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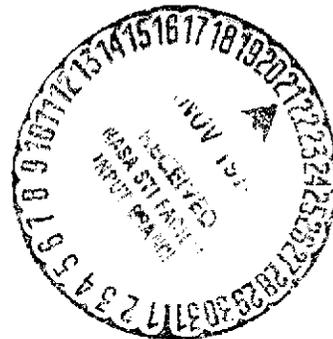
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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY
WITH INDEXES
Supplement 48

SEPTEMBER 1974



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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 48

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 August 1974 in

- *Scientific and Technical Aerospace Reports (STAR)*
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SEPTEMBER 1974

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INTRODUCTION

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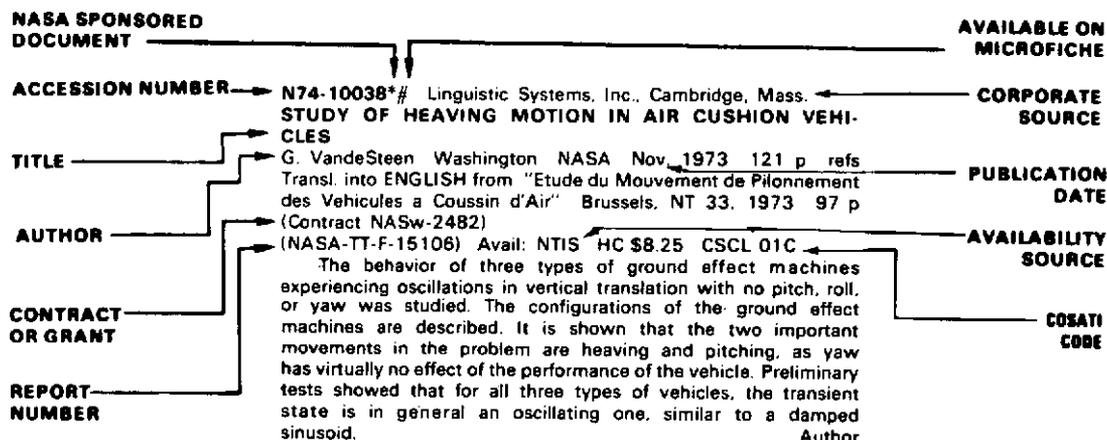
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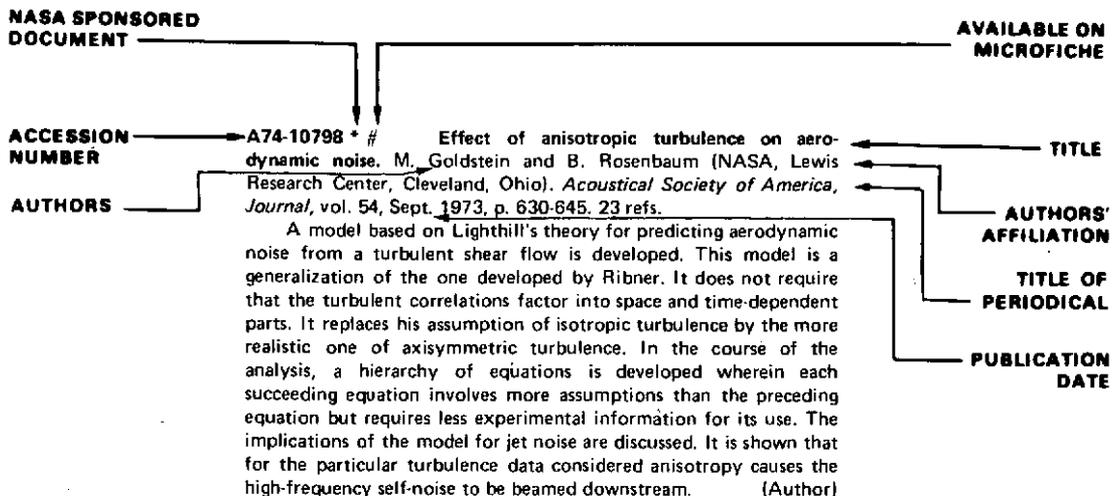
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TYPICAL CITATION AND ABSTRACT FROM IAA





AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 48) SEPTEMBER 1974

IAA ENTRIES

A74-31878 Hawker's new Hawk. C. M. Gilson. *Flight International*, vol. 105, May 23, 1974, p. 669-675.

Training aircraft tend to be asked to last a long time and this, coupled with the fact that the training environment is one of the toughest in military flying (a high number of cycles and a large amount of time spent at low level) makes severe demands on the designer in terms of structural integrity and fatigue life. The primary structure of the Hawk is designed for a safe fatigue life of 6000 hr with 40% of this spent in the weapon training role. The fuselage is of simple skin/stringer/frame construction with the one-piece low wing attached by three bolts on either side, which places the associated structure in compression for strength. The engine for the Hawk is the Rolls-Royce/Turbomeca RT.172-06 unheated Adour. F.R.L.

A74-31892 # Modern landing gear for aircraft (Współczesne podwozia lotnicze). A. J. Wroblewski and T. Wusatowski. *Technika Lotnicza i Astronautyczna*, vol. 29, Apr. 1974, p. 8-13. In Polish.

Description of novel structural design features of landing gear used in executive, combat, commercial, and STOL transport airplanes and helicopters. Details of operation and technical specifications are included for landing gear used in Falcon 20 and Falcon 30 executive jets, single-seater Mirage F-1 fighter, the Jaguar assault aircraft, Alpha-Jet trainer and fighter, Mirage IV, Concorde, Airbus A300 B2, Breugot 941, Fransall C160, and the SA 330 helicopter.

A74-31893 # Thermal loads on the turbine disk after turning off a turbojet engine (Obciążenia cieplne tarczy turbiny po wyłączeniu silnika turbodrzutowego). J. Borgon. *Technika Lotnicza i Astronautyczna*, vol. 29, Apr. 1974, p. 14-18, 25, 26. 6 refs. In Polish.

Description of a method for predicting thermal loads imposed on the turbine disk of a turbojet engine after shutdown in flight. The initial assumption adopts an altitude of 8000 m as the level at which the engine is turned off. Graphs and drawings of temperature distributions illustrate the results of measurement and computation. These data are used to determine radial thermal stresses and strains in the mid-plane of the disk. T.M.

A74-31894 # Oil filtration in modern aircraft systems (Filtracja oleju we współczesnych instalacjach lotniczych). J. Zmihorski (Instytut Lotnictwa, Warsaw, Poland). *Technika Lotnicza i Astronautyczna*, vol. 29, Apr. 1974, p. 31-34. In Polish.

The effects of contamination on the reliability and lifetimes of aircraft hydraulic systems are explained initially, and attention is given to factors governing the specific type of filter required and its location in typical hydraulic systems. Tables and graphs illustrate criteria for choosing filters which meet prescribed purity standards. T.M.

A74-31895 # Progress in the development of a versatile airborne simulator for V/STOL aircraft. W. S. Hindson, K. Lum, and W. E. B. Roderick (National Aeronautical Establishment, Flight Research Laboratory, Ottawa, Canada). *Canada, National Research*

Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin, no. 1, 1974, p. 25, 27-51. 17 refs.

The new airborne simulator will possess a number of capabilities not found in machines previously used. The motions of the simulated vehicle can be accurately reproduced in all six degrees of freedom. A significant improvement in the complexity of the simulation that can be carried out is possible through the use of a larger capacity digital/analog computing facility. This hybrid capability will be particularly useful in reproducing the nonlinear nature of V/STOL aerodynamics. The simulation technique and the control requirements are discussed along with simulator hardware developments, simulation equipment developments, auxiliary engine development, and simulator limitations. G.R.

A74-31975 # Aircraft characteristics and air traffic systems. V. W. Attwooll (Royal Aircraft Establishment, Farnborough, Hants., England). *Journal of Navigation*, vol. 27, Apr. 1974, p. 173-194.

It is likely that in the future, aircraft designs will be increasingly tailored to optimize the traffic system rather than the economics of the aircraft considered in isolation. The present work discusses the effect of the individual characteristics of aircraft on the properties of air traffic systems. (Author)

A74-32057 # A linear model of a finite amplitude Helmholtz instability. D. S. Jones and J. D. Morgan (Dundee University, Dundee, Scotland). *Royal Society (London), Proceedings, Series A*, vol. 338, no. 1612, May 21, 1974, p. 17-41. 12 refs. Research supported by the Ministry of Defence.

The Helmholtz instability of a vortex sheet separating two fluids in relative motion is unbounded in a simple linear model of the interaction of sound with the sheet. This paper presents a model which limits the amplitude of a harmonic wave in a physically realistic way but remains mathematically tractable. It is based on the idea that growth is limited by the onset of turbulence between the fluids when the Helmholtz wave reaches a critical size. An important consequence of the theory is a strong enhancement of the sound scattered upstream, which is significant both in the context of forward noise produced by a jet and possibly also of jet screech. The requirement of causality is of central importance in determining the correct solution, and detailed general results on the theory of zero ultradistributions are presented to establish an analytic definition of causality for the class of solutions encountered. (Author)

A74-32297 # Minimum induced drag of semi-elliptic ground effect wing. H. Mamada (Aichi University, Aichi, Japan) and S. Ando (Nagoya University, Nagoya, Japan). *Journal of Aircraft*, vol. 11, May 1974, p. 257, 258. 5 refs.

The main aim of the investigation is the derivation of explicit expressions for the span efficiency factor, taking into account the height ratio of the wing front view. It is assumed that the trailing vortex sheet extends to infinite downstream. Expressions for the span efficiency factor in the two limiting cases are derived and the physical meaning of the results is discussed. It is found that the wing with a hemi-circular front view has the least span efficiency factor of three types of ground effect wings with a common gap parameter. G.R.

A74-32321 # Ground testing and simulation. I - Key to efficient development of aerospace systems. J. D. Whitfield (ARO, Inc., von Karman Gas Dynamics Facility, Arnold Air Force Station, Tenn.). *Astronautics and Aeronautics*, vol. 12, June 1974, p. 54, 55. 6 refs.

Future developments of aerospace systems can be carried out faster, safer, and at a lower cost through more complete and earlier ground testing and simulation. This requires a change in present development philosophies as well as the availability of more advanced facilities, such as high-Reynolds number transonic tunnels, large full-scale subsonic tunnels, and propulsion facilities for testing very large turbine engines. (Author)

A74-32322 * # Ground testing and simulation. II - Aerodynamic testing and simulation: Saving lives, time, and money. B. Dayman, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and A. W. Fiore (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics*, vol. 12, June 1974, p. 56-61. 27 refs.

The present work discusses in general terms the various kinds of ground facilities, in particular, wind tunnels, which support aerodynamic testing. Since not all flight parameters can be simulated simultaneously, an important problem consists in matching parameters. It is pointed out that there is a lack of wind tunnels for a complete Reynolds-number simulation. Using a computer to simulate flow fields can result in considerable reduction of wind-tunnel hours required to develop a given flight vehicle. P.T.H.

A74-32482 Required flight-path variometer - The quiet revolution in gliding (Das Sollfahrvariometer - Die leise Revolution im Segelflug). H. Reichmann. *Deutscher Aerokurier*, vol. 18, May 1974, p. 334-336. In German.

The net variometer without total energy compensation indicates values regarding the rising or sinking of the air provided there are no changes in the flight of the glider. The principles of operation of the instrument are considered along with questions of capillary tube calibration. An indication of vertical air movements even in cases of glider flight changes is provided by the net variometer with total energy compensation. A new type of variometer indicates the rate of climb which corresponds to the flight path of the glider. The operational principles of this instrument are discussed along with the advantages provided by an employment of this instrument. G.R.

A74-32591 The effects of aircraft noise in schools around London Airport. M. A. Crook and F. J. Langdon (Building Research Establishment, Garston, Lancs., England). *Journal of Sound and Vibration*, vol. 34, May 22, 1974, p. 221-232. 8 refs.

The effects of aircraft noise on teaching and classroom activity were studied in a number of schools close to Heathrow Airport, both by direct observation and by a small sample survey of teachers' opinions. The principal changes in observed behavior result from interference with speech and this finding corresponds with the survey of teachers' opinions. The study was unable to identify any other consistent or systematic changes in class activities directly related to aircraft noise. (Author)

A74-32593 High intensity sound in a lined duct. D. Firth, M. West, D. J. Poole, and F. Walkden (Salford, University, Salford, England). *Journal of Sound and Vibration*, vol. 34, May 22, 1974, p. 261-273. 13 refs.

The nonlinear equations appropriate to the transmission of sound in a duct are derived from the equations of fluid dynamics. A numerical method is described by which solutions are obtained. For low sound pressure levels, the numerical solution is shown to provide results in close accord with theory for hard-walled and lined ducts. At high sound levels (in excess of 160 dB), the nonlinear effects are shown to lead to the formation of a sawtooth wave in a hard-walled duct. Further results are presented showing the attenuating effect of linings at high sound pressure levels. (Author)

A74-32600 Study of the effect of dilution on the lubricity of hydrotreated jet engine fuels. R. K. Agnihotri, J. R. Narang, K. C. Metha, and A. N. Nandy (Defence Research Laboratory, Kanpur, India). *Wear*, vol. 28, June 1974, p. 392-394. 5 refs.

Using the ball and cylinder technique developed by Agnihotri et al. (1971), it is shown that mere blending of hydrotreated jet engine fuel with conventionally refined fuels does not by itself restore the lubricity loss caused by the hydrotreatment process. The degree of hydrotreatment and the type of crude oil the fuel originates from are important and require due consideration. M.V.E.

A74-32631 # MRCA systems and related equipment - RB 199 powerplant. *Aircraft Engineering*, vol. 46, May 1974, p. 8-10, 13-16.

The RB 199 engine is to be used in the European multirole combat aircraft. The design, development, and manufacture of the new aircraft engine is being undertaken jointly by a British, a German, and an Italian company. Advanced technology features a new materials developed for commercial and military engines entering service during the 1970s have been fully utilized in the RB 199. Main design feature of the engine is a three-shaft layout. Other special features include an improved reheat system, and a light-weight fan. G.R.

A74-32632 # MRCA systems and related equipment - The MRCA cockpit. *Aircraft Engineering*, vol. 46, May 1974, p. 16-18.

A camera recorder, which is mounted on the pilot's display unit, is incorporated in the MRCA head up display. A control handle with a number of switches provides the pilot with vital flying and operational controls. An altitude direction indicator is used to supervise the flight attitude and to provide the necessary radio-controlled indications for the instrument landing approach. A detailed description is given of an escape system which is to function under conditions of high airspeeds at low altitude. G.R.

A74-32633 # MRCA systems and related equipment - Hydraulic system and flying controls. *Aircraft Engineering*, vol. 46, May 1974, p. 21-24, 26.

The aircraft hydraulics, controlled by the high lift and wing sweep control unit, are used to operate the flaps, slats, wing sweep actuators, Kreuger flaps, and pitch feel gearing mechanisms in response to pilot input and surface feedback signals. The pitch feel system includes two hydro-pneumatic control valve assemblies, one duplex feel force jack, and two solenoid controlled stand-by accumulators. The wheel brake system is also discussed along with hydraulic pumps, drive motors, the undercarriage emergency nitrogen bottle assembly, the wheel brakes, and the anti-skid system. G.R.

A74-32634 # MRCA systems and related equipment - Air conditioning. *Aircraft Engineering*, vol. 46, May 1974, p. 27, 28.

The canopy seal equipment is discussed along with the anti-g valve, the radar pressurization system, the wing seal relief valve, and the heat transfer equipment. The purpose of the anti-g valve is to provide an outlet pressure that is proportional to the applied g in the vertical plane. An inflatable seal is used in order to smooth air flow around the swing wing joint. The air-to-air intercooler for the environmental control system used ram air to cool the boot-strap cold air unit flow in the environmental control system. G.R.

A74-32635 # MRCA systems and related equipment - Landing gear. *Aircraft Engineering*, vol. 46, May 1974, p. 28, 30-32.

Both main and nose wheel tires are of tubeless construction and manufactured from natural rubber with nylon casing cords. Main and nose wheels are of conventional design and manufactured from light alloy forgings. All wheels use taper roller bearings mounted on axle sleeves. Each main landing gear consists of a main fitting, telescopic shock absorber, a lever attached to the top of the shock absorber, and a drag brace. The landing loads used in the strength analysis were obtained by a theoretical performance prediction. G.R.

A74-32636 # MRCA systems and related equipment - MRCA avionics. *Aircraft Engineering*, vol. 46, May 1974, p. 34-38, 40, 42.

Cockpit displays are considered, taking into account the TV tabular display, the combined display, and the TF E-scope display. Flight control systems include a digital autopilot and flight director system and a command stability augmentation system. Questions of flight management are discussed along with aspects of instrumentation, navigation systems, and the communications system. Attention is given to a fuel flowmeter system, a triplex transducer unit, the TACAN system, an instrument landing system, and the communications equipment used. G.R.

A74-32671 # Nickel cadmium aircraft battery run-a-way. *Tech Air*, vol. 30, June 1974, p. 2-5.

FAA documents describe two generalized methods for equipment and procedures to prevent the aircraft damaging effects of battery 'thermal runaway'. These techniques are some form of battery condition sensor to detect the presence of a runaway with appropriate flight panel indicators and placard instructions for action to be taken by the flight crew. Three variables which may be sensed are charge current, battery temperature, and cell voltage differential. A second technique is a battery charge control system that automatically controls the battery charge so as to prevent battery overheating. How a runaway gets started is discussed, as well as runaway detection and viable hazard prevention systems. Attention is given to the safe design for devices for use inside nickel-cadmium batteries, and a technical description of overcharge instability. F.R.L.

A74-32672 # Airframe maintenance and corrosion protection. H. Tyrer (British Aircraft Corp., Ltd., Weybridge, Surrey, England). *Tech Air*, vol. 30, June 1974, p. 5, 6.

Transgranular and intergranular corrosion in aircraft structures give rise to visible deposits that can be detected by a trained observer prior to cleaning, drying, and treatment with a good de-watering fluid will provide temporary protection until the regular maintenance period, when the area can be thoroughly renovated and recoated. Specific protective procedures and agents are described, and the general symptoms and causes of corrosion are discussed. J.K.K.

A74-32775 # Enhancement of durability of aircraft design elements /2nd revised and enlarged edition/ (Povyshenie iznosostoi-kosti detalei konstruktssii samoletov /2nd revised and enlarged edition/). D. N. Garkunov and A. A. Poliakov. Moscow, Izdatel'stvo Mashinostroenie, 1974. 200 p. 102 refs. In Russian.

The wear mechanism in aircraft parts is studied in detail along with the principles for the realization of wear-resistant and anti-friction materials. Points of friction were studied at various stages of an aircraft's life, and on this basis, the various types of wear and the laws governing their behavior are defined. The physico-chemical mechanism of the process of selective migration is studied, and the possible application of this process for decrease of parts wear is investigated. Attention is given to the interaction of solid bodies resulting in hydrogen wear. A method is described for studying the condition of points of friction and for determining their lifetime. P.T.H.

A74-32812 Strengths and failure mechanisms of a Co-15Cr-13TaC directionally solidified eutectic alloy. E. R. Buchanan (General Electric Co., Gas Turbine Products Div., Schenectady, N.Y.) and L. A. Tarshis (General Electric Co., Photo Lamp Dept., Nela Park, Ohio). *Metallurgical Transactions*, vol. 5, June 1974, p. 1413-1422. 11 refs.

The tensile and stress rupture properties of a Co(Cr)-TaC directionally solidified eutectic alloy have been investigated and compared to those of a single phase, directionally solidified Co(Cr) alloy corresponding in composition to that of the eutectic matrix. The temperature for 100 hr stress rupture life at 20,000 psi is about 200 F better than that of any cast nickel-base superalloy now used in aircraft or land gas turbines. The degree of superiority becomes progressively less at higher stresses, and at 50,000 psi the temperature for 100 hr stress rupture life in the eutectic is about 150 F less than for several high strength superalloys. This behavior is related to a bimodal stress rupture mechanism. (Author)

A74-32902 Computation of minimum-noise takeoff flight paths by varying the thrust and the inclination angle of the flight path (Berechnung fürminimale Startflughbahnen durch Variation von Bahnneigungswinkel und Schub). F. Henschel, E. Plaetschke, and H.-K. Schulze (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 22, May 1974, p. 163-167. 5 refs. In German.

In the vicinity of airports noise annoyance of the population by taking-off and landing aircraft has reached such a degree that principle investigations are necessary on possibilities how to reduce such environment-hostile component of air traffic. In this, efforts must be concentrated on the construction of more quiet engines as well as on the determination of suitable take-off and landing manoeuvres. This paper deals with the calculation of optimum noise climb-out flight paths. An important factor is the determination of a suitable standard for the noise load as well as the choice of a suitable optimization method. For selecting the method an essential point of view will be that restrictions with regard to flight dynamics must be taken into account without any efforts. Noise optimization is carried through for a VTOL aircraft as well as for a conventional aircraft. (Author)

A74-33049 The stability of a trailing line vortex. I - Inviscid theory. M. Lessen, P. J. Singh, and F. Paillet (Rochester, University, Rochester, New York). *Journal of Fluid Mechanics*, vol. 63, May 15, 1974, p. 763-763. 13 refs. NSF-supported research.

The inviscid stability of swirling flows with mean velocity profiles similar to that obtained by Batchelor (1964) for a trailing vortex from an aircraft is studied with respect to infinitesimal nonaxisymmetric disturbances. The flow is characterized by a swirl parameter q involving the ratio of the magnitude of the maximum swirl velocity to that of the maximum axial velocity. It is found that, as the swirl is continuously increased from zero, the disturbances die out quickly for a small value of q if $n = 1$ (n is the azimuthal wavenumber of the Fourier disturbance of a given type); but for negative values of n , the amplification rate increases and then decreases, falling to negative values at q slightly greater than 1.5 for $n = -1$. The maximum amplification rate increases for increasingly negative n up to $n = -6$ (the highest mode investigated). (Author)

A74-33065 Safe separation in controlled flight. J. M. Holt (McDonnell Douglas Electronics Co., St. Louis, Mo.). (*International Navigation Congress, Hanover, West Germany, Oct. 2-5, 1973.*) *Navigation*, vol. 21, Spring 1974, p. 1-8. 7 refs. Research supported by the Collins Radio Co.; U.S. Department of Transportation Contract No. TSC-144.

This paper examines the consequences of the point of view that aircraft separations must be adequate for ATC to provide effective, essentially redundant, protection against blunders or failures aboard the aircraft. The most conservative objective for separation standards is that they keep any two aircraft from reaching a position, velocity configuration from which it is possible for a collision to occur before effective ATC intervention can be accomplished. In implementing this philosophy one must consider position and velocity errors, computation and communication lags, as well as pilot and aircraft response delays. Further, however, the development requires a complete hazard detection and resolution strategy. Thus in addition to specifying separation standards, one must, in the process, also specify the primary data required for hazard assessment, the computational algorithms required for hazard determination, the complement of corrective commands, and an algorithm for the selection of the most effective command. (Author)

A74-33091 # The 'Materik' instrument landing system (Instrumentenlandesystem 'Materik'). G. Schmidt (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 2, 1974, p. 70-74. In German.

Developed and used since 1948 in the USSR for course and glide path determination, the Materik system resembles the ILS system, requiring however special adapters for use by ILS onboard instruments. The principles of operation of the Materik system are outlined, using a simplified form of the SP-50 version of the system. The characteristics of the improved SP-50 M version, currently installed at all major airports of the USSR, which provides landing capability under ICAO Category I conditions, are noted. A system (SP-70) expected to provide landing capability under Category II conditions is being developed. V.P.

A74-33092 # Investigation of the economic efficiency of surplus tanking of aircraft fuel (Untersuchung über die ökonomische Effektivität der Vorratsbetankung von Flugtreibstoffen). B. Söhler (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 2, 1974, p. 75-80. In German.

The effectiveness of the practice of tanking beyond the required amount in countries where the fuel prices are low is analyzed, using the IL-62 airliner as an example. The takeoff, horizontal flight (at constant altitude), and landing stages are examined separately, assuming normal atmospheric conditions and absence of wind in each stage. It is shown that economic efficiency depends primarily on the fuel price difference at home and abroad, on the distance flown, on the amount of surplus fuel, and on the flight altitude and velocity. The need for studying many other factors (including the problem of maximum landing weight) is demonstrated. V.P.

A74-33094 # Aircraft servicing and the network technique. II (Flugzeugabfertigung und Netzwerktechnik. II). R. Küttner (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany) and G. Aulerich. *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 2, 1974, p. 88-94. In German.

The application of a network technique in the form of graphically represented standard technologies with certain optimum characteristics to the general servicing and handling of an airliner between landing at its point of destination and the next takeoff is examined. The network technique takes into account all the conventional technical and supply activities (a total of 72) that are performed on the ground, starting with flagging the aircraft in, and finishing with flagging it out. V.P.

A74-33096 # Dolphin airship with undulatory-flow propulsion - Dynamic lift (Delphinluftschiff mit Wellantrieb - Dynamischer Auftrieb). W. Schmidt (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 2, 1974, p. 104-106. In German.

Queck and Schmidt (1970) have described a novel revolutionary concept of a droplet-shaped helium-filled airship developed on the basis of the dolphin principle. As the dolphin, the airship moves in a self-generated undulatory flow. Safe and comfortable in flight, it combines the maneuverability of a helicopter with the speed of a turboprop aircraft. An aerodynamic study is described, showing that the aerodynamic lift of the airship is roughly equal to that of a wing of the same (droplet) planform, and is 20 times that of a Zeppelin airship of equal volume. The capability of the airship to transport large loads over large distances at low cost is established. The possibility that the dolphin principle may lead to a revival of airship navigation is suggested. V.P.

A74-33097 # Flight mechanical analysis of various flight attitudes of conventional aircraft. X - Basic aerodynamic principles /Aerodynamics of the airfoil - Geometry of the airfoil/ (Flugmechanische Analyse verschiedener Flugzustände konventioneller Flugzeuge. X - Aerodynamische Grundlagen /Aerodynamik des Tragflügels - Geometrie des Tragflügels/). F. Seidler (Dresden, Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 2, 1974, p. 107-123. In German.

A74-33101 # A rapid computer aided transonic airfoil design method. T. L. Tranen (McDonnell Douglas Corp., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-501*. 9 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

A numerical method is presented for the design of airfoils with a specified transonic pressure distribution. The method involves iteration between the direct solution of Garabedian and Korn and a design solution. The governing equation is the full inviscid compressible potential flow equation. In the direct solution the Neumann problem for the potential is solved. In the design step the Neumann condition is replaced by a Dirichlet condition - i.e., the pressure distribution is specified. The design step yields a new geometry to be used in the next iteration of the direct solution. After convergence a boundary layer calculation is made, and the displacement thickness is subtracted to yield the actual airfoil geometry. By using computer graphics, a problem that would take weeks in batch mode can be solved in a typical one hour sitting at the graphics console. (Author)

A74-33102 # Investigation into and application of the high velocity circulation control wall jet for high lift and drag generation on STOL aircraft. R. J. Englar (U.S. Naval Material Command, Ship Research and Development Center, Bethesda, Md.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-502*. 13 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

A74-33103 * # Nonlinear prediction of the aerodynamic loads on lifting surfaces. O. A. Kandil, D. T. Mook, and A. H. Nayfeh (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-503*. 15 p. 29 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGR-47-004-090.

