, fuel flammability calculations, gust loading analysis, and an analytical G.Y. treatment of several hypotheses.

N79-30168 Committee on Commerce, Science, and Transportation (U. S. Senate).

INTERNATIONAL AIR TRANSPORTATION COMPETITION **ACT OF 1978** 

Washington GPO 1978 285 p refs Hearings on S. 3363 before the Subcomm. on Aviation of the Comm. on Commerce, Sci., and Transportation, 95th Congr., 2d Sess., 22-24 Aug. 1978

(GPO-34-912) Avail: Subcomm. on Aviation.

Testimony was given and arguments were heard to amend the Federal Aviation Act of 1958 in order to promote competition in International Air Transportation, provide greater opportunities for United States air carriers, create a structure and establish goals for developing United States International Aviation negotiating policy, and for other purposes. M.M.M.

N79-30169# Technology/Scientific Services, Inc., Dayton, Ohio. ATMOSPHERIC ELECTRICITY HAZARD (AEH) Final Report, 11 Jul. - 30 Sep. 1978

Arturo V. Serrano Dec. 1978 168 p refs

(Contract F33601-78-D-0042; AF Proj. 2202)

(AD-A069338; T/SSI-0140-01; AFFDL-TR-78-164) Avail: NTIS HC A08/MF A01 CSCL 01/3

A literature survey relating to the survivability of aircraft transparencies and electrical circuits embedded within them was performed. The types of materials used in transparencies and their edge construction were identified, the electrical properties of interest were defined along with test methods in use or available, the availability of electrical properties for the materials of interest was determined, the physiological hazards were documented, and analytical methods for evaluation of transparency systems were identified. As a result of this study it was concluded that the electrical parameters of interest are affected by temperature, frequency and exposure and that data for the materials of interest are not generally available over the ranges of interest for these parameters. It was also concluded that insufficient information is currently available for evaluation of the physiological hazards. Finally, analytical models for evaluation of transparency systems in an electromagnetic environment were found available that could be used to analyze transparency designs. However, these methods need to be computerized and validated. Recommendations are made to eliminate existing data gaps by tests and GRA analyses.

N79-30173\*# National Aeronautics and Space Administration.

### Langley Research Center, Hampton, Va. RADIO-CONTROLLED MODEL DESIGN AND TESTING TECHNIQUES FOR STALL/SPIN EVALUATION OF GENER-AL-AVIATION AIRCRAFT

Sanger M. Burk, Jr. and Calvin F. Wilson, Jr. (Piper Aircraft Corp., Lock Haven, Penn.) 1975 63 p refs Presented at the 1975 SAE Natl. Business Aircraft Meeting, Wichita, Kansas, 8-11 Apr. 1975

(NASA-TM-80510) Avail: NTIS HC A04/MF A01 CSCL 01C

A relatively inexpensive radio-controlled model stall/spin test technique was developed. Operational experiences using the technique are presented. A discussion of model construction techniques, spin-recovery parachute system, data recording system, and movie camera tracking system is included. Also discussed are a method of measuring moments of inertia, scaling of engine thrust, cost and time required to conduct a program, and examples of the results obtained from the flight tests. K.L.

#### N79-30174 Committee on Armed Services (U. S. House). ENFORCER AIRCRAFT

Washington GPO 1978 154 p refs Hearing before the Research and Development Subcomm. of the Comm. on Armed Services, 95th Congr., 2d Sess., 22 Jun. 1978

(GPO-32-569; HASC-95-86) Avail: Research and Development Subcomm.

The utility of a privately developed Enforcer-type aircraft as a tank killer in either the battlefield interdiction or close air support is assessed with emphasis on lethality and vulnerability. Characteristics are compared to those of the A-10 aircraft.

A.R.H.

N79-30175\*# Foster-Miller Associates, Inc., Waltham, Mass. HEAVE PITCH ROLL ANALYSIS AND TESTING OF AIR CUSHION LANDING SYSTEMS Final Report

A. B. Boghani, K. M. Captain, and D. N. Wormley Feb. 1978 205 p refs

(Contract NAS1-12403)

(NASA-CR-2917) Avail: NTIS HC A10/MF A01 CSCI 01C The analytical tools (analysis and computer simulation) needed to explain and predict the dynamic operation of air cushion landing systems (ACLS) is described. The following tasks were performed: the development of improved analytical models for the fan and the trunk; formulation of a heave pitch roll analysis for the complete ACLS; development of a general purpose computer simulation to evaluate landing and taxi performance of an ACLS equipped aircraft; and the verification and refinement of the analysis by comparison with test data obtained through lab testing of a prototype cushion. Demonstration of simulation capabilities through typical landing and taxi simulation of an ACLS aircraft are given. Initial results show that fan dynamics have a major effect on system performance. Comparison with lab test data (zero forward speed) indicates that the analysis can predict most of the key static and dynamic parameters (pressure, deflection, acceleration, etc.) within a margin of a 10 to 25 percent.

AWH

N79-30176\*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

SIMILITUDE REQUIREMENTS AND SCALING RE-LATIONSHIPS AS APPLIED TO MODEL TESTING

Chester H. Wolowicz, James S. Brown, Jr., and William P. Gilbert Aug. 1979 64 p refs Prepared jointly with NASA. Langley Res Center

(NASA-TP-1435; H-1022) Avail: NTIS HC A04/MF A01 CSCL 01C

The similitude requirements for the most general test conditions are presented. These similitude requirements are considered in relation to the scaling relationships, test technique, test conditions (including supersonic flow), and test objectives. Particular emphasis is placed on satisfying the various similitude requirements for incompressible and compressible flow conditions. For free flying models tests, the test velocities for incompressible flow are scaled from Froude number similitude requirements and those for compressible flow are scaled from Mach number similitude requirements. The limitations of various test techniques are indicated, with emphasis on the free flying model. ΔWH

N79-30177# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

#### AH-1G HELICOPTER, 19-ROUND LIGHTWEIGHT AIR-BORNE LAUNCHER JETTISON ENVELOPE DETERMINA-**TION Final Report**

Gary L. Skinner and Frederick S. Doten Mar. 1979 30 p. refs. (AD-A069828; USAAEFA-78-10) Avail: NTIS HC A03/MF A01 CSCL 19/7

The United States Army Aviation Engineering Flight Activity conducted a limited evaluation of a 19-round prototype launcher to determine a safe jettison envelope for the 19-round lightweight airborne rocket launcher. The evaluation was conducted from 25 May 1978 to 6 June 1978 at Edwards Air Force Base, California. Ten flights using an AH-1G helicopter were conducted totaling 3.5 flight hours. This evaluation defined a safe jettison envelope in coordinated (ball-centered) level flight to 120 knots calibrated airspeed (KCAS) and in autorotation at 70 KCAS. Establishment of a jettison envelope equivalent to that of the M159 and M200 launcher will require 75 7-round and 75 19-round lightweight airborne rocket launchers and 744 2.75-inch Model M229 rockets. Five reliability and maintainability launcher shortcomings were identified during the evaluation of the prototype launcher. GRA

N79-30178# Army Aviation Engineering Flight Activity, Edwards AFB Calif

**AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST.** OV-1C TAKEOFF PERFORMANCE Final Report, 11 Apr. -19 Jul. 1978

Raymond B. Smith, George M. Yamakawa, John R. Niemann, Joseph C. Watts, and Jerry R. Guin May 1979 33 p (AD-A069827 USAAFFA-78-07) Avail. NTIS HC A03/MF A01 CSCL 01/2

The United States Army Aviation Engineering Flight Activity conducted takeoff performance tests on an OV-1C aircraft, serial number 67-18918, from 11 April through 19 July 1978. The aircraft was tested at Edwards Air Force Base (field elevation 2273 feet) and South Lake Tahoe, California (field elevation 6262 feet). Twelve flights totaling 6.9 productive flight hours were conducted. Takeoff performance tests were conducted on the OV-1C to substantiate the performance data currently incorporated in the operator's manual. Tests were conducted using two normal takeoff techniques and a minimum run takeoff technique at each of three gross weights. All takeoffs were made from hard, dry, paved level runways. Test results show that the estimated data for normal takeoff is satisfactory but the data for the minimum run technique in the operator's manual is ontimistic GRA

#### N79-30179# Textron Bell Helicopter, Fort Worth Tex HELICOPTER OBSTACLE STRIKE TOLERANCE CONCEPTS ANALYSIS Final Report, Sep. 1977 - Jun. 1978

Bharat P. Gupta Apr. 1979 183 p refs (Contract DAAJ02-77-C-0049; DA Proj. 1L2-62209-AH-76) (AD-A069877; BHT-699-099-096; USARTL-TR-78-46) Avail NTIS HC A09/MF A01 CSCL 01/3

A large number of obstacle strikes have occurred during Army helicopter combat missions and nap-of-the-earth (NOE) training missions. Obstacle strike tolerance becomes particularly important for NOE flights in areas containing many obstacles such as western Europe. This report defines the obstacle strike problem, particularly for tree and wire strikes. Only a small percentage of obstacle strikes produce accidents, but these accidents account for a high proportion of helicopter damage costs. Tree strikes are more common than wire strikes, but the wire strikes are more likely to cause accidents. Generally, the main and tail rotors are most commonly struck, but a high proportion of wire strikes also occur on the fuselage. Helicopter obstacle strike tolerance designs for rotors, fuselage, and controls are analyzed and the most promising concepts are selected for both existing and future helicopter systems. In addition, obstacle strike tolerance design criteria are defined. GRA

#### N79-30180# Sikorsky Aircraft, Stratford, Conn. HELICOPTER DRIVE SYSTEM R AND M DESIGN GUIDE Final Report

K. R. Cormier Apr. 1979 91 p ref (Contract DAAJ02-76-C-0047; DA Proj. 1L2-62209-AH-76)

(AD-A069835; SER-50997; USARTL-TR-78-50) Avail: NTIS HC A05/MF A01 CSCL 01/3

This report is a reliability and maintainability design guide for helicopter drive systems. While not containing 'how to' design information, the guide points out those areas of design which can be troublesome in the reliability and maintainability of helicopter drive systems. Besides containing information on the various drive system components, a management section is included that outlines some practices which design managers may employ to insure that reliability and maintainability are given proper emphasis during a design program. The final section is devoted to a step-by-step procedure for hazard function analysis. which may be used to predict the reliability of a gearbox during the design stage. GRĂ

#### N79-30181# United Technologies Corp., Stratford, Conn. HELICOPTER DRIVE SYSTEM R AND M DESIGN GUIDE **Final Report**

K. R. Cormier and B. Trustee Apr. 1979 138 p refs (Contract DAAJ02-76-C-0047; DA Proj. 1L2-62209-AH-76) (AD-A069691; SER-510012; USARTL-TR-78-51) Avail: NTIS HC A07/MF A01 CSCL 01/3

This report covers the investigations conducted during the Helicopter Drive System R and M Design Guide program. The report discusses the present state of transmission reliability and how reliability and maintainability are dealt with during the design and development of a helicopter drive system. Other topics

discussed include the effect of quality control on drive system reliability, drive system maintainability problems, diagnostics, and the likely effect of advanced design concepts on the reliability and maintainability of future drive systems. Two different types of reliability prediction techniques, hazard function analysis and probabilistic design, are discussed, and the strengths and weaknesses of each are outlined. Test planning and maintainability analysis are included as separate appendices. GRA

### N79-30182# Sandia Labs., Albuquerque, N. Mex. DRIFTDOWN CALCULATIONS FOR THE FH/227D AIR-CRAFT

L. A. Bertram Feb. 1979 79 p refs

(Contract EY-76-C-04-0789)

(SAND-78-1807) Avail: NTIS HC A05/MF A01

Two codes are described: USIM, which simulates FH-227D flights with an enroute engine loss, and UNDRIFT, which locates the maximum takeoff weights satisfying driftdown terrain clearance and landing weight limits as well as falling within the climb capability of the aircraft. These codes are presented in a torm suitable for use at a remote terminal using the NOS timesharing system for the Sandia CDC 6600 computer and user instructions and examples are given. Some weaknesses in the FAA-approved driftdown analysis procedure are noted and discussed, but it is the approved procedure which is implemen-DOF ted in the codes

N79-30183# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst fuer Dynamik der Flugsysteme.

INVESTIGATIONS ON THE DESIGN OF ACTIVE VIBRATION ISOLATION SYSTEMS FOR HELICOPTERS WITH RIGID AND ELASTIC MODELING OF THE FUSELAGE

Gerd Schulz Mar. 1978 72 p refs In GERMAN; ENGLISH Report will also be announced as translation summarv (ESA-TT-556)

(DLR-FB-78-04) Avail: NTIS\_HC A04/MF A01: DFVLR, Cologne DM 25.70

Different methods for the design of controllers for active vibration isolation on helicopters are investigated. Based on the special structure of the controller, compensation for the rotor blade harmonic disturbance vibrations is achieved, guaranteeing good trim behavior during maneuvers. For the first controller design, done for a rigid helicopter fuselage with a modified Riccati design, different sensor configurations are investigated. A possibility for sensitivity reduction for rotor speed variations is shown. For the second controller design for an elastic helicopter fuselage the modified Riccati design, the design by means of Nyquist plots and pole assignment are investigated, especially with respect to the applicability for higher order systems.

Author (ESA)

### N79-30184# McDonnell Aircraft Co., St. Louis, Mo. RESEARCH ON VISUAL DISPLAY INTEGRATION FOR ADVANCED FIGHTER AIRCRAFT Final Technical Report, 13 Jul. 1977 - 13 Aug. 1978

George S. Mills, Marshall A. Grayson, Susan L. Loy, and Richard A. Jauer, Jr. Wright-Patterson AFB, Ohio AMRL Nov. 1978 162 p refs

(Contract F33615-77-C-0536; AF Proj. 7184)

(AD-A069605; MDC-A5425; AMRL-TR-78-97) Avail: NTIS HC A08/MF A01 CSCL 01/3

This 'Visual Display Integration' study was conducted to determine the display integration options projected available for inclusion in an attack/fighter aircraft crew station design in the 1985-1990 time. A second objective was the definition of an evaluation framework that would permit evaluation of the selected display options during future related studies. Summarizing the results, it is clearly evident that the CRT, as Option 1, will retain its preeminence as the multifunction display unit for 1985-1990. Option 2 is the flat-panel plasma display. Option 3 is the flat-panel liquid crystal display, and Option 4 is the electroluminescent thin-film-transistor display. It was concluded that man-in-the loop simulations provide the best opportunity for evaluating these display options in future related work. GRA N79-30185\*# Pratt and Whitney Aircraft Group, East Hartford. Conn

AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES, COMPRE-HENSIVE DATA REPORT, VOLUME 1

Richard S. Larson, Douglas P. Nelson, and Bradley S. Stevens Jun. 1979 312 p 2 Vol. (Contract NAS3-20061)

(NASA-CR-159515; PWA-5550-16-Vol-1) HC A14/MF A01 CSCL 21E Avail: NTIS

The experimental data necessary to establish aerodynamic and acoustic prediction systems for coannular exhaust nozzles with inverted velocity profiles are presented in graphical form. B F S

N79-30186\*# Pratt and Whitney Aircraft Group, East Hartford, Conn

AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES, COMPRE-HENSIVE DATA REPORT, VOLUME 2

Jun. 1979 225 p refs (Contract NAS3-20061)

(NASA-CR-159516; PWA-5550-17-Vol-2) HC A10/MF A01 CSCL 21E NTIS ∆vail.

The experimental data necessary to establish aerodynamic and acoustic prediction systems for coannular exhaust nozzles with inverted velocity profiles are presented in tabular form. The acoustic data are corrected to a 'theoretical day' and scaled to RES full engine size.

N79-30187\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF STEADY-STATE TEMPERATURE DISTORTION AND COMBINED DISTORTION ON INLET FLOW TO A TURBOFAN ENGINE

Ronald H. Soeder and George A. Bobula Aug. 1979 43 p refs

(NASA-TM-79237; E-143) Avail: NTIS HC A03/MF A01 CSCL 21E

Flow angle, static pressure, total temperature and total pressure were measured in the inlet duct upstream of a turbofan engine operating with temperature distortion or combined pressure-temperature distortion. Such measurements are useful in the evaluation of analytical models of inlet distortion. A rotating gaseous-hydrogen burner and a circumferential 180 degreesextent screen configuration mounted on a rotatable assembly generated the distortions. Reynolds number index was maintained at 0.5 and engine corrected low-rotor speeds were held at 6000 and 8600 rpm. The measurements showed that at the entrance to the engine, flow angle was largest in the hub region. As flow approached the engine, yaw angle (circumferential variation) increased and pitch angle (radial variation) decreased. The magnitude of static-pressure distortion measured along the inlet-duct and extended bullet nose walls increased exponentially as flow approached the engine. Author

N79-30188\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

A SUMMARY OF NASA/AIR FORCE FULL SCALE ENGINE RESEARCH PROGRAMS USING THE F100 ENGINE

W. J. Deskin (Pratt and Whitney Aircraft Group, West Palm Beach, Fia.) and H. G. Hurrell 1979 24 p refs Presented at 15th Joint Propulsion Conf., Las Vegas, Nev., 18-20 Jun. 1979; Sponsored by AIAA, Am. Soc. of Mech. Engr.

(NASA-TM-79267; E-183) Avail: NTIS HC A02/MF A01 CSCL 21E

A full scale engine research (FSER) program conducted with the F100 engine is presented. The program mechanism is described and the F100 test vehicles utilized are illustrated. Technology items were addressed in the areas of swirl augmentation, flutter phenomenon, advanced electronic control logic theory, strain gage technology and distortion sensitivity. The associated test programs are described. The FSER approach utilizes existing state of the art engine hardware to evaluate advanced technology concepts and problem areas. Aerodynamic phenomenon previously not considered by design systems were identified and incorporated into industry design tools. A.W.H.

N79-30189\*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.

ENERGY EFFICIENT ENGINE FLIGHT PROPULSION SYSTEM PRELIMINARY ANALYSIS AND DESIGN REPORT Progress Report, Mar. 1978 - Feb. 1979

W. B. Gardner Apr. 1979 480 p refs

(Contract NAS3-20646)

(NASA-CR-159487; PWA-5594-49) Avail: NTIS HC A21/MF A01 CSCL 21E

A flight propulsion system preliminary design was established that meets the program goals of at least a 12 percent reduction in thrust specific fuel consumption, at least a five percent reduction in direct operating cost, and one-half the performance deterioration rate of the most efficient current commercial engines. The engine provides a high probability of meeting the 1978 noise rule goal. Smoke and gaseous emissions defined by the EPA proposed standards for engines newly certified after 1 January 1981 are met with the exception of NOx, despite incorporation of all known NOx reduction technology. F.O.S.

N79-30190# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.

CRITICAL ASSESSMENT OF EMISSIONS FROM AIRCRAFT PISTON ENGINES Final Report, Jun. 1974 - May 1978

W. Mirsky, J. A. Nicholls, R. Pace, R. Ponsonby, and D. E. Geister Jun. 1979 163 p refs

(Contract DOT-FA74NA-1102)

(AD-A071002; FAA-RD-78-82; FAA-NA-78-166) Avail: NTIS HC A08/MF A01 CSCL 21/7

A comprehensive mathematical analysis for evaluating the measured emissions from piston type general aviation aircraft engines is presented and discussed. The analysis is used to calculate the fuel-air ratio, molecular weight of the exhaust products, and water correction factor. A sensitivity analysis is presented which shows the effects of emission measurement errors on calculated fuel-air ratio. The test facility is briefly described and the associated emissions instrumentation is discussed in detail. The experimental results obtained in this facility on the AVCO-Lycoming LIO-320 engine are presented. This includes baseline and lean-out emissions data and the influence of sampling probe location in the exhaust pipe. The influence of leaks in the exhaust system or emissions console are investigated and evaluated in terms of the mathematical model AWH

**N79-30191\***# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF TWO-STAGE FAN WITH A FIRST-STAGE ROTOR REDESIGNED TO ACCOUNT FOR THE PRESENCE OF A PART-SPAN DAMPER

William T. Gorrell and Donald C. Yrasek Sep. 1979 72 p refs

(NASA-TP-1483; E-9786; AVRADCOM-TR-79-10) Avail: NTIS HC A04/MF A01 CSCL 21E

The NASA two-stage fan was tested with a redesigned first-stage rotor. The redesign included a new design approach to account for the presence of a part-span damper. At design speed the fan achieved a peak efficiency of 0.803, which is 1.9 percentage points higher than the original design. The peak efficiencies of the first stage and first rotor were 0.789 and 0.821, respectively. An improvement in efficiency of up to 5 percentage points in the damper region was achieved over the original large damper version. The stall margin, based on flow conditions at peak efficiency, was 10 percent at design speed. Author

N79-30192# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Technische Akustik.

## NOISE GENERATION BY JET-ENGINE EXHAUST DEFLECTION

Burkhard Gehlhar, Werner Dobrzynski, and Bernhard Fuhrken Sep. 1978 56 p refs In German: ENGLISH summary Report will be also announced as translation (ESA-TT-553)

(DLR-FB-78-21) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 23,30

Noise radiation by jet-engine exhaust-flow-interaction with blast deflectors was investigated by means of model-experiments of scale 0.1; the investigations pertained to a specific deflector configuration. Noise spectra and directivity characteristics for various power-settings and configuration changes were determined and used for the prediction of noise generation by full-scale configuration. The investigation shows that the particular deflected gives rise to higher noise levels than those of the corresponding engine noise alone, when the distance between exhaust nozzle and deflector is loss than 10 nozzle-diameters. Author (ESA)

N79-30193\*# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.

VTOL CONTROLS FOR SHIPBOARD LANDING M.S. Thesis

Christopher Graham McMuldroch Aug. 1979 198 p refs (Contract NGL-22-009-124)

(NASA-CR-162140; LIDS-TH-928) Avail: NTIS HC A09/MF A01 CSCL 01C

The problem of landing a VTOL aircraft on a small ship in rough seas using an automatic controller is examined. The controller design uses the linear quadratic Gaussian results of modern control theory. Linear time invariant dynamic models are developed for the aircraft, ship, and wave motions. A hover controller commands the aircraft to track position and orientation of the ship deck using only low levels of control power. Commands for this task are generated by the solution of the steady state linear quadratic gaussian regulator problem. Analytical performance and control requirement tradeoffs are obtained. A landing controller commands the aircraft from stationary hover along a smooth, low control effort trajectory, to a touchdown on a predicted crest of ship motion. The design problem is formulated and solved as an approximate finite-time linear quadratic stochastic regulator. Performance and control results are found by Monte Carlo simulations. K L

#### N79-30194\*# Scientific Systems, Inc., Cambridge, Mass. A STUDY OF THE APPLICATION OF SINGULAR PERTUR-BATION THEORY Final Report

Raman K. Mehra, Robert B. Washburn, Salim Sajan, and James V. Carroll Aug. 1979 339 p refs

(Contract NAS1-15113)

(NASA-CR-3167) Avail: NTIS HC A15/MF A01 CSCL 01C A hierarchical real time algorithm for optimal three dimensional control of aircraft is described. Systematic methods are developed for real time computation of nonlinear feedback controls by means of singular perturbation theory. The results are applied to a six state, three control variable, point mass model of an F-4 aircraft. Nonlinear feedback laws are presented for computing the optimal control of throttle, bank angle, and angle of attack. Real Time capability is assessed on a TI 9900 microcomputer. The breakdown of the singular perturbation approximation near the terminal point is examined Continuation methods are examined to obtain exact optimal trajectories starting from the singular perturbation solutions. A.W.H.

N79-30195# Rockwell International Corp., Columbus, Ohio. Aircraft Div.

#### FLUIDICS: FEASIBILITY STUDY ELECTRO/HYDRAULIC/ FLUIDIC DIRECT DRIVE SERVO VALVE Final Report, 11 Apr. - 29 Dec. 1978

Louis P. Biafore and Bernie Holland Washington NASC Mar. 1979 74 p refs

(Contract N62269-78-C-0176; WF4,1400000)

(AD-A069798; NR78H-126; NADC-78-033-60) Avail: NTIS HC A04/MF A01 CSCL 13/7

The feasibility of providing a fluidic back-up control for the Navy's Advanced flight control actuation system (AFCAS) was

investigated and potential design concepts were evaluated. A prelim. spec. for an electro/hydraulic/fluidic direct drive servo valve was proposed. Technical data and supplier hardware was reviewed. A design concept for an electro/hydraulic/fluidic servo control valve was selected and a prelim, design drawing was prepared. The study confirms the feasibility of providing a fluidic back-up for the AFCAS direct drive servo valve. GRA

#### N79-30196# Boeing Vertol Co., Philadelphia, Pa. EVALUATION OF PYLON FOCUSING FOR REDUCED HELICOPTER VIBRATION Final Report, Aug. 1977 - May 1978

R. Gabel and D. Reed Apr. 1979 96 p refs (Contract DAAJ02-77-C-0034; DA Proj. 1L2-62209-AH-76) (AD-A069712; D210-11390-1; USARTL-TR-79-6) Avail: NTIS HC A05/MF A01 CSCL 01/3

A wind tunnel model test program was conducted to investigate the effectiveness of a focused isolation system in reducing the transmission of rotor-induced vibratory loads for a four-bladed hingeless rotor. The model consisted of a four-bladed hingeless rotor and a simulated transmission mounted on a focal isolation system having pitch and roll degrees of freedom. Analytical considerations indicate that there is no single focus which will simultaneously isolate both hub moments and inplane loads. For the four-bladed hingeless rotor with large vibratory hub moments, the optimum focus lies close to the combined rotor/transmission center of gravity. Model test results indicated two configurations with reasonable moment isolation. One was an upward focus near the combined rotor/transmission center of gravity. The second, which had an effective downward focus, produced high lateral and longitudinal loads. GRA

N79-30197# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Dynamik der Flugsysteme.

#### AN IN-FLIGHT CONTROLLER INSENSITIVE TO PARAME-TERS VARIATION

Gerhard Kreisselmeier and Reinhold Steinhauser May 1978 80 p refs in GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-565)

(DLR-FB-78-07) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 30.30

A design method, based on a systematic approach to aircraft attitude control parameters, was developed and tried on the design of a pitch controller for the Do28D Skyservant aircraft. The method takes into consideration the entire range of in-flight requirements posed by the guidance characteristics of the aircraft. including appropriate response (damping) to air turbulence. The controller is independent of radical changes in flight conditions and thus responds to the special problem of low speed elevator control as a harmonic progression of the elevator deflection angle. The influence of an onboard computer on flight behavior is examined and flight test results are compared with computer simulation results. Author (ESA)

N79-30198# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

THE GUIDANCE AND CONTROL OF HELICOPTERS AND V/STOL AIRCRAFT AT NIGHT AND IN POOR VISIBILITY May 1979 237 p refs Partly in ENGLISH and FRENCH

Papers presented at the Guidance and Control Panel Symp., The Hague, 9-12 Oct. 1978

(AGARD-CP-258; (SBN-92-835-0238-8) Avail: NTIS HC A11/MF A01

The following topics are discussed: (1) operational requirements; (2) controls and displays; (3) forward looking sensors; (4) man/machine aspects; (5) landing operations and systems; and (6) system implementation.

N79-30199# Army Training and Doctrine Command, Fort Monroe, Va

ADDING THE CHALLENGE OF NAP-OF-THE-EARTH

Joseph C. Tirre In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 5 p

Avail: NTIS HC A11/MF A01

In an attempt to defy the law of physics as it pertains to having two or more bodies occupy the same space at the same time, NAP-of-the Earth (NOE) was developed. The problems of night, weather, and NOE flying discussed include: (1) navigation; (2) communication; (3) aircraft control; (4) wire detection; and (5) target acquisition/engagement. SES

#### N79-30200# Smiths Industries Ltd., Cheltenham (England). THE DEVELOPMENT AND IN-FLIGHT EVALUATION OF A TRIPLEX DIGITAL AUTOSTABILIZATION SYSTEM FOR A HELICOPTER

J. Meadows and P. Robinson (RAE, Farnborough, Engl.) In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 22 p refs

#### Avail: NTIS HC A11/MF A01

The program and the triplex autostabilization system and its installation in the aircraft were reviewed. The final stages of development, with particular emphasis on the major contribution afforded by a comprehensive systems rig, both to the hardware and software development program are discussed. The results of in-flight evaluation program including performance under fault-free and simulated runaway conditions. A number of problem areas encountered during the initial phases of the flight trials and means to overcome these are presented. S.E.S.

N79-30201# Marconi-Elliott Avionic Systems Ltd., Rochester (England).

#### SOME ASPECTS OF THE DESIGN AND DEVELOPMENT OF THE MARITIME AUTOPILOT MODES FOR THE WESTLAND LYNX HELICOPTER

K. S. Snelling and M. V. Cook (Cranfield Inst. of Technol.) In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 18 p refs

#### Avail: NTIS HC A11/MF A01

The stability augmentation system and the transistion autopilot mode were reviewed. The requirement for Sea State filtering of the height control signal is discussed. The design and development of the Cable Angle and Cable Height hold autopilot modes that together provide sonar modes for stabilizing the position of a dunking sonar. S.E.S.

N79-30202\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

#### DESIGN AND TESTING OF A REDUNDANT SKEWED INERTIAL SENSOR COMPLEX FOR INTEGRATED NAVIGA-TION AND FLIGHT CONTROL

R. E. Ebner (Litton Systems, Inc., Woodland Hills, Calif.) and W. E. Howell In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Foor Visibility May 1979 13 p refs Avail: NTIS HC A11/MF A01 CSCL 01C

Requirements for a redundant strapdown inertial sensor complex applied to V/STOL aircraft as developed by NASA are presented. Flight test data of a redundant, skewed axis strapdown inertial system are given, demonstrating the feasibility of the primary design aspects. This data consisted of parity equation responses through various flight conditions, showing residual noise levels on redundant gyro and accelerometer comparisons as a measure of minimum failure-level detectability, plus failure isolation and navigation performance through several simulated instrument failures. S.E.S.

N79-30203# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

#### SCAN CONVERTER AND RASTER DISPLAY CONTROLLER FOR NIGHT VISION DISPLAY SYSTEMS

H. W. Killian and W. Voswinckel In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 10 p

Avail: NTIS HC A11/MF A01

A modular Raster Display System and its functional modules are described. Digital scan conversion of images of electro-optical sensors and digital storage of images with several gray tones are allowed. With the help of the digital symbol generator digital information is converted into adequate symbology which again can be superimposed on the sensor image. Superposition of two sensor images is performed with the same equipment. Some technical features are discussed which exceed the common modes of current display systems and may help to support missions of military helicopters flying low level at poor visibility conditions. SE 5.

**N79-30204**# Army Avionics Research and Development Activity, Fort Monmouth, N. J.

#### APPLICATIONS OF PATTERN RECOGNITION SYSTEMS FOR DAY/NIGHT PRECISION AIRCRAFT CONTROL

Alfred Kleider *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 7 n refs

Avail: NTIS HC A11/MF A01

The philosophical and practical foundations for the utilization of advanced technological developments in lasers and Charge Coupled Devices (CCD) to provide light weight, low cost solutions to theise problems in day/night operations are explored. The special case of weather limited visibility is presented and projected operational parameters are discussed relative to near term availability of infrared devices (IRCCD). The concept of feature extraction is explored using the complimentary one dimensional characteristics of wire/wire-like obstacles and a 1728 linear CCD Array as the foundation of the Wire Obstacle Warning System (WOWS) presently in development. In this instance the appropriate geometrical, optical, and electronic capatibilities were combined to provide a real time automatic pattern recognition system for Nap-of-the-Earth (NOE) helicopter operations. S.E.S.

**N79-30205**# Army Avionics Research and Development Activity, Fort Monmouth, N. J.

### HETERODYNING CO2 LASER RADAR FOR AIRBORNE APPLICATIONS

R. L. DelBoca and R. J. Mongeon (United Technol. Res. Center) In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 17 p refs

#### Avail: NTIS HC A11/MF A01

The design considerations, hardware configuration, and test results of flyable breadboard models are discussed which have demonstrated the feasibility of employing CO2 scanning laser systems for wire detection, precision hover, Doppler navigation, and terrain following. S.E.S.

N79-30206# Standard Elektrik Lorenz A.G., Stuttgart (West Germany).

## A SELF CONTAINED COLLISION AVOIDANCE SYSTEM FOR HELICOPTERS

S. Bloch, G. Hoefgen, and D. zurHeiden *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 6 p refs

#### Avail: NTIS HC A11/MF A01

A proposed solution to the problem of obstacle detection and collision warning pertaining to the operation of helicopters at low altitude and within a formation is described. A simple yet effective algorithm is used in order to assess the collision hazard posed by stationary obstacles as well as other helicopters in the proximity of the protected aircraft. The raw data needed (range and closing speed) is provided by a 35 GHz versatile low-cost FM/CW-radar that was originally developed for the protection of road vehicles. With the exception of the antenna assembly only minor modifications are needed in order to make this radar fit the requirements of an airborne anti-collision system. Author N79-30207# Ferranti Ltd., Edinburgh (Scotland). Radar Group.

#### A HELICOPTER HIGH DEFINITION ROTOR BLADE RA-DAR

C. M. Steward *In* AGARD . The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 10 p ref

#### Avail: NTIS HC A11/MF A01

By installing a radar aerial within the rotor blade, a sensor having unique capabilities for the operation of helicopters in darkness or bad weather can be provided. A description of such a system is given outlining the factors affecting the choice of the principal radar parameters and their interaction with the helicopter rotor design. Examples of the high definition pictures from the display are shown with the appropriate section of map for comparison and some suggestions are made on operational roles where such a radar system would have particular advantages. Author

#### N79-30208# Naval Air Development Center, Warminster, Pa. DESIGN PROCEDURE FOR AIRCREW STATION LABELING SELECTION AND ABBREVIATION

Patrick M. Curran and Norman E. Lane /n AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 16 p refs.

#### Avail: NTIS HC A11/MF A01

Methods are described of preparing the functional statements of what, where, when, and how the operator should act upon gathering information on a characteristic of a system/subsystem or component. The usage of common labeling of associated controls and displays is presented as well as specific procedures for abbreviating display/control labels. M.M.M.

N79-30209# Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.

#### SUBJECTIVE ASSESSMENT OF A HELICOPTER APPROACH SYSTEM FOR IFR CONDITIONS

H. Howells *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 7 p refs

Avail: NTIS HC A11/MF A01

The contribution of subjective assessment techniques used in the flight evaluation of 3 azimuth approach guidance laws presented on crosspointers of electromechanical instruments in a fully stabilized helicopter is outlined. The pilots were instructed to confine their attention to monitoring the instruments within the cockpit as a safety pilot was carried. The use of subjective assessment techniques, in conjunction with the interpretation of radar plots and comments of an airborne trials observer, provide a type of information not obtainable from other sources. The technique, although used here on electromechanical instruments, would be equally applicable to an assessment of electro-optical displays. M.M.M.

N79-30210 # Army Avionics Research and Development Activity, Fort Monmouth, N. J.

#### THE IMPACT OF A MULTI-FUNCTION PROGRAMMABLE CONTROL DISPLAY UNIT IN AFFECTING A REDUCTION OF PILOT WORKLOAD

Bernard S. Gurman *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 8 p refs

#### Avail: NTIS HC A11/MF A01

Three digitally-addressed Multi-Legend Display Switches (MLD/S) which employ different mechanizations, and the incorporating of these MLD/S's in a multi-purpose, programmable Control Display Unit (CDU) are described. Several programs are cited which logically led to the development of the Multi-Legend Display Switches and the CDU. These programs and that possible applications are presented. Developments that lead to the reduction of pilot workload and improve overall pilot/vehicle performance are pointed out. M.M.M.

#### N79-30211# GIE ISPENA, Paris (France). THE EQUIPMENT-SYSTEM INTERFACE IN AN ANTITANK HELICOPTER AT NIGHT [ETUDE D'INTERFACE EQUIPAGE SYSTEME DANS UN HELICOPTERE ANTI-CHAR DE NUITÌ

G. Ferlet and J. L. Mascle In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 10 p In FRENCH

#### Avail: NTIS HC A11/MF A01

A direct consequence of the growing complexity of modern aircraft missions is the increase of equipment workloads, which can reach a critical level in many cases. It is important to consider this problem from the beginning of the aircraft definition stage so that some really integrated solutions which guarantee maximum operational efficiency can be proposed for the equipment-system interface. Such a step requires the adoption of a rigorous, systematic work method that is capable of accounting for diverse data such as technological constraints or operational requirements, in order to obtain optimal solutions. A methodology used in the study of the equipment-system interface for an antitank helicopter capable of performing its mission by day as well as by night is presented. The technique distinguishes five stages in the iterative process, thus permitting progressive improvement in the definition of the interface, as a function of the difficulties Transl. by A.R.H. considered at different stages.

N79-30212# Naval Air Systems Command, Washington, D. C. Advanced Aircraft Development and Systems Objectives Office. PROJECT NAVTOLAND (NAVY VERTICAL TAKEOFF AND LANDING CAPABILITY DEVELOPMENT)

Thomas S. Momiyama In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 20 p refs

#### Avail: NTIS HC A11/MF A01

The U.S. Navy's integrated systems approach to improve the helicopter and fixed-wing VSTOL aircraft operational capabilities at sea and in tactical sites is described. The current capability is limited to generally 400 foot ceiling and one mile visibility to 200 foot and 1/2 mile weather minima due to elementary flight control systems or lack of precision approach and landing guidance. Inability to cope with ship motions limits the small air capable ship operations generally to Sea State 3. The NAVTOLAND project goals are zero ceiling and 1/8 mile visibility weather minima and Sea State 5 operation. An integrated development of the aircraft flight control and display systems to provide flying qualities with satisfactory level of pilot workload and the shipboard and tactical site installed guidance systems and visual landing aids to effect precision in touchdown is applied toward improvement of the helicopter and AV-8 HARRIER operations and toward development of all-weather and rough sea operations of all future Navy and Marine Corps VSTOL MMM aircraft.

N79-30213# Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).

#### GCU, THE GUIDANCE AND CONTROL UNIT FOR ALL WEATHER APPROACH

Hartmut Boehret In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 11 p refs

#### Avail: NTIS HC A11/MF A01

The guidance and control unit GCU development by Bodenseewerk and sponsored by the German Ministry of Defense, demonstrated in flight test the improvements of future landing procedures. The short-captured steep approach paths generated by the GCU can be flown manually with the flight director instrument due to the high accuracy of signal processing by means of Kalman filter techniques. The technical equipment is presented and the flight test results are discussed. M.M.M. N79-30214# McDonnell-Douglas Corp., St. Louis, Mo. Electronics Branch

#### SIMULATION AND STUDY OF V/STOL LANDING AIDS FOR USMC AV-8 AIRCRAFT

W. E. Bode, R. A. Kendrick, and E. J. Kane In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 16  $\rm p$ 

#### Avail: NTIS HC A11/MF A01

Motion base simulations, flown by USMC Harrier pilots, in which 600 low speed IFR approaches to a forward site and ship were made. Glideslope angles from 3 degrees to 9 degrees were simulated and flown both head up and head down. An attitude hold autopilot was evaluated and flight director steering was studied. The effects of crosswind, turbulence, sea state and system errors were included in the simulation. Visual landing aids for ships and forward sites were devised and aircraft and ground/ship based equipment selected. At the heart of the study was the evaluation by the pilots of the degree of improvement offered by the simulated landing aids. M.M.M.

N79-30215# Dornier-Werke G.m.b.H., Friedrichsbafen (West Germany)

#### IMPLEMENTATION OF FLIGHT CONTROL IN AN INTE-GRATED GUIDANCE AND CONTROL SYSTEM

H. J. Bangen, W. Hoffmann, and W. Metzdorff In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 11 p refs

#### Avail: NTIS HC A11/MF A01

The hardware and software technology is presented as it is required to solve the control problem in the integrated helicopter guidance and control system. M.M.M.

N79-30216# Societe de Fabrication d'Instruments de Mesure SFIM, Massy (France).

#### STABILIZING ELECTRO-OPTICAL SYSTEMS ON HELICOP-STABILISATION DES SYSTEMES ELECTRO-TERS **OPTIQUES SUR HELICOPTERES**

Dominique dePonteves In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 5 p In FRENCH; ENGLISH summary

#### Avail: NTIS HC A11/MF A01

The stabilization of both the APX-BEZU M260 gyrostabilized sights used for surveillance and the aiming of antitank missiles, and the APX M397 sight, used with an IR goniometer to aim the HOT missile, is implemented by a mechanical relation between a mirror and a conventional gyro. The development of infrared sensors needing large optical aperture led to the design and implementation of a two-axis, tuned gyro which can be used either as a free gyro or as a rate gyro. Its performance allows the stabilization of the most performing optical sensors with a MTF degradation of not more than 15 percent. Preliminary flight tests were performed on an electro-optical system which combines a TV camera with a very high focal length, a laser range finder, and a twin-focal FLIR in order to determine its feasibility for aiming a weapon aiming system suing 8 to 13 microns band. Transfer functions are discussed. ARH

N79-30217# Rockwell International Corp., Cedar Rapids, Iowa. Collins Government Avionics Div.

#### AN ADVANCED GUIDANCE AND CONTROL SYSTEM FOR **RESCUE HELICOPTERS**

Kenneth W. McElreath In AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 17 p Avail: NTIS HC A11/MF A01

After identifying the tasks in accomplishing a search and rescue mission, Rockwell-Collins established guidelines and priorities for designing and integrating the system elements. The development of the avionics system architecture is reported and the features of each element which contribute to the adverse weather capability of the integrated system are described.

#### N79-30218

N79-30218# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). STABILITY AND CONTROL

May 1979 359 p refs in ENGLISH and FRENCH Presented at the Flight Mech. Panel Symp. on Stability and Control, Ottawa, 25-28 Sep. 1978 (AGARD-CP-260;

ISBN-92-835-0239-6) Avail: NTIS HC A16/MF A01

The fundamental relationship between the use of advanced control concepts and appropriate aircraft design is considered. Experiences in stability and control, the application of active control and the general problems concerning its use, including those of mathematical models, and results obtained with control configured vehicles are discussed. Criteria for satisfactory behavior of aircraft with advanced stability and control systems and the participation of the pilot are included.

N79-30219<sup>\*</sup># National Aeronautics and Space Administration. Washington D.C.

#### SYSTEMS IMPLICATIONS OF ACTIVE CONTROLS

Peter R. Kurzhals In AGARD Stability and Control May 1979 16 p refs

Avail: NTIS HC A16/MF A01

Control configured vehicle design and system considerations are outlined and representative applications of active control for fighter and transport aircraft are summarized. Specific examples include relaxed static stability and angle of attack limiting on the F-16, envelope limiting and ride smoothing on the F-8. maneuver load and control and relaxed static stability on the L-1011, load alleviation for the C-5, and B-1 ride control. Principal features, problem areas, and mechanization trends for these and projected future active control applications are outlined. J.M.S.

#### N79-30220# Lockheed Missiles and Space Co., Sunnyvale, Calif. A SUMMARY OF AGARD FDP MEETING ON DYNAMIC **STABILITY PARAMETERS**

L. E. Ericsson /n AGARD Stability and Control May 1979 23 p refs

Avail: NTIS HC A16/MF A01

Wind tunnel and flight testing techniques, analytical techniques, including motion analysis and nonlinear formulations were covered along with sensitivity and simulator studies to assess the importance of the various dynamic stability parameters, including cross coupling effects between lateral and longitudinal degrees of freedom. The extent to which the practice of decoupling lateral and longitudinal degrees of freedom must be abandoned was addressed. It was decided that when describing the vehicle dynamics of advanced aircraft and aerospace vehicles, which perform sustained operations at high angles of attack, the cross coupling effects are usually significant, and lateral and longitudinal degrees of freedom must be considered together. J M S

N79-30221# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

#### STRUCTURAL ASPECTS OF ACTIVE CONTROLS

Roger Destuynder In AGARD Stability and Control May 1979 12 p refs In FRENCH: ENGLISH summary

#### Avail: NTIS HC A16/MF A01

Various papers presented at the specialists meeting sponsored by the Structures and Materials Panel in Lisbon (1977) are summarized. Emphasis is placed on the following main points: (1) the use of preliminary simple calculations to cover the different configurations and the possible control laws; (2) improvement with the help of corrections obtained by wind tunnel tests; and (3) proof, through flight test or wind tunnel test, of the validity of the solution. Progress in flutter suppression obtained at ONERA is also reported. A.R.H.

### N79-30223# General Dynamics/Fort Worth, Tex. ENHANCED FIGHTER MISSION EFFECTIVENESS BY USE **OF INTEGRATED FLIGHT SYSTEMS**

John H. Watson and Willie S. Bennett In AGARD Stability and Control May 1979 13 p refs

#### Avail: NTIS HC A16/MF A01

The performance of the modern fighter aircraft and its flight systems is discussed. Improvement in effectiveness through proper functional integration of the pilot, his crew station, and the flight systems is emphasized. The incorporation of advanced control modes, the integration of avionic systems and the flight control systems, and the unification of all aircraft functions under the control of a flight management system are among the factors considered. IMS

#### N79-30224# Societe Nationale Industrielle Aerospatiale. Toulouse (France)

#### RESULTS RELATED TO SIMULATED AND IN-FLIGHT EXPERIMENTATION WITH AN ELECTRIC FLIGHT CON-TROL SYSTEM THAT CAN BE GENERALIZED (RESULTATS RELATIFS A L'EXPERIMENTATION SUR SIMULATEUR ET EN VOL D'UN SYSTEME DE COMMANDES DE VOL ELECTRIQUES GENERALISABLES

A. Cazenave and J. Irvoas In AGARD Stability and Control May 1979 21 p In FRENCH

#### Avail: NTIS HC A16/MF A01

Studies of the performance of a transport aircraft with slender airfoils whose longitudinal stability is assured by the use of elevators show the advantage of moving back the center of gravity in order to improve finesse at low speeds; the optimal centering is located beyond the operationally acceptable rear limit for handling with classical flight controls. An electric flight control system which permits control under conditions of pronounced instability across the control stick was designed used in a simulator, and then flight tested on the T.S.S. Concorde. The form of the control laws considered is described as well as the improvements made after the simulation. Characteristics and the results obtained in flight are presented and compared to predictions Transl. by A.R.H.

#### N79-30225# Northrop Corp., Hawthorne, Calif. Aircraft Corp. IMPROVEMENT OF FIGHTER AIRCRAFT MANEUVERABIL ITY THROUGH EMPLOYMENT OF CONTROL CONFIGURED VEHICLE TECHNOLOGY

Janusz Stałony-Dobrzanski and Naren Shah In AGARD Stability and Control May 1979 22 p refs

#### Avail: NTIS HC A16/MF A01

The control configured vehicle (CCV) design concept employing concurrently the traditional disciplines as well as full authority automatic control system design, is shown to offer a very large combat performance improvement over conventional design approach. This improvement is due primarily to the freedom, under CCV concept, of designing statistically longitudinally unstable configurations. The configuration selected for the evaluation is a tailless clipped delta employing advanced structure and engine technologies. The performance gains are achieved simultaneously with decreased aircraft and fuel weight for the same mission. The feasibility of designing a stability and command augmentation (SCAS) for the statically unstable configurations is demonstrated. The full authority SCAS provides excellent flying qualities in general flying and target tracking modes. The departure prevention feature permits true 'head-out-ofcockpit' flying without the pilot having ever to consult flight instruments for safety. The system was evaluated extensively on a moving base simulator. The practical limitations to the degree of static instability are discussed. JMS

N79-30226# Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept. LATERAL STABILITY AT HIGH ANGLES OF ATTACK,

### PARTICULARLY WING ROCK

A. Jean Ross /n AGARD Stability and Control May 1979 19 p refs

Avail: NTIS HC A16/MF A01

The Gnat aircraft exhibits wing rock at high subsonic Mach numbers, but the onset of wing rock is delayed to higher angles of attack if fuel tanks are carried on the wings. Flight responses of Dutch roll and wing rock oscillations in steady turns were analyzed to give the variation of the stability derivatives with angles of attack at various Mach numbers for both aircraft configurations. The results show that the onset of wing rock occurs when the damping of the Dutch roll mode is zero, due mainly to loss in damping-in-roll derivative at high angle of attack. The stability derivatives from flight tests were compared with wind tunnel results, and show the same trends with angle of attack. The values of the linear derivatives were used as a basis for evaluating the effects of various added aerodynamic nonlinearities, both to explore the possible mechanisms for the limit cycle type of wing rock responses, and to calculate the changes in response due to an idealized stability augmentation Author system.

N79-30227# Hochschule der Bundeswehr, Munich. (West Germany).

## STALL BEHAVIOUR EVALUATION FROM FLIGHT TEST RESULTS

G. Sachs and H. Wuennenberg (Dornier-Werke G.m.b.H., Friedrichshafen) *In* AGARD Stability and Control May 1979 9 p refs

Avail: NTIS HC A16/MF A01

By comparing the dynamic stall behavior of a combat aircraft with a simulation, a special type of discrepancy in roll was found. The simulation was based on the best wind tunnel data available. The examination leads to the conclusion, that the aircraft is disturbed by random-type 'fluctuation' forces and moments. The order of magnitude was estimated from the scattering region of the wind tunnel data beyond C sub L max. By introducing these effects into the mathematical model it was possible to simulate the pilot in the loop dynamic stall behavior with the aid of a simple mathematical pilot model. For a general application in the design stage of a new project, new wind tunnel test techniques including the measurement of the time dependent parameters will be necessary. Author

N79-30229# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.

#### AIRCRAFT RESPONSE TO WINDSHEARS AND DOWN-DRAUGHTS

J. C. vanderVaart In AGARD Stability and Control May 1979 16 p refs

Avail: NTIS HC A16/MF A01

After a short review of current methods of modelling low altitude random atmospheric turbulence and variations of mean wind with altitude (windshears), a description is given of an analytical method to find deterministic wind or turbulence time histories that cause largest deviations of aircraft motion variables. Some numerical examples illustrate that small variations of wind, in particular of horizontal wind, may cause relatively large deviations relative to a desired aircraft trajectory. Finally, it is shown that the problem of finding 'worst case' response to deterministic changes in wind can be reduced to that of the statistics of a random white noise driven linear system. Author

## N79-30230# Aeritalia S.p.A., Torino (Italy). Combat Aircraft Group.

GUST ALLEVIATOR FEASIBILITY STUDY FOR G91Y

R. Carabelli In AGARD Stability and Control May 1979 12 p ref

Avail: NTIS HC A16/MF A01

A feasibility study was carried out of an active system to alleviate the turbulence effects on a light attack aircraft during the penetration phase of a ground attack mission. The study was tailored to the G91Y and the conclusions were that proceeding through an experimental research by developing a flying prototype would be preferable. The risks implicit in the achievement of the required accuracy in measuring the gust velocity were very high. The proposed system works on two axes. An open loop subsystem driven by the normal component of the gust velocity on the pitch axis and a roll damper on the lateral is indicated as an adequate solution to meet profitable cockpit 'g' reductions and weapon delivery accuracy improvement as well. R.E.S. N79-30231# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

## DESIGN CONSIDERATIONS FOR RELIABLE FBW FLIGHT CONTROL

James K. Ramage and James W. Morris  $\ \textit{In}$  AGARD Stability and Control May 1979 15 p refs

Avail: NTIS HC A16/MF A01

Critical design considerations which both aircraft designers and flight control systems engineers must bear in mind in the design and implementation of fly by wire flight control systems are presented.

N79-30232# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.

OPEN/CLOSED LOOP IDENTIFICATION OF STABILITY AND CONTROL CHARACTERISTICS OF COMBAT AIRCRAFT R. Koehler and M. Marchand *In* AGARD Stability and Control May 1979 11 p

Avail: NTIS HC A16/MF A01

General aspects of assessing flying qualities of augmented aircraft using system identification methods are discussed. The aircraft under test was equipped with a stability augmentation system which had a complex dynamic behavior. The dynamics influenced the flying qualities as well as the applicability of investigation methods. Therefore, the influence and recognizability of the stability augmentation system dynamics on handling quality evaluations and system identifications were inquired and pilot-in-the-loop investigations were made using the system identification results. R.E.S.

N79-30233# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik

### DYNAMIC WINDTUNNEL SIMULATION OF ACTIVE CONTROL SYSTEMS

P. G. Hamel and B. Krag *In* AGARD Stability and Control May 1979 10 p refs

Avail: NTIS HC A16/MF A01

Research studies were conducted to demonstrate the application potential of dynamic simulation in a wind tunnels test facility. Elastic mode control and ride smoothing systems were scaled to model frequency and tested in a 3 m subsonic gust windtunnel. An open loop active control ride smoothing system was optimized for the Dornier-TNT light transport aircraft experimental program. Dynamic wind tunnel flight tests of this program were successfully completed. R.E.S.

N79-30234# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Military Aircraft Div.

STABILITY AND CONTROL ASPECTS OF THE CCV-F104C H. Beh, U. Korte, and G. Loebert *In* AGARD Stability and Control May 1979 18 p refs

### Avail: NTIS HC A16/MF A01

The control configured vehicle and its implementation, and the design of the control laws are described. The superior flight performance of the control configured vehicle-flight control system is compared with that of the basic F 104G on the basis of simulator results. The validity of these results was demonstrated by comparison of the principal characteristics of longitudinal and lateral motion measured in flight with the corresponding predicted values. R.E.S.

N79-30235# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

#### DESIGN GUIDANCE FROM FIGHTER CCV FLIGHT EVALUA-TIONS

Frank R. Swortzel and Jack D. McAllister (Gen. Dyn./Ft. Worth, Tex.) /n AGARD Stability and Control May 1979 21 p refs

Avail: NTIS HC A16/MF A01

Flight control of the Fighter Control Configuration Vehicle (CCV) marked the first exploitation of six degree-of-freedcm flight control concepts for a new way to fly. An 87 flight, 125 flight hour test was conducted on a modified YF-16. Validation of the new control concepts was accomplished and significant capabilities to improve overall mission effectiveness of fighter aircraft were demonstrated. The program also included pilot evaluation of the CCV control modes applied to air-to-air and air-to-ground mission oriented tasks. Resulting control features included direct force control, independent fuselage aiming and translation, maneuver enhancement and gust alleviation. Performance benefits of relaxed static stability were also evaluated. G.Y.

#### N79-30236# Lockheed-California Co., Burbank. L-1011 ACTIVE CONTROLS, DESIGN PHILOSOPHY AND EXPERIENCE

David M. Urie In AGARD Stability and Control May 1979 9 p refs

Avail: NTIS HC A16/MF A01

Aircraft active control can be defined as control effectors activated by sensors through computers without pilot commands. A certificated commercial transport airplane, the Lockheed L-1011, currently employs several highly sophisticated systems satisfying this definition. The experience gained through development flight testing, commercial flight operation, and flight simulation research on active control applications is presented with the intent of relating design philosophy and results. G.Y.

N79-30237# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.

IN-FLIGHT HANDLING QUALITIES INVESTIGATION OF VARIOUS LONGITUDINAL SHORT TERM DYNAMICS AND DIRECT LIFT CONTROL COMBINATIONS FOR FLIGHT PATH TRACKING USING DFVLR HFB 320 VARIABLE STABILITY AIRCRAFT

D. Hanke and H.-H. Lange *In* AGARD Stability and Control May 1979 10 p refs

#### Avail: NTIS HC A16/MF A01

An in-flight investigation of DLC for wide body transport aircraft was carried out using DFVLR 320 variable stability aircraft which incorporates an advanced all digital model following system. The aircraft/DLC configuration parameters was investigated in an altitude compensatory tracking task in which the pilot has to minimize the error between commanded and actual altitude. To determine the influence of motion cues, the tracking task is carried out both on the ground and in-flight. Using the HFB 320 as a fixed base and an in-flight simulator, an ideal situation for comparing the fixed base and in-flight simulation results exists. In addition pilot-in-the-loop analysis for flight path tracking with DLC is performed. The results are given in the form of subjective pilot effort ratings and pilot-aircraft performance measures. The results are further compared with a flight path tracking criterion. G.Y.

#### N79-30238# British Aerospace Aircraft Group, Warton (England). FLYING QUALITIES AND THE FLY-BY-WIRE AEROPLANE J. C. Gibson *In* AGARD Stability and Control May 1979 8 p refs

Avail: NTIS HC A16/MF A01

The tornado flight control system was designed to give good stability, damping, and resistance to external disturbances. This was achieved by optimization of feedback gains and filters. Response to pilot inputs was then shaped by stick commands gains and filters. This process resulted in generally excellent flying qualities. Pilots reported a high level of confidence inspired by the easy and precise control with extremely good circuit handling and instrument flight characteristics. However, some deficiencies were noted associated in some cases with nonaircraft-like responses and these were eliminated by modifications to the command shaping. This experience emphasized that a specification which ensures entirely satisfactory flying qualities does not exist. Several areas where requirements are deficient or absent are illustrated.

#### N79-30239# Naval Air Systems Command, Washington, D. C. ARE TODAY'S SPECIFICATIONS APPROPRIATE FOR TOMORROW'S AIRPLANES?

R. C. AHarrah, W. J. Lamanna (McDonnell Aircraft Co., St. Louis, Mo.), and J. Hodgkinson *In* AGARD Stability and Control May 1979 12 p. refs

#### Avail: NTIS HC A16/MF A01

An approach for taking any system of a higher order that is addressed in the current specifications, and producing an equivalent system of an appropriate order, which is directly relatable to the specification parameters is presented. Example applications of the equivalent systems approach to various higher order systems are presented; the insights of this approach to the newest fighter aircraft design are discussed; and very preliminary results are presented on a flight program which investigates equivalent systems. G.Y.

#### N79-30240# National Aerospace Lab., Amsterdam (Netherlands), A SIMULATOR INVESTIGATION OF HANDLING QUALITY CRITERIA FOR CCV TRANSPORT AIRCRAFT

H. A. Mooij, W. P. deBoer, and M. F. C. vanGool *In* AGARD Stability and Control May 1979 14 p refs Sponsored in cooperation with Netherlands Agency for Aerospace Programs and Dept. of Civil Aviation of the Netherlands

#### Avail: NTIS HC A16/MF A01

The introduction of CCV (Control Configured Vehicle) concepts in the design of certain categories of future transport aircraft requires definition of handling quality criteria for such aircraft. These criteria should be applicable to guidance in flight control system design as well as in airworthiness certification. In an attempt to contribute new insight in this matter, approach and landing flight simulation investigations were performed using a moving base flight simulator. The conceptual aircraft was a jet transport aircraft developed around the relaxed static stability concept and equipped with a primary flight control system of the rate-command/attitude-hold type for pitch and roll control. Based on measured pilot/aircraft performance, pilot ratings and pilot commentary, boundary values for satisfactory handling qualities for the parameters investigated were established. G.Y.

N79-30242# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

ONERA'S MODEL OF THE PILOT IN DISCRETE TIME [LE MODELE DE PILOTE EN TEMPS DISCRET DE L'ONERA] Daniel Cavalli *In* AGARD Stability and Control May 1979 11 p refs In FRENCH

#### Avail: NTIS HC A16/MF A01

Numerical simulation of pilot performance provides a tool for evaluating the efficiency of pilot-aircraft systems and permits the study of the handling quality of new aircraft from the concept stage. Pilot performance is considered as a discreet time process in which decision making has a sequential character. The development of the ONERA model is described and its originality demonstrated by comparison with already existing models. Results obtained during application of the model in a study of performance degradation when the static margins of the simulated aircraft were decreased are presented. Transl. by A.R.H.

N79-30243\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FLIGHT EXPERIENCE WITH ADVANCED CONTROLS AND DISPLAYS DURING PILOTED CURVED DECELERATING APPROACHES IN A POWERED-LIFT STOL AIRCRAFT

W. S. Hindson (Natl. Res. Council of Can., Ottawa) and G. H. Hardy *In* AGARD Stability and Control May 1979 12 p refs

Avail: NTIS HC A16/MF A01

A program to assess the feasibility of piloted STOL approaches along predefined, steep, curved, and decelerating approach profiles was carried out with a powered-lift STOL aircraft. To reduce the pilot workload associated with the basic control requirements of a powered-lift aircraft equipped with redundant controls and

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operating on the backside of the power curve, separate stability augmentation systems for attitude and speed were provided, as well as a supporting flight director and special electronic cockpit displays. The control, display, and procedural features are described for the flight experiment that led to the conclusion that, given an adequate navigation environment, such constrained approaches may be feasible from a pilot acceptance point of view. G.Y.

N79-30246# New Mexico Univ., Albuquerque. Civil Engineering Research Facility.

#### AN EVALUATION OF ASPHALT-RUBBER MIXTURES FOR USE IN PAVEMENT SYSTEMS Final Report, Apr. 1977 -Feb. 1979

Dale S. Decker, Donald F. Griffin, and John P. Nielsen Tyndall AFB, Fla. Civil and Environ. Eng. Develop. Office Apr. 1979 83 p. refs

(Contract F29601-76-C-0015; AF Proj. 2104)

(AD-A069448; CEEDO-TR-79-02) Avail: NTIS HC A05/MF A01 CSCL 13/3

The design and construction of airfield pavements have not been developed sufficiently to provide pavements that will not crack. Cracking is a response to traffic and environmental conditions or to the construction material. For many years, rubber in several different forms has been added to asphalt with limited success in reducing pavement cracking. This report reviews the efforts to control cracking by incorporating rubber and asphalt for application as membrane interlayers, surface seal coats, crack fillers, and joint sealers. The extensive literature review indicates that conflicting conclusions have been reached regarding varied applications of the asphalt-rubber material. Of the asphalt-rubber products available, those with high percentages of rubber (20 to 30 percent by weight) appear to be the most promising for airfield pavements, although the effectiveness of asphalt-rubber in controlling or reducing pavement cracking has not been conclusively demonstrated. No superiority of one asphalt-rubber product was indicated in the literature. Because of the danger of loose aggregate chips, the literature indicates that chip seal applications should not be used on facilities where loose chips could be a problem. Therefore, the membrane interlayer is the only application of asphalt-rubber that should be considered for military runways at this time. GRA

#### N79-30247# European Space Agency, Paris (France). WALL CORRECTIONS IN TRANSONIC WIND TUNNEL: EQUIVALENT POROSITY

Xavier Vaucheret May 1979 135 p refs Transl. into ENGLISH of 'Corrections de Parois en Soufflerie Transsonique Porosite Equivalente', Rept. ONERA-P-1977-3 ONERA, Paris, 1977 (ESA-TT-545; ONERA-P-1977-3) Avail: NTIS HC A07/MF A01

A method for calculating wall effect corrections is presented for the present design of transonic wind tunnel test sections with perforated horizontal walls and for the dimensions of complete models or two dimensional profiles currently used in industrial testing. The calculations are performed using the concept of constant equivalent porosity on the walls, assuming symmetrical operation of the two walls in three dimensional flow and asymetrical operation in two dimensional flow. The experimental methods of determining the equivalent porosity are described. Finally, test section/model configurations are investigated in an attempt to minimize the wall effects. Author (ESA)

#### N79-30301\*# Boeing Aerospace Co., Seattle, Wash. DEVELOPMENT AND DEMONSTRATION OF MANUFAC-TURING PROCESSES FOR FABRICATING GRAPHITE/PMR-15 POLYIMIDE STRUCTURAL ELE-MENTS

C. H. Sheppard, J. T. Hoggatt, and W. A. Symonds *In* NASA. Langley Res. Center Graphite/Polyimide Composites Aug. 1979 p 61-84

(Contract NAS1-15009)

Avail: NTIS HC A19/MF A01 CSCL 11D

The processing requirements for graphite/PMR-15 polyimide composites developed to demonstrate the structural integrity of polyimide composite structural elements at temperatures up to

589K (600 F) are described. Major tasks included: quality assurance development; materials and process development; specification verification; flat panel fabrication; stiffened panel fabrication; honeycomb panel fabrication; chopped fiber moldings; and demonstration component fabrication. Materials, processing, and quality assurance documents were prepared from experimentally derived data. Structural elements consisting of flat panels, corrugated stiffeners, I-beams, hat stiffeners, honeycomb panels, and chopped fiber moldings were made and tested. Property data from 219K (-65 F) to 589K (600 F) were obtained. All elements were made in a production environment. The size of each element was sufficient to insure production capability and structural component applicability. Problems associated with adhesive bonding, laminate and structural element analysis, material variability, and test methods were addressed. J M S

N79-30315\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

#### FATIGUE AND FRACTURE

Walter IIIg and Richard A. Everett, Jr. (Army Res. and Technol. Labs.) In its Graphite/Polyimide Composites Aug. 1979 p 259-272

Avail: NTIS HC A19/MF A01 CSCL 11D

The effects of the load/temperature environment of the shuttle on the fatigue life of the body-flap were investigated by conducting real time and accelerated flight-by-flight tests up to 500 flights on coupons containing holes. On the fracture side, much is known about the sensitivity of the tensile strengths of composites to holes and other flaws, predominantly at room temperature. The effects of notches were assessed for graphite/polyimides at the expected temperature extremes of the body-flap: 117K (-250 F) to 589K (600 F). Results indicate that the shuttle temperature extremes may affect fatigue properties HTS/PMR-15. There is no significant effect of temperature on notch-strength. Tensile strengths for specimens with holes and slots are equal. S.E.S.

 $\textbf{N79-30317}^{\#}$  National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

#### MECHANICAL AND THERMOPHYSICAL PROPERTIES OF GRAPHITE/POLYIMIDE COMPOSITE MATERIALS

Donald R. Rummler and Ronald K. Clark *In its* Graphite/Polyimide Composites Aug. 1979 p 289-302 refs

#### Avail: NTIS HC A19/MF A01 CSCL 11D

An on-going program to characterize advanced composites for up to 50,000 hours of exposure to simulated supersonic cruise environments is summarized. Results are presented for up to 25,000 hours of thermal exposure and 10,000 hours of flight simulation at temperatures up to 560K (550 F) with emphasis on HTS/710 graphite/polyimide composite material. Results to date indicate that the maximum use temperature for HTS/710 may be reduced to 505K (450 F) for long-time (1000 hours) application such as the supersonic transport. Preliminary thermophysical properties data for HTS/PMR15 graphite/polyimide were generated. These data include thermal conductivity, thermal expansion, and specific heat from 115K (-252 F) to 590K (600 F) and emittance at room temperature and 590K (600 F). The purpose in generating these data was to validate use of state-of-the-art property measurement methods for advanced graphite fiber reinforced resin matrix composites. Based on results to this point, thermal expansion measurements for composites are most difficult to perform. A high degree of caution in conducting thermal expansion tests and analyzing results is required to produce reliable data. Author

N79-30332# Naval Research Lab., Washington, D. C. HIGH PERFORMANCE COMPOSITES AND ADHESIVES FOR V/STOL AIRCRAFT Annual Report, 1 Sep. 1977 -30 Nov. 1978

Luther B. Lockhart, Jr. 23 May 1979 163 p (SF54502001) (AD-A069611; NRL-MR-4005; AR-3) Avail: NTIS HC A08/MF A01 CSCL 11/2

An interdisciplinary program has been undertaken to address the composite and adhesive materials requirements of V/STOL aircraft. The primary tasks are to develop and characterize high modulus, high toughness resins with use temperatures of 350 F to 450 F or higher, to develop fabrication technology of newly developed resin matrices for graphite-fiber reinforced composites, to develop composite failure criteria for design optimization and to establish appropriate quality control parameters. This report is the third annual review of the program, covering the period 1 September 1977 to 30 November 1978. The reporting period was extended to permit completion of an important phase of the task on fracture behavior of composites. During the reporting period, two of the original tasks, Resin Synthesis and Radiation Curing, were terminated but related work is being continued under other in-house projects to follow up leads developed in this program. Among recent accomplishments are the demonstration that resin fracture energy can affect composite interlaminar toughness in fiber-reinforced composites, the development of quality control methodology for phthalocyanine precursor resins, the successful fabrication of phthalocyanine/graphite fiber composites from prepreg, and the completion of room temperature fracture tests of NARMCO 5208/T300 composite over four quadrants of load space and Hexcel F178/T300 composite in one quadrant and further verification of the ability to use this data to predict failure in a box-beam structure. GRA

N79-30334# Grumman Aerospace Corp., Bethpage, N.Y. COM-METALLIC COATINGS FOR GRAPHITE/EPOXY POSITES Final Report, 1 May 1977 - 31 Oct. 1978 Christian J. Staebler, Jr. and Bonnie F. Simpers May 1979 91 n refs

(Contract N00019-77-C-0250)

(AD-A069871) Avail: NTIS HC A05/MF A01 CSCL 11/2 Metallic coating systems for graphite/epoxy laminated aircraft structures were developed to provide protection against moisture penetration, electromagnetic interference (EMI), paint strippers and lightning strikes. Foil coatings and metal-filled resin coatings were evaluated to assess the protection ability in each of these areas. The foil coatings provided a significant reduction in the moisture penetration and the associated strength loss of the laminate after exposure to humidity and humidity-thermal spiking. Two techniques were developed for the application of foil coatings to graphite/epoxy laminates. Solid aluminum foil was applied to cured laminates in a secondary bonding operation. Perforated aluminum foil was bonded to the laminate in a co-curing operation. The co-curing application required that the laminate be prebled prior to application of the foil and final co-curing to obtain the GRA optimum strength and thickness of the laminate.

#### N79-30335# General Dynamics/Convair, San Diego, Calif. ULTRA-HIGH-MODULUS GRAPHITE-EPOXY CONICAL SHELL DEVELOPMENT, SUPPLEMENT Final Report, 1 Dec. 1976 - 30 May 1978

Julius Hertz, Edward E. Spier, and Norman R. Adsit Apr. 1979 73 n refs

(Contract DAAG46-76-C-0008; DA Proj. 1W1-62113-A-661) (AD-A069795; CASD-ASC-78-001; AMMRC-TR-78-38-Suppl) Avail: NTIS HC A04/MF A01 CSCL 11/2

The work reported herein represents a preliminary evaluation of support ring concepts for an advanced terminal interceptor (ATI). An ultra-high-modulus grahite/epoxy subscale cone was fabricated and a wedge shaped ring was secondary bonded internally. The cone and ring were successfully tested beyond ultimate load at both RT and 325F. A unique helicoil attachment concept for transferring load into the ring was demonstrated. GRA

#### N79-30391# European Space Agency, Paris (France). THE INFLUENCE OF THE ENVIRONMENT ON THE ELASTOPLASTIC PROPERTIES OF ADHESIVES IN METAL BONDED JOINTS

Walter Althof, Gerhard Klinger, Gerhard Neumann, and Johanna Schlothauer Feb. 1979 89 p refs Transl. into ENGLISH of Klimaeinfluss auf die Kennwerte des elasto-plastischen Verhaltens von Klebstoffen in Metallklebungen', DFVLR Brunswick Report DLR-FB-77-63, 8 Aug. 1978 Original report in GERMAN previously announced as ESA-90854 Original German report available from DEVLR. Cologne DM 43 40

(ESA-TT-521: DLR-FB-77-63) Avail: NTIS HC A05/MF A01 The shear modulus, the stress at 1% shear-strain, the shear strength, the strain at fracture, and the appertaining shear stress-strain diagrams were analyzed for ten aircraft structural adhesives. These values are calculated from the measured load-deflection behavior of the adhesive in the bond line of lap joints with a thick adherend and a small overlap length, as well as from the torsion pendulum testing of cast adhesives. The measurements are made before and after a long exposure to warmth, cold, moisture, warmth combined with moisture, and changes between cold and combined warmth and moisture. The environmental effects on the adhesion between adherend and adhesives as observed in the tests are described. Author (ESA)

N79-30490# Civil Aeromedical Inst., Oklahoma City, Okla. ELECTRICAL INSULATION FIRE CHARACTERISTICS VOLUME 2: TOXICITY Final Report, Jul. 1976 - Jul. 1978 Charles R. Crane, Boyd R. Endecott, Donald C. Sanders, and John K. Abbott Dec. 1978 102 p refs (Contracts DOT/TSC-RA-77-15; DOT/TSC-RA-77-16)

(PB-294841/2; UMTA-MA-06-0025;

DOT-TSC-UMTA-78-48-11) Avail: NTIS HC A06/MF A01 CSCL 13F

The relative inhalation toxicity of the thermal degradation products or gaseous pyrolysis of selected types of electrical wiring insulations was determined. The specific materials to be evaluated were selected from a much larger population on the basis of prior testing of properties other than toxicity. The relative toxicities of the combustion products of 14 electrical wiring insulations were evaluated using animal incapacitation as a measure of toxicity. One gram insulation samples were pyrolyzed in a quartz combustion tube connected in-line with a 12.6 liter exposure chamber by an air recirculation assembly to form a closed exposure system. Each material was pyrolyzed under three thermal degradation conditions and the time to incapacitation for the shortest time condition was used to rank the materials in order of their relative potential toxicity. GRA

N79-30555# Timken Co., Canton, Ohio.

#### TAPERED ROLLER BEARING DEVELOPMENT FOR AIR-CRAFT TURBINE ENGINES Final Report, 8 Mar. 1976 -8 Mar. 1979

Peter S. Orvos and G. J. Pressler Wright-Patterson AFB, Ohio AFAPL Mar. 1979 102 p refs (Contract F33615-76-C-2019; AF Proj. 3048)

(AD-A069440; AFAPL-TR-79-2007) NTIS Avail: HC A06/MF A01 CSCL 13/9

Finite element methods were used to structurally analyze various potential cage designs for tapered roller bearings operating at 3.5 million DN. The race guided Z design exhibited the greatest strength. Short duration evaluation tests verified these findings. Performance tests were conducted to determine bearing loss characteristics and oil-off survival. Parameters investigated, which influence losses (torque or heat generation), were speed, load, lubricant properties, lubricant flow rate and lubricant distribution. Oil-off survival tests were successfully run at 1.5 and 2.0 million DN. The bearing fatigue life tests conducted at 3 million DN showed a high degree of life scatter. The 90 percent survival level was 2.78 times the unadjusted catalog life expectancy. GRA

N79-30876\*# Air Force Flight Dynamics Lab., Wright-Patterson AFB. Ohio

#### LIGHTNING HAZARDS OVERVIEW: AVIATION REQUIRE-MENTS AND INTERESTS

Phillip B. Corn /n NASA. Marshall Space Flight Center Proc.: Workshop on the Need for Lightning Observations from Space Jul. 1979 p 126-135 refs

Avail: NTIS HC A12/MF A01 CSCL 04A

A ten-year history of USAF lightning incidents is presented along with a discussion of the problems posed by lightning to

current aircraft, and the hazards it constitutes to the electrical and electronic subsystems of new technology aircraft. Lightning technical protection technical needs, both engineering and operational, include: (1) in-flight data on lightning electrical parameters; (2) tech base and guidelines for protection of advanced systems and structures; (3) improved laboratory test techniques; (4) analysis techniques for predicting induced effects; (5) lightning strike incident data from general aviation; (6) lightning detection systems; (7) pilot reports on lightning strikes; and (8) better training in lightning awareness. A.R.H.

N79-30959# Computer Sciences Corp., Silver Spring, Md. Systems Sciences Div.

#### CENTRAL FLOW CONTROL SOFTWARE DESIGN DOCU-MENT. VOLUME 1: OPERATIONAL SOFTWARE COMPLEX Final Report

Jan. 1979 542 p refs

(Contract DOT-FA77WA-3955) (AD-A070973; CSC/SD-78/6172-Vol-1; FAA-RD-79-33-Vol-1)

Avail: NTIS HC A23/MF A01 CSCL 09/2

The Central flow control (CFC) software system functional requirements established in the Federal Aviation Administration's (FAA) computer program functional specifications are translated into implemented software programs. The exact configuration of the computer programs produced for CFC software system is described. A complete technical description of the software functions, structures, operating environment, data organization, visual table of contents, program listings, and data and module cross references is provided. The operational complex which operates in real time mode and is comprised of the executive, database, simulation, and applications subsystems is J.M.S.

N79-30960# Computer Sciences Corp., Silver Spring, Md. Systems Sciences Div.

#### CENTRAL FLOW CONTROL SOFTWARE DESIGN DOCU-MENT. VOLUME 2: SUPPORT SOFTWARE COMPLEX Final Report

Jan. 1979 593 p

(Contract DOT-FA77WA-3955)

(AD-A070771; CSC/SD-78/6172-Vol-2; FAA-RD-79-33-Vol-2) Avail: NTIS HC A25/MF A01 CSCL 09/2 The support complex (SPCX) which operates in an off-line

The support complex (SPCX) which operates in an off-line mode and is comprised of the system development, system generation, system test, and system analysis subsystems is described. J.M.S.

N79-31136\*# National Aeronautics and Space Administration, . Washington, D: C.

#### A COMPARISON OF PREDICTIONS OBTAINED FROM WIND TUNNEL TESTS AND THE RESULTS FROM CRUIS-ING FLIGHT: AIRBUS AND CONCORDE

J. Berger Aug. 1979 71 p refs Transl. into ENGLISH of "Comparison entre les resultats de vol en croisiere: Airbus et Concorde". AGARD-CP-242, Rept-20 Presented at Flight Mechanics Panel Specialists Meeting on Performance Prediction Methods, Paris, France, 11-13 Oct. 1977 Original language document was announced as N78-26074 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Aerospatiale (France)

(Contract NASw-3199)

(NASA-TM-75238; AGARD-CP-242; Rept-20) Avail: NTIS HC A04/MF A01 CSCL 02A

Following a summary of the methods used to establish aerodynamic data and propulsion data, a comparison was made in the form of the drag (or thrust) difference between flight results and predictions made on the basis of these data. Certain hypothesis and improvements on aerodynamic data were presented in order to explain the slight deficit found on Airbus and Concorde. M.M.M.

N79-31137<sup>\*</sup># National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. THE PROMISE OF MULTICYCLIC CONTROL John L. McCloud, III Aug. 1979 36 p refs

(NASA-TM-78621: A-7955) Avail: NTIS HC A03/MF A01 CSCL 02A

Several types of rotors which employ multicyclic control are reviewed and compared. Their differences are high-lighted and their potential advantages and disadvantages are discussed. The flow field these rotors must operate in is discussed, and it is shown that simultaneous elimination of vibration and oscillatory blade loads is not an inherent solution to the roughness problem. The use of rotor blades as energy absorbers is proposed. Input-output relations are considered and a gain control for ROMULAN, a multicyclic controlling computer program, is introduced. Implications of the introduction of multicyclic systems into helicopters are discussed. A.W.H.

#### N79-31138# Textron Bell Aerospace Co., New Orleans, La. MARITIME PATROL AIRSHIP CONCEPT STUDY Final Report, 18 Apr. - 31 Oct. 1978

James C. Bell, James D. Marketos, and A. D. Topping 16 Nov. 1978 242 p refs

(Contract N62269-78-M-6956)

(AD-A070131; NADC-78074-60; Rept-7575-927030) Avail: NTIS HC A11/MF A01 CSCL 01/3

Results of a preliminary conceptual parametric design study for a maritime patrol airship to be used by the U.S. Coast Guard or Navy are presented. Eight different Coast Guard mission profiles are considered, and an optimum airship point design is developed for each. The report discusses mission requirements, airship operational requirements, the conceptual design approach, and the parametric design study which uses a computer program to assist in optimizing the critical parameters for each airship mission design. The study includes airship sizes from 220,000 cu ft 18,000 lb vertical takeoff weight to 3,000,000 cu ft 230,000 lb vertical takeoff weight. Results show the unique features of the Bell unballasted, reversible thrust airship design and the critical need for design optimiztion, owing to the sensitivity of the airship design parameters. The computer design program shows airship conceptual differences and design trends rather than absolute design configurations, since it uses the preliminary subsystem weight relationships developed for recent airship parametric studies. Although the study design trends should remain valid, additional studies are recommended to establish better subsystem weight estimates and to incorporate life-cycle costing. GRA

N79-21141\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

POWERED LOW-ASPECT-RATIO WING IN GROUND EFFECT (WIG) AERODYNAMIC CHARACTERISTICS

James L. Thomas, John W. Paulson, Jr., and Richard J. Margason Jul. 1979  $\,$  49  $\,p$   $\,$  refs

(NASA-TM-78793) Avail: NTIS HC A03/MF A01 CSCL 01A

A wing-in-ground effect configuration was investigated. The configuration used large diameter, low pressure ratio fans mounted about 0.76 wing chord ahead of the wing leading edge to achieve a power augmented ram wing during operation in ground effect. Tests of both in and out of ground effect aerodynamic transition characteristics from very low speeds to cruise speeds are described. The investigation provided a number of conclusions concerning the aerodynamic/propulsive performance interaction. While power augmented lift is required for low speed flight, there is a thrust loss when the efflux is trapped under the wing which reduced the effective thrust to weight available for acceleration by about a third of the installed thrust to weight ratio. A.W.H.

N79-31143\*# Old Dominion Univ., Norfolk, Va.

SUBSONIC WIND-TUNNEL INVESTIGATION OF LEADING-EDGE DEVICES ON DELTA WINGS (DATA REPORT) M. Rao Dhanvada and Thomas D. Johnson, Jr. Aug. 1979

131 p refs

(Grant NGR-47-003-052)

(NASA-CR-159120) Avail: NTIS HC A07/MF A01 CSCL 01A

The drag reduction potential of leading edge devices on delta wings at high lift is presented. Fences, pylon type vortex

#### N79-31144

generators, chordwise slots, and sharp plate extensions were tested on wing models with 60 and 74 degree swept blunt leading edges at angles of attack to 32 degrees. Six component balance and leading edge surface pressure measurements were taken with various geometry and spanwise arrangements of the devices. Tables listing the data, without analysis, are presented. A.W.H

N79-31144\*# Boeing Commercial Airplane Co., Seattle, Wash. DYNAMIC LOADS ANALYSIS SYSTEM (DYLOFLEX) SUMMARY. VOLUME 1: ENGINEERING FORMULATION R. D. Miller, R. I. Kroll, and R. E. Clemmons Sep. 1979 88 p refs 2 Vol.

(Contract NAS1-13918)

(NASA-CR-2846-1; D6-44455-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 01A

The DYLOFLEX computer program system expands the aeroelastic cycle from that in the FLEXSTAB computer program system to include dynamic loads analyses involving active controls. Two aerodynamic options exist within DYLOFLEX. The analyst can formulate the problem with unsteady aerodynamics calculated using the doublet lattice method or with quasi-steady aerodynamics formulated from either FLEXSTAB or doublet lattice steady state aerodynamics with unsteady effects approximated by indicial lift growth functions. The equations of motion are formulated assuming straight and level flight and small motions. Loads are calculated using the force summation technique. DYLOFLEX consists of nine standalone programs which can be linked with each other by magnetic files used to transmit the required data between programs.

#### N79-31145<sup>\*</sup># Boeing Commercial Airplane Co., Seattle, Wash. DYNAMIC LOADS ANALYSIS SYSTEM (DYLOFLEX) SUMMARY. VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN INFORMATION

R. D. Miller, R. I. Kroll, and R. E. Clemmons Sep. 1979 60 p refs 2 Vol.

(Contract NAS1-13918)

(NASA-CR-2846-2; D6-44455-Vol-2) Avail: NTIS HC A04/MF A01 CSCL 01A

Contents: execution of the DYLOFLEX program system; magnetic file format; DYLIB - the DYLOFLEX alternate subroutine library; and prefaces for DYLIB subroutines. A.R.H.

#### N79-31146# Aeronautical Research Labs., Melbourne (Australia). LATERAL AERODYNAMICS EXTRACTED FROM FLIGHT TEST USING A PARAMETER ESTIMATION METHOD

R. A. Feik Oct. 1978 45 p refs (ARL-AERO-NOTE-380; AR-001-311) Avail: NTIS HC A03/MF A01

Flight data from a 60 deg delta wing aircraft was analyzed using a modified Newton-Raphson parameter estimation procedure. The model equations used for the analysis were extended to account for sideslip vane errors and for lateral accelerometer position error. Lateral derivatives extracted from the data were compared with wind tunnel measurements and theoretical estimates and areas of agreement and disagreement identified. The method was also applied to the analysis of fin loads measured in flight and some tentative conclusions reached. The results confirm the effectiveness of the parameter identification procedure in flight test analysis and its ready applicability to a variety of related problems. M.M.M.

#### N79-31147\*# Boeing Commercial Airplane Co., Seattle, Wash. MODAL INTERPOLATION PROGRAM, L215(INTERP). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT

M. Y. Hirayama and R. I. Kroll Washington NASA Sep. 1979 69  $p\ refs$ 

(Contract NAS1-13918)

(NASA-CR-2848; D6-44457) Avail: NTIS HC A04/MF A01 CSCL 01A

The design, structure, and usage of the modal interpolation program L215 are presented. The program uses modal data sets of arrays containing interpolation coefficients. The interpolation arrays are used to determine displacements at various aerodynamic control points. The displacements consist of translations normal to the aerodynamic surface and surface slopes that are parallel and perpendicular to the free stream direction. Five different interpolation methods are available.

A.W.H.

N79-31148<sup>\*</sup># Boeing Commercial Airplane Co., Seattle, Wash. A PROGRAM TO COMPUTE THREE-DIMENSIONAL SUBSONIC UNSTEADY AERODYNAMIC CHARACTERIS-TICS USING THE DOUBLET LATTICE METHOD, L216 (DUBFLEX). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 - May 1977

B. A. Harrison and M. Richard Washington NASA Sep. 1979 75 p refs 2 Vol.

(Contract NAS1-13918)

(NASA-CR-2850; D6-44459) Avail: NTIS HC A04/MF A01 CSCL 01A

The information necessary for execution of the digital computer program L216 on the CDC 6600 is described. L216 characteristics are based on the doublet lattice method. Arbitrary aerodynamic configurations may be represented with combinations of nonplanar lifting surfaces composed of finite constant pressure panel elements, and axially summetric slender bodies composed of constant pressure line elements. Program input consists of configurations geometry, aerodynamic coefficients, and data; output includes element geometry, pressure difference distributions, integrated aerodynamic coefficients, stability derivatives, generalized aerodynamic forces, and aerodynamic influence coefficient matrices. Optionally, modal data may be input on magnetic field (tape or disk), and certain geometric and aerodynamic output may be saved for subsequent use.

ΔRH

#### N79-31149<sup>\*</sup># Bihrle Applied Research, Inc., Jericho, N. Y. ROTARY BALANCE DATA FOR A TYPICAL SINGLE-ENGINE GENERAL AVIÁTION DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF 8 DEG TO 90 DEG. 2: HIGH-WING MODEL A

William Mulcay and Robert Rose Washington NASA Sep. 1979 116 p refs

(Contract NAS1-14849)

(NASA-CR-3101) Avail: NTIS HC A06/MF A01 CSCL 01A Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in the Langley spin tunnel are presented in plotted form for a 1/5-scale, single-engine, high-wing, general aviation airplane model. The configurations tested included various tail designs and fuselage shapes. Data are presented without analysis for an angle of attack range of 8 to 90 degrees and clockwises and counterclockwise rotations covering an Omega b/2 v range from 0 to 0.85.

N79-31151\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

#### WIND TUNNEL INVESTIGATION OF AN ARMED MINI REMOTELY PILOTED VEHICLE

Arthur E. Phelps, III Sep. 1979 62 p refs Prepared in cooperation with Army Aviation Research and Development Command, St. Louis, Mo.

(DA Proj. 1L1-61102-AH-45)

(NASA-TM-80132; L-13026; AVRADCOM-TR-79-41) Avail: NTIS HC A04/MF A01 CSCL 01A

A wind tunnel investigation of a full scale remotely piloted vehicle (RPV) armed with rocket launchers was conducted. The model had unacceptable longitudinal stability characteristics at negative angles of attack in the original design configuration. The addition of a pair of fins mounted in a V arrangement on the propeller shroud resulted in a configuration with acceptable longitudinal stability characteristics. The addition of wing mounted external stores to the modified configuration resulted in a slight reduction in the longitudinal stability. The lateral directional characteristics of the model were generally good, but the model had low directional stability at low angles of attack. Aerodynamic control power was very strong around all three axes. A.W.H. N79-31152\*# Bibrle Applied Research, Inc., Jericho, N. Y. ROTARY BALANCE DATA FOR A SINGLE-ENGINE TRAINER DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF 8 DEG TO 90 DEG

Paul Pantason and Waldo Dickens Washington NASA Aug. 1979 327 p

(Contract NAS1-14849)

(NASA-CR-3099) Avail: NTIS HC A15/MF A01 CSCL 01A Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in the Langley spin tunnel are presented in plotted form for a 1/6 scale, single engine trainer airplane model. The configurations tested included

the basic airplane, various wing leading edge devices, elevator, aileron and rudder control settings as well as airplane components. Data are presented without analysis for an angle of attack range of 8 to 90 degrees and clockwise and counter-clockwise rotations. Author

N79-31153\*# Boeing Commercial Airplane Co., Seattle, Wash. EQUATION MODIFYING PROGRAM, L219 (EQMOD). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 -May 1977

M Y Hiravama, R. E. Clemmons, and R. D. Miller Washington NASA Sep. 1979 65 p refs

(Contract NAS1-13918)

D6-44465-Vol-2) NTIS (NASA-CR-2856; ∆vail. HC A04/MF A01 CSCL 01A

A digital computer program, L219 (EQMOD), available for execution on the CDC 6600 is described. The program modifies matrices according to card input instructions and prepares magnetic files of matrices suitable for use in the linear systems analysis program (QR) and the random harmonic analysis program L221 (TEV156). The particular field of application of the program is the modification of the theoretical equations of motion and load equations generated in DYLOFLEX by the equation of motion program (L217) and the load equation program (L218), respectively. J M S

N79-31154\*# Boeing Commercial Airplane Co., Seattle, Wash. TIME HISTORY SOLUTION PROGRAM, L225 (TEV126). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 -May 1977

A. Tornallyay, R. E. Clemmons, and R. I. Kroll Washington NASA Sep. 1979 34 p refs (Contract NAS1-13918)

D6-44469-Vol-2) NTIS (NASA-CR-2860) Avail. HC A03/MF A01 CSCL 01A

The time history solution program L225 (TEV126) is described. The program calculates the time responses of a linear system by convoluting the impulsive response functions with the time dependent excitation. The convolution is performed as a multiplication in the frequency domain. Fast Fourier transform techniques are used to transform the product back into the time domain to obtain response time histories. The design and structure of the program is presented. ΑWΗ

N79-31155\*# Boeing Commercial Airplane Co., Seattle, Wash. A PROGRAM FOR CALCULATING LOAD COEFFICIENT MATRICES UTILIZING THE FORCE SUMMATION METHOD. L218 (LOADS). VOLUME 2: SUPPLEMENTAL SYSTEM **DESIGN AND MAINTENANCE DOCUMENT** Topical Report, May 1975 - May 1977

L. R. Anderson and R. D. Miller Washington NASA Sep. 1979 94 p refs

(Contract NAS1-13918) NTIS D6-44463-Vol-2) Avail: (NASA-CR-2854:

HC A05/MF A01 CSCL 01A The LOADS computer program L218 which calculates

dynamic load coefficient matrices utilizing the force summation method is described. The load equations are derived for a flight vehicle in straight and level flight and excited by gusts and/or control motions. In addition, sensor equations are calculated for use with an active control system. The load coefficient matrices are calculated for the following types of loads: (1) translational and rotational accelerations, velocities, and displacements; (2) panel aerodynamic forces: (3) net panel forces: and (4) shears. bending moments, and torsions. IMC

N79-31156# ARO, Inc., Arnold Air Force Station, Tenn. A FORCE AND MOMENT TEST OF A 1/24-SCALE F-111 MODEL AT MACH NUMBERS FROM 0.7 TO 1.3 Final Report

C. G. Burchfield AEDC 2 Mar. 1979 17 p refs (AD-A070192; AEDC-TSR-79-P14) HC A02/MF A01 CSCL 01/3 NITIS ∆vail<sup>.</sup>

A test program was conducted in the Propulsion Wind Tunnel 16 T to determine forces and moments on a 1/24-scale F-111 model. Data were obtained at Mach numbers from 0.7 to 1.3 at total pressures of 1200 and 2000 psfa. Model angle of attack was varied from 2 to 20 deg at 0 deg sideslip. Sideslip angles were varied from -10 to 10 deg at 10 and 15 deg angles GRA attack

N79-31157# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.

FLUTTER ANALYSIS OF TWO-DIMENSIONAL AND TWO-DEGREE-OF-FREEDOM AIRFOILS IN SMALL-DISTURBANCE, UNSTEADY TRANSONIC FLOW Final Report, Nov. 1977 - Oct. 1978

T. Y. Yang, Alfred G. Striz, and P. Guruswamy Dec. 1978 116 p refs

(Grant AF-AFOSR-3523-78; AF Proj. 2307)

(AD-A069223; AFFDL-TR-78-202) Avail. NTIS HC A06/MF A01 CSCL 20/4

Flutter analyses are performed for a NACA 64A006 and a NACA 64A010 airfoil by simultaneously using two transonic aerodynamic computational codes: (1) STRANS2 and UTRANS2 based on the relaxation method and (2) LTRAN2 based on the indicial and time-integration methods. Flutter results are obtained as plots of flutter speeds and the corresponding reduced frequencies versus one of the four parameters; airfoil-air mass ratio; position of the mass center; position of the elastic axis; and free stream Mach number. On each figure, several sets of curves for different values of plunge-to-pitch frequency ratios are shown simultaneously. The flutter results obtained by using relaxation and the indicial methods are, in general, in good agreement. The present flutter results for a special case of a thin parabolic airfoil at a low transonic Mach number of 0.7 compare favorably with that obtained by using linear flat plate theory. The trend of each flutter curve and the effect of each parameter are discussed in detail. GRA

N79-31159# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

EXPERIMENTAL DATA BASE FOR COMPUTER PROGRAM ASSESSMENT: REPORT OF THE FLUID DYNAMICS PANEL WORKING GROUP 04

May 1979	609 p	refs		
(AGARD-AR	3-138:	ISBN-92-835-1323-1)	Avail:	NTIS
HC A99/M	F A01			

The acquisition of highly reliable wind tunnel test data for aircraft design was investigated.

N79-31160# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).

INTRODUCTION AND OVERVIEW OF CONFIGURATIONS Juergen Barche In AGARD Expti. Data Base for Computer Program Assessment May 1979 5 p

Avail: NTIS HC A99/MF A01

An overview of the application of two- and threedimensional transonic flows to aircraft design is presented. The criteria for two-dimensional, three-dimensional, and body-alone EOS configurations are tabulated.

N79-31163\*# National Aeronautics and Space Administration, Washington, D. C.

SUPERSONIC TRANSPORT VIS-A-VIS ENERGY SAVINGS G. Cormery Sep. 1979 27 p Transl. into ENGLISH from Aeron, Astronaut (Paris), vol. 69, no. 2, 1978 p 3-14 Original language document was announced as A78-35893 Transl. by Kanner (Leo) Associates, Redwood City, Calif. (Contract NASw-3199)

(NASA-TM-75464) Avail: NTIS HC A03/MF A01 CSCL 01C

The energy and economic saving modifications in supersonic transportation are studied. Modifications in the propulsion systems and in the aerodynamic configurations of the Concorde aircraft to reduce noise generation and increase fuel efficiency are discussed. The conversion of supersonic aircraft from fuel oils to synthetic fuels is examined. A.W.H.

#### N79-31164\*# Boeing Vertol Co., Philadelphia, Pa. DEVELOPMENT OF CRASHWORTHY PASSENGER SEATS FOR GENERAL-AVIATION AIRCRAFT

M. J. Reilly and A. E. Tanner Aug. 1979 112 p refs (Contract NAS1-14637) (NASA-CR-159100; D210-11336-1) Avail: NTIS

HC A06/MF A01 CSCL 01C Two types of energy absorbing passenger seat concepts

suitable for installation in light twin-engine fixed wing aircraft were developed. An existing passenger seat for such an aircraft was used to obtain the envelope constraints. Ceiling suspended and floor supported seat concept designs were developed. A restraint system suitable for both concepts was designed. Energy absorbing hardware for both concepts was fabricated and tension and compression tests were conducted to demonstrate the stroking capability and the force deflection characteristics. Crash impact analysis was made and seat loads developed. The basic seat structures were analyzed to determine the adequacy of their strength under impact loading. R.E.S.

N79-31165# National Transportation Safety Board, Washington, D. C.

AIRCRAFT ACCIDENT REPORT: SWIFT AIRE LINES, INC., NORD 262, N418SA, MARINA DEL REY, CALIFORNIA, MARCH 10, 1979

16 Aug. 1979 32 p

(NTSB-AAR-79-13) Avail: NTIS HC A03/MF A01

On March 10, 1979, Flight 235, A-Nord 262, ditched in the Santa Monica Bay near Marina Del Rey, California, shortly after takeoff from Los Angeles International Airport. Flight 235 was a scheduled commuter airline passenger flight from Los Angeles, California, to Santa Maria, California, with four passengers and three crewmembers on board. The probable cause of the accident was determined to be the flightcrew's mismanagement of an emergency procedure following an autofeather of the right propeller which resulted in their shutting down the remaining engine. Contributing to the accident was the unavailability of vital restart information to the crew. A.W.H.

N79-31166\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

CONFERENCE ON FIRE RESISTANT MATERIALS: A COMPILATION OF PRESENTATIONS AND PAPERS

Demetrius A. Kourtides, ed. and Gerald A. Johnson, ed. (Boeing Com. Airplane Co., Seattle, Wash.) Jul. 1979 287 p Conf. held in Seattle, 1-2 Mar. 1979

(NASA-CP-2094; A-7894) Avail: NTIS HC A13/MF A01 CSCL 01C

The proceedings of the NASA IRE Resistant Materials Engineering (FIREMEN) Program held at Boeing Commercial Airplane Company, Seattle, Washington, on March 1-2, 1979 are reported. The conference was to discuss the results of research by the National Aeronautics and Space Administration in the field of aircraft fire safety and fire-resistant materials. The program topics include the following: (1) large-scale testing: (2) fire toxicology: (3) polymeric materials; and (4) fire modeling.

N79-31167\*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex. AIRPORT FLAMMABILITY, FULL SCALE FIRE TESTS Richard W. Bricker In NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 1-12

Avail: NTIS HC A13/MF A01 CSCL 01C

The primary objectives of the fire tests are: (1) conduct full scale test with 737 fuselages by the end of 1980; (2) demonstrate evacuation time increase to five minutes minimum; (3) show that exterior fire will not penetrate an intact cabin for five minutes: (4) show that closed cabin will not have excess smoke or temperatures above 400 F; and (5) demonstrate that fire in cabin opening will not propagate throughout cabin. The test program has three phases. A test schedule and status of required materials are presented. G.Y.

#### N79-31168\*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex. SEAT TEST PROGRAM

Richard W. Bricker /n NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 13-26

#### Avail: NTIS HC A13/MF A01 CSCL 01C

The test program has the objectives to: (1) evaluate severity of newspaper ignition source with contemporary seats (determine weight loss, visual damage, and if ignition source is severe enough to show improvement with new material configurations); (2) compare damage with jet A-1 ignition source; and (3) determine if materials for seat tests pass FAR 25 and obtain LO1. Test configurations, data acquired, material test results, seat test results, and conclusions are presented. G.Y.

N79-31169\*# Southwest Foundation for Research and Education, San Antonio, Tex.

#### RECENT ADVANCES IN MATERIALS TOXICOLOGY

Dane M. Russo /n NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 27-43

#### Avail: NTIS HC A13/MF A01 CSCL 01C

An overview of the fire toxicology program, its principal objectives and approach, is outlined. The laboratory methods of assessing pyrolysis product toxicity for two experiments are presented. The two experiments are: a comparison of test end points; and an evaluation of operant techniques. A third experiment is outlined for a comparison of full-scale and laboratory toxicity tests, with the purpose of determining animal survivability in full-scale tests. Future research plans are also outlined. G.Y.

# N79-31170\*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

# STATUS OF CANDIDATE MATERIALS FOR FULL-SCALE TESTS IN THE 737 FUSELAGE

Daniel Supkis In NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 45-69

#### Avail: NTIS HC A13/MF A01 CSCL 01C

The test program has the objectives to: (1) increase passenger evacuation time to a minimum of five minutes from commercial aircraft in case of a fire; (2) prevent an external fire from entering closed cabins for five minutes by using fire barrier materials in the exterior wall; (3) demonstrate that a closed cabin will not reach 400 F: and (4) prove that a fire near a cabin opening will not propagate through the cabin for a minimum of five minutes. The materials status is outlined for seat cushions, upholstery and associated seat materials, wall and ceiling panels, floor panels, carpet and carpet underlay, windows, cargo bay liners, insulation bagging, and thermal acoustical insulation. G.Y.

#### N79-31171\*# Solar Turbines International, San Diego, Calif. DEVELOPMENT OF FIRE-RESISTANT, LOW SMOKE GENERATING, THERMALLY STABLE END ITEMS FOR COMMERCIAL AIRCRAFT AND SPACECRAFT USING A BASIC POLYIMIDE RESIN

John Gagliani In NASA. Ames Res. Ceriter Conf. on Fire Resistant Mater. Jul. 1979 p 71-92

#### Avail: NTIS HC A13/MF A01 CSCL 01C

Experimental data pertinent to flexible resilient foams, low density wall panels, high strength floor panels and thermal acoustical insulation are presented. An evaluation of the effect of the heterocyclic diamine component on the compression set of the foams was carried out. Processes and compositions for

fabricating wall panels were evaluated. Thermal acoustical polyimide materials were developed to replace conventional glass batting insulation. To reduce the thermal stresses and improve the burn through resistance, cross linked polyimide foams were developed but not evaluated. G.Y.

#### N79-31172\*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. GLOBAL ENCLOSURE FIRE MODELING WITH APPLICA-TIONS

Jay William Stuart In NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 93-101

#### Avail: NTIS HC A13/MF A01 CSCL 01C

A brief review of LERC (Limiting Energy Release Criteria) is presented. Application of LERC to JSC/Boeing ignition source full-scale tests and to JSC/Dacfir math-model validation tests is outlined. It is concluded that: (1) a complete LERC application to the JSC/Boeing tests verifies the fuel load criterion as the limiting constraint: (2) the variability of magnitude and form of the results of repeated tests with and without small variations in parameters emphasizes the significance of the local flow, species concentration, and heat transfer distribution; and (3) weight loss measurements of recent JSC tests show consistent results with prior methods, fuel load constrained. G.Y.

**N79-31173\***# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. **ENCLOSURE FIRE DYNAMICS MODEL** 

Josette Bellan In NASA, Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 103-116

Avail: NTIS HC A13/MF A01 CSCL 01C

A practical situation of an enclosure fire is presented and why the need for a fire dynamic model is addressed. The difficulties in establishing a model are discussed, along with a brief review of enclosure fire models available. The approximation of the practical situation and the model developed are presented. G.Y.

N79-31175\*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. FUSELAGE VENTILATION UNDER WIND CONDITIONS Jay William Stuart /n NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 127-134

#### Avail: NTIS HC A13/MF A01 CSCL 01C

To determine realistic fuselage ventilation rates for postcrash fires and full-scale fire tests, the effects on wind-about fuselage ventilation rate of various parameters were studied. The parameters investigated were fuselage size and shape, fuselage orientation and proximity to ground, fuselage-opening and location, and wind speed and direction. F.O.S.

 $\textbf{N79-31176}^{\#}$  National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

## FIRE RESISTANT AIRCRAFT SEAT PROGRAM

Larry A. Fewell In its Conf. on Fire Resistant Mater. Jul. 1979 p 135-166

Avail: NTIS HC A13/MF A01 CSCL 01C

Foams, textiles, and thermoformable plastics were tested to determine which materials were fire retardant, and safe for aircraft passenger seats. Seat components investigated were the decorative fabric cover, slip covers, fire blocking layer, cushion reinforcement, and the cushioning layer. F.O.S.

#### N79-31177\*# Boeing Commercial Airplane Co., Seattle, Wash. A REVIEW OF BOEING INTERIOR MATERIALS AND FIRE TEST METHODS DEVELOPMENT PROGRAMS

Eugene Bara In NASA Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 167-181

Avail: NTIS HCA13/MFA01 CSCL01C

Total materials systems requirements, and government and industry programs are outlined along with a new fire test methodology, and the potential decrease in post crash fire hazards. The flammability, smoke and toxicity goals, and the scope of materials systems are tabulated. F.O.S. N79-31178\*# Boeing Commercial Airplane Co., Seattle, Wash. FIREMEN PROGRAM Status Report

Roy A. Anderson and Gerald A. Johnson *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 183-222

Avail: NTIS HC A13/MF A01 CSCL 01C

An overview of the program to improve fire retardant interior panels is presented. The sandwich panel makeup for different components, and the burn test results are presented. F.O.S.

#### N79-31183\*# Isovolta Co., Wiener Neudorf (Austria). THE FLUORENONE POLYESTER ISO FPE OF ISOVOLTA COMPANY, AUSTRIA

H. Weber In NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 271-282

Avail: NTIS HC A13/MF A01 CSCL 01C

Methods for the synthesis of ISO-FPE are described, and the mechanical properties are given. The industrial production of powder and film is discussed. F.O.S.

**N79-31184**# Air Force Engineering and Services Center, Tyndall AFB, Fla.

AN EVALUATION OF THE BIRD AIRCRAFT STRIKE HAZARD AT HILL AFB, UTAH (AFLC)

Jeffrey J. Short, James S. Kent, Ardrah L. Buddin, III, and William H. Niemeier Jan. 1979 45 p refs

(AD-A070459; AFESC-TM-1-79) Avail: NTIS HC A03/MF A01 CSCL 01/2

Hill Air Base was surveyed from 30 September to 12 October 1978 and from 28 to 30 January 1979 by the Air Force Engineering and Services Center Bird/Aircraft Strike Hazard Bash Team. Insect populations, vegetation, bird activity and local geography were studied to assess the impact of birds on flying operations at the base. GRA

**N79-31185\***# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

#### UHF COPLANAR-SLOT ANTENNA FOR AIRCRAFT-TO-SATELLITE DATA COMMUNICATIONS

Royce W. Myhre 1979 21 p refs Presented at the Printed Circuit Antenna Technol. Workshop, Las Cruces, N. Mex., 17-19 Oct. 1979; sponsored by New Mexico State Univ. and the Army Res. Office Physical Sci. Lab.

(NASA-TM-79239; E-146) Avail: NTIS HC A02/MF A01 CSCL 17B

A lightweight low drag coplanar slot antenna was developed for use on commercial jet aircraft that will provide upper hemisphere coverage in the UHF band at frequencies of 402 and 468 MHz is described. The antenna is designed to transmit meteorological data from wide body jet aircraft to ground users via synchronous meteorological data relay satellites. The low profile antenna (23.5 cm wide by 38.1 cm long slot by 1.9 cm high) is a conformal antenna utilizing the coplanar approach with the advantages of broad frequency bandwidth and improved electrical integrity over wide range of temperature. The antenna is circular polarized, has anon axis gain of near  $\pm 2.5$  dB, and a HPBW greater than 90 deg. Areas discussed include antenna design, radiation characteristics, flight testing, and system performance.

N79-31186\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FLIGHT PERFORMANCE OF THE TCV B-737 AIRPLANE AT KENNEDY AIRPORT USING TRSB/MLS GUIDANCE William F. White and Leonard V. Clark Jul. 1979 29 p refs (NASA-TM-80148) Avail: NTIS HC A03/MF A01 CSCL 17G

The terminal configured vehicle (TCV) B 737 was flown in demonstration of the time reference scanning beam/microwave landing system (TRSB/MLS). The flight performance of the TCV airplane during the demonstration automatic approaches and landings while utilizing TRSB/MLS guidance is reported. The TRSB/MLS is shown to provide the terminal area guidance necessary for flying curved automatic approaches with short finals. A.W.H.

#### N79-31189# Naval Postgraduate School, Monterey, Calif. A DEVELOPMENTAL COMPUTER MODEL FOR INVESTIGA-TIONS OF AIR TRAFFIC MANAGEMENT PROBLEMS: A CASE INVESTIGATING TWO DECISION STRATEGIES M.S. Thesis

John Thomas Malokas, Jr. and Arvid Paul Pederson Mar. 1979 133 p refs

(AD-A071075) Avail: NTIS HC A07/MF A01 CSCL 17/7 A computer simulation model designed to help solve regional air traffic scheduling problems was developed. Bases, mission areas, and aircraft were modeled using the simulation language SIMSCRIPT. Events in the simulation included takeoffs, departures, enroutes, missions, arrivals at Initial Approach Fixes (IAFs) and landings. To demonstrate potential use of the model, the problem of rescheduling Strategic Air Command (SAC) aircraft upon base closures was addressed. Two strategies for the diversion of such aircraft were developed, implemented and the results compared on the basis of impact on final destination bases and average aircraft airborne time. Strategy 1 entailed the rerouting of aircraft to designated alternate bases or to the nearest open base without constraint. Strategy 2 involved the selection of an alternate base by insuring that parking spaces and appropriate maintenance support were available. Finally, extensions to the model and recommendations are discussed. GRA

#### N79-31192\*# Lockheed-California Co., Burbank.

TESTING AND ANALYSIS OF DUAL-MODE ADAPTIVE LANDING GEAR, TAXI MODE TEST SYSTEM FOR YF-12A Max A. Gamon Sep. 1979 54 p refs Sponsored by NASA (NASA-CR-144884; LR-28776) Avail: NTIS HC A04/MF A01 CSCL 01C

The effectiveness of a dual mode adaptive landing gear system in reducing the dynamic response of an airplane during ground taxing was studied. The dynamic taxi tests of the YF-12A research airplane are presented. A digital computer program which simulated the test conditions is discussed. The dual mode system as tested provides dynamic taxi response reductions of 25 percent at the cg and 30 to 45 percent at the cockpit. A.W.H.

N79-31193\*# Rockwell International Corp., Los Angeles, Calif. Aircraft Div.

RIDE QUALITIES CRITERIA VALIDATION/PILOT PER-FORMANCE STUDY: FLIGHT TEST RESULTS Final Report

Louis U. Nardi, Harry Y. Kawana, and David C. Greek Sep. 1979 69 p refs

(Contract NAS4-2542)

(NASA-CR-144885; NA-78-897) Avail: NTIS HC A04/MF A01 CSCL 01C

Pilot performance during a terrain following flight was studied for ride quality criteria validation. Data from manual and automatic terrain following operations conducted during low level penetrations were analyzed to determine the effect of ride qualities on crew performance. The conditions analyzed included varying levels of turbulence, terrain roughness, and mission duration with a ride smoothing system on and off. Limited validation of the B-1 ride quality criteria and some of the first order interactions between ride qualities and pilot/vehicle performance are highlighted. An earlier B-1 flight simulation program correlated well with the flight test results. A.W.H.

#### N79-31194# Aeronautical Research Labs., Melbourne (Australia). LOAD SPECTRUM MEASURING EQUIPMENT. PART 1: DETAILS OF MK 1 SYSTEM PRESENTLY USED TO ACQUIRE DATA IN WESSEX MK 31B HELICOPTERS

K. F. Fraser and U. R. Krieser Aug. 1978 54 p refs

(ARL-MECH-ENG-NOTE-371; AR-001-301) Avail: NTIS HC A04/MF A01

Measuring equipment was developed which uses a set of electromechanical counters to indicate the integrated time in seconds for which torque loading on a transmission component falls within each of a number of bands. Separation of the torque level into bands is made possible using a single transducer, an amplifier with zero and gain adjustments for setting the extremes of the torque range of interest, an analogue to digital converter and decoder to separate the torque range into bands and counters to totalize contributions in each band. Author N79-31195<sup>\*</sup># Lockheed-Georgia Co., Marietta. CORRELATION OF DATA RELATED TO SHOCK-INDUCED TRAILING-EDGE SEPARATION AND EXTRAPOLATION TO FLIGHT REYNOLDS NUMBER

J. F. Cahill and P. C. Connor Washington NASA Sep. 1979 82 p refs

(Contract NAS2-9331)

(NASA-CR-3178) Avail: NTIS HC A05/MF A01 CSCL 01C Pressure data from a number of previous wind tunnel and flight investigations of high speed transport type wings were analyzed with the intent of developing a procedure for extrapolating low Reynolds number data to flight conditions. These analyses produced a correlation of the development of trailing-edge separation resulting from increases in Mach number and/or angle of attack and show that scale effects on this correlated separation development and the resulting shock location changes fall into a regular and apparently universal pattern. Further studies appear warranted to refine the correlation through a detailed consideration of boundary layer characteristics, and to evaluate scale effects on supercritical wings.

#### N79-31197# Douglas Aircraft Co., Inc., Long Beach, Calif. EFFECT OF TRANSPORT/BOMBER LOADS SPECTRUM ON CRACK GROWTH Final Technical Report, Sep. 1976 - Sep. 1978

P. R. Abelkis Nov. 1978 217 p refs (Contract F33615-76-C-3116) (AD-A069287; AFFDL-TR-78-134) Avail: NTIS HC A10/MF A01 CSCL 01/3

This program investigated analytically and experimentally the effect of transport/bomber loads spectrum variations on crack growth. The spectrum represented a STOL transport (C-15) wing lower surface loading. The 116 spectrum variations were generated, grouped in the following categories: (1) baseline spectra, (2) mission mix, (3) sequence of missions, (4) individual flight length, (5) flight segments, (6) exceedances spectra, (7) design stress level, (8) valley/peak coupling, (9) low load truncation, (10) high infrequent loads, (11) clipping of large loads, (12) miscellaneous variations, and (13) combined variations. Spectra were generated as random cycle-by-cycle, flight-by-flight sequences. Analyses and tests were performed on 7475-T7651 aluminum, to .25 inches, starting with an initial through-thethickness 0.03-inch crack out of a 1/4-inch diameter hole. Crack growth analysis predictions were made for all 116 spectra using the linear model. Crack growth tests were performed with 33 of these spectra. Good correlation was obtained between analysis and test results in all cases except with spectra dealing with increased frequency and magnitude of high infrequent loads and spectra which were drastically changed from a wing-type to a vertical tail-type spectrum. Largest effects on crack growth life, as measured in flight hours, was due to flight length, mission, mission mix, and design stress level variations. Based on the results of this program, fleetwide crack growth variations by a factor of 100 and 10 could be experienced, depending on whether it was short-term or long-term variation. GRA

#### N79-31198# Douglas Aircraft Co., Inc., Long Beach, Calif. A USER'S MANUAL FOR A COMPUTER PROGRAM TO GENERATE FATIGUE SPECTRUM LOADING SEQUENCES Final Technical Report, Sep. 1976 - Sep. 1978

P. R. Abelkis, P. M. Lee, and B. P. Tate Nov. 1978 246 p refs

(Contract F33615-	76-C-3116)		
(AD-A069288;	AFFDL-TR-78-136)	Avail:	NTIS
HC A11/MF A01	CSCL 01/3		

The report contains, in the form of a user's manual, the listing and complete description of a computer program to generate fatigue spectrum loading sequences. The program is specifically tailored for the development of random cycle-by-cycle, flight-by-flight loading sequences typical of aircraft structures. However, its general features allow the development of any type spectrum. The random sequence of cycles and flights is produced by a random number generator. Alternate non-random flight sequences can also be generated. The basic input data consists of loads exceedances spectra or data to calculate such spectra by the program. The program contains the following spectrum editing

features: (1) truncation - elimination of cycles as a function of range and R, peak or valley, (2) clipping - loads below or above a specified clipping value are set equal to that value, (3) all loads in the spectrum are multiplied by a constant. The output is a valley, peak sequence of the loads spectrum. The spectrum may be read into a magnetic tape to be used in other analyses GRA or in testing.

N79-31199# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

#### INVESTIGATION OF ROLL PERFORMANCE FOR A HIGHLY NONLINEAR STATICALLY UNSTABLE FIGHTER TYPE AIRCRAFT M.S. Thesis

Paul L. Vergez Mar. 1979 101 p refs

(AD-A069301: AFIT/GGO/EE/79-4) HC A06/MF A01 CSCL 01/3 NTIS Avail:

A linearized model of a fighter-type aircraft with significant roll-pitch inertial coupling, including its full flight control system is required in order to conduct a comparative analysis between body axis rolls and velocity (stability) axis rolls. The stability of the aircraft is checked at various roll rates for both body axis and velocity axis rolls. This is done by examining the signs of the eigenvalues of the linearized model-positive for unstable and negative for stable. It is found that at various angles of attack the velocity axis rolls prove to be at least as stable and, in most cases, more stable than body axis rolls. The stability is also observable for various combinations of flight control systems. In developing a nonlinear coupled equation solver, a single equation with known solutions is considered first. This is done to show a simplified version of what the nonlinear program is required to do. Next, a pair of nonlinear coupled equations is analyzed. The development of the program for the single equation case proves to be successful, but certain problems arise when working with a pair of coupled equations. This thesis provides a good foothold on a method of analysis known as Bifurcation Analysis and Catastrophe Theory which can be used to solve the nonlinear coupled aircraft equations. This thesis presents some of the problems which could be encountered. GRA

#### N79-31200# Dayton Univ. Research Inst., Ohio. FUEL TANK SURVIVABILITY FOR HYDRODYNAMIC RAM INDUCED BY HIGH VELOCITY FRAGMENTS. PART 2: NUMERICAL ANALYSES Final Report, Oct. 1977 - Oct. 1978

Sheldon H. Schuster and Jack S. Macales Wright-Patterson AFB, Ohio AFFDL Feb. 1979 104 p Prepared by California Research and Technology, Inc., Woodland Hills

(Contract F33615-77-C-2082; AF Proj. 2402)

(AD-A070128; AFFDL-TR-78-182-Pt-2) Avail: NTIS HC A06/MF A01 CSCL 01/3

Numerical finite difference CRALE and finite element NONSAP calculations of the behavior of fuel tank front panels, penetrated by steel fragments impacting at velocities of 1.0-2.0 km/sec were used to explain the phenomena observed in an accompanying experimental program Part I of this report. Analytic expressions for the variation of peak pressure and impulse along the panel as functions of fragment size, velocity, and panel areal density were derived from the finite difference runs and used as boundary conditions in the finite element calculations of panel failure and GRA displacements.

#### N79-31201# Douglas Aircraft Co., Inc., Long Beach, Calif. WINDSHIELD TECHNOLOGY DEMONSTRATOR PRO-GRAM-CANOPY DETAIL DESIGN OPTIONS STUDY Final Report, Feb. 1977 - Sep. 1978

M. J. Coker, J. B. Hoffman, and J. J. Lawrence, Jr. Wright-Patterson AFB, Ohio AFFDL Sep. 1978 352 p refs

(Contract F33615-75-C-3105; AF Proj. 2202)

(AD-A070376; MDC-J7176; AFFDL-TR-78-114) Avail: NTIS HC A16/MF A01 CSCL 01/3

This report documents the work accomplished for the Windshield Technology Demonstrator Program. The studies, analyses, testing, and development accomplished during this program involved a total system approach required for aircraft canopies in the context of the continuing Air Force generic wind shield development programs. State-of-the-art applications of new

transparency materials have been devised from both military and commercial aircraft with major attention directed to the topics of bird impact resistance, structural design integration, systems integration, and design for maintainability and reliability. The authors and Air Force Flight Dynamics Laboratory FEW agree that the various disciplines and essential technical design concepts represented, including associated reports noted in Section IV, should all be utilized in arriving at an optimum design of the GRA canopy system for any production aircraft.

N79-31202# Dayton Univ., Ohio. Research Inst.

FUEL TANK SURVIVABILITY FOR HYDRODYNAMIC RAM INDUCED BY HIGH VELOCITY FRAGMENTS. PART 1: EXPERIMENTAL RESULTS AND DESIGN SUMMARY Final Report, Sep. 1977 - Oct. 1978

S. J. Bless Wright-Patterson AFB, Ohio AFFDL Jan. 1979 127 p refs

(Contract F33615-77-C-2082; AF Proj. 2402)

(AD-A070113; UDR-TR-78-115-Pt-1; AFFDL-TR-78-182-Pt-1) Avail: NTIS HC A07/MF A01 CSCL 01/3

Failure data, displacement data, and pressure data were obtained from laboratory experiments. Panels were made from 7075- T6 and 2024- T3 aluminum and from graphite epoxy panel thicknesses were 1.6 to 6.35 mm. Protection included .10 mm ballistic foam and stiffeners. Projectiles were 5.6 g and 11.7 g spheres and cubes. Failures were always catastrophic, and failure thresholds were always abrupt. When cracks formed, they ran across the panels, except when stiffeners were present. In thin panels, cracks initiated at the corners of the perforation when cubical fragments were used. The entrance panel damage was primarily induced by the shock wave generated by the impact. The very high shock pressure resulted in impulsive loading of the panels that caused prompt crack formation. Cracks were propagated by the displacement field. GRA

N79-31203# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

EVALUATION OF F-111 WEAPON BAY AERO-ACOUSTIC AND WEAPON SEPARATION IMPROVEMENT TECH-NIQUES Final Technical Report, 1 May 1976 - 1 Aug. 1978

Rodney L. Clark Feb. 1979 150 p refs (AF Proj. 2404)

(AD-A070253; AFFDL-TR-79-3003) NTIS Avail<sup>.</sup> HC A07/MF A01 CSCL 01/3

Several aero-acoustic suppression devices have been evaluated which were considered feasible for installation on an F-111 aircraft for flight test evaluation. The most promising modification consists of a saw tooth spoiler mounted at the leading edge of the weapon bay. This device would be erected to a 90 degree position during the bay doors opening sequence. The spoiler is folded flush with the fuselage during all other flight conditions. Wind tunnel tests have shown that this spoiler improves the aero-acoustic environment within the open weapon bay and improves the weapon separation characteristics over the Mach range of .95 to 1.3 investigated during the drop test GRA phase.

#### N79-31204# Argonne National Lab., III. ANALYSIS OF PLUME RISE FROM JET AIRCRAFT

R. J. Yamartino, J. Lee, S. Bremer, D. Smith, and J. Calman 1979 7 p refs Presented at the 4th Symp. on Turbulence, Diffusion and Air Pollution, Boston, 15-18 Jan. 1979 Sponsored in part by FAA and Air Force Prepared in cooperation with Environmental Research and Technology, Lexington, Mass. (Contract W-31-109-eng-38)

(CONF-790142-1) Avail: NTIS HC A02/MF A01

Preliminary results of an investigation of the behavior of buoyant jet engine exhaust plumes in a crosswind are discussed and attempts are made to identify the degree to which the plume rise can be described by relationships developed for other types of sources. At least four factors were found to affect the rate of dilution of jet exhaust before it reached receptors adjacent to taxiways or runways: (1) turbulent mixing of the jet exhaust at the engine exit; (2) buoyant plume rise; (3) advective dilution; and (4) dispersion by ambient turbulence. DOF

#### N79-31205# Arinc Research Corp., Annapolis, Md. RELIABILITY IMPROVEMENT WARRANTY TERMS AND CONDITIONS FOR THE INTEGRATED AVIONICS CONTROL SYSTEMS (IACS) Final Report, Jan. - Mar. 1979 Larry Cox May 1979 44 p

(Contract DAAB07-78-A-6606)

(AD-A069454; Rept-1573-01-1-1927) Avail: NTIS HC A03/MF A01 CSCL 01/3

The Advanced Systems Division of the U.S. Army Avionics Research and Development Activity at Fort Monmouth. New Jersey, has issued Engineering Development (ED) contracts to two contractors for the Integrated Avionics Control System (IACS). One of the features of the ED progam will be a complete logistics support analysis (LSA) of Reliability Improvement Warranty (RIW) as an alternative to Army organic support. ARINC Research Corportion assisted the IACS Project Office in the development of draft RIW terms and conditions on which the LSA will be based. This report presents the activities that were performed and describes the draft RIW and conditions that were developed. GRA

N79-31206\*# National Aeronautics and Space Administration, Washington, D. C.

#### INVESTIGATION OF AIR STREAM FROM COMBUSTOR-LINER AIR ENTRY HOLES, 3

Tetsuro Aiba and Tokuji Nakano Aug. 1979 37 p refs Transl. into ENGLISH of "Ko fuka nenshoki no kukiko kara no nagare ni tsuite, 3" Natl. Aerospace Lab., Tokyo, NAL-TR-369, 1974 23 p Original language document was announced as N75-17358 Transl. by Scientific Translations Service, Santa Barbara, Calif. (Contract NASw-3198)

(NASA-TM-75430; NAL-TR-369) Avail: NTIS HC A03/MF A01 CSCL 21E

Jets flowing from air entry holes of the combustor liner of a gas turbine were investigated. Cold air was supplied through the air entry holes into the primary hot gas flows. The mass flow of the primary hot gas and issuing jets was measured, and the behavior of the air jets was studied by the measurement of the temperature distribution of the gas mixture. The air jets flowing from three circular air entry holes, single streamwise long holes, and two opposing circular holes, parallel to the primary flow were studied along with the effects of jet and gas stream velocities, and of gas temperature. The discharge coefficient, the maximum penetration of the jets, the jet flow path, the mixing of the jets, and temperature distribution across the jets were investigated. Empirical expressions which describe the characteristics of the jets under the conditions of the experiments were formulated AWH

#### N79-31207<sup>\*</sup># General Electric Co., Cincinnati, Ohio. EXPERIMENTAL CLEAN COMBUSTOR PROGRAM (ECCP), PHASE 3 Final Report

C. C. Gleason and D. W. Bahr 1 Jun. 1979 201 p refs (Contract NAS3-19736)

(NASA-CR-135384: R79AEG410) Avail: NTIS HC A10/MF A01 CSCL 21E

A double annular advanced technology combustor with low pollutant emission levels was evaluated in a series of CF6-50 engine tests. Engine lightoff was readily obtained and no difficulties were encountered with combustor staging. Engine acceleration and deceleration were smooth, responsive and essentially the same as those obtainable with the CF6-50 combustor. The emission reductions obtained in carbon monoxide, hydrocarbons, and nitrogen oxide levels were 55. 95, and 30 percent, respectively, at an idle power setting of 3.3 percent of takeoff power on an EPA parameter basis. Acceptable smoke levels were also obtained. The exit temperature distribution of the combustor was found to be its major performance deficiency. In all other important combustion system performance aspects, the combustor was found to be generally satisfactory. K.L.

N79-31208\*# Pratt and Whitney Aircraft, East Hartford, Conn. Commercial Products Div.

JT9D-70/59 IMPROVED HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL SYSTEM W. O. Gaffin<sup>®</sup> 8 Jun. 1979 66 p ref (Contract NAS8-20630) (NASA-CR-159661; PWA-5515-87C) Avail: NTIS HC A04/MF A01 CSCL 21E

The JT9D-70/59 high pressure turbine active clearance control system was modified to provide reduction of blade tip clearance when the system is activated during cruise operation. The modification increased the flow capacity and air impingement effectiveness of the cooling air manifold to augment turbine case shrinkage capability, and increased responsiveness of the airseal clearance to case shrinkage. The simulated altitude engine testing indicated a significant improvement in specific fuel consumption with the modified system. A 1000 cycle engine endurance test showed no unusual wear or performance deterioration effects on the engine or the clearance control system. Rig tests indicated that the air impingement and seal support configurations used in the engine tests are near optimum. K.L.

N79-31209# National Aviation Facilities Experimental Center, Atlantic City, N. J.

EXHAUST EMISSION TRAVERSE INVESTIGATION OF A JT3D-1 TURBOFAN ENGINE Final Report, Jan. 1975 - Aug. 1978

Gerald R. Slusher Jun. 1979 55 p refs

(FAA Proj. 201-521-100)

(AD-A072019; FAA-RD-79-23; FAA-NA-79-10) Avail: NTIS HC A04/MF A01 CSCL 21/5

The emissions in the exhaust plume of a JT3D-1 turbofan engine were investigated to optimize the shape, size, and location of fixed probes for acquiring representative emission samples. Traverse measurements of 153 points over the exhaust nozzle were accomplished with the sample points located in the corners of two inch squares forming a traverse grid. The average emission levels, contours, and profile distributions were determined. The predicted performances of area weighted cruciform and diamond probe designs were calculated from interpolations of the traverse contours. A.W.H.

N79-31210\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

# AN OVERVIEW OF NASA RESEARCH ON POSITIVE DISPLACEMENT TYPE GENERAL AVIATION ENGINES

E. E. Kempke and E. A. Willis 1979 40 p refs Presented at the Aircraft Systems and Technol. Meeting N. Y., 20-22 Aug. 1979; sponsored by AIAA

(NASA-TM-79254: E-165: AIAA-79-1824) Avail: NTIS HC A03/MF A01 CSCL 21E

The general aviation positive displacement engine program encompassing conventional, lightweight diesel, and rotary combustion engines is described. Lean operation of current production type spark ignition engines and advanced alternative engine concepts are emphasized. J.M.S.

N79-31211 # National Aviation Facilities Experimental Center, Atlantic City, N. J.

EXHAUST EMISSIONS CHARACTERISTICS FOR A GENERAL AVIATION LIGHT AIRCRAFT TELEDYNE CONTINENTAL MOTORS TSIO-360-C PISTON ENGINE Final Report

Eric E. Becker May 1979 78 p refs

(FAA Proj. 201-521-100)

(AD-A070010; FAA-RD-79-14; FAA-NA-79-3) Avail: NTIS HC A05/MF A01 CSCL 21/2

The TSIO-360-C engine (S/N 300244) was tested to develop an exhaust emissions data base. This data base consists of currents of current production baseline emissions characteristics, lean-out emissions data, effects of leaning-out the fuel schedule on cylinder head temperatures, and data showing ambient effects on exhaust emissions and cylinder head temperatures. The engine operating with its current full-rich production fuel schedule could not meet the proposed Environmental Protection Agency (EPA) standard for carbon monoxide (CO) and unburned hydrocarbons (HC) under sea level standard-day conditions. The engine did, however, meet the proposed EPA standard for oxides of nitrogen (NOX) under the same sea level conditions. The results of engine testing under different ambient conditions (essentially sea level standard day to sea level hot day) are also presented, and these results show a trend toward higher levels of emissions output for CO and HC while producing slightly lower levels of NOX. J.M.S.

N79-31212\*# United Technologies Corp., East Hartford, Conn. AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES Final Report

Richard S. Larson, Douglas P. Nelson, and Bradley S. Stevens Washington NASA Aug. 1979 223 p refs (Contract NAS3-20061)

INASA-CR-3168; PWA-5550-8) Avail: NTIS HC A10/MF A01 CSCL 21E

Five co-annular nozzle models, covering a systematic variation of nozzle geometry, were tested statically over a range of exhaust conditions including inverted velocity profile (IVP) (fan to primary stream velocity ratio > 1) and non IVP profiles. Fan nozzle pressure ratio (FNPR) was varied from 1.3 to 4.1 at primary nozzle pressure ratios (PNPR) of 1.53 and 2.0. Fan stream temperatures of 700 K (1260 deg R) and 1089 K(1960 deg R) were tested with primary stream temperatures of 700 K (1260 deg R), 811 K (1460 deg R), and 1089 K (1960 deg R). At fan and primary stream velocities of 610 and 427 m/sec (2000 and 1400 ft/sec), respectively, increasing fan radius ratio from 0.69 to 0.83 reduced peak perceived noise level (PNL) 3 dB, and an increase in primary radius ratio from 0 to 0.81 (fan radius ratio constant at 0.83) reduced peak PNL an additional 1.0 dB. There were no noise reductions at a fan stream velocity of 853 m/sec (2800 ft/sec). Increasing fan radius ratio from 0.69 to 0.83 reduced nozzle thrust coefficient 1.2 to 1.5% at a PNPR of 1.53, and 1.7 to 2.0% at a PNPR of 2.0. The developed acoustic prediction procedure collapsed the existing data with standard deviation varying from + or - 8 dB to + or - 7 dB. The aerodynamic performance prediction procedure collapsed thrust coefficient measurements to within + or - .004 at a FNPR of 4.0 and a PNPR of 2.0. Author

**N79-31213\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

#### AERODYNAMIC PERFORMANCE OF 1.38-PRESSURE-RATIO, VARIABLE-PITCH FAN STAGE

Royce D. Moore and Walter M. Osborn Sep. 1979 71 p (NASA-TP-1502; E-9700) Avail: NTIS HC A04/MF A01 CSCL 21E

The performance of a variable pitch fan stage tested over a range of blade setting angles, speeds, and flows is presented. The fan was designed for a tip speed of 289.6 m/sec and a flow of 29.6 kg/sec. The measured performance agreed reasonably well with the design point. The stall margin was only 5 percent. Static thrust values along an operating line ranged from less than 15 to over 115 percent of that at design angle as the blade setting angle was varied from 25 degrees (closed) to -8 degrees (opened). The use of casing treatment increased the stall margin to 20.6 percent but decreased efficiency by 4 percentage points.

N79-31214\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

#### AERODYNAMIC PERFORMANCE OF AXIAL-FLOW FAN Stage operated at nine inlet guide vane angles

Royce D. Moore and Lonnie Reid Sep. 1979 43 p refs (NASA-TP-1510; E-9714) Avail: NTIS HC A03/MF A01 CSCL 21E

The overall performance of a fan stage with nine inlet guide vane angle settings is presented. These data were obtained over the stable flow range at speeds from 60 to 120 percent of design for vane setting angles from -25 to 42.5 degrees. At design speed and design inlet guide vane angle, the stage has a peak efficiency of 0.892 at a pressure ratio of 1.322 and a flow of 25.31 kg/s. The stall margin based on peak efficiency and stall was 20 percent. Based on an operating line passing through the peak efficiency point at the design setting angle, the useful operating range of the stage at design speed is limited

by stall at the positive setting angles and by choke at the negative angles. At design the calculated static thrust along the operating line varied from 68 to 114 percent of that obtained at design setting angle. Author

N79-31215\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CONCEPTUAL STUDY OF A TURBOJET/RAMJET INLET John P. Weidner Washington Sep. 1979 25 p refs

(NASA-TM-80141; L-13036) Avail: NTIS HC A02/MF A01 CSCL 21A

An inlet concept for separate turbojet and ramjet engines was defined and compared with an equivalent inlet for a wraparound turboramjet engine. The comparison was made for a typical high altitude hypersonic cruise vehicle where the turbojet inlet capture area was required to be half as large as the ramjet inlet capture area at cruise. The use of a shorter nacelle having substantially lower cooling requirements at cruise for the inlet concept for separate turbojet and ramjet engines is suggested. The separate engine concept better isolates the turbojet from the ramjet, requires no special close off mechanisms within the turbojet, and avoids the circumferential heat load imposed by a wraparound ramjet. A more variable geometry is required.

A.W.H.

N79-31216# North Carolina State Univ. at Raleigh. Engineering Design Center.

AN ACTUATOR DISK ANALYSIS OF AN ISOLATED ROTOR WITH DISTORTED INFLOW Progress Report, Jan. 1976 -Dec. 1978

John N. Perkins 31 Mar. 1979 31 p Prepared in cooperation with United Technologies Research Center, E. Hartford, Conn. (Contract F44620-76-C-0055)

(AD-A069884: NCSU/EDC-79-1) Avail: NTIS HC A03/MF A01 CSCL 21/5

An analytical study of the passage of distorted flow through an isolated, high hub-tip ratio axial compressor is reported. The analysis involves the coupling of the unsteady blade row aerodynamic response (with the flow immediately upstream of the blade row prescribed) with the unsteady duct flow both upstream and downstream of the blade row under the influence of the blade row loading. The numerical solution uses a starting procedure which does not require the inlet plane to be far enough upstream to be unaffected by the presence of the blade row. Hence any experimentally determined distortion at any arbitrary distance upstream of the blade row can be modelled. The results obtained indicate that the predicted pressure profile at the blade row exit is strongly dependent on the experimentally determined steady-state loss and exit ilow angle curves, but is almost independent of the magnitude of the first order lag coefficient used to represent the boundary layer time delay through the blade passages. GRA

#### N79-31217# RAND Corp., Santa Monica, Calif. AIRCRAFT TURBINE ENGINE MONITORING EXPERIENCE: IMPLICATIONS FOR THE F100 ENGINE DIAGNOSTIC SYSTEM PROGRAM Interim Report, 1977 - 1978

J. L. Birkler and J. R. Nelson Apr. 1979 45 p refs (Contract F49620-77-C-0023)

(AD-A069282:	RAND/R-2391-AF)	Avail:	NTIS
HC A03/MF A01	CSCL 20/5		

This briefing report examines the experience gained from several aircraft turbine engine monitoring systems used over the last decade and a half and the implications of that experience for a new monitoring system--the Engine Diagnostic System-under development for the F100 engine on the F-15 and F-16 tactical fighter aircraft. The examination reveals that two different approaches to engine monitoring have evolved in attempts to achieve the goal of improved engine operations, maintenance, and management while reducing support costs. The first concentrates on short-term operations and maintenance aspects and is usually accomplished by recording inflight data in a snapshot mode, i.e., a few seconds of data either at predefined performance windows or when certain engine operating limits are exceeded. The second approach focuses on long-term design-oriented benefits through improved knowledge of the engine operating environment. To achieve the design-oriented

benefits, data must be recorded continuously on at least a few aircraft at each operational location. GRA

N79-31218# Air Force Aero Propulsion Lab., Wright-Patterson AFR Ohio

AMBIENT CORRECTION FACTORS FOR AIRCRAFT GAS TURBINE IDLE EMISSIONS Technical Report, Jan. 1975 -Oct 1978

William S. Blazowski and Joel W. Marzeski Mar. 1979 67 p refs Presented at the ASME Gas Turbine Conf. New Orleans Mar 1976

(AF Proj. 3048)

(AD-A069240; AFAPL-TR-79-2019) Avail: NTIS HC A04/MF A01 CSCL 20/5

Recent investigations have indicated that aircraft engine exhaust emissions are sensitive to ambient conditions. This paper reports on combustor rig testing intended to evaluate variations due to ambient temperature and pressure with special emphasis on idle engine operating conditions. Empirically determined CO. C sub x. H sub y, and NO sub x correction factors--the ratio of the pollutant emission index value obtained during standard day operation to that resulting during actual ambient conditions--are presented. The effects of engine idle cycle pressure ratio, primary zone fuel-air ratio, and fuel type were investigated. Ambient temperature variations were seen to cause substantial emission changes: correction factors in excess of 2.0 were determined in some cases. Ambient pressure variations were found to be less substantial. A previously published NO sub x emission model and a simplified hydrocarbon combustion analysis are shown to be in general agreement with the empirical results. GRA

N79-31220\*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

ANALYSIS OF A LATERAL PILOT-INDUCED OSCILLATION EXPERIENCED ON THE FIRST FLIGHT OF THE YF-16 AIRCRAFT

John W. Smith Sep. 1979 53 p refs

HC A04/MF A01 (NASA-TM-72867) Avail: NTIS CSCL 01C

In order to compare and assess potential improvements, two control systems were modeled; the original first flight or prototype aircraft system, and a modification of the prototype system, which essentially reduced the overall gain for the takeoff and landing phase. In general, the overall system gain reduction of the modified flight control system was sufficient to avoid lateral pilot-induced oscillation tendencies. Lowering the system gain reduced the tendency to rate saturate, which resulted in correspondingly higher critical pilot gains for the same control input. Author

N79-31221\*# Honeywell Systems and Research Center, Minneapolis, Minn.

#### HELICOPTER HIGH GRAIN CONTROL Final Report

Thomas B. Cunningham and Edwin C. Nunn Jul. 1979 171 p refs

(Contract NAS1-14789)

(NASA-CR-159052: HONEYWELL-79SRC33) Avail: NTIS HC A08/MF A01 CSCL 01C

High gain control is explored through a design study of the CH-47B helicopter. The plans are designed to obtain the maximum bandwidth possible given the hardware constraints. Controls are designed with modal control theory to specific bandwidths and closed loop mode shapes. Comparisons are made to an earlier complementary filter approach. Bandwidth improvement by removal of limitations is explored in order to establish hardware and mechanization options. Improvements in the pitch axis control system and in the rate gyro sensor noise characteristics in all axes are discussed. The use of rotor state feedback is assessed. AWH

N79-31222\*# Systems Technology, Inc., Mountain View, Calif. A COMPILATION AND ANALYSIS OF HELICOPTER HANDLING QUALITIES DATA. VOLUME 2: DATA ANALYSIS

Robert K. Heffley Aug. 1979 176 p refs (Contract NAS2-9344) (NASA-CR-3145; TR-1087-2-Vol-2) NTIS Avail: HC A09/MF A01 CSCL 01C

A compilation and an analysis of helicopter handling qualities data are presented. Multiloop manual control methods are used to analyze the descriptive data, stability derivatives, and transfer functions for a six degrees of freedom, guasi static model. A compensatory loop structure is applied to coupled longitudinal, lateral and directional equations in such a way that key handling qualities features are examined directly. AWH

N79-31223\*# National Aeronautics and Space Administration Langlev Research Center, Hampton, Va.

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF **GROUND-INDUCED EFFECTS FOR A LOW-ASPECT-RATIO** HIGHLY SWEPT ARROW-WING CONFIGURATION

Paul L. Coe, Jr. and James L. Thomas Washington Sep. 1976 102 p refs

(NASA-TP-1508; L-13088) Avail: NTIS HC A06/MF A01 CSCL 01C

An investigation was conducted in a V/STOL tunnel to determine the influence of ground proximity on the aerodynamic characteristics of a low-aspect-ratio highly swept arrow-wing configuration. The experimental results showed that as the height above the ground decreases, the configuration experiences substantial increases in lift and reductions in induced drag Although a significant percentage of these ground-induced performance improvements are lost due to trim requirements. the net performance improvement remains quite favorable. The tests also showed that decreasing ground height results in a substantial increase in the horizontal-tail contribution to longitudinal stability. Comparison of the experimental results with results predicted by a planar vortex-lattice theoretical model shows that the theoretical model provides a good estimate of the around-induced effect on lift, drag, and longitudinal stability for the wing-body combination. However, the theoretical model does not adequately predict either the zero lift pitching moment or the horizontal-tail downwash characteristics. Author

N79-31224# Air Force Inst. of Tech., Wright-Patterson AFB. Ohio. School of Engineering.