A numerical procedure is used to predict the nonlinear aerodynamic characteristics of lifting surfaces of low aspect ratio at high angles of attack for low subsonic Mach numbers. The procedure utilizes a vortex-lattice method and accounts for separation at sharp tips and leading edges. The shapes of the wakes emanating from the edges are predicted, and hence the nonlinear characteristics are

calculated. Parallelogram and delta wings are presented as numerical examples. The numerical results are in good agreement with the experimental data. (Author)

A74-33104 * # Far-field wake-vortex characteristics of wings. D. L. Ciffone and K. L. Orloff (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-505.* 10 p. 16 refs. Members, \$1.50; nonmembers, \$2.00.

Velocity measurements have been made in the wake of wings that were being towed underwater. As the wake aged, measurements of the tangential and axial velocity profiles were made with a two-dimensional scanning laser velocimeter at downstream distances of 5 to 200 span lengths behind wings with different span loadings. The results identify two characteristic flow regions for the dependence of vortex maximum tangential velocity on downstream distance. The first, a region with little, if any, change in maximum tangential velocity, extends from wake rollup to downstream distances as great as 100 span lengths, depending on span loading and angle of attack. This is followed by a decay region in which the maximum tangential velocity decreases with downstream distance at rates nominally proportional to the inverse one-half power. (Author)

A74-33105 # Analysis of predicted aircraft wake vortex transport and comparison with experiment. M. R. Brashers (Lockheed Missiles and Space Co., Inc., Huntsville, Ala.), J. N. Hallock (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.), and N. A. Logan (Lockheed Electronics Co., Inc., Houston, Tex.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-506.* 17 p. 14 refs. Members, \$1.50; nonmembers, \$2.00.

Predicted vortex tracks from a wake vortex transport model previously developed (including the effects of wind and wind shear, buoyancy, mutual and self-induction, ground plane interaction, viscous decay, and finite core and Crow instability effects) have been compared with vortex tracks obtained from B-747, B-707, CV-880, and DC-6 aircraft flybys. Excellent agreement was found between prediction and measurement when sufficient wind data were available. A detailed explanation of vortex tilting is given along with observations concerning the mechanism itself. (Author)

A74-33127 # The torsional flutter characteristics of a cantilevered airfoil cascade in a supersonic inlet flow field with a subsonic axial component. S. Fleeter, R. B. McClure, G. T. Sinnet, and R. L. Holtman (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-530.* 9 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. N00014-72-C-0351.

A74-33136 # Transonic shock-free aerofoil design by an analytic hodograph method. J. W. Boerstael and G. H. Huizing (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-539.* 10 p. 11 refs. Members, \$1.50; nonmembers, \$2.00. Research supported by the Netherlands Agency for Aerospace Programs.

A design method for transonic shock-free airfoils using hodograph theory is sketched. The method is based on the approximate solution of Tricomi boundary value problems for the elliptic-hyperbolic hodograph equations of transonic airfoil flows on a two-sheeted hodograph surface. Special attention is paid to a

numerical approximation method generating nearly always closed airfoils. The use of the computer programs in an aerodynamic design process is illustrated by an example. Several examples of computed airfoils (some of them advanced) demonstrate that the method is flexible and powerful. (Author)

A74-33137 # An inviscid analysis of transonic, slatted airfoils. D. A. Caughey (McDonnell Douglas Corp., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-541.* 9 p. 13 refs. Members, \$1.50; nonmembers, \$2.00.

A numerical method is presented for the analysis of the inviscid flowfields about airfoils with leading-edge slats operating in the transonic speed regime. The method is based upon a previously developed, small-disturbance theory for transonic airfoils, utilizing the geometrical advantages inherent in a preliminary conformal mapping to the complex potential plane of the incompressible flow about the body. In the current study, the mapping is performed for the main airfoil alone; the slat is incorporated using thin airfoil theory to displace the point of application of the slat boundary conditions to the nearest coordinate line of the computational grid. The finite-difference analog of the resulting equation for the perturbation potential is solved using type-dependent line over-relaxation. Arbitrary slat-airfoil combinations can be treated, and agreement with experimental data is quite good for cases in which viscous effects on the slat are not too important. (Author)

A74-33138 * # A finite difference method for the solution of the transonic flow around harmonically oscillating wings. F. E. Ehlers (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-543.* 7 p. 15 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS1-11564.

A74-33145.* # Finite-amplitude waves in cylindrical lined ducts. A. H. Nayfeh and M.-S. Tsai (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-553.* 9 p. 19 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGR-47-004-109.

A second-order uniformly valid expansion is obtained for nonlinear waves propagating in a cylindrical duct lined with a point-reacting acoustic material that consists of a porous sheet followed by honey-comb cavities and backed by the impervious walls of the duct. The effect of the liner is taken into account by coupling the waves in the duct with those in the liner. As in the two-dimensional case, the nonlinearity increases the attenuation rate at all frequencies except in narrow bandwidths around the resonant frequencies, irrespective of the geometrical dimensions of the liner or the acoustic properties of the porous sheet. (Author)

A74-33153 * # A method for studying near- and far-field noise characteristics of impinging jets. Y. S. Pan and J. S. Preisser (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-569.* 15 p. 17 refs. Members, \$1.50; nonmembers, \$2.00.

A new method based on cross-correlation techniques is presented for studying the near- and far-field noise characteristics of a jet impinging on a surface. Analyses show that, in near and far fields, the noise characteristics due to the contribution of fluctuating pressure on the surface and due to the combined contribution of turbulence in the impinging jet and fluctuating pressure on the surface can be determined. Both far-field noise intensities and near-field acoustic energy fluxes can be expressed in terms of appropriate cross correlations. These correlations are obtained by making microphone measurements in three different regions: on the

A74-33155

surface, in the near field, and in the far field. The method is currently being applied to study a cold, circular, subsonic jet impinging on a large rigid surface. Some preliminary experimental data are presented on fluctuating surface pressures and narrow-band far-field noise characteristics. (Author)

A74-33155 * # Aerodynamic design of a rotor blade for minimum noise radiation. K. Karamcheti (Stanford University, Stanford, Calif.) and Y. H. Yu. *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-571.* 7 p. 8 refs. Members, \$1.50; nonmembers, \$2.00. Army-sponsored research; Contract No. NAS2-6158.

An analysis of the aerodynamic design of a hovering rotor blade for obtaining minimum aerodynamic rotor noise has been carried out. In this analysis, which is based on both acoustical and aerodynamic considerations, attention is given only to the rotational noise due to the pressure fluctuations on the blade surfaces. The lift distribution obtained in this analysis has different characteristics from those of the conventional distribution. The present distribution shows negative lift values over a quarter of the span from the blade tip, and a maximum lift at about the midspan. Results are presented to show that the noise field is considerably affected by the shape of the lift distribution along the blade and that noise reduction of about 5 dB may be obtained by designing the rotor blade to yield minimum noise. (Author)

A74-33166 * # Nonstationary atmospheric boundary layer turbulence simulation. G. H. Fichtl (NASA, Marshall Space Flight Center, Huntsville, Ala.) and M. Perlmutter (Northrop Services, Inc., Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-587.* 11 p. 32 refs. Members, \$1.50; nonmembers, \$2.00.

Report on a new and general technique for simulating atmospheric turbulence-like random processes which are statistically homogeneous along the horizontal and nonhomogeneous along the vertical. This technique is general in the sense that it can be used for a broad class of similar problems. Like the other presently available schemes, the techniques presented are based on the Dryden hypothesis and Taylor's frozen eddy hypothesis; however, they go a step further by utilizing certain self-similarity properties of the Dryden spectral density function which permits the development of height invariant filters. These filters are in turn used to generate vertically homogeneous (statistically) random processes from which turbulence at any specified level in the boundary layer can be simulated, thus facilitating the simulation of a nonstationary turbulence process along the flight path of an aircraft during take-off or landing. (Author)

A74-33177 # Transonic laminar viscous-inviscid interaction over airfoils. T. C. Tai (U.S. Naval Material Command, Ship Research and Development Center, Bethesda, Md.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-600.* 12 p. 31 refs. Members, \$1.50; nonmembers, \$2.00. NAVAIR Task R230,201.

A theoretical model consisting of an inviscid external flow and a viscous boundary layer flow is formulated for the subject problem. Procedures developed independently for these two separate flows are combined to enable an analysis of the viscous-inviscid interaction problem at transonic speeds. Both attached and separated boundary layers are considered for either weak or strong interactions. The systems of resulting ordinary differential equations for both flows are coupled by the streamline angle at the edge of the boundary layer and integrated simultaneously for strong interactions. The weak interaction is accounted for by simply correcting the airfoil surface with the boundary layer displacement thickness. The theoretical results are in good agreement with recent laminar experimental data. (Author)

A74-33179 Holographic time-average vibration study of a structure dynamic model of an airplane fin. H. Bjelkhagen (Kungl. Tekniska Hogskolan, Stockholm, Sweden). *Optics and Laser Technology*, vol. 6, June 1974, p. 117-123.

A structure dynamic model of an airplane fin built by Saab-Scania, Sweden, has been vibration tested by the holographic time-average technique. The investigation was performed at Volvo-Flygmotor, Sweden, in their vibration laboratory. Holograms were made at every resonance frequency and, in all, eleven different patterns were created in the interval from 0 to 3400 Hz. The inner structure of the fin model was revealed by inducing a temperature difference between the two exposures of a double-exposed hologram. (Author)

A74-33274 # Acoustical model investigations of two versions of an airport noise suppressor (Akustyczne badania modelowe dwoch wersji tlumika lotniskowego). S. Czarnecki, M. Vogt, and M. Czechowicz (Polska Akademia Nauk, Instytut Cybernetyki Stosowanej, Warsaw, Poland). *Archiwum Akustyki*, vol. 8, no. 4, 1973, p. 361-382. 11 refs. In Polish.

Acoustic noise suppressors are often fitted to the nozzles of standing jet aircraft to reduce the noise produced at standstill. In view of high design costs, model investigations were carried out on prototype versions of a noise suppressor proposed for the jet aircraft Tu-134 and Tu-154. Although the 1:30 scale used did not permit the study of suppressors made of sound absorbing materials, it was shown that the suppressors have a small but definite effect on the acoustical parameters of the noise generated in the flow from the nozzles. The spectral density maximum is shifted to higher frequencies and the acoustical power is somewhat reduced. Comparison of the results obtained with both models has provided data useful for the design of an improved version of noise suppressor. J.K.K.

A74-33298 A proposed pricing procedure for domestic airlines. C. K. Walter (Nebraska, University, Lincoln, Neb.). *Journal of Air Law and Commerce*, vol. 40, Winter 1974, p. 61-74. 34 refs.

A tariff construction system for domestic airlines is proposed which it is argued is equitable to both passengers and airlines, logical, and programable for computation. The basis for determining fares would be the distance from origin airport to destination airport. A table of all commercial airports, their latitudes and longitudes, and some basic formulas would constitute sufficient information to determine the distance between any airport pair. The class of service would also be considered. This linear pricing system is simple, although possible arguments against it are also brought forward. P.T.H.

A74-33312 First results of environmental tests on board Concorde 001. R. Joatton (Société Nationale Industrielle Aérospatiale, Paris, France) and J. F. Leach (British Aircraft Corp., Ltd., Commercial Aircraft Div., Bristol, England). *Acta Astronautica*, vol. 1, Jan.-Feb. 1974, p. 225-235. 12 refs.

Review of the organization that have been set up to coordinate stratospheric research in France and England, including a discussion of the reasons behind the choice of the measuring methods employed by the research institutions involved. The various experiments that are developed on Concorde Prototype 001 are described, as are the calculations undertaken to determine the correct flight path for the aircraft, while observing the sun for the experiments involving solar absorption spectra. Where possible, preliminary information is given on the results that have been obtained so far by those conducting the experiments. (Author)

A74-33313 Dosage of minority stratospheric constituents, of the order of 1 ppb, by absorption spectrometry (Dosage des constituants stratosphériques minoritaires, de l'ordre de 1 ppb, par

spectrométrie d'absorption). A. Girard (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Acta Astronautica*, vol. 1, Jan.-Feb. 1974, p. 237-248. 10 refs. In French.

The presence of NO has recently been detected in the stratosphere by two methods: chemiluminescence and absorption spectrometry, the sun being utilized as source. In this second case, the equipment is essentially an infrared spectrometer associated with a heliostat. The experiments carried out by ONERA are based on the use of a grid spectrometer which makes it possible to reach the limit of resolution of 0.1/cm, a value close to the theoretical limit of the network utilized, while conserving a high luminosity. Dosages of NO were made in the course of experiments aboard an airplane and a stratospheric balloon. Several other chemical species were studied in the course of experiments carried out on board the prototype Concorde 001, among them NO₂ and NO₃H. F.R.L.

A74-33401 # Electromechanical simulation of helicopter blade responses to random excitation during forward flight. D. D. Kana and W.-H. Chu (Southwest Research Institute, San Antonio, Tex.). (*American Society of Mechanical Engineers, Design Engineering Technical Conference, Cincinnati, Ohio, Sept. 9-12, 1973, Paper 73-DET-28.*) ASME, *Transactions, Series B - Journal of Engineering for Industry*, vol. 96, May 1974, p. 405-410. 17 refs. Contract No. DA-31-124-ARO(D)-375.

The response of a model helicopter rotor blade to random excitation while in simulated forward flight is studied analytically and experimentally by means of an electromechanical apparatus. Generalized transfer functions are defined which relate steady-state responses in bending, flapping, and torsion modes to a sine input. Responses occur at the input and side-band frequencies. These transfer functions are then used along with excitation power spectra to predict the nonstationary time-averaged power spectrum of the response. Validity of the transfer function analysis is investigated by means of the electromechanical model which includes analog computer simulation of the interaction of blade deflections and aerodynamic load. Generalized transfer functions are measured for sinusoidal excitation. They are then used with measured excitation power spectra to predict the response, and the result is compared with measured response power spectra. Agreement is generally good for low advance ratio, but discrepancies diverge with increasing advance ratio. (Author)

A74-33404 # Gearbox noise reduction - Prediction and measurement of mesh-frequency vibrations within an operating helicopter rotor-drive gearbox. R. H. Badgley (Mechanical Technical, Inc., Latham, N.Y.) and R. M. Hartman (Boeing Vertol Co., Philadelphia, Pa.). (*American Society of Mechanical Engineers, Design Engineering Technical Conference, Cincinnati, Ohio, Sept. 9-12, 1973, Paper 73-DET-31.*) ASME, *Transactions, Series B - Journal of Engineering for Industry*, vol. 96, May 1974, p. 567-577. 14 refs. Grant No. DAAJ01-71-C-0840.

Correlations between analysis and test results for a complex mechanical system are given. In order to verify the analytical methods, a detailed and comprehensive test program was undertaken on a complete CH-47 forward-rotor-drive gearbox, operating under normal torque conditions in a test-cell environment. At the same time, predictions were made of quantities to be measured using previously published analytical methods. Comparisons between predicted and measured quantities show reasonably good correlation, indicating that the analytical procedures are suitable for careful use in gearbox design or redesign efforts directed at vibration and noise reduction. F.R.L.

A74-33428 An instrument for nitric oxide measurements in the stratosphere. B. A. Ridley (York University, Downsview, Ontario, Canada) and L. C. Howlett (Utah State University of Agriculture and Applied Science, Logan, Utah). *Review of Scientific*

Instruments, vol. 45, June 1974, p. 742-746. 9 refs. Research supported by the U.S. Department of Transportation and NOAA.

A completely automatic chemiluminescent instrument developed for in situ measurements of NO in the stratosphere is described. Signal intensity is linear in NO. Typical responsivity at 21.3 km is 1860 counts/sec ppbv. With a 1-sec measuring time constant, the detection limit as determined by noise is 0.03 ppbv. The instrument has been flown from balloon platforms to 30.8 km and from aircraft platforms between 12.2 and 18.3 km. (Author)

A74-33446 Computer-aided design; Proceedings of the Conference, Eindhoven, Netherlands, October 16-18, 1972. Conference sponsored by the International Federation for Information Processing. Edited by J. Vlietstra and R. F. Wielinga (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Amsterdam, North-Holland Publishing Co., 1973. 463 p. \$25.40.

Lifetime and evolutionary properties of applications software, foundations of the many manifestations of computer-augmented design, and computer generation of symbolic network functions are among the topics covered in papers concerned with advances in computer-aided design. Other topics covered include the application of computer aids to hospital building, nonnumerical problem solving methods in computer-aided design, and computer-aided system reliability analysis and optimization.

Individual items are announced in this issue.

M.V.E.

A74-33450 Computer-aided design in aircraft industry. H. Walter (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). In: *Computer-aided design; Proceedings of the Conference, Eindhoven, Netherlands, October 16-18, 1972.* (A74-33446 15-08) Amsterdam, North-Holland Publishing Co., 1973, p. 355-372; Discussion, p. 373-378.

Computer-aided design application systems and procedures used in the aircraft industry are reviewed. Special attention is given to: (1) the graphic master dimension system for numerical definition and processing of complex surfaces; (2) numerical acquisition and graphic processing of the geometry of single components and families of components beneath the external surface, and automatic drawing of the geometry for numerically controlled manufacturing; (3) verification and correction of complex static structures made necessary by the use of finite-element methods in aircraft design; (4) storage of numerically defined data in a central base simultaneously accessible to aerodynamicists, stress analysts, designers, and production engineers. M.V.E.

A74-33471 # Eddy current inspection - Testing of aircraft parts. L. Schickert (Deutsche Lufthansa AG, Hamburg, West Germany). In: *International Conference on Nondestructive Testing, 7th, Warsaw, Poland, June 4-8, 1973, Proceedings. Volume 1.* (A74-33451 15-15) Warsaw, Polish Society of Mechanical Engineers, 1973. 7 p.

The present work describes how the eddy current technique has been successfully applied to the inspection of various aircraft structural parts for corrosion and cracks. A device called the 'Circograph' is described which is used for the inspection of holes at different aircraft locations. Eddy-current inspection of turbine blades and fuselage skins is also described. P.T.H.

A74-33621 # Strengthening mechanisms in the multi-mechanical-thermal treatment of stainless steels. R. J. McElroy (Oxford University, Oxford, England), D. McLean (Aeronautical Research Council, National Physical Laboratory, Teddington, Middx., England), and Z. C. Szkopiak (Surrey University, Guildford, England). In: *The microstructure and design of alloys; Proceedings of the Third International Conference on the Strength of Metals and Alloys, Cambridge, England, August 20-25, 1973, Volume 1.* (A74-33615 15-17) London, Metals Society, 1973, p. 89-95. 18 refs.

Research supported by the Aeronautical Research Council.

Experimental investigation of the effect of multiple mechanical-thermal treatment (MMTT) on the strengthening of two austenitic stainless steels through the formation of appropriate dislocation substructures. It is found that in austenitic steels MMTT does not exhibit the considerable benefits obtained in room-temperature properties with bcc alloys, owing to the high temperature required for aging in these alloys which leads to the occurrence of recovery, so that it is not possible to build up high dislocation densities. Furthermore, the introduction of irrecoverable fracture damage in the form of cavities at inclusions and coarse undissolved carbides lowers the ductility drastically as the cumulative prestrain increases with MMTT. However, MMTT does have undoubted beneficial effects on recovery resistance, as is reflected in dramatically improved creep resistance at about 800 C. A.B.K.

A74-33622 # The development of thermomechanical processes for advanced dispersion strengthened alloys. M. J. H. Ruscoe, L. F. Norris, M. A. Clegg, and D. J. I. Evans (Sherritt Gordon Mines, Ltd., Fort Saskatchewan, Alberta, Canada). In: The microstructure and design of alloys; Proceedings of the Third International Conference on the Strength of Metals and Alloys, Cambridge, England, August 20-25, 1973. Volume 1. (A74-33615 15-17) London, Metals Society, 1973, p. 96-100. 7 refs. Research supported by the Defence Research Board of Canada.

The influence of dispersoid parameters, microstructure, and crystallographic texture on the room temperature and high temperature properties of dispersion strengthened alloys is reviewed. The dependence of these variables upon thermomechanical processing is shown for the Ni/ThO₂, Ni/Cr/ThO₂ and Ni/Cr/Al/ThO₂ systems. Deformation and annealing processes are studied and mechanical properties and oxidation resistance are determined at temperatures up to 2200 F. The application of this work to the production of DS nickel and DS nickel-chromium in the form of sheet and extrusions for high temperature aircraft turbine engine components is described. (Author)

A74-33682 * # New materials in the aerospace industries. J. J. Gangler (NASA, Washington, D.C.). In: The microstructure and design of alloys; Proceedings of the Third International Conference on the Strength of Metals and Alloys, Cambridge, England, August 20-25, 1973. Volume 2. London, Metals Society, 1973, p. 237-269. 13 refs.

Trends in the development of new aerospace metals and alloys are reviewed, and applications of these advanced materials in nonaerospace fields are indicated. Emphasis is placed on the light metals and the high-temperature alloys. Attention is given to the properties and uses of the high-strength aluminum alloy 7050, alpha and beta titanium alloys, dispersion strengthened superalloys, metal-metal composites, eutectic superalloys, and coated columbium alloys. T.M.

A74-33733 Effects of yaw on a Gothic wing at supersonic speeds. K. Y. Narayan (Cambridge University, Cambridge, England). *Aeronautical Quarterly*, vol. 25, May 1974, p. 119-128. 7 refs. Research supported by the Ministry of Defence.

Results are presented of an experimental study of the pressures on the flat windward surface of a Gothic wing at a free-stream Mach number of 3.5 and at moderately high angles of attack, including the effects of yaw. The results show that the perturbation in pressure due to yaw is almost independent of the streamwise distance from the vertex. As a result, it has been possible to calculate the pressure distribution on the yawed wing using the appropriate yawed conical wing results, the zero yaw results being calculated by the 'equivalent' delta wing method. The calculations show reasonable agreement with the experiments and confirm that the perturbation due to yaw generates a stabilizing rolling moment. (Author)

A74-33768 * Digital system identification and its application to digital flight control. S. Kotob and H. Kaufman (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Symposium on Nonlinear Estimation Theory and Its Applications, 4th, San Diego, Calif., September 10-12, 1973, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1974, p. 175-178. Grant No. NGR-33-018-183.

On-line system identification of linear discrete systems for implementation in a digital adaptive flight controller is considered by the conventional extended Kalman filter and a decoupling process in which the linear state estimation problem and the linear parameter identification problem are each treated separately and alternately. Input requirements for parameter identifiability are established using the standard conditions of observability for a time variant system. Experimental results for simulated linearized lateral aircraft motion are included along with the effect of different initialization and updating procedures for the priming trajectory used by the filter. (Author)

A74-33778 Application of nonlinear estimation theory to parameter identification of rigid and elastic aircraft. W. R. Wells (Cincinnati, University, Cincinnati, Ohio) and R. C. Schwanz (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Symposium on Nonlinear Estimation Theory and Its Applications, 4th, San Diego, Calif., September 10-12, 1973, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1974, p. 363-366. 6 refs.

The maximum likelihood method is discussed in the identification of unknown parameters in an assumed nonlinear aerodynamic model for rigid aircraft. Also aeroelastic stability and control parameters are defined and shown to consist of the usual 'rigid' airplane stability and control derivatives as well as those associated with generalized mass, stiffness and damping and forces due to rotational and translational elastic distortion. (Author)

A74-33811 # Minimum time and minimum fuel flight path sensitivity. M. A. Nichols (USAF; Arizona State University, Tempe, Ariz.) and J. K. Hedrick (Arizona State University, Tempe, Ariz.). *Journal of Aircraft*, vol. 11, June 1974, p. 320-325. 13 refs.

The sensitivity of minimum-time and minimum-fuel flight paths to variations in aircraft parameters in different atmospheric conditions was investigated using the energy state approximation. Numerical results are presented for a typical supersonic aircraft in Standard-Day, Hot-Day, and Cold-Day atmospheres. This paper shows how flight time and fuel consumption are affected by changes in thrust, weight, drag coefficients, and specific fuel consumption in each of three different atmospheric conditions. For each variation, the effect on performance (flight time or fuel consumption) is determined for the nominal paths. Then for each variation, the flight path is adjusted to be either time optimal or fuel optimal. (Author)

A74-33812 # Aircraft 4-D constant velocity control system. E. C. Foudriat (Marquette University, Milwaukee, Wis.). *Journal of Aircraft*, vol. 11, June 1974, p. 326-333. 7 refs.

A 4-D system for sequencing of aircraft in a traffic controlled environment is developed. A closed-form approximation for determination of the constant airspeed necessary to fly a fixed ground path consisting of straight line and constant radius arc segments is shown to have accuracy of better than 0.1%. Heading and bank angle required on the turns are also computed. These calculations are used as commands to an aircraft and are periodically updated to provide for elimination of errors accumulated during flight. The concept is capable of being implemented over a broad spectrum of aircraft under active control from those with full RNAV autopilots, to those under radar vector control where commands are relayed verbally from a traffic controller. The system capability is demonstrated in a simulation of a modern transport aircraft with a typical autopilot

and auto throttle, navigation information, and computer to process the command equations. Sequencing accuracies within a few seconds are obtained when the aircraft is subjected to combined unsteady winds (gusts) and errors in the knowledge of the steady wind conditions. (Author)

A74-33813 # Stability and control of hingeless rotor helicopter ground resonance. M. I. Young and D. J. Bailey (Delaware University, Newark, Del.). *Journal of Aircraft*, vol. 11, June 1974, p. 333-339. 21 refs. Grant No. DA-ARO(D)-31-1247-G112.

The ground resonance instability of advanced helicopters employing hingeless rotors is examined on a broad parametric basis, and a variety of conditions affording inherent stability are determined. Moderate levels of blade internal structural damping in conjunction with typical landing gear damping and stiffness characteristics are shown to be highly effective. This is shown to be a consequence of the offsets of the virtual flapping and lead-lag hinges together with the tuning of the elastically flapping and lead-lagging blades of a hingeless rotor system. Closed-loop stabilization of the ground resonance instability is considered by using a conventional helicopter swash-plate-blade cyclic pitch control system in conjunction with roll, roll rate, pitch, and pitch rate sensing. (Author)

A74-33815 # Comment on 'A finite-element method for calculating aerodynamic coefficients of a subsonic airplane'. W. P. Rodden (Virginia Polytechnic Institute and State University, Blacksburg, Va.), J. P. Giesing, T. P. Kalman, and J. C. Rowan (Douglas Aircraft Co., Long Beach, Calif.). *Journal of Aircraft*, vol. 11, June 1974, p. 366, 367; Author's Reply, p. 367, 368. 18 refs.

The contention of Hua (1973) that the 'existing methods for predicting aerodynamic coefficients are not very satisfactory' is disputed, at least at subsonic speeds, and comments are presented for helping distinguish 'between the real and the imaginary problems that remain'. In replying to his critics, the author recognizes that several points in his original paper require further elaboration and discusses them, accordingly. M.V.E.

A74-33820 # The filtration of oil in modern aircraft installations. II (Filtracja oleju w wspolczesnych instalacjach lotniczych. II). J. Zmihorski (Instytut Lotnictwa, Warsaw, Poland). *Technika Lotnicza i Astronautyczna*, vol. 29, May 1974, p. 28-30. 14 refs. In Polish.

Discussion of the effect of impurities on the lifetime and reliability of operation of hydraulic systems used for the filtration of oil, including an analysis of how and where to position the filters. A detailed account is given of the criteria for selecting filters which would ensure accurate filtration, and attention is paid to the factors governing the filtration quality and the reliability of operation of the entire system. A.B.K.