THE DESIGN OF DIGITAL CONTROLLERS FOR THE C-141 AIRCRAFT USING ENTIRE EIGENSTRUCTURE ASSIGNMENT AND THE DEVELOPMENT OF AN INTERAC-TIVE COMPUTER DESIGN PROGRAM M.S. Thesis

Thomas A. Kennedy Mar. 1979 194 p refs (AD-A069192; AFIT/GGC/EE/79-1) Avail<sup>.</sup> NTIS HC A09/MF A01 CSCL 01/2

In this report, a deadbeat tracker and regulator are developed for the C-141 aircraft for three different flight conditions using the method of entire eigenstructure assignment. A heuristic iterative method is presented for determining an 'optimal' sampling time for deadbeat controllers by using the controllability matrix In order to perform the above designs and to evaluate them through a continuous-time simulation, a computer aided design program is developed. This program allows the complete design and simulation of regulator, tracker, and disturbance rejection control systems with full-order observers. In addition, the program permits complete state-space analysis of the system being designed, including both discrete and continuous-time responses. A user's manual and programmer's guide are provided for further development of the program. GRA

N79-31225# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

INVESTIGATION OF INVERSE VANDERMONDE MATRIX CALCULATION FOR LINEAR SYSTEM APPLICATIONS M.S. Thesis

Donald Paul Seyler Mar. 1979 178 p refs (AD-A069241) (AD-A069241: AFIT/GGC/EE/79-2) HC A09/MF A01 CSCL 12/1 Avail: NTIS

Efficient inversion of a 2n x 2n Vandermonde matrix is a key requirement of a new algorithm developed for parameter identification in linear time-invariant systems. It has features very desirable for application to large systems with many unknown parameters, such as adaptive flight control systems. A generalized algorithm for inverting the Vandermonde matrix was proposed. It was chosen for study because its structure parallels that of the first algorithm. The algorithm was coded into a computer subroutine called 'VANINV', and 43 eigensystems were used to

test its computational accuracy and efficiency. Four potential problem areas tested were: large system orders, eigenvalues near each other, eigenvalues near zero, and eigenvalues with large magnitude differences. For a comparison, the Vandermonde matrix for each system was also inverted using routines from the International Mathematical and Statistical Library (IMSL). Test results indicated that VANINV is not quite as fast or as accurate as the IMSL routines. However, the tests were limited to systems with real distinct eigenvalues because the IMSL routines cannot handle other types. VANINV in its present form can handle systems having any combination of complex and/or repeated eigenvalues. Therefore, recommendations for further research and several possible means of improving VANINV are outlined. CDA

N79-31226# Honeywell, Inc., St. Louis Park, Minn. Avionics Div

#### PROGRAM FOR THE CRITICAL COMPONENTS OF A FLY-BY-TUBE BACKUP FLIGHT CONTROL SYSTEM, PART 1 Final Report, 1 Jan. - 15 Dec. 1978 Walter M. Posingies 15 Jan. 1979 121 p

(Contract N62269-78-C-0003)

(AD-A070387; W0471-FR1-Pt-1: NADC-77197-60-Pt-1) Avail: NTIS HC A06/MF A01 CSCL 01/3

This report presents the results of a program to develop two of the critical components in an advanced fluidic backup primary flight control system defined as the fly-by-tube concept. Components developed include an input transducer, which converts pilot commands into hydraulic differential pressure signals, and fluidic resistor networks that sum these hydraulic signals together to provide the required servoactuator commands. Results show that this concept which uses signal levels up to 400 PSID is accurate, linear, quiet, simple, low cost, relatively insensitive to changes in fluid viscosity, and has a stable null with adequate response. GRA

#### N79-31227# Systems Control, Inc., Palo Alto, Calif. PATH CONTROLLERS: UNIFICATION OF CONCEPTS AND COMPARISON OF DESIGN METHODS Final Technical Report, Sep. 1977 - Sep. 1978

J. E. Jones and J. S. Karmarkar Dec. 1978 123 p refs (Contract F33615-77-C-3079; AF Proj. 2403) (AD-A070252; AFFDL-TR-78-178) Avail: NTIS

HC A06/MF A01 CSCL 01/3

This report documents the basic theme of a series of seminars presented to the Air Force Flight Dynamics Laboratory concerning the role of modern control theory in advanced aircraft guidance and control concepts. The report discusses a number of optimal guidance and control concepts as cast in a path-control formal structure. Trajectory generation concepts include horizontal guidance with and without controlled time of arrival, threat avoidance, performance optimization, and terrain following. Control concepts include linear optimal control and classical techniques. Research areas of high potential payoff are identified. GRA

N79-31228\* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

#### SEAT CUSHION TO PROVIDE REALISTIC ACCELERATION CUES TO AIRCRAFT SIMULATOR PILOT Patent

Billy R. Ashworth, inventor (to NASA) Issued 14 Aug. 1979 10 p Filed 26 Jul. 1978 Supersedes N78-30821 (16 - 21 p 2857) Continuation-in-part of abandoned US Patent Appl. SN-829314, filed 31 Aug. 1977 (NASA-Case-LAR-12149-2; US-Patent-4,164-079;

US-Patent-Appl-SN-829314; US-Patent-Appl-SN-928131;

US-Patent-Class-35-12E; US-Patent-Class-35-12H) Avail: US Patent and Trademark Office CSCL 14B

Seat cushions, each including an air cell with a noncompressible surface, are disclosed. The apparatus are provided for initially controlling the air pressure in the air cells to allow the two main support areas of the simulator pilot to touch the non-compressible surface and thus begin to compress the flesh near these areas. During a simulated flight the apparatus control the air pressure in the cells to simulate the events that occur in a seat cushion during actual flight. Author

N79-31229# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Baumfahrt Goettingen (West Germany)

#### CONTRIBUTIONS TO EXPERIMENTAL FLUID MECHANICS BEITRAGE ZUR EXPERIMENTELLEN STROMUNGSMEC-HANIK]

1977 216 p refs In GERMAN Avail: NTIS HC A10/MF A01

Various aspects of the reconstruction of aerodynamics testing facilities in West Germany following World War 2 are described in this festschrift honoring Dr. Hubert Ludwieg. His contributions in the development of the high-speed wind tunnel, the 1m x 1m wind tunnel, and the transonic turbine nozzle are stressed. Experiments in spiral flow stability and the application of heated surface elements (films) to measure shear stress on the wall in the three dimensional boundary layer are also discussed. A biography of the scientist a. I a list of his scientific publications is included ARH

N79-31230\*# National Aeronautics and Space Administration, Washington, D. C.

#### WIND TUNNELS WITH ADAPTED WALLS FOR REDUCING WALL INTERFERENCE

U. Ganzer Aug. 1979 14 p refs Transl. into ENGLISH of Z. fur Flugwissenchaften und Weltraumforschung (West Germany), v 3, no. 2, 1979 p 129-133 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Aero-Space Inst. of Berlin (West Germany)

(Contract NASw-3199)

(NASA-TM-75501) Avail: NTIS HC A02/MF A01 CSCL 14B

The basic principle of adaptable wind tunnel walls is explained. First results of an investigation carried out at the Aero-Space Institute of Berlin Technical University are presented for two dimensional flexible walls and a NACA 0012 airfoil. With five examples exhibiting very different flow conditions it is demonstrated that it is possible to reduce wall interference and to avoid blockage at transonic speeds by wall adaptation. Author

#### N79-31231# Federal Aviation Administration, Washington, D. C. POTENTIAL CLOSURE OF AIRPORTS

Jan. 1978 40 p Avail: NTIS HC A03/MF A01

Airports which are expected to be converted to nonaviation use are identified and measures are suggested to forstall this in cases where the airports involved could help meet transportation and community objectives. The problems cited for the closings are high property taxes, and the high cost of capital improvements and airfield maintenance. Measures examined to aid airports are tax exemptions, zoning and land use controls, and financial aid to assist airport development and maintenance. AWH.

N79-31232# Federal Aviation Administration, Washington, D. C. ADVISORY CIRCULAR. THE PLANNING GRANT PROGRAM FOR AIRPORTS

31 Jan. 1979 75 p

(AC150/5900-1B) Avail: NTIS HC A05/MF A01

The process for applying for grants to prepare airport system plans and airport master plans is described as well as the administrative procedures to be followed in performing planning projects. R.E.S.

N79-31233# Naval Air Engineering Center, Lakehurst, N.J. SURVEYS OF GROOVES IN 19 BITUMINOUS RUNWAYS **Final Report** 

Richard Melone Mar. 1979 60 p refs

(Contract FA74WAI-423; FAA Proj. 082-431-02)

(AD-A069889: FAA-RD-79-28: NAEC-TD-Misc-R8) Avail: NTIS HC A04/MF A01 CSCL 01/5

The extent and frequency of problems, such as chipping, cracking, rounding, wearing, distorting, and contaminating of the runway grooves were determined A total of ten different problem areas was identified during the survey with wear, running together (closing), and rubber deposits being the most serious of the ten. In general, the grooves were in satisfactory condition and did not result in abnormal deterioration of runway surfaces. Three of the 19 runways surveyed appeared in need of resurfacing and/or regrooving. Groove depths averaged less than the required 1/4 inch, while groove width and pitch measured close to specified dimensions MMM

#### N79-31234# Mitre Corp., McLean, Va. METREK Div. RUNWAY CONFIGURATION MANAGEMENT SYSTEM **CONCEPTS** Final Report

A. N. Sinha and R. L. Fain May 1979 20 p refs (Contract DOT-FA79WA-4184) (AD-A069960): MP-79W00018) Avail: NTIS HC A02/MF A01 CSCL 01/5

Airport congestion is a problem at the busy airports in the U. S. today. Even under moderate growth projections, the problem of increasing delays will worsen at these busy airports, and will spread to other airports which would approach saturation conditions. While long term relief to the congestion problem would be provided by technological improvements, it is essential to fully and efficiently utilize the existing facilities to avoid excessive delays in the near term. This paper addresses the problem of selecting optimal runway configurations to minimize delays through the use of a Runway Configuration Management System. Three concepts of this system are developed to represent the full range of static and dynamic configuration selection processes. The basic model, representing the first level concept, has been developed for Chicago O'Hare International Airport. The applicaton of the model at O'Hare and its possible extensions are also discussed. GRA

N79-31235# Decision Science, Inc., San Diego, Calif. TACTICAL PERFORMANCE CHARACTERIZATION BASIC METHODOLOGY Final Report, Dec. 1977 - Sep. 1978 Michael J. Walsh, George H. Burgin, and Lawrence J. Fogel May 1979 65 p refs

(Contract F33615-78-C-0011)

(AD-A069297; AFHRL-TR-78-94) NTIS Avail: HC A04/MF A01 CSCL 05/9

This effort is to develop new methods of characterizing important features of tactical performance for display at an instructor/operator station of a flight simulator. In particular, the work included developing a technique for computing the weight or importance that a pilot assigns to various performance criteria. The work documented here represents the first of a two-phase program. Phase 1 involved developing the basic techniques and methods without collecting extensive pilot data. Phase 2 involves applying the methods to real pilot data collected on the Simulator for Air-to-Air Combat. The approach was based upon a previously developed Adaptive Maneuvering Logic (AML) program. This program operates one-on-one against a real opponent to provide practice in combat flying. It operates by computing a 'score' for each of several alternative next-moves and then executing the move rated highest. The score consists of a sum of weights assigned to each of the various criteria that would be satisfied if the move in question were chosen. The weights are fixed in the AML program. Thus, the program uses a fixed set of weights to produce a simulated performance. GRA

N79-31236# General Electric Co., Daytona Beach, Fla. Ground Systems Dept.

LABORATORY DEVELOPMENT OF COMPUTER GENER-ATED IMAGE DISPLAYS FOR EVALUATION IN TERRAIN 
 FLIGHT TRAINING Final Report

 Roland F. Pester 21 Feb. 1979 22 p refs

 (Contract DAHC19-77-C-0006; DA Proj. 207-63743-A-772)

(AD-A070065; ARI-RN-79-8) Avail: NTIS HC A02/MF A01 CSCL 05/9

This report describes the formulation of a digital data base and the equipment utilized to display computer generated images of the resultant terrain scenes. Real time and nonreal time equipment equipment is described. Necessary input data for formulation of digital data bases is delineated. Resulting scene data is to be utilized as stimulus material for evaluation of CGI systems to determine their effectiveness as a medium for training navigators and pilots. Author (GRA)

N79-31237# National Bureau of Standards, Washington, D. C. Fluid Engineering Div.

A LOW-VELOCITY AIRFLOW CALIBRATION AND RE-SEARCH FACILITY Final Technical Note

L. P. Purtell and F. S. Klebanoff Mar. 1979 26 p refs (Contract DI-BM-HO-133024)

(PB-294501/2; NBS-TN-989) Avail: NTIS HC A03/MF A01 CSCL 14R

A low velocity airflow facility suitable for the calibration of wind speed measuring instruments and research in aerodynamics is described. The flow facility is of the open return type with a test section 20 feet long, and nominally 3 x 3 feet in cross section. Special attention was given to obtaining an air stream with a high degree of spatial uniformity and low turbulence with excellent speed control over the range from 10 to 3300 feet per minute. Laser-optical methods with appropriate signal processing electronics were employed to establish a primary standard for the measurement of very low velocities. Detailed performance characteristics of flow facility and the laser velocity standard are presented. GRA

#### N79-31354\*# Boeing Commercial Airplane Co., Seattle, Wash. DEVELOPMENT OF AIRCRAFT LAVATORY COMPART-MENTS WITH IMPROVED FIRE RESISTANCE CHARACTER-ISTICS. PHASE 2: SANDWICH PANEL RESIN SYSTEM **DEVELOPMENT** Final Report

R. A. Anderson, D. B. Arnold, and G. A. Johnson 1979 284 p refs

(Contract NAS2-8700)

(NASA-CR-152120; D6-46839) Avail: NTIS HC A13/MF A01 CSCL 11D

A NASA-funded program is described which aims to develop a resin system for use in the construction of lavatory wall panels, sidewall panels, and ceiling panels possessing flammability, smoke and gas emission, and toxicity (FS&T) characteristics superior to the existing epoxy resin. Candidate resins studied were phenolic, polyimide, and bismaleimide. Based on the results of a series of FS&T as well as mechanical and aesthetic property tests, a phenolic resin was chosen as the superior material. Material and process specifications covering the phenolic resin based materials were prepared and a method of rating sandwich panel performance was developed. A.B.H.

#### N79-31357# Naval Weapons Center, China Lake, Calif. THERMAL CHARACTERISTICS OF 3501-6/AS AND 5208/T300 GRAPHITE EPOXY COMPOSITES Research Report, Feb. - Sep. 1978

Robert F. Kubin May 1979 24 p (AD-A071067; NWC-TP-6104) Avail: NTIS HC A02/MF A01 CSCL 11/4

The thermal characteristics of two graphite epoxy composites for use as aircraft structural components have been investigated. The activation energies and heats of reaction for pyrolysis of the composites were found to be 19.7 kcal/mole and -18.4 cal/g for 3501-6/AS and 25.0 kcal/mole and -20.4 cal/g for 5208/T300, respectively. The kinetic parameters enable prediction of thermal degradation at flight temperatures. In fire fighting, bulk material temperatures must be reduced well below 300 C to prevent continuation of exothermic pyrolysis reactions. It was also found that differential scanning calorimetry provides a more sensitive test of composite cure than reflectance infrared measurements. GRA

N79-31461# Carleton Univ., Ottawa (Ontario). Dept. of Systems Engineering and Computing Science.

A NOVEL APPROACH TO THE DESIGN OF AN ALL DIGITAL AERONAUTICAL SATELLITE COMMUNICATION SYSTEM M. E. Ulug In AGARD Digital Commun. in Avionics Jun. 1979 16 p refs

Avail: NTIS HC A20/MF A01 CSCL 17B

The design of an all digital aeronautical satellite communication system based on the transparent intelligent network (TI-NET) is described. The novel features of the system, namely a 9.6 kb/s ground to aircraft link which provides a TDMA operation and the statistical multiplexing of the encoded voice and data were experimentally tried out using 12-14 GHz satellite link between Carleton University, in Ottawa, Canada and the NASA AMES Research Center in Palo Alto, California using Hermes (CTS) satellite. Other unique features of the system are the trading off of the satellite up-down delay with the packet formation delay, multi-polling and multiaddressing capability, and the complete transparency to the user's protocol. In addition, the system has a turn around time of 22.5 ms. which is most useful in making quick changes in the polling sequence, as well as producing fast re-transmissions. A polling algorithm which meets the particular needs of the aircraft in high, medium, and low density areas is described. The terrestrial network connecting the communication centers and ground stations in North America is also discussed and its associated interfaces and protocols are defined. It is believed that the proposed system will result in a more efficient use of the communication channels, greater immunity against noise, and a less complex airborn computer with smaller memory. Although the system design is based on a set of hypothetical traffic data, the model can be readily modified to perform at a higher or lower traffic level. In this connection another system using a 4.8 kb/s ground-aircraft link is described and its performance compared with that of the proposed model. J M S

## N79-31463# Eurocontrol Agency, Maastricht (Netherlands). A DIGITAL COMMUNICATION SYSTEM AS GATEWAY BETWEEN ADJACENT COMPUTERIZED AIR TRAFFIC CONTROL CENTRES

M. Baum In AGARD Digital Commun. in Avionics Jun. 1979 14 p refs

Avail: NTIS HC A20/MF A01

A practical approach to improve data communication between adjacent computerized air traffic control centers is described. The applied concept is communication procedure conversion by which systems with incompatible transmission procedures can communicate with each other via a gateway system. Procedure conversion meets the basic requirement which is not to intervene in the functioning of the involved local networks and not to require modifications of locally used procedure envelopes. The transit function is realized by conversion of the procedure specific message type and priority on one hand and of address information on the other hand. A flexible table mechanism is chosen instead of fixed coding. Outstanding problems are an efficient link failure processing and an envisaged attachment of a circuit switching function to the message switching principle. J.M.S.

N79-31468# Standard Elektrik Lorenz A.G., Stuttgart (West Germany)

#### AN ASYNCHRONOUS DATA TRANSMISSION SYSTEM WITH LOW ERROR PROBABILITY FOR THE SETAC LANDING AID

Wolfgang Beier In AGARD Digital Commun. in Avionics Jun. 1979 5 p

Avail: NTIS HC A20/MF A01

A serial code which is used in the TACAN compatible landing aid SETAC is described. Its features are optimized for the expected error rate and types of errors as well as for the data transmission rate and the accepted error rate after correction. R.E.S.

N79-31476# Royal Aircraft Establishment, Farnborough (England). Radio and Navigation Dept.

#### PERFORMANCE PREDICTIONS AND TRIALS OF A HELICOPTER UHF DATA LINK

R. M. Harris In AGARD Digital Commun. in Avionics Jun. 1979 17 p refs Avail: NTIS HC A20/MF A01

A combination of theoretical and experimental studies conducted in order to estimate the bit error rate performance of a digital communication system are reviewed. The system is proposed for the transmission of binary digital data over dedicated simplex UHF radio links between helicopters, and between helicopters and ships. Initial predictions of system performance

were based on known characteristics of some helicopter-installed systems and classical treatment of multipath radio wave propagation over a smooth sea. The probability of achieving a particular grade of service was considered as the arithmetical product of several independent statistical parameters. Some of these were related to the temporal and spatial variability of radio wave propagation; others reflected the almost random orientation of the aircraft under operational conditions affecting the signal received via the aircraft's radiation pattern. A method of statistical analysis based on approximate Gaussian frequency distribution functions was applied to the experimental data. Performance predictions are presented in terms of time availability for selected bit error rates. R.E.S.

N79-31478# Technische Universitaet, Brunswick (West Germany),

#### MULTIPATH PROPAGATION MEASUREMENT BY DOPPLER TECHNIQUE

P. Form, R. Springer, H. Bothe, and K. Klein In AGARD Digital Commun. in Avionics Jun. 1979 23 p refs Prepared in cooperation with DFVLR, Brunswick

#### Avail: NTIS HC A20/MF A01

Some microwave landing system features are discussed with respect to multipath propagation. For illustration of specific multipath effects, a Doppler-shift measurement technique with high angle resolution is presented, which needs simple antennas and equipment and offers easy interpretation. MMM

N79-31480# Technische Universitaet, Brunswick (West "Inst. fuer Nachrichtentechnik. Germany).

#### INVESTIGATION ON INFORMATION ERROR CAUSED BY TRAFFIC LOADING IN APPROACH AND LANDING SYSTEMS

Wolfgang Skupin *In* AGARD Digital Commun. in Avionics Jun. 1979 15 p

Avail: NTIS HC A20/MF A01

For the evaluation of a required approach and landing systems with statistical interrogation ALSSI serving capacity, a traffic model was developed. This model is based on the operational requirements and gives a defined standard traffic volume for a ALSSI. For investigating the reply efficiency and the accuracy of an ALSSI several methods can be employed. By means of probability calculations the reply efficiency can be determined with comparatively low expense. For the determination of the accuracy it is useful to carry out real world system tests with a test a/c. Because of less expense the traffic load is simulated with these tests by pulse generators. More flexibility can be achieved by employing a software simulation. For this a computer model of the traffic loading has to be installed as well as a computer model of the system to be investigated. Some results achieved by employing these methods are presented. M.M.M.

#### N79-31481# Rome Air Development Center, Griffiss AFB, N.Y. NEW DEVICES FOR DIGITAL COMMUNICATIONS IN AVIONICS

F. I. Diamond, H. J. Bush, and J. A. Graniero In AGARD Digital Commun. in Avionics Jun. 1979 9 p refs

Avail: NTIS HC A20/MF A01

Technological advances in microelectronics to improve capabilities and reduce complexity of digital communication systems in the aircraft industry are assessed. MMM

N79-31482# California Univ., San Diego, La Jolla.

#### TRANSFORM DOMAIN PROCESSING FOR DIGITAL COMMUNICATION SYSTEMS USING SURFACE ACOUSTIC WAVE DEVICES

L. B. Milstein, D. R. Arsenault, and P. Das In AGARD Digital Commun. in Avionics Jun. 1979 16 p refs Prepared in cooperation with Rensselaer Polytech. Inst.

Avail: NTIS HC A20/MF A01

A surface acoustic wave receiver is presented. This device is light and small enough to be used on board aircraft and can receive continuous time-digital signals accurately and securely. The detection of digital signals in the presence of Gaussian noise and interference using this device is studied. M.M.M.

N79-31487# Rensselaer Polytechnic Inst., Troy, N. Y. Electrical and Systems Engineering. STATE OF THE ART IN DIGITAL SIGNAL PROCESSING

WITH APPLICATIONS TO MULTIPLE ACCESS SYSTEMS Lester A. Gerhardt In AGARD Digital Commun. in Avionics Jun. 1979 9 p refs

#### Avail: NTIS HC A20/MF A01

Advanced developments and trends in the fields of digital signal processing and digital communications were reported. The effects of microprocessors and minicomputers in this development were addressed. The availability of new devices, device technology, and directions are summarized with respect to the emphasis on speed. A discussion of CDM, CDMA, SSMA, and TDMA was reported. The Joint Tactical Information Distribution System was described as a system concept. M.M.M.

### N79-31491# Mitre Corp., Bedford, Mass. IMPLEMENTING JTIDS IN TACTICAL AIRCRAFT

David R. McMillan In AGARD Digital Commun. in Avionics Jun. 1979 13 p

Avail: NTIS HC A20/MF A01

The implementation of a high capacity, secure, jam-resistant time division multiple access information system for providing integrated communications, navigation, and identification capabilities is discussed. Major characteristics of the joint tactical information distribution system (JTIDS) in tactical aircraft are summarized and relevant elements of the JTIDS program plan are highlighted. The context for specific requirements to be satisfied with aircraft installations are established in terms of operational functions, sources and sinks of information which support those functions, and current information distribution systems and man-machine interfaces which mechanize the transfer to and from tactical aircraft and their crews. The relative benefit of JTIDS over present solutions to operational information needs is established in this context. An overview of key elements of the tactical aircraft implementation challenge is included. A.R.H.

N79-31524# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).

CONTRIBUTIONS TO FLUID MECHANICS [BEITRAEGE ZUR STREMUNGSMECHANIK]

1978 184 p refs In GERMAN Avail: NTIS HC A09/MF A01

Ten articles are presented which cover a wide spectrum of research in the field of theoretical and experimental fluid mechanics. The titles of the articles are: (1) Development of Data Acquistition and Processing Systems for a 3 mm Wind Tunnel; (2) Airfoil Lift in Compressible Subsonic Flow with Separation; (3) Sound Generation in an Induction Motor Fan; (4) The Hypersonic Vacuum Tunnel; (5) Remarks on a Hydraulic Ram; (6) Experimental and Theoretical Pressure Distribution on the Ellipsoid of Revolution; (7) Theoretical Study of the Effect of the Pressure Fluctuation Component in Three Dimensional Turbulent Boundary Layers; (8) Variations of a Parallel Flow Along a Flat Plate Due to a Normally Directed Free Jet; (9) Effects of Solid Boundary Surface in a Flow about a Profile with Separation: and (10) Introduction to the Electronic Data Processing to Improve Cataloging in the Library of the Aerodynamic Testing Facilities in Goettingen. G.Y.

N79-31530# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

#### MECHANICS OF BOUNDARY LAYER TRANSITION, PART 2: INSTABILITY AND TRANSITION TO TURBU-LENCE

Mark V. Morkovin (Martin Co., Baltimore, Md.) Feb. 1968 176 p refs Lecture held at Rhode-Saint-Genese, Belgium 3 Vol.

(VKI-Lecture-Series-3-Pt-2) Avail: NTIS HC A09/MF A01

Instability and transition from laminar to turbulent shear layers is discussed. Topics include advances in understanding the transition and contradictions in transition research. Transition correlations for hypersonic wakes, three dimensional boundary

layers, laminar suction wings, heat transfer and boundary layer transition, and Reynolds number effects are covered.

N79-31533\*# Douglas Aircraft Co., Inc., Long Beach, Calif. A NEW APPROACH TO THE SOLUTION OF LARGE, FULL MATRIX EQUATIONS: A TWO-DIMENSIONAL POTENTIAL FLOW FEASIBILITY STUDY Final Report R. M. James and R. W. Clark Washington NASA Sep. 1979

83 p refs

(Contract NAS1-14892)

(NASA-CR-3173) Avail: NTIS HC A05/MF A01 CSCL 20D An approach to the solution of matrix problems resulting from integral equations of mathematical physics is presented. Based on the inherent smoothness in such equations, the problem is reformulated using a set of orthogonal basis vectors, leading to an equivalent coefficient problem which can be of lower order without significantly impairing the accuracy of the solution. This approach was evaluated using a two-dimensional Neumann problem describing the inviscid, incompressible flow over an airfoil. Two different kinds of mode functions were investigated, namely eigenfunction series and Fourier series. The method using Fourier series was found preferable. It uses all of the coefficients from a Fast Fourier Transform algorithm in an approximate method which exploits the known structure of the transformed coefficient matrix and very promising results for the flow over a realistic airfoil are obtained. On the basis of the results presented here, an order of magnitude reduction in this computer time can be expected for such problems as compared with the time for a direct matrix solution. M.M.M.

#### N79-31624\*# Boeing Commercial Airplane Co., Seattle, Wash. ATLAS, AN INTEGRATED STRUCTURAL ANALYSIS AND DESIGN SYSTEM. VOLUME 5: SYSTEM DEMONSTRATION PROBLEMS

R. A. Samuel, ed. Jul. 1979 271 p refs (Contracts NAS1-12911; DAAG46-75-C-0072) (NASA-CR-159045; D6-25400-0005-Vol-5) Avail NTIS HC A12/MF A01 CSCL 20K

One of a series of documents describing the ATLAS System for structural analysis and design is presented. A set of problems is described that demonstrate the various analysis and design capabilities of the ATLAS System proper as well as capabilities available by means of interfaces with other computer programs. Input data and results for each demonstration problem are discussed. Results are compared to theoretical solutions or experimental data where possible. Listings of all input data are included. G.Y.

#### N79-31628\*# Rockwell International Corp., Downey, Calif. ACTIVELY COOLED PLATE FIN SANDWICH STRUCTURAL PANELS FOR HYPERSONIC AIRCRAFT Final Report

L. M. Smith and C. S. Beuyukian Washington NASA Aug 1979 172 p refs

(Contract NAS1-13382)

(NASA-CR-3159: SD-78-AP-0074) Avail: NTIS HC A08/MF A01 CSCL 01C

An unshielded actively cooled structural panel was designed for application to a hypersonic aircraft. The design was an all aluminum stringer-stiffened platefin sandwich structure which used a 60/40 mixture of ethylene glycol/water as the coolant. Eight small test specimens of the basic platefin sandwich concept and three fatigue specimens from critical areas of the panel design was fabricated and tested (at room temperature). A test panel representative of all features of the panel design was fabricated and tested to determine the combined thermal/ mechanical performance and structural integrity of the system. The overall findings are that; (1) the stringer-stiffened platefin sandwich actively cooling concept results in a low mass design that is an excellent contender for application to a hypersonic vehicle, and (2) the fabrication processes are state of the art but new or modified facilities are required to support full scale panel fabrication. R.E.S

N79-31687# Consiglio Nazionale delle Ricerche, Rome (Italy). Servizio Attivita Spaziali.

# TRANSATLANTIC FLIGHTS OF STRATOSPHERIC BALLOONS [LES VOLS TRANSATLANTIQUES DES BALLONS STRATOSPHERIQUES]

G. P. Cecchini and M. Malavasi  $\it In$  ESA European Sounding Rocket, Balloon and Related Res., with Emphasis on Expt. at High Latitudes Jun. 1978 p 377-381 In FRENCH; ENGLISH summary

Avail: NTIS HC A23/MF A01

The use of high altitude balloons as Spacelab complementary low cost research tools is discussed. The economic factors are reviewed and the payload capacity is analyzed, showing that a weight of 1500 kg at a height equivalent to 1.5 millibar is typical of Spacelab conditions. The Milo launching facility (Italy) is described. It is concluded that balloon flights are well suited for pretesting Spacelab payloads. Author (ESA)

N79-31691# Centre National d'Etudes Spatiales, Toulouse (France).

#### PREVISIONS AND EXPERIMENTAL RESULTS IN OPEN BALLOON CONTROLLED DESCENT [PREVISION ET DEPOUILLEMENTS DE VOLS DE BALLONS OUVERTS EN DESCENTE PILOTE]

M. Romero, M. Rougeron, and C. Tockert *In* ESA European Sounding Rocket, Balloon and Related Res., with Emphasis on Expt. at High Latitudes Jun. 1978 p 397-402 refs In FRENCH

Avail: NTIS HC A23/MF A01

Balloon flight remote control by means of a pole located relief valve and ballast reduction is discussed. A computerized simulation was performed and four balloon flights were executed in 1977. Results show that the proposed flight control method permits a controlled descent or a leveling-off in a simple manner. Author (ESA)

#### N79-32054\*# Boeing Vertol Co., Philadelphia, Pa. STUDY OF DESIGN CONSTRAINTS ON HELICOPTER NOISE

Harry Sternfeld, Jr. and Carl W. Wiedersum Jul. 1979 91 p refs

(Contract NAS1-15226)

(NASA-CR-159118) Avail: NTIS HC A05/MF A01 CSCL 20A

A means of estimating the noise generated by a helicopter main rotor using information which is generally available during the preliminary design phase of aircraft development is presented. The method utilizes design charts and tables which do not require an understanding of acoustical theory or computational procedures in order to predict the perceived noise level, a weighted sound pressure level, or C weighted sound pressure level of a single hovering rotor. A method for estimating the effective perceived noise level in forward flight is also included. In order to give the designer an assessment of the relative rotor performance, which may be traded off against noise, an additional chart for estimating the percent of available rotor thrust which must be expended in lifting the rotor and drive system, is included as well as approach for comparing the subjective acceptability of various rotors once the absolute sound pressure levels are A.R.H. predicted.

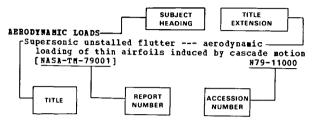
# SUBJECT INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Suppl. 116)

ADHESTVES

## DECEMBER 1979

# 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.

Δ	
A-300 AIRCRAFT	
A comparison of predictions obtained from	wind
tunnel tests and the results from cruisi	na
flight: Airbus and Concorde conferen	nces
[NASA-TM-75238]	N79-31136
ABERRATION	
Recent advances in radome design	
	A79-49574
ACCIDENT INVESTIGATION	
Special investigation report: Wing failure	eof
Boeing 747-131 near Madrid, Spain, 9 May	1976
[NTSB-AAR-78-12]	N79-30167
ACCUBACY	
Guidance accuracy considerations for the mi	crowave
landing system L-band precision DME	
ACOUSTIC DUCTS	A79-48692
Duct noise radiation through a jet flow	
Duct noise faulation through a jet flow	170 50110
ACOUSTIC PROPAGATION	A79-50110
Transform domain processing for digital	
communication systems using surface acoust	+ 1 0
wave devices	
	N79-31482
ACOUSTIC VELOCITY	173-31402
Aerodynamic and acoustic investigation of j	nverted
velocity profile coannular exhaust nozzle	models
and development of aerodynamic and acoust	ic
prediction procedures, comprehensive data	
report, volume 1	
[ NASA-CR-159515 ]	N79-30185
Aerodynamic and acoustic investigation of i	nverted
velocity profile coannular exhaust nozzle	models
and development of aerodynamic and acoust	ic
prediction procedures, comprehensive data	
report, volume 2	
[NASA-CR-159516]	N79-30186
ACTUATOR DISKS	
An actuator disk analysis of an isolated ro	tor
with distorted inflow [AD-A069884]	
ADAPTIVE CONTROL	N79-31216
Digital adaptive control laws for VTOL airc	64
Digital adaptive control laws for vior airc	A79-48000
Adaptive array tradeoffs for existing airbo	
radios	THE OUL
	A79-48598
Investigation of inverse Vandermonde matrix	
calculation for linear system application	s
adaptive flight control systems	~
	N79-31225

ADHESIVES	
The influence of the environment on the	
elastoplastic properties of adhesives in metal	
bonded joints In aircraft structures [ESA-TT-521] N79-30301	
LESA-TT-521] N79-30391 ABRIAL RECONNAISSANCE	ł
Tactical electronic reconnaissance sensor	
radar emission detection	
AFROACOUSTICS A79-48717	'
Experimental investigation of helicopter flight	
modes on helicopter-generated noise	
M79-47873	I.
The aeroacoustics of advanced turbopropellers A79-50236	,
Evaluation of F-111 weapon bay aero-acoustic and	
weapon separation improvement techniques [AD-A070253] N79-31203	
Aerodynamic and acoustic investigation of inverted	
velocity profile coannular exhaust nozzle models	
and development of aerodynamic and acoustic	
prediction procedures	
[NASA-CR-3168] N79-31212 AERODYNAMIC BALANCE	
Helicopter performance methodology at Bell	
Helicopter Textron	
[AHS 79-2] A79-49055	
AERODYNAMIC CHARACTERISTICS	
Surface-effect components of aerodynamic	
characteristics of air-cushion vehicle with ram pressurization	
A79-46995	
Analytic formulas for wing profile aerodynamic	
Analytic formulas for wing profile aerodynamic characteristics in incompressible flow	
λ79-47000	
On a smooth approximation method and its	
application to mathematical description of wing aerodynamic characteristics	
A79-47001	
Overall aerodynamic characteristics of caret and	
delta wings at supersonic speeds	
A79-47012	
The calculation of non-linear aerodynamic	
characteristics of wings and their wakes in subsonic flow	
A79-47099	
Some early experiments in the development of a	
flying platform for aerodynamic testing	
A79-47535	
Aerodynamic effects of an attitude control vane on	
a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] A79-47914	
[AIAA PAPER 79-1855] A79-47914 Flow patterns and aerodynamic characteristics of	
wing with strake	
[AIAA PAPER 79-1877] A79-47928	
A novel technique for obtaining aerodynamic data	
using simple, free flight trajectory measurements	
A79-48051 Aircraft longitudinal motion at high incidence	
A79-48052	
A design perspective on new technologies for	
general aviation	
A79-49486	
Aerodynamic interaction on a close-coupled	
Canard-wing configuration	
[ONERA, TP NO. 1979-95] A79-49543 Variables characterizing the wind effects on an	
aircraft	
A79-49807	
Design and development of the Agusta A 109	
helicopter	
179-49815	

#### AERODYNAMIC COEFFICIENTS

SUBJECT INDEX

Performance evaluation method for dissimilar aircraft designs --- using the square of the wing span for nondimensional comparisons of aerodynamic characteristics [ NASA-RP-1042] N79-30139 general aviation design for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 1: High-wing model B [NASA-CR-3097] N79-30145 Plow visualization studies of a general research fighter model employing a strake-wing concept at subsonic speeds --- in the Langley high speed 7-by 10-ft wind tunnel [NASA-TM-80057] N79-301 N79-30147 Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 1: Technical discussion and analysis of results [AD-A069646] N79-Analysis of wind tunnel data pertaining to high N79-30148 angle of attack aerodynamics. Volume 2: Data [AD-A069647] N79-30149 Airworthiness and flight characteristics test, OV-1C takeoff performance [AD-A069827] N79-30178 Dynamic loads analysis system (DYLOPLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-31 Dynamic loads analysis system (DYLOPLEX) summary. N79-31144 Volume 2: Supplemental system design information [NASA-CR-2846-2] N79-31145 Lateral aerodynamics extracted from flight test Lateral aerodynamics extracted from flight test using a parameter estimation method [ARL-AERO-NOTE-380]
 N79-3:
 A program to compute three-dimensional subsonic unsteady aerodynamic characteristics using the doublet lattice method, L216 (DUBPLEX). Volume 2: Supplemental system design and maintenance N79-31146 document [NASA-CR-2850] N79-31148 Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 2: High-wing model A [NASA-CR-3101] N79-31 Rotary balance data for a single-engine trainer design for an angle-of-attack range of 8 deg to 90 deg --- conducted in langely spin tunnel N79-31149 [NSA-CR-309] N79-311 Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic N79-31152 [NASA-CR-3168] N79-Theoretical and experimental investigation of ground-induced effects for a low-aspect-ratio N79-31212 highly swept arrow-wing configuration [NASA-TP-1508] N79-31223 ABRODYNAMIC COEFFICIENTS Estimation of longitudinal aircraft characteristics using parameter identification techniques A79-50432 Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NASA-TH-78603] N79-30143 Aerodynamic and acoustic investigation of inverted velocity profile coanular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 1 [NASA-CR-159515] N79-30185 Aerodynamic and acoustic investigation of inverted Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 2 [NASA-CR-159516] N79-3016 A program for calculating load coefficient matrices utilizing the force summation method, L218 (LOADS). Volume 2: Suplemental system design and maintenance document [NASA-CR-2854] N79-3115 N79-30186 N79-31155 ABRODYNAMIC CONFIGURATIONS A method of the theory of airfoil profiles with a jet flap A79-47119 Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] A79-47925

Active external store flutter suppression in the YF-17 flutter model A79-49866 Performance evaluation method for dissimilar aircraft designs --- using the square of the wing span for nondimensional comparisons of aerodynamic characteristics [NASA-RP-1042] N79-Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 2: Data N79-30139 Data base [AD-A069647] N79-30149 A flow field study for top mounted inlets on fighter aircraft configurations [AD-A069732] N79-Performance of two-stage fan with a first-stage N79-30151 rotor redesigned to account for the presence of a part-span damper [NASA-TP-1483] N79-30191 Modal interpolation program, L215(INTERP). Volume 2: Supplemental system design and maintenance document --- to calculate displacements at several points on an aerodynamic surface [NASA-CR-2848] N79-31147 ABRODYNAMIC DRAG 

 RODYNAMIC DWAG

 The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4]

 AN integrated analytical and experimental

 A79-49057 investigation of helicopter hub drag [AHS 79-5] A79-49 Theoretical flap-lag damping with various dynamic A79-49058 inflow models [AHS 79-20] 179-49073 The size and performance effects of high lift system technology on a modern twin engine jet transport [ATAA PAPER 79-1795] A79-49 Dynamic test techniques - Concepts and practices --- aircraft performance prediction from thrust/lift/drag model A79-49332 179-50164 Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind tunnel [NASA-CR-159120] N79-31143 ABRODYNAMIC FORCES A force and moment test of a 1/24-scale F-111 model at Mach numbers from 0.7 to 1.3 [ AD-A070192 ] ABRODINAMIC INTERPERENCE N79-31156 Engine-aircraft afterbody interactions Recommended testing techniques based on YF-17 experience [AIAA PAPER 79-1829] A79-47903 Benefits of aerodynamic interaction to the three surface configuration [AIAA PAPER 79-1830] A79-Interactional aerodynamics - A new challenge to A79-47904 helicopter technology [AHS 79-59] A79-49109 [And /9-39] Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft [AIAA PAPER 79-1856] AERODYNAMIC LOADS A79-49339 Wing aerodynamic loading caused by jet-induced lift associated with STOL-OTW configurations [AIAA PAPER 79-1664] A79 A79-47346 A lifting-surface method for hover/climb airloads [AHS 79-3] A79-49056 The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] A79-49 A79-49057 program for calculating load coefficient program for calculating load coefficient matrices utilizing the force summation method, L218 (LOADS). Volume 2: Supplemental system design and maintenance document [NASA-CR-2854] N79-3
 AERODYNAMIC ROISE N79-31155 Experiments of shock associated noise of supersonic jets [AIAA PAPER 79-1526] A79-1 Study of design constraints on helicopter noise [NASA-CR-159118] N79-1 A79-47341 N79-32054 ABRODYNAMIC STABILITY Some early experiments in the development of a flying platform for aerodynamic testing A79-47535

#### SUBJECT INDEX

Stability and control --- conferences [AGARD-CP-260] N79-30218 Stall behaviour evaluation from flight test results N79-30227 Wind-tunnel investigation of an armed mini "Inu-tunnel investigation of an armed mini remotely piloted vehicle --- conducted in Langley V/STOL tunnel [NASA-TM-80132] AERODYNAMIC STALLING \* N79-31151 The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AIAA PAPER 79-1786] 179-47876 Dutch roll excitation and recovery techniques on a C-141A Starlifter 179-47886 [AIAA PAPER 79-1801] Some flight data extraction techniques used on a general aviation spin research aircraft [AIAA PAPER 79-1802] 179-47887 [ATAN PAPER 79-1835] Radio-controlled model design and testing A79-47907 techniques for stall/spin evaluation of general-aviation aircraft [NASA-TM-80510] N79-30173 Stall behaviour evaluation from flight test results N79-30227 AERO DYNAMICS Aerodynamics for engineers --- Book A79-50375 AFROFLASTICITY Some observations on four current subjects related to aeroelastic stability A79-47093 Dynamics requirements for an Advanced Scout Helicopter /ASH/ [AHS 79-19] A79-49072 On single-degree-of-freedom flutter induced by activated controls A79-49867 Comment on \*active flutter control using generalized unsteady aerodynamic theory' A79-49873 Dynamic loads analysis system (DYLOPLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-31144 Dynamic loads analysis system (DYLOFLEX) summary. Volume 2: Supplement [NASA-CR-2846-2] AERONAUTICAL ENGINEERING Supplemental system design information N79-31145 Aerodynamics for engineers --- Book A79-50375 Enforcer aircraft [GP0-32-569] N79-30174 AERONAUTICAL SATELLITES A novel approach to the design of an all digital aeronautical satellite communication system N79-31461 AFTERBODIES Engine-aircraft afterbody interactions -Recommended testing techniques based on YP-17 experience [AIAA PAPER 79-1829] 179-47903 APTERBURNING Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber A79-48519 A simplified gross thrust computing technique for an afterburning turbofan engine A79-50440 AGRICULTURAL AIRCRAFT Agricultural helicopters --- test and simulation results [AHS 79-60] 179-49064 AIR COOLING Full-scale wind tunnel study of nacelle shape on cooling drag [AIAA PAPER 79-1820] Experimental study of the gasdynamic characteristics of a stator cascade with cooling A79-47900 air discharge through the vane surface A79-48498 ATE CUSHTON LANDING SYSTEMS Characteristics of an Air Cushion Landing System incorporating an inelastic trunk

Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79-30175 AIR DEPENSE Adding the challenge of nap-of-the-earth N79-30199 ATE PLOW Surface-effect components of aerodynamic characteristics of air-cushion vehicle with ram pressurization A79-46995 Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TH-75430] N79-31206 Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles --- to be used on vertical lift aircraft [NASA-TP-1510] N79-31214 AIR INTAKES Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TM-75430] N79-31206 AIR JETS Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TM-75430] N79-31206 AIR LAUNCHING Complex quaternion notation in coordinate transformations --- missile launching aircraft-inertial space transformations A79-48681 ATE NAVIGATION A simple integrated navigation based on multiple DME [DGLR PAPER 79-041] A79-48640 [DGLR FAPER /9-041] Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities --- Sandia Inertial Terrain Aided Navigation 179-48678 Dynamic simulator test and evaluation of a JTIDS relative navigation system --- Joint Tactical Information Distribution System A79-48694 Navstar user equipment for civil and military applications A79-49587 Aeronautical information data subsystems /AIDS/ A79-50920 AIR POLLUTION Correlation technique for ambient effects on oxides of nitrogen --- from combustion products in atmospheric pollution A79-49922 Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 Experimental Clean Combustor Program (ECCP), phase 3 --- commercial aircraft turbofan engine tests with double annular combustor [NASA-CR-135384] N79-31207 Exhaust emission traverse investigation of a JT3D-1 turbofan engine --- to acquire exhaust nozzle emission sample [AD-A072019] N79-31209 Ambient correction factors for aircraft gas turbine idle emissions [ AD-A069240] N79-31218 AIR TRAFFIC The aerial relay system - An energy-efficient solution to the airport congestion problem ---using cruise liner aircraft for in-air passenger transfer [AIAA FAPER 79-1865] A79-47921 Aeronautical information data subsystems /AIDS/ A79-50920 Runway configuration management system concepts [AD-A069960] N79-N79-31234 AIR TRAFFIC CONTROL Small lightweight electronically steerable cylindrical antenna successfully utilized in an air traffic management system A79-48597 The ATCBI-5 beacon interrogator --- Air Traffic Control Beacon Interrogator A79-48693 Modern systems for air traffic control A79-50921

179-49909

Central flow control software design document. Volume 1: Operational software complex ---automation support to the Air Traffic Control System Command Center [AD-A070973] N79-30959 [AD-AD/09/3] Central flow control software design document. Volume 2: Support software complex ---automation support to the Air Traffic Control System Command Center. [AD-AD70771] N79-3 N79-30960 A developmental computer model for investigations of air traffic management problems: A case investigating two decision strategies [AD-A071075] N79-31189 Advisory circular. The planning grant program for airports [AC150/5900-1B] N79-31232 adjacent computerized air traffic control centres N79-31463 AIR TRANSPORTATION The aerial relay system - An energy-efficient solution to the airport congestion problem ---using cruise liner aircraft for in-air passenger transfer [AIAA PAPER 79-1865] 179-47921 Injuries in air transport emergency evacuations A79-49995 International Air Transportation Competition Act of 1978 --- congressional reports of 1978 --- c [GPO-34-912] N79-30168 Supersonic transport vis-a-vis energy savings [NASA-TM-75464] N7 N79-31163 AIRBORNE BOUIPHENT Radar cross section fundamentals for the aircraft designer [AIAA PAPER 79-1818] A79-47898 Real time weather display in the general aviation cockpit [AIAA PAPER 79-1821] 179-47901 Power hybridization - Key to reducing avionics power supply weight and volume 179-48652 Multifunction CO2 heterodyning laser radar for low level tactical operations A79-48685 Airborne microwave ECM A79-49554 The A.I. tracking problem --- Airborne Interception A79-49566 An in-flight controller insensitive to parameters variation [DLR-FB-78-07] N79-30197 Heterodyning CO2 laser radar for airborne applications N79-30205 AIRBORNE SURVEILLANCE RADAR Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness --- in airborne radar systems A79-48621 Millimeter airborne radar target detection and selection techniques 179-48665 A new three-dimensional surveillance radar A79-49568 The servoed modulation FNCW radar altimeters in military applications A79-49589 Automated tracking for aircraft surveillance radar systems A79-49604 AIRBORNE/SPACEBORNE COMPUTERS Digital adaptive control laws for VTOL aircraft A79-48000 Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for advanced architectures using MIL-STD-1553B A79-48629 Computer Monitor and Control - A flexible, cost-effective implementation A79-48670 Evolving methods for reducing avionics data in an AISF environment --- Avionics Integration Support Facility flight program testing 179-48671 Integrated CNI avionics --- ECM-resistant Communication, Navigation and Identification A79-48711

E-3A sentry /AWACS/ ATPG --- Automatic Test Program Generation A79-48873 AIRCRAFT Airport flammability, full scale fire tests N79-31167 AIRCRAFT ACCIDENT INVESTIGATION Lusaka accident report 179-50109 Aircraft accident report: Swift Aire Lines, Inc., Nord 262, N4185A, Marina Del Rey, California, March 10, 1979 [NTSB-AAR-79-13] N79-N79-31165 AIRCRAFT ACCIDENTS A simulation of amphibious hovercraft overturning A79-49904 Special investigation report: Wing failure of Boeing 747-131 near Madrid, Spain, 9 May 1976 [NTSB-AAR-78-12] N79-N79-30167 Helicopter obstacle strike tolerance concepts analysis [ AD-A069877] N79-30179 Aircraft accident report: Swift Aire Lines, Inc., Nord 262, N4185A, Marina Del Rey, California, March 10, 1979 [NTSB-AAR-79-13] N79-N79-31165 AIRCRAFT ANTENNAS Multiband antenna --- for tactical naval aircraft A79-48596 Antennas for the Black Hawk helicopter [AHS 79-15] A79-490 Evaluation of the radar altimeter reference method A79-49068 for determining altitude system positioning errors A79-50436 Radiation from guarter-wavelength monopoles on finite cylindrical, conical, and rocket-shaped conducting bodies --- airborne antenna design A79-50606 A helicopter high definition rotor blade radar N79-30207 UHF coplanar-slot antenna for aircraft-to-satellite data communications [NASA-TH-79239] N79-31185 AIRCEAPT CABRIERS The T & E simulator - A comparison with flight test results A79-50169 AIRCRAFT COMMUNICATION Adaptive array tradeoffs for existing airborne UHF radios A79-48598 The ATCBI-5 beacon interrogator --- Air Traffic Control Beacon Interrogator A79-48693 A report on the Sperry Dome Radar A79-49567 UHF coplanar-slot antenna for aircraft-to-satellite data communications [NASA-TM-79239] N79-31185 URF data link N79-31476 New devices for digital communications in avionics N79-31481 Implementing JTIDS in tactical aircraft N79-31491 AIRCRAFT COMPARTMENTS Recent advances in materials toxicology N79-31169 A review of Boeing interior materials and fire test methods development programs N79-31177 FIREMEN program N79-31178 Development of aircraft lavatory compartments with improved fire resistance characteristics. Phase Sandwich panel resin system development 2: [ NASA-CR-152120 ] N79-31354 AIRCRAFT CONFIGURATIONS Recent V/STOL aircraft designs A79-47608 The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AILA FAPER 79-1786] Manned strategic system concepts 1990-2000 [AILA FAPER 79-1793] A79-47876 179-47882

Engine-aircraft afterbody interactions -	
Recommended testing techniques based or	¥?-17
experience [AIAA PAPER 79-1829]	A79-47903
Interactional aerodynamics - A new challe	
helicopter technology [AHS 79-59]	A79-49109
Application of Lagrange Optimization to t	the drag
polar utilizing experimental data	
[AIAA PAPER 79-1833] Effect of nozzle spacing on ground interf	A79-49335
forces for a two jet V/STOL aircraft	erence
[AIAA PAPER 79-1856]	A79-49339
In-flight handling qualities investigatic various longitudinal short term dynamic	n of s and
direct lift control combinations for fl	ight path
tracking using DFVLR HFB 320 variable s aircraft	tability
ultolait	N79-30237
Introduction and overview of configuratio	ns
for transonic flows	N79-31160
AIRCRAFT CONSTRUCTION MATERIALS	
High-performance reinforced plastic struc	tures for
civil aviation	A79-47302
Handbook on aircraft materials and their	A12 41302
application technology	170 40244
Metal-matrix composite structures	A79-48311
[AHS 79-34]	A79-49086
Certification of composites in civil airc [AHS 79-43]	
High performance composites and adhesives	A79-49095 for
V/STOL aircraft	
[AD-A069611] ~ AIRCRAFT CONTROL	N79-30332
Some results from the use of a control	
augmentation system to study the develo	ped spin
of a light plane [AIAA PAPER 79-1790]	A79-47879
Dutch roll excitation and recovery techni	ques on a
C-141A Starlifter [AIAA PAPER 79-1801]	170 #7004
Nonlinear decoupled control synthesis for	A79-47886
maneuvering aircraft	
The enhancement of aircraft parameter	A79-47959
identification using linear transformat:	ions
for stability	A79-47961
A multiple objective optimization approact	a to
aircraft control systems design	
Application of singular perturbation techn	A79-47962
<pre>/SPT/ and continuation methods for on-li</pre>	ine
aircraft trajectory optimization	179-47991
Digital adaptive control laws for VTOL air	
	A79-48000
The DG-800 - A rugged, high performance he reference unit directional gyro desi	aaing
considerations	-
Guidance accuracy considerations for the m	A79-48677
landing grater Labord anticity pur	TCTOMGA6
landing system L-band precision DME	
	A79-48692
Combined environment reliability test of t	A79-48692 he
Combined environment reliability test of t common strategic Doppler system	he A79-50368
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic	he 179-50368
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling qua	he A79-50368 n lities A79-50428
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling gua AFFTC parameter identification experience	he A79-50368 n lities A79-50428 Air
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling qua	he n lities A79-50428 Air testing
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling qua AFPTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system	he A79-50368 n lities A79-50428 Air testing A79-50434
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling gua AFFTC parameter identification experience Force Flight Test Center aircraft flight	he A79-50368 n lities A79-50428 Air testing A79-50434 s for
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling gua AFFTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system day/night precision aircraft control	he A79-50368 n lities A79-50428 Air testing A79-50434
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling gua AFFTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system day/night precision aircraft control Stability and control conferences f AGARD-CP-2601	he A79-50368 n lities A79-50428 Air testing A79-50434 s for N79-30204 N79-30218
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling gua AFFTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system day/night precision aircraft control Stability and control conferences [AGARD-CP-260] Enhanced fighter mission effectiveness by	he A79-50368 n lities A79-50428 Air testing A79-50434 s for N79-30204 N79-30218
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling gua AFFTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system day/night precision aircraft control Stability and control conferences f AGARD-CP-2601	he A79-50368 n lities A79-50428 Air testing A79-50434 s for N79-30204 N79-30218 use of
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling qua AFFTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system day/night precision aircraft control Stability and control conferences [AGARD-CP-260] Enhanced fighter mission effectiveness by integrated flight systems Results related to simulated and in-flight	he A79-50368 n lities A79-50428 Air testing A79-50434 s for N79-30204 N79-30218 use of N79-30223
<ul> <li>Combined environment reliability test of t common strategic Doppler system</li> <li>An evaluation of sidestick force/deflectic characteristics on aircraft handling gua</li> <li>APPTC parameter identification experience Force Flight Test Center aircraft flight</li> <li>Applications of pattern recognition system day/night precision aircraft control</li> <li>Stability and control conferences [AGARD-CP-260]</li> <li>Buhanced fighter mission effectiveness by integrated flight systems</li> <li>Results related to simulated and in-flight experimentation with an electric flight</li> </ul>	he A79-50368 n lities A79-50428 Air testing A79-50434 s for N79-30204 N79-30218 use of N79-30223
Combined environment reliability test of t common strategic Doppler system An evaluation of sidestick force/deflectic characteristics on aircraft handling qua AFFTC parameter identification experience Force Flight Test Center aircraft flight Applications of pattern recognition system day/night precision aircraft control Stability and control conferences [AGARD-CP-260] Enhanced fighter mission effectiveness by integrated flight systems Results related to simulated and in-flight	he A79-50368 n lities A79-50428 Air testing A79-50434 s for N79-30204 N79-30218 use of N79-30223

Design considerations for reliable PBW flight control
N79-30231 L-1011 active controls, design philosophy and experience
N79-30236 Flying qualities and the fly-by-wire aeroplane N79-30238
A simulator investigation of handling quality criteria for CCV transport aircraft
AIRCRAFT DESIGN On a smooth approximation method and its application to methodatical description of air
application to mathematical description of wing aerodynamic characteristics A79-47001
Solution of the inverse aerodynamics problem by the random search method
A79-47002 Selecting the passenger airplane fuselage A79-47014
Compass Cope airframe design history [AIAA PAPER 79-1792] A79-47881 Manned strategic system concepts 1990-2000
[AINA PAPER 79-1793] A79-47882 Identifying desirable design features for the C-XX
aircraft - A systems approach [AIAA PAPER 79-1796] A79-47883 Design of advanced titanium structures for
Advanced Tactical Systems aircraft fuselage [AIAA PAPER 79-1805] A79-47890
Historical development of worldwide supersonic aircraft [AIAA PAPER 79-1815] A79-47895
From HiMAT to future fighters Highly Maneuverable Aircraft Technology assessment [AIAA PAPER 79-1816] A79-47896
Radar crcss section fundamentals for the aircraft designer
[AIAA PAPER 79-1818] A79-47898 All electric subsystems for next generation transport aircraft
[AIAA PAPER 79-1832] A79-47906 Exploratory study of the influence of wing leading-edge modifications on the spin
characteristics of a low-wing single-engine general aviation airplane
[AIAA PAPER 79-1837] A79-47908 Design of the circulation control wing STOL demonstrator aircraft
[AIAA PAPER 79-1842] A79-47909 Geometric data transfer for computerized aircraft engineering drawings
[AIAA PAPER 79-1844] A79-47910 Engineering and manufacturing communication via
the computer data base [AIAA PAPER 79-1845] A79-47911 CADAM data handling from conceptual design through
produce support [AIAA PAPER 79-1846] A79-47912 Laminar flow stabilization by surface cooling on
hydrogen fueled aircraft [AINA PAPER 79-1863] A79-47920
High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] A79-47924
A multiple objective optimization approach to aircraft control systems design
A79-47962 Handbook on aircraft materials and their application technology
A79-48311 Analysis design of complex systems. II for simultaneous improvement of all basic prototype
flight vehicle performance characteristics A79-48505
Microprocessor-based digital autopilot development for the XBQM-106 Mini-RPV A79-48608
A status report on the advanced FIREFLY assessment program A79-48609
Multisensor integration for defensive fire control surveillance
A79-48610 Role of Numerical Control Design in the computer aided design/manufacturing interface at Sikorsky
[AHS 79-30] A79-49082

#### AIRCRAFT DETECTION

Self-contained grease lubrication systems for aircraft applications [AHS 79-39] 179-49091 Design criteria for airline operation [AIAA PAPER 79-1849] Recent applications of theoretical analysis to 170-10337 V/STOL inlet design A79-49530 Small hovercraft design - Evolution to simplicity 179-49906 Accodynamics for engineers --- Book 179-50375 Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NASA-TH-78603] N79-30143 [NASA-16-76003] Stability and control --- conferences [AGARD-CP-260] N79-30218 Systems implications of active controls N79-30219 Improvement of fighter aircraft maneuverability through employment of control configured vehicle technology N79-30225 L-1011 active controls, design philosophy and experience N79-30236 Are today's specifications appropriate for tomorrow's airplanes? N79-30239 Maritime patrol airship concept study [ AD-A0701311 ₩79-31138 Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TH-78793] N79-31 N79-31141 Experimental data base for computer program assessment: Report of the Fluid Dynamics Panel Working Group 04 [AGARD-AR-138] AIRCRAPT DETECTION ·N79-31159 Estimation of aircraft target motion using pattern recognition orientation measurements 179-47987 The alpha-beta-gamma tracking filter in the Z-domain --- in aircraft tracking A79-48680 Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes A79-49580 ATRCRAPT ENGINES Statistical diagnostics of aircraft engines A79-46996 Nozzles for vectored thrust jet engines ---Russian book 179-47428 Fuels, lubricants and other fluids used in aviation -- Russian book A79-47433 The characteristics of a lift cruise fan V/STOL configuration in near proximity to a small deck with finite edge positions [AIAA PAPER 79-1854] A79-47913 LAIME FALLS /9-1834] Energy efficient aircraft engines [ATAN PAPER 79-1861] Long-life GTE operation based on technical condition Gas Turbine Engine 179-48517 Development of a 'no adjustment' turboshaft engine control system [AHS 79-42] 179-19000 Fault diagnosis of gas turbine engines by means of component characteristics determination 179-49806 The Bell Model 222 A79-49816 Correlation technique for ambient effects on oxides of nitrogen --- from combustion products in atmospheric pollution A79-49922 Duct noise radiation through a jet flow A79-50110 Derivative engines for the 1980s will help limit acquisition and maintenance costs A79-50206 Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ --- Russian book A79-50421

#### SUBJECT INDEX

Energy efficient engine flight propulsion system preliminary analysis and design report [NASA-CR-159487] N79-30189 Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 Tapered roller bearing development for aircraft turbine engines [AD-A069440] An overview of NASA research on positive N79-30555 An overview or NASA research on positive displacement type general aviation engines [NSA-TH-79254] N79 Aircraft turbine engine monitoring experience: Implications for the P100 engine diagnostic N79-31210 system program [ AD-A069282] N79-31217 Ambient correction factors for aircraft gas turbine idle emissions [ AD-A0692401 N79-31218 AIRCRAFT EQUIPMENT NATA Equipment
 The feasibility of inflight measurement of lightning strike parameters
 [NASA-CR-158981]
 N79-.
 AH-1G helicopter, 19-round lightweight airborne N79-30165 [auncher jettison envelope determination [AD-A069828] N79-30177 The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 The equipment-system interface in an antitank helicopter at night N79-30211 Puel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 1: Experimental Results and Design summary FAD-A0701131 N79-31202 AIRCRAFT FUEL SYSTEMS The tendency of jet fuels to form deposits on a heated surface 179-48856 Drag reduction by cooling in hydrogen-fueled aircraft 179-49921 AIRCRAFT FUELS Fuels, lubricants and other fluids used in aviation --- Russian book A79-47433 On the question of selecting the characteristic quantity governing fuel self-ignition in a stream A79-48497 Method of determining mechanical-impurity contents in jet fuels A79-48859 Alternative fuels in aviation 179-49381 Supersonic transport vis-a-vis energy savings [NASA-TH-75464] N7 N79-31163 AIRCRAFT GUIDANCE Guidance accuracy considerations for the microwave landing system L-band precision DME 179-48692 The Guidance and control of Helicopters and V/STOL aircraft at night and in poor visibility FAGARD-CP-258] N79-30198 Subjective assessment of a helicopter approach system for IFR conditions N79-30209 The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 Project NAVTCLAND (Navy vertical takeoff and landing capability development) N79-30212 GCU, the Guidance and Control Unit for all weather approach N79-30213 Implementation of flight control in an integrated guidance and control system N79-30215 An advanced guidance and control system for rescue helicopters N79-30217 Path controllers: Unification of concepts and comparison of design methods [AD-A070252] N79-31227

AIRCRAFT HAZARDS Relicopter obstacle strike tolerance [AHS 79-7] A79-49059 Atmospheric Electricity Hazard (AEH) [ AD-A069338] N79-30169 Helicopter obstacle strike tolerance concepts analysis [ AD-A069877] N79-30179 Lightning hazards overview: Aviation requirements and interests N79-30876 AIRCRAFT HYDRAULIC SYSTEMS Fluidics: Peasibility study electro/hydraulic/fluidic direct drive servo valve [AD-A069798] N79-30195 AIRCRÀFT INDUSTRY Geometric data transfer --- for computerized aircraft engineering drawings [AIAA PAPER 79-1844] A A79-47910 Can avionic testability requirements be enforced A79-48887 Avionics design for testability - A vendor's viewpoint A79-48889 Financing the capital requirements of the US airline industry in the 1980's N79-30164 AIRCRAFT INSTRUMENTS A cheap, effective icing detector for general aviation aircraft [AIAA PAPER 79-1823] A79-47902 The application of pulsed 'G' band radio altimeters to modern military aircraft A79-49590 Automated tracking for aircraft surveillance radar systems A79-49604 ARIA takeoff performance flight test program ---Advanced Range Instrumented Aircraft A79-50437 Implementation of flight control in an integrated guidance and control system N79-30215 Reliability improvement warranty terms and conditions for the Integrated Avionics Control Systems (IACS) [AD-A069454] N79-31205 Transform domain processing for digital communication systems using surface acoustic wave devices N79-31482 AIRCRAFT LANDING Recent progress in aircraft sink rate measurement [AINA PAPER 79-1798] A79-47 A79-47884 Advances in decelerating steep approach and landing for helicopter instrument approaches [AHS 79-16] A79 A79-49069 High sink-rate landing testing of Navy aircraft A79-50163 Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YF-12A [NASA-CR-144884] N Investigation on information error caused by N79-31192 traffic loading in approach and landing systems N79-31480 AIRCRAFT MAINTENANCE ATE and aircraft mechanical diagnostics A79-48883 AN/USM-449/V/ ATE for worldwide support of the P3 Orion A79-48884 F-16 avionics maintenance concept and multinational aspects A79-48894 F-16 depot automatic test equipment A79-48895 Fault diagnosis of gas turbine engines by means of component characteristics determination A79-49806 Maintenance cost study of rotary wing aircraft, phase 2 [NASA-CR-152291] N79-30138 Naval aircraft operating and support cost-estimating model, FY 1977 revision [AD-A068175] N79-30140 Maintenance improvement: An analysis approach including inferential technical data --- nav. - naval aircraft N79-30141 [ AD-A068382]

AIRCRAFT MANEUVERS Analysis of optimal loop and split-S by energy state modeling 179-47098 An improved method for load survey flight testing --- of military cargo aircraft [AIAA PAPER 79-1799] 179-47885 Nonlinear decoupled control synthesis for maneuvering aircraft A79-47959 Aircraft longitudinal motion at high incidence 179-48052 Small signal compensation of magnetic fields resulting from aircraft maneuvers 179-49605 Considerations in the analysis of flight test maneuvers A79-50433 A study of the application of singular perturbation theory --- development of a real time algorithm for optimal three dimensional aircraft maneuvers [NASA-CR-3167] N79-30194 compilation and analysis of helicopter handling qualities data. Volume 2: Data analysis [NASA-CR-3145] N79-31222 AIRCRAFT MODELS Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes A79-49580 Radio-controlled model design and testing techniques for stall/spin evaluation of general-aviation aircraft [NASA-TM-80510] N79-30173 [NASA-TP-1435] N79-30 N79-30176 Wind-tunnel investigation of an armed mini remotely piloted vehicle --- conducted in Langley V/STOL tunnel [NASA-TM-80132] N79-31151 AIRCRAFT NOISE Experimental investigation of helicopter flight modes on helicopter-generated noise A79-47873 Helicopter noise rules - Are they appropriate and reasonable 179-49478 The aeroacoustics of advanced turbopropellers A79-50236 Supersonic transport aircraft noise, problems of noise reduction and establishment of standards A79-50237 Study of design constraints on helicopter noise [NASA-CR-159118] N79-3 AIRCRAFT PARTS N79-32054 Most rational linearization of nonlinear unsteady heat conduction problems --- for flight vehicle parts and engines A79-48501 AIRCRAFT PERFORMANCE APFTC parameter identification experience --- for aircraft flight characteristics [AIAA PAPER 79-1803] A79-47 A79-47888 Performance evaluation of an air vehicle utilizing AIAA PAPER 79-1811] A79-47894 Analysis design of complex systems. II --- for simultaneous improvement of all basic prototype flight vehicle performance characteristics A79-48505 Blown wings from Kiev --- short takeoff and landing through wing-overblowing A79-49232 Variables characterizing the wind effects on an aircraft A79-49807 Performance modelling methods --- in flight test programs A79-50167 A computer system for identifying aircraft characteristics A79-50168 Evaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Flying Qualities of Piloted Airplanes' A79-50439

SUBJECT INDER

Performance evaluation method for dissimilar aircraft designs --- using the square of the wing span for nondimensional comparisons of aerodynamic characteristics [NASA-RP-1042] N79-30139 A summary of AGARD FDP meeting on dynamic stability parameters --- advanced aircraft performance at high angle of attack N79-30220 Enhanced fighter mission effectiveness by use of integrated flight systems N79-30223 Open/closed loop identification of stability and control characteristics of combat aircraft N79-30232 AIRCRAFT PILOTS ONERA's model of the pilot in discrete time N79-30242 AIRCRAFT RELIABILITY Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft 179-17960 Failure detection in signal processing and sensing in flight control systems 179-47971 A status report on the advanced FIREFLY assessment program A79-48609 Terrain-following radar - Key to low-altitude flight A79-48686 Development of a 'no adjustment' turboshaft engine control system [AHS 79-42] A79-49094 What the PAA would like in airworthiness standards [AIAA PAPER 79-1851] A79-49338 Airworthiness and flight characteristics test, OV-1C takeoff performance [AD-A069827] N79-30178 AIRCRAFT SAFETY Lockheed urges hydrogen fuel A79-49224 A review of Boeing interior materials and fire test methods development programs N79-31177 AIRCRAFT SPECIFICATIONS Bvaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Plying Qualities of Piloted Airplanes' A79-50439 Are today's specifications appropriate for tomorrow's airplanes? N79-30239 AIRCRAFT SPIN The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AIAA PAPER 79-1786] A79-4 Some flight data extraction techniques used on a 179-47876 general aviation spin research aircraft [AIAA PAPER 79-1802] Radio-controlled model design and testing 179-47887 techniques for stall/spin evaluation of general-aviation aircraft [NASA-TM-80510] N79-30173 AIRCRAFT STABILITY Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack 179-47943 Nonlinear decoupled control synthesis for maneuvering aircraft A79-47959 The enhancement of aircraft parameter identification using linear transformations --for stability A79-47961 Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight [ABS 79-56] A79-49 Comment on 'Plight test of stick force stability in attitude-stabilized aircraft' A79-49106 A79-49925 Estimation of longitudinal aircraft characteristics using parameter identification techniques A79-50432

AFFTC parameter identification experience --- Air Force Flight Test Center aircraft flight testing A79-50434 An in-flight controller insensitive to parameters variation [ DLR-FB-78-07 ] N79-30197 A summary of AGARD FDP meeting on dynamic stability parameters --- advanced aircraft performance at high angle of attack N79-30220 AIRCRAFT STRUCTURES Some observations on four current subjects related to aeroelastic stability A79-47093 Design of advanced titanium structures --- for Advanced Tactical Systems aircraft fuselage [AIAA PAPER 79-1805] A79-Automatic test program generation selection ---for aircraft structures A79-47890 A79-48690 Helicopter obstacle strike tolerance [AHS 79-7] Designing with experimental mechanics ---A79-49059 three-dimensional photoelastic analysis of helicopter components [AHS 79-11] A79-49063 Superplastic forming diffusion bonding of titanium helicopter airframe components [AHS 79-33] A79-49085 [And (3-35] Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system [AHS 79-35] A79-49087 Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A79-49101 The DC-9 Super 80 - Nuch more than a simple stretch A79-49223 The influence of the environment on the The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints --- In aircraft structures [BSA-TT-521] N79-3039 Development of fire-resistant, low smoke generating, thermally stable end items for commercial aircraft and spacecraft using a basic N79-30391 polyimide resin N79-31171 The fluorenone polyester ISO PPE of Isovolta Company, Austria N79-31183 A user's manual for a computer program to generate fatigue spectrum loading sequences [AD-A069288] N79-31198 AIRCRÀFT SURVIVABILITY Helicopter obstacle strike tolerance [AHS 79-7] AIRCRAFT WAKES A79-49059 The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow A79-47099 AIRPIBLD SUBPACE HOVEMENTS Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YP-12A [NASA-CR-144884] N79-31192 AIRFOIL PROFILES A method of the theory of airfoil profiles with a jet flap 179-47119 Winglet toe out angle optimization for the Gates Learjet Longhorn Wing [AIAA PAPER 79-1831] A79-47905 High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] A79-47924 the influence of relative pitch in the subsonic On turbine cascade A79-48503 The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] A79-4905 Determining the contour of helicopter rotor blades A79-49057 automatically using electro-optical techniques [AHS 79-32] 179-49084 Wing geometry effects on leading-edge vortices [AIAA PAPER 79-1872] A79-A79-49341

A-8

#### SUBJECT INDEX

ANNULAR NOZZLES

N79-31212

Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics 170-10919 On single-degree-of-freedom flutter induced by activated controls 179-49867 Comment on 'active flutter control using generalized unsteady aerodynamic theory' 179-49873 Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NASA-TM-786031 N79-30143 ATRENTLS Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils 179-47342 TATAA PAPER 79-15551 Experimental measurements of shock/boundary-layer interaction of a supercritical airfoil [ATAA PAPER 79-1499] A79-47345 Aerodynamics for engineers --- Book A79-50375 Flutter analysis of two-dimensional and two-degree-of-freedom airfoils in small-disturbance, unsteady transonic flow N79-31157 [ AD-A069223 ] Wind tunnels with adapted walls for reducing wall interference [ NASA-TM-75501] N79-31230 AIRFRAME MATERIALS Superplastic forming diffusion bonding of titanium helicopter airframe components 179-49085 [AHS 79-33] ATOPPARES Metallic coatings for graphite/epoxy composites FAD-A0698711 N79-30334 ATRIANE OPERATIONS The aerial relay system - An energy-efficient solution to the airport congestion problem ---using cruise liner aircraft for in-air passenger transfer [AIAA PAPER 79-1865] 170-47921 Design criteria for airline operation [AIAA PAPER 79-1849] A79-49337 AIRPLANE PRODUCTION COSTS Testability, the key to economical and operationally effective avionic test software A79-48890 Financing the capital requirements of the US airline industry in the 1980's N79-30164 AIRPORT BEACONS The ATCBI-5 beacon interrogator --- Air Traffic Control Beacon Interrogator 179-48693 AIRPORT PLANNING Airport power supply --- Russian book A79-50499 Potential closure of airports N79-31231 Advisory circular. The planning grant program for airports [ AC150/5900-181 N79-31232 ATRPORTS Current status of airport terminal complex development abroad A79-50240 Potential closure of airports N79-31231 Surveys of grooves in 19 bituminous runways [ AD-A069889] N79-31233 [AD-AU69889] Runway configuration management system concepts 555 5550503 N79-31234 [AD-A069960] ATRSHTPS Air buoyant vehicles - Energy efficient aircraft [AILA PAPER 79-1862] A79 The feasibility of modern dirigibles [ONERA, TP NO. 1979-93] A79 Lighter than air vehicles. Citations from the A79-47919 A79-49541 NTIS data base [NTIS/PS-79/0471/7] N79-30162 Lighter than air vehicles. Citations from the Engineering Index data base [NTIS/PS-79/0472/5] N79-N79-30163 Maritime patrol airship concept study [AD-A070131] N79-31138

ATROPRED Adding the challenge of nap-of-the-earth N79-30149 AT CORTTRNS A real-time sequential filtering algorithm for GPS low-dynamics navigation system 170-10657 A study of the application of singular perturbation theory --- development of a real time algorithm for optimal three dimensional aircraft maneuvers ( NASA-CR-3167 ] N79-30194 ALL-WEATHER AIR NAVIGATION Pave Low III --- H-53 helicopter avionics for night/adverse weather rescue of military aircraft 179-48682 H-X combat search and rescue avionics study results A79-48684 ALL-WEATHER LANDING SYSTEMS GCU, the Guidance and Control Unit for all weather approach N79-30213 ALTITUDE CONTROL Adding the challenge of nap-of-the-earth N79-30199 ALUMINUM OXIDES Metal-matrix composite structures [AHS 79-34] 179-49086 AMPHIBIOUS VEHICLES The principles of hovercraft, powering and propulsion 179-47844 ANALOG CIRCUITS A Navy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design A79-48870 ANALOG TO DIGITAL CONVERTERS Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness --- in airborne radar systems A79-48621 The impact of software in automatic test equipment --- for evaluation of radar analog to digital converter 179-48691 ANGLE OF ATTACK Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack A79-47943 An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack A79-50165 The evolution of the high-angle-of-attack features of the P-16 flight control system A79-50438 Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 1: Technical discussion and analysis of results N79-30148 F AD-A0696461 Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 2: Data hase [ AD-A069647 ] N79-30149 A summary of AGARD FDP meeting on dynamic stability parameters --- advanced aircraft performance at high angle of attack N79-30220 Rotary balance data for a single-engine trainer design for an angle-of-attack range of 8 deg to 90 deg --- conducted in langely spin tunnel [NASA-CR-3099] N79-31152 ANGULAR DISTRIBUTION Determination of turning angle of a jet impinging on a bucket with visor --- for thrust reversers A79-48500 ANNULAR PLOY The inner regions of annular jets A79-47520 ANNULAR NOZZLES Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic

A-9

prediction procedures [NASA-CR-3168]

#### ANTENNA ARRAYS

SUBJECT INDEX

ANTENNA ARRAYS Adaptive array tradeoffs for existing airborne UHF radios A79-48598 ANTENNA DESTGN Multiband antenna --- for tactical naval aircraft A79-48596 Small lightweight electronically steerable cylindrical antenna successfully utilized in an air traffic management system A79-48597 Antennas for the Black Hawk helicopter [AHS 79-15] A report on the Sperry Dome Radar A79-49068 A79-49567 ANTENNA RADIATION PATTERNS Adaptive array tradeoffs for existing airborne UHF radios A79-48598 Radiation from guarter-wavelength monopoles on finite cylindrical, conical, and rocket-shaped conducting bodies --- airborne antenna design A79-50606 ANTIPRICTION BEARINGS Self-contained grease lubrication systems for aircraft applications [AHS 79-39] A79-49091 The Sikorsky elastomeric rotor --- helicopter rotor bearings [AHS 79-48] A79 A79-49100 APPROACH Driftdown calculations for the PH/227D aircraft [SAND-78-1807] N Flight experience with advanced controls and N79-30182 displays during piloted curved decelerating approaches in a powered-lift STOL aircraft N79-30243 APPROACH CONTROL Advances in decelerating steep approach and landing for helicopter instrument approaches [AHS 79-16] A79 A79-49069 Project NAVTOLAND (Navy vertical takeoff and landing capability development) N79-30212 **APPROXTHATTON** On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics 179-47001 ARCHITECTURE (COMPUTERS) Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for advanced architectures using MIL-STD-1553B A79-48629 Radar signal processing development for application of VHSI A79-48664 ARMOR Crashworthy armored crewseat for the UH-60A Black Havk [AHS 79-10] A79-49062 ARRESTING GEAR Recent progress in aircraft sink rate measurement [AIAA PAPER 79-1798] A79-47 A79-47884 ARROW WINGS Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I 179-46999 Overall aerodynamic characteristics of caret and delta wings at superscnic speeds A79-47012 Theoretical and experimental investigation of ground-induced effects for a low-aspect-ratio highly swept arrow-wing configuration [NASA-TP-1508] N79-31223 ASPECT RATIO The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow A79-47099 ASPHALT An evaluation of asphalt-rubber mixtures for use in pavement systems [AD-A069448] N79-30246

ATMOSPHERIC EFFECTS Correlation technique for ambient effects on oxides of nitrogen --- from combustion products in atmospheric pollution A79-49922 ATMOSPHERIC ELECTRICITY Atmospheric Electricity Hazard (AEH) [AD-A069338] N79-301 Lightning hazards overview: Aviation requirements N79-30169 and interests N79-30876 ATROSPHERIC TURBULENCE Aircraft response to windshears and downdraughts N79-30229 ATTITUDE CONTROL Microcomputer applications in strapdown heading and attitude reference system A79-48606 ATTITUDE INDICATORS F/A-18 Hornet display system 179-48630 ATTITUDE STABILITY Comment on 'Flight test of stick force stability in attitude-stabilized aircraft A79-49925 AUTOMATIC CONTROL Automated tracking for aircraft surveillance radar systems A79-49604 Modern systems for air traffic control A79-50921 Structural aspects of active controls N79-30221 Dynamic windtunnel simulation of active control systems N79-30233 Central flow control software design document. Volume 1: Operational software complex --automation support to the Air Traffic Control System Command Center [ AD-A070973] N79-30959 [10] NOISI (NY)-Central flow control software design document. Volume 2: Support software complex ---automation support to the Air Traffic Control System Command Center. [AD-A070771] N79-30960 AUTOMATIC FLIGHT CONTROL Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AHS 79-26] A79-4907 The evolution of the high-angle-of-attack features A79-49078 of the F-16 flight control system A79-50438 Stability and control --- conferences [AGARD-CP-260] N79-30218 Systems implications of active controls N79-30219 Enhanced fighter mission effectiveness by use of integrated flight systems N79-30223 Improvement of fighter aircraft maneuverability through employment of control configured vehicle technology N79-30225 L-1011 active controls, design philosophy and experience N79-30236 Flight performance of the TCV B-737 airplane at Kennedy Airport using TRSB/MLS guidance [NASA-TM-80148] N79-31186 AUTONATIC LANDING CONTROL The T & E simulator - A comparison with flight test results A79-50169 VTOL controls for shipboard landing [NASA-CR-162140] AUTOMATIC PILOTS N79-30193 An improved method for load survey flight testing --- of military cargo aircraft [AIAA PAPER 79-1799] A79-478 Microprocessor-based digital autopilot development A79-47885 for the XBQM-106 Mini-RPV 179-48608 Some aspects of the design and development of the maritime autopilot modes for the Westland Lynx helicopter

N79-30201

AUTOHATIC TEST EQUIPHENT Test implementation through support software - A FIT translator automated Fault Isolation	A real time video bandwidth reduction system based on a CCD Radamard transform device for avionics
Tests on airborne radar system A79-48687 Automatic test software for calibrating strapdown	A79-48702 Integrated CNI avionics ECM-resistant Communication, Navigation and Identification
systems A79-48689	A79-48711 AN/USM-449/V/ ATE for worldwide support of the P3
Automatic test program generation selection for aircraft structures A79-48690	Orion A79-48884 Can avionic testability requirements be enforced
The impact of software in automatic test equipment for evaluation of radar analog to digital converter	A79-48887 Avionics design for testability - An aircraft contractor's viewpoint
۸79-48691 ۸ Navy plan for the development of a practical	A79-48888 Avionics design for testability - A vendor's
computer-aided programming /CAP/ system for analog circuit test design	viewpoint A79-48889
A79-48870 Air Force modular automatic test equipment development program	Testability, the key to economical and operationally effective avionic test software A79-48890
A79-48878 ATE and aircraft mechanical diagnostics	Techniques for fault isolation ambiguity reduction in military avionics
A79-48883	A79-48891
AN/USH-449/V/ ATE for worldwide support of the P3 Orion A79-48884	F-16 avionics maintenance concept and multinational aspects A79-48894
Can avionic testability requirements be enforced	Helmet mounted display and sight development
A79-48887 Avionics design for testability - A vendor's viewpoint	[AHS 79-17] A79-49070 NASA/Princeton digital avionics flight test facility A79-49344
A79-48889	Reliability improvement warranty terms and
Testability, the key to economical and operationally effective avionic test software	conditions for the Integrated Avionics Control Systems (IACS)
A79-48890 Techniques for fault isolation ambiguity reduction	[AD-A069454] N79-31205 State of the art in digital signal processing with
in military avionics	applications to multiple access systems
A79-48891 F-16 depot automatic test equipment	N79-31487 AXIAL FLOW TURBINES
A79-48895 A new U.U.T./test station interface	Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of
A79-48896	interference from nearby cascades
AVIONICS F-16 Avionics Intermediate Shop /AIS/ Interim	A79-48572 Aerodynamic performance of 1.38-pressure-ratio,
Contractor Support initiatives FAINA PAPER 79-1868] A79-47923	<pre>variable-pitch fan stage [NASA-TP-1502] N79-31213</pre>
Avionics computer software operation and support cost estimation	Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles to
A79-48620 Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for	be used on vertical lift aircraft [NASA-TP-1510] N79-31214
advanced architectures using MIL-STD-1553E A79-48629	В
The effect of standardization of avionics software quality assurance	B-1 AIRCRAFT Separation testing of large weapons from the B-1
A79-48648	bomber
Power hybridization - Key to reducing avionics power supply weight and volume	A79-50429 Systems implications of active controls
A79-48652	N79-30219 BACKSCATTERING
Verification of operational flight programs by simulation	Radar cross section fundamentals for the aircraft
A79-48667 Computer Monitor and Control - A flexible,	designer [AIAA PAPER 79-1818] A79-47898
cost-effective implementation A79-48670	BALANCING Computer-assisted high-speed balancing of T53 and
Evolving methods for reducing avionics data in an AISF environment Avionics Integration	T55 power turbines [AHS 79-36] A79-49088 PATLAST (NASC)
Suppport Facility flight program testing A79-48671	BALLAST (MASS) Previsions and experimental results in open
Microcomputer control of a test facility for avionics	balloon controlled descent N79-31691
A79-48672 Operational experience with the AN/ARN-131 Omega	BALLOON FLIGHT Transatlantic flights of stratospheric balloons
Navigation Set A79-48676	N79-31687 Previsions and experimental results in open
Pave Low III H-53 helicopter avionics for night/adverse weather rescue of military aircraft	balloon controlled descent N79-31691
A79-48682 H-X combat search and rescue avionics study results	BALLOONS Lighter than air vehicles. Citations from the
A79-43684 Terrain-following radar - Key to low-altitude flight	NTIS data base [NTIS/PS-79/0471/7] Lister the meticles Situations from the
۸79-48686 Test implementation through support software – ۸	Lighter than air vehicles. Citations from the Engineering Index data base
PIT translator automated Pault Isolation Tests on airborne radar system	[NTIS/PS-79/0472/5] N79-30163 BEARINGLESS ROTORS
A79-48687	Full scale ground and air resonance testing of the
Rapid reaction time techniques for a strapdown navigator employing electrostatic gyro technology A79-48697	Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-49075

#### BELL AIBCRAFT

SUBJECT INDEX

BELL AIRCRAFT Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST [AHS 79-27] A79-4907 A79-49079 The Bell Model 222 A79-49816 BESSEL FUNCTIONS Stabilizing electro-optical systems on helicopters N79-30216 BIBLIOGRAPHIES Lighter than air vehicles. Citations from the NTIS data base [NTIS/PS-79/0471/7] N79 N79-30162 Lighter than air vehicles. Citations from the Engineering Index data base [NTIS/PS-79/0472/5] N79-30163 BIRD-AIRCRAFT COLLISIONS An evaluation of the bird aircraft strike hazard at Hill AFB, Utah (AFLC) [AD-A070459] BLADE TIPS N79-31184 Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover [AHS 79-1] A79-49054 The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 N79-31137 BLAST DEFLECTORS Noise generation by jet-engine exhaust deflection [DLR-PB-78-21] N79-30192 BLOWING Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control [AIAA PAPER 79-1163] BODY-WING AND TAIL CONFIGURATIONS A79-47347 Benefits of aerodynamic interaction to the three SURFACE CONFIGURATION [AIAA PAPER 79-1830] BOBING 707 AIRCRAFT A79-47904 Lusaka accident report A79-50109 BORING 737 AIRCRAFT Airport flammability, full scale fire tests N79-31167 Status of candidate materials for full-scale tests in the 737 fuselage N79-31170 BOEING 747 AIRCRAFT High-performance reinforced plastic structures for civil aviation A79-47302 Special investigation report: Wing failure of Boeing 747-131 near Madrid, Spain, 9 May 1976 [NTSB-ARF-78-12] N79-30167 BOMBER AIRCRAFT Manned strategic system concepts 1990-2000 [AIAA PAPER 79-1793] A79-47882 BONBING EQUIPMENT Evaluation of P-111 weapon bay aero-acoustic and weapon separation improvement techniques [AD-A070253] N79-3 N79-31203 BOUNDARY LAYER CONTROL Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control [AIAA PAPER 79-1163] A79-A79-47347 Plight testing the circulation control wing [AIAA PAPER 79-1791] A79-47880 Boundary layer control on wings using sound and leading edge serrations [AIAA PAPER 79-1875] A79-4792 Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind 179-47926 tunnel [NASA-CR-159120] N79-31143 BOUNDARY LAYER EQUATIONS Linearization of the boundary-layer equations of the minimum time-to-climb problem A79-49869 BOUNDARY LAYER SEPARATION Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind tunnel [NASA-CR-159120] N79-31143 BOUNDARY LAYER STABILITY Mechanics of boundary layer transition, part 2: Instability and transition to turbulence [VKI-LECTURE-SERIES-3-PT-2] ₩79-31530

BOUNDARY LAYER TRANSITION Mechanics of boundary layer transition, part 2: Instability and transition to turbulence [VKI-LECTUBE-SERIES-3-PT-2] N79-3 N79-31530 BOUNDARY LAYERS Experimental measurements of shock/boundary-layer interaction of a supercritical airfoil [AIAA PAPER 79-1499] 179-47345 BOUNDARY VALUE PROBLEMS Linearization of the boundary-layer equations of the minimum time-to-climb problem A79-49869 Solution of a mixed boundary value problem for flow past a thin delta wing A79-49882 BUOYANCY The feasibility of modern dirigibles [ONERA, TP NO. 1979-93] A79-49541 С C-5 AIRCRAFT Systems implications of active controls N79-30219 C-130 AIRCRAFT Operational experience with the AN/ARN-131 Omega Navigation Set 179-48676 C-135 AIRCRAFT ARIA takeoff performance flight test program ---Advanced Range Instrumented Aircraft A79-50437 C-141 AIRCRAFT Dutch roll excitation and recovery techniques on a C-141A Starlifter [ATAM PAPEB 79-1801] A79-476 The design of digital controllers for the C-141 aircraft using entire eigenstructure assignment and the development of an interactive computer A79-47886 design program [AD-A069192] N79-31224 CALIBRATING Automatic test software for calibrating strapdown systems . 179-48689 A low-velocity airflow calibration and research facility [PB-294501/2] N79-31237 CANARD CONFIGURATIONS Benefits of aerodynamic interaction to the three surface configuration [AIAA PAPER 79-1830] A79-47904 Aerodynamic interaction on a close-coupled canard-wing configuration [ONERA, TP NO. 1979-95] A79-49543 CANOPIES Windshield technology demonstrator program-canopy detail design options study [AD-A070376] N79-31 N79-31201 CARBON DIOXIDE LASERS Multifunction CO2 heterodyning laser radar for low level tactical operations A79-48685 Heterodyning CO2 laser radar for airborne applications ₩79-30205 CARBON FIBER REINFORCED PLASTICS Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements --- space shuttle aft body flap N79-30301 High performance composites and adhesives for V/STOL aircraft [AD-A069611] N79-30332 CARET WINGS Overall aerodynamic characteristics of caret and delta wings at supersonic speeds A79-47012 CARGO AIRCRAFT AIRCHAFT
 Identifying desirable design features for the C-XX aircraft - A systems approach
 [AIAA PAPER 79-1796] A79-4788
 An improved method for load survey flight testing
 --- of military cargo aircraft
 [AIAA PAPER 79-1799] A79-4788
 Blown wings from Kiev --- short takeoff and
 landing through wings-morphologing A79-47883 A79-47885 landing through wing-overblowing A79-49232

#### SUBJECT INDEX

#### COMPETITION

Current Canadian developments related to low-speed heavy lift ACV A79-49915 CASCADE FLOW On the influence of relative pitch in the subsonic turbine cascade A79-48503 Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of interference from nearby cascades 179-48572 CATASTROPHE THEORY Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack 179-17913 CH-47 HELICOPTER Helicopter high grain control [NASA-CR-159052] N79-31221 CHARGE COUPLED DEVICES A real time video bandwidth reduction system based on a CCD Hadamard transform device --- for avionics A79-48702 CHORDS (GEOMETRY) On the influence of relative pitch in the subsonic turbine cascade A79-48503 CIRCUIT PROTECTION Airport power supply --- Russian book ▲79-50499 Lightning hazards overview: Aviation requirements and interests N79-30876 CIRCULATION CONTROL ROTORS Flight testing the circulation control wing [AIAA PAPER 79-1791] A79-4786 Design and development of a hybrid composite rotor A79-47880 blade for the circulation control rotor system [AHS 79-46] A79-49098 The circulation control rotor flight demonstrator test program [AHS 79-51] A79-49103 CIVIL AVIATION Aerospatiale AS.350 and AS.355 A79-49814 CLIMBING FLIGHT A lifting-surface method for hover/climb airloads A79-49056 [AHS 79-3] Linearization of the boundary-layer equations of the minimum time-to-climb problem 179-49869 COAL GASIFICATION Lockheed urges hydrogen fuel A79-49224 COANDA EFFECT Flight testing the circulation control wing [ATAA PAPER 79-1791] Design of the circulation control wing STOL demonstrator aircraft A79-47880 [ATAA PAPER 79-1842] Blown wings from Kiev --- short takeoff and landing through wing-overblowing A79-47909 A79-49232 COCKPITS Real time weather display in the general aviation cockpit [AINA PAPER 79-1821] A79-47901 COLLISION AVOIDANCE A self contained collision avoidance system for helicopters N79-30206 COMBRISTIBLE FLOW Experimental study of the turbulent wake downstream of a fan jet A79-48507 COMBUSTION CHAMBERS The application of multiple swirl modules in the design and development of gas turbine combustors [AIAA PAPER 79-1196] A79-473 A79-47349 Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics A79-48495 Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TM-75430] N79-31 N79-31206

Experimental Clean Combustor Program (ECCP), phase 3 --- commercial aircraft turbofan engine tests with double annular combustor N79-31207 [NASA-CR-135384] COMBUSTION CONTROL The application of multiple swirl modules in the design and development of gas turbine combustors [AIAA PAPER 79-1196] A79-4734 Evaluation of airfield pavement materials based on A79-47349 synthetic polymers 179-49348 Aircraft engine developments centre on improved performance, higher efficiency A79-50207 CONBUSTION EFFICIENCY The application of multiple swirl modules in the design and development of gas turbine combustors {AIAA PAPER 79-1196] A79-473 A79-47349 CONBUSTION PHYSICS Factors controlling stability of swirling flames at diffusers in gas turbines A79-50209 COMBUSTION PRODUCTS Busilin of airfield pavement materials based on synthetic polymers A79-49348 Correlation technique for ambient effects on oxides of nitrogen --- from combustion products in atmospheric pollution A79-49922 Ultrasonic method of gun gas detection --- for engine ingestion prevention in F-15 A79-50166 Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] Recent advances in materials toxicology N79-30490 N79-31169 COMMAND AND CONTROL E-4B mission electrical power A79-48617 Dynamic simulator test and evaluation of a JTIDS relative navigation system --- Joint Tactical Information Distribution System 179-48694 Distributed TDMA - An approach to JTIDS phase II --- Time Division Multiple Access Joint Tactical Information Distribution System A79-49584 An advanced guidance and control system for rescue helicopters N79-30217 COMMERCIAL AIRCRAFT Design criteria for airline operation [AIAA PAPER 79-1849] A7 Pinancing the capital requirements of the US airline industry in the 1980's A79-49337 N79-30164 Development of fire-resistant, low smoke generating, thermally stable end items for commercial aircraft and spacecraft using a basic polyimide resin N79-31171 Experimental Clean Combustor Program (ECCP), phase 3 --- commercial aircraft turbofan engine tests with double annular combustor [NASA-CR-135384] N79-31207 COMMUNICATION EQUIPMENT Multiband antenna --- for tactical naval aircraft A79-48596 E-4B mission electrical power 179-48617 COMMUNICATION NETWORKS A digital communication system as gateway between adjacent computerized air traffic control centres N79-31463 Implementing JTIDS in tactical aircraft N79-31491 COMPRETETION International Air Transportation Competition Act of 1978 --- congressional reports f GP0-34-9121 N79-30168

#### COMPLEX SYSTEMS

#### SUBJECT INDEX

COMPLEX SYSTEMS Analysis design of complex systems. II --- for simultaneous improvement of all basic prototype flight vehicle performance characteristics .s 179-48505 COMPONENT RELEASETITY F-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives [AIAA PAPER 79-1868] 179-117923 Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A A79-49101 Relicopter drive system R and M design guide N79-30191 [AD-A069691] COMPOSITE MATERIALS High-performance reinforced plastic structures for civil aviation 179-47302 Fatigue and fracture N79-30315 Mechanical and thermophysical properties of graphite/polyimide composite materials N79-30317 The fluorenone polyester ISO FPE of Isovolta Company, Austria N79-31183 COMPOSITE STRUCTURES Composite helicopter tail booms [AHS 79-91 179-49061 [AHS 79-9] Model 206L composite litter door [AHS 79-31] 179-49083 Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system [AHS 79-35] A7 Certification of composites in civil aircraft 179-49087 [AHS 79-43] [Aus 79-43] [Qualification program of the composite main rotor blade for the Model 214B helicopter [AHS 79-44] [AHS 79-44] A79-49095 A79-49096 Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter [AHS 79-45] A79-49097 Ultra-high-modulus graphite-epoxy conical shell development, supplement [AD-A069795] N79-N79-30335 Thermal characteristics of 3501-6/AS and 5208/T300 graphite epoxy composites [AD-A071067] N79-31357 COMPRESSOR BLADES Aerodynamic performance of 1.38-pressure-ratio, variable-pitch fan stage [NASA-TP-1502] N79-N79-31213 COMPRESSOR EFFICIENCY Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor [ONERA, TP NO. 1979-30] A79-509 179-50925 COMPRESSOR BOTORS Performance of two-stage fan with a first-stage rotor redesigned to account for the presence of a part-span damper [NASA-TP-1483] N79-30191 COMPUTATIONAL PLUID DYNAMICS The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow A79-47099 Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils [AIAA PAPER 79-1555] A79-47342 Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] An integrated analytical and experimental A79-47925 investigation of helicopter hub drag [AHS 79-51 179-49058 Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave 179-49456 Dynamic loads analysis system (DYLOFLEX) summary. Volume 2: Suppl [NASA-CR-2846-2] Supplemental system design information N79-31145 COMPUTER GRAPHICS Geometric data transfer --- for computerized aircraft engineering drawings [AIAA PAPER 79-1844] A79-47910

CADAM data handling from conceptual design through produce support [AIAA PAPER 79-1846] INACT - Interactive test data analysis ---A79-47912 with minicomputers A79-50430 Modern systems for air traffic control A79-50921 CONDUCTER PROGRAMMING A Navy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design A79-48870 Modal interpolation program, L215(INTERP). Volume 2: Supplemental system design and maintenance document --- to calculate displacements at several points on an aerodynamic surface [NASA-CR-2848] N79-31147 COMPUTER PROGRAMS Avionics computer software operation and support cost estimation A79-48620 a/3-40 est implementation through support software - A FIT translator --- automated Fault Isolation Test Tests on airborne radar system 179-18697 The impact of software in automatic test equipment -- for evaluation of radar analog to digital converter 179-48691 Testability, the key to economical and operationally effective avionic test software 179-48890 F-16 depot automatic test equipment A79-48895 Role of Numerical Control Design in the computer aided design/manufacturing interface at Sikorsky [AHS 79-30] A79-49082 A computer program for aircraft identification and derivative extraction A79-50306 Naval aircraft operating and support cost-estimating model, FY 1977 revision [AD-A068175] N79-30140 Maintenance improvement: An analysis approach including inferential technical data --- nav - naval aircraft [AD-A068382] N79-30141 Driftdown calculations for the FH/227D aircraft [SAND-78-1807] N79-N79-30182 Dynamic loads analysis system (DYLOFLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-31144 [NASA CR-2040-1] Dynamic loads analysis system (DYLOFLEX) summary. Volume 2: Supplemental system design information [NASA-CR-2846-2] N79-3114 N79-31145 A program to compute three-dimensional subsonic unsteady aerodynamic characteristics using the doublet lattice method, L216 (DUBFLEX). Volum 2: Supplemental system design and maintenance Volume document [ NASA-CR-2850] N79-31148 ATLAS, an integrated structural analysis and design system. Volume 5: System demonstration problems [NASA-CR-159045] COMPUTER SYSTEMS DESIGN N79-31624 JTIDS relative navigation - Architecture, error characteristics and operational benefits Joint Tactical Information Distribution System A79-48715 A computer system for identifying aircraft characteristics 179-50168 Modern systems for air traffic control A79-50921 Central flow control software design document. Volume 1: Operational software complex ---automation support to the Air Traffic Control System Command Center [AD-A070973] N79-30959 Central flow control software design document. volume 2: Support software complex ----automation support to the Air Traffic Control System Command Center. [AD-A070771] N79-30960

#### SUBJECT INDEX

CONICAL BODIES

Modal interpolation program, L215(INTERP). Volume 2: Supplemental system design and maintenance document --- to calculate displacements at several points on an aerodynamic surface [NASA-CR-2848] N79-3 Equation modifying program, L219 (EQMOD). Volume 2: Supplemental system design and maintenance N79-31147 document. [NASA-CR-2856] N79-31153 Time history solution program, L225 (TEV126). Volume 2: Supplemental system design and maintenance document --- for airplane dynamic response using frequency response data [NASA-CR-2860] N79-31154 [NASA-CR-2860] N/9-3 A program for calculating load coefficient matrices utilizing the force summation method, L218 (LOADS). Volume 2: Supplemental system design and maintenance document [NASA-CR-2854] N79-3 N79-31155 COMPUTER SYSTEMS PROGRAMS The effect of standardization of avionics software quality assurance A79-48648 Automatic test software for calibrating strapdown svstems A79-48689 E-3A sentry /AWACS/ ATPG --- Automatic Test Program Generation A79-48873 Central flow control software design document. Volume 1: Operational software complex ---automation support to the Air Traffic Control System Command Center [AD-A070973] N79-30959 Central flow control software design document. Volume 2: Support software complex ---automation support to the Air Traffic Control System Command Center. [ AD-A070771] N79-30960 COMPUTER TECHNIQUES Computer-assisted high-speed balancing of T53 and T55 power turbines [AHS 79-36] A79-49088 simplified gross thrust computing technique for an afterburning turbofan engine 179-50440 COMPUTERIZED DESIGN Solution of the inverse aerodynamics problem by the random search method A79-47002 Engineering and manufacturing communication via the computer data base [AIAA PAPER 79-1845] A79-179-47911 CADAM data handling from conceptual design through produce support [AIAA PAPER 79-1846] A79-479 Microprocessor-based digital autopilot development A79-47912 for the XBQM-106 Mini-RPV A79-48608 A system for interdisciplinary analysis - A key to improved rotorcraft design [AHS 79-8] A79-49 Role of Numerical Control Design in the computer A79-49060 aided design/manufacturing interface at Sikorsky [ARS 79-30] Application of finite-element and holographic techniques in the design of turboshaft engine 179-49082 components [AHS 79-41] A79 Evaluation of finite element formulations for A79-49093 transient conduction forced-convection analysis A79-49343 Recent applications of theoretical analysis to V/STOL inlet design A79-49530 The design of digital controllers for the C-141 aircraft using entire eigenstructure assignment and the development of an interactive computer design program [AD-AO69192] N79-312 COMPUTERIZED SIMULATION CADAM data handling from conceptual design through N79-31224 [AIAA PAPER 79-1846] A79-Verification of operational flight programs by A79-47912 simulation A79-48667

Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes A79-49580 A simulation of amphibious hovercraft overturning A79-49904 Performance predictions for open ocean air cushion vehicles and surface effect ships A79-49905 A computer system for identifying aircraft characteristics A79-50168 ONERA's model of the pilot in discrete time N79-30242 The design of digital controllers for the C-141 aircraft using entire eigenstructure assignment and the development of an interactive computer design program [AD-A069192] N79-31224 Tactical performance characterization basic methodology [AD-A069297] N79-31235 Investigation on information error caused by traffic loading in approach and landing systems N79-31480 CONCORDE AIRCRAFT Results related to simulated and in-flight system that can be generalized N79-30224 A comparison of predictions obtained from wind tunnel tests and the results from cruising flight: Airbus and Concorde --- conferences [NASA-TM-75238] N79 N79-31136 [NASA-TA-75256] Supersonic transport vis-a-vis energy savings [NASA-TM-75464] N7 N79-31163 CONDUCTIVE HEAT TRANSFER Most rational linearization of nonlinear unsteady heat conduction problems --- for flight vehicle parts and engines 179-48501 Evaluation of finite element formulations for transient conduction forced-convection analysis 179-49343 CONFERENCES The Guidance and control of Helicopters and V/STOL aircraft at night and in poor visibility [AGARD-CP-258] N79-30198 [AGARD-CP-260] [AGARD-CP-260] N79-30218 [AGARD-CP-260] N79-A comparison of predictions obtained from wind tunnel tests and the results from cruising flight: Airbus and Concorde --- conferences [NASA-TM-75236] N79-Conference on Fire Resistant Materials: A N79-31136 compilation of presentations and papers [NASA-CP-2094] CONFIGURATION HANAGENEET N79-31166 Identifying desirable design features for the C-XX aircraft - A systems approach [AIAA PAPER 79-1796] A79-4786 A79-47883 CADAM data handling from conceptual design through produce support [AIAA PAPER 79-1846] A79-47912 Runway configuration management system concepts [AD-A069960] N79-31234 CONFORMAL MAPPING Analytic formulas for wing profile aerodynamic characteristics in incompressible flow A79-47000 CONGRESSIONAL REPORTS International Air Transportation Competition Act of 1978 --- congressional reports [GP0-34-912] N79-30168 Enforcer aircraft [GP0-32-569] N79-30174 CONICAL BODIES Overall aerodynamic characteristics of caret and delta wings at supersonic speeds A79-47012 Radiation from guarter-wavelength monopoles on conducting bodies --- airborne antenna design A79-50606 Oltra-high-modulus graphite-epoxy conical shell development, supplement [AD-A069795] N79-30335

#### CONSISTENCY

CONSISTENCY Achieving consistency in the production of critical jet engine components by means of press forging A79-48945 CONTINUOUS WAVE BADAB The servoed modulation FMCW radar altimeters in military applications A79-49589 CONTOURS Determining the contour of helicopter rotor blades automatically using electro-optical techniques [AHS 79-32] A79-49084 CONTRACT MANAGEMENT Avionics design for testability - An aircraft contractor's viewpoint 179-48888 CONTRACTORS P-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives [AIAA PAPEB 79-1868] A7 179-47923 CONTROL BOARDS Design procedure for aircrew station labeling selection and abbreviation N79-30208 The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 CONTROL CONFIGURED VEHICLES From HiNAT to future fighters --- Highly Maneuverable Aircraft Technology assessment [AIAA PAPER 79-1816] A7 A79-47896 A microprocessor system for flight control research A79-48623 Application of Lagrange Optimization to the drag polar utilizing experimental data [AIAA PAPER 79-1833] A79-49335 A computer program for aircraft identification and derivative extraction A79-50306 Stability and control --- conferences [AGARD-CP-260] N79-30218 Systems implications of active controls N79-30219 Structural aspects of active controls N79-30221 Enhanced fighter mission effectiveness by use of integrated flight systems N79-30223 Improvement of fighter aircraft maneuverability through employment of control configured vehicle technology N79-30225 Stability and control aspects of the CCV-F104C N79-30234 Design guidance from fighter CCV flight evaluations N79-30235 A simulator investigation of handling quality criteria for CCV transport aircraft N79-30240 CONTROL BOUIPHENT The equipment-system interface in an antitank helicopter at night N79-30211 Flight experience with advanced controls and displays during piloted curved decelerating approaches in a powered-lift STOL aircraft N79-30243 Helicopter high grain control [NASA-CR-159052] N79 CONTROL SINULATION Predictive guidance for interceptors with time N79-31221 delavs 179-47939 A status report on the advanced FIREFLY assessment program A79-48609 Results related to simulated and in-flight experimentation with an electric flight control system that can be generalized N79-30224 CONTROL STABILITY An improved method for load survey flight testing --- of military cargo aircraft [AIAA PAPER 79-1799] A79-47 Benefits of aerodynamic interaction to the three A79-47885 surface configuration [AIAA PAPER 79-1830] A79-47904

Synthesis of digital flight control tracking systems by the method of entire eigenstructure assignment A79-48625 Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AHS 79-26] An evaluation of sidestick force/deflection A79-49078 characteristics on aircraft handling gualities A79-50428 Stability and control --- conferences [AGARD-CP-260] N79-30218 Structural aspects of active controls N79-30221 CONTROL STICKS Comment on 'Flight test of stick force stability in attitude-stabilized aircraft A79-49925 An evaluation of sidestick force/deflection characteristics on aircraft handling qualities A79-50428 CONTROL SURPACES Benefits of aerodynamic interaction to the three surface configuration [AIAA PAPER 79-1830] A79-47904 The DC-9 Super 80 - Much more than a simple stretch A79-49223 Wind-tunnel investigation of an armed mini remotely piloted vehicle --- conducted in Langley V/STOL tunnel [NASA-TM-80132] N79-31151 CONTROL THEORY Analysis design of complex systems. II --- for simultaneous improvement of all basic prototype flight vehicle performance characteristics A79-48505 VTOL controls for shipboard landing [NASA-CR-162140] Helicopter high grain control [NASA-CR-159052] N79-30193 N79-31221 Investigation of inverse Vandermonde matrix calculation for linear system applications ---adaptive flight control systems [AD-A069241] N79-31225 Path controllers: Unification of concepts and comparison of design methods [AD-A070252] N79-31227 CONTROL VALVES Pluidics: Peasibility study electro/hydraulic/fluidic direct drive servo valve [AD-A069798] N79-30195 CONTROLLABILITY Spirit helicopter handling gualities design and development [AHS 79-24] A79-49076 Handling quality and display requirements for low speed and hover in reduced flight visibility [AHS 79-29] A79-49081 The influence of engine/fuel control design on helicopter dynamics and handling qualities [AHS 79-37] A79. A79-49089 Plight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics 179-49818 A simulator investigation of handling quality criteria for CCV transport aircraft N79-30240 Ride qualities criteria validation/pilot performance study: Plight test results [NASA-CR-144885] N79-31193 Analysis of a lateral pilot-induced oscillation experienced on the first flight of the YF-16 aircraft [NASA-TM-72867] N79-31220 A compilation and analysis of helicopter handling qualities data. [NASA-CR-3145] Volume 2: Data analysis N79-31222 CONTROLLERS Investigations on the design of active vibration isolation systems for helicopters with rigid and elastic modeling of the fuselage [DLR-FB-78-04] N79-30183 An in-flight controller insensitive to parameters variation [ DLR-FB-78-07 ] N79-30197

A-16

CONVERGENT-DIVERGENT NOZZLES Experiments of shock associated noise of supersonic jets [AIAA PAPER 79-1526] A79-47341 CONVETORS A combined air-cushion and endless belt transportation system A79-49911 COOLING SYSTEMS Drag reduction by cooling in hydrogen-fueled aircraft A79-49921 COORDINATE TRANSFORMATIONS Complex quaternion notation in coordinate transformations --- missile launching aircraft-inertial space transformations A79-48681 CORRECTION Wall corrections in transonic wind tunnel: Equivalent porosity [ESA-TT-545] N79-30247 COST EFFECTIVENESS A cheap, effective icing detector for general aviation aircraft A79-47902 [AIAA PAPER 79-1823] COST ESTIMATES Air buoyant vehicles - Energy efficient aircraft [AIAA PAPER 79-1862] A79-47919 Avionics computer software operation and support cost estimation A79-48620 Lockheed urges hydrogen fuel A79-49224 Aircraft engine developments centre on improved performance, higher efficiency A79-50207 Maintenance cost study of rotary wing aircraft, phase 2 [NASA-CR-152291] N79-30138 Naval aircraft operating and support cost-estimating model, FY 1977 revision [AD-A068175] N79-30140 COST REDUCTION ST REDUCTION
 New versus existing engines for new helicopter systems - A life cycle cost view

 [AINA PAPER 79-1316]
 Avy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design

 A79-47348 A79-48870 Ten years of Aerospatiale experience with the fenestron and conventional tail rotor 179-49108 [AHS 79-58] Small hovercraft design - Evolution to simplicity 179-49906 Derivative engines for the 1980s will help limit acquisition and maintenance costs 179-50206 Flight test technology development - A preview of DyMoTech --- dynamic modeling 179-50435 CRACK PROPAGATION Effect of transport/bomber loads spectrum on crack growth N79-31197 [AD-A069287] user's manual for a computer program to generate fatigue spectrum loading sequences [AD-A069288] N79-3119 N79-31198 CRASH LANDING Crashworthy armored crewseat for the UH-60A Black Hawk A79-49062 [AHS 79-10] Fuselage ventilation under wind conditions N79-31175 CRASHES. Special investigation report: Wing failure of Boeing 747-131 near Madrid, Spain, 9 May 1976 [NTSB-MAR-78-12] N79-N79-30167 CRITERIA A simulator investigation of handling quality criteria for CCV transport aircraft N79-30240 CROSS COUPLING Considerations in the analysis of flight test maneuvers A79-50433

CRUISING PLIGHT Aircraft longitudinal motion at high incidence A79-48052 DC 9 AIRCRAFT

A79-49223

CUSHIONS Seat cushion to provide realistic acceleration cues to aircraft simulator pilot [NASA-CASE-LAR-12149-2] N79-31228 CYLINDRICAL ANTENNAS Small lightweight electronically steerable cylindrical antenna successfully utilized in an air traffic management system A79-48597 CYLINDRICAL BODIES Radiation from guarter-wavelength monopoles on finite cylindrical, conical, and rocket-shaped conducting bodies --- airborne antenna design A79-50606 D DAMPING

Theoretical flap-lag damping with various dynamic inflow models [AHS 79-20] DATA ACQUISITION A79-49073 Some flight data extraction techniques used on a general aviation spin research aircraft [AIAA PAPER 79-1802] A computer system for identifying aircraft A79-47887 characteristics A79-50168 DATA BASES Engineering and manufacturing communication via the computer data base [AIAA PAPER 79-1845] A79-47911 Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 2: Data hase [AD-A069647] N79-30149 DATA COMPRESSION A real time video bandwidth reduction system based on a CCD Hadamard transform device --- for avionics A79-48702 Real time compression of video signals --protection against jamming A79-48712 DATA CORRELATION Correlation of data related to shock-induced trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] DATA LINKS N79-31195 JTIDS relative navigation - Architecture, error characteristics and operational benefits ---Joint Tactical Information Distribution System A79-48715 An asynchronous data transmission system with low error probability for the SETAC landing aid N79-31468 Performance predictions and trials of a helicopter UHF data link N79-31476 DATA MANAGEBERT Geometric data transfer --- for computerized aircraft engineering drawings A79-47910 [AIAA PAPER 79-1844] DATA PROCESSING INACT - Interactive test data analysis --- with minicomputers A79-50430 AFFTC parameter identification experience --- Air Force Flight Test Center aircraft flight testing A79-50434 DATA SYSTEMS Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing [AHS 79-50] A79 A79-49102 Aeronautical information data subsystems /AIDS/ 179-50920 DATA TRANSMISSION Distributed TDMA - An approach to JTIDS phase II --- Time Division Multiple Access Joint Tactical Information Distribution System A79-49584 A digital communication system as gateway between adjacent computerized air traffic control centres N79-31463 DC 9 AIRCRAFT The DC-9 Super 80 - Much more than a simple stretch

#### DEAD RECKONING

SUBJECT INDEX

DEAD RECKONING A simple integrated navigation based on multiple nwp [DGLR PAPER 79-041] 179-48640 DECODERS Performance of a pulse-decode circuit in the presence of interference A79-48713 DECODING Performance of a pulse-decode circuit in the presence of interference A79-48713 DECOUPLING Nonlinear decoupled control synthesis for maneuvering aircraft 179-47959 DEFENSE PROGRAM Enforcer aircraft [GP0-32-5691 N79-30174 DEGREES OF FREEDOM On single-degree-of-freedom flutter induced by activated controls A79-49867 Plutter analysis of two-dimensional and two-degree-of-freedom airfoils in small-disturbance, unsteady transonic flow [ AD-A069223 ] N79-31157 DELTA WINGS Overall aerodynamic characteristics of caret and delta wings at supersonic speeds 179-47012 The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow 370-117000 Solution of a mixed boundary value problem for flow past a thin delta wing 179-49882 Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind tunnel [NASA-CR-159120] N79-31143 Lateral aerodynamics extracted from flight test using a parameter estimation method [ARL-AERO-NOTE-380] N79-31146 DESIGN ANALYSIS Developments in gear analysis and test techniques for helicopter drive systems [ASME PAPER 79-DE-15] 179-47654 Design, analysis, and testing of a new generation tail rotor [AHS 79-57] A79-49107 Performance of current radar systems in an EW environment --- Electronic Warfare 179-49555 The Bell Model 222 A79-49816 DIESEL ENGINES An overview of NASA research on positive displacement type general aviation engines [NASA-TM-79254] N DIFFUSERS Pactors controlling stability of swirling flames at diffusers in gas turbines A79-50209 DIFFUSION WELDING Superplastic forming diffusion bonding of titanium helicopter airframe components 79-33] **FAHS** 179-49085 DIGITAL COMMAND SYSTEMS Flight control systems development of highly maneuverable aircraft technology /HiMAT/ vehicle [AIAA PAPER 79-1789] A79-47878 Flight test verification of the ASSET system ---Advanced Skewed Sensory Electronic Triad A79-48622 A microprocessor system for flight control research A79-48623 Synthesis of digital flight control tracking systems by the method of entire eigenstructure assignment A79-48625 DIGITAL COMPUTERS Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for advanced architectures using NIL-STD-1553B 179-48629

DIGITAL DATA State of the art in digital signal processing with applications to multiple access systems N79-31487 DIGITAL NAVIGATION Digital adaptive control laws for VTOL aircraft 179-48000 Bicrocomputer applications in strapdown heading and attitude reference system A79-48606 Microprocessor-based digital autopilot development for the XBOM-106 Mini-RPV A simple integrated navigation based on multiple DME FROTE DADRE 79-0411 A79-48640 A79-48608 [DGLR PAPER 79-041] JTIDS relative navigation - Architecture, error characteristics and operational benefits ---Joint Tactical Information Distribution System A79-48715 DIGITAL RADAR SYSTEMS Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness --- in airborne radar systems 179-48621 Digital sensor simulation at the Defense Mapping Agency Aerospace Center A79-48705 Combined X/Ka-band tracking radar 179-49565 Automated tracking for aircraft surveillance radar systems 179-49604 DIGITAL SIMULATION Digital simulation of a three-phase generator A79-48618 A developmental computer model for investigations of air traffic management problems: A case investigating two decision strategies FAD-A0710751 N79-31189 DIGITAL SISTEMS F/A-18 Bornet display system A79-48630 NASA/Princeton digital avionics flight test facility A79-49344 The development and in-flight evaluation of a triplex digital autostabilization system for a helicopter N79-30200 The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 New devices for digital communications in avionics N79-31481 Transform domain processing for digital communication systems using surface acoustic wave devices N79-31482 DIGITAL TECHNIONES An analysis of SAPPHIRE image parameters as a function of processing parameters --- fo synthetic aperture radar data processing for A79-48666 The design of digital controllers for the C-141 aircraft using entire eigenstructure assignment and the development of an interactive computer design program [AD-A069192] N79-31224 Laboratory development of computer generated image displays for evaluation in terrain flight training [AD-A070065] DIRECTIONAL CONTROL N79-31236 The DG-860 - A rugged, high performance heading reference unit --- directional gyro design considerations A79-48677 Analytical and experimental investigation of V-type empenhage contribution to directionalcontrol in hower and forward flight[AHS 79-56] A79-179-49106 DISPLAY DEVICES Real time weather display in the general aviation cockpit [AIAA PAPER 79-1821] A79-47901 A real time video bandwidth reduction system based on a CCD Hadamard transform device --for avionics A79-48702

#### SUBJECT INDEX

#### DYNAMIC STRUCTURAL ANALYSIS

Real time compression of video signals --protection against jamming 179-119712 Multiplex technology applied to helicopters A79-49067 [AHS 79-14] [AHS 79-14] [Handling quality and display requirements for low speed and hover in reduced flight visibility A79-49081 [AHS 79-29] Research on visual display integration for advanced fighter aircraft N79-30184 [ AD-A069605] Scan converter and raster display controller for night vision display systems N79-30203 Design procedure for aircrew station labeling selection and abbreviation N79-30208 Project NATTOLAND (Navy vertical takeoff and landing capability development) N70-30212 Implementation of flight control in an integrated guidance and control system N79-30215 Flight experience with advanced controls and displays during piloted curved decelerating approaches in a powered-lift STOL aircraft N79-30243 Reliability improvement warranty terms and conditions for the Integrated Avionics Control Systems (IACS) [AD-A069454] DISTANCE MEASURING EQUIPMENT N79-31205 A simple integrated navigation based on multiple DME [DGLR PAPER 79-041] A79-48640 DITCHING (LANDING) CHING (LAHDING) Aircraft accident report: Swift Aire Lines, In Nord 262, N4185A, Marina Del Rey, California, March 10, 1979 [NTSB-AAR-79-13] N79-Inc. N79-31165 DOMES (STRUCTURAL PORMS) A report on the Sperry Dome Radar 179-49567 DOPPLER RADAR Recent progress in aircraft sink rate measurement [ATAA PAPER 79-1798] A79-47 Radar signal processing development for A79-47884 application of VHSI A79-48664 Combined environment reliability test of the common strategic Doppler system A79-50368 Multipath propagation measurement by Doppler technique N79-31478 DOWNTIME Maintemance improvement: An analysis approach including inferential technical data --- nav • naval aircraft [ AD-A0683821 N79-30141 DRAG The principles of hovercraft, powering and propulsion 179-47844 DRAG MEASUREMENT The size and performance effects of high lift system technology on a modern twin engine jet transport [AIAA PAPER 79-1795] A79-49332 Performance modelling methods --- in flight test programs A79-50167 DRAG REDUCTION Full-scale wind tunnel study of nacelle shape on cooling drag [AIAA PAPER 79-1820] A79-47900 Laminar flow stabilization by surface cooling on hydrogen fueled aircraft [AIAA PAPER 79-1863] A79-47920 [ATAA PAPER 79-1863] Application of Lagrange Optimization to the drag polar utilizing experimental data [ATAA PAPER 79-1833] Wing geometry effects on leading-edge vortices [ATAA PAPER 79-1872] ATAA PAPER 79-1872] A79-49335 A79-49341 Drag reduction by cooling in hydrogen-fueled aircraft 179-49921

.

Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind tunnel [NASA-CR-159120] DUAL THRUST NOZZLES N79-31143 The nonaxisymmetric nozzle - It is for real --fighter aircraft performance viewpoint [AIA PAPER 79-1810] A79-4789 Performance evaluation of an air vehicle utilizing 179-47893 non-axisymmetric nozzles [AIAA PAPER 79-1811] DUCTED FAN ENGINES 179-117891 The principles of hovercraft, powering and propulsion 179-47844 Aerodynamic effects of an attitude control wane on a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] A79-4791 179-47914 Energy efficient aircraft engines [AIAA PAPER 79-1861] 179-117918 DYNAMIC CHARACTERISTICS Estimation of longitudinal aircraft characteristics using parameter identification techniques 179-50432 DYNAMIC LCADS Dynamic loads analysis system (DYLOFLEX) summary. Volume 1: Engineering formulation [ NASA-CR-2846-1] N79-31144 Dynamic loads analysis system (DYLOFLEX) summary. Volume 2: Supplemental system design information [NASA-CR-2846-2] N79-31105 DYNAHIC MODELS Plight test technology development - A preview of DyMoTech --- dynamic modeling 179-50435 Enclosure fire dynamics model N79-31173 DYNAMIC RESPONSE Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack A79-47943 Improved method of predicting helicopter control response and gust sensitivity [AHS 79-25] A79-49 A79-49077 Time history solution program, L225 (TEV126). Volume 2: Supplemental system design and maintenance document --- for airplane dynamic [NASA-CR-2860] N79-31154 [MSA CA-2000] N79-3115 Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YP-12A [NASA-CR-144884] N79-3119 N79-31192 DYNAMIC STABILITY A summary of AGARD FDP meeting on dynamic stability parameters --- advanced aircraft performance at high angle of attack N79-30220 DYNAMIC STRUCTURAL ANALYSIS Simplified analysis spectrum for joints exposed to complex continuously varying stresses --aerospace structures [AIAA PAPER 79-1808] Application of bifurcation analysis and 179-47892 catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack A79-47943 Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] A79-49071 Theoretical flap-lag damping with various dynamic inflow models [AHS 79-20] A79-49073 Lans (J-Zu) Application of finite-element and holographic techniques in the design of turboshaft engine components [AHS 79-41] A79-49093 The circulation control rotor flight demonstrator test program [AHS 79-51] A79-49103 E-3A AIRCRAFT

E-3A AIRCRAFT

An approach for estimating vibration characteristics of nonuniform rotor blade	es
	A79-49718
<pre>INACT - Interactive test data analysis minicomputers</pre>	with
	A79-50430
Considerations in the analysis of flight te maneuvers	
	A79-50433
ATLAS, an integrated structural analysis an	d
design system. Volume 5: System demonst problems	ration
[NASA-CR-159045]	N79-31624

# Ē

E-3A sentry /AWACS/ ATPG --- Automatic Test Program Generation A79-48873 B-4A AIRCRAFT E-4B mission electrical power 179-48617 ECONOMIC ANALYSIS Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems 179-49910 ECONOMIC FACTORS International Air Transportation Competition Act of 1978 --- congressional reports [GPO-34-912] N79-36 N79-30168 Supersonic transport vis-a-vis energy savings [NASA-TM-75464] N7 ECONOMIC IMPACT N79-31163 Maintenance improvement: An analysis approach including inferential technical data --- naval aircraft [AD-A068382] N79-30141 EDDY CURRENTS Small signal compensation of magnetic fields resulting from aircraft maneuvers A79-49605 EIGENVECTORS A new approach to the solution of large, full matrix equations: A two-dimensional potential flow feasibility study [NASA-CR-3173] N79-31533 BJECTION SEATS The Swedish approach to escape system testing A79-50427 ELASTOMERS The Sikorsky elastomeric rotor --- helicopter rotor bearings [AHS 79-48] A79-49100 **ELASTOPLASTICITY** The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints --- In aircraft structures [ESA-TT-521] N79-30 N79-30391 BLECTRIC CONTROL Electric power system control techniques A79-48614 Results related to simulated and in-flight experimentation with an electric flight control system that can be generalized N79-30224 ELECTRIC GENERATORS Electrical power system for new-technology transport power-by-wire airplane A79-48616 E-4B mission electrical power A79-48617 Digital simulation of a three-phase generator A79-48618 ELECTRIC MOTOR VEHICLES All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] A79-47906 ELECTRIC NETWORKS Airport power supply --- Russian book A79-50499 ELECTRIC POWER SUPPLIES All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] A79-47906 Electric power system control techniques A79-48614

#### SUBJECT INDEX

Advanced RPV electrical systems	A79-48615
Electrical power system for new-technology	A73-4007J
transport power-by-wire airplane	
Airport power supply Russian book	A79-48616
Allpoit power suppry kussian book	A79-50499
ELECTRIC POWER TRANSMISSION	
Electric power system control techniques	
Electrical power system for new-technology	A79-48614
transport power-by-wire airplane	
	A79-48616
BLECTRICAL ENGINEERING	
Electric power system control techniques	A79-48614
Electrical power system for new-technology	2.5 10011
transport power-by-wire airplane	
ELECTRICAL INSULATION	A79-48616
Electrical insulation fire characteristics.	•
Volume 2: Toxicity	
[PB-294841/2] BLECTRO-OPTICS	N79-30490
Determining the contour of helicopter roto:	r blades
automatically using electro-optical tech	niques
[AHS 79-32] Stabilizing electro-optical systems on hel:	A79-49084
Stabilizing electio-optical systems on net	N79-30216
ELECTRONAGNETIC PULSES	
Atmospheric Electricity Hazard (AEH)	
[AD-A069338] BLECTRONECHANICAL DEVICES	N79-30169
Load spectrum measuring equipment. Part 1:	
Details of MK 1 system presently used to	acquire
data in Wessex MK 31B helicopters [ARL-MECH-ENG-NOTE-371]	N79-31194
ELECTRONIC CONTROL	
Small lightweight electronically steerable	
cylindrical antenna successfully utilized air traffic management system	i in an
	A79-48597
A summary of NASA/Air Porce full scale eng:	ine
research programs using the P100 engine	enc.
research programs using the P100 engine [NASA-TM-79267]	N79-30188
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES	
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant	N79-30188
[NASA-TM-79267] BLECTRONIC COUNTERNEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat	N79-30188
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant	N79-30188 ion A79-48711
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM	N79-30188 tion A79-48711 A79-49554
[NASA-TM-79267] BLECTRONIC COUNTERNEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat	N79-30188 tion A79-48711 A79-49554 EW
[NASA-TM-79267] <b>BLECTRONIC COUNTERMEASURES</b> Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare	N79-30188 ion A79-48711 A79-49554 EW A79-49555
[NASA-TM-79267] <b>BLECTRONIC COUNTERMEASURES</b> Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an	N79-30188 ion A79-48711 A79-49554 EW A79-49555
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes	N79-30188 ion A79-48711 A79-49554 EW A79-49555
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets f evaluation of electronic fuzes ELECTRONIC EQUIPMENT</pre>	N79-30188 10n A79-48711 A79-49554 EW A79-49555 cor A79-49580
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes	N79-30188 10n A79-48711 A79-49554 EW A79-49555 cor A79-49580
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes ELECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures	N79-30188 A79-48711 A79-49554 EW A79-49555 cor A79-49580 A79-49580 A79-48690
[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes ELECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an	N79-30188 A79-48711 A79-49554 EW A79-49555 cor A79-49580 A79-49580 A79-48690
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes BLECTRONIC EQUIPTENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 cor A79-49580 A79-49580 A79-48690
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets f evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare BLECTRONIC EQUIPMENT TESTS</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 for A79-49550 A79-49580 A79-48690 EW
<pre>[NASA-TM-79267] BLECTRONIC COUNTERREASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets f evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare BLECTBONIC EQUIPMENT TESTS Built in test of A/D converters - Present</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 for A79-49550 A79-49580 A79-48690 EW A79-49555
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets f evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare BLECTRONIC EQUIPMENT TESTS</pre>	N79-30188 A79-49554 EW A79-49555 or A79-49555 A79-49580 A79-49580 A79-48690 EW A79-49555 red BIT
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 for A79-49550 A79-49580 A79-48690 EW A79-49555 red BIT ms A79-48621
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets f evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare BLECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facility</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 for A79-49550 A79-49580 A79-48690 EW A79-49555 red BIT ms A79-48621
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 for A79-49550 A79-49580 A79-48690 EW A79-49555 red BIT ms A79-48621
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets is evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facility avionics Operational experience with the AN/ARN-131</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 For A79-49580 A79-48690 EW A79-48690 EW A79-48621 - for A79-48672
<pre>[NASA-TM-79267] BLECTRONIC COUNTERREASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTBONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facility avionics</pre>	N79-30188 A79-48711 A79-49554 EW A79-49555 For A79-49580 A79-48690 EW A79-48690 EW A79-48621 - for A79-48672
[NASA-TM-79267] <b>BLECTRONIC COUNTERMEASURES</b> Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets is evaluation of electronic fuzes <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT TESTS</b> Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facilityavionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practional experience	N79-30188 A79-48711 A79-49554 EW A79-49555 cor A79-49580 A A79-48690 EW A79-49555 red BIT ms A79-48621 - for A79-48672 Omega A79-48676 cal
[NASA-TM-79267] <b>BLECTRONIC COUNTERREASURES</b> Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets if evaluation of electronic fuzes <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT TESTS</b> Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facility avionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practic computer-aided programming /CAP/ system face	N79-30188 A79-48711 A79-49554 EW A79-49555 cor A79-49580 A A79-48690 EW A79-49555 red BIT ms A79-48621 - for A79-48672 Omega A79-48676 cal
[NASA-TM-79267] <b>BLECTRONIC COUNTERMEASURES</b> Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets is evaluation of electronic fuzes <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT TESTS</b> Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facilityavionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practional experience	N79-30188 A79-48711 A79-49554 EW A79-49555 cor A79-49580 A A79-48690 EW A79-49555 red BIT ms A79-48621 - for A79-48672 Omega A79-48676 cal
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets f evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare BLECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar syste Nicrocomputer control of a test facility avionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practif computer-aided programming /CAP/ system f analog circuit test design AN/OSN-449/V/ ATE for worldwide support of</pre>	N79-30188 A79-49554 EW A79-49555 cor A79-49550 A79-49580 A A79-48690 EW A79-49555 red BIT ms A79-48621 - for A79-48672 Omega A79-48676 cal or A79-48870
[NASA-TM-79267] <b>BLECTRONIC COUNTERMEASURES</b> Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets is evaluation of electronic fuzes <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT</b> Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare <b>BLECTRONIC EQUIPMENT TESTS</b> Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Microcomputer control of a test facilityavionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practic computer-aided programming /CAP/ system fanalog circuit test design	N79-30188 A79-48711 A79-49554 EW A79-49555 Cor A79-49580 A79-49580 EW A79-48690 EW A79-48690 EW A79-48621 - for A79-48672 Omega A79-48676 Cal Cor A79-48870 the P3
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets if evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar syste Microcomputer control of a test facility avionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practif computer-aided programming /CAP/ system f analog circuit test design AN/DSM-449/V/ ATE for worldwide support of Orion</pre>	N79-30188 A79-49554 EW A79-49555 or A79-49555 A79-49580 A79-49580 A79-49555 MA79-48690 EW A79-49555 red BIT ms A79-48672 Omega A79-48676 cal or A79-48870 the P3 A79-48884
<pre>[NASA-TM-79267] BLECTRONIC COUNTERREADURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Nicrocomputer control of a test facility avionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practi computer-aided programming /CAP/ system f analog circuit test design AN/OSM-449/V/ ATE for worldwide support of Orion Can avionic testability requirements be enf</pre>	N79-30188 A79-48711 A79-49554 EV A79-49555 Cor A79-49580 A79-49580 Cor A79-48690 EV A79-48621 - for A79-48672 Omega A79-48676 Cal Sor A79-48870 the P3 A79-48884 A79-48887
<pre>[NASA-TM-79267] BLECTRONIC COUNTERMEASURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets is evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTBONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Nicrocomputer control of a test facility avionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practi computer-aided programming /CAP/ system f analog circuit test design AN/USM-449/V/ ATE for worldwide support of Orion Can avionic testability requirements be enf Avionics design for testability - An aircra</pre>	N79-30188 A79-48711 A79-49554 EV A79-49555 Cor A79-49580 A79-49580 Cor A79-48690 EV A79-48621 - for A79-48672 Omega A79-48676 Cal Sor A79-48870 the P3 A79-48884 A79-48887
<pre>[NASA-TM-79267] BLECTRONIC COUNTERREADURES Integrated CNI avionics ECM-resistant Communication, Navigation and Identificat Airborne microwave ECM Performance of current radar systems in an environment Electronic Warfare Ellipsoidal modelling of aircraft targets i evaluation of electronic fuzes BLECTRONIC EQUIPMENT Automatic test program generation selection for aircraft structures Performance of current radar systems in an environment Electronic Warfare ELECTRONIC EQUIPMENT TESTS Built in test of A/D converters - Present approaches and recommendations for improv effectiveness in airborne radar system Nicrocomputer control of a test facility avionics Operational experience with the AN/ARN-131 Navigation Set A Navy plan for the development of a practi computer-aided programming /CAP/ system f analog circuit test design AN/OSM-449/V/ ATE for worldwide support of Orion Can avionic testability requirements be enf</pre>	N79-30188 A79-48711 A79-49554 EV A79-49555 Cor A79-49580 A79-49580 Cor A79-48690 EV A79-48621 - for A79-48672 Omega A79-48676 Cal Sor A79-48870 the P3 A79-48884 A79-48887

.

ENGINE TESTS

Avionics design for testability - A vendor's
viewpoint
A79-48889 Techniques for fault isolation ambiguity reduction in military avionics
F-16 depot automatic test equipment
A79-48895
ELECTRONIC MODULES Air Force modular automatic test equipment development program
A79-48878 ELECTROSTATIC GYROSCOPES
Application of instrument rotation in the N73 standard inertial navigation system
A79-48696 Rapid reaction time techniques for a strapdown
navigator employing electrostatic gyro technology A79-48697
ELEVATORS (CONTROL SURFACES)
Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST
[AHS 79-27] A79-49079 ENCLOSURES
Global enclosure fire modeling with applications N79-31172
Enclosure fire dynamics model N79-31173
ENERGY CONSERVATION
Air buoyant vehicles - Energy efficient aircraft [AIAA PAPER 79-1862] A79-47919
Energy efficient engine flight propulsion system
preliminary analysis and design report [NASA-CR-159487] N79-30189
JT9D-70/59 improved high pressure turbine active
clearance control system for specific fuel consumption improvement
[NASA-CR-159661] N79-31208
ENERGY POLICY Supersonic transport vis-a-vis energy savings
[NASA-TM-75464] N79-31163
JT9D-70/59 improved high pressure turbine active clearance control system for specific fuel
consumption improvement
[NASA-CR-159661] N79-31208 ENERGY TECHNOLOGY
Utilization of alternative fuels for transportation; Proceedings of the Symposium,
University of Santa Clara, Santa Clara, Calif.,
June 19-23, 1978 A79-49376
ENERGY TRANSFEE
Global enclosure fire modeling with applications N79-31172
ENGINE CONTBOL Estimation for advanced technology engines
A79-47957 The influence of engine/fuel control design on
helicopter dynamics and handling qualities
[AHS 79-37] A79-49089 Development of a 'no adjustment' turboshaft engine
control system
[AHS 79-42] A79-49094 ENGINE DESIGN
Optimal thermogasdynamic design of gas turbine
engines using element prototypes. I A79-46997
Gas turbines for ACV's and hydrofoils A79-47845
Jet propulsion for ACV's and hydrofoils A79-47847
Energy efficient aircraft engines [AIAA PAPER 79-1861] A79-47918
Influence of gas turbine engine combustion chamber
geometric parameters on mixture formation characteristics
A79-48495 Application of finite-element and holographic
techniques in the design of turboshaft engine
components [AHS 79-41] A79-49093
Development of a 'no adjustment' turboshaft engine
control system [AHS 79-42] A79-49094
Characterization of a swept-strut hydrogen
fuel-injector for scramjet applications A79-49345

.