A74-34145 # Alloys for helicopter rotor-blade spars (Splavy dlia lonzheronov lopastei vertoletov). E. I. Kutaitseva, V. S. Komissarova, I. V. Butusova, and N. V. Egorova. *Metallovedenie i Termicheskaja Obrabotka Metallov*, no. 5, 1974, p. 15-18. In Russian.

The AVT1 and AD33T1 alloys of the Al-Mg-Si system currently used in hollow spars of helicopter rotor blades, and a new V91T1 alloy of the Al-Zn-Mg-Cu system were studied by electron microscopy and in fatigue tests in air and in a 0.001% NaCl solution. The V91T1 alloys were found to exhibit the best fatigue and corrosion strength. The test data are tabulated and electron microphotographs are presented. V.P.

A74-34208 Sonic boom of supersonic aircraft (Le bang des avions supersoniques). C. Thery (Institut Franco-Allemand de Recherches, Saint-Louis, Haut-Rhin, France). In: *Shocks and shock waves. Volume 2 - Technical applications.* Paris, Masson et Cie., Editeurs, 1973, p. 66-116. 43 refs. In French.

The discussion is centered on the physical phenomenon, rather than on its analytical and numerical treatment. The conditions leading to sonic boom are studied on the basis of simple examples. The influence of shock and atmosphere parameters on the propagation of sonic boom is analyzed, along with the effects which may enhance the boom intensity. Certain in-flight measurement data that are still not amenable to theoretical interpretation are examined. Means of reducing boom intensity are discussed. V.P.

A74-34287 # How Eastern Airlines uses nondestructive evaluation to assure quality of specific jet engine hardware. V. J. Erdeman (Eastern Air Lines, Inc., Miami, Fla.). In: *Symposium on Nondestructive Evaluation, 9th, San Antonio, Tex., April 25-27, 1973, Proceedings.* San Antonio, Tex., Southwest Research Institute, 1973, p. 106-117. 5 refs.

Nondestructive evaluation methods are used by the airline to determine the quality of parts returning from service, to investigate repair requirements, and to assure the quality of parts after repair. Methods best suited for the particular application involved are selected in each case. In the case of the examination of a fan blade, for instance, an internal ultrasonic shear wave technique had to be used because an ultrasonic surface wave method and a fluorescent penetrant approach did not provide information about required subsurface characteristics. G.R.

A74-34288 # Nondestructive testing of aircraft wheels at Eastern Airlines. C. W. Bussey, D. M. Coston, and R. L. Pasley (Eastern Airlines, Inc., Miami, Fla.). In: *Symposium on Nondestructive Evaluation, 9th, San Antonio, Tex., April 25-27, 1973, Proceedings.* San Antonio, Tex., Southwest Research Institute, 1973, p. 118-126.

A description is provided concerning a new immersion ultrasonic system developed for inspecting aircraft wheel halves. The inspection system consists of four major parts, including the frame, the immersion tank, the turntable and centering mechanism, and the manipulator with the electronics. The immersion method is found to be faster and more repeatable than the contact method. However, the new method requires a larger initial investment for the equipment involved. G.R.

A74-34290 # Acoustic emissions used to nondestructively determine crack locations in aircraft structural fatigue specimen. C. D. Bailey and W. M. Pless (Lockheed-Georgia Co., Marietta, Ga.). In: *Symposium on Nondestructive Evaluation, 9th, San Antonio, Tex., April 25-27, 1973, Proceedings.* San Antonio, Tex., Southwest Research Institute, 1973, p. 224-232. 5 refs.

The investigation reported demonstrates that acoustic emission monitoring techniques can be used for many applications involving the inherently noisy aircraft structure. The acoustic emission detection system used in the investigation consisted of a flaw locator with two input channels, an x-y oscilloscope and an x-y plotter. The flaw locator has a digital memory with 1000 locations. Good correlation was found between the results of acoustic emission monitoring and metallurgical investigations. G.R.

A74-34294 # Electromagnetic proof stressing of bonded airplane structure. I. G. Hendrickson, K. A. Hansen, and J. W. Norbury (Boeing Co., Seattle, Wash.). In: *Symposium on Nondestructive Evaluation, 9th, San Antonio, Tex., April 25-27, 1973, Proceedings.* San Antonio, Tex., Southwest Research Institute, 1973, p. 362-374. 6 refs.

An adhesive bond strength test method based on electromagnetic induction led to the design and fabrication of an electromagnet proofload (EMPL) test system. An evaluation of the system has produced valuable data and answered some very significant questions. This paper reviews theory and method of operation and discusses calibration of the system to achieve repeatable applied stresses on various bonded structures, maximum stress levels achievable on bonded skins up to .063 inch thick, the results of testing a bonded structure to failure, the detection of failed areas, and laboratory techniques used in the investigation. A production test unit as presently conceived is described along with proposed applications. (Author)

A74-34320 # The calculation of subsonic and transonic turbulent boundary layers on an infinite yawed airfoil. J. C. Adams, Jr. (ARO, Inc., von Karman Gas Dynamics Facility, Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-557*. 19 p. 43 refs. Members, \$1.50; nonmembers, \$2.00. USAF-sponsored research.

Formulation and application of a three-dimensional compressible turbulent boundary-layer analysis is presented for subsonic and transonic flow over a yawed airfoil of infinite extent. The governing turbulent boundary-layer equations are integrated using an implicit finite-difference procedure in conjunction with a scalar eddy viscosity model of three-dimensional turbulence. Comparisons with other analysis techniques as well as experimental measurements under subsonic wind tunnel conditions are presented to establish and ascertain the basic validity and applicability of the current technique. Also considered are the effects of a hot wall on the transonic, three-dimensional, turbulent boundary layer which have practical application to transonic Space Shuttle reentry, where the wing surface temperature may reach soak values on the order of twice the free-stream stagnation temperature because of the hypersonic high-heating phase of the reentry trajectory. (Author)

A74-34332 * # Preliminary measurements of aircraft aerodynamic noise. P. L. Lasagna and T. W. Putnam (NASA, Flight Research Center, Edwards, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-572*. 8 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

Flight measurements of aerodynamic noise were made on an AeroCommander airplane with engines off and a JetStar airplane with engines at both idle power and completely shut off. The overall sound level for these airplanes in the landing configuration varied as the sixth power of the aircraft velocity. For the JetStar airplane, the overall sound level decreased as the inverse square of the distance in the lateral direction. The aerodynamic noise was approximately 11 decibels below the FAR Part 36 noise level for the JetStar airplane. The landing gear were a significant contributor to aerodynamic noise for both aircraft. (Author)

A74-34352 Nonlinear generation of secondary waves in fluids. J. E. Ffowcs Williams (Cambridge University, Cambridge, England). In: *Finite-amplitude wave effects in fluids; Proceedings of the Symposium, Danmarks Tekniske Højskole, Copenhagen, Denmark, August 20-22, 1973*. (A74-34351 16-23) Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1974, p. 9-18. 6 refs. Research sponsored by Rolls-Royce (1971), Ltd.

Possible causes of the short-duration peaks which are characteristic of continuous random-noise pressure fields produced by high-powered jet aircraft are analyzed. Nonlinear radiation from a spherical source, with acoustic scales much larger or much smaller than the source diameter, and acoustic radiation from a nonlinearly pulsating spherical surface are studied in an attempt to determine the origin of such peaks. It is concluded that nonlinear near-field effects in sound produced by compact sources may be responsible for some

of the anomalies which are detected in experimental studies of jet noise. V.Z.

A74-34699 # Stall/spin seventy years later. R. J. Woodcock and T. J. Cord (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Air University Review*, vol. 25, May-June 1974, p. 25-36. 20 refs.

A sketch of past and present approaches to aircraft spin and stall problems is given. Despite the long standing of stall/spin problems, loss of control at high angle of attack is a major factor in the accident rates of current fighter aircraft such as the F-4 and F-111. Systematic design data for high angle of attack do not exist; in fact, even aerodynamic force and moment data on specific configurations of interest are sparse. Precise working definitions are given for stall, post-stall gyration, and spin. Generally, post-stall design and testing have emphasized spins and spin recovery, but emphasis needs to shift to departure resistance and early recovery. A short description of various areas of technology being developed to minimize the high-angle-of-attack problem is then given. Studies under way or planned entail fundamental flow theory including viscid-inviscid interaction, with highly instrumented wind-tunnel models to provide data and validation. Also, new dynamic model mounts are in prospect for wind-tunnel testing, and free-flight models are being improved at both ends of the cost spectrum. P.T.H.

A74-34761 Interactive computer graphics application of the bi-cubic parametric surface to engineering design problems. G. J. Peters (McDonnell Douglas Automation Co., St. Louis, Mo.). In: *National Computer Conference and Exposition, Chicago, Ill., May 6-10, 1974, Proceedings*. Montvale, N.J., AFIPS Press, 1974, p. 491-511. 21 refs.

Parametric cubic (PC) curves and patches are unique among mathematical forms for their broad applicability to problems of engineering design. The use of PC curves in interactive computer inclusion in black box devices. The progression from clapper type relays to hermetically sealed relays and the gain in performance attendant on the introduction of balanced armature and balanced force type relays are described. Emphasis is placed on the standardization of all relays used in a given type of aircraft, and it is suggested that the responsibility for testing and developing new relays be borne by the manufacturers. J.K.K.

A74-34775 Application and design of relays for commercial aircraft. R. J. Zimmerman and N. L. Hug (Douglas Aircraft Co., Long Beach, Calif.). In: *International Relay Conference, 3rd and National Relay Conference, 22nd, Stillwater, Okla., April 30-May 1, 1974, Proceedings*. Scottsdale, Ariz., National Association of Relay Manufacturers, 1974, p. 26-1 to 26-6.

The history of aircraft relays in use at Douglas Aircraft is reviewed from the era of the DC-3 to the present. The natural division of relays into the categories of large contactors, general purpose relays, miniature relays, and special purpose relays is noted, and attention is focused on the improved reliability and greater sophistication of the miniature type relays manufactured for inclusion in black box devices. The progression from clapper type relays to hermetically sealed relays and the gain in performance attendant on the introduction of balanced armature and balanced force type relays are described. Emphasis is placed on the standardization of all relays used in a given type of aircraft, and it is suggested that the responsibility for testing and developing new relays be borne by the manufacturers. J.K.K.

A74-34798 * # Geometry considerations for jet noise shielding with CTOL engine-over-the-wing concept. U. von Glahn, D. Groesbeck, and M. Reshotko (NASA, Lewis Research Center, V/STOL and Noise Div., Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Con-*

ference, 7th, Palo Alto, Calif., June 17-19, 1974, Paper 74-568, 40 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

Jet noise shielding benefits for CTOL engine-over-the-wing installations were obtained with various model-scale circular nozzles and wing chord geometries. Chord-to-nozzle diameter ratios were varied from 3 to 20, while ratios of nozzle height above the wing to the diameter were varied from near zero to 3. Spectral noise data were obtained with jet velocities from 640 to 1110 ft/sec. Characteristics of low frequency noise sources are discussed. Jet-noise shielding is correlated in terms of acoustic and geometric parameters. Implications of extending the model-scale data to full-scale are discussed. (Author)

A74-34799 System integration in business aircraft avionics. A. K. Wohlers (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 2-5, 1974, Paper 740346*. 9 p. Members, \$1.25; nonmembers, \$2.00.

There is an increasing need for improved efficiency in flight operations of business aircraft while preserving the operational flexibility that is essential to the business aircraft mission. The growing complexity of the air traffic control environment coupled with new regulatory demands has spawned the development of new avionic devices to meet the new requirements. These devices must be integrated into the avionic equipment complex in a manner that fits the normal pattern of pilot activity and does not increase his workload. The operational integration will result in less overall avionic system complexity, fewer interface compatibility problems, improved reliability, and lower cost of ownership. (Author)

A74-34800 * Low-speed aerodynamic characteristics of a 13.1-percent-thick, high-lift airfoil. K. R. Sivier, A. I. Ormsbee, and R. W. Awker (Illinois, University, Urbana, Ill.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 2-5, 1974, Paper 740366*. 38 p. 14 refs. Members, \$1.25; nonmembers, \$2.00. Grant No. NGR-14-005-144.

Experimental study of the low-speed, sectional characteristics of a high-lift airfoil, and comparison of these characteristics with the predictions of the theoretical methods used in the airfoil's design. The 13.1% thick UI-1720 airfoil was found to achieve the predicted maximum lift coefficient of nearly 2.0. No upper-surface flow separation was found below the stall angle of attack of 16 deg; it appeared that stall was due to an abrupt leading-edge flow separation. (Author)

A74-34801 Flight test results for an advanced technology light airplane wing. D. L. Kohlman (Kansas, University, Lawrence, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 2-5, 1974, Paper 740368*. 21 p. 6 refs. Members, \$1.25; nonmembers, \$2.00.

Flight test results are reported for a Cessna Cardinal single-engine light airplane modified by the installation of advanced technology wings incorporating reduced-area Fowler and Kruger flaps and spoilers for roll and flight-path control. Comparisons with the unmodified airplane show increased cruise speeds, smoother ride in turbulence, and major increases in maximum lift coefficient. Excellent roll control is achieved with spoilers. Several design features incorporated in the new wings show considerable promise for incorporation in future light airplanes. (Author)

A74-34837 Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. Symposium sponsored by the Society of Flight Test Engineers. California, Md., Society of Flight Test Engineers, 1973. 144 p. \$20.

The papers deal with advances in the state of the art of flight testing and with improved techniques developed to meet the challenge of growth and evolution in this field. They cover such areas as performance evaluation, flight and handling qualities testing, evaluation of the performance and flying qualities of aircraft and helicopter systems, determination of instrument flight capability, mathematical modeling of rotary wing aircraft, simulation of flight control systems, and data management during aircraft performance tests and evaluations.

Individual items are announced in this issue.

V.P.

A74-34838 # Air-to-air tracking techniques to evaluate aircraft handling qualities. B. L. Schofield and D. L. Franklin (USAF, Flight Test Center, Edwards AFB, Calif.). In: *Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973*. California, Md., Society of Flight Test Engineers, 1973. 7 p.

A flight study aimed at the development of handling qualities testing using tracking test techniques is described. Three air-to-air maneuvers were found to be useful in evaluating closed loop handling properties. These are the wind-up (increasing g) turn, the constant-angle-of-attack turn, and the reversal maneuver. All maneuvers were performed using a fixed gunsight, with the reticle only slightly depressed to avoid jet-wake encounters from the target aircraft. The tracking wind-up turn was found to be particularly useful for problem identification; it proved possible to quickly cover large ranges of angle of attack at a specific Mach number. V.P.

A74-34839 # Flight evaluation of four low airspeed indicating systems. F. L. Dominick and B. H. Boirun (U.S. Army, Aviation Systems Test Activity, Edwards AFB, Calif.). In: *Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973*. California, Md., Society of Flight Test Engineers, 1973. 8 p.

A summary of helicopter flight evaluations conducted on four different low-air-speed vector indicating systems from June 1971 to July 1973 is presented. The systems tested were the Aeroflex TAVS (True Airspeed Vector System), the J-TEC system, the Elliott LASSIE II, and the LORAS II (developed at the Cornell Aeronautical Laboratory). TAVS was chosen as the best compromise concerning technical feasibility, schedule, and costs. The characteristics of each system are outlined. V.P.

A74-34840 # Inflight thrust and base pressure survey on the A-7 airplane. W. C. Schaeper (LTV Aerospace Corp., Vought Systems Div., Dallas, Tex.). In: *Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973*. California, Md., Society of Flight Test Engineers, 1973. 5 p.

The flight test program described was planned to define the base pressure influence parameters and to quantify the base pressure/thrust interface. The aircraft used was a A-7E with a TF41-A-2 engine installed. Data were obtained from stabilized and quasi-stabilized maneuvers. The quasi-stabilized maneuvers proved very effective, and were essential in isolating the control parameters. The data obtained are diagrammed and analyzed. V.P.

A74-34841 # The use of a navigation platform for performance flight testing. J. N. Olhausen, Jr. (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). In: *Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973*. California, Md., Society of Flight Test Engineers, 1973. 5 p.

Some theoretical and practical aspects of the use of navigation platforms as instrumentation inertial reference sets (IIRS) for performance flight testing are examined, with particular reference to high-performance aircraft. It is shown that to make the most of the IIRS potential, great care should be given to such matters as the selection of the platform and computer; the location of the IIRS in the aircraft; the interfacing between it and other onboard and ground equipment; and the structuring of the data analysis procedures required to reduce the data to good performance information. V.P.

A74-34842 # Survivable flight control system Fly-by-Wire flight testing. J. E. Hunter (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 6 p. 5 refs.

The Fly-by-Wire (FBW) portion of the Survivable Flight Control System (SFCS) Program is described. The program was aimed at developing a highly reliable flight control system, involving improvements in handling qualities, stability and performance, and weapon delivery accuracy. It is shown how the program's flight testing provided design criteria, reliability, cost and maintenance data, specification requirements, and the confidence level required for installation of an advanced flight control system in future aircraft. The quadruply redundant dispersed three-axis FBW primary flight control system allows the pilot to command aircraft motion, rather than the conventional control surface position. It is seen that the SFCS configuration will greatly reduce combat losses due to flight control damage. V.P.

A74-34843 # Performance considerations for terrain following flight. R. E. Willis (USAF, Flight Test Center, Edwards AFB, Calif.) and S. A. Ball, Jr. (General Dynamics Corp., St. Louis, Mo.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 6 p.

A digital computer simulation developed for the terrain following radar (TFR) installed in the F-111 high-performance penetrator aircraft is described. The computer simulation includes a complete representation of the TFR and flight control systems and of the aerodynamic forces, thrust, fuel flow, airframe dynamics, and atmospheric properties. A block diagram of the simulation is given and discussed. V.P.

A74-34844 # Energy management display. D. C. Sederstrom, R. C. McLane (Honeywell, Inc., Minneapolis, Minn.), and W. M. Branch (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p. Contract No. N00014-72-C-0194.

A research program in the field of energy management (efficient use of an aircraft's energy resources), aimed at developing a display suitable for exploring the areas of performance calibration, energy maneuverability, throttle-setting aids, efficient establishment of steady-state flight conditions, and similar flight research areas is described. The program led to the development of an energy/energy rate meter, whose theory of operations and applications is described. The results of flight tests conducted to evaluate the accuracy and utility of this relatively simple display concept are examined. V.P.

A74-34845 # The shock adjustment concept - A new method for improved supersonic air data sensing. R. E. Rose (Honeywell Systems and Research Center, Minneapolis, Minn.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 10 p. 7 refs.

A pressure probe configuration is discussed that allows shock wave adjustment and swallowing to optimize the accurate measurement or determination of total and static pressure in supersonic flow. Static pressures are measured along the internal side walls of the probe. By proper valve setting, the normal shock portion of the detached bow shock wave can be positioned at the tube inlet or swallowed within the tube when the internal side walls are aligned parallel to the flow direction. Some preliminary experimental results obtained using simple shock positioning models have indicated the feasibility of the method. The shock position can be controlled. However, it is shown that probe configuration design is extremely important for satisfactory probe performance. (Author)

A74-34846 # Flight test evaluation of a low cost electrostatic autopilot. C. D. Wandrey and D. K. Bergstrom (Lear Siegler, Inc., Astronics Div., Santa Monica, Calif.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p.

The test and evaluation program described was conducted to gain insight into the concept of a simple RPV autopilot, and to obtain practical experience in its application. The test system is described and its theory is outlined. Particular attention is given to the solution of the major problems encountered in the program. Conclusions of recommendations derived from the test data are presented. V.P.

A74-34847 # Are existing nav aids adequate for commercial STOL operations in coming STOL environments. D. W. Faris (Lockheed-Georgia Co., Marietta, Ga.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p. U.S. Department of Transportation Contract No. TSC-379.

Synopsis of a Department of Transportation flight test program investigating the adequacy of existing nav aids for typical STOL and Short Haul operations. Although many data had been previously collected to determine nav aid coverage and possible navigational accuracies for conventional aircraft, little information was available relative to STOL operations in typical STOL environments. The DOT Transportation Systems Center designed and developed an STOL navigation and Guidance System to provide both 3-dimensional navigation guidance and a data acquisition capability for VOR, DME and LORAN 'C' nav aids. The system was installed in the NASA Convair 340 Flying Laboratory and the program was completed in a total of 53 flights for 145 hours and 45 minutes between May 18, 1972 and Sept. 29, 1972. (Author)

A74-34848 # Determining helicopter instrument flight capability. R. B. Lewis, II (U.S. Army, Aviation Systems Test Activity, Edwards AFB, Calif.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p. 8 refs.

Two U.S. Army Aviation Systems Test Activity (USAASTA) test programs conducted to study the instrument flight capability of the OH-58A and OH-6A light observation helicopters are described. The test results obtained with each helicopter are analyzed. Among the topics discussed are helicopter stability and control requirements, qualitative evaluation of handling qualities, measurement of pilot workload, and determination of helicopter flight path accuracy. The data obtained emphasize the importance of stability and control in the determination of instrument flight capability. Other factors of importance include crew requirements, displays, cockpit environment, mission requirements, navigation and guidance, and subsystem performance and reliability. V.P.

A74-34849 # CC-115 Buffalo aircraft engine and engine inlet duct anti-icing system evaluation trials. T. J. Brideau (Aerospace Engineering Test Establishment, Ottawa, Canada). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las

Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p.

Modifications introduced to the CT 64-820-1 (T64-GE-13) turboprop engine to prevent engine compressor stalls (resulting in engine flameouts) while operating under light icing conditions are described. The inlet duct anti-icing system was redesigned to include two bleed outlets from the intake lip with the purpose of directing hot air to the area above the intake lip and to the oil cooler inlet located below the intake lip. An intake lip bypass line was installed to increase the quantity and minimize the temperature drop of the airflow to the duct. Further modifications included a manifold to supply extra heat to the rear portion of the duct, a special duct insulating material, and a redesigned airflow regulator. To permit even better airflow to the system, the airflow regulator will be replaced by a new regulator valve. V.P.

A74-34850 # Development and flight test of a radio controlled ornithopter prototype. G. Bennett (Mississippi State University, State College, Miss.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p. Research supported by the Mississippi State University; NSF Grant No. GK-27795.

Description of a radio-controlled ornithopter model developed with the objective to create the largest possible vehicle using readily available components, with a wing and drive mechanism for testing both flapping and twisting motions, and an automobile chassis permitting a tethered flight with a maximum possible number of degrees of freedom. A large tail volume was chosen to suppress pitching motions due to wing flapping and to ensure stability. A twin spar wing was constructed with the ribs hinged about the main spar to achieve the simultaneous wing flapping and twisting motions. The wings were covered with natural rubber sheeting to allow wing surface distortion with wing twist. Several flapping wing flight attempts have been made with the ornithopter. More experimentation is required to evaluate the performance of the ornithopter in flapping flight. V.Z.

A74-34851 # Simulation and flight test evaluation. W. L. Young (USAF, Washington, D.C.) and A. J. Welch (American Nucleonics Corp., Woodlands Hill, Calif.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p.

The present work gives a general description of a 4-axis Pilot Assist System (PAS) which is undergoing evaluation for installation in an H-500 helicopter. The avionic equipment was designed to investigate control laws and modes required for precision hover, precision approach control to touchdown, gust alleviation, and vehicle stabilization, decoupling of basic modes, and maneuverability. Off-line analysis by means of analog and digital simulations was used to provide reference data for closed loop testing. P.T.H.

A74-34852 # 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., Washington, D.C.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 5 p.

High angle-of-attack rolling stability tests for a T-tail fighter in a wind tunnel indicate that the roll damping drops off abruptly and the roll-induced yaw increases negatively when the angle of attack on a model with a clean wing increases. Wing fences, slats and strakes produce a favorable effect on the roll damping and adverse yaw. Wing fences appear to be the simplest effective aerodynamic modification for increasing the roll damping at high angles of attack without degrading the longitudinal characteristics. Wing tip end plates, on the other hand, decreased the roll damping at angles of attack below the stall. V.Z.

A74-34853 # Piloted power approach simulation. G. J. Gerken (USAF, Aeronautical Systems Div., Washington, D.C.) and J. R. Stone (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. (A74-34837 16-02) California, Md., Society of Flight Test Engineers, 1973. 5 p.

A ground-based simulator was used in piloted simulation of the B-1 variable wingsweep bomber in order to evaluate its handling qualities during a power approach to landing. Nonlinear pitching moment characteristics, flight control system performance, pitch transients due to slat and flap deflection, and roll control with the flaps down were investigated by piloted simulation. A pilot model/air vehicle closed-loop analysis was also conducted to obtain predicted Cooper-Harper pilot ratings, pilot model parameters, and closed-loop pitch tracking error. It is believed that the B-1 will have acceptable handling qualities during a power approach after some flight control system tuning. V.Z.

A74-34854 # F-15 Eagle flight control system. E. H. McDonald (USAF, Aeronautical Systems Div., Washington, D.C.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 6 p.

It is pointed out that research and development work in the case of the F-15 included more than 500 hours of fixed and moving base simulator studies. Flight control system problems resolved during these studies are associated with high angles of attack, tracking, control forces, transients, and reliability. Qualification and flight tests have confirmed the correctness of the approach. The longitudinal control system is discussed together with aspects of lateral control, directional control, the automatic flight control system, the hydraulic system, the flap system, the control stick boost and pitch compensator, and the stabilator actuator. G.R.

A74-34855 # Implementation of the uniform flight test analysis system. C. van Norman (USAF, Flight Test Center, Edwards AFB, Calif.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 6 p.

The Uniform Flight Test Analysis System (UFTAS) is a modular system of computer programs for the engineering analysis of flight test data. UFTAS has the capability of calculating performance from climbs, level accelerations, turns, speed powers, and dynamic maneuvers such as roller coasters and windup turns. UFTAS is made up of several categories of programs related to system integration, data files, curve files, numerical analysis and utility, control, input, output, performance, and aircraft-specific software. G.R.

A74-34856 # Flight test applications and analysis of parameter identification techniques. R. A. Burton (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 11 p. 5 refs.

An overview is presented regarding a research program designed to develop airframe parameter identification technology for use in flight testing Navy aircraft. Specific applications for airframe parameter identification technology are presented in the areas of flying qualities research, determination of specification compliance, and aircraft landing systems. Attention is also given to preliminary analytical and flight test results. G.R.

A74-34857 # Data management during the Navy performance test and evaluation of the F-14A airplane. W. M. Branch (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las

A74-34858

Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 7 p.

The tasks of the Naval Air Test Center with regard to the F-14A performance include the evaluation of the total system performance and the provision of Navy flight test data to decision making agencies. Flight test data for the generation of performance charts for the fleet are also to be provided. The test aircraft and the employed instrumentation are discussed along with questions of test methodology and program management, aspects of data acquisition, and details concerning the test maneuvers. G.R.

A74-34858 # Tracking systems for flight development of today's commercial aircraft. P. D. Moore (Douglas Aircraft Co., Long Beach, Calif.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. California, Md., Society of Flight Test Engineers, 1973. 6 p.

In the development and demonstration of commercial aircraft performance, a significant requirement is precise position and velocity of the aircraft relative to the runway. Tracking systems currently in use for flight development are on-board camera systems, ground phototheodolite systems, and a newly developed laser tracker. Comparison of these systems is made based upon system studies as applied to DC-10 and DC-9 flight tests. Tracking system requirements are defined for development and demonstration tests of today's commercial aircraft. (Author)

A74-34874 Forgings for jet engines - More quality at less cost. E. F. Bradley and M. J. Donachie, Jr. (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Metal Progress*, vol. 106, July 1974, p. 80-82.

Discussion of the use of forging to obtain enhanced properties of materials used in gas turbine engine components. A process of microstructure control (by forging) used on nickel-based alloys is described in which a very fine grain size is developed, thus considerably improving fatigue strength. It is also shown how forging can be used to achieve energy storage in nickel-based alloys, thereby raising tensile properties while keeping adequate creep properties. A trend to near-net shape forging of disks to achieve cost savings and improved and more uniform mechanical properties is noted. Another improvement cited is beta forging of titanium to raise creep resistance and improve fracture toughness. A. B. K.

A74-34877 Certification of helicopters for flight in instrument meteorological conditions. H. E. Le Sueur (Civil Aviation Authority, London, England). *Aeronautical Journal*, vol. 78, May 1974, p. 185-187. 11 refs.

A74-34878 Westland design philosophy on the Lynx for instrument and all-weather flying. L. R. Moxam (Westland Helicopters, Ltd., Yeovil, Somerset, England). *Aeronautical Journal*, vol. 78, May 1974, p. 187-193.

A general description of the Lynx helicopter is given, followed by a more detailed discussion of the automatic flight control system, the anti-ice and de-ice systems, and navigation and approach aids. It is maintained that the Lynx can safely and easily operate in IMC conditions both in and out of controlled airspace. Indications for future developments are given. P.T.H.

A74-34879 The operation of the Bell 212 under instrument flight rules. M. C. Ginn (Irish Helicopters, Ltd., Dublin, Ireland). *Aeronautical Journal*, vol. 78, May 1974, p. 194-197.

The present work discusses some of the requirements which the Bell 212 helicopter had to meet in order to obtain clearance for IFR operation. Operation of the aircraft under IFR is briefly described along with pilot training procedures. Problems encountered in flight under icing conditions are discussed, and future needs for nav aids are indicated. P.T.H.

A74-34880 Requirements for the helicopter instrument rating. W. H. Perry (Civil Aviation Authority, London, England). *Aeronautical Journal*, vol. 78, May 1974, p. 200-203.

Guidelines are proposed for the introduction and operation of ratings for instrument flight in helicopters. Implementation of a rating system will involve testing knowledge, experience, and skill. Those temporary arrangements required to bring a new rating into force in an existing situation are also discussed. P.T.H.

A74-34881 A simplified approach to helicopter ground resonance. G. T. S. Done (Edinburgh, University, Edinburgh, Scotland). *Aeronautical Journal*, vol. 78, May 1974, p. 204-208. 8 refs.

A simplified model of the ground resonance instability phenomenon of helicopters is considered, in which the number of degrees of freedom is reduced to two. The basic parameters of the problem are retained without the complexity of the equations of motion which would arise in a fully representative description. Stability of the system in the regions for which the uncoupled system exhibits frequency crossing is examined. The minimum amount of damping needed for the suppression of ground resonance is found to depend in a simple way on the mass ratio and on the blade lag and chassis natural frequencies. P.T.H.

A74-34884 Glass windshields for wide bodied aircraft. W. G. Roberts (Triplex Safety Glass Co., Ltd., Birmingham, England). *Aeronautical Journal*, vol. 78, May 1974, p. 221-225.

The present work discusses an alternative in windshield construction design for transport aircraft, consisting of a multi-laminate glass construction, where the resistance to both bird-impact and pressurization is provided by two or more plies of tempered glass, with the interlayer holding the glasses together in an essentially nonstructural role. Impact and life test results are discussed. De-ice/de-mist capability can be provided by the recently developed Hyviz electroconductive coating, which is positioned in the laminated face of the outer Chemcor ply. P.T.H.

A74-34919 Low-weight, impact-resistant helicopter drive shafts. I. E. Figue (U.S. Army, Air Mobility Laboratory, Fort Eustis, Va.), J. Henshaw, P. A. Roy, and E. F. Olster (Avco Corp., Avco Systems Div., Lowell, Mass.). In: Composite materials: Testing and design; Proceedings of the Third Conference, Williamsburg, Va., March 21, 22, 1973. Philadelphia, Pa., American Society for Testing and Materials, 1974, p. 651-662.

In response to the need for weight savings without the sensitivity to low-energy impact, two composite metal hybrid helicopter drive shafts have been designed and tested. These are constructed with unidirectional (parallel to the tube axis) boron epoxy composite, for increasing the flexural stiffness, sheathed with an inner and outer metal tube, for torsional strength and damage resistance. The hybrid drive shaft is considered to have a significant weight savings potential. As compared to an all-aluminum drive shaft, its specific flexural stiffness is increased by a factor of 2.6 and its specific critical buckling stress by a factor of 1.5. As compared to an all-boron epoxy drive shaft, its specific flexural stiffness is approximately equal and the critical buckling stress is reduced by 40%. In addition to the advantage of impact resistance, the hybrid designs offers the advantage of metal-to-metal attachment with conventional splicers and nuts and bolts. (Author)

A74-34929 F-14, A-6 assembly woes seen easing. W. H. Gregory. *Aviation Week and Space Technology*, vol. 100, July 1, 1974, p. 34-38.

Evaluation of the current state of Navy F-14 and A-6 aircraft assembly and delivery schedules at the Grumman Calverton facility indicates an improvement of the production cost and output situation in the final stage of the assembly process. The efforts made to correct the crisis situation which existed heretofore are reviewed. V.Z.

A74-34975 * A perspective on short-haul STOL. L. V. Malthan (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740503*. 9 p. Members, \$1.40; nonmembers, \$2.25. Contract No. NAS2-6994.

Discussion of the basic incentives motivating the development of the short-haul STOL air transportation system. The technological impact on the aircraft and its related economics required to achieve short field performance is generally detrimental. Considerations such as wing and empennage sizing, engine thrust sizing and cycle selection, thrust reverser requirements, cruise Mach number effects, noise, and fuel usage impacts are discussed. The direct operating economics are adversely affected, although it is thought that the indirect costs can be correspondingly reduced. A study of the total operating costs of the short-haul system and its related fare structure indicates that a definite potential exists for the evolution of an economically viable system yielding positive returns on investment to the operators. It is concluded that this potential is sufficient to warrant more detailed studies of these economics and the alternative implementation schemes. (Author)

A74-34976 The effect of runway traction on commercial airplane stopping systems. B. C. Hainline and N. S. Attri (Boeing Commercial Airplane Co., Renton, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740500*. 11 p. 9 refs. Members, \$1.40; nonmembers, \$2.25.

Traction variations with runway contaminants, ice, snow, and rain must be considered along with factors such as airplane and stopping system configuration, weather conditions, performance information, and pilot technique. Further improvements in airplane braking and directional control can be attained if certification and operational regulations provide performance credit, safety, and economic motivation for airline cost of ownership. Recent Boeing brake control system work is summarized as an indication of industry effort to improve performance. Technology requirements and recommendations for improving adverse runway performance are included. (Author)

A74-34977 Impact of increasing secondary power requirements on engine and accessory system design. J. W. Jongeneel and R. T. Kawai (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740495*. 6 p. Members, \$1.40; nonmembers, \$2.25.

Future transport aircraft secondary power requirements can be expected to increase due to advancements that utilize additional pneumatic, hydraulic, and electric power. The power requirement trends are reviewed, and possible alternative approaches for future secondary power generation installations are suggested. Airline ideas and comments are solicited to enable early incorporation into technology development programs. (Author)

A74-34978 Flight/propulsion control integration aspects of energy management. M. J. Wendl, G. G. Grose, J. L. Porter, and V. R. Pruitt (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740480*. 17 p. Members, \$1.40; nonmembers, \$2.25. Contracts No. F33615-71-C-1144; No. F33615-73-C-3130; No. F33615-72-C-1163.

Analytical studies indicate substantial aircraft performance benefits can result from proper application of energy management principles, and that conceptual approaches involving close coupling of aerodynamic, propulsion, and control technical elements are required to achieve these benefits. Analytic tools used in these studies include a modified Rutowski technique for simultaneously optimizing throttle position and flight path. Pilot-in-the-loop simulation results are presented and the use of advanced pilot displays utilizing energy management techniques are described. (Author)

A74-34981 * Sonic inlet technology development and application to STOL propulsion. F. Klujber and J. V. O'Keefe (Boeing Commercial Airplane Co., Renton, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740458*. 7 p. Members, \$1.40; nonmembers, \$2.25. NASA-supported research.

Recent developments in sonic inlet technology are presented with particular emphasis on STOL propulsion systems. Inlet noise reduction requirements are considered for an augmentor wing and an upper surface blowing type of propulsion system. The current state of the art is discussed with respect to performance and noise potential of different sonic inlet concepts. An acoustic and aerodynamic performance comparison is presented for several inlet configurations based on experimental results. (Author)

A74-34982 * New design and operating techniques for improved terminal area compatibility. J. P. Reeder, R. T. Taylor, and T. M. Walsh (NASA, Langley Research Center, Hampton, Va.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740454*. 70 p. 9 refs. Members, \$1.40; nonmembers, \$2.25.

Current aircraft operating problems that must be alleviated for future high-density terminal areas are safety, dependence on weather, congestion, energy conservation, noise, and atmospheric pollution. The microwave landing system (MLS) under development by FAA provides increased capabilities over the current ILS. It is, however, necessary and urgent to develop the airborne system's capability to take maximum advantage of the MLS capabilities in order to solve the terminal area problems previously mentioned. A major limiting factor in longitudinal spacing for capacity increase is the trailing vortex hazard. Promising methods for causing early dissipation of the vortices are being explored. Also, flight procedures for avoiding the hazard will be explored. (Author)

A74-34983 * Propulsion system sizing for powered lift and mechanical flap quiet aircraft. J. V. Bowles, T. L. Galloway, and M. H. Waters (NASA, Ames Research Center, Moffett Field, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740455*. 35 p. 9 refs. Members, \$1.40; nonmembers, \$2.25.

A method of propulsion system sizing for mechanical flap and externally blown flap aircraft is demonstrated. Included in this study is the effect of various levels of noise suppression on the aircraft final design characteristics. Both aircraft are sized to operate from a 3000-ft runway and perform the same mission. For each aircraft concept, propulsion system sizing is demonstrated for two different engine cycles - one having a fan pressure ratio of 1.5 and a bypass ratio of 9 and the other having a fan pressure ratio of 1.25 and a bypass ratio of 17.8. The results presented include the required thrust to weight ratio and wing loading and the resulting gross weight and direct operating costs as functions of the engine noise level for each of the four combinations of engine cycles and aircraft concepts. (Author)

A74-34984 ACLS for a commercial transport. T. D. Earl (Bell Aerospace Co., Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740452*. 31 p. 13 refs. Members, \$1.40; nonmembers, \$2.25.

The application of an air cushion landing system (ACLS) to a commercial transport is considered. An example aircraft based on a modified configuration of a Boeing 737-100 is used to derive weight and cost figures. The effect on takeoff and landing field lengths due to use of a suction braking system is analyzed. Comparative safety of ACLS versus wheel gear is argued. It is concluded that an ACLS aircraft can show economic and cost advantage and that its operational differences are acceptable within the existing and developing air transport system. (Author)

A74-34985 Application of hydrogen to commercial transports. D. L. Kelly (Lockheed-California Co., Burbank, Calif.).

A74-34986

Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740451. 9 p. Members, \$1.40; nonmembers, \$2.25.

A design analysis of the conversion of an in-production wide-bodied transport to hydrogen fuel is presented. Comparisons are drawn between storage of hydrogen in the fuselage and storage in wing-external tanks. Required structural modifications are defined and costed, and a preferred configuration is selected on the basis of direct operating cost. It is shown that a conversion of a jet fueled wide-bodied transport to hydrogen fuel is technically and economically feasible, provided that it is preceded by a long-life tankage and insulation development. The preferred configuration has the hydrogen stored in pylon-mounted tanks above the wings. Flyaway cost of the hydrogen fueled conversion is 8 percent greater than that of the baseline jet fueled transport. M.V.E.

A74-34986 Improved methods for construction and maintenance of runway pavement surfaces. T. H. Morrow (FAA, Engineering Div., Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740498.* 10 p. 16 refs. Members, \$1.40; nonmembers, \$2.25.

A74-34987 Impact of runway traction on possible approaches to certification and operation of jet transport aircraft. L. R. Merritt (FAA, Flight Standards Service, Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740497.* 29 p. 10 refs. Members, \$1.40; nonmembers, \$2.25.

A74-34988 * Elements affecting runway traction. W. B. Horne (NASA, Langley Research Center, Hampton, Va.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740496.* 14 p. 23 refs. Members, \$1.40; nonmembers, \$2.25.

The five basic elements affecting runway traction for jet transport aircraft operation are identified and described in terms of pilot, aircraft system, atmospheric, tire, and pavement performance factors or parameters. Where possible, research results are summarized, and means for restoring or improving runway traction for these different conditions are discussed. (Author)

A74-34989 Performance versus cost tradeoffs - Initial look at alternatives. G. P. Sallee (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740494.* 6 p. Members, \$1.40; nonmembers, \$2.25.

Review of some of the engine alternatives suggested to reduce the impact of rising fuel prices. It is concluded, based on an analysis which considered the depreciation of investment, the cost of capital, insurance and maintenance expenses, as well as fuel savings, that in order of priority, it is necessary to investigate the optimum way to improve current inservice engine performance at minimum increase in maintenance cost and to investigate the possibility of improving current engines by means of modification within current dimensions to improve components. Only after these are investigated and fuel prices have substantially increased, will retrofit of new engines on old aircraft be worthy of consideration. (Author)

A74-34990 An approach to aeroengine tradeoff factors. T. D. Sills (Rolls-Royce /1971/, Ltd., Derby, England). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740493.* 7 p. Members, \$1.40; nonmembers, \$2.25.

Engine tradeoff factors are discussed in a general manner. Some of the problems of their interpretation and their limitations in use, particularly when presented by the aircraft constructor or operator to the aeroengine manufacturer, are shown. The discussion is

restricted to the performance and economic aspects of civil transport aircraft. Illustrative examples are given. (Author)

A74-34991 Jet noise suppression. G. Banerian (U.S. Department of Transportation, Office of Noise Abatement, Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740492.* 16 p. 14 refs. Members, \$1.40; nonmembers, \$2.25.

This paper describes a variety of methods employed in the past to modify or suppress jet noise. Some of the intriguing aspects of the factors that contribute to noise suppression are brought out. The paper concludes that a systematic study of the physics of jet suppression, in place of the ad hoc methods used in the past, is required if the concepts involved are to be utilized for design and accurate predictions in the quest for the quiet aircraft. (Author)

A74-34992 FAA aircraft retrofit feasibility program. J. F. Woodall (FAA, Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740489.* 11 p. Members, \$1.40; nonmembers, \$2.25.

The FAA retrofit feasibility program is a success story. The cooperation of the aircraft industry in general, and the FAA's contractors in particular have made the success of the program possible. We can now state that all JT3D- and JT8D-powered aircraft can meet reduced noise levels, such as FAR 36 levels, by means of technologically feasible and economically reasonable nacelle retrofit solutions. These solutions will not aggravate the energy crisis by virtue of a negligible increase in fuel consumption for the nominal flight conditions. A Notice of Proposed Rulemaking (NPRM) is about to be disseminated which could lead to the requirement that all JT3D/JT8D-powered aircraft be retrofitted by 1978 with quiet nacelles so that FAR 36 requirements can be satisfied. (Author)

A74-34993 Amphibian STOL and its facilities. R. G. Smethers, Jr. (Lockheed-Georgia Co., Marietta, Ga.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740488.* 15 p. 15 refs. Members, \$1.40; nonmembers, \$2.25.

The short-haul transportation problem, worldwide, is characterized by congestion both on the ground and in the air. Solutions in the form of ground transportation are expensive in terms of land utilization, high development costs, their adverse effect on the environment and ecology, and are 20-30 years in the future. STOL offers a solution, but the high cost of land for downtown STOLports has precluded implementation. The STOL amphibian provides a solution which uses existing waterways situated downtown in every major city. It will relieve ground congestion and alleviate saturated airports. Studies show that such a system meets the ten basic requirements established by the National Environmental Policy Act of 1969 and that it contributes significantly to a reduction in the energy consumed in travel to and from the airports. (Author)

A74-34994 Design and development of Montreal and Ottawa STOLports. D. L. Button (Canadian Air Transportation Administration, Ottawa, Canada). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740487.* 8 p. 6 refs. Members, \$1.40; nonmembers, \$2.25.

The Canadian Ministry of Transport has embarked on a program to provide a downtown-to-downtown scheduled IFR STOL service between Montreal, Quebec and Ottawa, Ontario. As part of the total systems approach to the development of the service, two STOLports were designed and built. Preliminary standards and criteria were developed to enable the design to be carried out. New electronic approach aids and modified visual aids are incorporated into the system. The STOLports will be completed and operating by March, 1974. (Author)

A74-34995 Development of a reduced smoke combustor for the JT3D engine. A. W. Nelson (United Aircraft Corp., Pratt and

Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740484*. 8 p. 8 refs. Members, \$1.40; nonmembers, \$2.25.

A new combustor configuration having substantially lower smoke emission characteristics is now in the final stages of development for the JT3D commercial aircraft turbofan engine. In addition, the low-power emissions of hydrocarbons and carbon monoxide are considerably reduced. This burner configuration utilizes many of the features developed in the JT8D turbofan engine smoke reduction program; however, it was also necessary to incorporate air-assist fuel injection nozzles to achieve smoke levels below the EPA regulation requirement of 25. Correction of a nozzle carbon formation problem and further durability testing must be accomplished before this combustor can be released for in-service commercial airline controlled-service use evaluation. (Author)

A74-34996 **Development of pollution controls for Rolls-Royce RB 211 and Olympus 593 engines.** A. B. Wassell (Rolls-Royce /1971/, Ltd., Derby Engine Div., Derby, England). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740483*. 12 p. 20 refs. Members, \$1.40; nonmembers, \$2.25.

Progress in the application of well-known pollution-control techniques to existing engines is demonstrated in relation to the visibility of the exhaust smoke plume in the RB211 Olympus 593 engines. The reasons for the apparently protracted nature of this progress are discussed and shown to be related to the maintenance of safety and durability standards. Methods being used to reduce the other combustion-generated pollutants are mentioned, especially in relation to the standards promulgated by the Environmental Protection Agency (EPA). A review of some problems associated with measurement and sampling of pollutants is given. (Author)

A74-34997 **Integrated flight/propulsion control design techniques starting with the engine.** G. J. Sevich and E. C. Beattie (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740481*. 14 p. Members, \$1.40; nonmembers, \$2.25.

New techniques are being developed to determine the analytical design and hardware implementation of multivariable control systems for complex aircraft propulsion systems. The analytical design can be accomplished with applied optimal control theory. Hardware configuration trade studies can be used to determine the best way to implement the propulsion system for a particular aircraft. These techniques may be expanded to the design of integrated flight/propulsion control systems. (Author)

A74-34998 * **Cooperative airframe/propulsion control for supersonic cruise aircraft.** W. G. Schweikhard and D. T. Berry (NASA, Flight Research Center, Edwards, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740478*. 8 p. 5 refs. Members, \$1.40; nonmembers, \$2.25.

Interactions between propulsion systems and flight controls have emerged as a major control problem on supersonic cruise aircraft. This paper describes the nature and causes of these interactions and the approaches to predicting and solving the problem. Integration of propulsion and flight control systems appears to be the most promising solution if the interaction effects can be adequately predicted early in the vehicle design. Significant performance, stability, and control improvements may be realized from a cooperative control system. (Author)

A74-35002 * **Propulsion integration for a hybrid propulsive-lift system.** M. K. Bowden, J. H. Renshaw, and H. S. Sweet (Lockheed-Georgia Co., Marietta, Ga.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2,*

1974, Paper 740471. 12 p. Members, \$1.40; nonmembers, \$2.25. NASA-supported research.

In a discussion of STOL vehicles with conventional high-lift devices, the need for efficient power-augmented lift systems is presented, and the implications of quiet operation are noted. The underlying philosophy of a promising hybrid lift system with major interactions between aerodynamic, thermodynamic, acoustic, and configuration design technologies is derived. The technique by which engine and airframe-related characteristics for this application may be matched in an optimum manner is described and illustrated by describing the features of a particular short-haul commercial STOL vehicle. (Author)

A74-35003 **Nozzle development for the upper surface - Blown jet flap on the YC-14 airplane.** H. Skavdahl, T. Wang, and W. J. Hirt (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740469*. 12 p. Members, \$1.40; nonmembers, \$2.25.

A discussion of wing-nozzle configuration development for the application of upper surface blowing to an STOL airplane is presented. The technical challenge is to achieve an integrated system which provides the desired performance for the low speed design conditions and also results in efficient operation during cruise. The resulting configuration is a complete integration of the propulsion system and airplane aerodynamics to achieve efficient operation at all regimes. This paper examines the major design parameters to be considered, describes a number of the configurations tested, and presents static and wind tunnel test results for these configurations. Concluding remarks are made relative to USB nozzle development. (Author)

A74-35004 **L-1011 secondary power systems - Design and function.** E. A. Green (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740466*. 15 p. Members, \$1.40; nonmembers, \$2.25.

The secondary power systems on the L-1011, that is, the hydraulic, electrical power, and pneumatic systems and their components, were all designed with the total aircraft system operation integrated into each subsystem as a firm design requirement. The design philosophy used in each of these power systems is reviewed, and their operation is described. Conclusions are drawn concerning the improvements in system or design approach which may be proposed for future designs. (Author)

A74-35005 **Secondary power systems.** W. P. Hannan (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740465*. 7 p. Members, \$1.40; nonmembers, \$2.25.

The DC-10 has four secondary power systems: auxiliary power unit, hydraulic, pneumatic, and electrical. An attempt is made to identify what is good and should continue as well as projects where aircraft configuration and utilization changes will dictate new design. Also, an attempt is made to forecast future developments in secondary power system equipment design. (Author)

A74-35006 **Heavy-lift helicopter power systems.** D. Stein (Boeing Vertol Co., Philadelphia, Pa.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740464*. 30 p. Members, \$1.40; nonmembers, \$2.25.

Review of the analytical, developmental, and test efforts used to achieve an integrated system responsive to the U.S. Army's heavy-lift helicopter needs. A comprehensive discussion of various approaches which were examined with particular emphasis on elements unique to this aircraft is presented. The methodology used in interfacing various components in determining the final design configuration is also presented. (Author)

A74-35007 **Effects of STOL thrust reversers and powered lift on inlet flow quality.** D. A. Sherman and W. J. Usab (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, Air Transportation Meet-*

A74-35008

ing, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740457. 13 p. Members, \$1.40; nonmembers, \$2.25.

An experimental test program was conducted to determine the engine environment which results from STOL operation with blown flaps and thrust reversers. Testing was conducted in a low speed wind tunnel with a 1/11 scale model of a STOL transport consisting of a fuselage and high-lift wing with triple-slotted externally blown flaps, leading edge slats, and powered model engines. Steady-state and dynamic total pressure distortion were moderate at takeoff and approach conditions with blown flaps. The cascade type STOL thrust reversers tested produced severe dynamic distortion due to unstable interactions of the reversed streams with the oncoming flow and vortex ingestion. Comments on methods used to alleviate these problems are presented. (Author)

A74-35008 **Advanced controls for commercial transport aircraft.** H. A. Shomber (Boeing Commercial Airplane Co., Renton, Wash.) and R. B. Holiaway (Boeing Co., Wichita, Kan.). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740453.* 14 p. 27 refs. Members, \$1.40; nonmembers, \$2.25.

Advanced control concepts, e.g., CCV and ACT, hold considerable promise of more efficient operation for commercial transports. These potential improvements, greatest for new designs that include the control concepts from their outset, yield reductions in airplane weight and/or drag with associated impact on fuel requirements, operating costs, etc. Limited improvement is also available for existing airplanes that meet certain control system requirements. This paper discusses the potential impact of advanced controls on commercial transports as performance improvements or fuel savings, and the improvement sensitivity to the design mission and configuration. The commercial application of these advanced concepts must follow flight demonstration of the flight-critical aspects, and careful determination of the reliability (safety and dispatch), certification, and economic aspects. Finally, research and demonstration activities necessary for the commercial application of these advanced control concepts are recommended. (Author)

A74-35009 * **Reduction of JT8D powered aircraft noise by engine refanning.** L. E. Stitt and A. A. Medeiros (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740490.* 25 p. 8 refs.

The purpose of the Refan Program is to establish the technical feasibility of substantially reducing the noise levels of existing JT8D powered aircraft. This would be accomplished by retrofitting the existing fleet with quieter refan engines and new acoustically treated nacelles. No major technical problems exist that preclude the development and installation of refanned engines on aircraft currently powered by the JT8D engine. The refan concept is technically feasible and provides calculated noise reductions of from 7 to 8 EPNdB for the B727-200 aircraft and from 10 to 12 EPNdB for the DC-9-32 aircraft at the FAR Part 36 measuring stations. Corresponding reductions in the 90 EPNdB footprint area are estimated to vary from about 70 percent for the DC-9 to about 80 percent for the B727. (Author)

A74-35011 * **Externally blown flap noise research.** R. G. Dorsch (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, National Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740468.* 43 p. 45 refs.

The Lewis Research Center cold-flow model externally blown flap (EBF) noise research test program is summarized. Both engine under-the-wing and over-the-wing EBF wing section configurations were studied. Ten large scale and nineteen small scale EBF models were tested. A limited number of forward airspeed effect and flap noise suppression tests were also run. The key results and conclusions drawn from the flap noise tests are summarized and discussed. (Author)

A74-35012 * **Investigation of noise from full-scale high bypass engine and blown flap system.** W. L. Jones and L. J. Heidelberg (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Air Transportation Meeting, Dallas, Tex., Apr. 30-May 2, 1974, Paper 740467.* 28 p. 11 refs.

A summary is presented of an acoustic test program for investigating engine noise suppression and jet/flap interaction noise associated with an externally blown flap (EBF) STOL powered lift system. A highly suppressed TF-34 engine and EBF wing were used in the investigation. The engine was suppressed 21 PndB to a level of 94 PndB. An under the wing (UTW) powered lift system was tested with conventional, mixer, and decayer-type nozzles. The configuration with velocity decayer nozzle and acoustically treated shroud had the lowest noise (98 PndB). An over the wing (OTW) configuration with nondecayer nozzle was about 10 dB quieter than the corresponding UTW system. UTW and OTW noise data are compared with scale model correlations. (Author)

A74-35027 **Aircraft floor panel developments at British Airways /1967-1973/.** K. B. Armstrong (British Airways Board, Overseas Div., London Heathrow Airport, Hounslow, Middx., England). *Composites*, vol. 5, July 1974, p. 165-173. 26 refs.