Derivative engines for the 1980s will help limit acquisition and maintenance costs 179-50206 Aircraft engine developments centre on improved performance, higher efficiency A79-50207 QCSEE - The key to future short-haul air transport --- Quiet, Clean, Short-Haul Experimental Engine program A79-50208 Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ --- Russian book 179-50421 A summary of NASA/Air Force full scale engine research programs using the P100 engine [NASA-TM-79267] N79-30188 [NASA-TM-(9267] Energy efficient engine flight propulsion system preliminary analysis and design report [NASA-CR-159487] N79-30 JT9D-70/59 improved high pressure turbine active N79-30189 clearance control system --- for specific fuel consumption improvement [ NASA-CR-159661 ] N79-31208 Exhaust emissions characteristics for a general aviation light aircraft Teledyne Continental Motors TSIO-360-C piston engine N79-31211 [AD-A070010] Conceptual study of a turbojet/ramjet inlet [NSA-TM-80141] ้ง79-31215 ENGINE FAILURE Fault diagnosis of gas turbine engines by means of component characteristics determination 179-49806 ARIA takeoff performance flight test program Advanced Range Instrumented Aircraft 179-50437 J85-CAN-15 compressor stall and flameout investigation A79-50441 ENGINE INLETS J85-CAN-15 compressor stall and flameout investigation A79-50441 A flow field study for top mounted inlets on fighter aircraft configurations [ AD-A069732] N79-30151 Conceptual study of a turbojet/ramjet inlet [NASA-TM-80141] ENGINE MONITORING INSTRUMENTS N79-31215 A simplified gross thrust computing technique for an afterburning turbofan engine A79-50440 Aircraft turbine engine monitoring experience: Implications for the F100 engine diagnostic system program [AD-A069282] N79-31217 ENGINE NOISE Duct noise radiation through as jet flow A79-50110 Noise generation by jet-engine exhaust deflection [DLR-FB-78-21] ENGINE TESTING LABORATORIES N79-30192 A summary of NASA/Air Force full scale engine research programs using the P100 engine [NASA-TM-79267] N79-30188 ENGINE TESTS Statistical diagnostics of aircraft engines A79-46996 Aerospatiale AS.350 and AS.355 A79-49814 Correlation technique for ambient effects on oxides of nitrogen --- from combustion products in atmospheric pollution A79-49922 A summary of NASA/Air Porce full scale engine research programs using the P100 engine [NASA-TM-79267] N79-30188 Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 Experimental Clean Combustor Program (ECCP), phase 3 --- commercial aircraft turbofan engine tests with double annular combustor [NASA-CR-135384] N79-31207

Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles --- to be used on vertical lift aircraft [NSA-TP-1510] N79-31214

#### ENGINEERING DRAWINGS

ENGINEERING DRAWINGS Geometric data transfer --- for computerized aircraft engineering drawings [AIAA PAPER 79-1844] ENVIRONMENT SIMULATION A79-47910 Dynamic simulator test and evaluation of a JTIDS relative navigation system --- Joint Tactical Information Distribution System 179-18694 ENVIRONMENTAL TESTS Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A79-49101 Combined environment reliability test of the common strategic Doppler system A79-50368 The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints --- In aircraft structures [ESA-TT-521] N79-3 N79-30391 Ambient correction factors for aircraft gas turbine idle emissions [AD-A069240] N79-31218 EPOXY RESINS Model 206L composite litter door [AHS 79-31] 179-49083 Oltra-high-modulus graphite-epoxy conical shell development, supplement [AD-A069795] N79-30335 EQUATIONS OF MOTION The enhancement of aircraft parameter identification using linear transformations --for stability 179-47961 Equation modifying program, L219 (EQMOD). Volume 2: Supplemental system design and maintenance document [NASA-CR-2856] Flutter analysis of two-dimensional and two-degree-of-freedom airfoils in N79-31153 [AD-A069223] N79 Investigation of roll performance for a highly . ₩79-31157 nonlinear statically unstable fighter-type aircraft [AD-A069301] N79-31199 ERROR ANALYSIS Investigation on information error caused by traffic loading in approach and landing systems N79-31480 ERROR CORRECTING CODES An asynchronous data transmission system with low error probability for the SETAC landing aid N79-31468 ERROR DETECTION CODES Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness --- in airborne radar systems A79-48621 Evaluation of the radar altimeter reference method for determining altitude system positioning errors A79-50436 ESCAPE SYSTEMS The Swedish approach to escape system testing A79-50427 ESTIBATING Estimation for advanced technology engines A79-47957 Estimation of aircraft target motion using pattern recognition orientation measurements A79-47987 EXHAUST DIFFUSERS Self-contained grease lubrication systems for aircraft applications [AHS 79-39] 179-49091 EXHAUST GASES Ultrasonic method of gun gas detection --- for engine ingestion prevention in F-15 A79-50166 Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 Exhaust emission traverse investigation of a JT3D-1 turbofan engine --- to acquire exhaust nozzle emission sample [AD-A072019]

#### SUBJECT INDEX

Exhaust emissions characteristics for a ge	Doral	
aviation light aircraft Teledyne Continental		
Motors TSI0-360-C piston engine		
[ AD-A070010]	N79-31211	
Ambient correction factors for aircraft ga	S	
turbine idle emissions		
[AD-A069240]	N79-31218	
EXHAUST NOZZLES		
Aerodynamic and acoustic investigation of	inverted	
velocity profile coannular exhaust nozzl	e models	
and development of aerodynamic and acous prediction procedures, comprehensive dat	tic	
report, volume 1	a	
[NASA-CR-159515]	N70 30405	
Aerodynamic and acoustic investigation of	N79-30185	
velocity profile coannular exhaust nozzl		
and development of aerodynamic and acous	tic	
prediction procedures, comprehensive dat	2	
report, volume 2	u	
[ NASA-CR-1595161	N79-30186	
Aerodynamic and acoustic investigation of	inverted	
velocity profile coannular exhaust nozzl	e models	
and development of aerodynamic and acous	tic	
prediction procedures		
[NASA-CR-3168]	N79-31212	
BIHAUST SYSTEMS		
Full-scale wind tunnel study of nacelle shi	ape on	
cooling drag		
[AIAA PAPER 79-1820] BITERNAL STORE SEPARATION	A79-47900	
Separation testing of large weapons from t		
bomber	he B-1	
Bomber	A79-50429	
EXTERNAL STORES	A75-50425	
Active external store flutter suppression :	in the	
YF-17 flutter model	in the	
	A79-49866	
A helicopter high definition rotor blade ra		
	N79-30207	
EXTERNALLY BLOWN FLAPS		
A method of the theory of airfoil profiles	with a	
jet flap		
	A79-47119	
EXTREMELY HIGH FREQUENCIES Combined X/Ka-band tracking radar		
comprised A/Ka-pand tracking radar	170 40575	
	A79-49565	
-		

## F

r-4 AIRCRAFT	
A study of the application of singular	
perturbation theory development of a	real
time algorithm for optimal three dimensi-	
aircraft maneuvers	onur
[NASA-CR-3167]	N79-30194
P-5 AIRCRAFT	013-30134
Analysis of wind tunnel data pertaining to	high
angle of attack aerodynamics. Volume 1:	
Technical discussion and analysis of res	
[AD-A069646]	N79-30148
F-8 AIRCRAFT	
Systems implications of active controls	
- ·	N79-30219
F-15 AIRCRAFT	
Evolving methods for reducing avionics data	a in an
AISF environment Avionics Integration	n in di
Support Facility flight program testing	
Support factility flight program testing	A79-48671
Mitmaconic mothed of our out detection	
Ultrasonic method of gun gas detection	TOL
engine ingestion prevention in F-15	
	A79-50166
F-16 AIRCRAFT	
F-16 Avionics Intermediate Shop /AIS/ Interim	
Contractor Support initiatives	
[AIAA PAPER 79-1868]	<b>∆79-47923</b>
F-16 avionics maintenance concept and	
multinational aspects	
	A79-48894
F-16 depot automatic test equipment	
	A79-48895
The evolution of the high-angle-of-attack	
of the F-16 flight control system	
or the f to fright control system	A79-50438
Systems implications of active controls	Z1) J0430
Systems implications of active controls	N79-30219
	m/9-30219

N79-31209

P-4 ATRCRAPT

F-17 AIRCRAFT Engine-aircraft afterbody interactions -Recommended testing techniques based on YF-17 experience [AIAA PAPER 79-1829] A79-47903 Active external store flutter suppression in the YF-17 flutter model 179-49866 P-18 AIRCRAFT F/A-18 Hornet display system A79-48630 Testing the F-18 at the U.S. Naval Air Test Center A79-50444 P-104 ATRCRAFT An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack **∆79-50165** Stability and control aspects of the CCV-F104C N79-30234 F-111 AIRCRAFT A force and moment test of a 1/24-scale F-111 model at Mach numbers from 0.7 to 1.3 [AD-A070192] N79-3 Evaluation of F-111 weapon bay aero-acoustic and weapon separation improvement techniques N79-31156 [AD-A070253] N79-31203 FAIL-SAFE SYSTEMS Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft A79-47960 Failure detection in signal processing and sensing in flight control systems 179-47971 FAILURE ANALYSIS Failure detection in signal processing and sensing in flight control systems A79-47971 Test implementation through support software - A PIT translator --- automated Pault Isolation Tests on airborne radar system A79-48687 Techniques for fault isolation ambiguity reduction - in military avionics A79-48891 Fault diagnosis of gas turbine engines by means of component characteristics determination 179-49806 FAILURE MODES Lusaka accident report A79-50109 FAIRCHILD-HILLER AIRCRAFT Driftdown calculations for the PH/227D aircraft [SAND-78-1807] N79-N79-30182 FAST FOURIER TRANSFORMATIONS Transform domain processing for digital communication systems using surface acoustic wave devices N79-31482 A new approach to the solution of large, full matrix equations: A two-dimensional potential flow feasibility study [NASA-CR-3173] N79-31533 PATIGUE (MATERIALS) Lusaka accident report A79-50109 PATTGUE LIPE Long-life GTE operation based on technical condition - Gas Turbine Engine A79-48517 A Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A A79-49101 FATIGUE TESTS Qualification program of the composite main rotor blade for the Model 214B helicopter [AHS 79-44] A79-Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter A79-49096 FAHS 79-451 A79-49097 Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A79-49101 Fatigue and fracture N79-30315

PEASIBILITY ANALYSIS A new approach to the solution of large, full matrix equations: A two-dimensional potential flow feasibility study [NASA-CR-3173] N79-31533 FEEDBACK CONTROL Estimation for advanced technology engines A79-47957 Nonlinear decoupled control synthesis for maneuvering aircraft 179-47959 A study of the application of singular perturbation theory --- development of a real time algorithm for optimal three dimensional aircraft maneuvers [NASA-CR-3167] N79-30 Open/closed loop identification of stability and control characteristics of combat aircraft N79-30194 N79-30232 Helicopter high grain control [NASA-CR-159052] FIBER COMPOSITES N79-31221 Model 206L composite litter door [AHS 79-31] A79-49083 Certification of composites in civil aircraft A79-49095 [AHS 79-43] FIBER OPTICS Helmet mounted display and sight development [AHS 79-17] A A79-49070 FIBER ORIENTATION Metal-matrix composite structures [AHS 79-34] A79-49086 FIGHTER AIRCRAFT Analysis of optimal loop and split-S by energy state modeling A79-47098 Design of advanced titanium structures --- for Advanced Tactical Systems aircraft fuselage [AIAA PAPER 79-1805] A7 **Ă79-47890** The nonaxisymmetric nozzle - It is for real --fighter aircraft performance viewpoint [AIAA PAPER 79-1810] From HiMAT to future fighters --- Highly A79-47893 Maneuverable Aircraft Technology assessment [AIAA PAPER 79-1816] A79-4 Benefits of aerodynamic interaction to the three A79-47896 surface configuration [AIAA PAPER 79-1830] A79-User requirements for future combat search and 179-47904 rescue vehicles A79-48683 Airborne microwave ECM A79-49554 Maintenance improvement: An analysis approach including inferential technical data --- naval aircraft [ AD-A068382] N79-30141 Flow visualization studies of a general research fighter model employing a strake-wing concept at subsonic speeds --- in the Langley high speed 7by 10-ft wind tunnel [NASA-TM-80057] N' A flow field study for top mounted inlets on fighter aircraft configurations N79-30147 [AD-A069732] N79-30151 Research on visual display integration for advanced fighter aircraft [AD-A069605] N79-30184 Enhanced fighter mission effectiveness by use of integrated flight systems N79-30223 Improvement of fighter aircraft maneuverability through employment of control configured vehicle technology N79-30225 Lateral stability at high angles of attack, particularly wing rock N79-30226 Stall behaviour evaluation from flight test results N79-30227 Open/closed loop identification of stability and control characteristics of combat aircraft N79-30232 Design guidance from fighter CCV flight evaluations N79-30235 Wind-tunnel investigation of an armed mini remotely piloted vehicle --- conducted in Langley V/STOL tunnel [NASA-TM-80132] N79-31151

#### FINANCIAL MANAGEMENT

Investigation of roll performance for a highly nonlinear statically unstable fighter-type aircraft [ AD-A0693011 N79-31199 Implementing JTIDS in tactical aircraft ₩79-31491 FINANCIAL MANAGEMENT Potential closure of airports N79-31231 FINITE DIFFERENCE THEORY Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils [AIAA PAPER 79-1555] 179-17342 Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave A79-49456 FINITE ELEMENT METHOD Application of finite-element and holographic techniques in the design of turboshaft engine components [AHS 79-41] Evaluation of finite element formulations for 179-49093 transient conduction forced-convection analysis A79-49343 Tapered roller bearing development for aircraft turbine engines [AD-A069440] N79-30555 FIRE CONTROL A status report on the advanced FIREFLY assessment ргодгат 179-48609 Multisensor integration for defensive fire control surveillance 179-48610 PTRE PIGHTING Fuselage ventilation under wind conditions N79-31175 PTREBREAKS Conference on Fire Resistant Materials: A compilation of presentations and papers [NASA-CP-2094] λ N79-31166 FIREPROOFING Conference on Fire Resistant Materials. A compilation of presentations and papers [NASA-CP-2094] N79-31166 pevelopment of fire-resistant, low smoke generating, thermally stable end items for commercial aircraft and spacecraft using a basic polvimide resin N79-31171 Fire resistant aircraft seat program N79-31176 A review of Boeing interior materials and fire test methods development programs N79-31177 FIREMEN program N79-31178 FIRES Conference on Fire Resistant Materials: compilation of presentations and papers [NASA-CP-2094] N79-31166 Airport flammability, full scale fire tests N79-31167 Seat test program N79-31168 Recent advances in materials toxicology N79-31169 Status of candidate materials for full-scale tests in the 737 fuselage N79-31170 Global enclosure fire modeling with applications N79-31172 Enclosure fire dynamics model N79-31173 Development of aircraft lavatory compartments with improved fire resistance characteristics. Phase 2: Sandwich panel resin system development [NASA-CR-152120] N7 N79-31354 FLAME BETARDANTS Fire resistant aircraft seat program N79-31176 A review of Boeing interior materials and fire test methods development programs N79-31177 FIREMEN program N79-31178

#### SUBJECT INDEX

The fluorenone polyester ISO FPE of Isovolta Company, Austria N79-31183 PLAME STABILITY Pactors controlling stability of swirling flames at diffusers in gas turbines 170-50200 PLANDONT J85-CAN-15 compressor stall and flameout investigation 179-50MU 1 PLANNABILITY Conference on Fire Resistant Materials: A compilation of presentations and papers [NASA-CP-2094] N79-31166 Airport flammability, full scale fire tests N79-31167 Seat test program N79-31168 Status of candidate materials for full-scale tests in the 737 fuselage N79-31170 Development of aircraft lavatory compartments with improved fire resistance characteristics. Phase [NASA-CR-152120] N7 N79-31350 PLAPS (CONTROL SURFACES) Theoretical flap-lag damping with various dynamic inflow models [AHS 79-20] A79-49073 The size and performance effects of high lift system technology on a modern twin engine jet transport [AIAA PAPER 79-1795] 179-49332 Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements --- space shuttle aft body flap. N79-30301 FLIGHT CHARACTERISTICS APPTC parameter identification experience --- for aircraft flight characteristics [AIAA PAPER 79-1803] A79-47 Winglet toe out angle optimization for the Gates 179-47888 Learjet Longhorn Wing [AIAA PAPER 79-1831] A79-47905 A microprocessor system for flight control research A79-48623 Helicopter performance methodology at Bell Helicopter Textron [AHS 79-2] 179-49055 Improved method of predicting helicopter control response and gust sensitivity [AHS 79-25] 179-49077 investigation of the rolling stability derivatives of a T-tail fighter configuration at An high angles-of-attack A79-50165 Evaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Flying Qualities of Piloted Airplanes' A79-50439 Similitude requirements and scaling relationships as applied to model testing [NASA-TP-1435] N79-30176 Aircraft response to windshears and downdraughts N79-30229 Stability and control aspects of the CCV-F104C N79-30234 Flying qualities and the fly-by-wire aeroplane N79-30238 Are today's specifications appropriate for tomorrow's airplanes? N79-30239 Flight performance of the TCV B-737 airplane at [NASA-TN-80148] N79-31186 PLIGHT CONTROL Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft 179-47960 Failure detection in signal processing and sensing in flight control systems 179-47971 A status report on the advanced FIREFLY assessment program 179-48609

N79-31184

A79-47098

A79-48667

A79-47098

A79-47921

179-48051

179-49069

A79-49807

N79-30182

N79-31227

A79-50920

A79-48682

N79-31184

N79-30214

N79-30233

N79-30240

N79-31193

N79-31235

A79-49078

A79-50169

A79-50307

A79-49904

A79-49925

N79-30237

An evaluation of the bird aircraft strike hazard Synthesis of digital flight control tracking at Hill AFB, Utah (AFLC) systems by the method of entire eigenstructure assignment FLIGHT OPTIMIZATION A79-48625 Terrain-following radar - Key to low-altitude flight Analysis of optimal loop and split-S by energy A79-48686 state modeling Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight Verification of operational flight programs by simulation [AHS 79-56] 179-49106 PLIGHT PATHS [AD-A069798] Analysis of optimal loop and split-S by energy state modeling The Guidance and control of Helicopters and V/STOL Ine suigance and control of Helicopters and V/STO aircraft at night and in poor visibility [AGARD-CP-258] N79-30 Some aspects of the design and development of the maritime autopilot modes for the Westland Lynx The aerial relay system - An energy-efficient solution to the airport congestion problem ---using cruise liner aircraft for in-air passenger N79-30198 transfer [AIAA PAPER 79-1865] A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements helicopter N79-30201 Design and testing of a redundant skewed inertial sensor complex for integrated navigation and Advances in decelerating steep approach and landing for helicopter instrument approaches [AHS 79-16] A79flight control N79-30202 Subjective assessment of a helicopter approach system for IFR conditions Variables characterizing the wind effects on an aircraft N79-30209 Simulation and study of V/STOL landing aids for Driftdown calculations for the PH/227D aircraft [SAND-78-1807] N79-3 Path controllers: Unification of concepts and USMC AV-8 aircraft N79-30214 Implementation of flight control in an integrated comparison of design methods quidance and control system N79-30215 [AD-A070252] FLIGHT BOLES Structural aspects of active controls Aeronautical information data subsystems /AIDS/ N79-30221 Stability and control aspects of the CCV-F104C N79-30234 PLIGHT SAFETY Pave Low III --- H-53 helicopter avionics for night/adverse weather rescue of military arcraft Design guidance from fighter CCV flight evaluations N79-30235 In-flight handling qualities investigation of various longitudinal short term dynamics and direct lift control combinations for flight path tracking using DFVLR HFB 320 variable stability An evaluation of the bird aircraft strike hazard at Hill AFB, Utah (AFLC) [AD-A070459] FLIGHT SIMULATION aircraft Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30237 Flying qualities and the fly-by-wire aeroplane N79-30238 Dynamic windtunnel simulation of active control Flight experience with advanced controls and displays during piloted curved decelerating approaches in a powered-lift STOL aircraft systems A simulator investigation of handling quality N79-30243 The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 criteria for CCV transport aircraft Ride qualities criteria validation/pilot performance study: Plight test results [NASA-CR-144885] N79-31137 Investigation of roll performance for a highly nonlinear statically unstable fighter-type Tactical performance characterization basic methodology aircraft N79-31199 AD-A069301] Reliability improvement warranty terms and conditions for the Integrated Avionics Control [AD-A069297] PLIGHT SIMULATORS Systems (IACS) [AD-A069454] Helicopter high grain control [NASA-CR-159052] Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AHS 79-26] A79-N79-31205 N79-31221 The design of digital controllers for the C-141 The T & E simulator - A comparison with flight aircraft using entire eigenstructure assignment test results and the development of an interactive computer Flight testing and simulator flight fidelity ---determination at Naval Air Test Center design program [AD-A069192] N79-31224 Investigation of inverse Vandermonde matrix calculation for linear system applications ---Seat cushion to provide realistic acceleration Seat cushion to provide realistic acceleration cues to aircraft simulator pilot [NASA-CASE-LAR-12149-2] N79-31228 Laboratory development of computer generated image displays for evaluation in terrain flight training [AD-A070065] N79-31236 adaptive flight control systems [AD-A069241] Path controllers: N79-31225 Unification of concepts and comparison of design methods N79-31227 [AD-A070252] FLIGHT STABILITY TESTS PLIGHT CREWS A simulation of amphibious hovercraft overturning Design procedure for aircrew station labeling selection and abbreviation Comment on 'Flight test of stick force stability in attitude-stabilized aircraft' N79-30208 Aircraft accident report: Swift Aire Lines, Inc., Nord 262, N4185A, Marina Del Rey, California, March 10, 1979 [NTSB-AAR-79-13] N79-In-flight handling gualities investigation of various longitudinal short term dynamics and N79-31165 direct lift control combinations for flight path FLIGHT HAZARDS tracking using DFVLR HFB 320 variable stability The feasibility of inflight measurement of lightning strike parameters [NASA-CR-158981] aircraft N79-30165

#### PLIGHT TEST INSTRUMENTS

PLIGHT TEST INSTRUMENTS Plight test verification of the ASSET system ----Advanced Skewed Sensory Electronic Triad 179-48622 High sink-rate landing testing of Navy aircraft 179-50163 Plight test technology development - A preview of DyMoTech --- dynamic modeling A79-50435 ARIA takeoff performance flight test program ---Advanced Range Instrumented Aircraft 179-50437 Some early experiments in the development of a flying platform for aerodynamic testing ×79-47535 

 Plight testing the circulation control wing

 [AIAA PAPER 79-1791]

 An improved method for load survey flight testing

 A79-47880 --- of military cargo aircraft [AIAA PAPER 79-1799] 179-47885 Dutch roll excitation and recovery techniques on a C-141A Starlifter [AIAA PAPER 79-1801] 179-17886 Some flight data extraction techniques used on a general aviation spin research aircraft [AIAA PAPER 79-1802] 179-47887 AFFTC parameter identification experience --- for aircraft flight characteristics [AIAA PAPER 79-1803] 179-47888 Winglet toe out angle optimization for the Gates Learjet Longhorn Wing [AIAA PAPER 79-1831] Å79-47905 Design of the circulation control wing STOL demonstrator aircraft [AIRA PAPER 79-1842] 179-47909 Flight test verification of the ASSET system Advanced Skewed Sensory Electronic Triad A79-48622 Operational experience with the AN/ARN-131 Omega Navigation Set 179-48676 Realization of a helicopter-oriented real-time 

 data system for research, experimental, and

 prototype flight testing

 [AES 79-50]

 A79-49102 Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] A79-49104 Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [AHS 79-54] A79-49105 [AILA PAPER 79-1839] NASA/Princeton digital avionics flight test facility A79-49344 Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics A79-49818 High sink-rate landing testing of Navy aircraft A79-50163 Dynamic test techniques - Concepts and practices --- aircraft performance prediction from thrust/lift/drag model A79-50164 Performance modelling methods --- in flight test programs A79-50167 A computer system for identifying aircraft characteristics 179-50168 A computer program for aircraft identification and derivative extraction A79-50306 Flight testing and simulator flight fidelity --determination at Naval Air Test Center A79-50307 Separation testing of large weapons from the B-1 bomber A79-50429 INACT - Interactive test data analysis --- with minicomputers A79-50430 Estimation of longitudinal aircraft characteristics using parameter identification techniques

#### SUBJECT INDEX

Considerations in the analysis of flight test maneuvers
A79-50433 Flight test technology development - A preview of DymoTech dynamic modeling
A79-50435 Evaluation of the radar altimeter reference method for determining altitude system positioning errors A79-50436
The evolution of the high-angle-of-attack features of the F-16 flight control system A79-50438 J85-CAN-15 compressor stall and flameout
investigation A79-50441
Testing the P-18 at the U.S. Naval Air Test Center A79-50444 Radio-controlled model design and testing
techniques for stall/spin evaluation of general-aviation aircraft (NSA-M-05101
[NASA-TH-80510] N79-30173 AH-1G helicopter, 19-round lightweight airborne launcher jettison envelope determination
[AD-A069828] N79-30177 Airworthiness and flight characteristics test, OV-1C takeoff performance
[AD-A069827] N79-30178 The development and in-flight evaluation of a triplex digital autostabilization system for a helicopter
N79-30200 GCU, the Guidance and Control Unit for all weather approach
N79-30213 Design guidance from fighter CCV flight evaluations N79-30235
L-1011 active controls, design philosophy and experience N79-30236
A comparison of predictions obtained from wind tunnel tests and the results from cruising flight: Airbus and Concorde conferences
[NASA-TH-75238] N79-31136 Lateral aerodynamics extracted from flight test using a parameter estimation method
[ARL-AERO-NOTE-380] N79-31146 Flight performance of the TCV B-737 airplane at Kennedy Airport using TRSB/MLS guidance
[NASA-TH-80148] N79-31186 Ride qualities criteria validation/pilot performance study: Flight test results
[NASA-CR-144885] N79-31193 FLIGHT TRAINING
Dutch roll excitation and recovery techniques on a C-141A Starlifter [AIAA PAPER 79-1801] A79-47886
FLIGHT VEHICLES Gas turbines for flight vehicle engines: Theory,
design, and calculation /Third review and enlarged edition/ Russian book A79-50421
FLOW CHARACTERISTICS Theoretical estimation of nonlinear longitudinal characteristics of wings with small and moderate aspect ratio by the vortex-lattice method in
DLR-FB-78-26] N79-30161
FLOW DEFLECTION Determination of turning angle of a jet impinging on a bucket with visor for thrust reversers A79-48500
FLOW DISTORTION Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor [ONERA, TP NO. 1979-30] A79-50925
FLOW DISTRIBUTION A flow field study for top mounted inlets on
fighter aircraft configurations [AD-A069732] N79-30151 Investigation of air stream from combustor-liner airc antry bolog 2
air entry holes, 3 [NASA-TM-75430] N79-31206 FLOW GEOMETRY The import regions of entries data
The inner regions of annular jets 179-47520 Flow patterns and aerodynamic characteristics of
wing with strake [AIAA PAPER 79-1877] A79-47928

A79-50432

FUEL CONTROL

Effect of steady-state temperature distort combined distortion on inlet flow to a t engine	
[NASA-TH-79237]	N79-30187
<b>FLOW NEASURENERS</b> Experimental study of the turbulent wake downstream of a fan jet	
Investigation of air stream from combustor	A79-48507 -liner
air entry holes, 3 [NASA-TH-75430]	N79-31206
<b>PLOW STABILITY</b> Laminar flow stabilization by surface cool	ing on
hydrogen fueled aircraft [AIAA, PAPER 79-1863]	<b>2</b> 79-47920
<b>PLOW THEORY</b> Lifting-line theory for a swept wing at tr	ansonic
speeds	179-47750
Aerodynamics for engineers Book	A79-50375
Nechanics of boundary layer transition, pa Instability and transition to turbulence	rt 2:
[VKI-LECTURE-SERIES-3-PT-2] FLOW VELOCITY	N79-31530
LDV measurements on propellers PLOV VISUALIZATION	A79-49052
Aerodynamics of spoiler control devices [AIAA PAPER 79-1873]	<b>179-47925</b>
LDV measurements on propellers	
Flow visualization studies of a general re fighter model employing a strake-wing co subsonic speeds in the Langley high	ncept at
by 10-ft wind tunnel [NASA-TH-80057] PLUID DYNAHICS	N79-30147
Contributions to fluid mechanics	N79-31524
<pre>FLUID FLOW Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 1: High-wing [NASA-CR-3097] FLUID JETS</pre>	ngine attack model B N79-30145
Jet propulsion for ACV's and hydrofoils	A79-47847
PLUID MECHANICS Contributions to experimental fluid mechan development of aerodynamics test facilit Germany following World War 2	ics ies in
Contributions to fluid mechanics	N79-31229
FLUOROSCOPY	N79-31524
Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system	
[AHS 79-35] PLUTTER	A79-49087
Some observations on four current subjects to aeroelastic stability	related
Structural aspects of active controls	A79-47093
PLUTTER ANALYSIS	N79-30221
Harmonic oscillations of annular wing in s ideal fluid flow	teady
Active external store flutter suppression YF-17 flutter model	A79-47009 in the
Comment on 'active flutter control using generalized unsteady aerodynamic theory'	<b>∆79-49866</b>
A summary of NASA/Air Porce full scale eng research programs using the F100 engine	
[NASA-TM-79267] Flutter analysis of two-dimensional and two-degree-of-freedom airfoils in	N79-30188
small-disturbance, unsteady transonic fl. [AD-A069223] FLY BY TUBE CONTROL	ม¥ 19−31157
Program for the critical components of a fly-by-tube backup flight control system [AD-A070387]	, part 1 N79-31226

FLY BY WIRE CONTROL Plight test verification of the ASSET system ---Advanced Skewed Sensory Electronic Triad A79-48622 A microprocessor system for flight control research 179-48623 Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST [AHS 79-27] A79-49079 NASA/Princeton digital avionics flight test facility A79-49344 The evolution of the high-angle-of-attack features of the P-16 flight control system A79-50438 Results related to simulated and in-flight experimentation with an electric flight control system that can be generalized N79-30224 Design considerations for reliable PBW flight control N79-30231 Flying qualities and the fly-by-wire aeroplane N79-30238 Analysis of a lateral pilot-induced oscillation experienced on the first flight of the YP-16 aircraft [NASA-TH-72867] N79-31220 FLYING PLATFORMS Some early experiments in the development of a flying platform for aerodynamic testing A79-47535 FOILS (MATERIALS) Metallic coatings for graphite/epoxy composites [AD-A069871] N79-30334 FORCED CONVECTION Evaluation of finite element formulations for transient conduction forced-convection analysis 179-49343 FORGING Achieving consistency in the production of critical jet engine components by means of press forging A79-48945 FRACTORE STRENGTH Fatigue and fracture N79-30315 FRAGEBOTS 

 Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 2: Numerical analyses [AD-A070128]

 FREE FLIGHT

 N79-31200 A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements **X79-48051** PREQUENCY MODULATION The servoed modulation PMCW radar altimeters in military applications A79-49589 FUEL CONBUSTION On the question of selecting the characteristic quantity governing fuel self-ignition in a stream \A79-48497 Experimental study of the turbulent wake downstream of a fan jet A79-48507 FUEL CONSUMPTION Energy efficient aircraft engines [AIAA PAPER 79-1861] A79-47918 Alternative fuels in aviation 179-49381 Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics 179-49818 Derivative engines for the 1980s will help limit acquisition and maintenance costs 179-50206 Aircraft engine developments centre on improved performance, higher efficiency A79-50207 JT9D-70/59 improved high pressure turbine active clearance control system --- for specific fuel consumption improvement [NASA-CR-159661] N79-31208 FUEL CONTROL The influence of engine/fuel control design on helicopter dynamics and handling qualities A79-49089 [AHS 79-37]

FUEL CORROSION Changes in the quality of T-6 fuel upon prolonged storage A79-48858 FUEL FLOW Laminar flow stabilization by surface cooling on hydrogen fueled aircraft [AIAA PAPER 79-1863] A79-47920 On the question of selecting the characteristic quantity governing fuel self-ignition in a stream A79-48497 FUEL INJECTION Characterization of a swept-strut hydrogen fuel-injector for scramjet applications A79-49345 FUEL TANKS Puel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 2: Numerical analyses [AD-A070128] N79-31200 Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Part Experimental Results and Design summary Part 1: N79-31202 [AD-A070113] PURL TESTS The tendency of jet fuels to form deposits on a heated surface A79-48856 Changes in the quality of T-6 fuel upon prolonged storage 179-48858 Method of determining mechanical-impurity contents in jet fuels A79-48859 FULL SCALE TESTS Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] A79-49071 Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-490 A79-49075 Design, analysis, and testing of a new generation tail rotor fAHS 79-571 A79-49107 FUNCTIONAL ANALYSIS On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics A79-47001 PUSELAGES Selecting the passenger airplane fuselage A79-47014 Design of advanced titanium structures --- for Advanced Tactical Systems aircraft fuselage [AIAA PAPER 79-1805] A7 A79-47890 Investigations on the design of active vibration isolation systems for helicopters with rigid and elastic modeling of the fuselage [DLR-FB-78-04] N79-30183 Status of candidate materials for full-scale tests in the 737 fuselage N79-31170 Fuselage ventilation under wind conditions N79-31175

# G

G-91 AIRCRAFT

Gust alleviator feasibility study for G91¥ N79-30230 GAS DYNAMICS Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface A79-48498 GAS STREAMS On the question of selecting the characteristic quantity governing fuel self-ignition in a stream A79-48497 GAS TURBINE ENGINES Optimal thermogasdynamic design of gas turbine engines using element prototypes. I A79-46997 The application of multiple swirl modules in the design and development of gas turbine combustors [AIAA PAPER 79-1196] A79-473

Nozzles for vectored thrust jet engines ---Russian book 179-47428 A/9-4742: Fuels, lubricants and other fluids used in aviation --- Russian book A79-47433 Gas turbines for ACV's and hydrofoils A79-47845 Estimation for advanced technology engines 179-47957 Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics A79-48495 Long-life GTE operation based on technical condition Gas Turbine Engine A79-48517 Development of a 'no adjustment' turboshaft engine control system [ARS 79-42] A79-4900 Fault diagnosis of gas turbine engines by means of component characteristics determination A79-49094 A79-49806 Duct noise radiation through a jet flow A79-50110 Factors controlling stability of swirling flames at diffusers in gas turbines A79-50209 Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ --- Russian book A79-50421 Ambient correction factors for aircraft gas turbine idle emissions [AD-A069240] GEAR TEETH N79-31218 Developments in gear analysis and test techniques for helicopter drive systems [ASME PAPER 79-DE-15] 179-47654 GBARS Helicopter drive system R and M design guide [AD-A069835] GENERAL AVIATION AIRCRAFT N79-30180 The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AIAA PAPEB 79-1786] 179-47876 Some flight data extraction techniques used on a general aviation spin research aircraft [AIAA PAPER 79-1802] A79-47887 Pull-scale wind tunnel study of nacelle shape on cooling drag [AIAA PAPER 79-1820] A79-47900 Real time weather display in the general aviation cockpit [AIAA PAPER 79-1821] A79-47901 A cheap, effective icing detector for general aviation aircraft [AIAA PAPER 79-1823] The Beech Model 77 'Skipper' spin program A79-47902 [AIAA PAPER 79-1835] A79-47907 Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane [AIAA PAPER 79-1837] A79-47908 NASA/Princeton digital avionics flight test facility A79-47908 179-49344 A design perspective on new technologies for general aviation A79-49486 Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 1: High-wing model B [NASA-CR-3097] N79-301 N79-30145 Radio-controlled model design and testing techniques for stall/spin evaluation of general-aviation aircraft [NASA-TM-80510] N79-30173 Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 2: High-wing model 8 [NASA-CR-3101] N79-31149 Development of crashworthy passenger seats for general-aviation aircraft

[NASA-CR-159100] N79-31164 An overview of NASA research on positive displacement type general aviation engines [NASA-TH-79254] N N79-31210

A79-47349

Exhaust emissions characteristics for a general aviation light aircraft Teledyne Continental Notors TSIO-360-C piston engine [AD-A070010] N79-31211 Potential closure of airports N79-31231 GLASS FIBER REINFORCED PLASTICS Qualification program of the composite main rotor blade for the Model 214B helicopter [AHS 79-44] A79-4900 Evaluation of airfield pavement materials based on synthetic polymers 170-49096 170-40349 GLIDERS Some early experiments in the development of a flying platform for aerodynamic testing A79-47535 GLOBAL POSITIONING SYSTEM A real-time sequential filtering algorithm for GPS low-dynamics navigation system 179-48657 GRANTS Advisory circular. The planning grant program for airports [AC150/5900-18] N79-31232 GRAPEITE High performance composites and adhesives for V/STOL aircraft [AD-A069611] N75 N70-30332 [AD-A069795] [AD-A069795] [AD-A069795] N70-30335 GRAPHITE-BPOXY COMPOSITE MATERIALS Composite helicopter tail booms [ABS 79-9] A79-49061 Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter A79-49097 FAES 79-451 Design and development of a hybrid composite rotor blade for the circulation control rotor system [AHS 79-46] A79-49098 Metallic coatings for graphite/epoxy composites [AD-A069871] N79-303: Thermal characteristics of 3501-6/AS and 5208/T300 graphite epoxy composites [AD-A071067] N79-313! N79-30334 N79-31357 GREASES Self-contained grease lubrication systems for aircraft applications [AHS 79-39] 179-49091 GROOVTNG Surveys of grooves in 19 bituminous runways N70-31233 [AD-A069889] GROUND BASED CONTROL CALL DATABLE CONTROL Plight control systems development of highly maneuverable aircraft technology /HiMAT/ vehicle [AINA PAPER 79-1789] A79-478 A79-47878 GROUND EFFECT (AERODYNAMICS) Surface-effect components of aerodynamic characteristics of air-cushion vehicle with ram pressurization 179-46995 A/3-46 Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TH-78793] N79-31 N79-31141 Theoretical and experimental investigation of ground-induced effects for a low-aspect-ratio highly swept arrow-wing configuration N79-31223 [ NASA-TP-15081 GROUND EFFECT MACHINES The principles of hovercraft, powering and propulsion A79-47844 Gas turbines for ACV's and hydrofoils A79-47845 Jet propulsion for ACV's and hydrofoils A79-47847 Performance predictions for open ocean air cushion vehicles and surface effect ships 179-49905 Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems A79-49910

A combined air-cushion and endless belt transportation system 179-49911 Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] GROUND SUPPORT BOUIPMENT N79-30175 F-16 depot automatic test equipment 170-119905 Airport power supply --- Russian book 179-50499 GROUND SUPPORT SYSTEMS AN/USM-449/V/ ATE for worldwide support of the P3 Orion 170-19980 GROUND TESTS Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor 179-49075 [AHS 79-23] A7 Ground test vehicle testing --- in helicopter development programs [AHS 79-40] 179-49092 GROUND-ATR-GROUND COMMUNICATIONS A novel approach to the design of an all digital aeronautical satellite communication system N79-31461 Investigation on information error caused by traffic loading in approach and landing systems N79-31480 GUIDANCE (NOTION) Predictive guidance for interceptors with time delays A79-47939 Design guidance from fighter CCV flight evaluations N79-30235 GUITER VANES Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] Experimental study of the gasdynamic 179-47914 characteristics of a stator cascade with cooling air discharge through the wane surface A79-48498 Aerodynamic performance of axial-flow fan stage Actouynamic performance of axial-flow fan stag operated at nine inlet guide vane angles ---be used on vertical lift aircraft [NASA-TP-1510] N79 GUBS (ORDBABCE) +0 N79-31214 Ultrasonic method of gun gas detection --- for engine ingestion prevention in P-15 179-50166 GUST ALLEVIATORS Gust alleviator feasibility study for G91Y N79-30230 GUST LOADS Improved method of predicting helicopter control response and gust sensitivity [AHS 79-25] GYROSCOPIC STABILITY A79-49077 The DG-880 - A rugged, high performance heading reference unit --- directional gyro design considerations A79-48677 CVROSTARTITZERS Stabilizing electro-optical systems on helicopters N79-30216

## Н

H-53 HELICOPTER Pave Low III --- H-53 helicopter avionics for night/adverse weather rescue of military aircraft A79-48682 HARMONIC OSCILLATION Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 HARRIER AIRCRAFT Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30214 HEAD-UP DISPLAYS F/A-18 Hornet display system A79-48630 Helmet mounted display and sight development [AHS 79-17] A79-49070

#### HEAT RESISTANT ALLOYS

BEAT RESISTANT ALLOYS Achieving consistency in the production of critical jet engine components by means of press forging A79-48945 HEAVING Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79-30175 HELICOPTER CONTROL Helicopter performance methodology at Bell Helicopter Textron [AHS 79-2] A79-49055 [AHS 79-14] 179-49067 Advances in decelerating steep approach and landing for helicopter instrument approaches [ABS 79-16] A79 A79-49069 Spirit helicopter handling qualities design and development [AHS 79-24] A79-49076 Improved method of predicting helicopter control response and gust sensitivity [ARS 79-25] A7 Piloted simulator investigation of helicopter A79-49077 control systems effects on handling qualities during instrument flight [AHS 79-26] A79-4 A79-49078 Advanced Scout Helicopter flying qualities requirements - How realistic are they [AHS 79-28] A79-49080 [And ing quality and display requirements for low speed and hover in reduced flight visibility [AHS 79-29] Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] A79-49104 Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight [AHS 79-56] A79 179-49106 The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 N79-31137 [NASA-TR-76021] Helicopter high grain control [NASA-CR-159052] N79-312 A compilation and analysis of helicopter handling gualities data. Volume 2: Data analysis N70-312 N79-31221 N79-31222 [NASA-CE-3145] RELICOPTER DESIGN New versus existing engines for new helicopter systems - A life cycle cost view [AIAA PAPER 79-1316] A79-A79-47348 User requirements for future combat search and rescue vehicles A79-48683 E-X combat search and rescue avionics study results A79-48684 Helicopter obstacle strike tolerance [AHS 79-7] A system for interdisciplinary analysis - A key to A79-49059 improved rotorcraft design [AHS 79-8] A79-49060 [AHS 79-9] Designing with experimental mechanics ---179-49061 three-dimensional photoelastic analysis of helicopter components [AHS 79-11] A79-49063 Dynamics requirements for an Advanced Scout Helicopter /ASH/ [AES 79-19] Evaluation of the practical aspects of vibration reduction using structural optimization techniques [AES 79-21] A79-49074 Spirit helicopter handling qualities design and development FAHS 79-241 179-49076 Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST [AES 79-27] A79-490 Nodel 206L composite litter door [AHS 79-31] A79-490 Superplastic forming diffusion bonding of titanium A79-49079 A79-49083 helicopter airframe components [AHS 79-33] A79-49085

#### SUBJECT INDEX

Ground test vehicle testing in helicopter development programs
[AHS 79-40] A79-49092
Design, analysis, and testing of a new generation tail rotor
[AHS 79-57] A79-49107
Ten years of Aerospatiale experience with the fenestron and conventional tail rotor
[AHS 79-58] A79-49108
Interactional aerodynamics - A new challenge to helicopter technology
[AHS 79-59] A79-49109
Helicopter noise rules - Are they appropriate and reasonable
A79-49478
Aerospatiale AS.350 and AS.355 A79-49814
Design and development of the Agusta A 109
helicopter A79-49815
The Bell Model 222
A79-49816 Study of design constraints on helicopter noise
[NASA-CR-159118] N79-32054
BELICOPTER ENGINES
New versus existing engines for new helicopter systems - A life cycle cost view
[AINA PAPER 79-1316] A79-47348
The influence of engine/fuel control design on helicopter dynamics and handling gualities
[AHS 79-37] A79-49089
Ground test vehicle testing in helicopter development programs
[AHS 79-40] A79-49092
Aerospatiale AS.350 and AS.355 A79-49814
HELICOPTER PERFORMANCE
Experimental investigation of helicopter flight modes on helicopter-generated noise
A79-47873
Helicopter performance methodology at Bell Helicopter Textron
[AHS 79-2] A79-49055
Helicopter obstacle strike tolerance [AHS 79-7] A79-49059
Theoretical flap-lag damping with various dynamic
inflow models [AHS 79-20] A79-49073
Full scale ground and air resonance testing of the
Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-49075
Piloted simulator investigation of helicopter
control systems effects on handling qualities during instrument flight
[AHS 79-26] A79-49078
Advanced Scout Helicopter flying qualities requirements - How realistic are they
[AHS 79-28] A79-49080
The influence of engine/fuel control design on helicopter dynamics and handling qualities
[AHS 79-37] A79-49089
Realization of a helicopter-oriented real-time data system for research, experimental, and
prototype flight testing
[AHS 79-50] A79-49102 Design and development of the Agusta A 109
helicopter
۸79-49815 ۸ compilation and analysis of helicopter handling
qualities data. Volume 2: Data analysis
[NASA-CR-3145] N79-31222 HELICOPTER PROPELLER DRIVE
Developments in gear analysis and test techniques
for helicopter drive systems [ASME PAPER 79-DE-15] A79-47654
Dynamics requirements for an Advanced Scout
Helicopter /ASH/ [AHS 79-19] A79-49072
Metal-matrix composite structures
[AHS 79-34] A79-49086 Ground test vehicle testing in helicopter
development programs
[AHS 79-40] A79-49092 The Sikorsky elastomeric rotor helicopter
rotor bearings
[AHS 79-48] A79-49100

#### BYBRID NAVIGATION SYSTEMS

HELICOPTER TAIL BOTOES Design, analysis, and testing of a new generation tail rotor [AHS 79-57] A79-49107. HELICOPTER WAKES A lifting-surface method for hover/climb airloads [AHS 79-3] A79-49 A79-49056 Interactional aerodynamics - A new challenge to helicopter technology [AHS 79-59] A79-49109 HELICOPTERS Agricultural helicopters --- test and simulation results [AHS 79-60] 179-49064 Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system [ARS 79-35] 179-49087 Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A 179-49101 Helicopter obstacle strike tolerance concepts analysis [AD-A069877] Helicopter drive system R and H design guide N79-30179 [AD-A069835] N Helicopter drive system R and M design guide N79-30180 N79-30181 [AD-A069691] Investigations on the design of active vibration isolation systems for helicopters with rigid and elastic modeling of the fuselage [DLR-PB-78-04] N79-301 The Guidance and control of Helicopters and V/STOL N79-30183 aircraft at night and in poor visibility [AGARD-CP-258] N79-30198 The development and in-flight evaluation of a triplex digital autostabilization system for a helicopter N79-30200 Some aspects of the design and development of the maritime autopilot modes for the Westland Lynx helicopter N79-30201 A self contained collision avoidance system for helicopters N79-30206 An advanced guidance and control system for rescue helicopters N79-30217 The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 N79-31137 Load spectrum measuring equipment. Part 1: Details of MK 1 system presently used to acquire data in Wessex MK 31B helicopters [ARL-MECH-ENG-NOTE-371] N79-31194 compilation and analysis of helicopter handling A Volume 2: Data analysis qualities data. [NASA-CR-3145] N79-31222 Performance predictions and trials of a helicopter UBP data link N79-31476 HELETS Helmet mounted display and sight development [AHS 79-17] A79-49070 HFB-320 AIRCRAFT In-flight handling gualities investigation of various longitudinal short term dynamics and direct lift control combinations for flight path tracking using DFVLR BFB 320 variable stability aircraft N79-30237 HIGH ALTITUDE BALLOONS Transatlantic flights of stratospheric balloons N79-31687 HIGH FIELD MAGNETS All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] A79-47906 HIGH GAIN Helicopter high grain control [NASA-CR-159052] N79-31221 HISTORIES Historical development of worldwide supersonic aircraft [AIAA PAPER 79-1815] A79-47895

HOLE DISTRIBUTION (MECHANICS) Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TH-75430] HOLOGRAPHIC INTERPEROMETRY N79-31206 Application of finite-element and holographic techniques in the design of turboshaft engine COmponents [AHS 79-41] HONEYCOMB STRUCTURES A79-49093 Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter 

 Stabilizer for the Sikorsky Spillt Helicopter

 [AHS 79-45]
 A79 

 HORIZONTAL TAIL SURFACES
 Operation and test of composite horizontal

 stabilizer for the Sikorsky Spirit helicopter
 170 
 A79-49097 [AHS 79-45] \$79-49097 BOT SURFACES The tendency of jet fuels to form deposits on a heated surface A79-48856 HOVERCEAPT GROUND EFFECT MACHINES A simulation of amphibious hovercraft overturning 179-49904 Small hovercraft design - Evolution to simplicity 179-49906 Hovercraft skirt design requirements A79-49907 Iceater I - Air cushion ice breaker in commercial operations A79-49912 Current Canadian developments related to low-speed heavy lift ACV A79-49915 HOVERING Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover [AHS 79-1] A79-49054 A lifting-surface method for hover/climb airloads [ARS 79-3] A79-49 A79-49056 Handling quality and display requirements for low speed and hover in reduced flight visibility [AHS 79-29] A79-49 179-49081 Analytical and experimental investigation of V-type empennage contribution to directional control in hower and forward flight [AHS 79-56] HOVERING STABILITY A79-49106 The principles of howercraft, powering and propulsion 179-47844 Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [ARS 79-54] A79-49105 V-15 flight test results compared with design goals [AIAA PAPER 79-1839] A79-49336 XV HUBS An integrated analytical and experimental investigation of helicopter hub drag [AHS 79-5] A79-49058 HUNAN PACTORS ENGINEERING Research on visual display integration for advanced fighter aircraft [ AD-A069605] N79-30184 The equipment-system interface in an antitank helicopter at night N79-30211 HUMAN PERFORMANCE Tactical performance characterization basic methodology [AD-A069297] N79-31235 HYBRID NAVIGATION SYSTEMS Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities --- Sandia Inertial Terrain Aided Navigation A79-48678 Dynamic simulator test and evaluation of a JTIDS relative navigation system --- Joint Tactical Information Distribution System A79-48694 System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function --- Joint Tactical Information Distribution System A79-48716

#### HYBRID STRUCTURES

#### SUBJECT INDEX

HYBRID STRUCTURES Design and development of a hybrid composite rotor blade for the circulation control rotor system [AES 79-46] A79-49098 HYDRAULIC BOUIPHENT Program for the critical components of a fly-by-tube backup flight control system, part 1 [AD-A070387] N79-31226 HUD-AUVISION RAM EFFECT Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 2: Numerical analyses [AD-A070128] Fuel tank survivability for hydrodynamic ram N79-31200 induced by high velocity fragments. Part 1: Experimental Results and Design summary [ AD-A070113 ] N79-31202 HYDROFOIL CRAFT Gas turbines for ACV's and hydrofoils A79-47845 Jet propulsion for ACV's and hydrofoils A79-47847 HYDROGEN FUELS Laminar flow stabilization by surface cooling on hydrogen fueled aircraft [AIAA PAPER 79-1863] A79-47920 Lockheed urges hydrogen fuel A79-49224 Characterization of a swept-strut hydrogen fuel-injector for scramjet applications A79-49345 Drag reduction by cooling in hydrogen-fueled aircraft A79-49921 HYPERSONIC AIRCRAFT Conceptual study of a turbojet/ramjet inlet [NASA-TM-80141] N79-31215 Actively cooled plate fin sandwich structural panels for hypersonic aircraft [NASA-CR-3159] N7 N79-31628 HYPERSONIC FLOW Solution of a mixed boundary value problem for flow past a thin delta wing A79-49882 HYPERSONIC INLETS Conceptual study of a turbojet/ramjet inlet [NASA-TH-80141] N79-31215 HYPERVELOCITY IMPACT Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Fart 2: Numerical analyses N79-31200 [ AD-A070128] ſ ICE ENVIRONMENTS Iceater I - Air cushion ice breaker in commercial operations A79-49912 ICE REPORTING A cheap, effective icing detector for general aviation aircraft [AIAA PAPER 79-1823] A79-47902 IDEAL FLUIDS Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 TDENTIFYING The enhancement of aircraft parameter identification using linear transformations --for stability A79-47961 A computer program for aircraft identification and derivative extraction A79-50306 Estimation of longitudinal aircraft characteristics using parameter identification techniques A79-50432 IGNITION Seat test program N79-31168 IGNITION LIMITS On the question of selecting the characteristic quantity governing fuel self-ignition in a stream

IMAGE CONVERTERS Real time compression of video signals --protection against jamming A79-48712 Scan converter and raster display controller for night vision display systems N79-30203 IMAGE NOTION COMPENSATION Quaternion matching in transfer alignment for SAR motion compensation A79-48641 IMAGE PROCESSING Preprocessing for advanced image matching techniques A79-48602 Synthetic aperture radar map matching for navigation A79-48603 An analysis of SAPPHIRE image parameters as a function of processing parameters --- for synthetic aperture radar data processing A79-48666 IMAGING TECHNIQUES Digital sensor simulation at the Defense Mapping Agency Aerospace Center A79-48705 Real time compression of video signals --protection against jamming A79-48712 IMPACT DAMAGE Helicopter obstacle strike tolerance [AHS 79-7] A79-49059 Crashworthy armored crewseat for the UH-60A Black Hawk ARS 79-101 A79-49062 Helicopter obstacle strike tolerance concepts analysis [AD-A069877] N79-30179 IMPACT STRENGTH Windshield technology demonstrator program-canopy detail design options study [ AD-A070376 ] N79-31201 INPURÌTIES Method of determining mechanical-impurity contents in jet fuels A79-48859 IN-FLIGHT MONITORING Some flight data extraction techniques used on a general aviation spin research aircraft AIAA PAPER 79-1802] A79-47887 ATE and aircraft mechanical diagnostics A79-48883 Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing [AHS 79-50] A79-49 in-flight controller insensitive to parameters **≥79-4910**2 Åπ variation [DLR-FB-78-07] N79-30197 INCOMPRESSIBLE PLOW Analytic formulas for wing profile aerodynamic characteristics in incompressible flow A79-47000 Comment on 'active flutter control using generalized unsteady aerodynamic theory' A79-49873 INDEPENDENT VARIABLES AFFTC parameter identification experience --- Air Force Plight Test Center aircraft flight testing A79-50434 INDICATING INSTRUMENTS A cheap, effective icing detector for general aviation aircraft [AIAA PAPER 79-1823] A79 A79-47902 INERTIAL NAVIGATION Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation A79-48656 Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities --- Sandia Inertial Terrain Aided Navigation 179-48678 Transfer alignment for precision pointing applications --- in inertial navigation systems A79-48679 Application of instrument rotation in the N73 standard inertial navigation system A79-48696

179-48497

JET EXHAUST

Rapid reaction time techniques for a strapdown navigator employing electrostatic gyro technology A79-48697 System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function --- Joint Tactical Information Distribution System A79-48716 Design and testing of a redundant skewed inertial sensor complex for integrated navigation and flight control N79-30202 INERTIAL PLATFORMS Quaternion matching in transfer alignment for SAR motion compensation 179-48641 INFORMATION SYSTEMS JTIDS relative navigation - Architecture, error characteristics and operational benefits --Joint Tactical Information Distribution System A79-48715 Implementing JTIDS in tactical aircraft N79-31491 INFRARED LASERS Multifunction CO2 heterodyning laser radar for low level tactical operations A79-48685 INLET FLOW Performance of a V/STCL tilt nacelle inlet with Latural of a vision till machine infet with blowing boundary layer control [AITAN PAPER 79-1163] Recent applications of theoretical analysis to A79-47347 V/STOL inlet design A79-49530 Effect of steady-state temperature distortion and combined distortion on inlet flow to a turbofan engine N79-30187 [NASA-TM-79237] INPUT/OUTPUT ROUTINES Modal interpolation program, L215(INTERP) - Volume 2: Supplemental system design and maintenance document --- to calculate displacements at several points on an aerodynamic surface NTC-21 N79-31147 [NASA-CR-2848] Time history solution program, L225 (TEV126). Volume 2: Supplemental system design and maintenance document --- for airplane dynamic response using frequency response data [NASA-CR-2860] N79-31154 INSTRUMENT APPROACH Subjective assessment of a helicopter approach system for IPR conditions N79-30209 Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30214 INSTRUMENT COMPENSATION Small signal compensation of magnetic fields resulting from aircraft maneuvers 179-49605 INSTRUMENT ERRORS A deterministic investigation of strapped down navigation system accuracy A79-48695 INSTRUMENT PLIGHT RULES Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AES 79-26] Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping A79-49078 radar FAHS 79-521 A79-49104 INSTRUMENT LANDING SYSTEMS Advances in decelerating steep approach and landing for helicopter instrument approaches [AHS 79-16] A79 A79-49069 The T & E simulator - A comparison with flight test results A79-50169 An asynchronous data transmission system with low error probability for the SETAC landing aid N79-31468 THTEGRATED CIRCUITS Radar signal processing development for application of VBSI A79-48664

Integrated CNI avionics ECM-resistant Communication, Navigation and Identific	ation A79-48711
INTERCEPTORS	
Predictive guidance for interceptors with	time
delays	A79-47939
INTERFERENCE DRAG	
Wind tunnels with adapted walls for reduc	ing wall
interference	
[NASA-TH-75501]	N79-31230
INTERNATIONAL RELATIONS	
International Air Transportation Competit	ion Act
of 1978 congressional reports	N79-30168
[GPO-34-912]	N75-30108
ITERATIVE SOLUTION	
P-16 avionics maintenance concept and	
multinational aspects	170.0000
	A79-48894

# J

J-85 ENGINE

J85-CAN-15 compressor stall and flameout investigation A79-50441 JANNING Adaptive array tradeoffs for existing airborne UHF radios A79-48598 Real time compression of video signals --protection against jamming A79-48712 Performance of a pulse-decode circuit in the presence of interference A79-48713 Airborne microwave ECM A79-49554 JET AIRCRAFT The size and performance effects of high lift system technology on a modern twin engine jet transport A79-49332 [AIAA PAPER 79-1795] Investigation of roll performance for a highly nonlinear statically unstable fighter-type aircraft N79-31199 [ AD-A069301 ] Analysis of plume rise from jet aircraft [CONF-790142-1] N79-31204 JET AIRCRAFT NOISE Duct noise radiation through a jet flow A79-50110 QCSEE - The key to future short-haul air transport -- Quiet, Clean, Short-Haul Experimental Engine program A79-50208 JET ENGINE FUELS The tendency of jet fuels to form deposits on a heated surface A79-48856 Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness factor 179-48857 Changes in the quality of T-6 fuel upon prolonged storage A79-48858 Method of determining mechanical-impurity contents in jet fuels A79-48859 Lockheed urges hydrogen fuel A79-49224 Alternative fuels in aviation A79-49381 JET ENGINES Achieving consistency in the production of critical jet engine components by means of press forging A79-48945 A flow field study for top mounted inlets on fighter aircraft configurations [AD-A069732] N79-30151 Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TM-75430] N79-31206 JET BRHAUST Analysis of plume rise from jet aircraft N79-31204 [CONF-790142-1]

JET FLAPS

SUBJECT INDEX

Exhaust emission traverse investigation of a JT3D-1 turbofan engine --- to acquire exhaust nozzle emission sample [AD-A072019] N79-31209 JET FLAPS A method of the theory of airfoil profiles with a jet flap A79-47119 JET FLOW The inner regions of annular jets 179-47520 Experimental study of the turbulent wake downstream of a fan jet A79-48507 JET IMPINGEMENT Engine-aircraft afterbody interactions -Recommended testing techniques based on YF-17 experience [AIAA PAPER 79-1829] A79-47903 Determination of turning angle of a jet impinging on a bucket with visor --- for thrust reversers 179-48500 JET LIFT Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TM-78793] N79-31 N79-31141 JET HIXING FLOW Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics A79-48495 JET NOZZLES Nozzles for vectored thrust jet engines ---Russian book A79-47428 JET PROPULSION Jet propulsion for ACV's and hydrofoils A79-47847 JET THRUST Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TM-78793] N79-31 N79-31141 JETTISON SISTEMS AH-1G helicopter, 19-round lightweight airborne launcher jettison envelope determination [AD-A069828] N79-30177 JOINTS (JUNCTIONS) Simplified analysis spectrum for joints exposed to complex continuously varying stresses --aerospace structures A79-47892 Ķ KALMAN FILTERS Estimation for advanced technology engines A79-47957

A real-time sequential filtering algorithm for GPS low-dynamics navigation system A79-48657 KEROSENE On the question of selecting the characteristic quantity governing fuel self-ignition in a stream A79-48497 KEVLAR (TRADEMARK) Model 206L composite litter door [AHS 79-31] A79-49083 Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter f AHS 79-451 A79-49097 Ľ L-1011 AIRCRAFT Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft 179-47960 Systems implications of active controls N79-30219 L-1011 active controls, design philosophy and experience N79-30236 LAGRANGE MULTIPLIERS Application of Lagrange Optimization to the drag polar utilizing experimental data [AINA PAPER 79-1833] A79-49 A79-49335

LAMIBAR FLOW Laminar flow stabilization by surface cooling on hydrogen fueled aircraft [AIAA PAPER 79-1863] A79-47920 LABINAR FLOW ATBPOILS Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NASA-TH-78603] N79-30143 LANDING AIDS Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30214 LANDING GEAR Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YP-12A [NASA-CR-144884] N79-3119 N79-31192 LANDING INSTRUMENTS Flight performance of the TCV B-737 airplane at Kennedy Airport using TRSB/MLS guidance [NASA-TM-80148] N79-31186 LANDING LOADS Recent progress in aircraft sink rate measurement [AIAA PAPER 79-1798] A79-47 A79-47884 Characteristics of an Air Cushion Landing System incorporating an inelastic trunk 179-49909 Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YF-12A [NASA-CR-144884] N79-31192 LANDING MATS An evaluation of asphalt-rubber mixtures for use in pavement systems [AD-A069448] N79-30246 LANDING RADAR Plight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] LANDING SITES A79-49104 The characteristics of a lift cruise fan V/STOL configuration in near proximity to a small deck with finite edge positions [AIAA PAPER 79-1854] A79-47913 LANGUAGE PROGRAMMING First implementation through support software - A FIT translator --- automated Pault Isolation Tests on airborne radar system 179-48687 LASER DOPPLER VELOCIMETERS LDV measurements on propellers A79-49052 Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor [ONERA, TP NO. 1979-30] A79 LASEE RANGEB/TRACKEE A79-50925 Recent progress in aircraft sink rate measurement
[AIAA PAPER 79-1798] A79-47 A79-47884 LATERAL CONTROL A multiple objective optimization approach to aircraft control systems design 179-47962 LATERAL OSCILLATION Analysis of a lateral pilot-induced oscillation experienced on the first flight of the YF-16 aircraft [NASA-TM-72867] N79-31220 LATERAL STABILITY A summary of AGARD FDP meeting on dynamic stability parameters --- advanced aircraft performance at high angle of attack N79-30220 Lateral stability at high angles of attack, particularly wing rock N79-30226 Lateral aerodynamics extracted from flight test using a parameter estimation method [ARL-AERO-NOTE-380] N79-31146 LATTICES (MATHEMATICS) Theoretical estimation of nonlinear longitudinal characteristics of wings with small and moderate aspect ratio by the vortex-lattice method in incompressible flow [DLR-PB-78-26] N79-30161

A program to compute three-dimensional subsonic

unsteady aerodynamic characteristics using the doublet lattice method, L216 (DUBPLEX). Volume 2: Supplemental system design and maintenance Volume document [NASA-CR-28501 N79-31148 AUING EDGE SWEEP High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] NTWE TOTAL LEADING EDGE SWEEP A79-47924 179-19057 LEADING EDGES ADING EDGES Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane [AIAA PAPER 79-1837] A79-4 Boundary layer control on wings using sound and leading edge corrections 170-17908 leading edge serrations (ATAA PAPER 79-1875) 179-47926 [AIAA PAPER 79-1875] Rotary balance data for a single-engine trainer design for an angle-of-attack range of 8 deg to 90 deg --- conducted in langely spin tunnel [NASA-CR-3099] N79-31 N70-31152 LIFE CICLE COSTS PE CYCLE COSTS New versus existing engines for new helicopter systems - A life cycle cost view [ATAA PAPER 79-1316] A79-4 Derivative engines for the 1980s will help limit 179-47348 acquisition and maintenance costs A79-50206 Naval aircraft operating and support cost-estimating model, FY 1977 revision [AD-A0681751 N79-30140 LIPT rr Wing aerodynamic loading caused by jet-induced lift associated with STOL-OTW configurations [AINA PAPER 79-1664] A79-47 Lifting-line theory for a swept wing at transonic 179-47346 speeds 179-47750 Dynamic test techniques - Concepts and practices --- aircraft performance prediction from thrust/lift/drag model A79-50164 Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NSA-TH-78603] N79-3012 In-flight handling qualities investigation of various longitudinal short term dynamics and direct lift control combinations for flight path tracking using DPVLR HFB 320 variable stability N79-30143 aircraft N79-30237 LIFT AUGMENTATION Plight testing the circulation control wing [ATAA PAPER 79-1791] A79-47880 LIFT DEVICES Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] 179-47909 The size and performance effects of high lift system technology on a modern twin engine jet transport [AIAA PAPER 79-1795] A79-4933 Current Canadian developments related to low-speed heavy lift ACV 179-49332 A79-49915 LIFT FANS Heave-pitch-roll analysis and testing of air cushion landing systems [NSA-CR-2917] Aerodynamic performance of 1.30-pressure-ratio, variable-pitch fan stage [NSA-TP-1502] N79-879-30175 N79-31213 [NASA-TP-1502] Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles --- to be used on vertical lift aircraft [NASA-TP-1510] N79-31: N79-31214 LIFTING ROTORS The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NSA-TH-78621] N79-31 N79-31137 LIGHT AIRCRAFT Some results from the use of a control augmentation system to study the developed spin of a light plane [AIA PAPER 79-1790] A79-478 What the FAA would like in airworthiness standards 179-17979 [AIAA PAPER 79-1851] 179-49338 Dynamic windtunnel simulation of active control systems N79-30233 Development of crashworthy passenger seats for general-aviation aircraft [NASA-CR-159100] R79 N79-31164 [NASA-CR-159100] Exhaust emissions characteristics for a general aviation light aircraft Teledyne Continental Motors TSIO-360-C piston engine [AD-A070010] LIGHT BHITTING DIODES 879-31211 Helmet mounted display and sight development [AHS 79-17] A 179-119070 LIGHTNING The feasibility of inflight measurement of lightning strike parameters [NASA-CR-158981] N79-30165 Atmospheric Electricity Hazard (AEB) [AD-A069338] [AD-A069338] [Advantation requirements N79-30169 and interests N79-30876 TTURAR SUSTRES Linearization of the boundary-layer equations of the minimum time-to-climb problem 179-49869 Time history solution program, L225 (TEV126). Volume 2: Supplemental system design and maintenance document --- for airplane dynamic response using frequency response data [NSA-CR-2860] N79-3 Investigation of inverse Vandermonde matrix calculation for linear system applications ---adaptive flight control systems [AD-A063241] N79-3 LINEAR TRANSFORMATIONS N79-31154 N79-31225 The enhancement of aircraft parameter identification using linear transformations --for stability 179-117961 LIQUID BEARINGS The DG-800 - A rugged, high performance heading reference unit --- directional gyro design considerations A79-48677 LIQUID PROPELLANT BOCKET ENGINES Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ --- Russian book 179-50421 LOAD DISTRIBUTION (FORCES) An improved method for load survey flight testing --- of military cargo aircraft [AIAA PAPER 79-1799] A79-47 A79-47885 LOAD TRSTS An improved method for load survey flight testing --- of military cargo aircraft [AIAA PAPER 79-1799] ¥79-#7885 LOADING HOMENTS Load spectrum measuring equipment. Part 1: Details of MK 1 system presently used to acquire data in Wessex MK 31B helicopters [ARL-MECH-ENG-NOTE-371] N79-311 N79-31194 LOADS (FORCES) A combined air-cushion and endless belt transportation system A79-49911 Effect of transport/bomber loads spectrum on crack growth [AD-A069287] N79-31197 [ab-A069288] N79-3115 N79-31198 LOGISTICS HANAGERERT Reliability improvement warranty terms and conditions for the Integrated Avionics Control Systems (IACS) [AD-A069454] N79-31205 LONGITUDINAL CONTROL Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] A79-479 A79-47914

#### LONGITUDINAL STABILITY

Aircraft longitudinal motion at high incidence **▲79-48052** Comment on 'Plight test of stick force stability in attitude-stabilized aircraft' A79-49925 LONGITUDINAL STABILITY Estimation of longitudinal aircraft characteristics using parameter identification techniques A79-50432 A summary of AGARD FDP meeting on dynamic stability parameters --- advanced aircraft performance at high angle of attack N79-30220 LOW ALTITUDE Terrain-following radar - Key to low-altitude flight A79-48686 Meeting the challenge of precise navigation during nap-of-the-earth flight [ABS 79-12] Ride qualities criteria validation/pilot performance study: Flight test results A79-49065 N79-31193 [NASA-CR-144885] LOW ASPECT BATIO WINGS Theoretical estimation of nonlinear longitudinal characteristics of wings with small and moderate aspect ratio by the vortex-lattice method in incompressible flow [DLR-PB-78-26] N79-30161 LOW SPEED LOW SPEED Handling quality and display requirements for low speed and hover in reduced flight visibility [AHS 79-29] A79-49081 Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor [ONERA, TP NO. 1979-30] A79-50925 LOW SPEED WIND TUNNELS Aerodynamic interaction on a close-coupled canad-wing configuration Canard-wing configuration [ONERA, TP NO. 1979-95] LOW VISIBILITY A79-49543 Handling quality and display requirements for low speed and hover in reduced flight visibility [AHS 79-29] A79-49 Project NAVTOLAND (Navy vertical takeoff and A79-49081 landing capability development) N79-30212 LUBRICANTS Fuels, lubricants and other fluids used in aviation --- Russian book A79-47433 LUBRICATION SYSTEMS Self-contained grease lubrication systems for aircraft applications [AHS 79-39] A79

## Μ

- MAGNETIC FIELDS Small signal compensation of magnetic fields resulting from aircraft maneuvers A79-49605 NAGN ETON ETERS Small signal compensation of magnetic fields resulting from aircraft maneuvers 179-49605 MAINTAINABILITY Helicopter drive system R and M design guide [ AD-A069691] N79-30181 MAINTENANCE F-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives [AIAA PAPER 79-1868] 179-47923 MAN MACHINE SYSTEMS A deterministic investigation of strapped down navigation system accuracy A79-48695 A/y-Helmet mounted display and sight development [AHS 79-17] A79-Piloted simulator investigation of helicopter control systems effects on handling qualities A79-49070 during instrument flight [AHS 79-26] A79-49( Handling quality and display requirements for low speed and hover in reduced flight visibility [AHS 79-29] A79-49( Role of Numerical Control Design in the computer 179-49078 179-49081
  - aided design/manufacturing interface at Sikorsky [AHS 79-30] A79-490 A79-49082

#### SUBJECT INDEX

Comment on 'Flight test of stick force stability	
in attitude-stabilized aircraft'	_
A79-4992 The T & E simulator - A comparison with flight test results	5
A79-5016 Research on visual display integration for	9
advanced fighter aircraft	
[AD-A069605] N79-3018 Open/closed loop identification of stability and	4
control characteristics of combat aircraft	
N79-3023 ONEEA's model of the pilot in discrete time N79-3024	
MANAGEMEET PLANEING	2
Pinancing the capital requirements of the US airline industry in the 1980's	
NANBUVERABILITY N79-3016	4
Improvement of fighter aircraft maneuverability through employment of control configured vehicle technology	
N79-3022	5
<b>HANUAL CONTROL</b> A compilation and analysis of helicopter handling	
qualities data. Volume 2: Data analysis	
[NASA-CR-3145] N79-3122: HANUFACTURING	2
Role of Numerical Control Design in the computer	
aided design/manufacturing interface at Sikorsky [AHS 79-30] A79-49082	,
Model 206L composite litter door	
[AHS 79-31] A79-49083 MAP NATCHING GUIDANCE	3
Meeting the challenge of precise navigation during	
nap-of-the-earth flight [AHS 79-12] A79-49065	5
BARINE PROPULSION	
Gas turbines for ACV's and hydrofoils A79-47845	5
Jet propulsion for ACV's and hydrofoils	
MARKET BESEARCH A79-47847	'
Design criteria for airline operation [AIAA PAPER 79-1849] A79-49337	
HARKING	,
Design procedure for aircrew station labeling selection and abbreviation	
N79-30208	3
MATERIALS SCIENCE Handbook on aircraft materials and their	
application technology	
NATHEMATICAL NODELS A79-48311	
Optimal thermogasdynamic design of gas turbine engines using element prototypes. I	
A79-46997	,
Performance modelling methods in flight test programs	
A79-50167	1
ONERA's model of the pilot in discrete time N79-30242	2
Global enclosure fire modeling with applications	
N79-31172 Fuel tank survivability for hydrodynamic ram	
induced by high velocity fragments. Part 2: Numerical analyses	
[AD-A070128] N79-31200	
An actuator disk analysis of an isolated rotor with distorted inflow	
[AD-A069884] N79-31216	ı
HATRICES (HATHENATICS) Equation modifying program, L219 (EQMOD). Volume	
2: Supplemental system design and maintenance	
document [NASA-CR-2856] N79-31153	
A program for calculating load coefficient matrices utilizing the force summation method,	
L218 (LOADS). Volume 2: Supplemental system	
design and maintenance document [NASA-CR-2854] N79-31155	
Investigation of inverse Vandermonde matrix	
calculation for linear system applications adaptive flight control systems	
[AD-A069241] N79-31225	
BAXINUE LIKELIHOOD ESTIMATES Digital adaptive control laws for VTOL aircraft	
A79-48000	