In 1967, testing started on balsa, polyvinyl chloride, and aluminum alloy cores with aluminum alloy skins, and a cost-effectiveness formula was developed to provide a basis for comparison. A specification for improved aluminum/balsa floors was produced, and flight trials began with aluminum/aluminum honeycomb floors. Carbon fiber and later glass fiber came on the scene, and a new specification was raised, based on more fundamental criteria. As a result, over 500 carbon fiber reinforced plastic/Nomex panels have been fitted in 747 aircraft and about 70 glass fiber reinforced plastic/Nomex panels. These are much lighter than earlier types of flooring and more cost-effective. (Author)

STAR ENTRIES

N74-25533*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

AN ANALYTICAL STUDY OF THE EFFECTS OF JETS LOCATED MORE THAN ONE JET DIAMETER ABOVE A WING AT SUBSONIC SPEEDS

Lawrence E. Putnam May 1974 50 p refs
(NASA-TM-X-71965) Avail: NTIS HC \$3.25 CSCL 01A

A procedure has been developed to calculate the effects of blowing two jets over a swept tapered wing at low subsonic speeds. The algorithm used is based on a vortex lattice representation of the wing lifting surface and a line sink-source distribution to simulate the effects of the jet exhaust on the wing lift and drag. The method is limited to those cases where the jet exhaust does not intersect or wash the wing. The predictions of this relatively simple procedure are in remarkably good agreement with experimentally measured interference lift and interference induced drag. Author

N74-25536*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

WATER TABLE TESTS OF PROPOSED HEAT TRANSFER TUNNELS FOR SMALL TURBINE VANES

Peter L. Meitner Washington Jun. 1974 17 p ref Prepared in cooperation with Army Air Mobility R and D Lab., Cleveland (NASA-TM-X-3073; E-7870) Avail: NTIS HC \$3.00 CSCL 01A

Water-table flow tests were conducted for proposed heat-transfer tunnels which were designed to provide uniform flow into their respective test sections of a single core engine turbine vane and a full annular ring of helicopter turbine vanes. Water-table tests were also performed for the single-vane test section of the core engine tunnel. The flow in the heat-transfer tunnels was shown to be acceptable. Author

N74-25537*# Boeing Commercial Airplane Co., Seattle, Wash.

LOW SPEED WIND TUNNEL FLOW FIELD RESULTS FOR JT8D REFAN ENGINES ON THE BOEING 727-200
W. G. Easterbrook and W. H. Roberts Apr. 1974 25 p
(Contract NAS3-17842)
(NASA-CR-134630; D6-43098) Avail: NTIS HC \$4.25 CSCL 01A

Low speed flow angularity results are presented showing flow direction at the nacelle locations on the Boeing 727-200. Flow angle probes (yawheads) were used for measurements at side and center inlet positions on the aft fuselage. A range of flap settings were tested with flap angles of 0 deg, 15 deg, and 40 deg selected for investigation. Author

N74-25543# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio, School of Engineering.

PREDICTING LATERAL HOVER, FLYING QUALITIES WITH PAPER PILOT M.S. Thesis

David L. Nolting Dec. 1973 133 p refs
(AD-775704; GA/MA/73A-2) Avail: NTIS CSCL 01/1

Data were obtained from a fixed base simulation of VTOL aircraft in the lateral hover mode and used to develop a technique for predicting lateral hover flying qualities. The task for the simulation was to maintain position in the presence of lateral gusts. Root-mean-square aircraft state and pilot input data were obtained and correlated with Cooper-Harper Pilot Ratings. A mathematical model for predicting the pilot rating of VTOL aircraft in lateral hover is developed. This model includes: the lateral hover aircraft equations of motion; a stochastic gust model; a linear pilot model; and a pilot rating expression that is a function of rms position error, rms lateral velocity, rms roll rate, and pilot lead terms. (Modified author abstract) GRA

N74-25544# Boeing Vertol Co., Philadelphia, Pa.
INVESTIGATION OF THE EFFECT OF TORSIONAL NATURAL FREQUENCY ON STALL-INDUCED DYNAMIC LOADING Final Technical Report, Jul. 1972 - Jul. 1973
F. J. Tarzanin and Joseph Ranieri Feb. 1974 162 p refs
(Contract DAAJ02-72-C-0093; DA Proj. 1F1-62208-AA-82)
(AD-776415; D210-10678-1; USAAMRDL-TR-73-94) Avail: NTIS CSCL 01/1

For helicopter flight conditions at high blade loadings or airspeeds, the rotor control system experiences a rapid load growth resulting from stall-induced blade torsional moments. These loads frequently grow so large that the aircraft flight envelope is restricted. This report describes an analytical study that determined the effect of changing blade torsional properties on control loads for a wide range of flight conditions. (Modified author abstract) GRA

N74-25545+ National Aeronautical Lab., Bangalore (India), Information Centre for Aeronautics.

AUTOMATIC FLIGHT CONTROL (1966-1973)

4 Feb. 1973 35 p refs
(NAL-Bibl-Ser-51) Avail: NTIS HC \$4.75

A bibliography of technical reports on automatic flight control is presented. The literature includes journal articles and conference papers arranged according to year of publication in ascending order. Sources of information are based on NASA technical reports and AIAA aerospace abstracts. Author

N74-25547+ National Aeronautical Lab., Bangalore (India), Information Centre for Aeronautics.

BIBLIOGRAPHY ON SAFETY IN AIRCRAFT OPERATIONS (1970-1972)

Sep. 1973 57 p refs
(NAL-Bibl-Ser-45) Avail: NTIS HC \$5.50

Aspects of aircraft and flight safety are presented in this bibliography. Entries are grouped chronologically under 1970 to 1972. An author index is provided. S.K.W.

N74-25548* LTV Aerospace Corp., Hampton, Va. Technical Center.

A STRUCTURAL DESIGN FOR AN EXTERNALLY BLOWN FLAP (EBF) MEDIUM STOL RESEARCH AIRCRAFT

29 Dec. 1972 134 p
(Contract NAS1-10900)
(NASA-CR-112249) Avail: NTIS HC \$9.75 CSCL 01C

A computer program to predict, by reference to structural drawings, the dynamic response of a high lift STOL wing with externally blown flaps was developed. Structural data for the computer program are presented in the form of sketches, weight and dynamic loads information graphs, and tables for an external blown, triple-slotted flap, high lift STOL transport wing. Weight, mass distribution, and moment of inertia data are summarized in table form and presented pictorially by drawing layout. The methods used for obtaining weight data were: (1) actual know, weight of components, (2) preliminary stress sizing, and (3) statistical weight estimating methods. Author

N74-25550# Advisory Group for Aerospace Research and Development, Paris (France).

ACTIVE CONTROL SYSTEMS FOR LOAD ALLEVIATION, FLUTTER SUPPRESSION AND RIDE CONTROL

Mar. 1974 77 p refs
(AGARDograph-175; AGARD-AG-175) Avail: NTIS HC \$7.00

Papers are presented which were selected to define the present status of industrial applications of active control technology in reducing loads on modern aircraft, and the future potential of active control for aircraft flutter suppression. For individual titles, see N74-25551 through N74-25555.

N74-25551 Lockheed-California Co., Burbank.
EFFECT OF YAW DAMPER ON LATERAL GUST LOADS IN DESIGN OF THE L-1011 TRANSPORT

Frederick M. Hobilt In AGARD Active Control Systems for Load Alleviation, Flutter Suppression and Ride Control Mar. 1974 p 1-10 refs

In the design of the L-1011 transport, the reduction lateral gust loads, in continuous turbulence, due to the presence of a yaw damper was reflected in the limit design loads. The resulting load reduction was about 27 percent. In establishing the limit design loads, both the mission analysis and design envelope forms of continuous turbulence gust loads criteria were used. Account was taken, under both forms of criteria, of the fraction of time the damper might be inoperative. The effect of saturation of the damper at the limit-load level was also taken into account. This effect was determined by means of time-history analyses in which the input was a random gust velocity and the rudder angle limits (governed by available hinge moment) were included in the simulation. Author

N74-25552 British Aircraft Corp., Filton (England). Commercial Aircraft Div.

THE EFFECT OF ACTIVE CONTROL SYSTEMS ON STRUCTURAL DESIGN CRITERIA

N. F. Harper. *In* AGARD Active Control Systems for Load Alleviation, Flutter Suppression and Ride Control Mar. 1974 p 11-22 refs

The design criteria for fixed wing aircraft are considered in relation to the active control systems. The reduction of static design loads, engine failure and surge loads, gust loads, and fatigue design loads are discussed along with the improvement of flutter characteristics. F.O.S.

N74-25553* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

STATUS OF TWO STUDIES ON ACTIVE CONTROL OF AEROELASTIC RESPONSE AT NASA LANGLEY RESEARCH CENTER

Irving Abel and M. C. Sandford. *In* AGARD Active Control Systems for Load Alleviation, Flutter Suppression and Ride Control Mar. 1974 p 23-48 refs

CSCL 01B

The application of active control technology to the suppression of flutter was successfully demonstrated during two recent studies in the Langley transonic dynamics tunnel. The first study involved the implementation of an aerodynamic-energy criterion, using both leading- and trailing-edge controls, to suppress flutter of a simplified delta-wing model. Use of this technique resulted in an increase in the flutter dynamic pressure of approximately 12 percent for this model at a Mach number of 0.9. Analytical methods used to predict the open- and closed-loop behavior of the model are also discussed. The second study, which is a joint effort with the Air Force Flight Dynamics Laboratory, was conducted to establish the effect of active flutter suppression on a model of the Boeing B-52 Configured Vehicle (CCV). Some preliminary results of this study indicate significant improvements in the damping associated with the critical flutter mode. Author

N74-25555 Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).

ACTIVE FLUTTER SUPPRESSION ON WINGS WITH EXTERNAL STORES

G. Haidl, A. Lotze, and O. Sensburg. *In* AGARD Active Control Systems for Load Alleviation, Flutter Suppression and Ride Control Mar. 1974 p 57-76 refs (For availability see N74-25550 15-02)

A control system is described, which is able to suppress flutter of wing-external store combinations. The aerodynamic flutter suppression forces are generated by movable vanes, attached to the stores, which are moved by a feedback signal from the store motion in such a way, that these forces damp the store motion. By adjusting the phase of the servoloop it is possible to have an active flutter-system below the flutter-speed of the passive system. This arrangement can be used to excite the flutter-mode at subcritical speeds. By switching off the servoloop, damping and frequency can be evaluated. The active flutter suppression system can also be used for reducing the level of externally forced vibration on stores which could occur through excitation by buffet or gusts. Tests results for an elastic wind-tunnel model are given and compared with analytical predictions. Correlation is very good, considering the complexity of the problem. Author

N74-25560# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: NORTH CENTRAL AIRLINES, INCORPORATED MCDONNELL DOUGLAS DC-9-31, N954N AND DELTA AIR LINES, INCORPORATED CONVAIR CV-880, N8807E O'HARE INTERNATIONAL AIRPORT, CHICAGO, ILLINOIS, 20 DECEMBER 1972

5 Jul. 1973 44 p

(NTSB-AAR-73-15) Avail: NTIS HC \$5.25

An aircraft accident involving the collision of two commercial transport aircraft at a runway intersection of O'Hare International Airport is discussed. The fatalities and injuries to the passengers are described. The damage incurred by each aircraft is reported. It was determined that the probable cause of the accident was the failure of the traffic control system to insure separation of the aircraft during a period of restricted visibility. Author

N74-25561*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

DISPLAY REQUIREMENTS FOR THE FINAL APPROACH AND LANDING PHASE OF AN RPV MISSION

James C. Howard Apr. 1974 24 p refs

(NASA-TM-X-62346) Avail: NTIS HC \$4.25 CSCL 01B

A two part investigation was conducted to determine the display requirements for the final approach and landing phase of a remotely piloted vehicle (RPV) mission, and to assess the relative merits of several possible display configurations. The objective of the first part of the investigation was to obtain subjective assessments of several display configurations, and to select the most promising display concepts for subsequent evaluation in terms of performance measures. A basic display consisting of a perspective image of terrain and runway, a horizon bar and an aircraft symbol was used, and guidance symbology was added to the basic displaying selected state variables. Initial results suggested that as guidance symbology is added to the basic display, pilot acceptance tends to increase. A point of diminishing returns is eventually reached, however, when additional information produces too much clutter, and makes it difficult for the pilot to process the displayed information. Author

N74-25562*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

FLIGHT INVESTIGATION OF THE VFR AND IFR LANDING APPROACH CHARACTERISTICS AND TERMINAL AREA AIRSPACE REQUIREMENTS FOR A LIGHT STOL AIRPLANE

Harold L. Crane, Kenneth R. Yenni, and Bruce D. Fisher Washington Jun. 1974 40 p refs

(NASA-TM-X-3008; L-9155) Avail: NTIS HC \$3.25 CSCL 01B

A flight research program was conducted to determine the terminal area instrument flight capabilities of a light STOL airplane. Simulated (hooded) instrument landing approaches were made using steep single-segment and two-segment glide slopes. A brief investigation was also made of the visual flight terminal area capabilities of the aircraft. The results indicated that the airplane could be flown on a 7 deg glide-slope ILS-type approach in still air with an adequate 3 deg margin for downward correction. Author

N74-25563*# Boeing Vertol Co., Philadelphia, Pa.

CIVIL HELICOPTER NOISE ASSESSMENT STUDY BOEING-VERTOL MODEL 347 Final Report

Ernest G. Hinterkeuser and Harry Sternfeld, Jr. 3 May 1974 99 p refs

(Contract NAS1-12494)

(NASA-CR-132420; D210-10752-2) Avail: NTIS HC \$8.00 CSCL 01C

A study was conducted to forecast the noise restrictions which may be imposed on civil transport helicopters in the 1975-1985 time period. Certification and community acceptance criteria were predicted. A 50 passenger tandem rotor helicopter based on the Boeing-Vertol Model 347 was studied to determine the noise reductions required, and the means of achieving them. Some of the important study recommendations are: (1) certifica-

tion limits should be equivalent to 95 EPNdb at data points located at 500 feet to each side of the touchdown/takeoff point, and 1000 feet from this point directly under the approach and departure flight path. (2) community acceptance should be measured as Equivalent Noise Level (Leq), based on dBA, with separate limits for day and night operations, and (3) in order to comply with the above guidelines, the Model 347 helicopter will require studies and tests leading to several modifications.

Author

N74-25564*# Techtran Corp., Glen Burnie, Md.
LONGITUDINAL MOTION OF AN AIRLINER DURING STEEP APPROACH

G. Bruening, J. Lademann, and D. Schafranek Washington NASA Jun. 1974 25 p ref Transl. into ENGLISH from the german report DGLR-Paper-73-023 Presented at the DGLR-DGON Symp. on New Approach and Landing Tech., Duesseldorf, 2-4 May 1973

(Contract NASw-2485)
(NASA-TT-F-15616; DGLR-Paper-73-023) Avail: NTIS HC \$4.25 CSCL 01C

The requirement for steeper angles of approach for commercial aircraft were examined to determine the effects on aircraft performance and stability. The subjects discussed are model data, thrust requirements, flight characteristics, phugoid curves, and leveling off. Mathematical models of the factors considered in the study are provided. Data on aircraft performance during various phases of the flight path are shown in graph form.

Author

N74-25565*# Techtran Corp., Glen Burnie, Md.
EFFECTS OF NEW APPROACH PROCEDURES ON COCKPIT DESIGN AND CHANCES FOR REALIZATION

Haeuser Washington NASA Jun. 1974 19 p refs Transl. into ENGLISH from the German report DGLR-73-033 Presented at the Symp. on New Approach and Landing Tech., Duesseldorf, 4 May 1973

(Contract NASw-2485)
(NASA-TT-F-15613; DGLR-73-033) Avail: NTIS HC \$4.00 CSCL 01C

Design of the cockpit as the working place for the crew and the interface between man and machine for aircraft guidance is a task of great complexity which can be structured and better mastered through the methodology of systems development. After defining the task of cockpit design, necessities are specified and the chances of using these specified values in practice in all phases of development are indicated. Examples of modifications of these specified parameters by new approach procedures are discussed.

Author

N74-25566*# Kanner (Leo) Associates, Redwood City, Calif.
FLIGHT-MECHANICS PROBLEMS DURING LANDING APPROACH WITH DIRECT LIFT CONTROL, EXEMPLIFIED BY HFB 320 HANSA

D. Hanke and H. H. Lange Washington NASA Jun. 1974 34 p refs Transl. into ENGLISH from the German report DGLR-73-024 Presented at the Symp. on New Approach and Landing Tech., Duesseldorf, 2-4 May 1973

(Contract NASw-2481)
(NASA-TT-F-15614; DGLR-73-024) Avail: NTIS HC \$4.75 CSCL 01C

The problems relating to path control which are encountered during landing approach with jumbo and STOL aircraft are outlined, and special consideration is given to those which occur during steep approaches used for noise abatement. The direct control of lift represents one possibility for alleviating these problems. The capabilities and limits of a DLC system such as was used in an HFB 320 Hansa are evaluated on the basis of simulation and flight test results. The preliminary empirical data from steep two-segment noise-abatement flights with the HFB 320 are reported.

Author

N74-25567*# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
COMMUNITY ACCEPTANCE OF HELICOPTER NOISE: CRITERIA AND APPLICATION

Charles L. Munch and Robert J. King [1974] 87 p refs (Contract NAS1-12495)
(NASA-CR-132430) Avail: NTIS HC \$7.50 CSCL 01C

A study was conducted to define those criteria necessary for civil helicopter operations to be acoustically acceptable to the communities from which they operate and over which they fly. The study involved surveying existing domestic and foreign Federal regulations and guidelines, state and local noise ordinances, results of community noise annoyance studies, and results of individual aircraft noise annoyance studies, and results of individual aircraft noise annoyance studies in order to establish the criteria. The final criteria selection are based on the Day-Night Level, L sub DN, a measure of total noise exposure. The basic rating unit is the A weighted sound pressure level (dba) which has accuracy comparable to other units currently used for aircraft. An L sub DN of 60 is recommended as a criterion for areas where the ambient noise is below 58 dbA. An L sub DN value 2 dbA above the local ambient is recommended for areas where the ambient is above 58 dbA.

Author

N74-25568*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

GEOMETRY CONSIDERATIONS FOR JET NOISE SHIELDING WITH CTOL ENGINE-OVER-THE-WING CONCEPT

U. VonGlahn, D. Groesbeck, and M. Reshotko Jun. 1974 40 p refs Presented at 7th Fluid and Plasma Dyn. Conf., Palo Alto, Calif., 17-19 Jun. 1974; sponsored by AIAA

(NASA-TM-X-71562; E-7991) Avail: NTIS HC \$3.25 CSCL 01C

Jet noise shielding benefits for CTOL engine-over-the-wing installations were obtained with various model-scale circular nozzles and wing chord geometries. Chord-to-nozzle diameter ratios were varied from 3 to 20, while ratios of nozzle height above the wing to the diameter were varied from near zero to 3. Spectral noise data were obtained with jet velocities from 640 to 1110 ft/sec. Characteristics of low frequency noise sources are discussed. Jet-noise shielding is correlated in terms of acoustic and geometric parameters. Implications of extending the model-scale data to full-scale are discussed.

Author

N74-25569*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

PARAMETER ESTIMATION TECHNIQUES AND APPLICATION IN AIRCRAFT FLIGHT TESTING

Washington Apr. 1974 390 p refs Symp. held at Edwards, Calif., 24-25 Apr. 1973

(NASA-TN-D-7647; H-806) Avail: NTIS HC \$8.25 CSCL 01C

Technical papers presented at the symposium by selected representatives from industry, universities, and various Air Force, Navy, and NASA installations are given. The topics covered include the newest developments in identification techniques, the most recent flight-test experience, and the projected potential for the near future. For individual titles, see N74-25570 through N74-25593.

N74-25571* Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

A SURVEY OF AFFDL PARAMETER ESTIMATION EFFORTS AND FUTURE PLANS

D. C. Eckholdt and W. R. Wells (Cincinnati Univ.) *In* NASA, Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 19-38 refs

CSCL 01C

An overview is presented of the applications of parameter estimation methods to the following areas of interest at the Air Force Flight Dynamics Laboratory (AFFDL): (1) conventional stability and control parameter estimation of rigid aircraft; (2) extension to elastic aircraft; (3) extension to stall/spin aerodynamics of rigid aircraft with a nonlinear model; (4) application to the pilot model identification; and (5) correlation of wind tunnel, drop model and flight test data. Only well-documented algorithms are used with modification to the model as required for the specific application. The genesis of each problem and other background information are discussed which enumerate the

algorithms and explain how this information is used to improve existing operational aircraft characteristics as well as specify design criteria for future USAF aerospace vehicles. Author

N74-25572* Naval Air Test Center, Patuxent River, Md.
NAVY PARTICIPATION IN THE DEVELOPMENT OF AIRFRAME PARAMETER IDENTIFICATION TECHNIQUES
 Roger A. Burton and Arthur J. Schuetz (Naval Air Development Center) *In* NASA. Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 39-42

CSSL 01C

The Navy is currently involved in the development of advanced parameter identification techniques for use in aircraft flight testing and refinement of aircraft dynamic systems modeling. An overview is presented of the Navy's research programs, capabilities, and facilities. The use of parameter identification techniques are related to the flight testing, development, and simulation of aircraft and aircraft systems in the areas of flying qualities, automatic flight controls, flight dynamics, and advanced landing systems. Preliminary analytical and flight test results are presented. The impact that new parameter identification technology has on Navy flight test philosophy is discussed. Future plans are outlined. Author

N74-25574* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
EXTRACTION OF DERIVATIVES FROM FLIGHT DATA FOR SEVERAL AIRCRAFT, USING THE LRC INTERACTIVE COMPUTER SYSTEM c01
 William T. Suit and James L. Williams *In its* Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 49-76 ref

CSSL 01A

Results are presented of a procedure for estimating stability and control parameters from flight data, by using maximum likelihood methods employing an interactive computer system, which was established at the NASA Langley Research Center. Problems encountered are discussed. Author

N74-25575* National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.
IDENTIFICATION OF AIRCRAFT STABILITY AND CONTROL DERIVATIVES IN THE PRESENCE OF TURBULENCE c01
 Kenneth W. Hiff *In its* Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 77-114 refs (For availability see N74-25569 15-02)

CSSL 01A

A maximum likelihood estimator for a linear system with state and observation noise is developed to determine stability and control derivatives from flight data obtained in the presence of turbulence. The formulation for the longitudinal short-period mode is presented briefly, including a special case that greatly simplifies the problem if the measurement noise on one signal is negligible. The effectiveness and accuracy of the technique are assessed by applying it first to simulated flight data, in which the true parameter values and state noise are known, then to actual flight data obtained in turbulence. The results are compared with data obtained in smooth air and with wind-tunnel data. The complete maximum likelihood estimator, which accounts for both state and observation noise, is shown to give the most accurate estimate of the stability and control derivatives from flight data obtained in turbulence. It is superior to the techniques that ignores state noise and to the simplified method that neglects the measurement noise on the angle-of-attack signal. Author

N74-25577* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
ESTIMATION OF LONGITUDINAL AERODYNAMIC COEFFICIENTS AND COMPARISON WITH WIND-TUNNEL VALUES
 Rodney C. Wingrove *In its* Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 125-148 refs (For availability see N74-25569 15-02)
 CSSL 01A

N74-25578* Calspan Corp., Buffalo, N.Y.
APPLICATION OF A KALMAN FILTER IDENTIFICATION TECHNIQUE TO FLIGHT DATA FROM THE X-22A VARIABLE STABILITY V/STOL AIRCRAFT

J. Victor Lebacqz *In* NASA. Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 149-174 refs Sponsored in part by NASA and FAA

(Contracts N00019-69-C-0534; N00019-71-C-0044; N00019-72-C-0417)

CSSL 01C

A digital identification technique based on Kalman filter theory was developed for the estimation of V/STOL aircraft stability and control parameters from flight data. The application of this technique to flight data from flying qualities experiments using the variable stability X-22A V/STOL aircraft is discussed. The estimation algorithm is briefly reviewed, experimental and data acquisition procedures used in the X-22A flight programs are outlined, and specific problem areas such as the determination of noise statistics and selection of pilot inputs to enhance identifiability are discussed. Results are presented for a wide range of simulated dynamic configurations. Author

N74-25579* United Aircraft Corp., East Hartford, Conn. Sikorsky Aircraft Div.
HELICOPTER DERIVATIVE IDENTIFICATION FROM ANALYTIC MODELS AND FLIGHT TEST DATA
 John Molisus and Stan Briczinski *In* NASA. Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 175-186 refs

CSSL 01C

Recent results of stability derivative identification from helicopter analytic models and flight test data are presented. Six and nine degree-of-freedom (DOF) linear models are identified from an analytic nonlinear helicopter simulation using a least square technique. The identified models are compared with the convectional partial differentiation method for obtaining derivatives to form the basis for interpretation of derivatives identified from flight data. Six degree-of-freedom models are identified from CH-53A and CH-54B flight data, using an extended Kalman filter modified to process several maneuvers simultaneously. The a priori derivative estimate is obtained by optimal filtering of the data and then using a least square method. The results demonstrate that a six DOF identified model is sufficient to determine the low frequency modes of motion, but a nine DOF rotor/body model is necessary for proper representation of short-term response. Author

N74-25580* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
NONLINEAR PARAMETER IDENTIFICATION: BALLISTIC RANGE EXPERIENCE APPLICABLE TO FLIGHT TESTING c01

Gary Chapman and Donn Kirk *In its* Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 191-195 refs (For availability see N74-25569 15-02)

CSSL 01A

The parameter identification scheme being used is a differential correction least squares procedure (Gauss-Newton method). The position, orientation, and derivatives of these quantities with respect to the parameters of interest (i.e., sensitivity coefficients) are determined by digital integration of the equations of motion and the parametric differential equations. The application of this technique to three vastly different sets of data is used to illustrate the versatility of the method and to indicate some of the problems that still remain. Author

N74-25581* Southern Methodist Univ., Dallas, Tex. Information and Control Sciences Center.
IDENTIFICATION OF AIRCRAFT STABILITY AND CONTROL PARAMETERS USING MULTILEVEL, HIERARCHICAL ESTIMATION
 C. M. Fry and A. P. Sage *In* NASA. Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 199-222 refs

(Grant NSF GK-33348)
CSCL 01C

Previous attempts to identify aircraft stability and control derivatives from flight test data, using three-degrees-of-freedom (3-DOF) longitudinal or lateral-directional perturbation-equations-of-motion models, suffer from the disadvantage that the coupling between the longitudinal and lateral-directional dynamics has been ignored. In this paper the identification of aircraft stability parameters is accomplished using a more accurate 6-DOF model which includes this coupling. Hierarchical system identification theory is used to reduce the computational effort involved. The 6-DOF system of equations is decomposed into two 3-DOF subsystems, one for the longitudinal dynamics and the other for the lateral-directional dynamics. The two subsystem parameter identification processes are then coordinated in such a way that the overall system parameter identification problem is solved.

Author

N74-25582* Northeastern Univ., Boston, Mass. Dept. of Electrical Engineering.

PARAMETER ESTIMATION USING AN A POSTERIORI CRITERION

Ralph E. Bach, Jr. *In* NASA, Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 223-230 refs

(Contract NAS2-7397)

CSCL 01C

A procedure for estimating noise statistics as well as system model parameters, based on a maximum likelihood criterion, has been successfully applied to a number of aircraft parameter-identification problems. In the present investigation, an a posteriori criterion is examined for use in such an application, when it is desired to model process noise. The criteria lead to identical results when there is no process noise.

Author

N74-25584* Systems Control, Inc., Palo Alto, Calif.