179-49091

#### NTLITARY OPERATIONS

N79-31235

#### CORTECT THORY

Multisensor integration for defensive fire control surveillance 179-48610 A computer program for aircraft identification and derivative extraction 179-50306 Considerations in the analysis of flight test Manonvors \$70-50433 MEASURING INSTRUMENTS Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft 179-47960 Flight test verification of the ASSET system ---Advanced Skewed Sensory Electronic Triad 170-48622 BRCHANTCAL DRIVES Rotorshaft torquemeter --- principles and applications A79-49090 [AHS 79-38] A7 Ground test vehicle testing --- in helicopter development programs A79-49092 [AHS 79-40] Helicopter drive system R and M design guide N70-30180 [ AD-A069835] BECHANICAL PROPERTIES An approach for estimating vibration characteristics of nonuniform rotor blades A79-49718 Mechanical and thermophysical properties of graphite/polyimide composite materials N79-30317 Development of aircraft lavatory compartments with improved fire resistance characteristics. Phase Sandwich panel resin system development 2. N79-31354 [ NASA-CR-152120 ] METAL BONDING The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints -- In aircraft structures [ESA-TT-521] N79-3 ₩79-30391 METAL CONTINGS Metallic coatings for graphite/epoxy composites [AD-A069871] N79-N79-30334 BETAL MATRIX COMPOSITES Metal-matrix composite structures [AHS 79-34] A79-49086 METEOROLOGICAL INSTRUMENTS A low-velocity airflow calibration and research facility [PB-294501/2] N79-31237 HETEOROLOGICAL RADAR Real time weather display in the general aviation cockpit 179-47901 [AIAA PAPER 79-1821] HH-262 AIRCRAFT Aircraft accident report: Swift Aire Lines, Inc., Nord 262, N4185A, Marina Del Rey, California, March 10, 1979 [NTSB-AAR-79-13] N79-N79-31165 HICROCOMPUTERS Microcomputer applications in strapdown heading and attitude reference system A79-48606 Microcomputer control of a test facility --- for avionics 179-48672 **MTCRORLECTRONICS** New devices for digital communications in avionics N79-31481 MICROPROCESSORS Microprocessor-based digital autopilot development for the XBQM-106 Mini-RPV A79-48608 Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness --- in airborne radar systems A79-48621 A microprocessor system for flight control research A79-48623 The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 MICROWAVE EQUIPMENT Airborne microwave FCM A79-49554 STORANT LANDING SYSTEMS Guidance accuracy considerations for the microwave landing system L-band precision DME 179-48692 Advances in decelerating steep approach and landing for helicopter instrument approaches [AHS 79-16] GCU, the Guidance and Control Unit for all weather 179-49069 approach ₩79-30213 Flight performance of the TCV B-737 airplane at [NASA-TH-80148] N79-31186 Multipath propagation measurement by Doppler technique N79-31478 STCROWAVE SENSORS The application of pulsed 'G' band radio altimeters to modern military aircraft 179-49590 NTCROBAVE TRANSMISSION The servoed modulation PMCW radar altimeters in military applications A79-49589 MILITARY AIR FACILITIES An evaluation of asphalt-rubber mixtures for use in pavement systems [AD-A069448] N79-30246 HILITARY AIRCRAFT Electric power system control techniques 179-48614 Advanced RPV electrical systems 179-48615 The effect of standardization of avionics software quality assurance A79-48648 Evaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Flying Qualities of Piloted Airplanes' A79-50439 Naval aircraft operating and support cost-estimating model, FY 1977 revision N79-30140 [AD-A068175] Enforcer aircraft [GP0-32-569] N79-30174 Design procedure for aircrew station labeling selection and abbreviation N79-30208 GCU, the Guidance and Control Unit for all weather approach N79-30213 MILITARY AVIATION The application of pulsed 'G' band radio altimeters to modern military aircraft A79-49590 MTLTTARY HELICOPTERS Design and development of the Agusta A 109 helicopter 179-49815 Maintenance cost study of rotary wing aircraft, phase 2 pnase 2
[NASA-CR-152291]
N79AH-16 helicopter, 19-round lightweight airborne
launcher jettison envelope determination
[AD-A069828]
N79-N79-30138 N79-30177 A helicopter high definition rotor blade radar N79-30207 Subjective assessment of a helicopter approach system for IFR conditions N79-30209 The equipment-system interface in an antitank helicopter at night N79-30211 Project NAVTOLAND (Navy vertical takeoff and landing capability development) N79-30212 Implementation of flight control in an integrated guidance and control system N79-30215 Stabilizing electro-optical systems on helicopters N79-30216 MILITARY OPERATIONS Distributed TDMA - An approach to JTIDS phase II --- Time Division Multiple Access Joint Tactical Information Distribution System A79-49584 Tactical performance characterization basic methodology [AD-A069297]

#### MILITARY TECHNOLOGY

MILITARY TECHNOLOGY Multiband antenna --- for tactical naval aircraft A79-48596 Application of instrument rotation in the N73 standard inertial navigation system A79-48696 Air Force modular automatic test equipment development program A79-48878 Techniques for fault isolation ambiguity reduction -- in military avionics A79-48891 MILLIMETER WAVES Millimeter airborne radar target detection and selection techniques A79-48665 MINICOMPUTERS INACT - Interactive test data analysis --- with minicomputers A79-50430 MISSILE COMPONENTS Oltra-high-modulus graphite-epoxy conical shell development, supplement [AD-A069795] N79-30335 MISSILE CONTROL Complex guaternion notation in coordinate transformations --- missile launching aircraft-inertial space transformations A79-48681 MISSION PLANNING Advanced Scout Helicopter flying qualities requirements - How realistic are they [AHS 79-28] A79-49080 MODAL RESPONSE Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] MONOPOLE ANTENNAS A79-49071 Radiation from guarter-wavelength monopoles on conducting bodies --- airborne antenna design 179-50606 MONTE CARLO METHOD Performance of a pulse-decode circuit in the presence of interference A79-48713 NOVING TARGET INDICATORS Automated tracking for aircraft surveillance radar systems 💡 A79-49604 NULTIPATH TRANSMISSION Multipath propagation measurement by Doppler technique N79-31478 Investigation on information error caused by traffic loading in approach and landing systems N79-31480 AULTIPLEXING

Multiplex technology applied to helicopters [AES 79-14] A79-49067 State of the art in digital signal processing with applications to multiple access systems N79-31487 Implementing JTIDS in tactical aircraft N79-31491

# Ν

••	
NACELLES	
Performance of a V/STOL tilt nacelle inlet blowing boundary layer control	with
[AIAA PAPER 79-1163]	A79-47347
Pull-scale wind tunnel study of nacelle sha cooling drag	ape on
[AIAA PAPER 79-1820]	A79-47900
Recent applications of theoretical analysis V/STOL inlet design	s to
	A79-49530
NASA PROGRAMS	
Design and testing of a redundant skewed in sensor complex for integrated navigation flight control	nertial and
	N79-30202
NATIONAL AVIATION SYSTEM	
International Air Transportation Competitic of 1978 congressional reports	on Act
[GPO-34-912]	N79-30168

SUBJECT INDEX

NAVIGATION AIDS A simple integrated navigation based on multiple DME [DGLR PAPER 79-041] A79-48640 A79-48640 Application of instrument rotation in the N73 standard inertial navigation system A79-48696 Meeting the challenge of precise navigation during nap-of-the-earth flight
[AHS 79-12] A79-49065 Navstar user equipment for civil and military applications 179-49587 NAVIGATION INSTRUMENTS A deterministic investigation of strapped down navigation system accuracy A79-48695 JTIDS relative navigation - Architecture, error Characteristics and operational benefits ---Joint Tactical Information Distribution System A79-48715 System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function --- Joint Tactical Information Distribution System A79-48716 NAVSTAR SATELLITES Navstar user equipment for civil and military applications 179-49587 NAVY Naval aircraft operating and support cost-estimating model, FY 1977 revision [AD-A068175] N79-30140 Maintenance improvement: An analysis approach including inferential technical data -- naval aircraft [AD-A068382] N79-30141 NETWORK SINTHESIS Performance of current radar systems in an EW environment --- Electronic Warfare A79-49555 NEWTON-RAPHSON METHOD Lateral aerodynamics extracted from flight test using a parameter estimation method [ARL-AERO-NOTE-380] N79-31146 NIGHT FLIGHTS (AIRCRAFT) Pave Low III --- H-53 helicopter avionics for night/adverse weather rescue of military aircraft A79-48682 H-X combat search and rescue avionics study results A79-48684 The equipment-system interface in an antitank helicopter at night ₹79-30211 NIGHT VISION Scan converter and raster display controller for night vision display systems N79-30203 NITROGEN OXIDES Orrelation technique for ambient effects on oxides of nitrogen --- from combustion products in atmospheric pollution 179-49922 NOISE GENERATORS Study of design constraints on helicopter noise [NASA-CR-159118] N79-NOISE INTENSITY N79-32054 Experimental investigation of helicopter flight modes on helicopter-generated noise A79-47873 Noise generation by jet-engine exhaust deflection [DLR-FB-78-21] NOISE MEASUREMENT N79-30192 The aeroacoustics of advanced turbopropellers A79-50236 NOISE PROPAGATION QCSEE - The key to future short-haul air transport --- Quiet, Clean, Short-Baul Experimental Engine program A79-50208 NOISE REDUCTION Helicopter noise rules - Are they appropriate and reasonable 179-49478 Supersonic transport aircraft noise, problems of noise reduction and establishment of standards A79-50237 Supersonic transport vis-a-vis energy savings [NASA-TH-75464] N79-31163

Evaluation of F-111 weapon bay aero-acoustic and weapon separation improvement techniques [AD-A070253] N79-31

N70-21202

NONFLAMMABLE MATERIALS Conference on Fire Resistant Materials: A compilation of presentations and papers [NASA-CP-2094] N79-3116 Status of candidate materials for full-scale tests in the 737 fuselage N70-31166 ¥70-31170 Fire resistant aircraft seat program N79-31176 A review of Boeing interior materials and fire test methods development programs N79-31177 FIREMEN program N79-31178 NONLINEAR BOUATIONS Most rational linearization of nonlinear unsteady heat conduction problems --- for flight vehicle narts and engines 179-48501 NONLINEAR PROGRAMMING (LINEAR PHOGRAMMING Optimal thermogasdynamic design of gas turbine engines using element prototypes. I 179-116997 NONLINEAR SYSTEMS Application of bifurcation analysis and ppication of pirurCation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack 179-47943 Theoretical estimation of nonlinear longitudinal characteristics of wings with small and moderate aspect ratio by the vortex-lattice method in incompressible flow N79-30161 [DLR-FB-78-26] N79-Investigation of roll performance for a highly nonlinear statically unstable fighter-type aircraft r AD-A0693011 N79-31199 NONUNIFORM PLOW An actuator disk analysis of an isolated rotor with distorted inflow [AD-A069884] N79 N79-31216 NOSE PINS An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack 179-50165 NOZZLE DESIGN Nozzles for vectored thrust jet engines ---Russian book A79-47428 The nonaxisymmetric nozzle - It is for real fighter aircraft performance viewpoint [ATA PAPER 79-1810] A79-478 Performance evaluation of an air vehicle utilizing A79-47893 non-axisymmetric nozzles [AIAA PAPER 79-1811] A79-47894 NOZZLE PLON Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface 170-18198 Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft [AIAA PAPEE 79-1856] A79-4 179-49339 NOZZLE GBOMETRY The nonaxisymmetric nozzle - It is for real --fighter aircraft performance viewpoint [AIAA PAPER 79-1810] 179-47893 Aerodynamic and acoustic investigation of inverted erodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic nu development of aer prediction procedures [NASA-CR-3168] NUMBRICAL CONTROL N79-31212 Computer Monitor and Control - A flexible, cost-effective implementation 179-48670 Microcomputer control of a test facility --- for avionics A79-48672 Role of Numerical Control Design in the computer aided design/manufacturing interface at Sikorsky A79-49082 [AHS 79-30]

DIDPPC

BUBERICAL INTEGRATION Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades 179-48518 Ω OPPSHORE PLATFORMS Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] 370-49104 ONEGA BAVIGATION SYSTEM Operational experience with the AN/ARN-131 Omega Navigation Set 179-48676 OPERATING SYSTEMS (COMPUTERS) Modal interpolation program, L215 (INTERP). Volume 2: Supplemental system design and maintenance document -- to calculate displacements at several points on an aerodynamic surface ×79-31147 [NASA-CR-2848] OPTICAL HETEBODINING Multifunction CO2 heterodyning laser radar for low level tactical operations 179-48685 OPTICAL PROPERTIES Windshield technology demonstrator program-canopy detail design options study [AD-A070376] N79-31201 OPTICAL RADAR Multifunction CO2 heterodyning laser radar for low level tactical operations A79-48685 Heterodyning CO2 laser radar for airborne applications N79-30205 OPTICAL RANGE FINDERS Determining the contour of helicopter rotor blades automatically using electro-optical techniques [AHS 79-32] A79-49084 [AHS 79-32] OPTIMAL CONTROL Predictive guidance for interceptors with time delavs 179-47939 A multiple objective optimization approach to aircraft control systems design A79-47962 Linearization of the boundary-layer equations of the minimum time-to-climb problem A79-49869 ONERA's model of the pilot in discrete time N79-30242 OPTINTZATION Optimal thermogasdynamic design of gas turbine engines using element prototypes. I 179-46997 Solution of the inverse aerodynamics problem by the random search method 179-47002 Application of Lagrange Optimization to the drag polar utilizing experimental data [AIAA PAPER 79-1833] 179-49335 OTTCRE Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber A79-48519 P P-3 AIRCRAFT AN/USM-449/V/ ATE for worldwide support of the P3 Orion A79-48884

P-531 HELICOPTER Advanced Scout Helicopter flying qualities requirements - How realistic are they [AHS 79-28] 179-49080 PANELS Actively cooled plate fin sandwich structural panels for hypersonic aircraft [NASA-CR-3159] N7 N79-31628 PAPERS Contributions to fluid mechanics

N79-31524

#### PARABETERIZATION

DIDIERTRETTIETOR AFFTC parameter identification experience --- for aircraft flight characteristics [AIAA PAPER 79-1803] 179-47888 Similitude requirements and scaling relationships as applied to model testing [ NASA-TP-14351 N79-30176 PASSENGER AIRCRAFT Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I 179-46999 Selecting the passenger airplane fuselage A79-47014 The aerial relay system - An energy-efficient solution to the airport congestion problem ---using cruise liner aircraft for in-air passenger transfer [AIAA PAPER 79-1865] 179-47921 [AIAA PAPER 79-1805] Design criteria for airline operation [AIAA PAPER 79-1849] 179-49337 Fire resistant aircraft seat program N79-31176 PATTERN RECOGNITION Estimation of aircraft target motion using pattern recognition orientation measurements 179-47987 Preprocessing for advanced image matching techniques A79-48602 Synthetic aperture radar map matching for navigation 179-48603 Applications of pattern recognition systems for day/night precision aircraft control N79-30204 PAVENENTS An evaluation of asphalt-rubber mixtures for use in pavement systems N79-30246 PERFORMANCE PREDICTION Air buoyant vehicles - Energy efficient aircraft [AIAA PAPER 79-1862] A79-47919 Helicopter performance methodology at Bell Helicopter Textron [AHS 79-2] A79-49055 [Ans /9-2] Improved method of predicting helicopter control response and gust sensitivity [AHS 79-25] A79-49077 The size and performance effects of high lift system technology on a modern twin engine jet transport [AIAA PAPER 79-1795] A79-49332 A design perspective on new technologies for general aviation A79-49486 Performance predictions for open ocean air cushion vehicles and surface effect ships A79-49905 Dynamic test techniques - Concepts and practices --- aircraft performance prediction from thrust/lift/drag model A79-50164 Performance modelling methods --- in flight test programs A79-50167 PERFORMANCE TESTS The DG-880 - A rugged, high performance heading reference unit --- directional gyro design considerations A79-48677 A new U.U.T./test station interface A79-48896 Crashworthy armored crewseat for the UH-60A Black Hawk [AHS 79-10] A79-49062 The Sikorsky elas rotor bearings [AHS 79-48] elastomeric rotor --- helicopter A79-49100 The circulation control rotor flight demonstrator test program A79-49103 Ultrasonic method of gun gas detection --- for engine ingestion prevention in F-15 A79-50166 Plight testing and simulator flight fidelity ---determination at Naval Air Test Center The Swedish approach to escape system testing 179-50427 A79-50307

#### SUBJECT INDEX

An evaluation of sidestick force/deflection characteristics on aircraft handling qualities A79-50428 Subjective assessment of a helicopter approach system for IRR conditions N79-30209 Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YF-12A [NASA-CR-144884] N79-31192 Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles --- to be used on vertical lift aircraft [NASA-TP-1510] PERIPHERAL JET FLOW Surface-effect components of aerodynamic N79-31214 characteristics of air-cushion vehicle with ram pressurization 179-46995 PERTURBATION THEORY Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization A79-47991 A study of the application of singular perturbation theory --- development of a real time algorithm for optimal three dimensional aircraft maneuvers [NASA-CR-3167] N79-30194 PHENOLIC RESTNS Development of aircraft lavatory compartments with improved fire resistance characteristics. Phase 2: Sandwich panel resin system development [NASA-CR-152120.] N7 N79-31354 PHILOSOPHY L-1011 active controls, design philosophy and experience N79-30236 PHOTOBLASTIC ANALYSIS Designing with experimental mechanics ---three-dimensional photoelastic analysis of helicopter components [AHS 79-11] PILOT PERFORMANCE 179-49063 ONERA's model of the pilot in discrete time N79-30242 Flight experience with advanced controls and aisplays during piloted curved decelerating approaches in a powered-lift STOL aircraft N79-30243 Ride gualities criteria validation/pilot performance study: Plight test results [ NASA-CR-144885 ] N79-31193 A compilation and analysis of helicopter handling qualities data. Volume 2: Data analysis [NASA-CR-3145] N79-31222 PILOT TRAINING Flight testing and simulator flight fidelity --determination at Naval Air Test Center 179-50307 PISTON ENGINES Fuels, lubricants and other fluids used in aviation --- Russian book A79-47433 Critical assessment of emissions from aircraft piston engines AD-A0710021 N79-30190 Exhaust emissions characteristics for a general aviation light aircraft Teledyne Continental Motors TSIO-360-C piston engine [AD-A070010] N79-31211 PITCE (INCLIMATION) On the influence of relative pitch in the subsonic turbine cascade 179-48503 Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79-30175 

 [NADA-CA-CST]
 NTO SO

 PLASTIC AIRCHAFT STRUCTURES
 Windshield technology demonstrator program-canopy detail design options study

 [AD-A070376]
 N79-312

 N79-31201 PLUMES Analysis of plume rise from jet aircraft [CONF-790142-1] PNEUMATIC EQUIPMENT N79-31204 The circulation control rotor flight demonstrator test program [AHS 79-51] A79-49103

DOTITING CONTROL STOTING Transfer alignment for precision pointing applications --- in inertial navigation systems A79-48679 POLLUTION CONTROL Experimental Clean Combustor Program (ECCP), phase 3 -- commercial aircraft turbofan engine tests with double annular combustor [NASA-CR-135384] N79-31207 POLLUTION MONITORING Exhaust emission traverse investigation of a JT3D-1 turbofan engine --- to acquire exhaust nozzle emission sample N79-31209 AD-A072019] Exhaust emissions characteristics for a general aviation light aircraft Teledyne Continental Motors TSI0-360-C piston engine FAD-A0700101 N79-31211 POLYESTER RESINS Evaluation of airfield pavement materials based on synthetic polymers A79-49348 POLYESTERS The fluorenone polyester ISO PPE of Isovolta Company, Austria N79-31183 DOLVINIDE RESING Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements --- space shuttle aft body flap N79-30301 Development of fire-resistant, low smoke generating, thermally stable end items for commercial aircraft and spacecraft using a basic polyimide resin N79-31171 POLYMER MATRIX COMPOSITE MATERIALS Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements --- space shuttle aft body flap N79-30301 POLYNERS Evaluation of airfield pavement materials based on synthetic polymers 179-49348 POLYURETHANE FOAM Evaluation of airfield pavement materials based on synthetic polymers 179-49348 POROSITY Wall corrections in transonic wind tunnel: Equivalent porosity [ESA-TT-545] N79-30247 POSITION (LOCATION) Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation 179-48656 POSTTION ERRORS Transfer alignment for precision pointing applications --- in inertial navigation systems 179-48679 Evaluation of the radar altimeter reference method for determining altitude system positioning errors 179-50436 POTENTIAL FLOW Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils A79-47342 [AIAA PAPER 79-1555] POWER SUPPLY CIRCUITS power hybridization - Key to reducing avionics power supply weight and volume A79-48652 POWER TRANSMISSION E-4B mission electrical power A79-48617 POWERED LIFT AIBCRAFT ISEBULIT ALBURART Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TM-78793] N79-31 N79-31141 PRECISION Guidance accuracy considerations for the microwave landing system L-band precision DMB

Applications of pattern recognition systems for day/night precision aircraft control N79-30204 PERDICTION ANALYSIS TECHNIOUES Predictive guidance for interceptors with time delays 179-17939 Avionics computer software operation and support cost estimation 179-48620 PREDICTIONS Study of design constraints on helicopter noise [NASA-CR-159118] N79-3205# PRESSING (PORMING) Achieving consistency in the production of critical jet engine components by means of press forging A79-48945 PRESSURE DISTRIBUTION Solution of the inverse aerodynamics problem by the random search method 179-117002 PRESSURE REFECTS Effect of steady-state temperature distortion and combined distortion on inlet flow to a turbofan engine [ NASA-TM-792371 N79-30187 PRESSURE MEASUREMENTS Aerodynamic performance of 1.38-pressure-ratio, variable-pitch fan stage [NASA-TP-1502] N79-N79-31213 PROBLEM SOLVING ATLAS, an integrated structural analysis and design system. Volume 5: System demonstration problems [NASA-CR-159045] N79-31624 PRODUCT DEVELOPMENT Compass Cope airframe design history [AIAA PAPER 79-1792] 179-47881 CADAM data handling from conceptual design through produce support [AIAA PAPER 79-1846] A79-47912 Air Force modular automatic test equipment development program 179-48878 Antennas for the Black Hawk helicopter [AHS 79-15] A79-4906 The DC-9 Super 80 - Much more than a simple stretch 179-49068 179-49223 A design perspective on new technologies for general aviation A79-49486 Small hovercraft design - Evolution to simplicity A79-49906 Current Canadian developments related to low-speed heavy lift ACV 179-49915 Aircraft engine developments centre on improved performance, higher efficiency A79-50207 PRODUCTION ENGINEERING Engineering and manufacturing communication via the computer data base [AIAA PAPER 79-1845] A79-4 A79-47911 PRODUCTION MANAGEMENT Geometric data transfer --- for computerized aircraft engineering drawings [AIAA PAPER 79-1844] A79-47910 F-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives [AIAA PAPER 79-1868] A79-47923 PROGRAM VERIFICATION (COMPUTERS) Computer Monitor and Control - A flexible, cost-effective implementation 179-48670 Evolving methods for reducing avionics data in an AISF environment --- Avionics Integration Suppport Facility flight program testing A79-48671 Testability, the key to economical and operationally effective avionic test software A79-48890 PROPELLER BLADES The aeroacoustics of advanced turbopropellers A79-50236 PROPELLER FANS LDV measurements on propellers A79-49052

179-48692

#### PROPULSION SYSTEM CONFIGURATIONS

PROPULSION SYSTEM CONFIGURATIONS The principles of hovercraft, powering and propulsion A79-47844 Engine-aircraft afterbody interactions -Recommended testing techniques based on YF-17 experience [AIAA PAPER 79-1829] A79-The characteristics of a lift cruise fan V/STOL A79-47903 configuration in near proximity to a small deck with finite edge positions [AIAA PAPER 79-1854] A79-47 A79-47913 Conceptual study of a turbojet/ramjet inlet [NASA-TM-80141] N79-31215 [NASA-TH-BUI41] N/9-312 PROPULSION STSTEM PERFORMANCE Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system [AIAP PAPER 79-1855] A79-479 PROPULSIVE EFFICIENCY A79-47914 Ten years of Aerospatiale experience with the fenestron and conventional tail rotor [AHS 79-58] A79-49108 Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TH-78793] N79-31 N79-31141 PROTECTION Helicopter obstacle strike tolerance concepts analysis [AD-A069877] PROTECTIVE COATINGS N79-30179 Metallic coatings for graphite/epoxy composites [AD-A069871] PROTOTYPES N79-30334 Optimal thermogasdynamic design of gas turbine engines using element prototypes. I A79-46997 Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing [AHS 79-50] A79 PULSE COMMUNICATION 179-49102 Performance of a pulse-decode circuit in the presence of interference A79-48713 Distributed TDMA - An approach to JTIDS phase II --- Time Division Multiple Access Joint Tactical Information Distribution System A79-49584 A novel approach to the design of an all digital aeronautical satellite communication system N79-31461 A digital communication system as gateway between adjacent computerized air traffic control centres N79-31463 Performance predictions and trials of a helicopter UHF data link N79-31476 PULSE RADAR The application of pulsed 'G' band radio altimeters to modern military aircraft A79-49590 PYROLYSIS Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 Q QUALITY CONTROL The effect of standardization of avionics software quality assurance 179-48648 A Navy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design

- A79-48870 Avionics design for testability - An aircraft contractor's viewpoint
- A79-48888 Techniques for fault isolation ambiguity reduction --- in military avionics A79-48891
- Achieving consistency in the production of critical jet engine components by means of press forging

A79-48945

#### SUBJECT INDEX

What the FAA would like in airworthiness st [ATAN PAPER 79-1851] QUATERNIONS Complex guaternion notation in coordinate transformations missile launching aircraft-inertial space transformations	igues A79-49084 A79-49087 andards A79-49338 A79-48681 ansport
R	A79-50208
••	
BADAR ANTENNAS A report on the Sperry Dome Radar	
	A79-49567
BADAR APPBOACH CONTROL Flight investigation of helicopter IPR appr to oil rigs using airborne weather and ma	oaches pping
radar [AHS 79-52]	A79-49104
A helicopter high definition rotor blade rad	
Small lightweight electronically steerable	
cylindrical antenna successfully utilized air traffic management system	in an
	A79-48597
Radar cross section fundamentals for the air designer	craft
[AIAA PAPER 79-1818]	A79-47898
RADAR DATA Radar signal processing development for	
application of VHSI	179-48664
An analysis of SAPPHIRE image parameters as function of processing parameters for synthetic aperture radar data processing	a a
BADAR BOUIPNENT	79-48666
Test implementation through support softwar FIT translator automated Pault Isolati Tests on airborne radar system	e - A Lon
The impact of software in automatic test equ for evaluation of radar analog to digi converter	179-48687 Lipment Ital
Performance of current radar systems in an H	79-48691 W
environment Electronic Warfare RADAR IMAGEBY	79-49555
Preprocessing for advanced image matching te	
A Synthetic aperture radar map matching for na	79-48602 vigation
	79-48603
Agency Aerospace Center	79-48705
RADAR MAPS Digital sensor simulation at the Defense Map	ping
Agency Aerospace Center	79-48705
RADAR MEASUREMENT Multiradar tracking system using radial velo	-
measurements	79-49608
RADAR HAVIGATION Synthetic aperture radar map matching for na	vigation
A Plight investigation of helicopter IFR appro to oil rigs using airborne weather and map radar	79-48603 aches ping
	79-49104
common strategic Doppler system	79-50368

RELIEF MAPS

RADAB TARGETS Millimeter airborne radar target detection and selection techniques A79-48665
Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes
A79-49580 BADAB TRACKING
Estimation of aircraft target motion using pattern recognition orientation measurements
A79-47987 The alpha-beta-gamma tracking filter in the Z-domain in aircraft tracking
A79-48680 The A.I. tracking problem Airborne Interception A79-49566
Bultiradar tracking system using radial velocity measurements
A79-49608 RADAR TRANSMISSION The servoed modulation FMCW radar altimeters in
military applications A79-49589
BADAB TRANSMITTERS Tactical electronic reconnaissance sensor radar emission detection A79-48717
RADIAL VELOCITY Multiradar tracking system using radial velocity
measurements A79-49608
RADIATION PROTECTION Lightning hazards overview: Aviation requirements and interests
RADIO ALTINETERS
A new three-dimensional surveillance radar A new three-dimensional surveillance radar
The servoed modulation FMCW radar altimeters in military applications
The application of pulsed "G" band radio altimeters to modern military aircraft
A79-49590 Evaluation of the radar altimeter reference method for determining altitude system positioning errors A79-50436
BADIO ANTENNAS Radiation from quarter-wavelength monopoles on
finite cylindrical, conical, and rocket-shaped conducting bodies airborne antenna design A79-50606
UHF coplanar-slot antenna for aircraft-to-satellite data communications
[NASA-TH-79239] N79-31185 RADIO COMMUNICATION
Multiband antenna for tactical naval aircraft A79-48596
UHF coplanar-slot antenna for aircraft-to-satellite data communications [NASA-TH-79239] N79-31185
RADIO CONTROL Radio-controlled model design and testing
techniques for stall/spin evaluation of general-aviation aircraft
[NASA-TH-80510] N79-30173 RADIO RECEIVERS
Navstar user equipment for civil and military applications
RADOMES Recent advances in radome design
Recent advances in radome design A79-49574 RANJET ENGINES
Conceptual study of a turbojet/ramjet inlet [NASA-TH-80141] N79-31215 RANDOM PROCESSES
Solution of the inverse aerodynamics problem by the random search method
A79-47002 REACTION TIME Rapid reaction time techniques for a strapdown
navigator employing electrostatic gyro technology A79-48697
REAL TIME OPERATION Real time weather display in the general aviation
COCKPIT [AIAA PAPER 79-1821] A79-47901

A real-time sequential filtering algorithm for GPS low-dynamics navigation system 179-48657 A real time video bandwidth reduction system based on a CCD Hadamard transform device --- for avionics A79-48702 Real time compression of video signals --protection against jamming A79-48712 Realization of a helicopter-oriented real-time Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing [AHS 79-50] A79-Central flow control software design document. Volume 1: Operational software complex ---automation support to the Air Traffic Control 179-49102 System Command Center [ AD-A070973] N79-30959 [AD-A070973] N/9-. Central flow control software design document. Volume 2: Support software complex ---automation support to the Air Traffic Control System Command Center. [AD-A070771] N79-: RECONNAISSANCE AIRCEAFT N79-30960 COMPAINSANCE AIRCHAFT Compass Cope airframe design history [AIRA PAPER 79-1792] A79-47881 Maritime patrol airship concept study [AD-A070131] N79-31138 RECTANGULAR WINGS The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow 179-17099 REDUNDANT COMPONENTS Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft 179-47960 Failure detection in signal processing and sensing in flight control systems 179-47971 Program for the critical components of a [ly-by-tube backup flight control system, part 1 [AD-A070387] N79-312 N79-31226 REPERENCE SUSTERS Microcomputer applications in strapdown heading and attitude reference system 179-48606 REGIONAL PLANNING A developmental computer model for investigations of air traffic management problems: A case investigating two decision strategies [ AD-A071075] N79-31189 BEINFORCED PLASTICS High-performance reinforced plastic structures for civil aviation A79-47302 RETREORCIEG FIBERS High performance composites and adhesives for V/STOL aircraft [AD-A069611] N79-30332 RELEASING Global enclosure fire modeling with applications N79-31172 RELIABILITY ANALYSTS Statistical diagnostics of aircraft engines A79-46996 Combined environment reliability test of the common strategic Doppler system A79-50368 RELIABILITY ENGINEERING The DG-800 - A rugged, high performance heading reference unit --- directional gyro design considerations A79-48677 User requirements for future combat search and rescue vehicles A79-48683 Reliability improvement warranty terms and conditions for the Integrated Avionics Control Systems (IACS) [AD-A069454] N79-31205 RELIEP MAPS Meeting the challenge of precise navigation during nap-of-the-earth flight [AHS 79-12] A79-4906 A79-49065

#### RELIEF VALVES

SUBJECT INDEX

RELIEF VALVES Previsions and experimental results in open balloon controlled descent N79-31691 REMOTE CONTROL Previsions and experimental results in open balloon controlled descent N79-31691 REMOTE SENSORS Preprocessing for advanced image matching techniques A79-48602 Multisensor integration for defensive fire control surveillance A79-48610 REMOTELY PILOTED VEHICLES Flight control systems development of highly maneuverable aircraft technology /HiMAT/ vehicle [AIAA PAPEE 79-1789] A79-478 Compass Cope airframe design history A79-47878 [AIAA PAPER 79-1792] A79-4788 Microprocessor-based digital autopilot development A79-47881 for the XBQM-106 Mini-RPV A79-48608 Advanced RPV electrical systems A79-48615 Wind-tunnel investigation of an armed mini remotely piloted vehicle --- conducted in Langley V/STOL tunnel [NASA-TM-80132] N79-31151 REPORTS Contributions to fluid mechanics N79-31524 RESCUE OPERATIONS Pave Low III --- H-53 helicopter avionics for night/adverse weather rescue of military aircraft A79-48682 User requirements for future combat search and rescue vehicles A79-48683 H-X combat search and rescue avionics study results A79-48684 An advanced guidance and control system for rescue helicopters N79-30217 RESEARCH Contributions to fluid mechanics N79-31524 RESEARCE AIRCRAFT The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane 

 Aviation research airplane
 A79-478

 [AIAA PAPER 79-1786]
 A79-478

 Plight control systems development of highly
 maneuverable aircraft technology /HiMAT/ vehicle

 [AIAA PAPER 79-1789]
 A79-478

 A79-47876 A79-47878 Some flight data extraction techniques used on a general aviation spin research aircraft [AIAA PAPER 79-1802] A79-4 A79-47887 A microprocessor system for flight control research A79-48623 Performance evaluation method for dissimilar aircraft designs --- using the square of the wing span for nondimensional comparisons of aerodynamic characteristics [NASA-RP-1042] N79-30139 RESEARCH AND DEVELOPMENT Historical development of worldwide supersonic aircraft [AIAA PAPER 79-1815] A79-47895 RESEARCH VEHICLES Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] RESONANCE TESTING 179-47909 Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] 179-49075 RESONANT PREQUENCIES Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] A79-49071 RESONANT VIBRATION Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-49075

REYNOLDS NUMBER Correlation of data related to shock-induced trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-31195 RIDING QUALITY Ride gualities criteria validation/pilot performance study: Flight test results [NASA-CR-144885] N79-31193 BIGID ROTOR HELICOPTERS Project NAVTOLAND (Navy vertical takeoff and landing capability development) N79-30212 RING WINGS Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 ROCKET LAUNCHERS Helicopter component environmental vibration testing - The poor man's fatigue test [ABS 79-49] AB-1G helicopter, 19-round lightweight airborne A79-49101 launcher jettison envelope determination [AD-A069828] ROCKET THRUST N79-30177 Some results from the use of a control augmentation system to study the developed spin of a light plane [AIAA PAPER 79-1790] A79-47879 ROLL Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79 Investigation of roll performance for a highly N79-30175 nonlinear statically unstable fighter-type aircraft [ AD-A069301] N79-31199 ROLLER BEARINGS Tapered roller bearing development for aircraft turbine engines [AD-A069440] N79-30555 ROTARY STABILITY Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 2: High-wing model A [NASA-CR-3101] N79-31149 DOTARY WING AIRCRAFT A system for interdisciplinary analysis - A key to improved rotorcraft design [AHS 79-8] A79-49060 Maintenance cost study of rotary wing aircraft, phase 2 [NASA-CR-152291] N79-30138 ROTARY WINGS Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover [AHS 79-1] A79-49054 [Aliffing-surface method for hover/climb airLoads [AHS 79-3] A79-49 A79-49056 The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] A79-49 A79-49057 integrated analytical and experimental An investigation of helicopter hub drag [AHS 79-5] 179-49058 Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] A79-49071 Dynamics requirements for an Advanced Scout Belicopter /ASH/ [AHS 79-19] Theoretical flap-lag damping with various dynamic A79-49072 inflow models [AHS 79-20] A79-49073 Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-49075 Determining the contour of helicopter rotor blades automatically using electro-optical techniques [AHS 79-32] A79-49084 Qualification program of the composite main rotor blade for the Model 214B helicopter [AHS 79-44] A79-49096 The Sikorsky elastomeric rotor --- helicopter rotor bearings [AES 79-48] A79 **∆79-49100** 

SERVICE LIFE

A79-48517

The circulation control rotor flight demonstrator test program [AHS 79-51] \$79-09103 Helicopter obstacle strike tolerance concepts analysis [ AD-A069877 ] N70-30170 Evaluation of pylon focusing for reduced helicopter vibration [AD-A069712] N79-30196 helicopter high definition rotor blade radar N79-30207 Study of design constraints on helicopter noise [NASA-CR-159118] N79-ROTOR ABRODYNAMICS N79- 32054 Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of interference from nearby cascades 179-48572 Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover FARS 79-11 179-49054 integrated analytical and experimental Αn investigation of helicopter hub drag A79-49058 [AHS 79-5] A7 Ten years of Aerospatiale experience with the fenestron and conventional tail rotor [AHS 79-58] A79-Interactional aerodynamics - A new challenge to 179-49108 teractional aerodynamics - A activity for technology A79-49109 [AHS 79-59] A79-49109 W-15 flight test results compared with design goals A79-49336 Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor . [ONERA, TP NO. 1979-30] A79-5092 179-50925 Performance of two-stage fan with a first-stage rotor redesigned to account for the presence of a part-span damper [NASA-TP-1483] N79-30191 [NASA-TF-1483] The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 N79-31137 [NASA-TH-/8521] ROTOR LADES (TORBONACHIMENY) Design and development of a hybrid composite rotor blade for the circulation control rotor system [AHS 79-46] An approach for estimating vibration A79-49098 characteristics of nonuniform rotor blades A79-49718 Performance of two-stage fan with a first-stage rotor redesigned to account for the presence of a part-span damper a part-span damper [NASA-TP-1483] N79-Aerodynamic performance of 1.38-pressure-ratio, variable-pitch fan stage [NASA-TP-1502] N79-N79-30191 N79-31213 An actuator disk analysis of an isolated rotor with distorted inflow N79-31216 [AD-A069884] ROTOR LIFT A lifting-surface method for hover/climb airloads [AHS 79-3] 179-49056 240408 Digital simulation of a three-phase generator A79-48618 RUBBER An evaluation of asphalt-rubber mixtures for use in pavement systems FAD-A0694481 N79-30246 RUNHAVS Evaluation of airfield pavement materials based on synthetic polymers A79-49348 An evaluation of asphalt-rubber mixtures for use in pavement systems N79-30246 FAD-A0694481 Surveys of grooves in 19 bituminous runways N79-31233 [AD-A069889] Runway configuration management system concepts N79-31234 [ AD-A069960 ] S S-N DIAGRAMS

A user's manual for a computer program to generate fatigue spectrum loading sequences [AD-A069288] N79-31198 SAFETY MANAGEMENT Development of crashworthy passenger seats for general-aviation aircraft [NASA-CR-159100] N79-31164 SATLWTNGS Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics 179-49818 SANDRICH STRUCTURES Recent advances in radome design 179-49574 Development of aircraft lavatory compartments with improved fire resistance characteristics. 2: Sandwich panel resin system development Phase [ NASA-CR-152120] N79-3135H SATELLITE NAVIGATION SYSTEMS Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation 179-48656 A real-time sequential filtering algorithm for GPS low-dynamics navigation system 179-48657 SATELLITE TRANSMISSION A novel approach to the design of an all digital aeronautical satellite communication system N79-31461 SCALE MODELS The Beech Model 77 'Skipper' spin program [AIAA PAPER 79-1835] A79-47 Multiband antenna --- for tactical naval aircraft 179-47907 179-48596 Similitude requirements and scaling relationships as applied to model testing [NASA-TP-1435] N79-30176 A force and moment test of a 1/24-scale F-111 model at Mach numbers from 0.7 to 1.3 [AD-A070192] N79-31156 SEA TOP Iceater I - Air cushion ice breaker in commercial operations 179-49912 SEAPLANES Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics --- conducted in Langley V/STOL tunnel [NASA-TM-78793] N79-31 N79-31141 SEATS Crashworthy armored crewseat for the UH-60A Black Hawk [AHS 79-10] 179-49062 Development of crashworthy passenger seats for general-aviation aircraft [NASA-CR-159100] N79-31164 Seat test program N79-31168 Fire resistant aircraft seat program N79-31176 Seat cushion to provide realistic acceleration cues to aircraft simulator pilot [NASA-CASE-LAR-12149-2] N79-31228 SELECTION Millimeter airborne radar target detection and selection techniques 179-48665 SELF ALIGNMENT Transfer alignment for precision pointing applications --- in inertial navigation systems 179-48679 SEPARATED FLOW Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] A' Correlation of data related to shock-induced 179-47925 trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-N79-31195 SEQUENTIAL CONTROL A real-time sequential filtering algorithm for GPS low-dynamics navigation system A79-48657 SERRATIA Boundary layer control on wings using sound and leading edge serrations [ATAA PAPER 79-1875] A79-4 A79-47926 SERVICE LIFE Long-life GTE operation based on technical condition --- Gas Turbine Engine

#### SERVOCONTROL

Designing with experimental mechanics --three-dimensional photoelastic analysis of helicopter components [AHS 79-11] 179-49063 SERVOCONTROL Structural aspects of active controls N79-30221 Results related to simulated and in-flight experimentation with an electric flight control system that can be generalized N79-30224 Program for the critical components of a fly-by-tube backup flight control system, [AD-A070387] part 1 N79-31226 SERVONECHANISMS [AD-A069798] [NO-A069798] [NO-A069788] [NO-A0697888] [NO-A0697888] [NO-A0697888] [NO-A0697888] [NO-A0697888] [NO-A0697888] [NO-A0697888] [NO-A06978888] [NO-A0697 SHAFTS (MACHINE ELEMENTS) Helicopter drive system R and M design guide [AD-A069835] N79-30180 SHIPS Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation A79-48656 VTOL controls for shipboard landing [NASA-CR-162140] N79-Simulation and study of V/STOL landing aids for N79-30193 USMC AV-8 aircraft N79-30214 SHOCK WAVE INTERACTION Experimental measurements of shock/boundary-layer interaction of a supercritical airfoil [AIAA PAPER 79-1499] SHOCK WAVE PROPAGATION A79-47345 Experiments of shock associated noise of supersonic jets [ATAA PAPER 79-1526] A79 Numerical solution of the problem of unsteady supersonic flow around the front part of the A79-47341 wings with a detached shock wave 179-49456 SHOCK WAVES Subsonic and transonic flows on a variable sweep wing [ONERA, TP NO. 1979-102] A79-48849 Correlation of data related to shock-induced trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-31195 SHORT HAUL AIRCHAFT QCSEB - The key to future short-haul air transport --- Quiet, Clean, Short-Haul Experimental Engine program A79-50208 SHORT TAKEOFF AIRCRAFT Wing aerodynamic loading caused by jet-induced lift associated with STOL-OTW configurations [AIAA PAPER 79-1664] A79-Design of the circulation control wing STOL 179-47346 demonstrator aircraft [AIAA PAPER 79-1842] A Flight experience with advanced controls and A79-47909 displays during piloted curved decelerating approaches in a powered-lift STOL aircraft N79-30243 Effect of transport/bomber loads spectrum on crack growth [AD-A069287] N79-31197 SIDE-LOOKING RADÁR An analysis of SAPPHIRE image parameters as a function of processing parameters --- for synthetic aperture radar data processing A79-48666 SIGNAL DETECTION Tactical electronic reconnaissance sensor --radar emission detection A79-48717 SIGNAL DISTORTION Preprocessing for advanced image matching techniques 179-48602 SIGNAL PROCESSING Failure detection in signal processing and sensing in flight control systems 179-47971 Microcomputer applications in strapdown heading

and attitude reference system

#### SUBJECT INDEX

Multisensor integration for defensive fire control surveillance 179-48610 Quaternion matching in transfer alignment for SAR motion compensation 179-48641 Radar signal processing development for application of VHSI A79-48664 Transform domain processing for digital communication systems using surface acoustic wave devices N79-31482 State of the art in digital signal processing with applications to multiple access systems 179-31487 SIGNAL TO HOISE RATIOS Small signal compensation of magnetic fields resulting from aircraft maneuvers 179-49605 STGNATURE ANALYSTS Radar cross section fundamentals for the aircraft designer [AIAA PAPER 79-1818] SIKORSKY AIRCRAFT A79-47898 Spirit helicopter handling qualities design and development [AHS 79-24] 179-49076 SIMILITUDE LAW Similitude requirements and scaling relationships as applied to model testing [NASA-TP-1435] N79-30176 SINULATION The Swedish approach to escape system testing 179-50427 SKIN (STRUCTURAL MEMBER) Actively cooled plate fin sandwich structural panels for hypersonic aircraft [NASA-CR-3159] N7 N79-31628 SKIN FRICTION Drag reduction by cooling in hydrogen-fueled aircraft A79-49921 SETETS Performance predictions for open ocean air cushion vehicles and surface effect ships 179-49905 Hovercraft skirt design requirements A79-49907 Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems A79-49910 SLENDER WINGS Wing geometry effects on leading-edge vortices [AIAA PAPER 79-1872] A79-A79-49341 SLOT ANTENNAS UHF coplanar-slot antenna for aircraft-to-satellite data communications [NASA-TM-79239] N79-31185 SOLID STATE DEVICES The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 SOUND PRESSURE Experiments of shock associated noise of supersonic jets [AIAA PAPER 79-1526] 179-47341 SOUND TRANSMISSION Duct noise radiation through a jet flow A79-50110 SPACE SHUTTLE ORBITERS Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements --- space shuttle aft body flap N79-30301 SPACECBAFT COMMUNICATION UHF coplanar-slot antenna for aircraft-to-satellite data communications [NASA-TM-79239] N79-31185 SPACECRAFT STRUCTURES Development of fire-resistant, low smoke generating, thermally stable end items for commercial aircraft and spacecraft using a basic polyimide resin

1-46

A79-48606

SPACELAB PAYLOADS Transatlantic flights of stratospheric balloons N79-31687 SPAIN Special investigation report: Wing failure of Boeing 747-131 near Madrid, Spain, 9 May 1976 [NTSB-ARR-78-12] N79-N79-30167 SPECTRAL SIGNATURES Effect of transport/bomber loads spectrum on crack growth [AD-A069287] N79-31197 user's manual for a computer program to generate fatigue spectrum loading sequences FAD-A0692881 N79-31198 SPHERICAL ANTENNAS A report on the Sperry Dome Radar A79-49567 SPIN Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane [AIAA PAPER 79-1837] 179-47908 SPIN DYNAMICS Some results from the use of a control augmentation system to study the developed spin of a light plane [AIAA PAPER 79-1790] SPIN TESTS 179-47879 The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AIAA PAPER 79-1786] Some results from the use of a control augmentation system to study the developed spin A79-47876 of a light plane [AIAA PAPER 79-1790] A79-47879 Some flight data extraction techniques used on a general aviation spin research aircraft General aviation spin research alrorant [AINA PAPER 79-1802] A79-4788 The Beech Model 77 'Skipper' spin program [AINA PAPER 79-1835] The evolution of the high-angle-of-attack features of the P-16 flight control system A79-47887 A79-47907 A79-50438 Radio-controlled model design and testing techniques for stall/spin evaluation of general-aviation aircraft [NASA-TM-80510] N79-30173 Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 2: High-wing model A [NASA-CR-3101] N79-31149 Rotary balance data for a single-engine trainer design for an angle-of-attack range of 8 deg to 90 deg --- conducted in langely spin tunnel [NASA-CR-3099] N79-31 N79-31152 SPOILERS Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] A79-47925 STABILITY DERIVATIVES An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack A79-50165 A computer program for aircraft identification and derivative extraction A79-50306 Considerations in the analysis of flight test maneuvers A79-50433 AFFTC parameter identification experience --- Air Force Flight Test Center aircraft flight testing A79-50434 A force and moment test of a 1/24-scale F-111 model at Mach numbers from 0.7 to 1.3 [AD-A070192] STABILITY TESTS N79-31156 Design, analysis, and testing of a new generation tail rotor [AHS 79-57] STABILIZATION A79-49107 Stabilizing electro-optical systems on helicopters N79-30216 STALLING J85-CAN-15 compressor stall and flameout investigation A79-50441

STATIC TESTS Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter [AHS 79-45] A79-A79-49097 STATISTICAL ANALYSIS Statistical diagnostics of aircraft engines 179-46996 STATORS Digital simulation of a three-phase generator A79-48618 STEADY FLOW Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 STEERABLE ANTENNAS Small lightweight electronically steerable cylindrical antenna successfully utilized in an air traffic management system A79-48597 STORAGE STABILITY Changes in the quality of T-6 fuel upon prolonged storage A79-48858 STRAIN ENERGY METHODS Evaluation of the practical aspects of vibration reduction using structural optimization techniques A79-49074 [AHS 79-21] STRAKES Flow patterns and aerodynamic characteristics of wing with strake [AIAA PAPER 79-1877] STRAPDOWN INBRTIAL GUIDANCE A79-47928 Microcomputer applications in strapdown heading and attitude reference system A79-48606 Transfer alignment for precision pointing applications --- in inertial navigation systems A79-48679 Automatic test software for calibrating strapdown systems A79-48689 A deterministic investigation of strapped down navigation system accuracy A79-48695 Application of instrument rotation in the N73 standard inertial navigation system A79-48696 Rapid reaction time techniques for a strapdown navigator employing electrostatic gyro technology 179-48697 Design and testing of a redundant skewed inertial sensor complex for integrated navigation and flight control N79-30202 STRESS ANALYSIS for helicopter drive systems [ASME PAPER 79-DE-15] A79-47654 Simplified analysis spectrum for joints exposed to complex continuously varying stresses --aerospace structures [AIAA PAPER 79-1808] Designing with experimental mechanics ----three-dimensional photoelastic analysis of helicopter components A79-47892 [AHS 79-11] A79-49063 ATLAS, an integrated structural analysis and design system. Volume 5: System demonstration problems [NASA-CR-159045] N79-31624 STRUCTURAL ANALYSIS Some observations on four current subjects related to aeroelastic stability A79-47093 Evaluation of finite element formulations for transient conduction forced-convection analysis A79-49343 Tapered roller bearing development for aircraft turbine engines [AD-A069440] N79-30555 STRUCTURAL DESIGN Design of advanced titanium structures --- for Advanced Tactical Systems aircraft fuselage [AIAA PAPER 79-1805] A7 A79-47890 Composite helicopter tail booms [AHS 79-9] A79-4900 Design and development of a hybrid composite rotor A79-49061

blade for the circulation control rotor system [AHS 79-46] A79-49098

#### STRUCTURAL DESIGN CRITERIA

Design and development of the Agusta A 109 helicopter A79-49815 STRUCTURAL DESIGN CRITERIA Dynamics requirements for an Advanced Scout Helicopter /ASH/ [AHS 79-19] A79-49072 Certification of composites in civil aircraft [AHS 79-43] A79-49095 [And 75-43] Design criteria for airline operation [AIAA PAPER 79-1849] The feasibility of modern dirigibles [ORERA, TP NO. 1979-93] Hovercraft skirt design requirements 179-49337 179-49541 A79-49907 Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 Design considerations for reliable FBW flight control N79-30231 Windshield technology demonstrator program-canopy detail design options study [AD-A070376] N79-31: N79-31201 STRUCTURAL ENGINEERING Wind tunnels with adapted walls for reducing wall interference [ NASA-TM-75501 ] N79-31230 STRUCTURAL STABILITY Some observations on four current subjects related to aeroelastic stability A79-47093 Developments in gear analysis and test techniques for helicopter drive systems [ASME PAPER 79-DE-15] A79-47654 Dynamics requirements for an Advanced Scout Helicopter /ASH/ [AHS 79-19] STRUCTURAL VIBRATION 179-49072 Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] A79-49071 Evaluation of the practical aspects of vibration reduction using structural optimization techniques [AHS 79-21] A An approach for estimating vibration characteristics of nonuniform rotor blades A79-49074 A79-49718 INACT - Interactive test data analysis --- with minicomputers A79-50430 ATLAS, an integrated structural analysis and design system. Volume 5: System demonstration problems [NASA-CR-159045] N79-31624 SUBSONIC FLOW The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow A79-47099 On the influence of relative pitch in the subsonic turbine cascade A79-48503 Subsonic and transonic flows on a variable sweep wing [ONERA, TP NO. 1979-102] 179-48849 SUBSONIC SPEED Flow visualization studies of a general research fighter model employing a strake-wing concept at subsonic speeds --- in the Langley high speed 7-by 10-ft wind tunnel [NASA-TM-80057] N79-301 N79-30147 A program to compute three-dimensional subsonic unsteady aerodynamic characteristics using the doublet lattice method, L216 (DUBFLEX). Volume 2: Supplemental system design and maintenance document [ NASA-CE-28501 N79-31148 SUBSONIC WIND TUNNELS Dynamic windtunnel simulation of active control systems N79-30233 Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind tunnel [NASA-CR-159120] N79-31143

#### SUBJECT INDEX

A low-velocity airflow calibration and research facility [PB-294501/2] 879-31237 SUPERCRITICAL WINGS Experimental measurements of shock/boundary-layer interaction of a supercritical airfoil [AIAA PAPER 79-1499] A79-47 179-47345 SUPERHIGH FREQUENCIES Combined X/Ka-band tracking radar 179-49565 SUPERPLASTICITY Superplastic forming diffusion bonding of titanium helicopter airframe components [AHS 79-33] SUPERSONIC AIRCRAFT A79-49085 Historical development of worldwide supersonic aircraft [AIAA PAPER 79-1815] A79-47895 Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization 179-47991 SUPERSONIC COMBUSTION RANJET ENGINES Characterization of a swept-strut hydrogen fuel-injector for scramjet applications A79-49345 SUPERSONIC DRAG Wing geometry effects on leading-edge vortices [AIAA PAPER 79-1872] A79-SUPERSONIC PLIGHT A79-49341 Overall aerodynamic characteristics of caret and delta wings at supersonic speeds A79-47012 SUPERSONIC FLOW Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave A79-49456 Comment on "active flutter control using generalized unsteady aerodynamic theory" A79-49873 SUPERSONIC NOZZLES Experiments of shock associated noise of supersonic jets [ATAN PAPER 79-1526] SUPERSONIC SPEEDS 179-47341 High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] SUPERSONIC TRANSPORTS A79-47924 Supersonic transport aircraft noise, problems of noise reduction and establishment of standards A79-50237 SUPERSONICS Supersonic transport vis-a-vis energy savings [NASA-TM-75464] N7 N79-31163 SURFACE COOLING Laminar flow stabilization by surface cooling on hydrogen fueled aircraft [AIAA PAPER 79-1863] A79-47920 SURFACE EFFECT SHIPS vehicles and surface effect ships 179-49905 SURFACE NAVIGATION JTIDS relative navigation - Architecture, error characteristics and operational benefits --Joint Tactical Information Distribution System A79-48715 SURFACE PROPERTIES Bodal interpolation program, L215 (INTERP). Volume 2: Supplemental system design and maintenance document --- to calculate displacements at several points on an aerodynamic surface (NUCL COLOURS) [NASA-CR-2848] N79-31147 SURVEILLANCE Multisensor integration for defensive fire control surveillance A79-48610 SURVEILLANCE RADAR An analysis of SAPPHIRE image parameters as a function of processing parameters --- for synthetic aperture radar data processing 179-48666 SURVEYS Surveys of grooves in 19 bituminous runways [AD-A069889] N79-31233

#### TECHNOLOGY ASSESSMENT

SURVIVAL Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 1: Experimental Results and Design summary N79-31202 [ AD-A070113] SWEEP EFFECT The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] A79-49 SWEPT FORWARD WINGS 179-119057 Application of Lagrange Optimization to the drag polar utilizing experimental data [AIAA PAPER 79-1833] A79-49 179-49335 SURDY STRCS Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel tost data. T 179-46999 Lifting-line theory for a swept wing at transonic speeds A79-47750 A79-Wing geometry effects on leading-edge vortices [AIAA PAPER 79-1872] A79-SWIRLING A79-49341 The application of multiple swirl modules in the design and development of gas turbine combustors [AIAA PAPER 79-1196] A79-473 A79-47349 Factors controlling stability of swirling flames at diffusers in gas turbines A79-50209 SYNCHRONOUS MOTORS Digital simulation of a three-phase generator A79-48618 SYNTHETIC APERTURE RADAR Synthetic aperture radar map matching for navigation A79-48603 Quaternion matching in transfer alignment for SAR motion compensation A79-48641 An analysis of SAPPHIRE image parameters as a function of processing parameters --- for synthetic aperture radar data processing A79-48666 SYNTHETIC FUELS Utilization of alternative fuels for transportation; Proceedings of the Symposium, University of Santa Clara, Santa Clara, Calif., June 19-23, 1978 A79-49376 SYSTEM REFECTIVENESS Avionics design for testability - An aircraft contractor's viewpoint 179-48888 A new U.U.T./test station interface 179-48896 Enhanced fighter mission effectiveness by use of integrated flight systems N79-30223 SYSTEMS ANALYSIS A system for interdisciplinary analysis - A key to improved rotorcraft design A79-49060 [AĤS 79-8] AFFTC parameter identification experience --- Air Force Flight Test Center aircraft flight testing A79-50434 Dynamic loads analysis system (DYLOFLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-31 N79-31144 SYSTEMS ENGINEERING TEMS ENGLANGUAL Identifying desirable design features for the C-XX aircraft - A systems approach [AIRA PAPER 79-1796] A multiple objective optimization approach to A79-47883 aircraft control systems design A79-47962 Analysis design of complex systems. II --- for simultaneous improvement of all basic prototype flight vehicle performance characteristics A79-48505 Electric power system control techniques A79-48614 Electrical power system for new-technology transport power-by-wire airplane A79-48616 Tactical electronic reconnaissance sensor -radar emission detection A79-48717 Multiplex technology applied to helicopters 179-49067 [AHS 79-14]

A design perspective on new technologies for general aviation A79-49486 Aeronautical information data subsystems /AIDS/ A79-50920 Nodern systems for air traffic control A79-50921 Are today's specifications appropriate for tomorrow's airplanes? N79-30239

T TATL SURFACES An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack 179-50165 T-53 RNGINE Computer-assisted high-speed balancing of T53 and T55 power turbines [AHS 79-36] A79-49088 -55 ENGINE Computer-assisted high-speed balancing of T53 and T55 power turbines [AHS 79-36] 179-49088 TACAN An asynchronous data transmission system with low error probability for the SETAC landing aid N79-31468 TATL ASSEMBLIES Analytical and experimental investigation of V-type empennage contribution to directional control in hower and forward flight [AHS 79-56] A79-49106 TAIL ROTORS Ten years of Aerospatiale experience with the fenestron and conventional tail rotor [AHS 79-58] A79-49108 TAKEOFF RUNS ARIA takeoff performance flight test program ---Advanced Range Instrumented Aircraft 179-50437 Airworthiness and flight characteristics test, OV-1C takeoff performance [AD-A069827] N79-30178 TARGET RECOGNITION Estimation of aircraft target motion using pattern recognition orientation measurements A79-47987 Millimeter airborne radar target detection and selection techniques 179-48665 Multiradar tracking system using radial velocity measurements A79-49608 TASK COMPLEXITY The equipment-system interface in an antitank helicopter at night N79-30211 TAXIING Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YP-12A [NASA-CR-144884] N79-31192 TECHNOLOGICAL PORECASTING All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] 179-47906 User requirements for future combat search and rescue vehicles A79-48683 TECHNOLOGY ASSESSMENT Recent V/STOL aircraft designs A79-47608 Manned strategic system concepts 1990-2000 [AIAA PAPER 79-1793] 179-47882 Ristorical development of worldwide supersonic aircraft [AIAA PAPER 79-1815] A79-47895 From HiMAT to future fighters --- Highly Maneuverable Aircraft Technology assessment [AIAA PAPER 79-1816] A7 A79-47896 A status report on the advanced FIREFLY assessment program A79-48609 Terrain-following radar - Key to low-altitude flight A79-48686

Agricultural helicopters --- test and simulation results [AHS 79-60] A79-49064 Superplastic forming diffusion bonding of titanium helicopter airframe components [AHS 79-33] A79-49085 Lockheed urges hydrogen fuel A79-49224 A design perspective on new technologies for general aviation 179-49486 The feasibility of modern dirigibles [ONERA, TP NO. 1979-93] The application of pulsed 'G' band radio altimeters to modern military aircraft A79-49541 A79-49590 Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems A79-49910 An evaluation of sidestick force/deflection characteristics on aircraft handling qualities -50428 Evaluation of the radar altimeter reference method for determining altitude system positioning errors A79-50436 New devices for digital communications in avionics N79-31481 State of the art in digital signal processing with applications to multiple access systems N79-31487 TECHNOLOGY UTILIZATION Advanced RPV electrical systems A79-48615 Radar signal processing development for application of VHSI A79-48664 Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems A79-49910 TELECONNUNICATION State of the art in digital signal processing with applications to multiple access systems N79-31487 TELEVISION SYSTEMS Laboratory development of computer generated image displays for evaluation in terrain flight training [AD-A070065] N79-31236 N79-31236 TREPERATURE DISTRIBUTION use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades 179-48518 TEMPERATURE INVERSIONS Combined distortion on inlet flow to a turbofan engine [NASA-TH-79237] TEMPERATURE NEASUREMENT N79-30187 Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness factor! A79-48857 TERRIBAL BALLISTICS Puel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 1: Experimental Results and Design summary FAD-A0701131 N79-31202 TERMINAL CONFIGURED VEHICLE PROGRAM Flight performance of the ICV B-737 airplane at Kennedy Airport using TRSB/MLS guidance [NASA-TM-801481 N79-31186 TERMINAL PACILITIES Current status of airport terminal complex development abroad A79-50240 Airport power supply --- Russian book A79-50499 TERRAIN ANALYSIS Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities --- Sandia Inertial Terrain Aided Navigation A79-48678 Meeting the challenge of precise navigation during nap-of-the-earth flight [AHS 79-12] A79-4906 A79-49065

#### SUBJECT INDEX

TERBAIN FOLLOWING AIRCRAFT Terrain-following radar - Key to low-altitude flight A79-48686 neeting the challenge of precise navigation during nap-of-the-earth flight [AHS 79-12] Ride gualities criteria validation/pilot 179-49065 performance study: Flight test results [NASA-CR-144885] N79-31193 TEST EQUIPMENT Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 A simplified gross thrust computing technique for an afterburning turbofan engine A79-50440 TEST PACILITIES Microcomputer control of a test facility --- for avionics A79-48672 NASA/Princeton digital avionics flight test facility A79-49344 THEORETICAL PHYSICS. Contributions to fluid mechanics N79-31524 THERMAL CONDUCTIVITY Most rational linearization of nonlinear unsteady heat conduction problems --- for flight vehicle parts and engines A79-48501 THERMAL DECOMPOSITION Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness factor A79-48857 THERMAL DEGRADATION Flectrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 TREBEAL STABILITY The tendency of jet fuels to form deposits on a heated surface A79-48856 THERMAL STRESSES Evaluation of finite element formulations for transient conduction forced-convection analysis A79-49343 THERMODYNAMIC PROPERTIES Thermal characteristics of 3501-6/AS and 5208/T300 graphite epoxy composites - 1071067] Γ A D N79-31357 THERMOPHYSICAL PROPERTIES Mechanical and thermophysical properties of graphite/polyimide composite materials N79-30317 THIN WINGS Solution of a mixed boundary value problem for flow past a thin delta wing A79-49882 THRUST Dynamic test techniques - Concepts and practices --- aircraft performance prediction from thrust/lift/drag model A79-50164 TERUST AUGEENTATION High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] A79-47924 Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber A79-48519 A simplified gross thrust computing technique for an afterburning turbofan engine A79-50440 THRUST CONTROL Some results from the use of a control augmentation system to study the developed spin of a light plane [AIAA PAPER 79-1790] A79-47879 THRUST MEASUREMENT Performance modelling methods --- in flight test programs A79-50167 THRUST REVERSAL Determination of turning angle of a jet impinging on a bucket with visor --- for thrust reversers A79-48500

TRANSPORT AIRCRAFT

THRUST VECTOR CONTROL Nozzles for vectored thrust jet engines ---Russian book A79-47428 TILT ROTOR RESEARCH AIRCRAFT PROGRAM XV-15 flight test results compared with design goals [ATAA PAPER 79-1839] A79-49336 TIME DIVISION MULTIPLE ACCESS Distributed TDMA - An approach to JTIDS phase II --- Time Division Multiple Access Joint Tactical Information Distribution System 170-10584 Implementing JTIDS in tactical aircraft N79-31491 TTHE LAG Predictive guidance for interceptors with time delavs 170-117030 THE OPETHEL CONTROL Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization 179-117991 TINE RESPONSE Radar signal processing development for application of VHSI 179-48664 TITANTON ALLOYS Design of advanced titanium structures --- for Advanced Tactical Systems aircraft fuselage [AINA PAPER 79-1805] A79-4789 Superplastic forming diffusion bonding of titanium A79-47890 helicopter airframe components [AHS 79-33] 179-49085 TOROUR 

 AQUE

 Load spectrum measuring equipment. Part 1:

 Details of MK 1 system presently used to acquire

 data in Wesser MK 31B helicopters

 [ARL-MECH-ENG-NOTE-371]

 N79-31194 TOROUENETERS Rotorshaft torquemeter --- principles and applications [AHS 79-38] 179-49090 TOXIC HAZARDS Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 TOXICITY Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 TOTICITY AND SAPETY HAZARD Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 TOTTCOLOGY Recent advances in materials toxicology N79-31169 TRACKING (POSITION) Synthesis of digital flight control tracking systems by the method of entire eigenstructure assignment A79-48625 TRACKING FILTERS The alpha-beta-gamma tracking filter in the Z-domain --- in aircraft tracking A79-48680 TRACKING RADAR Combined X/Ka-band tracking radar A79-49565 The A.I. tracking problem --- Airborne Interception A79-49566 TRAILING EDGES Flight testing the circulation control wing [AIAA PAPER 79-1791] A79-47880 On single-degree-of-freedom flutter induced by activated controls A79-49867 Correlation of data related to shock-induced trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-N79-31195 TRAINING AIRCRAFT INING AIRCRAFT The Beech Model 77 'Skipper' spin program [AIAA PAPER 79-1835] A79-47907 Rotary balance data for a single-engine trainer design for an angle-of-attack range of 8 deg to 90 deg --- conducted in langely spin tunnel [NASA-CR-3099] N79-31152

TRAJECTORY MEASUREMENT A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements 170-09051 TRAJECTORY OPTIMIZATION Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization 179-47991 A study of the application of singular study of the application of singular perturbation theory -- development of a real time algorithm for optimal three dimensional aircraft maneuvers [NASA-CR-3167] N79-30194 NSFER FUNCTIONS Stabilizing electro-optical systems on helicopters N79-30216 TRANSFER FUNCTIONS TRANSIENT RESPONSE Estimation for advanced technology engines 179-47957 TRANSHISSIONS (MACHINE BLEMENTS) Helicopter drive system R and M design guide [AD-A069835] N N79-30180 Helicopter drive system R and M design guide [AD-A069691] N79-30181 [AD-A003051] Evaluation of pylon focusing for reduced helicopter vibration [AD-A069712] TRANSONIC PLOW N79-30196 Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils [AIIA PAPER 79-1555] A79-4 Subsonic and transonic flows on a variable sweep A79-47342 wing Wing [ONERA, TP NO. 1979-102] Plutter analysis of two-dimensional and two-degree-of-freedom airfoils in 179-48849 small-disturbance, unsteady transonic flow [AD-A069223] Experimental data base for computer program N79-31157 Assessment: Report of the Fluid Dynamics Panel Working Group 04 [AGARD-AR-138] N79-31 Introduction and overview of configurations ---for transonic flows N79-31159 N79-31160 Wind tunnels with adapted walls for reducing wall interference [NASA-TM-75501] N79-31230 TRANSONIC NOZZLES Contributions to experimental fluid mechanics ---development of aerodynamics test facilities in Germany following World War 2 N79-31229 TRANSONTC SPEED Lifting-line theory for a swept wing at transonic speeds 179-47750 Correlation of data related to shock-induced trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-N79-31195 TRANSONIC WIND TUNNELS Wall corrections in transonic wind tunnel: Equivalent porosity [ESA-TT-545] N79-30247 TRANSPORT AIRCRAFT All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] A79-47906 The aerial relay system - An energy-efficient solution to the airport congestion problem ---using cruise liner aircraft for in-air passenger transfer [AIAA PAPER 79-1865] Electrical power system for new-technology transport power-by-wire airplane A79-47921 A79-48616 What the FAA would like in airworthiness standards [AIAA PAPER 79-1851] A79-49338 simulator investigation of handling quality criteria for CCV transport aircraft N79-30240 Effect of transport/bomber loads spectrum on crack growth f AD-A0692871 N79-31197

#### TRANSPORTATION ENERGY

TRANSPORTATION ENERGY Utilization of alternative fuels for transportation; Proceedings of the Symposium, University of Santa Clara, Santa Clara, Calif., June 19-23, 1978 A79-49376 JT9D-70/59 improved high pressure turbine active clearance control system --- for specific fuel consumption improvement N79-31208 [ NASA-CR-159661 ] TURBINE BLADES On the influence of relative pitch in the subsonic turbine cascade A79-48503 Long-life GTE operation based on technical condition -- Gas Turbine Engine A79-48517 Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades A79-48518 TURBINE ENGINES Energy efficient engine flight propulsion system preliminary analysis and design report [NASA-CR-159487] N79-30 N79-30189 Tapered roller bearing development for aircraft . turbine engines [AD-A069440] N79-30555 Aircraft turbine engine monitoring experience: Implications for the P100 engine diagnostic system program [AD-A069282] N79-31217 TURBINE EXHAUST NOZZLES Exhaust emission traverse investigation of a JT3D-1 turbofan engine --- to acquire exhaust nozzle emission sample [AD-A072019] N79-31209 TURBINE WHEELS Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades A79-48518 TIRBOCOMPRESSORS ABOCOMPRESSORS Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor [OMERA, TP NO. 1979-30] Aerodynamic performance of 1.38-pressure-ratio, variable-pitch fan stage [NASA-TP-1502] An actuator dist applied of a state of the A79-50925 N79-31213 An actuator disk analysis of an isolated rotor with distorted inflow [AD-A069884] N79-31216 TURBOPAN ENGINES Energy efficient aircraft engines [AIAA PAPER 79~1861] A79-47918 The DC-9 Super 80 - Much more than a simple stretch A79-49223 Blown wings from Kiev --- short takeoff and landing through wing-overblowing A79-49232 Derivative engines for the 1980s will help limit acquisition and maintenance costs A79-50206 Aircraft engine developments centre on improved performance, higher efficiency A79-50207 QCSEE - The key to future short-haul air transport --- Quiet, Clean, Short-Haul Experimental Engine program A79-50208 A simplified gross thrust computing technique for an afterburning turbofan engine A79-50440 Effect of steady-state temperature distortion and combined distortion on inlet flow to a turbofan engine [ NASA-TM-79237 ] N79-30187 summary of NASA/Air Force full scale engine research programs using the F100 engine [NASA-TM-79267] N7 N79-30188 Experimental Clean Combustor Program (ECCP), phase 3 -- commercial aircraft turbofan engine tests with double annular combustor [NASA-CR-135384] N79-31207 JT9D-70/59 improved high pressure turbine active

clearance control system --- for specific fuel consumption improvement [NASA-CR-159661] N79-31208