A UNIFIED APPROACH TO AIRCRAFT PARAMETER IDENTIFICATION

c01

David E. Stegner and John A. Sorensen *In* NASA, Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 243-259 refs

(Contracts NAS1-10700; NAS1-1079; F44620-71-C-0077)

CSCL 01A

The most accurate identification results are obtained when all three elements of the identification process - the identification algorithm, the control input, and the instrumentation system - are considered in a unified approach. This type of approach for the design of optimal control inputs and for determining the effect of the instrumentation system, in each case with respect to the identification process is discussed. Design of control inputs which optimize the sensitivity of the system output to the unknown parameters is given. Results using these inputs in an extensive simulation of the identification process indicate they perform measurably better than doublet type inputs. A technique is then presented for specifying an optimal instrumentation system or for determining the effect, the instrumentation system has on the accuracy of the parameter estimates.

Author

N74-25585* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

EFFECTS OF FLIGHT INSTRUMENTATION ERRORS ON THE ESTIMATION OF AIRCRAFT STABILITY AND CONTROL DERIVATIVES

c01

Wayne H. Bryant and Ward F. Hodge *In* its Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 261-280 refs

CSCL 01A

An error analysis program based on an output error estimation method was used to evaluate the effects of sensor and instrumentation errors on the estimation of aircraft stability and control derivatives. A Monte Carlo analysis was performed using simulated flight data for a high performance military aircraft, a large commercial transport, and a small general aviation aircraft for typical cruise flight conditions. The effects of varying the input sequence and combinations of the sensor and instrumenta-

tion errors were investigated. The results indicate that both the parameter accuracy and the corresponding measurement trajectory fit error can be significantly affected. Of the error sources considered, instrumentation lags and control measurement errors were found to be most significant.

Author

N74-25588* Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.

A PRACTICAL SCHEME FOR ADAPTIVE AIRCRAFT FLIGHT CONTROL SYSTEMS

Michael Athans and Dieter Willner *In* NASA, Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 315-336 refs

(Grants NGL-22-009-124; AF-AFOSR-2273-72)

CSCL 01C

A flight control system design is presented, that can be implemented by analog hardware, to be used to control an aircraft with uncertain parameters. The design is based upon the use of modern control theory. The ideas are illustrated by considering control of STOL longitudinal dynamics.

Author

N74-25589* Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio. Control Criteria Branch.

ESTIMATION OF ELASTIC AIRCRAFT PARAMETERS USING THE MAXIMUM LIKELIHOOD METHOD

R. C. Schwanz and W. R. Wells *In* NASA, Flight Res. Center Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 337-358 refs

CSCL 01C

The application of the maximum likelihood method to estimate the aerodynamic parameters of elastic flight vehicles in a symmetric flight condition is discussed. In this application, particular attention is directed toward the center of mass, elastic deformation, and sensor equations of motion. It is shown that the two major computational problems to be overcome are the inversion of large-sized matrices and the time-wise integration of a large number of linear, ordinary, differential equations.

Author

N74-25591* National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

DETERMINATION OF PROPULSION SYSTEM-INDUCED FORCES AND MOMENTS OF A MACH 3 CRUISE AIRCRAFT

Glenn B. Gilyard *In* its Parameter Estimation Tech. and Appl. in Aircraft Flight Testing Apr. 1974 p 369-374 refs

CSCL 01C

During the joint NASA/USAF flight research program with the YF-12 airplane, the Dutch roll damping was found to be much less during automatic inlet operation than during fixed inlet operation at Mach numbers greater than 2.5 and with the yaw stability augmentation system off. It was concluded that the significant reduction in Dutch roll damping was due to the forces and moments induced by the variable-geometry features of the inlet. Two stability-derivative extraction techniques were applied to the flight data; the recently developed Newton-Raphson technique and the time vector method. These techniques made it possible to determine the forces and moments generated by spike and bypass door movement.

Author

N74-25594*# Kanner (Leo) Associates, Redwood City, Calif. GENERAL PRINCIPLES OF DESIGNING CONTROL SYSTEMS

O. A. Chembrovskiy, Yu. I. Topcheyev, and G. V. Samoylovich Washington NASA May 1974 391 p refs Transl. into ENGLISH from "Obshchiye Printsipy Proyektirovaniya Sistem Upravleniya" Moscow, Mashinostroyeniye Press, 1972 416 p (Contract NASW-2481)

(NASA-TT-F-782) Avail: NTIS HC \$8.25 CSCL 01C

General methods for the initial stages of designing control systems of aircraft, missile, and spacecraft complexes are presented. The methods are based on statistical estimates of the characteristics of flight craft and of ground and onboard control system components. Illustrations are taken from foreign

technology. Failure rates and standby status of the control systems of aircraft and missile complexes are discussed. Cost effectiveness criteria in the designing of attack and defense aircraft-missile complexes are described and evaluated with examples. Handbook material presented in the book can be used in the initial stage of designing or in setting up preliminary requirements for systems. The book is written for design engineers and estimator engineers concerned with designing flight craft control systems.

Author

N74-25595# Naval Air Test Facility, Lakehurst, N.J. Ship Installations.

EVALUATION OF THE AUTOMATIC JBD (JET BLAST DEFLECTOR) SYSTEM Final Report, 19 Sep. 1973 - 15 Jan. 1974

William F. Kappler, Jr. 28 Feb. 1974 19 p refs
(AD-775665; NATF-EN-1130) Avail: NTIS CSCL 01/2

The report presents the results of the final evaluation testing of the Automatic JBD (Jet Blast Deflector) System on the MK 4 Mod O Jet Blast Deflector Panel located on the TC13 Mod 1 catapult at the Naval Air Test Facility, Lakehurst, N. J. and includes an analysis of the test procedures, problem areas, and reliability of the Automatic JBD System. (Modified author abstract) GRA

N74-25596# Stanford Research Inst., Menlo Park, Calif.
EVALUATION OF THE LIDAR TECHNIQUE OF DETERMINING SLANT RANGE VISIBILITY FOR AIRCRAFT LANDINGS OPERATIONS Final Report, Part 2, 1 Nov. 1972 - 1 Aug. 1973

William Viezee, John Oblanas, and Ronald T. H. Collis Nov. 1973 138 p refs

(Contract F19628-71-C-0152; AF Proj. 6670)
(AD-776054; AFCRL-TR-73-0708) Avail: NTIS CSCL 01/2

The report presents and interprets the data from an experiment specifically designed to more precisely evaluate the lidar technique of measuring slant-range visibility. The evaluation experiment was conducted at Travis AFB, California, in January 1973. The primary instruments were a pulsed ruby lidar and four transmissometers installed on towers and aligned along horizontal and slant paths. Also, arrays of three passive reflectors or targets (two wire-mesh and one solid) were used to provide a measure of attenuation over the distance between targets by comparing the intensity of the target-reflected lidar signals. Single-ended lidar backscatter measurements were made alongside the transmissometer. Daytime visual range was computed from the lidar observations by the slope method. (Modified author abstract) GRA

N74-25597# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

CATAPULT FATIGUE TEST OF THE MODEL C-2A AIRPLANE Final Report

Edward F. Kautz 31 Dec. 1973 33 p refs
(AD-775615; NADC-73179-30) Avail: NTIS CSCL 01/3

A laboratory fatigue test was performed on a C-2A airframe to determine whether the airframe could sustain the effects of 3000 catapult launches. A total of 6000 catapult launch cycles were applied to the airframe with no structural failures. With a test scatter factor of 2, the 6000 test cycles are equivalent to 3000 service catapult launches. Author (GRA)

N74-25598# Southwest Research Inst., San Antonio, Tex.
AERODYNAMIC DAMPING OF VIBRATING HELICOPTER ROTORS Final Report, 11 Jun. 1970 - 21 Dec. 1973

R. L. Bass, III, J. E. Johnson, and J. F. Unruh Jan. 1974 65 p refs

(Contract DAHC04-70-C-0050; SwRI Proj. 02-2865; AROD Proj. 9055-E)
(AD-775929; SwRI-02-2865-F; AROD-9055-1-E) Avail: NTIS CSCL 01/3

An experimental and theoretical study of aerodynamic damping of a hingeless helicopter rotor harmonically excited in heave in one of several bending modes is presented. Experimental damping data is given for rotor pitch angles of 0, 1 and 5 degrees. At each pitch angle, damping data is presented for a

wide range of the oscillation to rotational frequency ratio, m . Rotor structural damping as a function of rpm is also determined so an accurate measure of aerodynamic contributions to total rotor damping is obtained. Theoretical aerodynamic damping is determined by treating the model rotor as a multi-degree of freedom system wherein the structural and aerodynamic properties of the rotor are treated as a series of finite structural elements and a series of two-dimensional strip theory aerodynamic panels. (Modified author abstract) GRA

N74-25599# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

QUALIFICATION TEST METHODS FOR HELICOPTER CARGO HANDLING SYSTEMS Final Report, Feb. - Nov. 1972

David O. Adams Dec. 1973 243 p refs
(Contract DAAJ02-72-C-0037; DA Proj. 1F1-62203-AA-33)
(AD-776991; SER-50795; USAAMRDL-TR-73-77) Avail: NTIS CSCL 01/3

The unreliability of some current cargo handling systems has resulted in the loss of expensive military equipment. Additionally, the unavailability of aircraft and the many maintenance man-hours on cargo handling systems have caused increased costs and mission aborts. The basic reason for this has been a lack of appreciation, by both the Army and the helicopter manufacturer, for the rigors of cargo helicopter operation. Southeast Asia experience has shown that rough handling and the combined effects of extreme environmental conditions and operational cycles are the leading causes of cargo handling system failures. The purpose of the report is to present cargo handling system qualification test methods which better represent actual field use and to systematize methods for demonstrating stated reliability requirements for these devices. (Modified author abstract) GRA

N74-25601# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

OPTIMAL CONTROL AIRCRAFT LANDING ANALYSIS Technical Report, Jan. 1972 - Jul. 1973

Robert E. Huber, Jr. Dec. 1973 136 p refs
(AD-776316; AFFDL-TR-73-141) Avail: NTIS CSCL 01/2

A digital computer analysis technique was developed to predict aircraft longitudinal landing performance to touchdown. A microwave landing system provided sampled data elevation angle guidance and assumed continuous DME (distance measuring equipment) information. The linearized longitudinal equations for perturbations about trimmed flight were used for the aircraft model. Atmospheric disturbances including deterministic winds and random gusts were modeled. The deterministic gusts included headwinds and wind shears. The random gusts included longitudinal and normal gusts which were modeled as first order Gauss Markov processes. The microwave landing system noise was also included. (Modified author abstract) GRA

N74-25602# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.

APPLICATION OF PRACTICAL OPTIMAL CONTROL THEORY TO THE C-5A LOAD IMPROVEMENT CONTROL SYSTEM (LICS) Final Report, 15 Aug. - 15 Sep. 1972

Albert J. VanDierendonck, Charles R. Stone, and Michael D. Ward Oct. 1973 49 p refs
(Contract F33615-72-C-2008; AF Proj. 487T)
(AD-776297; F0161-FR-Vol-3; AFFDL-TR-73-122) Avail: NTIS CSCL 01/3

Practicalizing quadratic optimal control algorithms were used to design load relief systems for the C-5A, a large flexible aircraft. The predicted rms stresses at the wing root were reduced by more than 40 percent. Handling qualities or stability were not compromised. The control is realized with a gyro and three accelerometers affecting ailerons and elevator two accelerometers more than an existing stability augmentation system. The quadratic performance index is defined to enforce good handling qualities and to limit the control system bandwidth. Author (GRA)

N74-25603# National Aviation Facilities Experimental Center, Atlantic City, N.J.

AEROSPACE VEHICLE HAZARDS PROTECTION PROGRAM: DETECTORS MATERIALS FUEL VULNERABILITY Final Technical Report, 10 Oct. 1970 - 30 Sep. 1972

John H. O'Neill, Daniel E. Sommers, and Eldon B. Nicholas Oct. 1973 63 p refs

(Contract F33615-71-M-5002; AF Proj. 3048)

(AD-776301; FAA-NA-73-63; AFAPL-TR-73-87) Avail: NTIS CSCL 01/3

Fire tests were conducted in a turbojet powerplant installation to determine the effectiveness of an Edison and a Honeywell Ultra-violet Fire Detection System. A study of flammability and smoke generation characteristics was performed on different types of litter pads and pillows. Fire resistance tests in a standard 2,000F flame-test environment were conducted on two flexible self-sealing low pressure Aeroquip hoses and an aluminized asbestos-faced flexible fiberglass cloth. An investigation of the vulnerability of JP-4 and JP-8 fuel, contained in a fuel tank, to ignition by incendiary gunfire was made. (Modified author abstract) GRA

N74-25604# Ohio State Univ., Columbus. Dept. of Mechanical Engineering.

VIBRATION SIGNAL ANALYSIS TECHNIQUES Final Report, 1 Jul. 1972 - 15 Jun. 1973

Donald R. Houser and Michael J. Drosjack Dec. 1973 246 p refs

(Contract DAAJ02-72-C-0085; DA Proj. 1F1-62203-A-434)

(AD-776397; USAAMRDL-TR-73-101) Avail: NTIS CSCL 01/3

The program was initiated to investigate the many means of using vibration signals to detect the condition of mechanical components, with particular emphasis on gears and bearings in the helicopter power train. An exhaustive literature search was performed in which specific techniques were identified. Several visits were made to people active in the vibration diagnostics field. The techniques which were identified as being potentially useful were investigated in detail. The results of this investigation include a presentation of the art of each technique and an analysis via actual helicopter data, test rig data, and a dynamic model simulation. The techniques have been broken down by mathematical function, i.e., time domain and frequency domain, and also by the components being monitored, i.e., gears or bearings. Both mechanically related and pattern recognition techniques are discussed. An extensive reference listing and a listing of companies and agencies active in diagnostics work are included. (modified author abstract) GRA

N74-25605# Army Aviation Systems Command, St. Louis, Mo. **MAJOR ITEM SPECIAL STUDY (MISS). CH-47A ROTARY WING BLADE Interim Report, Jan. 1964 - Jul. 1973**

Mar. 1974 23 p

(AD-776419; USAAVSCOM-TR-74-15) Avail: NTIS CSCL 01/3

The report is designed to illustrate cost savings which would result from specific efforts in the areas of product improvement in quality and design. For the purpose of this study the cost savings produced in the area of product improvement are based on total elimination of a certain failure mode or modes. Appropriate modes are chosen because of their proportion of the total removals or their proportion in combination with other similar modes. These eliminated removals are then assumed to follow the distribution of the remaining removal modes. The actual cost savings are determined from the increase in the mean time to removal based on the new removal distributions. GRA

N74-25606# Army Aviation Systems Command, St. Louis, Mo. **MAJOR ITEM SPECIAL STUDY (MISS). CH-47A SYNCHRONIZER SHAFT ASSEMBLY Interim Report, Jan. 1964 - Jul. 1973**

Mar. 1974 22 p refs

(AD-776418; USAAVSCOM-TR-74-14) Avail: NTIS CSCL 01/3

Major Item Special Study (MISS) reports are performed on DA Form 2410 reportable components. These are time change items and certain condition change items selected because of

high cost or need for intensive management. Basically, the MISS reports are concerned with analyzing reported removal data presented in the Major Item Removal Frequency (MIRF) report. The failure modes reported for each removal are examined and grouped into categories which are intended to clarify the intent of the data reporting. From this data, removal distributions can be plotted and an MTR (mean time to removal) can be calculated. The MISS reports then investigate possible cost savings based on total elimination of selected failure modes. These modes are chosen because of the percentage of failures they represent and/or because they appear to be feasible Product Improvement Program (PIP) areas. Author (GRA)

N74-25609# Bell Helicopter Co., Fort Worth, Tex. **ANALYSIS OF MANEUVERABILITY EFFECTS ON ROTOR/WING DESIGN CHARACTERISTICS Final Report**

R. D. Foster, J. C. Kidwell, and C. D. Wells Feb. 1974 251 p refs

(Contract DAAJ02-70-C-0031; DA Proj. 1X1-64206-D-378)

(AD-776981; USAAMRDL-TR-74-26) Avail: NTIS CSCL 01/3

A parametric study was conducted to determine the effects of maneuverability requirements on the design characteristics of rotors and wings for helicopters. The study was performed for both single-rotor helicopters and single-rotor winged helicopters. Study results indicate that for typical UTTAS configurations, both winged and pure helicopters, designed for equal maneuvering capability, had equal payload capability. Therefore, for equal maneuvering capability, there was no discernible difference in weight or overall size. Winged configurations were more limited in their ability to achieve low (i.e., near zero) g, high-speed, maneuvering flight due to the difficulty in reducing wing lift sufficiently. (Modified author abstract) GRA

N74-25610# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE STRENGTH AND RIGIDITY OF STRUCTURES AT HIGH AIRCRAFT VELOCITIES

P. G. Zykin 7 Mar. 1974 17 p refs Transl. into ENGLISH from Tr. Aviats. Inst., Ufa (USSR), no. 7, 1967 p 3-12

(AD-776743; FTD-HT-23-395-74) Avail: NTIS CSCL 01/3

The effects of aerodynamic heating at supersonic and hypersonic speeds on the structural stability of airframes are discussed. Diagrams are provided to show the nature of the change in temperature of aircraft skin in various flight regimes. Graphs are developed to show the change in yield point and the elastic modulus of aircraft structural materials as a function of temperature. Construction techniques for reducing the effects of aerodynamic heating are reported. Author

N74-25611# Naval Ship Research and Development Center, Bethesda, Md. Aviation and Surface Effects Dept.

HELICOPTER/TECHNOLOGY PROGRAM: FISCAL 1973 Progress Report

Peter S. Montana Sep. 1973 105 p refs

(WF41421201)

(AD-776580; TN-AL-310) Avail: NTIS CSCL 01/3

The current fiscal year's effort in the Helicopter Technology Program was directed toward the development of a design methodology for helicopter fuselages. Effort was concentrated in the development and utilization of computer programs to design a fuselage for a high speed helicopter in the 25,000 pound gross weight class. Particular emphasis was placed on minimizing flow separation in the rotor hub-pylon region of the vehicle. The flow separation in this region was previously determined to be the cause of up to fifty percent of current helicopter drag. Measureable success has been achieved in this regard. Progress has also been made in the development of a comprehensive wind tunnel investigation (currently under way) to verify analytical predictions and further refine the design methodology being developed. Author (GRA)

N74-25613# Army Aviation Systems Test Activity, Edwards AFB, Calif.

ENGINEERING FLIGHT TEST: AH-1G HELICOPTER WITH MODEL 212 TAIL ROTOR. PART 2: PERFORMANCE AND

HANDLING QUALITIES Final Report, 29 May - 7 Aug. 1973

John I. Nagata, Gary L. Skinner, Leslie J. Hepler, Gary A. Smith, and Paul R. Bonin Sep. 1973 120 p refs 2 Vol. (AD-776360; USAASTA-72-30-Pt-2) Avail: NTIS CSCL 01/3

The United States Army Aviation Systems Test Activity conducted a limited performance and handling qualities evaluation of the AH-1G helicopter with a Bell Helicopter Company commercial Model 212 tail rotor installed. This installation included changes to the pitch links and pitch control tube to accommodate the Model 212 tail rotor; however, the remaining components of the tail rotor drive system were standard AH-1G items. The evaluation was performed during the period 29 May to 7 August 1973 at Edwards Air Force Base, Bakersfield, and Bishop, California. (Modified author abstract) GRA

N74-25614# Borst (Henry V.) and Associates, Rosemont, Pa. SUMMARY OF PROPELLER DESIGN PROCEDURES AND DATA. VOLUME 3: HUB, ACTUATOR, AND CONTROL DESIGNS Final Report

Edward Sand, Douglas A. Elliott, Jr., and Henry V. Borst Nov. 1973 330 p refs (Contract DAAJ02-72-C-0033; DA Proj. 1G1-62207-AA-72) (AD-776998; USAAMRDL-TR-73-34C) Avail: NTIS CSCL 01/3

The technology needed for the design and installation of propellers is presented and summarized in three volumes. Volume 3 (Hub, Actuator, and Control Design) contains material on the design of the hub and actuator systems. The theories of propeller controls are presented with the details of the types used with conventional and V/STOL airplanes. A brief discussion of past and future propeller installations is given along with recommendations for future work. Design criteria, airfoil data, and a computer program are given. Author (GRA)

N74-25790# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

FREE JET ENGINE TESTING: WIND TUNNEL STARTING Paul J. Ortwerth Dec. 1973 33 p refs (AF Proj. 3012)

(AD-776318; AFAPL-TR-73-105) Avail: NTIS CSCL 14/2

Free jet wind tunnels are used extensively for jet engine testing and development. A facility diffuser is employed for altitude simulation. Diffuser size and performance must be matched to the exhaust pumping capacity and engine installation drag or diffuser unstarts will occur. The diffuser starting theory of Rudolf Herman was reviewed and extended to determine the allowable drag coefficient of ramjet test installations in free jet wind tunnels. Specific drag limits are calculated for the Air Force free jet test stand located at The Marquardt Corporation, Van Nuys, California. Author (GRA)

N74-25791# ARO, Inc., Arnold Air Force Station, Tenn. EVALUATION OF A WIND TUNNEL TECHNIQUE TO DETERMINE AIRCRAFT DEPARTURE CHARACTERISTICS Final Report, 2 Feb. - 18 May 1973

R. W. Bulter AEDC Mar. 1974 29 p refs (AD-776317; ARO-PWT-TR-73-121; AEDC-TR-73-183) Avail: NTIS CSCL 14/2

A wind tunnel pilot test was conducted to develop a captive aircraft testing technique. By utilizing wind tunnel research to determine the static aerodynamic forces and moments in conjunction with an on-line digital computer programmed with the equations of motion, a series of aircraft stall/departure type maneuvers was generated. A 1/72-scale A-7D aircraft model was utilized. All maneuvers were initiated at Mach number 0.50 at a simulated altitude of 20,000 ft. (Modified author abstract) GRA

N74-25812*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

REYNOLDS NUMBER EFFECTS ON BOATTAIL DRAG OF EXHAUST NOZZLES FROM WIND TUNNEL AND FLIGHT TESTS

Fred A. Wilcox and Roger Chamberlin [1974] 27 p refs Proposed for presentation at AGARD Fluid Dyn. Panel Specialists

Meeting on Airframe/Propulsion Interference, Rome, 3-6 Sep. 1974

(NASA-TM-X-71548; E-7763) Avail: NTIS HC \$3.25 CSCL 20D

A family of nacelle mounted high angle boattail nozzles was tested to investigate Reynolds number effects on drag. The nozzles were flown on a modified F-106B and mounted on scale models of a F-106 in a wind tunnel. A 19- to 1-range of Reynolds number was covered as a result of the large size differences between models and by flying over a range of altitude. In flight, the nozzles were mounted behind J-85 turbojet engines. Jet boundary simulators and a powered turbojet engine simulator were used on the wind tunnel models. Data were taken at Mach numbers of 0.6 and 0.9. Boattail drag was found to be affected by boattail number. The effect is a complex relationship dependent upon boundary layer thickness and nozzle boattail shape. As Reynolds number was increased from the lowest values obtained with scale models, boattail drag first increased to a maximum at the lowest flight Reynolds number and then decreased.

Author

N74-25933# Advisory Group for Aerospace Research and Development, Paris (France).

AGARD FLIGHT TEST INSTRUMENTATION SERVICES. VOLUME 1: BASIC PRINCIPLES OF FLIGHT TEST INSTRUMENTATION ENGINEERING

A. Pool, ed. and D. Bosman, ed. Apr. 1974 168 p refs (AGARDograph-160-Vol-1; AGARD-AG-160-Vol-1) Avail: NTIS HC \$11.50

Monographs on the more important aspects of flight test instrumentation are presented. The subjects discussed include: (1) in-flight temperature measurements, (2) fuel flow and engine rotation speed measurements, (3) open and closed-loop accelerometers, and (4) magnetic tape recording. The main emphasis is on large automated instrumentation systems for the initial flight testing of modern military and civil aircraft. The overall areas of consideration are the design of the instrumentation system, the characteristics of the individual measuring channel, and the integration of the individual data channels into one data collection system. For individual titles, see N74-25934 through N74-25945.

N74-25934 British Aircraft Corp., Preston (England).

THE USERS' REQUIREMENTS

M. L. Henney *In* AGARD AGARD Flight Test Instrumentation Ser., Vol. 1 Apr. 1974 9 p refs (For availability see N74-25933 15-14)

The process for determining the general requirements for a flight test instrumentation system is discussed. The manner in which the requirements are derived is indicated by considering the test planning process and data analysis. Specific requirements arising in various categories of tests are detailed. Explanation of the data analysis requirements is given. The application of the selection process to flight tests of uncertificated and certificated aircraft is compared. Author

N74-25935* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

AN INDUCTION INTO THE DESIGN OF FLIGHT TEST INSTRUMENTATION SYSTEMS

B. L. Dove *In* AGARD AGARD Flight Test Instrumentation Ser., Vol. 1 Apr. 1974 9 p refs (For availability see N74-25933 15-14)

The development of flight test instrumentation systems based on specific requirements for the flight tests is discussed. The factors which influence the instrumentation system design are described. The use of a measurements list as a device for determining flight test requirements is explained. A block diagram of a typical flight test instrumentation system is provided. The effects of factors such as cost, schedule, personnel, accuracy, environmental qualifications, and reliability are analyzed. Author

N74-25936 Centre d'Essais en Vol, Bretagne-sur-Orge (France). METEOROLOGICAL CHARACTERISTICS OF A MEASURING CHANNEL

J. Idrac *In* AGARD AGARD Flight Test Instrumentation Ser.,

Vol. 1 Apr. 1974 11 p refs (For availability see N74-25933 15-14)

An analysis of the fundamental characteristics of a measuring process is provided. The technical aspects of designing a measuring channel are discussed. The phases in a measuring operation are explained. The errors in measurement are analyzed to show the type of errors, the shape of the distribution curve, and the effects of various degrees of error. Curves are developed to show the amplitude and response characteristics of flight instrumentation systems. Author

N74-26073# Naval Air Propulsion Test Center, Trenton, N.J. **EVALUATION OF MIL-L-23699 LUBRICATION OIL PERFORMANCE IN THE J79 ENGINE Final Report** Frank Feinberg Mar. 1974 18 p refs (AD-776535; NAPTC-PE-39) Avail: NTIS CSCL 11/8

An evaluation was made of the service performance characteristics of MIL-L-23699B oils in the J79 engine. Operational experience and problems, lubricant condition, and the condition of lubricant wetted engine components at overhaul are discussed. Recommendations are made concerning the expected life of MIL-L-23699 oils in this engine. Author (GRA)

N74-26078# Army Natick Labs., Mass. Clothing and Personal Life Support Equipment Lab. **THE RESPONSE OF AIRCRAFT CAMOUFLAGE LACQUERS TO THERMAL RADIATION. PART 2; 6000 DEGREES K RADIATOR AND 800 FT/SEC AIR FLOW** Earl T. Waldron Nov. 1973 22 p refs (AD-776884; C/PLSEL-116-Pt-2; USA-NLABS-TR-74-12-CE-Pt-2) Avail: NTIS CSCL 11/3

Three colors of each of two lacquers on aluminum panels were exposed to radiation simulating that from 100 KT and 1 MT weapons, while air at a velocity of 800 ft/sec flowed across the exposed surface of the panels. Differences in the response of the lacquer-color combinations were observed, temperatures at the rear surface of the panels were measured, and an expression relating response to weapon size was derived. Author (GRA)

N74-26104# Advisory Group for Aerospace Research and Development, Paris (France). **THE FLUID DYNAMICS ASPECTS OF AIR POLLUTION RELATED TO AIRCRAFT OPERATIONS** P. A. Libby, ed. (California Univ., San Diego) Feb. 1974 53 p refs (AGARD-AR-55) Avail: NTIS HC \$5.75

The proceedings of the round table discussion are presented and include: (1) aircraft dispersion of pollutants, (2) air pollution characteristics of aircraft engines, (3) research in Germany on air pollution related to aircraft operations, (4) large scale mass transport, and (5) air pollution from aircraft.