#### SUBJECT INDEX

Exhaust emission traverse investigation of a JT3D-1 turbofan engine --- to acquire exhaust nozzle emission sample [ AD-A072019] N79-31209 TURBOJZT ENGINE CONTROL A summary of NASA/Air Force full scale engine research programs using the P100 engine [NASA-TM-79267] N79-30188 TURBOJET ENGINES Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber A79-48519 Conceptual study of a turbojet/ramjet inlet [NASA-TH-80141] N79-31215 TURBOMACHINE BLADES Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of interference from nearby cascades A79-48572 TURBONACHINERY Computer-assisted high-speed balancing of T53 and T55 power turbines [AHS 79-36] TURBOPROP AIRCRAFT A79-49088 The aeroacoustics of advanced turbopropellers A79-50236 Driftdown calculations for the FH/227D aircraft [SAND-78-1807] TURBOPROP ENGINES Energy efficient aircraft engines [AIAA PAPER 79-1861] N79-30182 A79-47918 TURBOSHAFTS Rotorshaft torquemeter --- principles and applications [AHS 79-38] A79-49090 Application of finite-element and holographic techniques in the design of turboshaft engine components [AHS 79-41] A79-49093 Development of a 'no adjustment' turboshaft engine Development of a 'no adjustment' turboshaft eng. control system [AHS 79-42] A79-TURBULENT BOUNDARY LAYER Mechanics of boundary layer transition, part 2: Instability and transition to turbulence [VKI-LECTURE-SERIES-3-PT-2] N79-TURBULENT FLOW A79-49094 N79-31530 Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft [AIAA PAPER 79-1856] A79-4 A79-49339 Gust alleviator feasibility study for G91Y N79-30230 Evaluation of F-111 weapon bay aero-acoustic and weapon separation improvement techniques [ AD-A070253] N79-31203 TURBULENT WAKES Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 Experimental study of the turbulent wake downstream of a fan jet A79-48507 TURNING FLIGHT A study of the application of singular perturbation theory --- development of a real time algorithm for optimal three dimensional aircraft maneuvers [NASA-CR-3167] N79-30194 TWO DIMENSIONAL PLOW A new approach to the solution of large, full matrix equations: A two-dimensional potential flow feasibility study [ NASA-CR-31731 N79-31533 U UH-60A HELICOPTER Crashworthy armored crewseat for the UH-60A Black Hawk LAWK [AHS 79-10] Antennas for the Black Hawk helicopter 179-49062 [AHS 79-15] ULTRAHIGH PREQUENCIES A79-49068 Adaptive array tradeoffs for existing airborne UHF radios

A79-48598

A-52

#### VIBRATION ISOLATORS

UHF coplanar-slot antenna for aircraft-to-satellite data communications ้พ**79-311**85 ILTRASONIC TESTS Ultrasonic method of gun gas detection --- for engine ingestion prevention in F-15 179-50166 INSTRADY FLOW Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils 179-47342 [AIAA PAPER 79-1555] A79-47 Theoretical flap-lag damping with various dynamic inflow models 179-49073 f AHS 79-201 Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave A79-49456 HDWASH Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft [ATAA PAPER 79-1856] A79-170-49339 URBAN RESEARCH Experimental investigation of helicopter flight modes on helicopter-generated noise 179-47873 USER MANUALS (COMPUTER PROGRAMS) A user's manual for a computer program to generate fatigue spectrum loading sequences N79-31198 [ AD-A069288] USER REQUIREMENTS User requirements for future combat search and rescue vehicles **x79-48683** Can avionic testability requirements be enforced 179-48887 Advanced Scout Helicopter flying qualities requirements - How realistic are they [AHS 79-28] 179-49080

# V

-	
V/STOL AIRCRAFT	
Performance of a V/STOL tilt nacelle inlet	with
blowing boundary layer control	
[AIAA PAPER 79-1163]	A79-47347
Recent V/STOL aircraft designs	
Recent V/SIOL allocate designs	179-47608
The characteristics of a lift cruise fan V	STOL
configuration in near proximity to a small	ll deck
with finite edge positions	
[AIAA PAPER 79-1854]	A79-47913
Aerodynamic effects of an attitude control	vane on
a tilt-nacelle V/STOL propulsion system	
[AIAA PAPER 79-1855]	A79-47914
LALAA PAPER /9-1000 j	
Blown wings from Kiev short takeoff and	1
landing through wing-overblowing	
	A79-49232
Effect of nozzle spacing on ground interfe	rence
forces for a two jet V/STOL aircraft	
[AIAA PAPER 79-1856]	A79-49339
Recent applications of theoretical analysis	
Recent applications of theoretical analysis	5 00
V/STOL inlet design	A79-49530
The Guidance and control of Helicopters and	d V/STOL
aircraft at night and in poor visibility	
FAGARD-CP-2581	N79-30198
High performance composites and adhesives	for
V/STOL aircraft	
[AD-A069611]	N79-30332
Theoretical and experimental investigation	of
ground-induced effects for a low-aspect-	ratio
ground-induced effects for a low-aspect-	Latio
highly swept arrow-wing configuration	
[NASA-TP-1508]	N79-31223
VACUUM TESTS	
Experimental measurements of the rotating	
frequencies and mode shapes of a full sc	ale
helicopter rotor in a vacuum and correla	tions
with calculated results	
[AHS 79-18]	A79-49071
	1.2 .2011
VALVES	
Program for the critical components of a	
fly-by-tube backup flight control system	, part I
[AD-A070387]	N79-31226
VARTARIE DITCH PROPELLERS	
Aerodynamic performance of 1.38-pressure-r	atio,
variable-pitch fan stage	
[NASA-TP-1502]	N79-31213
[NR9B-IL-1967]	

VARIABLE SWEEP WINGS (1ABLE SWEEP WINGS High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] A79-4 Subsonic and transonic flows on a variable sweep A79-47924 wing [ONERA, TP NO. 1979-1021 179-48849 VECTOR ANALYSIS Complex guaternion notation in coordinate aircraft-inertial space transformations 179-48681 WRIGCTON DISTRIBUTION Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic and development of aerodynamic and acoust. prediction procedures, comprehensive data report, volume 1 [NASA-CR-159515] N70-30185 [NASA-CR-159515] Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 2 N79-30186 [NASA-CR-159516] Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic predicticn procedures N79-31212 VELOCITY MEASUREMENT Multiradar tracking system using radial velocity measurements A79-49608 VENTILATION Fuselage ventilation under wind conditions N79-31175 VERTICAL PLIGHT Analysis of optimal loop and split-S by energy state modeling 179-17098 VERTICAL LANDING VTOL controls for shipboard landing [NASA-CR-162140] N79-30193 VERTICAL TAKBOFF AIRCRAFT Nozzles for vectored thrust jet engines ---Russian book A79-47428 Digital adaptive control laws for VTOL aircraft A79-48000 Maintenance cost study of rotary wing aircraft, phase 2 [NASA-CR-152291] N79-30138 VTOL controls for shipboard landing [NASA-CR-162140] N79-30193 Maritime patrol airship concept study [AD-A070131] N79-31138 [AU-AU/UI31] Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles --- to be used on vertical lift aircraft [NASA-TP-1510] N79-31 ₩79-31214 VIBRATION The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 N79-31137 VIBRATION DAMPING Dynamics requirements for an Advanced Scout Helicopter /ASH/ A79-49072 [ARS 79-19] Evaluation of the practical aspects of vibration reduction using structural optimization techniques [AHS 79-21] 179-49074 Active external store flutter suppression in the YF-17 flutter model A79-49866 On single-degree-of-freedom flutter induced by activated controls A79-49867 Comment on 'active flutter control using generalized unsteady aerodynamic theory' A79-49873 The promise of multicyclic control --- to control fatiguing blade loads and rotor vibration [NASA-TH-78621] N79-31 N79-31137 VIBRATION ISOLATORS Investigations on the design of active vibration isolation systems for helicopters with rigid and elastic modeling of the fuselage N79-30183 [ DLR-FB-78-04 ]

#### VIBRATION MEASUREMENT

SUBJECT INDER

Performance of two-stage fan with a first-stage rotor redesigned to account for the presence of a part span damper [MASA-TP-1483] Evaluation of pylon focusing for reduced helicopter vibration [AD-A069712] Barrow Waysnowpare N79-30191 N79-30196 VIBRATION MEASUREMENT An approach for estimating vibration characteristics of nonuniform rotor blades A79-49718 VIBRATION TESTS Computer-assisted high-speed balancing of T53 and T55 power turbines [AHS 79-36] A79-49088 Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A79-49101 VORTEX GENERATORS Benefits of aerodynamic interaction to the three surface configuration [AIAA PAPER 79-1830] A79-4 A79-47904 Subsonic and transcnic flows on a variable sweep wing [ONERA, TP NO. 1979-102] A79-48849 VORTEX SHEETS The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow A79-47099 Theoretical estimation of nonlinear longitudinal characteristics of wings with small and moderate aspect ratio by the vortex-lattice method in incompressible flow [DLR-FB-78-26] N79-3016 N79-30161 VORTICES The inner regions of annular jets A79-47520 Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 1: High-wing model B [NASA-CR-3097] N79-3014 Rotary balance data for a single-engine trainer docing for a pagle-of-attack range of 0 desta N79-30145 design for an angle-of-attack range of 8 deg to 90 deg --- conducted in langely spin tunnel [NASA-CR-3099] N79-31152 W WAKES The inner regions of annular jets A79-47520

WALLS	A15-41520
Wind tunnels with adapted walls for reducing	ng wall
interference	
[NASA-TM-75501]	N79-31230
WANKEL ENGINES	
An overview of NASA research on positive	
displacement type general aviation engine	es
[NASA-TN-79254]	N79-31210
WARFARR	W/3-31210
Performance of current radar systems in an	70
environment Electronic Warfare	2.4
environment Electronic warrare	
manting to the second sec	A79-49555
Tactical performance characterization basic	3
methodology	
[AD-A069297]	N79-31235
WARNING SYSTEMS	
A self contained collision avoidance system	for
helicopters	
-	N79-30206
WAVE PROPAGATION	M73-30200
Multipath propagation measurement by Dopple	
technique	÷C
recurrdae	
WEAPON SYSTEMS	N79-31478
Avionics design for testability - An aircra	ft
contractor's viewpoint	
	A79-48888
Adding the challenge of nap-of-the-earth	
· · · · · · · · · · · · · · · · · · ·	N79-30199
WEAPONS DELIVERY	
Separation testing of large weapons from th	
	0 R-1
bomber	ie B-1
bomber	
bomber	A79-50429
bomber Evaluation of F-111 wearon bay aero-acousti	A79-50429
bomber	A79-50429

WEATHER	
An advanced guidance and control system for helicopters	or rescue
WEIGHT REDUCTION	N79-30217
Power hybridization - Key to reducing avia power supply weight and volume	DNICS
Antennas for the Black Hawk helicopter	A79-48652
[AHS 79-15] Ten years of Aerospatiale experience with fenestron and conventional tail rotor	A79-49068 the
[AHS 79-58] WIND BFFECTS	A79-49108
Interactional aerodynamics - A new challer helicopter technology	ige to
[AHS 79-59] Variables characterizing the wind effects aircraft	A79-49109 on an
Fuselage ventilation under wind conditions	A79-49807
WIND SHEAR	N79-31175
Aircraft response to windshears and downdr WIND TUNNEL APPARATUS	N79-30229
Contributions to experimental fluid mechan development of aerodynamics test facilit Germany following World War 2	ics ies in
WIND TUNNEL NODELS	N79-31229
Plight experiments to evaluate the effect wing-tip sails on fuel consumption and h characteristics	of andling
Plow visualization studies of a general re fighter model employing a strake-wing co	ncept at
subsonic speeds in the Langley high by 10-ft wind tunnel [NASA-TH-80057]	N79-30147
Similitude requirements and scaling relati as applied to model testing	onships
[NASA-TP-1435] NIND TUNNBL TESTS	N79-30176
Selection of geometric parameters and loca nose flap on swept wing root profile fro test data. I	tion of m tunnel
Experimental measurements of shock/boundar interaction of a supercritical airfoil	<b>A</b> 79-46999 <b>y</b> -layer
[AIAA PAPER 79-1499] Full-scale wind tunnel study of nacelle sh	A79-47345 ape on
cooling drag [AIAA PAPER 79-1820] A cheap, effective icing detector for gene	A79-47900 ral
aviation aircraft [AIAA PAPER 79-1823]	A79-47902
Engine-aircraft afterbody interactions - Recommended testing techniques based on 1	YF-17
experience [AIAA PAPER 79-1829] Winglet toe out angle optimization for the	A79-47903 Gates
Learjet Longhorn Wing [AIAA PAPER 79-1831] Aerodynamic effects of an attitude control	A79-47905 vane on
a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] Boundary layer control on wings using sound	A79-47914 1 and
leading edge serrations [AIAA PAPER 79-1875] Experimental study of the turbulent wake downstream of a fan jet	A79-47926
Subsonic and transonic flows on a variable	A79-48507 sweep
wing [ONERA, TP NO. 1979-102]	A79-48849
LDV measurements on propellers The influence of sweep on the aerodynamic ]	A79-49052 loading
of an oscillating NACA 0012 airfoil [AHS 79-4] An integrated analytical and experimental	A79-49057
investigation of helicopter hub drag [AHS 79-5] The circulation control rotor flight demons	A79-49058 trator
test program [AHS 79-51]	A79-49103

	nd tunnel and flight test of the XV-15 Ti	.10	
	Rotor Research Aircraft	A79-49105	
<b>v</b> v	[AHS 79-54] -15 flight test results compared with des		
	[AIAA PAPER 79-1839]	179-49336	
	fect of nozzle spacing on ground interfer		
	forces for a two jet V/STOL aircraft		
	[AIAA PAPER 79-1856]	A79-49339	
	aracterization of a swept-strut hydrogen		
	fuel-injector for scramjet applications	170-00205	
1		A79-49345	
	rodynamic interaction on a close-coupled canard-wing configuration		
	[ONERA, TP NO. 1979-95]	A79-49543	
An	investigation of the rolling stability		
	derivatives of a T-tail fighter configura	tion at	
	high angles-of-attack		
		179-50165	
TU	e aeroacoustics of advanced turbopropelle	A79-50236	
ጥከ	e evolution of the high-angle-of-attack f		
	of the F-16 flight control system		
		A79-50438	
An	alysis of wind tunnel data pertaining to	high	
	angle of attack aerodynamics. Volume 1:		
	Technical discussion and analysis of resu	N79-30148	
8 7	[AD-A069646] alysis of wind tunnel data pertaining to		
п	angle of attack aerodynamics. Volume 2:	Data	
	base		
	[AD-A069647]	N79-30149	
si	militude requirements and scaling relation	onships	
	as applied to model testing	N79-30176	
Fr	[NASA-TP-1435] aluation of pylon focusing for reduced	175 30170	
D.	helicopter vibration		
	[AD-A069712]	N79-30196	
Wa	11 corrections in transonic wind tunnel:		
	Equivalent porosity	N70 20247	
,	[ESA-TT-545] comparison of predictions obtained from v	N79-30247	
A	tunnel tests and the results from cruising	na	
	flight: Airbus and Concorde conferen	ices	
	[NASA-TM-75238]	N79-31136	
St	bsonic wind-tunnel investigation of lead		
St	ibsonic wind-tunnel investigation of lead devices on delta wings (data report)	ing-edge	
St	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subso	ing-edge	
Sı	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subso tunnel	ing-edge	
	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini	ing-edge nic wind N79-31143	
	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in	ing-edge nic wind N79-31143	
	bsonic wind-tunnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel	ing-edge nic wind N79-31143 N	
Wj	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132]	ing-edge nic wind N79-31143 N N79-31151	
Wj	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor- tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F-	ing-edge nic wind N79-31143 N N79-31151	
Wj	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor- tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3	ing-edge nic wind N79-31143 N N79-31151	
ĹW A	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor- tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program	ing-edge nic wind N79-31143 N79-31151 111 N79-31156	
ĹW A	bsonic wind-tunnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor- tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics	ing-edge nic wind N79-31143 N79-31151 111 N79-31156	
ĹW A	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 S Panel	
Wj A Ey	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] seessment: Report of the Fluid Dynamics Working Group 04 [AGARD-AR-138]	ing-edge nic wind N79-31143 N79-31151 111 N79-31156	. ,
Wİ A E7 IND	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor- tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGARD-AR-138] TUNNELS	ing-edge nic wind N79-31143 N79-31151 111 X79-31156 Panel N79-31159	. ,
Wİ A E7 IND	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGABD-AR-138] TUNMELS ntributions to experimental fluid mechan: development of aerodynamics test facilit:	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics	
Wİ A E7 IND	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] cperimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGABD-AR-138] TUNNELS notributions to experimental fluid mechanic	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics ies in	
Wj A E3 IND Cc	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS nutributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics ies in N79-31229	
Wj A E3 IND Cc	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGARD-AR-138] TUNBLS nutributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2 ind tunnels with adapted walls for reducing	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics ies in N79-31229	. ,
Wj A E3 IND Cc	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGABD-AR-138] TUNNELS intributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2 ind tunnels with adapted walls for reducing interference	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall	. ,
WJ A EJ IND CC WJ	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS nutributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2 .nd tunnels with adapted walls for reducin interference [NASA-TM-75501]	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics ies in N79-31229	. ,
Wj A E3 IND Cc Wj IND	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TB-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGABD-AR-138] TUNRELS ontributions to experimental fluid mechans development of aerodynamics test facilit: Germany following World War 2 ind tunnels with adapted walls for reducin interference [NASA-TM-75501] VELOCITY	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 Lics Lies in N79-31229 ng wall N79-31230	. ,
Wj A E3 IND Cc Wj IND	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNELS nutributions to experimental fluid mechanic development of aerodynamics test facilit: Germany following World War 2 .nd tunnels with adapted walls for reducin interference [NASA-TM-75501] VELOCITY low-velocity airflow calibration and rest	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 earch	. ,
WJ A EJ CC WJ IND A	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TR-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] teprimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGARD-AR-138] TUNBLS untributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2 ind tunnels with adapted walls for reducin interference [NASA-TH-75501] VELOCITY low-velocity airflow calibration and resu facility [PB-294501/2]	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 Lics Lies in N79-31229 ng wall N79-31230	
Wi A E3 CC Wi IND A	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS INTributions to experimental fluid mechans development of aerodynamics test facilit; Germany following World War 2 and tunnels with adapted walls for reducin interference [NASA-TH-75501] VELOCITY IOW-PELOS	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 earch	. ,
Wi A E3 CC Wi IND A	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS nutributions to experimental fluid mechanic development of aerodynamics test facilit: Germany following World War 2 .nd tunnels with adapted walls for reducin interference [NASA-TM-75501] VBLOCITY low-velocity airflow calibration and rest facility [PB-294501/2] SHIELDS mospheric Electricity Hazard (AEH)	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 earch	
Wj A Ey IND Cc Wj A IND A IND	bsonic wind-tunnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS INTributions to experimental fluid mechans development of aerodynamics test facilit; Germany following World War 2 and tunnels with adapted walls for reducin interference [NASA-TH-75501] VELOCITY IOW-PELOS	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics ies in N79-31229 ng wall N79-31230 earch N79-31237 N79-31237	. ,
Wj A Ey IND Cc Wj A IND A IND	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS nutributions to experimental fluid mechanic development of aerodynamics test facilit: Germany following World War 2 .nd tunnels with adapted walls for reducin interference [NASA-TM-75501] VBLOCITY low-velocity airflow calibration and rest facility [PB-294501/2] SHIELDS mospheric Electricity Hazard (AEH) [AD-A069338] indshield technology demonstrator program- detail design options study	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics nes in N79-31229 ng wall N79-31230 earch N79-31237 N79-30169 -canopy	
Wj A Ey Co Wj A IND A IND A X X	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TR-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] terimental data base for computer progran assessment: Report of the Fluid Dynamics Working Group 04 [AGARD-AR-138] TUNBLS nutributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2 ind tunnels with adapted walls for reducin interference [NASA-TH-75501] VELOCITY low-velocity airflow calibration and rest facility [PB-294501/2] SHIELDS mospheric Electricity Hazard (AEH) [AD-A069338] mdshield technology demonstrator program- detail design options study [AD-A70376]	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 ics ies in N79-31229 ng wall N79-31230 earch N79-31237 N79-31237	
Wi A E3 IND Cc Wi IND A IND A IND IND IND	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS intributions to experimental fluid mechani development of aerodynamics test facilit Germany following World War 2 ind tunnels with adapted walls for reducin interference [NASA-TM-75501] VELCCITY low-velocity airflow calibration and rese facility [PB-294501/2] SHELDS mospheric Electricity Hazard (AEH) [AD-A069338] indshield technology demonstrator program- detail design options study [AD-A070376] FLAPS	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 Parch N79-31237 N79-30169 -canopy N79-31201	
Wi A E3 IND Cc Wi IND A IND A IND IND IND	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGAED-AR-138] TUNBLS mutributions to experimental fluid mechanic development of aerodynamics test facilit: Germany following World War 2 int tunnels with adapted walls for reducing interference [NASA-TH-75501] VELOCITY low-velocity airflow calibration and rest facility [PB-294501/2] SHIELDS mospheric Electricity Hazard (AEH) [AD-A069338] indshield technology demonstrator program- detail design options study [AD-A070376] PLAPS	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 earch N79-31237 N79-30169 -canopy N79-31201 tion of	
Wi A E3 IND Cc Wi IND A IND A IND IND IND	bsonic wind-turnel investigation of lead devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] perimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGADD-AR-138] TUNNELS intributions to experimental fluid mechani development of aerodynamics test facilit Germany following World War 2 ind tunnels with adapted walls for reducin interference [NASA-TM-75501] VELCCITY low-velocity airflow calibration and rese facility [PB-294501/2] SHELDS mospheric Electricity Hazard (AEH) [AD-A069338] indshield technology demonstrator program- detail design options study [AD-A070376] FLAPS	ing-edge hic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 hics his in N79-31229 ng wall N79-31230 Parch N79-31237 N79-31201 hiton of hitunnel	
Wi EJ IND CC Wi IND A INDS A INDS S	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TH-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] cprimental data base for computer program assessment: Report of the Fluid Dynamics Working Group 04 [AGAED-AR-138] TUNBLS mutributions to experimental fluid mechanic development of aerodynamics test facilit: Germany following World War 2 int tunnels with adapted walls for reducing interference [NASA-TH-75501] VELOCITY low-velocity airflow calibration and rest facility [PB-294501/2] SHIELDS mospheric Electricity Hazard (AEH) [AD-A069338] indshield technology demonstrator programs detail design options study [AD-A070376] FLAPS election of geometric parameters and location nose flap on swept wing root profile from test data. I	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 earch N79-31237 N79-31237 N79-30169 -canopy N79-31201 tion of tunnel A79-46999	
Wi EJ IND CC Wi IND A INDS A INDS S	bsonic wind-turnel investigation of lead: devices on delta wings (data report) conducted in Langley 7- by 10-foot subsor tunnel [NASA-CR-159120] .nd-tunnel investigation of an armed mini remotely piloted vehicle conducted in Langley V/STOL tunnel [NASA-TR-80132] force and moment test of a 1/24-scale F- model at Mach numbers from 0.7 to 1.3 [AD-A070192] terimental data base for computer program assessment: Report of the Pluid Dynamics Working Group 04 [AGARD-AR-138] TUNBLS untributions to experimental fluid mechani development of aerodynamics test facilit: Germany following World War 2 ind tunnels with adapted walls for reducin interference [NASA-TH-75501] VELOCITY low-velocity airflow calibration and resu facility [PB-294501/2] SHIELDS mospheric Electricity Hazard (AEH) [AD-A070376] PLAPS election of geometric parameters and locations for profile from	ing-edge nic wind N79-31143 N79-31151 111 N79-31156 Panel N79-31159 nics ies in N79-31229 ng wall N79-31230 earch N79-31237 N79-31237 N79-30169 -canopy N79-31201 tion of tunnel A79-46999	

NTRGS

N79-31195

WING LOADING Wing acrodynamic loading caused by jet-induced lift associated with STOL-OTW configurations [ATAA PAPER 79-1664] An investigation of the rolling stability derivatives of a T-tail fighter configuration at A79-47346 high angles-of-attack A79-50165 WING BACBLLE CONFIGURATIONS Blown wings from Kiev --- short takeoff and landing through wing-overblowing A79-49232 WING OSCILLATIONS Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 Lateral stability at high angles of attack, particularly wing rock N79-30226 WING PLANFORMS Wing geometry effects on leading-edge vortices [AIAA PAPER 79-1872] A79-49 Flow visualization studies of a general research 179-49341 fighter model employing a strake-wing concept at subsonic speeds --- in the Langley high speed 7by 10-ft wind tunnel [NASA-TM-80057] N79-30147 WING PROFILES Analytic formulas for wing profile aerodynamic characteristics in incompressible flow A79-47000 Solution of the inverse aerodynamics problem by the random search method A79-47002 Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] A79 Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave A79-47909 A79-49456 Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) ---conducted in Langley 7- by 10-foot subsonic wind tunnel [NASA-CR-159120] WING SLOTS N79-31143 Flight testing the circulation control wing [AIAA PAPER 79-1791] 179-17880 NTNG SPAN Performance evaluation method for dissimilar aircraft designs --- using the square of the wing span for nondimensional comparisons of aerodynamic characteristics [NASA-RP-1042] N79 N79-30139 WING TIPS Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics A79-49818 WINGLETS Winglet toe out angle optimization for the Gates Learjet Longhorn Wing [AIAA PAPER 79-1831] A79-47905 WINGS On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics A79-47001 Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane [ATA FAPER 79-1837] A79-1 Boundary layer control on wings using sound and leading edge serrations A79-47908 [AIAA PAPER 79-1875] A79-47926 Flow patterns and aerodynamic characteristics of wing with strake
[AIAA PAPER 79-1877] A79-4
Special investigation report: Wing failure of
Boeing 747-131 near Wadrid, Spain, 9 May 1976
[NTSB-AAR-78-12] N79-2
Correlation of data related to shock-induced A79-47928 N79-30167 trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-

#### WORKING FLUIDS

WORKING FLUIDS Puels, lubricants and other fluids used in aviation --- Russian book 179-47433

# Х

I RAY INSPECTION X RAY INSPECTION Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system [AHS 79-35] A79-49087 Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [AHS 79-54] A79-49105 XV-15 flight test results compared with design goals [AIAA PAPER 79-1839] A79-49336

γ

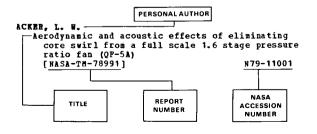
YP-12 AIRCRAFT Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YP-12A [NASA-CR-144884] N79-3119 N79-31192 YF-16 AIRCRAFT Analysis of a lateral pilot-induced oscillation experienced on the first flight of the YF-16 aircraft [NASA-TM-72867] N79-31220

# **PERSONAL AUTHOR INDEX**

### AERONAUTICAL ENGINEERING / A Continuing Bibliography (Suppl. 116)

#### DECEMBER 1979

#### 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. N79-11001. Under any one author's name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first.

# Α

ABBOTT, J. K.	
Electrical insulation fire characteristics.	
Volume 2: Toxicity [PB-294841/2]	N79-30490
ABELKIS, P. R.	173 30430
Effect of transport/bomber loads spectrum	on crack
growth	
[ AD-A069287 ]	N79-31197
A user's manual for a computer program to	generate
fatigue spectrum loading sequences	-
[AD-A069288]	N79-31198
ACORACI, J. A.	
Small lightweight electronically steerable	
cylindrical antenna successfully utilize	d in an
air traffic management system	
	A79-48597
ADSIT, N. R. Ultra-high-modulus graphite-epoxy conical shell	
development, supplement	N79-30335
[AD-A069795] Agliulin, I. N.	N/9-30335
Optimal thermogasdynamic design of gas turbine	
engines using element prototypes. I	Dinc
engines using crement protocipose r	A79-46997
AGNEW, J. W.	
Benefits of aerodynamic interaction to the	three
surface configuration	
[AIAA PAPER 79-1830]	A79-47904
AHABRAH, R. C.	
Are today's specifications appropriate for	
tomorrow's airplanes?	N79-30239
	N79-30239
AIBA, T. Investigation of air stream from combustor-liner	
air entry holes, 3	TINGT
[NASA-TM-75430]	N79-31206
AKITA, R.	
Low cost inertial aiding for NAVSTAR/GPS receivers	
in naval ship navigation	
• •	A79-48656
ALBRECHT, C.	
Developments in gear analysis and test tec	
Developments in dear analysis and cest cee	hniques
for helicopter drive systems	
for helicopter drive systems [ASME PAPER 79-DE-15]	hniques A79-47654
for helicopter drive systems [ASME PAPER 79-DE-15] ALDERETE, T. S.	A79-47654
for helicopter drive systems [ASME PAPER 79-DE-15] ALDERETE, T. S. Piloted simulator investigation of helicop	A79-47654 ter
for helicopter drive systems [ASME PAPER 79-DE-15] ALDERETE, T. S. Piloted simulator investigation of helicop control systems effects on handling qual	A79-47654 ter
for helicopter drive systems [ASME PAPER 79-DE-15] ALDERETE, T. S. Piloted simulator investigation of helicop	A79-47654 ter

ALEKSANDROV. V. G. Handbook on aircraft materials and their application technology 179-48311 ALKER, G. L. Test implementation through support software - A FIT translator 179-48687 ALLEN, R. Certification of composites in civil aircraft FAHS 79-431 A79-49095 ALLEN. S. G. Navstar user equipment for civil and military applications 179-49587 ALTHOF, W. The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints [ESA-TT-521] N79-30391 ANDERSON, G. Y. Characterization of a swept-strut hydrogen fuel-injector for scramjet applications A79-49345 ANDERSON, J. M. A real time video bandwidth reduction system based on a CCD Hadamard transform device A79-48702 ANDERSON, L. R. A program for calculating load coefficient matrices utilizing the force summation method, L218 (LOADS). Volume 2: Supplemental system design and maintenance document [NASA-CR-2854] N79-3 N79-31155 ANDERSON, R. A. FIREMEN program N79-31178 Development of aircraft lavatory compartments with improved fire resistance characteristics. 2: Sandwich panel resin system development [NASA-CR-152120] N7 Phase N79-31354 ANDREEV, P. L. Airport power supply 179-50499 ANDREWS. A. P. Automatic test software for calibrating strapdown systems A79-48689 ANTONOVA, A. M. Solution of a mixed boundary value problem for flow past a thin delta wing A79-49882 ARDENA, M. D. Linearization of the boundary-layer equations of the minimum time-to-climb problem 179-49869 ARNOLD, D. B. Development of aircraft lavatory compartments with improved fire resistance characteristics.2: Sandwich panel resin system development Phase [ NASA-CR-152120 ] N79-31354 ARSEMULT, D. R. Transform domain processing for digital communication systems using surface acoustic wawe devices N79-31482 ASHKENAS, I. L. Handling quality and display requirements for low speed and hover in reduced flight visibility .1ty 179-49081 [AHS 79-29] ASHLEY, H. Some observations on four current subjects related A79-47093

ASHWORTH, B. R.

PERSONAL AUTHOR INDEX

ASHWORTH, B. R. Seat cushion to provide realistic acceleration cues to aircraft simulator pilot [NASA-CASE-LAR-12149-2] N79-31228 В BABISTER. A. W. Aircraft longitudinal motion at high incidence A79-48052 BAHR. D. W. R, D. W. Experimental Clean Combustor Program (ECCP), phase 3 [NASA-CR-135384] N79-31207 BAIR. G. L. Radar signal processing development for application of VESI A79-48664 BALLARD, J. D. Effect of tip shape on blade loading characteristics for a two-bladed rotor in hower [AHS 79-1] A79-49054 BANGEN, H. J. Implementation of flight control in an integrated guidance and control system N79-30215 BARA, E. A review of Boeing interior materials and fire test methods development programs N79-31177 BARCHE, J. Introduction and overview of configurations N79-31160 BARNES, D. R. The circulation control rotor flight demonstrator test program [AHS 79-51] A79-49103 BAUM, Н. A digital communication system as gateway between adjacent computerized air traffic control centres N79-31463 BAZANOV, B. I. Handbook on aircraft materials and their application technology 179-48311 BECKER, E. E. Exhaust emissions characteristics for a general aviation light aircraft Teledyne Continental Notors TSIO-360-C piston engine [AD-A070010] N79-31211 BECKMANN, R. C. Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities A79-48678 BEH. H. Stability and control aspects of the CCV-F104C N79-30234 BEIER, W. An asynchronous data transmission system with low error probability for the SETAC landing aid N79-31468 BELL, J. C. Maritime patrol airship concept study [AD-A070131] BELLAN, J. N79-31138 **`**... Enclosure fire dynamics model N79-31173 BELOV, V. B. Fuels, lubricants and other fluids used in aviation A79-47433 BELROSE, T. C. ATE and aircraft mechanical diagnostics A79-48883 BENDOR, G. A. Quaternion matching in transfer alignment for SAR motion compensation A79-48641 BBNNETT, W. S. Enhanced fighter mission effectiveness by use of integrated flight systems N79-30223 BERGER, J. A comparison of predictions obtained from wind tunnel tests and the results from cruising flight: Airbus and Concorde [NASA-TM-75238] N79-31136 BERRY, J. E. Preprocessing for advanced image matching techniques A79-48602

BERTIN, J. J. Aerodynamics for engineers A79-50375 BERTRAM, L. A. Driftdown calculations for the PH/227D aircraft [SAND-78-1807] N79-30182 BETZINA, M. D. Aerodynamic effects of an attitude control wane on a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] A79-4791 A79-47914 BEUYUKIAN, C. S. Actively cooled plate fin sandwich structural panels for hypersonic aircraft [NASA-CR-3159] N7 N79-31628 

 BIAPOBE, L. P.
 Fluidics: Feasibility study

 electro/hydraulic/fluidic direct drive servo valve

 [AD-A069798]

 N79-30195

 BICKEL, S. H. Small signal compensation of magnetic fields resulting from aircraft maneuvers A79-49605 BIERBAUE, C. Evolving methods for reducing avionics data in an AISF environment A79-48671 BIHRLE, W., JR. Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 1: High-wing model B [NASA-CR-3097] N79-30145 BILL, F. A. The circulation control rotor flight demonstrator test program [AHS 79-51] A79-49103 BIRLER, J. L. Aircraft turbine engine monitoring experience: Implications for the P100 engine diagnostic system program [ÅD-A069282] N79-31217 BLACKMAN, S. Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [AHS 79-54] A7 BLAIR, P. K. Navstar user equipment for civil and military A79-49105 applications A79-49587 BLAKE, B. B. Improved method of predicting helicopter control response and gust sensitivity [AHS 79-25] A79-49077 BLAZOWSKI, W. S. Ambient correction factors for aircraft gas turbine idle emissions [ AD-A069240] N79-31218 BLESS, S. J. Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 1: Experimental Results and Design summary [AD-A070113] N79-31202 BLIAULT, A. Small hovercraft design - Evolution to simplicity A79-49906 BLOCH, S. A self contained collision avoidance system for helicopters N79-30206 BOBULA, G. A. Effect of steady-state temperature distortion and combined distortion on inlet flow to a turbofan engine [NÁSA-TM-79237] N79-30187 BODE, W. E. Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30214 BOBBRET, H. GCU, the Guidance and Control Unit for all weather approach N79-30213 BOGHANI, A. B. Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79-30175

BOGOHOLOV, A. I. Analysis design of complex systems. II	A79-48505
BONA, B. E. Rapid reaction time techniques for a strapd navigator employing electrostatic gyro te	own chnology A79-48697
BORGER, J. G. Alternative fuels in aviation	A79-49381
BOROVIK, V. O. Optimal thermogasdynamic design of gas turb	
engines using element prototypes. I	A79-46997
BOSCHMA, J. H. Advances in decelerating steep approach and landing for helicopter instrument approac [AHS 79-16] BOSSLER, R. B., JR.	hes A79-49069
Rotorshaft torguemeter [AHS 79-38]	A79-49090
BOTHA, D. G. Integrated CNI avionics	
BOTHE, H.	A79-48711
Nultipath propagation measurement by Dopple technique	
BOTROS. A. Z.	N79-31478
Radiation from guarter-wavelength monopoles finite cylindrical, conical, and rocket-s conducting bodies	s on shaped
BOULET, J.	A79-50606
Aerospatiale AS.350 and AS.355	A79-49814
BOUTTES, J. The feasibility of modern dirigibles [ONERA, TP NO. 1979-93]	A79-49541
BOWHAN, C. L. Multisensor integration for defensive fire	control
surveillance	A79-48610
BRAUER, D. P. Evaluation of airfield pavement materials !	based on
synthetic polymers	A79-49348
BREMER, S. Analysis of plume rise from jet aircraft [CONF-790142-1]	N79-31204
BRBUHAUS, W. O. Comment on 'Flight test of stick force stal	<b>ility</b>
in attitude-stabilized aircraft	A79-49925
BREWER, G. D. Laminar flow stabilization by surface cool:	ing on
hydrogen fueled aircraft [AIAA PAPER 79-1863] PATCERP B H	A79-47920
BRICKER, B. W. Airport flammability, full scale fire test:	s N79-31167
Seat test program	N79-31168
BRIGHT, J. T. Aerodynamics of spoiler control devices [AIAA PAPER 79-1873]	A79-47925
BROCARD, Y. Aerodynamic interaction on a close-coupled	
canard-wing configuration [ONERA, TP NO. 1979-95] BROCCHI, R.	A79-49543
Can avionic testability requirements be en	forced A79-48887
BROCKHAUS, B. Variables characterizing the wind effects	on an
aircraft	A79-49807
BROKOF, U. A simple integrated navigation based on mu [DGLR PAPER 79-041]	ltiple DME A79-48640
BROWN, H. J. Composite helicopter tail booms [AHS 79-9]	A79-49061
[Ans //-/] BROWE, J. S., JE. Similitude requirements and scaling relati	
as applied to model testing	•

as applied to model testing	
[NASA-TP-1435]	N79-30176

BROWN, R. B. Compass Cope airframe design history [AIAA PAPER 79-1792] A79-47881 BRUNKEN, J. E. Helicopter obstacle strike tolerance A79-49059 BRYANT, W. H. NASA/Princeton digital avionics flight test facility A79-49344 BUCKLEY, K. Navstar user equipment for civil and military applications A79-49587 BUCKNER, J. K. The evolution of the high-angle-of-attack features of the P-16 flight control system 179-50438 BUDDIN, A. L., III An evaluation of the bird aircraft strike hazard at Hill APB, Utah (APLC) [AD-A070459] N79-31 179-31184 [AD-A070459] BUILTN, K. E. Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST [ABS 79-27] BUKHARKIN, A. K. Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness A79-49079 factor! A79-48857 BULL, J. S. Plight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] 179-49104 BURCHFIELD, C. G. A force and moment test of a 1/24-scale F-111 model at Mach numbers from 0.7 to 1.3 [AD-A070192] N79-31156 BURDGES. K. P. Experimental measurements of shock/boundary-layer interaction of a supercritical airfoil [AIAA PAPER 79-1499] A79-47. A79-47345 [AIAA PAPER 79-1499] BURGIN, G. H. Tactical performance characterization basic methodology [AD-A069297] N79-31235 BURK, S. M., JR. Radio-controlled model design and testing techniques for stall/spin evaluation of general-aviation aircraft N79-30173 [NASA-TM-80510] BURROUGHS, B. A. Superplastic forming diffusion bonding of titanium helicopter airframe components [AHS 79-33] BURROWS, L. T. A79-49085 Helicopter obstacle strike tolerance A79-49059 [AHS 79-7] BUSE, B. J. New devices for digital communications in avionics N79-31481 BYERLY, D. C. Avionics design for testability - A vendor's viewpoint A79-48889

# Ç

Ý	
CAHILL, J. F.	
Correlation of data related to shock-induce	
trailing-edge separation and extrapolation	n to
flight Reynolds number	
	N79-31195
CALAPODAS, N. J.	
Evaluation of the practical aspects of vibr	ation
reduction using structural optimization t	echniques
[AHS 79-21]	A79-49074
CALDWELL, E. W.	
Identifying desirable design features for t	he C-XX
aircraft - A systems approach	
[AIAA PAPER 79-1796]	A79-47883
CALMAN, J.	
Analysis of plume rise from jet aircraft	
[CONP-790142-1]	N79-31204
[COM1 / 30142 1]	117 51204
CAPONE, F. J.	
The nonaxisymmetric nozzle - It is for real	
[AIAA PAPER 79-1810]	A79-47893
•	

#### CAPTAIN, K. M.

#### PERSONAL AUTHOR INDEX

CAPTAIN, K. M. Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79-30175 CARABELL, R. Gust alleviator feasibility study for G91Y N79-30230 CARLSON, H. W. High-performance wings with significant leading-edge thrust at supersonic speeds [AIAA PAPEB 79-1871] A79-47924 CARRETTO, J. A., JR. Microcomputer control of a test facility A79-48672 CARBOLL. J. Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack 179-47943 A study of the application of singular perturbation theory [NASA-CR-3167] N79-30194 CARTA, F. O. The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] 179-49057 CAVALLI, D. ONERA's model of the pilot in discrete time N79-30242 CAZENAVE, A. Results related to simulated and in-flight experimentation with an electric flight control system that can be generalized N79-30224 CECCHINI, G. P. Transatlantic flights of stratospheric balloons N79-31687 CERNOSEK, J. Designing with experimental mechanics [AHS 79-11] 179-49063 CHAMBERLIN, B. Energy efficient aircraft engines [AIAA PAPER 79-1861] 179-47918 CHAN, W. T. The inner regions of annular jets A79-47520 CHEN, R. T. N. Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AHS 79-26] A79-4 A79-49078 CHERENUKINN, G. A. Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel 179-46999 CHIPMAN, R. Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils [AIAA PAPER 79-1555] A79-47342 CIEPLUCE, C. C. QCSEE - The key to future short-haul air transport A79-50208 CLARK, C. K The evolution of the high-angle-of-attack features of the F-16 flight control system **∆79-50438** CLARK, D. R. A lifting-surface method for hover/climb airloads [AHS 79-3] A79-49 A79-49056 An integrated analytical and experimental investigation of helicopter hub drag [AHS 79-5] A79-CLARK, L. V. Flight performance of the TCV B-737 airplane at A79-49058 Kennedy Airport using TRSB/MLS guidance [NASA-TM-80148] N79-31186 CLARK. N. M. Techniques for fault isolation ambiguity reduction 179-48891 CLARK, R. K. Mechanical and thermophysical properties of graphite/polyimide composite materials N79-30317

CLARK, R. L. Evaluation of F-111 weapon bay aero-acoustic and weapon separation improvement techniques [AD-A070253] N79-3: N79-31203 CLARK, R. W. A new approach to the solution of large, full matrix equations: A two-dimensional potential flow feasibility study [ NASA-CR-3173] N79-31533 CLARKE, G. E. Recent progress in aircraft sink rate measurement [AIAA PAPER 79-1798] A79-47. High sink-rate landing testing of Navy aircraft A79-47884 A79-50163 CLEMMONS, R. E. Dynamic loads analysis system (DYLOFLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-3 Dynamic loads analysis system (DYLOFLEX) summary N79-31144 Volume 2: Supplemental system design information [NASA-CR-2846-2] N79-3114 N79-31145 Equation modifying program, L219 (EQMOD). Volume 2: Supplemental system design and maintenance document [ NASA-CR-2856] N79-31153 Time history solution program, L225 (TEV126). Volume 2: Supplemental system design and maintenance document [NASA-CR-2860] N79-31154 CLIFF, E. H. A computer program for aircraft identification and derivative extraction A79-50306 CLIFFORD, J. E. Pave Low III A79-48682 CLYMAN, M. Maintenance improvement: An analysis approach including inferential technical data [ AD-A068382] ₩79-30141 COE, P. L., JR. Theoretical and experimental investigation of ground-induced effects for a low-aspect-ratio highly swept arrow-wing configuration [NASA-TP-1508] N79-31223 COKER, M. J. Windshield technology demonstrator program-canopy detail design options study [ AD-A070376 ] N79-31201 COLLINS, P. G. Boundary layer control on wings using sound and leading edge serrations [AIAA PAPER 79-1875] A79-47926 CONLEY, N. E. Winglet toe out angle optimization for the Gates Learjet Longhorn Wing [AIAA PAPER 79-1831] A79-47905 CONNOR, P. C. Correlation of data related to shock-induced trailing-edge separation and extrapolation to flight Reynolds number [NASA-CR-3178] N79-2 N79-31195 COOK, L. P. Lifting-line theory for a swept wing at transonic speeds 179-47750 COOK, H. V. Some aspects of the design and development of the maritime autopilot modes for the Westland Lynx helicopter N79-30201 COOPER, D. E. The influence of engine/fuel control design on helicopter dynamics and handling qualities [AHS 79-37] A79-49089 COOPER, J. H. Dynamic test techniques - Concepts and practices A79-50164 CORLETT, R. C. Evaluation of airfield pavement materials based on synthetic polymers A79-49348 CORMERY, G. Supersonic transport vis-a-vis energy savings [NASA-TH-75464] N79-31163 CORNIER, K. R. Helicopter drive system R and M design guide [AD-A069835] N79-30180

Helicopter drive system R and M design guide [AD-A069691] N79-301 COBN, P. B. Lightning hazards overview: Aviation requirements N79-30181 and interests N79-30876 CORSIGLIA, V. R. Full-scale wind tunnel study of nacelle shape on COOLING drag [AIAA PAPER 79-1820] COX, C. R. A79-47900 Helicopter noise rules - Are they appropriate and reasonable A79-49478 COI, L. Reliability improvement warranty terms and conditions for the Integrated Avionics Control Systems (IACS) N79-3 N79-31205 CRANE, C. R. Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 CREWS, S. T. Helicopter component environmental vibration testing - The poor man's fatigue test [AHS 79-49] A7 CRIST, D. Model 206L composite litter door A79-49101 Model 206L composite litter door [AHS 79-31] A79-4908 CROSS, K. D. Meeting the challenge of precise navigation during nap-of-the-earth flight [AHS 79-12] A79-4906 CROUCE, K. E. The feasibility of inflight measurement of lightning strike parameters [NASA-CR-158981] N79-3016 CUBNINGBAH, T. B. Helicopter high grain control [NASA-CR-159052] N79-3122 CURRAN, J. J. Development of a 'no adjustment' turboshaft engine control system 179-49083 179-49065 N79-30165 N79-31221 control system [AHS 79-42] CURRAN, P. N. A79-49094 Design procedure for aircrew station labeling selection and abbreviation N79-30208

# D

DAHL. G.	
Fault diagnosis of gas turbine engines by m component characteristics determination	
-	A79-49806
DAMOULAKIS, J. H. A real-time sequential filtering algorithm low-dynamics navigation system	for GPS
100 affaultob havigation office	A79-48657
DAS, P.	
Transform domain processing for digital communication systems using surface acous wave devices	stic
Have derived	N79-31482
DAVIS, J. M.	
A system for interdisciplinary analysis - A	l key to
improved rotorcraft design [AHS 79-8]	179-49060
DAY, D. B.	175 45000
Automatic test program generation selection	
	A79-48690
F-16 depot automatic test equipment	A79-48895
DAZZO, J. J.	A/9-40093
Synthesis of digital flight control tracking	a
systems by the method of entire eigenstru assignment	
d 35 I g m c 1 c	A79-48625
DEBOER, W. P.	
A simulator investigation of handling quali	lty
criteria for CCV transport aircraft	N79-30240
DECARLI, H. E.	MID 30240
Analytic redundancy for flight control sens	sors on

Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft A79-47960

DECKER, D. S.	
An evaluation of asphalt-rubber mixtures f	or use
in pavement systems	
[AD-A069448] DECKERT, W. H.	N79-30246
DECKERT, W. H.	
Recent V/STOL aircraft designs	
	A79-47608
DEL BOCA, R. L.	
Multifunction CO2 heterodyning laser radar	for low
level tactical operations	
· · · · · · · · · · · · · · · · · · ·	A79-48685
DELBOCA, R. L.	
Heterodyning CO2 laser radar for airborne	
applications	
	N79-30205
DENKO, P. S.	
Advances in decelerating steep approach an	
landing for helicopter instrument approa	
[AHS 79-16]	A79-49069
DEPONTEVES, D.	
Stabilizing electro-optical systems on hel	
	N79-30216
DESJARDINS, S. P.	
Crashworthy armored crewseat for the UH-60	A Black
Hawk	
[AHS 79-10]	A79-49062
DESKIN, W. J.	
A summary of NASA/Air Force full scale eng	ine
research programs using the F100 engine	
[NASA-TM-79267]	N79-30188
DESTUYNDER, R.	
Structural aspects of active controls	
	N79-30221
DHANVADA, M. R.	
Subsonic wind-tunnel investigation of lead	ing-edge
devices on delta wings (data report)	
[NASA-CR-159120]	N79-31143
DIAMOND, F. I.	
New devices for digital communications in	
	N79-31481
DICARLO, D. J.	
Exploratory study of the influence of wing	
leading-edge modifications on the spin	
characteristics of a low-wing single-eng	ine
characteristics of a low-wing single-eng general aviation airplane	ine
characteristics of a low-wing single-eng general aviation airplane [AIAA FAPER 79-1837]	ine A79-47908
general aviation airplane	
general aviation airplane [AIAA PAPER 79-1837]	<b>∆79-47</b> 908
general aviation airplane [AIAA PAPER 79-1837] DICKENS, W.	<b>A79-47</b> 908 ainer
general aviation airplane [AIAA PAPER 79-1837] <b>DICKENS, W.</b> Rotary balance data for a single-engine tr	<b>A79-47</b> 908 ainer
general aviation airplane [AIAA PAPER 79-1837] <b>DICKENS, W</b> . Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099]	<b>A79-47</b> 908 ainer
general aviation airplane [AIAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg	A79-47908 ainer deg to
general aviation airplane [AIAA PAPER 79-1837] <b>DICKENS, W</b> . Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099]	A79-47908 ainer deg to N79-31152
general aviation airplane [AIAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D.	A79-47908 ainer deg to N79-31152 e method
general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc	A79-47908 ainer deg to N79-31152 e method
general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc	A79-47908 ainer deg to N79-31152 e method ing errors
<pre>general aviation airplane [AIAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436
<pre>general aviation airplane [AIAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow</pre>	A79-47908 ainer deg to N79-31152 e method ing errors
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436
<pre>general aviation airplane [AIAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZINSKI, W.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-FB-78-21] DOMKUBUWAR, V. E.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192
<pre>general aviation airplane [AIAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PB-78-21] DOMKUNDWAR, V. M. Factors controlling stability of swirling</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-FB-78-21] DOMKUBUWAR, V. E.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-FB-78-21] DOMKUBDWAR, V. E. Pactors controlling stability of swirling at diffusers in gas turbines</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PB-78-21] DOMKUNDWAR, V. M. Pactors controlling stability of swirling at diffusers in gas turbines DOWLEY, S. T.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-FB-78-21] DOMKUBDWAR, V. E. Pactors controlling stability of swirling at diffusers in gas turbines</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def (DLR-FB-78-21] DOMKUBJWAR, V. H. Factors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PB-78-21] DOMKUNDWAR, V. M. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOMKUDDWAR, V. M. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-16 helicopter, 19-round lightweight air</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZINSKI, W. Noise generation by jet-engine exhaust def [DLR-PB-78-21] DOMKUBDWAR, V. E. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOMKUBWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Plight test verification of the ASSET syst DOTEW, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828]</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOHKUNDWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEW, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DUUPLE, G. S.</pre>	λ79-47908         ainer         deg to         N79-31152         e method         ing errors         λ79-50436         λ79-50110         lection         N79-30192         flames         λ79-50209         em         λ79-48622         borne         N79-30177
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DIR-FB-78-21] DOMKUBDWAR, V. E. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t</pre>	λ79-47908         ainer         deg to         N79-31152         e method         ing errors         λ79-50436         λ79-50110         lection         N79-30192         flames         λ79-50209         em         λ79-48622         borne         N79-30177
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOHKUNDWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEW, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DUUPLE, G. S.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne N79-30177 he
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOHKUNDWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Plight test verification of the ASSET syst DOTEW, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DUWPLE, G. S. Performance of a pulse-decode circuit in t presence of interference</pre>	λ79-47908         ainer         deg to         N79-31152         e method         ing errors         λ79-50436         λ79-50110         lection         N79-30192         flames         λ79-50209         em         λ79-48622         borne         N79-30177
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZINSKI, W. Noise generation by jet-engine exhaust def [DLR-PB-78-21] DOMKUBJWAR, V. H. Factors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-48622 borne N79-30177 he A79-48713
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOHKUNDWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Plight test verification of the ASSET syst DOTEW, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DUWPLE, G. S. Performance of a pulse-decode circuit in t presence of interference</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne N79-30177 he A79-48713 t facility
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOMKUNDWAR, V. M. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R. NASA/Princeton digital avionics flight test</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-48622 borne N79-30177 he A79-48713
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DIR-FB-78-21] DOMKUBJWAR, V. E. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. MH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWHING, D. R. NASA/Princeton digital avionics flight tes DOWSETT, P. H.</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne N79-30177 he A79-48713 t facility
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOMKUNDWAR, V. M. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R. NASA/Princeton digital avionics flight test</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne N79-30177 he A79-48713 t facility A79-49344
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOHKUNDWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEM, P. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R. NASA/Princeton digital avionics flight tes DOWSETT, P. H. Recent advances in radome design</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne N79-30177 he A79-48713 t facility
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DIR-FB-78-21] DOMKUBJWAR, V. E. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. MH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R. NASA/Princeton digital avionics flight tes DOWSETT, P. H. Recent advances in radome design DRAPE, D. J.</pre>	λ79-47908         ainer         deg to         N79-31152         e method         ing errors         λ79-50436         λ79-50110         lection         N79-30192         flames         λ79-50209         em         Λ79-48622         borne         N79-30177         he         λ79-486713         t facility         ۸79-49344         ۸79-49574
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOMKUBWAR, V. R. Factors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R. NASA/Princeton digital avionics flight tes DOWSETT, P. H. Recent advances in radome design DRAPE, D. J. Performance evaluation of an air vehicle u</pre>	λ79-47908         ainer         deg to         N79-31152         e method         ing errors         λ79-50436         λ79-50110         lection         N79-30192         flames         λ79-50209         em         Λ79-48622         borne         N79-30177         he         λ79-486713         t facility         ۸79-49344         ۸79-49574
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBEZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOHKUNDWAR, V. H. Pactors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Plight test verification of the ASSET syst DOTEW, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DUUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. B. NASA/Princeton digital avionics flight test DOWSETT, P. H. Recent advances in radome design DRAFE, D. J. Performance evaluation of an air vehicle u non-axisymmetric nozzles</pre>	A79-47908 ainer deg to N79-31152 e method ing errors A79-50436 A79-50110 lection N79-30192 flames A79-50209 em A79-48622 borne N79-30177 he A79-48713 t facility A79-49344 A79-49574 tillizing
<pre>general aviation airplane [ATAA PAPER 79-1837] DICKENS, W. Rotary balance data for a single-engine tr design for an angle-of-attack range of 8 90 deg [NASA-CR-3099] DINKEL, J. D. Evaluation of the radar altimeter referenc for determining altitude system position DOAK, P. E. Duct noise radiation through a jet flow DOBRZYNSKI, W. Noise generation by jet-engine exhaust def [DLR-PE-78-21] DOMKUBWAR, V. R. Factors controlling stability of swirling at diffusers in gas turbines DONLEY, S. T. Flight test verification of the ASSET syst DOTEN, F. S. AH-1G helicopter, 19-round lightweight air launcher jettison envelope determination [AD-A069828] DOUPLE, G. S. Performance of a pulse-decode circuit in t presence of interference DOWNING, D. R. NASA/Princeton digital avionics flight tes DOWSETT, P. H. Recent advances in radome design DRAPE, D. J. Performance evaluation of an air vehicle u</pre>	λ79-47908         ainer         deg to         N79-31152         e method         ing errors         λ79-50436         λ79-50110         lection         N79-30192         flames         λ79-50209         em         Λ79-48622         borne         N79-30177         he         λ79-486713         t facility         ۸79-49344         ۸79-49574

DUDLEY, R. E.

#### DUDLEY, R. E. A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements A79-48051 DUBMER, R. J Crashworthy armored crewseat for the UH-60A Black Hawk [AHS 79-10] A79-49062 DUNN, J. L. Testing the F-18 at the U.S. Naval Air Test Center A79-504 A79-50444 DUPLESSIS, R. M. Rapid reaction time techniques for a strapdown navigator employing electrostatic gyro technology A79-48697 DYKE, R. W. Current Canadian developments related to low-speed heavy lift ACV A79-49915 DZVONIK, L. I. Solution of a mixed boundary value problem for flow past a thin delta wing A79-49882

# Ε

BBNER, R. E. Design and testing of a redundant skewed inertial sensor complex for integrated navigation and flight control N79-30202 EDWARDS, T. E. Some results from the use of a control augmentation system to study the developed spin of a light plane A79-47879 EGOROV, IU. N. Selecting the passenger airplane fuselage 179-47014 ELOWITZ. N. Evolving methods for reducing avionics data in an AISF environment 179-48671 EMERY, J. H. Multiplex technology applied to helicopters [AHS 79-14] A79-49067 EMIN, O. N. Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface A79-48498 ENDECOTT, B. R. Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 ENGLAR, R. J. Flight testing the circulation control wing [AIAA PAPER 79-1791] Design of the circulation control wing STOL A79-47880 demonstrator aircraft [AIAA PAPER 79-1842] 179-47909 ENGLISH, B. B. The A.I. tracking problem A79-49566 ERICSSON, L. E. A summary of AGARD FDP meeting on dynamic stability parameters N79-30220 EVERETT, R. A., JR. Fatigue and fracture N79-30315 EYRE, D. Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems A79-49910

### F

- Runway configuration management system concepts [AD-A069960] N79-31234

#### PERSONAL AUTHOR INDEX

PAINTICH, M. B. Digital sensor simulation at the Defense Mapping Agency Aerospace Center A79-48705 PANNING, A. E. Engine-aircraft afterbody interactions -Recommended testing techniques based on YF-17 experience [AIAA PAPER 79-1829] A79-47903 PARINÀ, A. Multiradar tracking system using radial velocity measurements A79-49608 FARRAR. F. A. Estimation for advanced technology engines A79-47957 FARRBLL, J. L. Transfer alignment for precision pointing applications A79-48679 FEDOROV, E. IA. On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics A79-47001 FEIK. R. A. Lateral aerodynamics extracted from flight test using a parameter estimation method [ARL-AERO-NOTE-380] N79-31146 PERENS, D. V. Avionics computer software operation and support cost estimation A79-48620 FERGUSON, S. W. Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST [AHS 79-27] A79-49079 FEBLET, G. The equipment-system interface in an antitank helicopter at night N79-30211 PEWELL, L. A.
Fire resistant aircraft seat program N79-31176 FISCHER, F. W. Aeronautical information data subsystems /AIDS/ A79-50920 FISHBEIN, B. D. Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber A79-48519 POGEL, L. J. Tactical performance characterization basic methodology [AD-A069297] N79-31235 FORB, P. Multipath propagation measurement by Doppler technique N79-31478 FORREST, R. D. Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AHS 79-26] A79-0 A79-49078 POSTER, C. R. What the PAA would like in airworthiness standards [AIAA PAPER 79-1851] A79-49338 FOX. D. Electric power system control techniques A79-48614 FRASER, K. P. Load spectrum measuring equipment. Part 1: Details of MK 1 system presently used to acquire data in Wessex MK 31B helicopters [ARL-MECH-ENG-NOTE-371] N79-31194 PRAZEE, L. A. Multiplex technology applied to helicopters [AHS 79-14] A79-49067 REEBAN, C. B. Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight [AHS 79-56] A79-49106 FREI, D. G. Power hybridization - Key to reducing avionics power supply weight and volume A79<sup>-</sup> A79-48652

FRIED, W. R. JTIDS relative navigation - Architecture, error characteristics and operational benefits A79-48715 System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function 179-48716 FUHRKEN, B. Noise generation by jet-engine exhaust deflection [DLR-FB-78-21] N79-30192 G GABEL, R. BEL, R. Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-490 Evaluation of pylon focusing for reduced helicopter vibration [AD-A069712] N79-3019 PTW. R. O. A79-49075 N79-30196 GAFFIN W. O. JT9D-70/59 improved high pressure turbine active clearance control system [NASA-CR-159661] N79-31208 GAGLIANI, J. Development of fire-resistant, low smoke generating, thermally stable end items for commercial aircraft and spacecraft using a basic polyimide resin N79-31171 GALBRAITH, T. J. A computer system for identifying aircraft characteristics A79-50168 GALLOWAY, B. T. Flight testing and simulator flight fidelity 79-50307 GAMON, M. A. Testing and analysis of dual-mode adaptive landing gear, taxi mode test system for YP-12A [NASA-CR-144884] N79-311 N79-31192 GANZER, U. Wind tunnels with adapted walls for reducing wall interference N79-31230 [NASA-TH-75501] GAOBERAR, G. H. Theoretical flap-lag damping with various dynamic inflow models [AHS 79-20] A79-49073 GARDNER, B. G. Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation A79-48656 GARDNER, W. B. Energy efficient engine flight propulsion system preliminary analysis and design report [NASA-CR-159487] N79-3 N79-30189 GARRISON, J. R. The Bell Model 222 A79-49816 GEDDES, J. P. The DC-9 Super 80 - Much more than a simple stretch A79-49223 GEE, D. R. Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight [AHS 79-26] A79-7 A79-49078 GBHLHAR, B. Noise generation by jet-engine exhaust deflection [DLR-FB-78-21] N79-30192 GEISTER, D. E. Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 GERDES, B. M. Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight (AHS 79-26] A79-49078 GRHARDT, L. A. State of the art in digital signal processing with applications to multiple access systems N79-31487 GIBSON, J. C. Flying qualities and the fly-by-wire aeroplane

N79-30238

GIESY, D. P. A multiple objective optimization approach aircraft control systems design	
GILBERT, W. P.	A79-47962
Similitude requirements and scaling relation as applied to model testing	nships
[NASA-TP-1435] GLADYSH, I. S. Airport power supply	N79-30176
GLBASON, C. C.	A79-50499
Experimental Clean Combustor Program (ECCP) [NASA-CR-135384] GLOWER, K. B.	, pnase з N79-31207
Some results from the use of a control augmentation system to study the develope of a light plane	d spin
	<b>1</b> 79-47879
The tendency of jet fuels to form deposits	on a
heated surface	A79-48856
GORDON, R. Design of advanced titanium structures	
[AIAA PAPER 79-1805] Gorodetskii, V. G.	<b>∆79-47890</b>
The tendency of jet fuels to form deposits heated surface	on a
GORRELL, W. T.	<b>∆79-48856</b>
Performance of two-stage fan with a first-s rotor redesigned to account for the prese a part-span damper	
[NASA-TP-1483]	N79-30191
GOVINDARAJ, K. S. The enhancement of aircraft parameter	
identification using linear transformation	A79-47961
GRANIERO, J. A. New devices for digital communications in a	vionics N79-31481
GBANT, R. L. Ultrasonic method of gun gas detection	A79-50166
GRAYSON, H. A. Research on visual display integration for	
advanced fighter aircraft [AD-A069605]	N79-30184
GREEK, D. C. Ride qualities criteria validation/pilot	
performance study: Flight test results [NASA-CR-144885]	N79-31193
GREENWOOD, J. C. Navstar user equipment for civil and milit:	ary
applications	A79-49587
GREMET2, P. S. Maintenance improvement: An analysis appro including inferential technical data	bach
including inferential technical data [AD-A068382]	N79-30141
GREY, J. Utilization of alternative fuels for	
transportation; Proceedings of the Sympos University of Santa Clara, Santa Clara, G June 19-23, 1978	sium, Calif.,
	A79-49376
GRIFFIN, D. F. An evaluation of asphalt-rubber mixtures for	or use
in pavement systems [AD-A069448]	N79-30246
GRIGORENKO, P. P. Influence of gas turbine engine combustion	chamber
geometric parameters on mixture formation characteristics	<b>1</b>
GRIMM, J. D.	<b>∆79-48495</b>
Radar signal processing development for application of VHSI	
GROESBECK, D.	A79-48664
<pre>GROSSHEAR, D- Wing aerodynamic loading caused by jet-ind lift associated with STOL-OTW configurat: [AIAA PAPER 79-1664]</pre>	uced ions A79-47346
GRUZDEV, V. N. On the question of selecting the character:	
quantity governing fuel self-ignition in	a stream A79-48497

GUIN, J. R.

#### PERSONAL AUTHOR INDEX

HARRIS, R. H.

GUIN, J. R. Airworthiness and flight characteristics test, 0V-1C takeoff performance [AD-A069827] N79-30178 GUNKO, IU. P. Overall aerodynamic characteristics of caret and delta wings at supersonic speeds A79-47012 GUPTA, B. P. Helicopter obstacle strike tolerance [AHS 79-7] A79-49059 Helicopter obstacle strike tolerance concepts analysis [ AD-A069877 ] N79-30179 GUPTA, N. C. Factors controlling stability of swirling flames at diffusers in gas turbines A79-50209 GURIABOV, M. A. Surface-effect components of aerodynamic characteristics of air-cushion vehicle with ram pressurization A79-46995 GURMAN, B. S. The impact of a multi-function programmable control display unit in affecting a reduction of pilot workload N79-30210 GURUSWANY, P. Flutter analysis of two-dimensional and two-degree-of-freedom airfoils in small-disturbance, unsteady transonic flow [AD-A069223] N79-31157

# Η

HABERCON, G. E., JR. Lighter than air vehicles. Citations from the NTIS data base N115 Uata Dase [N115/PE-79/0471/7] N79-Lighter than air vehicles. Citations from the Engineering Index data base [N15/PE-79/0472/5] N79-HALMANDARIS, A. N79-30162 N79-30163 Microcomputer applications in strapdown heading and attitude reference system A79-48606 HALWES, D. R. INACT - Interactive test data analysis A79-50430 HAMEL, P. G. Dynamic windtunnel simulation of active control systems N79-30233 HAMER, M. J A simplified gross thrust computing technique for an afterburning turbofan engine A79-50440 HANKE, D. In-flight handling gualities investigation of various longitudinal short term dynamics and direct lift control combinations for flight path tracking using DPVLR HFB 320 variable stability N79-30237 HANSON, D. B. The aeroacoustics of advanced turbopropellers A79-50236 HANSON, H. W. Evaluation of the practical aspects of vibration reduction using structural optimization techniques A79-49074 [AHS 79-21] A79-49074 HARDY, G. H. Flight experience with advanced controls and displays during piloted curved decelerating approaches in a powered-lift STOL aircraft N79-30243 HARGRAVE, P. J. Navstar user equipment for civil and military applications 179-49587 HARRIS, F. D. Helicopter performance methodology at Bell Helicopter Textron [AHS 79-2] A79-49055 HARRIS, R. L. Avionics computer software operation and support cost estimation

#### A79-48620

Performance predictions and trials of a helicopter UHF data link N79-31476 HARRISON, B. A. A program to compute three-dimensional subsonic unsteady aerodynamic characteristics using the doublet lattice method, L216 (DUBPLEX). Volume 2: Supplemental system design and maintenance Volume document [ NASA-CR-2850 ] N79-31148 HART, R. E. Dutch roll excitation and recovery techniques on a C-141A Starlifter [AIAA PAPER 79-1801] A79-47886 HARTHANN, G. L. Digital adaptive control laws for VTOL aircraft A79-48000 HARVEY, K. W. Design, analysis, and testing of a new generation tail rotor [ABS 79-57] A79-49 A79-49107 HEACOCK, F. E. Advanced Scout Helicopter flying gualities requirements - How realistic are they [AHS 79-28] [AHS 19-20] HEADLEY, J. W. Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 1: Technical discussion and analysis of results N79-20 A79-49080 [ AD-A069646] N79-30148 Analysis of wind tunnel data pertaining to high angle of attack aerodynamics. Volume 2: Data base [ AD-A069647] N79-30149 BBCBT, C. Predictive guidance for interceptors with time delays 179-47939 HECTOR. R. A computer program for aircraft identification and derivative extraction A79-50306 HEFFLEY, R. K. A compilation and analysis of helicopter handling qualities data. Volume 2: Data analysis [NASA-CR-3145] N79-31222 HEGARTY, D. M. Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] A79-4910 HEITZ, H. E. High-performance reinforced plastic structures for A79-49104 civil aviation A79-47302 HENNERLY, R. A. Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] A79-47909 BERTZ, J. Ultra-high-modulus graphite-epoxy conical shell development, supplement [ AD-A069795] N79-30335 HESS, J. R., JR. Benefits of aerodynamic interaction to the three surface configuration [AIAA PAPER 79-1830] A79-4 179-47904 HICKS, J. W. Flight test technology development - A preview of DynoTech A79-50435 HICKS, R. M. Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NASA-TM-78603] N79-30143 HILADO, C. J. Evaluation of airfield pavement materials based on synthetic polymers A79-49348 HILEY, P. E. Performance evaluation of an air vehicle utilizing non-axisymmetric nozzles [AIAA PAPER 79-1811] A79-47894

HILL, W. G., JR. Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft [AIAA PAPER 79-1856] A79-49339

JENKINS, R. C.

HILLER, E. R. Synthetic aperture radar map matching for navigation A79-48603 HINDSON, W. S. Flight experience with advanced controls and displays during piloted curved decelerating approaches in a powered-lift STOL aircraft 179-30243 HIRAYAMA, H. Y. Modal interpolation program, L215(INTERP). Volume 2: Supplemental system design and maintenance N79-31147 [NASA-CR-2848] Equation modifying program, L219 (EQMOD). Volume 2: Supplemental system design and maintenance document [NASA-CR-2856] N79-31153 HODGKINSON, J. Are today's specifications appropriate for tomorrow's airplanes? N79-30239 HOEFGEN, G. A self contained collision avoidance system for N79-30206 HOFFMAN, Windshield technology demonstrator program-canopy detail design options study N79-31201 [AD-A070376] HOFFHANN, W. Implementation of flight control in an integrated guidance and control system N79-30215 HOGGATT, J. T. Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements N79-30301 HOH. R. H Handling quality and display requirements for low speed and hover in reduced flight visibility [AES 79-29] A79-49081 HOLCONB, M. L. The Beech Model 77 'Skipper' spin program 179-47907 [AIAA PAPER 79-1835] HOLLAND, B. Fluidics: luidics: Feasibility study electro/hydraulic/fluidic direct drive servo valve [AD-A069798] N79-30195 HOSKING, M. B. A new U.U.T./test station interface A79-48896 HOSTETLER, L. D. Expanding the region of convergence for SITAN through improved modelling of terrain 179-48678 HOWARD, W. L. Geometric data transfer [AIAA PAPER 79-1844] 179-47910 HOWBLL, W. B. Design and testing of a redundant skewed inertial sensor complex for integrated navigation and flight control N79-30202 HOWELLS, H. Subjective assessment of a helicopter approach system for IFR conditions N79-30209 HOWLETT, J. J. The influence of engine/fuel control design on helicopter dynamics and handling qualities N79. 879. A79-49089 [AHS 79-37] HUGHES, C. W. Design, analysis, and testing of a new generation tail rotor [AHS 79-57] A79-49107 HUGHES, D. L. Dynamic test techniques - Concepts and practices A79-50164 HULTBERG, R. S. Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 1: High-wing model B N79-30145 [NASA-CR-3097]

HUNTER, B. J. Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system [AHS 79-35] A79-49087 HUNTING, A. W. Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] A79-49104 HURRELL, H. G. A summary of NASA/Air Force full scale engine research programs using the F100 engine [NASA-TM-79267] HUTCHINSON, C. N79-30188 Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing [AHS 79-50] A73 A79-49102 ILIPP, K. W. Considerations in the analysis of flight test maneuvers A79-50433 ILLG, W. Fatigue and fracture N79-30315 INGLEE, C. F. Self-contained grease lubrication systems for aircraft applications 179-49091 [AHS 79-39] IRVOAS, J. Results related to simulated and in-flight experimentation with an electric flight control system that can be generalized N79-30224 IRVIN, A. S. Self-contained grease lubrication systems for aircraft applications 179-49091 [AHS 79-39] ISAEV, V. V. Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I A79-46999 IVANOV, V. N. Current status of airport terminal complex development abroad A79-50240 IVANOV, V. S. Optimal thermogasdynamic design of gas turbine engines using element prototypes. I A79-46997 J JACKSON, E. N.

Microcomputer applications in strapdown heading and attitude reference system 179-48606 JACKSON, J. A. Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] A79-47909 JAMES, R. M. A new approach to the solution of large, full matrix equations: A two-dimensional potential flow feasibility study N79-31533 [NASA-CR-3173] JAMESON, A. Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils A79-47342 TATAA PAPER 79-15551 JARVINER, W. A. Complex guaternion notation in coordinate transformations 179-48681 JAUER, R. A., JR. Research on visual display integration for advanced fighter aircraft [AD-A069605] N79-30184 JENKINS, R. C. Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft [AIAA PAPER 79-1856] A79-4 179-49339

JEPSON, W. D. The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] A79-49( A79-49057 JOHNS, A. L. Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control [AIAA PAPER 79-1163] A79-47347 JOHNSON, G. A. Conference on Fire Resistant Materials: A compilation of presentations and papers [NASA-CP-2094] N79-31166 FIREMEN program N79-31178 Development of aircraft lavatory compartments with improved fire resistance characteristics. Phase 2: Sandwich panel resin system development [NASA-CR-152120] N7 N79-31354 JOHNSON, J. L., JR. Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane [AIAA PAPER 79-1837] 179-47908 JOHNSON, K. G. A multiple objective optimization approach to aircraft control systems design A79-47962 JOBNSON, T. D., JR. Subsonic wind-tunnel investigation of leading-edge devices on delta wings (data report) [NASA-CR-159120] N79-31143 JONES, A. A. Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems A79-49910 JONES, B. The application of multiple swirl modules in the The application of multiple swirl modules in the design and development of gas turbine combustors [AIAA PAPER 79-1196] A79-4730 JONES, H. D. Ground test vehicle terting [AHS 79-40] A79-4905 JONES, J. E. Path controllers: Unification of concepts and A79-47349 A79-49092 comparison of design methods [ AD-A070252 ] N79-31227 JORGENSEN, P. A. Modern systems for air traffic control A79-50921 JUERGENS, R. A. F/A-18 Hornet display system A79-48630

# K

KALITINA, N. N. Changes in the quality of T-6 fuel upon prolonged storage A79-48858 KANE, E. J. Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30214 KARMARKAR, J. S. Path controllers: Unification of concepts and comparison of design methods [AD-A070252] N79-31227 KATZ, J. Full-scale wind tunnel study of nacelle shape on Rida guardian study of nacelle sl cooling drag
 [AIAA PAPER 79-1820]
 KAWANA, H. Y.
 Ride qualities criteria validation/pilot performance study: Flight test results A79-47900 [NASA-CR-144885] N79-31193 KEEN, D. W. Operational experience with the AN/ARN-131 Omega Navigation Set A79-48676 KELLY, R. J. Guidance accuracy considerations for the microwave landing system L-band precision DME A79-48692 KEMPKE, E. E. An overview of NASA research on positive displacement type general aviation engines [NASA-TM-79254] N79-31210

RENDRICK, J. D. Estimation of aircraft target motion using pattern recognition orientation measurements 179-47987 KENDRICK, R. A. Simulation and study of V/STOL landing aids for USMC AV-8 aircraft N79-30214 KENNEDY, T. A. Synthesis of digital flight control tracking systems by the method of entire eigenstructure assignment A79-48625 The design of digital controllers for the C-141 aircraft using entire eigenstructure assignment and the development of an interactive computer design program [AD-A069192] N79-31224 KENNOY, J., JR. Evolving methods for reducing avionics data in an AISF environment A79-48671 KENT, J. S. An evaluation of the bird aircraft strike hazard at Hill AFB, Utah (AFLC) [AD-A070459] N79-31184 KERR, A. W. A system for interdisciplinary analysis - A key to improved rotorcraft design [AHS 79-8] A79-49060 KHACHATURIAN, O. A. Experimental study of the turbulent wake downstream of a fan jet A79-48507 KHVOSTOV, N. I. Nozzles for vectored thrust jet engines A79-47428 RILLIAN, H. W. Scan converter and raster display controller for night vision display systems N79-30203 KIRKPATRICK, G. H. Real time weather display in the general aviation cockpit FAIAA PAPER 79-18211 A79-47901 KITA. B. Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system [AIAA PAPER 79-1855] A79-479 A79-47914 KLAVER, L. J. Combined X/Ka-band tracking radar A79-49565 KLEBANOFF, F. S. A low-velocity airflow calibration and research facility [ PB-294501/2 ] N79-31237 KLEIDER, A. Applications of pattern recognition systems for day/night precision aircraft control N79-30204 KLEIN, K. Multipath propagation measurement by Doppler technique N79-31478 KLEINHANN, M. E. E-4B mission electrical power 179-48617 KLINGER, G. The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints [ESA-TT-521] N79-30391 KNAPP, P. B. AN/USM-449/V/ ATE for worldwide support of the P3 A79-48884 KO, N. W. H. The inner regions of annular jets A79-47520 KOCUBEK, J. D. Helicopter performance methodology at Bell Helicopter Textron [AHS 79-2] A79-49055 KOBELER, R. Open/closed loop identification of stability and control characteristics of combat aircraft N79-30232

KOGER. O. D. Microprocessor-based digital autopilot development for the XBQM-106 Mini-RPV 179-48608 KOHN. J. S. Application of Lagrange Optimization to the drag polar utilizing experimental data [AIAA PAPER 79-1833] A79-4 179-49335 A method of the theory of airfoil profiles with a iet flap 370-17119 KORNOUKHOV, A. A. Long-life GTE operation based on technical condition 179-48517 KORTE, U. Stability and control aspects of the CCV-P104C N79-30234 KOTLIAR. L. M. Determination of turning angle of a jet impinging on a bucket with visor A79-48500 KOURTIDES. D. A. Conference on Pire Resistant Materials: A compilation of presentations and papers λ N79-31166 [NASA-CP-2094] KOVALEV, A. A. Long-life GTE operation based on technical condition 179-48517 KOVALEV, G. I. Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness factor 179-48857 KOZHEVNIKOV, IU. V. Statistical diagnostics of aircraft engines 179-16996 Optimal thermogasdynamic design of gas turbine engines using element prototypes. I 179-46997 KRAG, B. Dynamic windtunnel simulation of active control systems N79-30233 KRASNAIA, L. V. Method of determining mechanical-impurity contents in jet fuels A79-488 A79-48859 KREISSELMEIER, G. An in-flight controller insensitive to parameters variation [DLR-FB-78-07] N79-30197 KRICHAKIN, V. I. Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades A79-48518 KRIESER, U. R. Load spectrum measuring equipment. Part 1: Details of MK 1 system presently used to acquire data in Wessex MK 31B helicopters [ARL-MECH-ENG-NOTE-371] N79-31194 KROEGER, R. A. Full-scale wind tunnel study of nacelle shape on cooling drag [AIAA PAPER 79-1820] A79-47900 KROLL, R. I. Dynamic loads analysis system (DYLOFLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-31144 [NASA-CH-2846-1] Dynamic loads analysis system (DYLOFLEX) summary. Volume 2: Supplemental system design information [NASA-CR-2846-2] N79-31 Modal interpolation program, L215(INTERP). Volume 2: Supplemental system design and maintenance N79-31145 document N79-31147 [NASA-CR-2848] Time history solution program, L225 (TEV126). Volume 2: Supplemental system design and maintenance document [NASA-CR-2860] KUBIN, R. F. N79-31154 Thermal characteristics of 3501-6/AS and 5208/T300 graphite epoxy composites [AD-A071067] N79-313. LAD-AU/106/] N79-KUCZINSKI, W. A. The influence of engine/fuel control design on helicopter dynamics and handling qualities [AHS 79-37] A79-N79-31357 179-49089

Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] 170-17925 [AIAA PAPER 79-18/3] KULPAN, R. H. Wing geometry effects on leading-edge vortices [AIAA PAPER 79-1872] KUO, P. S. Application of finite-element and holographic techniques in the design of turboshaft engine 179-49341 components [AHS 79-49] [AHS 79-49] KURTENBACH, F. J. A simplified gross thrust computing technique for x70-110003 an afterburning turbofan engine 179-50440 KURZHALS. P. R. Systems implications of active controls N79-30219 RUTYSH. I. I. Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface 179-48498 KYSER, A. C. The aerial relay system - An energy-efficient solution to the airport congestion problem [AIAA PAPER 79-1865] A75 179-47921 LA BURTHE, C. The feasibility of modern dirigibles [ONERA, TP NO. 1979-93] LAANANEN, D. H. A79-49541 Crashworthy armored crewseat for the UH-60A Black Hawk [AHS 79-101 179-49062 LABBE, J. Laser velocimeter applied to the study of circular Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor [ONERA, TP NO. 1979-30] A79-509 LABBRGF, E. F. C. Guidance accuracy considerations for the microwave 179-50925 landing system L-band precision DME 179-48692 LAGRANCE. J. B. Terrain-following radar - Key to low-altitude flight 179-48686 LAMANNA, W. J. Are today's specifications appropriate for tomorrow's airplanes? N79-30239 LAMONT, G. B. Microprocessor-based digital autopilot development for the XBON-106 Mini-RPV A79-48608 LANE. N. E. Design procedure for aircrew station labeling selection and abbrewiation N79-30208 LANG. K.-W. An approach for estimating vibration characteristics of nonuniform rotor blades A79-49718 LANGE, H. H. In-flight handling qualities investigation of various longitudinal short term dynamics and direct lift control combinations for flight path tracking using DFVLR HPB 320 variable stability aircraft N79-30237 LANNI, M. J. The DG-800 - A rugged, high performance heading. reference unit A79-48677 LAPPOS, N. Spirit helicopter handling gualities design and development [AHS 79-24] A79-49076

KUHN, W. G.

LARSON, R. S. Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 1 [NASA-CR-159515] N79-30185

#### LAUGHREY, J. A.

Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 2 [NASA-CR-159516] N79-30186 Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures [NASA-CR-3168] N79-31212 LAUGHERY, J. A. Performance evaluation of an air vehicle utilizing non-axisymmetric nozzles [AIAA PAPER 79-1811] LAUTHER, D. E. 179-47894 Electric power system control techniques A79-48614 LAWRENCE, J. J., JR. Windshield technology demonstrator program-canopy detail design options study [AD-A070376] N79-31201 LEATHÀN, A. L. H-X combat search and rescue avionics study results A79-48684 LEBOVITZ, H. A. ARIA takeoff performance flight test program A79-50437 LEE, B. L. Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results [AHS 79-18] A79-49071 LEE. J. Analysis of plume rise from jet aircraft [CONF-790142-1] LEE, P. H. N79-31204 A user's manual for a computer program to generate fatigue spectrum loading sequences [AD-A069288] N79-31198 LEMONT, H. E. Agricultural helicopters [AHS 79-60] A79 LENSKI, J. W., JR. Self-contained grease lubrication systems for A79-49064 aircraft applications [AHS 79-39] 179-49091 LEONG, P. J. Digital simulation of a three-phase generator A79-48618 LEVINE, A. M. Development of a 'no adjustment' turboshaft engine control system [AHS 79-42] A79-49094 LEWIS, C. J. G. Helmet mounted display and sight development [AHS 79-17] A79-49070 LIEBMAN, P. H. A report on the Sperry Dome Radar A79-49567 LIENHART, W. Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of interference from nearby cascades 179-48572 LIGUORI, F. A Navy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design A79-48870 LITTLE, R. E. Separation testing of large weapons from the B-1 . bomber A79-50429 LOCKHART, L. B., JR. High performance composites and adhesives for V/STOL aircraft [AD-A069611] N79-30332 LOEBERT, G. Stability and control aspects of the CCV-F104C N79-30234 LOELIGER, R. System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function A79-48716

#### PERSONAL AUTHOR INDEX

LOGAN, A. H. An integrated analytical and experimental investigation of helicopter hub drag [AHS 79-5] A79-49058 LOKAI, V. I. Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ A79-50421 LONGNIRE, D. E. A status report on the advanced FIREFLY assessment program A79-48609 LOTTATI, I. Active external store flutter suppression in the YF-17 flutter model A79-49866 On single-degree-of-freedom flutter induced by activated controls A79-49867 LOVERA, B. Design and development of the Agusta A 109 helicopter 179-49815 LOY, S. L. Research on visual display integration for advanced fighter aircraft [AD-A069605] N79-30184 LUCAS, E. J. Engine-aircraft afterbody interactions Recommended testing techniques based on YF-17 experience [AIAA PAPER 79-1829] 179-47903 LUCKRING, J. M. Flow visualization studies of a general research fighter model employing a strake-wing concept at subsonic speeds [NASA-TM-80057] N79-30147 LUDINGTON, D. Real time compression of video signals A79-48712 LUBBS, A. B. Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover [AHS 79-1] A79-49054 LUNN. K. Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing [AHS 79-50] A79-49102 Μ

HACALES, J. S. Fuel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 2: Numerical analyses [AD-A070128] N79-31200 HACDONALD, H. I. Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor [AHS 79-23] A79-49075 MACK, H. D. Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] A79-47925 HACHILLAN, W. L. J85-CAN-15 compressor stall and flameout investigation A79-50441 HAGEE, J. P. XV-15 flight test results compared with design goals A79-49336 MAINE, R. E. Considerations in the analysis of flight test maneuvers A79-50433 HAKSUTOVA, H. K. Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ A79-50421 MALAVASI, M. Transatlantic flights of stratospheric balloons N79-31687 MALISHEVSKAIA, N. A. On the question of selecting the characteristic quantity governing fuel self-ignition in a stream A79-48497

HELNIKOV, B. N.

MALOKAS, J. T., JR. A developmental computer model for investigations of air traffic management problems: A case investigating two decision strategies N79-31189 TAD-A0710751 HALYSHEVA, I. V. Changes in the quality of T-6 fuel upon prolonged storage 179-48858 MANDELL, R. W. Financing the capital requirements of the US airline industry in the 1980's N79-30164 MANIE, F. Subsonic and transonic flows on a variable sweep wing [ONERA, TP NO. 1979-1021 A79-48849 HANOR, D. A cheap, effective icing detector for general aviation aircraft A79-47902 [AIAA PAPER 79-1823] HARCHAND, H. Open/closed loop identification of stability and control characteristics of combat aircraft N79-30232 MARCHMAN, J. P., III A cheap, effective icing detector for general aviation aircraft [AIAA PAPER 79-1823] A79-47902 MAREK, A. J. Electric power system control techniques A79-48614 MARGASON, R. J. Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics [NASA-TM-78793] N79-N79-31141 MARGULIS, S. G. Determination of turning angle of a jet impinging on a bucket with visor A79-48500 MARKETOS. J. D. Maritime patrol airship concept study [AD-A070131] N79-31138 MARR. RB, B. L. Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [AHS 79-54] A79-49105 HARTHER, R. An integrated analytical and experimental investigation of helicopter hub drag [AHS 79-5] A79-49058 MARTIN, N. S. E-3A sentry /AWACS/ ATPG A79-48873 MARZESKI, J. W. Ambient correction factors for aircraft gas turbine idle emissions [AD-A069240] N79-31218 MASCLE, J. L. The equipment-system interface in an antitank helicopter at night N79-30211 EATIAZH, A. I. Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I A79-46999 HAUNDER, D. P. AFFTC parameter identification experience [AIAA PAPER 79-1803] A computer program for aircraft identification and derivative extraction A79-47888 A79-50306 AFFTC parameter identification experience A79-50434 MAYBECK. P. S. Estimation of aircraft target motion using pattern recognition orientation measurements A79-47987 MAZHUL, I. I. Overall aerodynamic characteristics of caret and delta wings at supersonic speeds A79-47012 MCALLISTER, J. D. Design guidance from fighter CCV flight evaluations N79-30235 MCCABE, R. J. Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness A79-48621 MCCALL, M. B. Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for advanced architectures using MIL-STD-1553B A79-48629 MCCLOUD, J. L., III The promise of multicyclic control [NASA-TM-78621] MCCOLLOR, R. L. N79-31137 Techniques for fault isolation ambiguity reduction A79-48891 MCCOLLOUGH, J. B. A design perspective on new technologies for general aviation A79-49486 ECCOUBREY, G. A. Design and development of a hybrid composite rotor blade for the circulation control rotor system A79-49098 [AHS 79-46] MCELERATH, K. W. An advanced guidance and control system for rescue helicopters N79-30217 HCGINPSEY, R. M. J85-CAN-15 compressor stall and flameout investigation A79-50441 HCLIRTY, T. T. Helicopter performance methodology at Bell Helicopter Textron [AHS 79-2] 179-49055 MCHILLAN, D. R. Implementing JTIDS in tactical aircraft N79-31491 MCMULDROCH, C. G. VTOL controls for shipboard landing N79-30193 [NASA-CR-162140] MCVITIE, A. Plight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics A79-49818 MEADOWS, J. The development and in-flight evaluation of a triplex digital autostabilization system for a helicopter N79-30200 MEEDI, I. S. Digital simulation of a three-phase generator A79-48618 MEHRA, R. K. Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack A79-47943 Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization A79-47991 A study of the application of singular perturbation theory [NASA-CR-3167] N79-30194 HELANCON, C. A combined air-cushion and endless belt transportation system A79-49911 HELENTEVA, B. I. Changes in the quality of T-6 fuel upon prolonged storage A79-48858 MELLOR, A. N. Correlation technique for ambient effects on oxides of nitrogen A79-49922 MELLOTT, R. R. Maintenance improvement: An analysis approach including inferential technical data [AD-A068382] N79-30141 MELNIKOV, B. N. Experimental investigation of helicopter flight modes on helicopter-generated noise A79-47873

#### MELONE, R.

PERSONAL AUTHOR INDEX

Supersonic transport aircraft noise, problems of noise reduction and establishment of standards 179-50237 MELONE, R. Surveys of grooves in 19 bituminous runways [AD-A069889] N79-31233 HELUZOV, IU. V. Optimal thermogasdynamic design of gas turbine engines using element prototypes. I 179-46997 MENSBIKH, N. L. Nost rational linearization of nonlinear unsteady heat conduction problems A79-48501 BERSON, R. L. Recent progress in aircraft sink rate measurement [AIAA PAPER 79-1798] A79-47 A79-47884 METZDORFF. W. Implementation of flight control in an integrated quidance and control system N79-30215 STCHARL, G. J. Estimation for advanced technology engines 179-47957 MIKOLOWSKY, W. T. Identifying desirable design features for the C-XX aircraft - A systems approach [AIAA PAPER 79-1796] A79-4780 179-47883 MILLER, B. Energy efficient aircraft engines [AIAA PAPER 79-1861] A79-47918 HILLER, C. M. An evaluation of sidestick force/deflection characteristics on aircraft handling qualities 179-50428 HILLER, P. L. Advanced RPV electrical systems A79-48615 MILLER, G. E. A microprocessor system for flight control research 179-48623 HILLER, R. D. Dynamic loads analysis system (DYLOFLEX) summary. Volume 1: Engineering formulation [NASA-CR-2846-1] N79-31 N79-31144 Volume 2: Supplemental system design information [NASA-CR-2846-2] N79-31145 Equation modifying program, L219 (EQMOD). Volume 2: Supplemental system design and maintenance document [NASA-CR-2856] N79-31153 A program for calculating load coefficient matrices utilizing the force summation method, L218 (LOADS). Volume 2: Supplemental system design and maintenance document [NASA-CR-2854] N79-3 N79-31155 MILLS, G. S. Research on visual display integration for advanced fighter aircraft [AD-A069605] N79-30184 MILSTEIN, L. B. Transform domain processing for digital communication systems using surface acoustic wave devices N79-31482 HIBANDA, L. B. Laminar flow stabilization by surface cooling on [AIAA PAPER 79-1863] 179-47920 HIRSKY W. Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 MOCEBINO, N. J. Superplastic forming diffusion bonding of titanium helicopter airframe components [AHS 79-33] A79-49085 NOCH, W. A. H, W. A. F-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives [AIAA PAPER 79-1868] A79 A79-47923 HOHITANA, T. S. Project NAVTOLAND (Navy vertical takeoff and landing capability development) N79-30212

MONAKHOV, N. H. Analytic formulas for wing profile aerodynamic characteristics in incompressible flow A79-47000 NONGEON, R. J. Multifunction CO2 heterodyning laser radar for low A79-48685 Heterodyning CO2 laser radar for airborne applications N79-30205 MONTGOMERY, T. D. Considerations in the analysis of flight test Manonvore 179-50433 HOOIJ, H. A. A simulator investigation of handling quality criteria for CCV transport aircraft N79-30240 MOORE, R. D. Aerodynamic performance of 1.38-pressure-ratio, variable-pitch fan stage [NASA-TP-1502] N79-N79-31213 Aerodynamic performance of axial-flow fan stage operated at nine inlet guide vane angles [NASA-TP-1510] N79-31214 HOORE, W. H. Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] 179-47909 MORDEN, R. B. An analysis of SAPPHIRE image parameters as a function of processing parameters A79-48666 MORKOVIN, M. V. KOVIN, B. V. Mechanics of boundary layer transition, part 2: Instability and transition to turbulence [VKI-LECTURE-SERIES-3-PT-2] N79-31530 HORREIS, J. W. Design considerations for reliable PBW flight control N79-30231 MOTYKA, P. A deterministic investigation of strapped down navigation system accuracy A79-48695 HOU-JIE, L. Flow patterns and aerodynamic characteristics of wing with strake A79-47928 HOUILLE, R. Ten years of Aerospatiale experience with the fenestron and conventional tail rotor [AHS 79-58] 179-49108 HUBBB, C. E. Automated tracking for aircraft surveillance radar systems A79-49604 MUKHIN, A. A. Long-life GTE operation based on technical condition A79-48517 HULCAY, W. Rotary balance data for a typical single-engine general aviation design for an angle-of-attack range of 8 deg to 90 deg. 2: High-wing model A [NASA-CR-3101] N79-31 N79-31149 NUNRO, A. M. Recent advances in radome design 179-49574 NYHRE, R. W. UHF coplanar-slot antenna for aircraft-to-satellite data communications [NASA-TM-79239] N79-31185 Ν NAKANO, T. Investigation of air stream from combustor-liner

Investigation of air stream from combustor-liner air entry holes, 3 [NASA-TR-75430] N79-31206 NARDI, L. U. Ride gualities criteria validation/pilot performance study: Plight test results [NASA-CR-144885] N79-31193

PANTASON, P.

NELSON, D. P. Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 1 [NASA-CR-159515] N79-30185 [MASA-UK-199515] Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data resourt reluce 2 report, volume 2 [NASA-CR-159516] N79-30186 Aerodynamic and acoustic investigation of inverted and development of aerodynamic and acoustic prediction procedures [NASA-CR-3168] N79-31212 WELSON, J. R. Aircraft turbine engine monitoring experience: Implications for the F100 engine diagnostic system program N79-31217 [ÅD-A069282] NELSON, K. D. J85-CAN-15 compressor stall and flameout investigation A79-50441 NEMAT-NASSER, S. An approach for estimating vibration characteristics of nonuniform rotor blades 179-49718 BENEC, C Verification of operational flight programs by simulation 179-48667 NESTERENKO, V. G. On the influence of relative pitch in the subsonic turbine cascade A79-48503 NESTEROV, E. D. Determination of turning angle of a jet impinging on a bucket with visor A79-48500 NEURADE, G The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints [ESA-TT-521] N79-30391 NEVNAÑ, M. utilization of alternative fuels for Transportation; Proceedings of the Symposium, University of Santa Clara, Santa Clara, Calif., June 19-23, 1978 A79-49376 NEWTON, R. C., JR. Power hybridization - Key to reducing avionics power supply weight and volume A79-48652 NICHOLLS, J. A. Critical assessment of emissions from aircraft piston engines [AD-A071002] N79-30190 NIBLSEN, J. P. An evaluation of asphalt-rubber mixtures for use in pavement systems N79-30246 [AD-A069448] NIEMANN, J. R. Airworthiness and flight characteristics test, OV-1C takeoff performance N79-30178 [AD-A069827] NIENFIER, W. H. An evaluation of the bird aircraft strike hazard at Hill AFB, Utah (AFLC) [AD-A070459] N79-31184 NILSON, E. N. Engineering and manufacturing communication via the computer data base [AIAA PAPER 79-1845] A79-47911 NILSSON, N.-A. Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes A79-49580 MISS. G. The Swedish approach to escape system testing A79-50427 NISSIN, B. Active external store flutter suppression in the YF-17 flutter model A79-49866

#### On single-degree-of-freedom flutter induced by activated controls 179-49867 NORTHAN, G. B. Characterization of a swept-strut hydrogen fuel-injector for scranjet applications A79-49345 NORUE. T. D. Experiments of shock associated noise of supersonic jets [AIAA PAPER 79-1526] A79-47341 NOVAK, L. H. Millimeter airborne radar target detection and selection techniques A79-48665 NOVOSELOV, IU. N. Solution of the inverse aerodynamics problem by the random search method A79-47002 NUNN, E. C. Helicopter high grain control [NASA-CR-159052] N79-31221

# 0

OBBARD, J.	
Realization of a helicopter-oriented real-t	ine
data system for research, experimental, a	ind
prototype flight testing	
[AHS 79-50]	A79-49102
OBRYAN, T. C.	
Some results from the use of a control	
augmentation system to study the develope	d snin
of a light plane	d opin
	A79-47879
[AIAA PAPER 79-1790]	R/9-4/0/9
ODONNELL, R. M.	
Automated tracking for aircraft surveilland	e radar
systems	
	A79-49604
OLSON, W. M.	
Performance modelling methods	
	A79-50167
ONKEN, R.	
Failure detection in signal processing and	sensing
in flight control systems	,
In flight conclor bystems	A79-47971
ORLOFF, K. L.	
Effect of tip shape on blade loading	
characteristics for a two-bladed rotor in	honor
	A79-49054
[AHS 79-1]	A/9-49054
ORVOS, P. S.	<i>a</i> .
Tapered roller bearing development for airc	craft
turbine engines	
[AD-A069440]	N79-30555
OSBORN, W. M.	
Aerodynamic performance of 1.38-pressure-ra	atio,
variable-pitch fan stage	
[ NASA-TP-1502 ]	N79-31213
OSORGIN, V. D.	
On a smooth approximation method and its	
application to mathematical description of	of wing
aerodynamic characteristics	JI WING
aerodynamic characteristics	A79-47001
	A/3-4/00
OVCHINNIKOV, V. A.	
On a smooth approximation method and its	<i>.</i> .
application to mathematical description of	or wing
aerodynamic characteristics	
	A79-47001
OVEREND, W. J.	
Design criteria for airline operation	
[AIAA PAPER 79-1849]	A79-49337
• •	
_	

# Ρ

Critical assessment of emissions from airc	raft
piston engines	
[AD-A071002]	N79-30190
PABZ, C. A.	
Design of advanced titanium structures	
[AIAA PAPEB 79-1805]	A79-47890
PANTASON, P.	
Rotary balance data for a single-engine tra	
design for an angle-of-attack range of 8	deg to
90 deg	
[ NASA-CR-3099]	N79-31152

PACE. R.

PARDINI, S.

PERSONAL AUTHOR INDEX

PARDINI. S. Multiradar tracking system using radial velocity measurements A79-49608 PARDOE, R. J. L. The application of pulsed 'G' band radio altimeters to modern military aircraft A79-49590 PARENT, M. L. Antennas for the Black Hawk helicopter [AHS 79-15] A79-49068 PATE, D. P. Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] A79-49104 PATTON, J. H., JR. The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AIAA PAPER 79-1786] PAULSON, J. W., JR. Powered low-aspect-ratio Wing In Ground effect A79-47876 (WIG) aerodynamic characteristics [NASA-TM-78793] N79-31141 PAVLECKA, V. H. Air buoyant vehicles - Energy efficient aircraft [AIAA PAPER 79-1862] A79-4 179-47919 PAVLOY, V. G.
 On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics A79-47001 PEDBRSON, A. P. A developmental computer model for investigations of air traffic management problems: A case investigating two decision strategies [AD-A071075] N79-31189 PELLMAN, A. Determining the contour of helicopter rotor blades automatically using electro-optical techniques [AHS 79-32] 179-49084 PERKINS, J. N. An actuator disk analysis of an isolated rotor with distorted inflow [AD-A069884] N79-31216 PERKINS, J. H. Electric power system control techniques 179-48614 PESHATOV, G. D. Solution of the inverse aerodynamics problem by the random search method A79-47002 PESTER, R. F. Laboratory development of computer generated image displays for evaluation in terrain flight training N79-31236 PETERS, D. A. Theoretical flap-lag damping with various dynamic inflow models [AHS 79-20] PETERSEN, K. L. A79-49073 Flight control systems development of highly maneuverable aircraft technology /HiMAT/ vehicle [AIAA PAPER 79-1789] A79-478 179-47878 PETERSEN, T. J. A computer system for identifying aircraft characteristics · A79-50168 PETROVSKII, V. S. Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades A79-48518 PHELPS, A. An integrated analytical and experimental investigation of helicopter hub drag [AHS 79-5] A79-49058 [And /9-5] PHELPS, A. E., III. Wind-tunnel investigation of an armed mini remotely piloted vehicle [NASA-TM-80132] N79-31151 PHILLIPS, J. D. Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] A79-49104

PHILLIPS, J. W. All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] A79-47906 PICHA, D. G. Dutch roll excitation and recovery techniques on a C-141A Starlifter [AIAA PAPER 79-1801] A79-4784 A79-47886 PINCKNEY, R. L. Metal-matrix composite structures [AHS 79-34] A79-49086 PISKOV, H. G. Current status of airport terminal complex development abroad A79-50240 PITT, D. H. Advanced Scout Helicopter flying qualities requirements - How realistic are they [AHS 79-28] A79-49080 PLUMBLEE, H. E. Duct noise radiation through a jet flow A79-50110 PLUMER, J. A. The feasibility of inflight measurement of lightning strike parameters [NASA-CR-158981] N79-30165 PODVIDZ, G. L. On the influence of relative pitch in the subsonic turbine cascade A79-48503 POJETA, T. J. Determining the contour of helicopter rotor blades automatically using electro-optical techniques [AHS 79-32] A79-49 Computer-assisted high-speed balancing of T53 and A79-49084 T55 power turbines [AHS 79-36] A79-49088 POLIAROV, A. H. Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades 179-48518 POLLARD, D. W. Injuries in air transport emergency evacuations A79-49995 PONSONBY, R. Critical assessment of emissions from aircraft piston engines [AD-A071002] N79 N79-30190 POPE, R. L. A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements A79-48051 POPOV. K. N. Nozzles for vectored thrust jet engines A79-47428 POPOV, V. A. Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I A79-46999 PORTER, R. H. Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system [AHS 79-35] A79-49087 POSINGIES, W. H. Program for the critical components of a fly-by-tube backup flight control system, part 1 [AD-A070387] N79-312 N79-31226 POST. P. W. Tactical electronic reconnaissance sensor A79-48717 POSTNIKOVA, H. G. Nethod of determining mechanical-impurity contents in jet fuels A79-48859 POTONIDES, H. C. Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control [AIAA PAPER 79-1163] 179-47347 PRANSPILL, G. O. Role of Numerical Control Design in the computer aided design/manufacturing interface at Sikorsky [AHS 79-30] A79-49082 PRASAD, R. A. A simulation of amphibious hovercraft overturning A79-49904

-

PRESSLER, G. J.	
Tapered roller bearing development for air	craft
turbine engines	
[AD-A069440]	N79-30555
PRINCE, S. W.	
A flow field study for top mounted inlets	on
fighter aircraft configurations	
[AD-A069732]	N79-30151
PRIOR, J. R.	
Performance of current radar systems in an	EW
environment	
	A79-49555
PROKUDIN, V. N.	
The tendency of jet fuels to form deposits	on a
heated surface	• .
	A79-48856
PUGLIESE, A. J.	
Flight testing the circulation control win	
[AIAA PAPER 79-1791]	A79-47880

PURTELL, L. P. A low-velocity airflow calibration and research facility [PB-294501/2] N79-31237

# R

RADFORD, H. F. A new three-dimensional surveillance radar	A79-49568
RAMACHANDRA, S. M. Some early experiments in the development o	
flying platform for aerodynamic testing	A79-47535
RNMAGE, J. K. Design considerations for reliable FBW flig	ht
control .	N79-30231
Lusaka accident report	A79-50109
RAPSON, J. E. Hovercraft skirt design requirements	A79-49907
BATCLIFFE, H. T. Flight experiments to evaluate the effect of ving-tip sails on fuel consumption and has	of
characteristics RAWLINGS, K., III	A79-49818
Dynamic test techniques - Concepts and prac	tices 179-50164
RAY, J. D. Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helico [AHS 79-45] RAYMER. D. P.	opter A79-49097
Manned strategic system concepts 1990-2000 [AIAA PAPER 79-1793]	A79-47882
REBEL, J. H. The T & E simulator - A comparison with flittest results	.ght
REDDY, D. J.	A79-50169
Qualification program of the composite main blade for the Model 214B helicopter [AHS 79-44]	a rotor
REED, D. Byluation of pylon focusing for reduced	M12 43,050
helicopter vibration [AD-A069712]	N79-30196
REID, J. G. Estimation of aircraft target motion using	pattern
recognition orientation measurements	A79-47987
REID, L. Aerodynamic performance of axial-flow fan s operated at nine inlet guide vane angles	stage
[NASA-TP-1510] REILLY. H. J.	N79-31214
Development of crashworthy passenger seats general-aviation aircraft	
[NASA-CR-159100] REIQUAM, E. T.	N79-31164
Electrical power system for new-technology transport power-by-wire airplane	A79-48616

RESHOTKO, E. Drag reduction by cooling in hydrogen-fuel	ed
aircraft	A79-49921
REY, J. A. Computer Monitor and Control - A flexible, cost-effective implementation	
RICHARD, H.	179-48670
A program to compute three-dimensional sub unsteady aerodynamic characteristics usi doublet lattice method, L216 (DUBPLEX). 2: Supplemental system design and maint document	ng the Volume enance
[NASA-CR-2850] BOBINS, A. W. High-performance wings with significant	N79-31148
leading-edge thrust at supersonic speeds [AIAA PAPER 79-1871] ROBINSON, M. R.	A79-47924
From HiMAT to future fighters [AIAA PAPER 79-1816]	A79-47896
ROBINSON, P. The development and in-flight evaluation o triplex digital autostabilization system helicopter	
ROBINSON, S. R.	N79-30200
Performance of a pulse-decode circuit in t presence of interference	he
ROCHE, J. M.	<b>∆79-48713</b>
Avionics design for testability - An aircr contractor's viewpoint	
ROGERS, S. P.	A79-48888
<pre>Meeting the challenge of precise navigatio     nap-of-the-earth flight     f AHS 79-12 ]</pre>	A79-49065
<b>RON</b> , J. The calculation of non-linear aerodynamic	115 45005
characteristics of wings and their wakes subsonic flow	in
ROMERO, M.	A79-47099
Roundad, us	
Previsions and experimental results in ope balloon controlled descent	
Previsions and experimental results in ope balloon controlled descent BOSE, E.	N79-31691
Previsions and experimental results in ope balloon controlled descent ROSE, E. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101]	N79-31691 ngine attack
Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight	N79-31691 ngine attack model A N79-31149 testing
Previsions and experimental results in ope balloon controlled descent ROSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack	N79-31691 ngine attack model A N79-31149 testing A79-47885
Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock	N79-31691 ngine attack model A N79-31149 testing A79-47885
Previsions and experimental results in ope balloon controlled descent ROSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226
Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock BOTH, C. B. A computer system for identifying aircraft characteristics BOTHAN, I.	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168
<ul> <li>Previsions and experimental results in ope balloon controlled descent</li> <li>ROSE, R.</li> <li>Rotary balance data for a typical single-e general aviation design for an angle-of-range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101]</li> <li>ROSENDE, A., JR.</li> <li>An improved method for load survey flight [AIAA PAPER 79-1799]</li> <li>ROSS, A. J.</li> <li>Lateral stability at high angles of attack particularly wing rock</li> <li>ROTH, C. E.</li> <li>A computer system for identifying aircraft characteristics</li> </ul>	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168
Previsions and experimental results in ope balloon controlled descent EOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] EOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] EOSS, A. J. Lateral stability at high angles of attack particularly wing rock EOTH, C. E. A computer system for identifying aircraft characteristics EOTHAN, Y. Analysis of optimal loop and split-S by en state modeling EOUGEBON, H. Previsions and experimental results in ope	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168 ergy A79-47098
Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock BOTH, C. B. A computer system for identifying aircraft characteristics BOTHAN, Y. Analysis of optimal loop and split-S by en state modeling ROUGEBON, H. Previsions and experimental results in ope balloon controlled descent	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168 ergy A79-47098
<pre>Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock ROTH, C. B. A computer system for identifying aircraft characteristics BOTHAN, Y. Analysis of optimal loop and split-S by en state modeling ROUGEBON, H. Previsions and experimental results in ope balloon controlled descent BUBEY, R. J. The effect of standardization of avionics</pre>	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168 ergy A79-47098 n N79-31691
<ul> <li>Previsions and experimental results in ope balloon controlled descent</li> <li>BOSE, R. Rotary balance data for a typical single-egeneral aviation design for an angle-of-range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock BOTH, C. E.  A computer system for identifying aircraft characteristics BOTHAN, Y.  Analysis of optimal loop and split-S by enstate modeling BOUGEBON, H.  Previsions and experimental results in ope balloon controlled descent RUBEY, R. J.</li></ul>	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168 ergy A79-47098 n N79-31691
Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [ATAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock BOTH, C. B. A computer system for identifying aircraft characteristics BOTHAN, Y. Analysis of optimal loop and split-S by en state modeling BOUGEBON, M. Previsions and experimental results in ope balloon controlled descent BUBEY, R. J. The effect of standardization of avionics quality assurance BUBIN, J. Distributed TDNA - An approach to JTIDS ph	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168 ergy A79-47098 n N79-31691 software A79-48648 ase II A79-49584
<ul> <li>Previsions and experimental results in ope balloon controlled descent</li> <li>BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of-range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR.  An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J.  Lateral stability at high angles of attack particularly wing rock BOTH, C. E.  A computer system for identifying aircraft characteristics ROTHAN, Y.  Analysis of optimal loop and split-S by en state modeling BOUGEBON, M.  Previsions and experimental results in ope balloon controlled descent BUBEY, R. J.  The effect of standardization of avionics quality assurance BUBIN, J.  Distributed TDNA - An approach to JTIDS ph</li></ul>	N79-31691 ngine attack model A N79-31149 testing A79-47885 N79-30226 A79-50168 ergy A79-50168 ergy A79-47098 n N79-31691 software A79-48648 ase II A79-49584 f
Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock BOTH, C. B. A computer system for identifying aircraft characteristics BOTHAN, Y. Analysis of optimal loop and split-S by en state modeling ROUGEBON, M. Previsions and experimental results in ope balloon controlled descent BUBEY, R. J. The effect of standardization of avionics quality assurance RUBIN, J. Distributed TDMA - An approach to JTIDS ph RUMHLEE, D. R. Mechanical and thermophysical properties o graphite/polyimide composite materials RUSSO, D. M.	N79-31691 ngine attack model A N79-31149 testing A79-47885 , N79-30226 A79-50168 ergy A79-47098 n N79-31691 software A79-48648 ase II A79-49584
<pre>Previsions and experimental results in ope balloon controlled descent BOSE, R. Rotary balance data for a typical single-e general aviation design for an angle-of- range of 8 deg to 90 deg. 2: High-wing [NASA-CR-3101] BOSENDE, A., JR. An improved method for load survey flight [AIAA PAPER 79-1799] BOSS, A. J. Lateral stability at high angles of attack particularly wing rock BOTH, C. B. A computer system for identifying aircraft characteristics BOTHAN, Y. Analysis of optimal loop and split-S by en state modeling BOUGEBON, H. Previsions and experimental results in ope balloon controlled descent BUBEY, R. J. The effect of standardization of avionics quality assurance RUBIN, J. Distributed TDMA - An approach to JTIDS ph RUMHLEB, D. R. Mechanical and thermophysical properties o graphite/polyimide composite materials</pre>	N79-31691 ngine attack model A N79-31149 testing A79-47885 N79-30226 A79-50168 ergy A79-50168 ergy A79-47098 n N79-31691 software A79-48648 ase II A79-49584 f

#### RYNASKI, E. G.

PERSONAL AUTHOR INDEX

RYNASKI, E. G. The enhancement of aircraft parameter identification using linear transformations A79-47961

# S

SACES, G. Stall behaviour evaluation from flight test results N79-30227 SAINT HILAIRE, A. O. The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil [AHS 79-4] A79-49 179-49057 SAJAN. S. Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization 179-47991 A study of the application of singular perturbation theory [NASA-CR-3167] N79-30194 SALWIKOVA, H. V. Method of determining mechanical-impurity contents in jet fuels 179-48859 SAMANT, V. S. Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation 179-48656 SABUEL, R. A. ATLAS, an integrated structural analysis and design system. Volume 5: System demonstration problems Ĩ NASA-CR-1590451 N79-31624 SANDERS, D. C. Electrical insulation fire characteristics. Volume 2: Toxicity [PB-294841/2] N79-30490 SATTLER, D. H. User requirements for future combat search and rescue vehicles A79-48683 SAVIN, L. N. Changes in the quality of T-6 fuel upon prolonged storage A79-48858 SATLOR, F. G. Complex quaternion notation in coordinate transformations 179-48681 SCHLOTHAUER, J. The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints [ESA-TT-521] N79-30391 SCHHIDT, D. J. Quaternion matching in transfer alignment for SAR motion compensation A79-48641 SCHHITT, V. Subsonic and transonic flows on a variable sweep wing [ONERA, TP NO. 1979-102] A79-48849 [UNERA, IP NO. 1575-102] Aerodynamic interaction on a close-coupled canard-wing configuration [ONERA, TP NO. 1979-95] SCHRAGE, D. P. Dynamics requirements for an Advanced Scout Heliconter (ASM/ A79-49543 Helicopter /ASH/ [AHS 79-19] A79-49072 SCHROBDER, W. Theoretical estimation of nonlinear longitudinal characteristics of wings with small and moderate aspect ratio by the vorter-lattice method in incompressible flow [DLR-FB-78-26] N79-30161 SCHROBRS, L. G. Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [AHS 79-54] A79-49105 SCHULZ, G. Investigations on the design of active vibration isolation systems for helicopters with rigid and elastic modeling of the fuselage [DLR-FB-78-04] N79-30183

SCHUSTER, S. H. Puel tank survivability for hydrodynamic ram induced by high velocity fragments. Part 2: Numerical analyses [ AD-A070128] N79-31200 SCHWARTZMAN, L. A report on the Sperry Dome Radar A79-49567 SCHT, A. A. Nonlinear decoupled control synthesis for maneuvering aircraft A79-47959 A multiple objective optimization approach to aircraft control systems design 179-47962 SEAT, J. C. A microprocessor system for flight control research A79-48623 SEETHARAM, H. C. Aerodynamics of spoiler control devices [AIAA PAPER 79-1873] A79-47925 SBINER, J. H. Experiments of shock associated noise of supersonic jets [AIAA PAPER 79-1526] A79-47341 SBLEZOV, I. T. A method of the theory of airfoil profiles with a jet flap A79-47119 SENS. W. H. Aircraft engine developments centre on improved performance, higher efficiency **▲79-**50207 SEREDINSKY, V. Design of the circulation control wing STOL demonstrator aircraft [AIAA PAPER 79-1842] 179-47909 SEREGIN, E. P. The tendency of jet fuels to form deposits on a heated surface 179-48856 SERRANO, A. V. Atmospheric Electricity Hazard (AEH) [AD-A069338] N79-30169 SEYLER, D. P. Investigation of inverse Vandermonde matrix calculation for linear system applications [AD-A069241] N79-31225 B. B. Simplified analysis spectrum for joints exposed to complex continuously varying stresses
 [AIAA PAPER 79-1808] SHAH. ×79-47892 SHAH, N. Improvement of fighter aircraft maneuverability through employment of control configured vehicle N79+30225 SHAPIRO, E. Y. Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft A79-47960 SHEPPARD, C. H. Development and demonstration of manufacturing processes for fabricating graphite/PNR-15 polyimide structural elements N79-30301 SHERIDAN, P. F. Interactional aerodynamics - A new challenge to helicopter technology [AHS 79-59] 179-49109 SHESTERWINA, Z. W. Harmonic oscillations of annular wing in steady ideal fluid flow A79-47009 SHINAR, J. Analysis of optimal loop and split-S by energy state modeling A79-47098 SHISHKOV, I. N. Fuels, lubricants and other fluids used in aviation A79-47433 SHORT, J. J. An evaluation of the bird aircraft strike hazard at Hill APB, Utah (AFLC) [AD-A070459] N79-3 N79-31184

SHVARTSMAN, P. I. Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface 179-48498 SILVERHAN, S. H. From HiMAT to future fighters [AIAA PAPEE 79-1816] A79-47896 SIMPERS, B. F. Metallic coatings for graphite/epoxy composites N79-30334 [AD-A069871] SINGH, S. N. Nonlinear decoupled control synthesis for maneuvering aircraft 179-47959 SINHA, A. N. Runway configuration management system concepts [AD-A069960] N79-: SIRAEEDINOV, T. K. Analysis design of complex systems. II 179-/ N79-31234 179-48505 SKINNER, G. L. AH-1G helicopter, 19-round lightweight airborne launcher jettison envelope determination [AD-A069828] N79-30177 SKUPIN. W. Investigation on information error caused by traffic loading in approach and landing systems N79-31480 SLAVKIN, R. G. The impact of software in automatic test equipment A79-48691 SLIWA, S. M. Some flight data extraction techniques used on a general aviation spin research aircraft 179-47887 [AIAA PAPER 79-1802] SLUSHER, G. R. Exhaust emission traverse investigation of a JT3D-1 turbofan engine [AD-A072019] N79-31209 SHITH, D. Analysis of plume rise from jet aircraft [CONF-790142-1] N79-31204 SHITH, J. W. Analysis of a lateral pilot-induced oscillation experienced on the first flight of the YF-16 aircraft [NASA-TM-72867] N79-31220 SHITH, L. H. Actively cooled plate fin sandwich structural panels for hypersonic aircraft [NASA-CR-3159] N75 N79-31628 SHITH, N. L. Aerodynamics for engineers A79-50375 SHITH, R. B. Airworthiness and flight characteristics test, 0V-1C takeoff performance N79-30178 [AD-A069827] SHITH, R. P. Interactional aerodynamics - A new challenge to helicopter technology [AHS 79-59] A79-A79-49109 SHITH, S. B. An evaluation of sidestick force/deflection characteristics on aircraft handling qualities A79-50428 SHYTH, S. J. CADAM data handling from conceptual design through produce support AIAA PAPER 79-18461 A79-47912 SNELLING, K. S. Some aspects of the design and development of the maritime autopilot modes for the Westland Lynx helicopter N79-30201 SODERQUIST, J. R. Certification of composites in civil aircraft A79-49095 [AHS 79-43] SOEDBR, R. H. Effect of steady-state temperature distortion and combined distortion on inlet flow to a turbofan engine N79-30187 [NÁSA-TM-79237] SOKOLOV, V. D. Nozzles for vectored thrust jet engines A79-47428 SOLONON, R. D. Flight test verification of the ASSET system x79-48622 SPEARNAN, M. L. Historical development of worldwide supersonic aircraft [AIAA PAPER 79-1815] 179-47895 SPENCER, D. J. A real time video bandwidth reduction system based on a CCD Hadamard transform device A79-48702 SPIER, E. E. Ultra-high-modulus graphite-epoxy conical shell development, supplement [AD-A069795] NT SPILLMAN, J. J. Flight experiments to evaluate the effect of N79-30335 wing-tip sails on fuel consumption and handling characteristics 179-49818 SPIRIDONOV, IU. A. Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics A79-48495 SPRINGER, R. Bultipath propagation measurement by Doppler technique N79-31478 SRIBAHOLU, V. Factors controlling stability of swirling flames at diffusers in gas turbines 179-50209 STADNORE, H. A. Radar cross section fundamentals for the aircraft designer [AIAA PAPER 79-1818] A79-47898 STAEBLER, C. J., JR. Metallic coatings for graphite/epoxy composites [AD-A069871] N79-30334 STALEY, J. A. Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor . A79-49075 [AHS 79-23] Info (5-23) STALOUP-DOBRZAMSKI, J. Improvement of fighter aircraft maneuverability through employment of control configured vehicle technology N79-30225 STAVE. L. P. Automatic test software for calibrating strapdown systems A79-48689 STEER, D. J. Airborne microwave ECM A79-49554 STEIN. G. Digital adaptive control laws for VTOL aircraft A79-48000 STEINHAUSER, R. An in-flight controller insensitive to parameters variation [DLR-FB-78-07] N79-30197 STENGEL, R. P. A microprocessor system for flight control research A79-48623 NASA/Princeton digital avionics flight test facility 179-49344 STERNETT, S. H. Test implementation through support software - A FIT translator A79-46 A79-48687 STERLIN. V. A Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I 179-46999 STERNFELD, H., JR. Study of design constraints on helicopter noise [NASA-CR-159118] N79-N79-32054 STEVENS, A. D. A new three-dimensional surveillance radar A79-49568 STEVENS, B. S.

PERSONAL AUTHOR INDEX

STEVENS, B. S. Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 1 [NASA-CR-159515] N79-30185 Aerodynamic and acoustic investigation of inverted velocity profile coannular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures, comprehensive data report, volume 2 [NASA-CR-159516] N79-30186 Aerodynamic and acoustic investigation of inverted velocity profile coancular exhaust nozzle models and development of aerodynamic and acoustic prediction procedures [NASA-CR-3168] N79-31212 STEWARD, C. H. A helicopter high definition rotor blade radar N79-30207 STEWART, A. A. E-4B mission electrical power A79-48617 STEWART, V. R. The characteristics of a lift cruise fan V/STOL configuration in near proximity to a small deck with finite edge positions [AIAA PAPER 79-1854] A79-47913 STOCKING, W. B. Iceater I - Air cushion ice breaker in commercial operations A79-49912 STOCKMAN, N. O. Recent applications of theoretical analysis to V/STOL inlet design A79-49530 STOUGH, H. P., III The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane [AIAA PAPER 79-1786] A79-47876 STRIZ, A. G. Flutter analysis of two-dimensional and two-degree-of-freedom airfoils in small-disturbance, unsteady transonic flow [AD-A069223] N79-31157 STRUKIN, V. A. Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ A79-50421 STUÁRT, J. W. Global enclosure fire modeling with applications N79-31172 Fuselage ventilation under wind conditions N79-31175 STUCKENBERG, N. Failure detection in signal processing and sensing in flight control systems 179-47971 STURGEON, W. R. Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar [AHS 79-52] SULLIVAN, J. P. A79-49104 LDV measurements on propellers A79-49052 SULLIVAN, R. L. The size and performance effects of high lift system technology on a modern twin engine jet transport [AIAA PAPER 79-17951 A79-49332 SUNNA, J. H. A lifting-surface method for hover/climb airloads [AHS 79-3] 179-49056 SUPKIS, D. Status of candidate materials for full-scale tests in the 737 fuselage N79-31170 SVARD, L. Bllipsoidal modelling of aircraft targets for A79-49580 SWEENEY, D. A. Adaptive array tradeoffs for existing airborne UHP radios A79-48598

SWORTZEL, F. R. Design guidance from fighter CCV flight evaluations N79-30235 SYMONDS, W. A. Development and demonstration of manufacturing processes for fabricating graphite/PMR-15 polyimide structural elements N79-30301 SZELAZEK, C. A. Upper-surface modifications for C sub 1 max improvement of selected NASA 6-series airfoils [NASA-TM-78603] N79-3 N79-30143 Т TABAK, D. A multiple objective optimization approach to aircraft control systems design A79-47962 TALANTOV, A. V. Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics A79-48495 TALYZIN, V. A. Optimal thermogasdynamic design of gas turbine engines using element prototypes. I 179. A79-46997 TANNEE, A. E. Development of crashworthy passenger seats for general-aviation aircraft [NASA-CR-159100] N79-31164 TATE, B. P. A user's manual for a computer program to generate fatigue spectrum loading sequences [AD-A069288] N79-31198 **TAVGER, H. D.** On the question of selecting the characteristic the question of selecting the undiductive quantity governing fuel self-ignition in a stream A79-48497 TAYLOR, R. L. Crashworthy armored crewseat for the UH-60A Black Hawk [AHS 79-10] A79-49062 THEISEN, J. G. Laminar flow stabilization by surface cooling on hydrogen fueled aircraft [AIAA PAPER 79-1863] A79-47920 THOMAS, J. L. Powered low-aspect-ratio Wing In Ground effect (WIG) aerodynamic characteristics [NASA-TM-78793] N79-31141 Theoretical and experimental investigation of ground-induced effects for a low-aspect-ratio highly swept arrow-wing configuration [NASA-TP-1508] N79-31223 THOMPSON, B. K. Computer Monitor and Control - A flexible, cost-effective implementation A79-48670 THOMPSON, S. G. Identifying desirable design features for the C-XX aircraft - A systems approach [AIAA PAPER 79-1796] A79-4786 A79-47883 THOR, W. A. An investigation of the rolling stability fighter configu derivatives of a T-tail fighter configuration at high angles-of-attack 179-50165 THORNTON, E. A. Evaluation of finite element formulations for transient conduction forced-convection analysis A79-49343 TIETZ, D. B. Microprocessor-based digital autopilot development for the XBQM-106 Mini-RPV A79-48608 TIRRE, J. C. Adding the challenge of nap-of-the-earth N79-30199 TOCKERT, C. Previsions and experimental results in open balloon controlled descent N79-31691 TONASI, J.-P. The servoed modulation PMCW radar altimeters in military applications

A79-49589

TOPPING, A. D. Maritime patrol airship concept study [AD-A070131] TORNALIXAY, A.	N79-31138
Time history solution program, L225 (TEV126 Volume 2: Supplemental system design and	5) - 1
maintenance document [NASA-CR-2860] TRAIN, D.	N79-31154
A combined air-cushion and endless belt transportation system	A79-49911
	K73 43511
TREMILLS, J. A. Performance predictions for open ocean air vehicles and surface effect ships	cushion
AGUICIES and Satiage circle surf-	A79-49905
TREPT, T. J., JR. Helicopter performance methodology at Bell	
Helicopter Textron [AHS 79-2]	<b>∆79-4905</b> 5
TREXLER, C. A. Characterization of a swept-strut hydrogen	
fuel-injector for scramjet applications	A79-49345
TROESCH, A. Predictive guidance for interceptors with	time
delays	A79-47939
TRUBAN, A. P.	
Application of instrument rotation in the standard inertial navigation system	N73
	A79-48696
TRUSTEE, B. Helicopter drive system R and M design gui [AD-A069691]	de №179-30181
TURNER, C. R. Analysis and evaluation of current MIL-STD digital avionics architecture as the bas advanced architectures using MIL-STD-155	is for
TURBER, F. Achieving consistency in the production of critical jet engine components by means	of press
forging	A79-48945

A79-48945 **TWOMEY, W. J.** The influence of engine/fuel control design on helicopter dynamics and handling qualities [AHS 79-37] A79-49089

# U

- ULUG, N. E. A novel approach to the design of an all digital aeronautical satellite communication system N79-31461
- UNDERWOOD, H. W. Operational experience with the AN/ARN-131 Omega Navigation Set A79-48676
- UPADHYAY, T. N. A real-time seguential filtering algorithm for GPS low-dynamics navigation system
- URIE, D. H. L-1011 active controls, design philosophy and
  - experience N79-30236

# V

BILCERBE BOR H

VALCREBADED, "	
Design of the circulation control wing STOL	•
demonstrator aircraft	
[AIAA PAPER 79-1842]	A79-47909
VANDRRVAART, J. C.	
Aircraft response to windshears and downdra	ughts
Allelalt response to armetere and anter	N79-30229
VANGOOL, M. F. C.	
A simulator investigation of handling quali	Lty
criteria for CCV transport aircraft	- \
CITCELIA TOL CCI CIUNSPOLO ULICITIC	N79-30240
	N/J-J0240
VAUCHEBET, X.	
Wall corrections in transonic wind tunnel:	
Equivalent porosity	N79-30247
[ESA-TT-545]	N/9-30247

VEPA, R.	
Comment on 'active flutter control using generalized unsteady aerodynamic theory'	
generalized ansteady aerodynamic theory	A79-49873
VERGEZ, P. L.	
Investigation of roll performance for a hig	hly
nonlinear statically unstable fighter-typ	e
aircraft [AD-A069301]	N79-31199
VICKBRY, G. L.	
F-16 avionics maintenance concept and	
multinational aspects	A79-48894
VOGT, G. L.	A/9-40094
The ATCBI-5 beacon interrogator	
· · · · · · ·	A79-48693
VON GLAHN, U.	
Wing aerodynamic loading caused by jet-indu lift associated with STOL-OTW configurati	ons
[AIAA PAPER 79-1664]	A79-47346
VORTHBIER, P. W.	
Multiband antenna	A79-48596
VOSKRESENSKII, G. P.	A79-40590
Numerical solution of the problem of unstea	ıdy
supersonic flow around the front part of	the
wings with a detached shock wave	A79-49456
VOSWINCKEL, W.	A79-49450
Scan converter and raster display controlle	er for
night vision display systems	
	N79-30203
VOTB, P. W. Millimeter airborne radar target detection	and
selection techniques	
-	A79-48665
W	
WAGNER, J. P., III	
Combined environment reliability test of the	1e
common strategic Doppler system	<b>1</b> 479-50368
WALKER, G. I.	
New versus existing engines for new helicop	pter
systems - A life cycle cost view [AIAA PAPER 79-1316]	A79-47348
WALKER, H. J.	ar) 41340
Performance evaluation method for dissimila	ar
aircraft designs	N79-30139
[NASA-RP-1042] WALKER, J. E.	N/9-30139
The evolution of the high-angle-of-attack	features
of the P-16 flight control system	
	A79-50438
WALSH, M. J. Tactical performance characterization basic	
	3
methodology	
methodology [AD-A069297]	0 079-31235
methodology [AD-A069297] WALTER T. J.	N79-31235
methodology [AD-A069297] WALTER, T. J. Computer-assisted high-speed balancing of "	N79-31235
methodology [AD-A069297] WALTER T. J.	N79-31235

- WARD, F. S. Recent advances in radome design A79-49574
- WASHAN, R. M. Correlation technique for ambient effects on oxides of nitrogen A79-49922
- WASHBURN, R. B. Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization A study of the application of singular perturbation theory [NASA-CR-3167] N79-30194
- WATERS, D. H.
   A simulation of amphibious hovercraft overturning A79-49904
   WATSON, J. H.
   Enhanced fighter mission effectiveness by use of
- integrated flight systems N79-30223
- WATTS, J. C. Airworthiness and flight characteristics test, OV-1C takeoff performance [AD-A069827] N79-30178

WEBER, H.

#### PERSONAL AUTHOR INDEX

WEBER, H. The fluorenone polyester ISO FPE of Isovolta Company, Austria N79-31183 WEBER, M. Testability, the key to economical and operationally effective avionic test software A79-48890 WEIBERG, J. A. Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft [AHS 79-54] WBIDNER, J. P. A79-49105 Conceptual study of a turbojet/ramjet inlet [NASA-TM-80141] N79-31215 WELT, S. Dynamic simulator test and evaluation of a JTIDS relative navigation system A79-48694 WERNICKE, K. G. IV-15 flight test results compared with design goals [AIAA PAPER 79-1839] A79-49336 WHEELOCK, C. H. Air Force modular automatic test equipment development program A79-48878 WHITE, P. Improved method of predicting helicopter control response and gust sensitivity [AHS 79-25] A79-49077 WHITE, W. F. Flight performance of the TCV B-737 airplane at Kennedy Airport using TRSB/MLS guidance [NASA-TM-80148] N79-31186 WICKBNDEN, B. V. A. Recent advances in radome design A79-49574 WIEDERSUN, C. W. Study of design constraints on helicopter noise [NASA-CR-159118] N79-32054 WIBTING, A. R. Evaluation of finite element formulations for transient conduction forced-convection analysis A79-49343 WILCON, R. E. The alpha-beta-gamma tracking filter in the Z-domain A79-48680 WILER, C. D. Manned strategic system concepts 1990-2000 [AIAA PAPER 79-1793] A79-47882 WILKERSON, J. B. The circulation control rotor flight demonstrator test program [AHS 79-51] WILLIANS, C. D. A79-49103 Verification of operational flight programs by simulation A79-48667 WILLIAMS, R. C. Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control [AIAA PAPER 79-1163] A79-47347 WILLIS, B. A. An overview of NASA research on positive displacement type general aviation engines [NASA-TM-79254] N79-31210 WILLIS, W. S. QCSEE - The key to future short-haul air transport A79-50208 WILSON, C. F., JR. Radio-controlled model design and testing techniques for stall/spin evaluation of general-aviation aircraft [NASA-TH-80510] N79-30173 WINGBOVE, R. C. Estimation of longitudinal aircraft characteristics using parameter identification techniques A79-50432 WITHERS, C. C. Evaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Flying Qualities of Piloted Airplanes' A79-50439 WITHBAB, R. L. An analysis of SAPPHIRE image parameters as a function of processing parameters 179-48666

WOLPE, R. A. Dynamics requirements for an Advanced Scout Helicopter /ASH/ [AHS 79-19] A79-49072 WOLOBICZ, C. H. Similitude requirements and scaling relationships as applied to model testing [NASA-TP-1435] N79-30 N79-30176 NOOD, N. E. All electric subsystems for next generation transport aircraft [AIAA PAPER 79-1832] A79-47906 WOODWARD, A. C. Terrain-following radar - Key to low-altitude flight A79-48686 WOODWARD, N. Performance of current radar systems in an EW environment A79-49555 WORALEY, D. N. Characteristics of an Air Cushion Landing System incorporating an inelastic trunk A79-49909 Heave-pitch-roll analysis and testing of air cushion landing systems [NASA-CR-2917] N79-30175 WORSHAM, J. E. Derivative engines for the 1980s will help limit acquisition and maintenance costs A79-50206 WRIGHT, G. P. Spirit helicopter handling qualities design and development [AHS 79-24] 179-49076 WUENNENBERG, H. Stall behaviour evaluation from flight test results N79-30227

# Y

YAIR, D. Analysis of optimal loop and split-S by energy state modeling A79-47098 YAMAKAWA, G. M. Airworthiness and flight characteristics test, OV-1C takeoff performance [AD-A069827] N79 ₩79-30178 YAHARTINO, R. J. Analysis of plume rise from jet aircraft [CONF-790142-1] N79-31204 YANG, T. I. Flutter analysis of two-dimensional and two-degree-of-freedom airfoils in small-disturbance, unsteady transonic flow [AD-A069223] N79-31157 YEAGER, W. T., JR. Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight [AHS 79-56] A79-A79-49106 100, J. K. Preprocessing for advanced image matching techniques A79-48602 YRASEK, D. C. Performance of two-stage fan with a first-stage rotor redesigned to account for the presence of a part-span damper [NASA-TP-1483] N79-30191

# Ζ

 ZELASCO, C. L. H-X combat search and rescue avionics study results A79-48684
 ZHULDYBIN, E. N. Method of determining mechanical-impurity contents in jet fuels A79-48859
 ZIMINA, I. I. Method of determining mechanical-impurity contents in jet fuels A79-48859
 ZOMICK, D. A. The DG-800 - A rugged, high performance heading reference unit A79-48677

- ZORBA, C. R. The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow ZRELOV, V. N. Method of determining mechanical-impurity contents in jet fuels A79-48859
- ZURHEIDEN, D. A self contained collision avoidance system for helicopters N79-30206

B-23

# **CONTRACT NUMBER INDEX**

# AERONAUTICAL ENGINEERING / A Continuing Bibliography (Suppl. 116)

### **DECEMBER 1979**

# Typical Contract Number Index Listing





Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section.

AF PROJ. 2104	DAAK51-78-C-0011
N79-30246 AF PROJ. 2202	А79-49074 DAHC19-77-С-0006
AF PROJ. 2202 N79-30169	N79-31236
N79-31201	DI-BM-H0-133024 N79-31237
AF PROJ. 2307 N79-31157	DOT-FATO-679 A79-49604
AF PROJ. 2402	DOT-FA72WA-2801 A79-48692
N79-31200 N79-31202	DOT-FA72WAI-242
AF PROJ. 2403	A79-49604
₩79-31227 AF PROJ. 2404	DOT-FA74NA-1102 N79-30190
N79-30148	DOT-FA74WAI-423
N 79-30149 N 79-31203	N79-31233 DOT-FA77WA-3955
AF PROJ. 3048	N79-30959
N79-30555	N79-30960
N79-31218	DOT-FA79WA-4184
AF PROJ. 7184	N79-31234
N79-30184	DOT/TSC-RA-77-15
AF-AFOSR-71-2145	N79-30490 DOT/TSC-RA-77-16
A79-47099 AF-AFOSR-74-2712	N79-30490
A79-47093	EY-76-C-04-0789
AF-AFOSR-3523-78 N79-31157	N79-30182 FAA PROJ. 082-431-02
DA PROJ. 1L1-61102-AH-45	N79-31233
N79-31151	FAA PROJ. 201-521-100
DA PROJ. 112-62209-AH-76	N79-31209 N79-31211
N79-30179	F4701-77-C-0078
N79-30180 N79-30181	A79-47939
N79-30196	F04701-76-C-0002
DA PROJ. 1W1-62113-A-661	A79-48603 F04701-78-0181
N79-30335 DA PROJ. 207-63743-A-772	A79-48657
N79-31236	F19628-78-C-002
DAAB07-77-C-2176 A79-48597	F29601-76-C-0015
DAAB07-78-A-6606	N79-30246
N79-31205	F33601-78-D-0042
DAAG29-77-G-0034 A79-49718	N79-30169 F33615-75-C-3105
DAAG29-77-G-0205	N79-31201
N79-31482	F33615-76-C-2019 N79-30555
DAAG29-78-G-0149 A79-49718	F33615-76-C-3116
DAAG46-75-C-0072	N79-31197
N79-31624	N79-31198
DAAG46-76-C-0008 N79-30335	F33615-77-C-0115 A79-47882
DAAJ02-76-C-0047	F33615-77-C-0536
N79-30180	N79-30184 F33615-77-C-2082
N79-30181	N79-31200
DAAJ02-76-C-0069 A79-49056	N79-31200
DAAJ02-77-C-0034	F33615-77-C-3062
N 79-30196	N79-30148 N79-30149
DAAJ02-77-C-0049 N79-30179	F33615-77-C-3079
DAAK40-77-C-0107	N79-31227
A79-48602	F33615-77-3109 A79-47890
DAAK50-78-C-0008 A79-49084	F33615-78-C-0011
A, 7	N79-31235

F33615-78-C-(	
F33615-78-C-1	
F33615-78-C-1	1479-48657 1563
F33615-78-C-2	A79-48695
	124141414141414
F33616-78-C-	1576 A79-48610
F33657-74-C-0	0604 179-48666
P44620-76-C-0	
F49620-77-C-	0023
F4 142 1000	N79-31217 N79-30151
MDA903-78-C-	0176
NASW-3198	N79-30141 N79-31206
NASW-3199	N79-31136 N79-31163
NAS1-12403	N79-31230 A79-49909
	N79-30175
NAS1-12911 NAS1-13382	N79-31624 N79-31628
NAS1-13918	N79-31144 N79-31145
	N79-31147 N79-31148
	N79-31153 N79-31154
_	N79-31155
NAS1-14637 NAS1-14742	N79-31164 A79-49332
NAS1-14789 NAS1-14849	N79-31221 N79-30145
NASI-14849	N79-31149 N79-31152
NAS1-14892	N79-31152 N79-31533 A79-48000
NAS1-14921 NAS1-15009 NAS1-15113	A79-48000 N79-30301
NAS1-15113	A79-47991
NAS1-15216 NAS1-15226	N79-30194 N79-30165
NAS1-15226 NAS2-8700	N79-32054 N79-31354
NAS2-9143	N79-31354 N79-30138
NAS2-9331	N79-31195 N79-31222
NAS2-9344 NAS2-10097	A79-49339
NAS3-19736	N79-31207
NAS3-20061	N79-30185
	N 79-30186 N 79-31212
NAS3-20646	N79-30189
NAS4-2542 NAS8-20630	N79-31193 N79-31208
NGL-05-020-2	
NGL-22-009-	A79-47093
	N79-30193
NGR-47-003-0	N79-31143
NSF GR-4213	
NSG-1321 NSG-7072	A79-49343 A79-49866
NSG-7072 NSG-7373	A79-49867
N00014-76-C	-0710
N00014-76-C	
N00014-77-C	A79-47943 -0180
N00014-78-C	N79-30140
	A79-48623
N00019-77-C	N79-30334
N 622 6 9 <b>-7</b> 5-C	A79-49605
N62269-76-C	-0105 179-49584
N62269 <b>-77</b> -C	
	A/9-48596

N62269-78-C-0	003
	N79-31226
N62269-78-C-0	176
	N79-30195
N62269-78-M-6	
	N79-31138
SF54502001	N79-30332
W-31-109-ENG-	-38
	N79-31204
WF41400000	N79-30195
505-02-24	N79-31193
505-04	N79-30191
	N79-31213
	N79-31214
505-05-41	N79-31195
505-06-34	N79-30176
505-06-53-01	N79-30147
505-06-53-03	N79-31533
505-06-64	N79-31220
505-10-13-07	N79-30145
	N79-31149
	N79-31152
505-10-23-05	N79-31151
505-11-24	N79-30139
505-11-33-01	N79-31215
517-53-43-02	
518-51-01	N79-31137
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