N74-26130# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div. **MODIFICATION OF CONVECTIVE CLOUDS BY JETS** N. I. Vulfson and A. V. Kondratova 25 Feb. 1974 28 p refs Transl. into English from Tr. v Vsesoyuznogo Meteorol. Sezda. Sekts. Aktivn Vozdeistvii na Atm. Protsessy (USSR), v. 4, 1972 p 62-78 (FTD Proj. T74-01-20) (AD-776730; FTD-MT-24-217-74) Avail: NTIS CSCL 04/2

Contents: Stimulation of convective cloud development by artificially created ascending jets; Breaking up cumulus clouds with descending jets. GRA

N74-26149# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering. **MICROWAVE LANDING SYSTEM INTEGRATION STUDY. VOLUME 1: SUMMARY REPORT Final Report, 25 Jun. 1973 - 4 Mar. 1974** Edward Andrews, Jr., John E. Arnold, Charles R. Brittain, Garth R. Cooke, William M. Curran, Phillip H. Hermes, Gerald K. Hobart, John M. Molnar, John F. Schleich, and Jack L. Wolff 4 Mar. 1974 85 p refs

(AF Proj. 404L)

(AD-775703; GSE/SE/74-1-Vol-1) Avail: NTIS

The integration of the Microwave Landing System (MLS) into a representative selection of United States Air Force aircraft is investigated to identify problems affecting Air Force requirements for MLS. Antenna configurations and signal processing and interface designs are developed for the C-130E, C-5A, FB-111A, and F-15. These configurations and designs provide data for the environmental, cost, and systems effectiveness analyses presented in this report. A comparative analysis of different approach capabilities is carried out, using the C-130E as an illustration. These capabilities include straight, curved, and stepped approach paths as well as approaches into forward operating bases. (Modified author abstract) GRA

N74-26150*# Kanner (Leo) Associates, Redwood City, Calif. **FLIGHT PATH CONTROL EQUIPMENT FOR PRODUCING CURVED FLIGHT PATH PROFILES WITH MICROWAVE LANDING SYSTEMS** G. Schaezner Washington NASA Jun. 1974 34 p refs Transl. into ENGLISH from the German report DGLR-73-016 Presented at the DGLR-DGON Symp. on New Approach and Landing Tech., Duesseldorf, 2-4 May 1973 (Contract NASw-2481) (NASA-TT-F-15608; DGLR-73-016) Avail: NTIS HC \$4.75 CSCL 17G

The characteristics of a flight path control instrument for producing curved approach profiles and guidance along these profiles are presented. For safety reasons, steep noise abatement approaches must be flown along curved profiles. The problems of flyability, accuracy, and the requirements to be placed on the IFR beacon system and on the flight control system are derived. Flight tests have shown that the techniques discussed contribute to a reduction in the burden on the pilot. Author

N74-26151*# Kanner (Leo) Associates, Redwood City, Calif. **DESIGN STUDY OF AN ELECTRONIC LANDING DISPLAY FOR STOL AIRCRAFT** W. Holstein Washington NASA Jun. 1974 30 p refs Transl. into ENGLISH from the German report DGLR-73-038 Presented at the DGLR-DGON Symp. on New Approach and Landing Tech., Duesseldorf, 2-4 May 1973 (Contract NASw-2481) (NASA-TT-F-15618; DGLR-73-038) Avail: NTIS HC \$4.50 CSCL 17G

The design of landing display devices for STOL aircraft was investigated. A proposal is made for a contact analog landing display, which includes the perspective representation of mean flight path, information about actual flight status, predisplay of flight path coordinates, and boundary values for flight parameters. An approach procedure using the improved display is described. Author

N74-26155# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering. **MICROWAVE LANDING SYSTEM INTEGRATION STUDY. VOLUME 3: APPENDICES Final Report, 25 Jun. 1973 - 4 Mar. 1974** Edward Andrews, Jr., John E. Arnold, Charles R. Brittain, Garth R. Cooke, William M. Curran, Phillip H. Hermes, Gerald K. Hobart, John M. Molnar, John F. Schleich, and Jack L. Wolff 4 Mar. 1974 258 p refs (AF Proj. 404L) (AD-775724; GSE/SE/74-1-Vol-3) Avail: NTIS CSCL 17/7

Contains computer programs and data in support of the study. GRA

N74-26242# Air Force Weapons Lab., Kirtland AFB, N.Mex. **AVIATION FUEL SPILL CONTAINMENT USING ABSORBENT MATERIALS Final Report, Aug. - Dec. 1973** Eugene E. Mazewski and Ronald H. Kroop Mar. 1974 32 p (AF Proj. 683L) (AD-776762; AFWL-TR-74-9) Avail: NTIS CSCL 21/4

An evaluation on using absorbent materials to control aviation fuel spills was conducted. A literature search was made to determine what materials would be applicable. Three materials

were chosen. Evaluations were made on a laboratory scale, a slightly expanded scale on actual pavement, and a gulf-scale field demonstration under controlled conditions. It was determined that only one of the materials was feasible for the rapid containment of small (10 to 100 gallon) fuel spills. It is recommended that a full-scale evaluation of this product be conducted at an Air Force base. Author (GRA)

N74-26243# Naval Civil Engineering Lab., Port Hueneme, Calif.
SUBSTITUTION OF JP-5 AVIATION FUEL FOR DF-2 DIESEL UNDER FIELD CONDITIONS

John S. Williams Feb. 1974 10 p refs
 (AD-777047; NCEL-TN-1333) Avail: NTIS CSCL 21/4

The report covers the work done to determine whether JP-5 aviation turbine fuel is a suitable substitute for DF-2 diesel fuel in the heavy equipment of the Naval Construction Force woen such equipment is deployed on a large construction project. (Modified author abstract) GRA

N74-26251# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

FLIGHT-MEASURED INLET PRESSURE TRANSIENTS ACCOMPANYING ENGINE COMPRESSOR SURGES ON THE F-111A AIRPLANE

Jack Nugent and Jon K. Holzman Washington Jun. 1974 30 p refs
 (NASA-TN-D-7696; H-804) Avail: NTIS HC \$3.25 CSCL 21E

Two-F-111A airplanes were subjected to conditions that caused engine compressor surges and accompanying duct hammer shock pressure transients. Flight speed ranged from Mach 0.71 to Mach 2.23, and altitude varied from approximately 3200 meters to 14,500 meters. A wide range of compressor pressure ratios was covered. Stabilized free-stream, engine, and duct conditions were established before each compressor surge. Dynamic pressure instrumentation at the compressor face and in the duct recorded the pressure transients associated with the surges. Hammer shock pressures were analyzed with respect to the stabilized conditions preceding the compressor surges. The hammer shock transients caused large pressure rises at the compressor face and in the duct. Hammer shock pressure ratios at the compressor face were not affected by free-stream Mach number or altitude but were functions of engine variables, such as compressor pressure ratio. The maximum hammer shock pressure ratio of approximately 1.83 occurred at a compressor pressure ratio of approximately 21.7. Author

N74-26255# Avco-Everett Research Lab., Everett, Mass.
DISK GEOMETRY MHD GENERATOR FOR HIGH VOLTAGE HIGH POWER AIRCRAFT REQUIREMENTS Final Technical Report, Jul. 1971 - Dec. 1973

James E. Klepeis and Jean F. Louis Feb. 1974 111 p refs
 (Contract F33615-71-C-1905; AF Proj. 3145)
 (AD-775749; AFAPL-TR-74-6) Avail: NTIS CSCL 21/3

The disk represents a magnetohydrodynamic (MHD) channel geometry in which either a simple outward radial flow occurs, or there is a combination of radial flow with swirl. Distinguishing features and major advantages of the disk are electrodeless walls, and the simplicity of channel and magnet design. For airborne applications of the MHD generator, the goal is to achieve high power density and high power per unit weight. For certain electrical loads, a high voltage output is also desirable. The disk is uniquely suited to airborne applications because the radial symmetry peculiar to the geometry, and its capability to operate at very high electric fields, makes the disk a compact, high-voltage power supply. Described in the report is an experimental program concerned with the investigation and demonstration of the high-interaction performance of a large-scale disk generator driven by a large diameter (61.0 cm) shock tube. (Modified author abstract) GRA

N74-26258# Naval Postgraduate School, Monterey, Calif.
CALCULATING PROCEDURE OF SEA-LEVEL STATIC PERFORMANCE OF TWO-SPOOL AFTERBURNING BYPASS

JET ENGINE Progress Report

Michael H. Vavra Jun. 1973 107 p
 (AD-776547; NPS-57VA73061A) Avail: NTIS CSCL 21/5

A calculating procedure is presented for the sea-level static performance of duct burning and afterburning by pass jet engines that have a low pressure and a high pressure spool. Performance values can be determined also for operation without reheat. Influence of temperature and fuel/air ratio on the thermodynamic properties of air and combustion gases is taken into account. A calculating program for a Monroe 1880-43 programmable electronic desk calculator is described which makes it possible to evaluate effects of changes of parameters on performance with minimum effort. (Modified author abstract) GRA

N74-26389# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

MEASUREMENTS OF LINER COOLING EFFECTIVENESS WITHIN A FULL SCALE DOUBLE-ANNULAR RAM-INDUCTION COMBUSTOR

Edward J. Mularz and Donald F. Schultz Washington Jun. 1974 39 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Cleveland
 (NASA-TN-D-7689; E-7831) Avail: NTIS CSCL 20M

Combustor liner temperatures were measured on a full-scale combustor to evaluate the effectiveness of various liner cooling designs. The experimental results indicate that considerable reduction of cooling airflow rate is possible by optimum utilization of available convective cooling. The liner total cooling effectiveness was not significantly dependent on inlet-air temperature and was independent of combustor temperature rise. The experimental data from various liner configurations compared quite well with the results of an analytical heat-transfer model only if a turbulent mixing coefficient $C_{sub M}$ of 2 to 4 percent was chosen. These values of $C_{sub M}$ were much lower than the measured value of combustor turbulence intensity, contrary to the model's assumption that they are numerically equal. Author

N74-26421# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ORGANIZATION AND PLANNING OF PRODUCTION AT AIRCRAFT ENGINE-BUILDING PLANTS

V. I. Tikhomirov and F. I. Paramonov 14 Jan. 1974 642 p refs Transl. into ENGLISH of the book "Organizatsiya i Planirovanie Proizvodstva na Aviadvigatele-Stroitelnykh Zavodakh" Moscow, Machine Building Publishing, House, 1972 p 1-448
 (FTD Proj. T74-01-67)

(AD-775780; FTD-MT-24-499-73) Avail: NTIS CSCL 21/5
 The research was to identify and evaluate the importance of selected factors of the employees and their environment which might motivate them to work non-day shift schedules in Air Material Area (AMA) Aircraft Maintenance functions of the Air Force Logistics Command. Four general factor areas were considered: selected individual characteristics, hygiene, motivational and off-the-job aspects. A mailed questionnaire was developed to measure the perceived importance of selected factors with respect to shift preference. Data was gathered from a sample of 204 employees randomly selected from the Aircraft Divisions of the five AMA's. The results of the research indicated three sub-factors that were significantly different across shift preference groups. These subfactors were age, grade classification and salary. The other 13 subfactors were not supported as being different across shift preference groups. The implications of these results reinforce the intuitive conclusion that shift preference is largely tempered by differential pay considerations. Author (GRA)

N74-26423# Kanner (Leo) Associates, Redwood City, Calif.
INVESTIGATIONS ON ROLLING DAMPING OF SLENDER WINGS

F. Schlottmann Washington NASA Jun. 1974 22 p refs Transl. into ENGLISH from "Untersuchungen der Rolldämpfung von Schlanke Flugeln" Inst. for Thermodyn. and Fluid Dyn., Ruhr Univ., West Ger., Report 71-078, 1971 20 p
 (Contract NASw-2481)
 (NASA-TT-F-15729; Rept-71-078) Avail: NTIS HC \$4.25 CSCL 01A

The aerodynamic forces acting upon slender wing configurations in roll were measured in a low-speed wind tunnel in order to determine the influence of variation of the angle of attack and roll angular velocity. It was shown, for the delta- and square-wing models investigated, that a nonlinear relationship exists between rolling moment and roll angular velocity, and relationship between roll damping and angle of attack. The reason for this is the presence of the leading-edge separation together with the formation of rolled-up vortices over the wing plane. The different vortex configurations and the resulting effects on roll damping are discussed, and compared with the theory.

Author

N74-26424*# Technion - Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.
FLUTTER SUPPRESSION AND GUST ALLEVIATION USING ACTIVE CONTROLS Final Report
E. Nissim [1974] 83 p refs
(Grant NGR-52-012-006)
(NASA-CR-138658; TAE-198) Avail: NTIS HC \$7.25 CSCL 01A

The effects of active controls on the suppression of flutter and gust alleviation of two different types of subsonic aircraft (the Arava, twin turboprop STOL transport, and the Westwind twin-jet business transport) are investigated. The active controls are introduced in pairs which include, in any chosen wing strip, a leading-edge (LE) control and a trailing-edge (TE) control. Each control surface is allowed to be driven by a combined linear-rotational sensor system, located on the activated strip. The control law, which translates the sensor signals into control surface rotations, is based on the concept of aerodynamic energy. The results indicate the extreme effectiveness of the active systems in controlling flutter. A single system spanning 10% of the wing semispan made the Arava flutter-free, and a similar active system, for the Westwind aircraft, yielded a reduction of 75% in the maximum bending moment of the wing and a reduction of 90% in the acceleration of the cg of the aircraft. Results for simultaneous activation of several LE - TE systems are presented. Further work needed to bring the investigation to completion is also discussed.

Author

N74-26425*# United Aircraft Corp., East Hartford, Conn.
THE PASSAGE OF AN INFINITE SWEEP AIRFOIL THROUGH AN OBLIQUE GUST Final Report
John L. Adamczyk Washington NASA May 1974 96 p refs
(Contract NAS1-11557)
(NASA-CR-2395) Avail: NTIS HC \$4.00 CSCL 01B

An approximate solution is reported for the unsteady aerodynamic response of an infinite swept wing encountering a vertical oblique gust in a compressible stream. The approximate expressions are of closed form and do not require excessive computer storage or computation time, and further, they are in good agreement with the results of exact theory. This analysis is used to predict the unsteady aerodynamic response of a helicopter rotor blade encountering the trailing vortex from a previous blade. Significant effects of three dimensionality and compressibility are evident in the results obtained. In addition, an approximate solution for the unsteady aerodynamic forces associated with the pitching or plunging motion of a two dimensional airfoil in a subsonic stream is presented. The mathematical form of this solution approaches the incompressible solution as the Mach number vanishes, the linear transonic solution as the Mach number approaches one, and the solution predicted by piston theory as the reduced frequency becomes large.

Author

N74-26430# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
EJECTOR BLOWN LIFT/CRUISE FLAP WIND TUNNEL INVESTIGATION Final Report, Dec. 1971 - May 1973
Rodney L. Clark Nov. 1973 123 p refs
(AF Proj. 1476)
(AD-777181; AFFDL-TR-73-132) Avail: NTIS CSCL 01/3

The report presents the results of a wind tunnel investigation of a two dimensional powered wing section model employing a trailing edge ejector flap as a combination high lift and cruise

propulsion device. The concept investigated was proposed for application to STOL aircraft. Thrust augmentation data is presented for the static (zero velocity), Mach .12 and Mach .3 conditions. The compact ejector employed had a nominal inlet area ratio of 5 and produced a peak thrust augmentation ratio of 1.3 under static conditions. The thrust augmentation capability of the ejector decreased rapidly between 0 and Mach .12 to a value of approximately 1.0. Between Mach .12 and .3, the thrust produced by the ejector reduced at a much slower rate. Good high lift performance was obtained with the model in the low speed flight regime.

Author (GRA)

N74-26431 West Virginia Univ., Morgantown.
NON-LINEAR HELICOPTER ROTOR LIFTING SURFACE THEORY Ph.D. Thesis
Thomas Anthony Csencsitz 1973 342 p
Avail: Univ. Microfilms Order No. 74-11389

A numerical method is developed based on potential flow non-linear lifting surface theory for predicting the surface velocities and pressures on a rotor blade of an arbitrary helicopter rotor system which is executing a constant rotatory and constant axial translatory motion including, specifically, the hover flight mode. The formulation of the problem is exact in the sense that the normal surface boundary condition is satisfied on the surface of the rotor blade. The problem is governed by a Fredholm integral equation of the first kind which relates a singular velocity doublet potential surface distribution applied on the rotor blades and wakes to the normal relative velocity on the rotor blade surface. The wake model is assumed to be of a prescribed shape.

Dissert. Abstr.

N74-26432 Stanford Univ., Calif.
AUTOMATIC TRANSITIONS OF A TILT-ROTOR AIRCRAFT, PART 1. AUTOMATIC CONTROL OF A HELICOPTER WITH A HANGING LOAD, PART 2 Ph.D. Thesis
Narendra Kumar Gupta 1974 205 p
Avail: Univ. Microfilms Order No. 74-13633

Guidance and control of tilt rotor VTOL aircraft and of helicopters with hanging loads are studied. A mathematical model is developed to describe the motions of tilt rotor VTOL aircraft during hover, transition and cruise. This nonlinear model is used to generate satisfactory nominal take-off and landing trajectories. A perturbation guidance technique is then used; the equations of motion are linearized around the nominal trajectories and feedback laws are developed on the deviation of the aircraft states from these nominal values. An autopilot logic is designed for controlling a helicopter with a hanging load. The Sikorsky S-61 helicopter is chosen as an example vehicle. The performance of the controlled system is studied in the presence of longitudinal and lateral winds. Satisfactory response is obtained under design conditions and also with nominal changes in system parameters and configuration.

Dissert. Abstr.

N74-26435*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
PRELIMINARY PERFORMANCE APPRAISAL OF NAVY V/STOL TRANSPORT AND SEARCH-TYPE AIRPLANES USING HYDROGEN FUEL
W. C. Strack May 1974 33 p refs
(NASA-TM-X-71550; E-7962) Avail: NTIS HC \$3.25 CSCL 01C

First-cut estimates are given of the performance advantages of liquid-hydrogen-fueled, ejector wing, V/STOL aircraft designed for shipboard delivery and search-type missions. Results indicate that the use of LH2 could reduce gross weights 30 percent, empty weights 15 percent, and energy consumption 10 percent for a fixed payload and mission. If gross weight is fixed, the delivery range could be increased about 60 percent or the hover time during a search mission doubled. No analysis or discussion of the economic and operational disadvantages is presented.

Author

N74-26436*# Boeing Commercial Airplane Co., Seattle, Wash.
THE 727/JT8D BOEING SIDE NACELLE AIRLOADS
R. W. Bailey and H. J. Vadset Mar. 1974 263 p refs
(Contract NAS3-17842)

N74-26438

{NASA-CR-134547; D6-41527} Avail: NTIS HC \$16.25 CSCI 01B

Airloads on the 727/JT8D refan side engine nacelle are presented. These consist of surface static pressure distributions from two low speed wind tunnel tests. External nacelle surface pressures are from testing of a flow-through, body mounted nacelle model, and internal inlet surface pressures are from performance testing of a forced air inlet model. The method for obtaining critical airloads on nacelle components and a representative example are discussed. Author

N74-26438# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: WORLD AIRWAYS, INCORPORATED, DC-8-63F, N802WA, KING COVE, ALASKA, 8 SEPTEMBER 1973

8 May 1974 30 p

{NTSB-AAR-74-6} Avail: NTIS HC \$4.50

A DC-8 aircraft crashed into Mount Dutton, Alaska with total loss of life of six occupants. The aircraft had been cleared to land at Cold Bay airport while approximately 125 miles east of the airport. The crash occurred approximately 15 miles from the airport. The probable cause was deviation from approved instrument approach procedures and descent into an area of unreliable navigation signals and obstructing terrain. Author

N74-26439# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: PIEDMONT AIRLINES, BOEING 737, N75IN, GREENSBORO, NORTH CAROLINA, 28 OCTOBER 1973

22 May 1974 19 p

{NTJB-AAR-74-7} Avail: NTIS HC \$4.00

A Boeing 737 aircraft ran off the runway following a successful instrument landing approach and touchdown. The touchdown was 2,600 feet beyond the approach end of the runway and the airspeed was excessive at touchdown. It was determined that the cause of the accident was ineffective braking action due to hydroplaning on a wet runway. Contributing factors were: (1) an unstabilized downwind approach, (2) relatively long, fast touchdown on a downsloping runway, (3) delayed deployment of the automatic spoilers, and (4) failure of the crew to deploy the spoilers manually. Author

N74-26440# National Aerospace Lab., Tokyo (Japan).

SHEAR AND MOMENT RESPONSE OF THE AIRPLANE WING TO NONSTATIONARY TURBULENCE

Yoshinori Fujimori 14 May 1974 38 p refs Backup document for AIAA synoptic scheduled for publication in AIAA journal, Nov. 1974

Avail: NTIS HC \$5.00

A response formulation for the shear force and bending moment of an airplane wing has been established in terms of an evolutionary cross spectrum. Frequency distribution of the responses of arbitrary wing sections are obtained at any time after the airplane enters the nonstationary atmospheric turbulence. Contribution by the pitching motion is the highest to both shear and moment responses. The effect of the shear force to the stress level is negligibly smaller than that due to the bending moment. When the envelope profile looks like a step function, the mean square moment reaches the maximum in the transient stage whose spectrum is dominated by rigid modes. But the spectrum at stationary state, shows both rigid and flexible motions. Author

N74-26445# Advisory Group for Aerospace Research and Development, Paris (France).

PREDICTION METHODS FOR AIRCRAFT AERODYNAMIC CHARACTERISTICS

May 1974 349 p refs

{AGARD-LS-67} Avail: NTIS HC \$20.50

The proceedings of a conference on methods of predicting aircraft performance are presented. Emphasis was placed on predicting aircraft range and radius, airfield and maneuver performance, and aerodynamic characteristics. Combat and

transport aircraft were considered over conditions ranging from extremely low speeds through subsonic/transonic to supersonic speeds. Aircraft lift and drag estimation methods were analyzed along with related aerodynamic optimization techniques. Practical methods for wing/body aerodynamic design and boundary layer flow treatments were considered. The prediction and implications of special aerodynamic characteristics associated with engine installation and external store effects are examined, relevant stability/control needs are reviewed, and some aircraft noise restraints on aerodynamic design are investigated.

N74-26446 Royal Aircraft Establishment, Farnborough (England). **GENERAL TECHNICAL INFORMATION**

John Williams *In* AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 5 p (For availability see N74-26445 16-02)

Prediction and optimization methods for determining aircraft performance are discussed. The major deficiencies in the state of knowledge on aerodynamic characteristics are assessed. Recommendations for improvement in theoretical treatments, ground based testing facilities, and flight testing techniques are submitted. The overall technical constraints on aircraft performance prediction are defined. Specific technical lectures on the subjects of aircraft performance, wing aerodynamic design, engine installation aerodynamics, external store aerodynamics, and stability and control implications are identified. Author

N74-26447 McDonnell-Douglas Corp., Long Beach, Calif. Aerodynamics Subdivision.

AERODYNAMIC PREDICTION METHODS FOR AIRCRAFT AT LOW SPEEDS WITH MECHANICAL HIGH LIFT DEVICES

J. G. Callaghan *In* AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 52 p refs

A survey of present methodology used for the estimation of low speed aerodynamic characteristics of aircraft with mechanical high lift systems is presented. While this methodology is applicable to a large variety of aircraft with unpowered high lift systems, the emphasis is on transport type aircraft. Prediction methods empirically derived from experimental data, as well as more sophisticated theoretical methods are discussed. Correlations of calculated results with both wind tunnel and flight measurements are presented. To place the current state of the art of methodology into proper perspective, a critical review of areas of both strength and weakness is presented, with emphasis on future requirements. Within this context, the particular need for methods to estimate the high lift characteristics of aircraft with thin, highly swept, low aspect ratio wings, such as supersonic transport configurations are reviewed. Author

N74-26448 Royal Aircraft Establishment, Bedford (England).

A REVIEW OF THE LOW SPEED AERODYNAMIC CHARACTERISTICS OF AIRCRAFT WITH POWERED LIFT SYSTEMS

D. N. Foster *In* AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 43 p refs

The aerodynamic characteristics of a number of different configurations of fixed-wing aircraft with powered lift systems are discussed. Methods for predicting the aerodynamic characteristics are developed. Consideration is given to aircraft employing boundary layer control, based on jet flaps with internal blowing, external blowing from underwing and overwing engines, and augmentor systems. Spanwise blowing and other specialized techniques are examined. Aerodynamic characteristics in ground effect, as well as in free air, are reported. Some aspects of the noise problems which are directly related to the particular lowered lift system under discussion are considered. Author

N74-26449 Boeing Commercial Airplane Co., Renton, Wash. **AIRCRAFT LIFT AND DRAG PREDICTION AND MEASUREMENT**

G. M. Bowes *In* AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 44 p refs

Techniques for predicting and measuring lift and drag relationships for subsonic cruise flight are described. The status of this drag methodology is reviewed. Recent presentations on the subject are referenced and incorporated into an overall summary describing current capabilities for developing the basis of aircraft performance predictions. The role of the wind tunnel in airplane design and development is discussed, and the importance of flight test measurements of specific range and engine parameters is emphasized. Theoretical developments for three-dimensional design and lift/drag predictions are described. The accuracy with which the drag levels of a new design can be determined is examined. Examples of specialized wind tunnel and flight investigations into the airflow and pressures on localized portions of an airplane are presented. Author

N74-26450 British Aircraft Corp., Filton (England).
PREDICTION OF SUPERSONIC AIRCRAFT AERODYNAMIC CHARACTERISTICS
 S. S. Leyman and T. Markham In AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 52 p refs

The methods currently available for the prediction of the aerodynamic characteristics of supersonic aircraft as they effect performance are reviewed. The problems of supersonic aircraft design are illustrated by consideration of hypothetical transport and fighter aircraft. The methods used to predict the performance of the Concorde aircraft are stressed. The aerodynamic principles which make supersonic aircraft different from subsonic designs are analyzed. The accuracy and suitability of design methods for various stages of design are examined. The state of the art for estimating parasitic drag and thrust loss due to air leakage is described. Problems of estimating the installed powerplant performance are included. Author

N74-26451 National Aerospace Lab., Amsterdam (Netherlands).
APPRAISAL OF WING AERODYNAMIC DESIGN METHODS FOR SUBSONIC FLIGHT SPEED
 N. Loeve In AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 41 p refs

For a number of direct calculation methods for the prediction of flows around wings at subsonic speed, the basic assumptions are discussed. This forms the basis for the applicability of the methods. Comparison of calculated pressure distributions with results from wind-tunnel tests serve to illustrate this for three-dimensional wings and for the limiting case of plane flows around airfoils. Attention is paid to the use of inverse methods. In this context the use of hodograph methods for the design of airfoils with transonic shockfree flow is discussed. Author

N74-26453 Office National d'Etudes et de Recherches Aérospatiales, Paris (France).
ENGINE INSTALLATION AERODYNAMICS
 J. Leynaert In AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 22 p refs

Aspects of engine installation aerodynamics are considered to include theoretical design, optimization of the engine installation, and experimental study. Air intake, afterbody, and engine/aircraft integration problems are analyzed for high subsonic and supersonic aircraft. High speed and low speed performance are discussed. Comments are made on variable geometry devices. Special attention is given to the significance of the various propulsion and drag balance terms. Author

N74-26454 Aircraft Research Association, Ltd., Bedford (England).
EXTERNAL STORE AERODYNAMICS FOR AIRCRAFT PERFORMANCE PREDICTION
 J. B. Berry In AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 34 p refs

Some effects of external stores on the aerodynamic characteristics of aircraft and in particular the incremental drag due to various types of store installation are described. Examples of drag increments for single and multiple store assemblies installed underwing and underfuselage and the effects of C sub L and Mach number up to high subsonic speeds, illustrate some of the interference features in the aircraft-store flow field which contribute to high or low drag. The prospects for incremental drag prediction, the possible use of calculated or measured flow field data, empirical methods and flight-tunnel comparisons are discussed. Approximate empirical estimation procedures for simple underwing and underfuselage store installations are described. It is suggested that for multiple store assemblies, opportunities for drag reduction offer considerably more promise than attempts to predict the drag increment. Significant drag savings are demonstrated not only for new types of installation but also by relatively simple modifications to existing designs. Author

N74-26455 Royal Aircraft Establishment, Farnborough (England).
SUPPLEMENTARY CONTRIBUTION ON AIRCRAFT PERFORMANCE CONSIDERATIONS FOR NOISE REDUCTION
 John Williams In AGARD Prediction Methods for Aircraft Aerodyn. Characteristics May 1974 1 p

The problem of achieving much lower noise levels outside airport boundaries, while at the same time predicting and quaranting the noise field from future aircraft with greater accuracy, is examined. Methods for obtaining reductions in aircraft noise levels are identified. The integration of aircraft performance characteristics, airframe design, and airframe-engine aero-acoustic interference parameters to produce reduced noise levels is emphasized. Author

N74-26456* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
WINGTIP VORTEX DISSIPATOR FOR AIRCRAFT Patent Application
 James C. Patterson, Jr., inventor (to NASA) Issued 24 May 1974 12 p
 (NASA-Case-LAR-11645-1; US-Patent-App'l-SN-473973) Avail: NTIS HC \$4.00 CSCL 01C

An apparatus for reducing the effects of aircraft wingtip vortices is discussed. The device consists of a spline structure containing hinged and retractable flat plates which create a positive-pressure gradient in the area downstream of the wing trailing edge. This positive pressure gradient causes the vortex to dissipate by forcing the linear air flow around and through the core of the vortex. Alternate configurations in the form of a drag chute or a wingtip mounted engine are considered. NASA

N74-26457* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
LOW SPEED WIND TUNNEL TESTS OF A 1/8-SCALE MODEL OF A VARIABLE-SWEEP ADVANCED SUPERSONIC TRANSPORT An Early Domestic Dissemination Report
 H. Clyde McLamore, Lysle P. Parlett, and William G. Sewall

N74-26458

May 1974 84 p refs
(NASA-TM-X-71960) Avail: NASA Regional Dissemination Centers only to U.S. Requesters: HC \$4.00/MF \$1.45 CSCI 01C

Tests have been conducted in the Langley full-scale tunnel to determine the aerodynamic characteristics of a 1/9-scale variable-sweep advanced supersonic transport configuration. The model configurations investigated were the basic unflapped arrangement, and a takeoff and landing flap arrangement with several strake leading edge flow control devices. The tests were conducted for an angle-of-attack range from about minus 5 deg to 36 deg and a sideslip range from minus 5 deg to 10 deg. The tests were conducted for a range of Reynolds number from 3.92 million to 5.95 million corresponding to test velocities of about 54.5 knots and 81.7 knots, respectively. Author

N74-26458# Royal Aircraft Establishment, Farnborough (England).

FAIL-SAFE AIRCRAFT STRUCTURES, VOLUME 1

A. M. Stagg, comp. Mar. 1974 363 p refs Proc. of the 7th Intern. Comm. on Aeron. Fatigue Symp., London, 18-20 Jul. 1973 2 Vol.

(RAE-TR-73183-Vol-1; BR39889) Avail: NTIS HC \$21/25

Among the topics covered are: fatigue life of aircraft structures under loads; fatigue and failure procedures and programs; fail-safe and airworthiness philosophy; and fatigue crack propagation.

N74-26460 Royal Aircraft Establishment, Farnborough (England).
FAIL-SAFE PHILOSOPHY: AN INTRODUCTION TO THE SYMPOSIUM

R. D. J. Maxwell *In its* Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 13 p refs

The current approach to the fail-safe philosophy of design against fatigue is examined. The general principles to be followed, are stated, and some of the problems involved, both in writing requirements that adhere to the stated principles and in interpreting those requirements, are assessed. Some of the potential dangers that have developed in the application of the fail-safe approach over the years are also considered.

Author (ESRO)

N74-26461 Societe Nationale Industrielle Aerospatiale, Paris (France).

INTERRELATED ASPECTS OF SERVICE SAFETY ARISING FROM CONSIDERATION OF SAFE LIFE, FAIL-SAFE, MANUFACTURING QUALITY AND MAINTENANCE PROCEDURES

W. G. Barrois *In* RAE Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 44 p refs

An attempt is made to determine whether a quantitative appraisal may be achieved concerning safe-life and fail-safe characteristics of aircraft structures. The conclusion reached is somewhat negative: substantiation of safe-life, fail-safe or of both safe-life and fail-safe, does not always give sufficient levels of safety. It must be combined with levels of manufacturing quality and of inspection efficiency, which are all the higher as the fatigue stressing is higher. Remedies against fatigue and other causes of damage are not to be found by consideration of a single concept but may be obtained by considering a combination of concepts, taking into consideration their effects on safety, weight, and cost. Safety ensured by fail-safe alone would entail unacceptable weight penalization when applied to the whole structure. Real fail-safe is not always realizable. On the other hand, a general high level of manufacturing quality may be very expensive to achieve and may induce catastrophic failure in cases in which the quality is jeopardized by an undetected defect. Frequent, scheduled inspections may be costly and may even become illusory owing to the repeated observation of no damage. Author (ESRO)

N74-26462 Lockheed-California Co., Burbank.
THE LOCKHEED L-1011 TRISTAR FATIGUE AND FAIL-SAFE DEVELOPMENT PROGRAM

L. W. Nelson, M. A. Melcon, and H. Simons *In* RAE Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 115 p refs

The various tests performed on the Lockheed L-1011 are described. The elements of the program included formulation of criteria, analysis, development tests, component design verification tests, and fatigue and fail-safe tests on two separate airframes.

Author (ESRO)

N74-26463 Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost.

INVESTIGATION OF THE FAIL-SAFE PROPERTIES OF CIVIL AIRCRAFT

G. J. Fonk *In* RAE Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 27 p

Current fail-safe methods are discussed with respect to inspection, crack growth, and residual strength. Attention is paid to the variety of components to be considered, testing procedures, and interpretation of the results. Emphasis is placed on the basic ideas, which are illustrated by procedures adopted for the F-28 aircraft. Author (ESRO)

N74-26464 McDonnell-Douglas Corp., Long Beach, Calif.
AIRWORTHINESS PHILOSOPHY DEVELOPED FROM FULL-SCALE TESTING

M. Stone *In* RAE Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 40 p refs

Results derived from full-scale repeated load tests are presented to aid in the development of airworthiness philosophy. Information is considered on testing philosophy, test spectrum, crack-free structure, crack growth, residual strength, and inspection programs. The test spectrum is derived from analysis spectra and is strongly influenced by economic and schedule considerations. A large number of low loads and infrequent high loads which do not contribute any substantial amount of damage are excluded. Testing to two lifetimes and finding relatively few cracks proved the long-term reliability of the DC 10 structure. The few places requiring design improvements, as expected in any fatigue tests, are described and the scatter of fatigue lives caused by variability of interference fit fasteners is evaluated. The inspection program developed for the DC 10 structure is discussed in conjunction with the full scale fatigue test results. The evaluation of these fatigue tests considers the scatter factor in relation to expected service experience. An understanding of the inspection objectives is required in order to minimize cost and delay in schedules.

Author (ESRO)

N74-26465* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

A UNIFIED TECHNOLOGY PLAN FOR FATIGUE AND FRACTURE DESIGN

H. F. Hardrath *In* RAE Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 22 p refs

An integrated research program is proposed that seeks to improve the technology of designing against fatigue and fracture and to develop a computerized capability for assessing the adequacy of a given design. Both fatigue life prediction and damage tolerance considerations are incorporated. The research for each of these considerations is organized to account for material behavior, the effect of structural configurations, the cumulative effects of the operating loadings, and the effects of temperature and corrosion. Author (ESRO)

N74-26467 National Aerospace Lab., Amsterdam (Netherlands).
THE PREDICTION OF FATIGUE CRACK PROPAGATION UNDER SERVICE LOAD-TIME HISTORIES

J. Schijve *In* RAE Fail-safe Aircraft Struct., Vol. 1 Mar. 1974 31 p refs
(NLR-MP-73016-U)

Results are presented from crack propagation tests on aluminum alloy sheet specimens tested by flight simulation loading. Five design stress levels were adopted. The usefulness of the stress intensity factor for correlating the data was evaluated. Various approaches for predicting crack rates under service loading damage calculations, and the significance of flight simulation testing procedures are discussed. Author (ESRO)

N74-26468# Royal Aircraft Establishment, Farnborough (England).

FAIL-SAFE AIRCRAFT STRUCTURES, VOLUME 2

A. M. Stagg, comp. Mar. 1974 379 p refs Proc. of the 7th Intern. Comm. on Aeron. Fatigue Symp., London, 18-20 Jul. 1973 2 Vol.

(RAE-TR-73183-Vol-2; BR39890) Avail: NTIS HC \$22.00

Fail-safe methods and fatigue and fracture problems under various conditions are discussed.

N74-26469 Societe Nationale Industrielle Aerospatiale, Marignane (France.) Helicopter Div.

INFLUENCE OF THE DEGREE OF FAIL-SAFE ACHIEVED, USING THE INTERNAL PRESSURE INDICATOR (BIM), ON THE FLIGHT SAFETY DURING A SPECIFIED SERVICE LIFE OF MAIN ROTOR BLADES OF SA 321 AND SA 330 HELICOPTERS

F. Liard and C. Marcoux /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 29 p refs

In order to increase the retirement life of hollow helicopter blades, the blades are pressure drop sensed by a pressure blade indicator system (called BIM for blade inspection method) which is inspected before each flight. The increase in retirement life is supported by probability computations based on the crack propagation rate measured during blade fatigue tests.

Author (ESRO)

N74-26470 United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

FATIGUE AND FRACTURE CONSIDERATIONS IN CRITICAL TITANIUM COMPONENTS c32

M. J. Salkind /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 12 p refs

The use of titanium for aircraft structures, because of its fatigue and fracture strength, is discussed. The example given is its use in the H-53 rotor blade which provides a significant increase in lift and speed for the same weight as aluminum.

Author (ESRO)

N74-26471 Oklahoma City Air Materiel Area, Tinker AFB, Okla. **EFFECT OF PROOF LOAD APPLICATION ON FATIGUE TEST RESULTS** c32

J. Bell and J. B. Dempster (Boeing Co., Wichita, Kans.) /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 25 p refs

The effect of high loads on fatigue crack initiation and growth was evaluated based on data obtained from two full-scale fatigue tests of generally identical 7178-T6 structures. The flight-by-flight loading spectrum applied during a 1962 fatigue test included a proof load (90 % limit load) once every 200 flights. A 1972 fatigue test with a similar flight-by-flight loading spectrum included only those loads expected in fleet operation. The maximum applied load in the second test was 62% of limit load applied once every 200 flights. Fatigue cracking developed earlier in the 1972 fatigue test than in the 1962 test. Small specimen testing was conducted to confirm and quantify this high load effect. Both test loading spectra were applied to 7178-T6 specimens. Analysis predictions of the specimen test crack propagation were also developed to show the effects of high loads on crack retardation. The full scale fatigue test, specimen fatigue test, and analysis results indicate support of the premise that application of high loads will delay crack initiation and retard crack growth in 7178-T6.

Author (ESRO)

N74-26473 Boeing Commercial Airplane Co., Seattle, Wash. **THE 747 FAIL-SAFE STRUCTURAL VERIFICATION PROGRAM**

R. V. Sanga /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 66 p refs

The extension of a previously developed analytical approach and development of a finite element technique for the 747 structural development program are described. Subsequent improvements include the fastener flexibility effects on the first fastener load and residual strength response within a simulated

elastic-plastic range; scope of the methods for applications to riveted, bonded, and integrally stiffened configurations containing realistic complex damages at fastener locations; comparisons with laboratory component tests; and correlations with the full-scale test configurations. As part of the 747 structural integrity verification, an extensive full-scale fatigue and fail-safe test program was conducted. The basic test approach consisted of subjecting each major structural item to at least one lifetime of fatigue testing. Fail-safe tests were conducted on several test damage configurations, and in all cases fail-safe load was successfully demonstrated. Good correlation was found between test data and calculated stress distributions and residual strengths.

Author (ESRO)

N74-26474 Ministry of Defence, London (England).

AIRCRAFT FATIGUE AND STRUCTURAL INTEGRITY IN THE ROYAL AIR FORCE FROM A MAINTENANCE ENGINEERING VIEWPOINT

H. A. Mills and G. D. MacDonald /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 12 p

An indication is given of the military environment and of the current policy designed to establish a Royal Air Force contribution to the ultimate aim of improving assessment of aircraft structural reliability. Current problems are reviewed against the background of a multirole, mobile force with a wide variety of aircraft types of differing ages and technologies. Emphasis is placed on the ever present need for close cooperation between research, design, operations, and maintenance to achieve peak operating efficiency while preserving structural integrity.

Author (ESRO)

N74-26475 Department of Civil Aviation, Melbourne (Australia). **THE IMPACT OF LONG SERVICE ON THE FATIGUE OF TRANSPORT AIRCRAFT: AIRWORTHINESS ASPECTS**

K. R. A. O'Brien, C. Torkington, M. B. Benoy, and R. B. Douglas /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 30 p refs

Actual case studies involving fatigue problems in large civil aircraft, which have occurred in Australia in recent years as a result of long service, are discussed. The current design standards covering fatigue evaluation of flight structures are briefly reviewed, and service problems and their effects on fail-safe are discussed. Effects of developments in fracture and fatigue analysis methods are described, and the pressing of aged aircraft into extended service is considered.

Author (ESRO)

N74-26476 Laboratorium fuer Betriebsfestigkeit, Darmstadt (West Germany).

A STANDARDIZED FLIGHT-BY-FLIGHT TEST PROGRAM FOR THE FATIGUE LIFE EVALUATION OF WING COMPONENTS OF TRANSPORT AIRCRAFT

D. Schuetz /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 34 p

A life calculation for spectra different from the standardized load spectrum is proposed using Miner's rule. Tests were run to check the accuracy of the concept taking into account effective differences between load spectra. It is shown that Miner's rule when applied to this concept does not provide too satisfying results for most of the extreme spectra modifications.

Author (ESRO)

N74-26477 Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (West Germany).

FULL-SCALE FATIGUE TESTING. A COMPARISON WITH SERVICE EXPERIENCE AND INTERPRETATION OF TEST RESULTS c32

H. J. Zocher /in RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 35 p refs

The basic requirements which should be met by full-scale fatigue tests for reliable fatigue life predictions are briefly outlined. A comparison of test results obtained from two full scale fatigue tests with different types of loading programs demonstrates that flight-by-flight fatigue tests are superior to block program loading. Flight-by-flight test lives were compared to service experience and showed reasonable agreement. Some conclusions to be drawn from test results are discussed.

Author (ESRO)

N74-26478 Royal Aircraft Establishment, Farnborough (England). **FATIGUE IN CARBON FIBRE REINFORCED PLASTIC STRUCTURES: A REVIEW OF THE PROBLEMS** c32 A. W. Cardrick *In its* Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 28 p refs

The properties of carbon fiber reinforced plastics are discussed, and an attempt has been made to anticipate the more important questions which must be answered in order to aid design and the formulation of airworthiness requirements for fatigue loaded CFRP structures. Programs of fatigue research on carbon fiber reinforced plastics are summarized. Plans are presented for complementary intramural work in which specimens containing typical structural features will be tested under realistic loading.

Author (ESRO)

N74-26479 Westland Helicopters Ltd., Hayes (England). **FATIGUE OF COMPOSITE STRUCTURES: EXPERIENCE GAINED IN THE DESIGN OF CFRP STRUCTURES FOR HELICOPTERS**

H. F. Winny *In* RAE Fail-safe Aircraft Struct., Vol. 2 Mar. 1974 20 p refs

Fatigue testing on carbon fiber reinforced plastic (CFRP) components for helicopter structural members is described. It includes fatigue testing on flat laminates in compression, bolted joints in tension and coupon rings in bending. These were planned to give fatigue design data on the actual angled-ply used, as well as overall testing in torsion of completed CFRP shafts, and joint in tension of a 30 in. length of tail boom. The results in general are satisfactory, and certain criteria are suggested for future designs.

Author (ESRO)

N74-26481# Physikalisch-Technische Bundesanstalt, Brunswick (West Germany).

AIRCRAFT NOISE IN URBAN AREAS. MEASUREMENT AND EVALUATION [FLUGLAERM IN WOHNGEBIETEN - MESSUNG UND BEURTEILUNG]

H.-O. Finke and R. Martin 1974 8 p refs *In* GERMAN Presented at the DGLR Symp. Triebwerkslaerm, Brunswick, 20-21 Feb. 1974

(DGLR-Paper-74-013) Avail: NTIS HC \$4.00

Acoustic measurements of aircraft noise in an urban area were made and evaluated. A district of Munich, Germany, with 100,000 inhabitants was the urban area selected. The following measurements were made: maximum aircraft-sound level number, duration and frequency of overflights, and background noise. The evaluations are discussed in detail.

ESRO

N74-26482# Luftfahrt-Bundesamt, Brunswick (West Germany). **NOISE LIMIT VALUES OF AIRCRAFT [LAERMGRENZWERTE BEI LUFTFAHRZEUGEN]**

F. K. Franzmeyer 20 Feb. 1974 18 p refs *In* GERMAN Presented at the DGLR Symp. Triebwerkslaerm, Brunswick, 21 Feb. 1974

(DGLR-Paper-74-015) Avail: NTIS HC \$4.00

Aircraft noise threshold values for jet aircraft with a maximum takeoff weight above 5700 kg, propeller aircraft with a maximum takeoff weight up to 5700 kg, and motor gliders, as laid down in regulations in Germany, are detailed. International noise regulations on the official admission of aircraft are discussed.

ESRO

N74-26483# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

SYSTEMATIC SOUND INSULATION INVESTIGATIONS [SYSTEMATISCHE UNTERSUCHUNGEN AUF DEM GEBIET DER SCHALLABSCHIRMUNG]

H. Hoelscher 15 Feb. 1974 30 p refs *In* GERMAN Presented at the DGLR Symp. Triebwerkslaerm, Brunswick, 21 Feb. 1974 Sponsored by Bundesmin. fuer Forsch. und Technol.

(MBB-UH-06-74-0; DGLR-Paper-74-021) Avail: NTIS HC \$4.50

Acoustic measurements on nonabsorbing and absorbing planes with one, two, and three diffracting edges and one round edge at different distances from the shielding plane were carried out. The results were evaluated and compared with similar experiments of other authors.

ESRO

N74-26485# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

HELICOPTER ROTOR NOISE AND POSSIBILITIES FOR ITS REDUCTION [LAERMERSCHWINGUNGEN BEI HUBSCHRAUBERROTOREN UND MOEGlichkeiten ZUR LERMINDERUNG]

V. Langenbacher 8 Feb. 1974 17 p refs *In* GERMAN Presented at the DGLR Symp. Triebwerkslaerm, Brunswick, 20-21 Feb. 1974

(MBB-UD-118-74-0; DGLR-Paper-74-024) Avail: NTIS HC \$4.00

Helicopter rotor and tail rotor noise production, including blade slap, rotation sound, and rotor noise, is discussed. Measures to reduce the noise are outlined. Noise reduction of tail rotors was investigated experimentally and future developments are indicated.

ESRO

N74-26486# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

COMPARISON OF FOKKER F-28 WIND TUNNEL AND FLIGHT DATA, A SUMMARY

J. T. M. VanDoorn, L. J. Erkalens, S. O. T. H. Han, and Y. G. Kho 5 Jan. 1973 41 p refs Sponsored by Neth. Agency for Aerospace Res.

(NLR-TR-73007-U) Avail: NTIS HC \$5.25

For an accurate prediction of aircraft characteristics, the wind tunnel tests are of paramount importance. Therefore the significance of the test results and available extrapolation techniques have to be investigated as thoroughly as possible. For this reason a program for comparing wind tunnel and flight test data of the Fokker F-28 was set up, comprising lift, development of flow separation at low speed, high speed buffet boundary, drag, pitching moments, ground effects, and elevator hinge moment derivatives. The investigation confirmed that full-scale characteristics of the aircraft can in general be predicted from model experiments within an acceptable accuracy with the aid of existing knowledge about scale effects and corrections applied to the wind tunnel test results. A further refinement of prediction methods and test techniques is nevertheless desirable.

Author (ESRO)

N74-26488# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FLIGHT CONTROL OF AIRPLANES AND HELICOPTERS

V. T. Borodin and G. I. Rylsky 21 Mar. 1974 357 p refs Transl. into ENGLISH of the book "Upravlenie Poletom Samoletov i Vertoletov" USSR, 1972 p 1-240

(AD-777297; FTD-MT-24-251-74) Avail: NTIS CSCL 01/3

The book provides an analysis and systematizes the basic results of foreign investigations into the automation of flight control of airplanes and helicopters. It presents the block diagrams and descriptions of the control systems of contemporary airplanes and helicopters, flexible aircraft, and also of adaptive (self-tuning, with variable structure, self-organizing) aviation systems. It examines the bionic principles of adaptation and the possibility of their use in control systems of aircraft, and also the problems of the automation of landings, flight at low and maximally low altitudes, and the integration of airborne equipment. It describes the methods for the display of flight information to the pilot, the system of semiautomatic control, the system for the prevention of the collision of airplanes in the air, landing systems, systems of profile flight, and contemporary complexes of airborne equipment.

GRA

N74-26489# LTV Aerospace Corp., Dallas, Tex. Vought Systems Div.

LIMIT CRITERIA FOR LOW COST AIRFRAME CONCEPTS Final Report, May - Nov. 1973

S. H. Yarbrough Oct. 1973 109 p refs

(Contract F33615-73-C-3126; AF Proj. 1368)

(AD-777572; Rept-2-57110/3R-3126; AFFDL-TR-73-140) Avail: NTIS CSCL 01/3

The report presents the results of a study program which evaluated the primary cost factors of selected airframe baseline components and alternate designs compatible with low cost concepts. The data from this study is compiled and presented

in a ready reference format defined as the Limit Criteria. Six A-7D aircraft components representing the characteristic stress types were selected as the baseline designs, then a minimum of two or more alternate designs were selected for each component. The baseline and alternates were analyzed and estimated on the basis of strength, stiffness, fracture toughness, weight and cost. Weight and cost of the design variations was plotted on a Cost/Weight/Value Diagram of each component for direct comparison of current design results. (Modified author abstract) GRA

N74-26490# Sage Action, Inc., Ithaca, N.Y.
A CORRELATION STUDY OF IN-FLIGHT VIBRATION MEASUREMENTS FOR PATROL-TYPE AIRCRAFT Technical Report, 15 Oct. 1968 - 30 Jun. 1971

P. Tan Dec. 1973 51 p refs
 (Contract N00014-69-C-0031; NR Proj. 215-039)
 (AD-777668; SAI-RR-7303; TR-1) Avail: NTIS CSCL 01/3

A correlation study of vibration data for patrol-type and similarly-configured aircraft in turbulence-free, straight and level flight is presented. All of the known existing measurements for six planes are examined. A free-free uniform beam with a single lumped mass at midspan for the fuselage, together with an approximate representation of the exciting forces, is proposed as a mathematical model. The expression for the vibrational response is derived by the second form of the Ritz method. Computed results for the double displacement amplitude spectrums are compared with the measured data and found to agree very well. A simple correlation formula is also developed. Author (GRA)

N74-26491# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AUTOMATION OF THE LANDING CONTROL OF AIRCRAFT

S. L. Belogorodskii 7 Mar. 1974 517 p refs Transl. into ENGLISH of the book "Avtomatizatsiya Upravleniya Posadkoi Samoleta", 1972 p 1-351
 (AD-777174; FTD-MT-24-720-73) Avail: NTIS CSCL 01/2

Questions on the automation of one of the most complex stages of flight -- the landing of the aircraft -- are examined. The operating principles of the radio technical devices utilized for formation of landing trajectories are illuminated. Questions of the dynamics of semiautomatic and automatic aircraft control are presented and block diagrams and features of domestic and foreign systems of automated landing control of aircraft are examined. GRA

N74-26492# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

DEVELOPMENT OF CARGO SLINGS WITH NONDESTRUCTIVE CHECKOUT SYSTEMS Final Report

Horace T. Hone, Walter E. Huebner, and Donald J. Baxter Feb. 1974 166 p refs

(Contract DAAJ02-72-C-0008; DA Proj. 1F1-63209-DB-33)
 (AD-777497; SER-50859; USAAMRDL-TR-73-106) Avail: NTIS CSCL 01/3

The report describes the design, fabrication and testing of the following equipment which was developed to extend the facilities for carrying external loads on U.S. Army helicopters: four-legged wire rope slings of 6,000, 25,000 and 60,000 pounds nominal capacity, four-legged nylon rope slings of 6,000 and 25,000 pounds nominal capacity, nylon rope pendants of 6,000 and 20,000 pounds nominal capacity for use in conjunction with the 6,000- and 25,000-pound slings, and nondestructive test apparatus for the wire rope slings. Author (GRA)

N74-26493# Mechanical Technology, Inc., Latham, N.Y.
PREDICTION OF GEAR-MESH-INDUCED HIGH-FREQUENCY VIBRATION SPECTRA IN GEARED POWER TRAINS

Aiston L. Gu and Robert H. Badgley Jan. 1974 91 p refs
 (Contract DAAJ02-72-C-0040; DA Proj. 1G1-62207-AA-72)
 (AD-777496; MTI-73TR28; USAAMRDL-TR-74-5) Avail: NTIS CSCL 01/3

Characteristics of vibration spectra induced by gear meshes in both single gear reductions and planetary gear reductions were investigated. Methods were developed to analyze the planet-pass induced vibrations which exist in normal planetary gear reduction systems. It was found that the planet-pass vibration sideband frequencies occur both below and above the base signal at integer multiples of planet-pass frequency and that the sideband amplitudes may exceed that of the base signal. The effect of planet pair phasing on the vibration sideband spectra was determined for the CH-47 helicopter forward rotor drive transmission first-stage planetary reduction. A computer-implemented analysis was established for predicting vibration sidebands produced by variations in centerline distance, tooth transmitted force, and tooth support discontinuities for single gear mesh systems. (Modified author abstract) GRA

N74-26494# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ANTONOW'S TRANSPORT PLANE
 M. Jurleit 28 Mar. 1973 17 p refs Transl. into ENGLISH from Flieger Revue (East Germany), no. 8, 1973 p 358-362
 (AD-777661; FTD-HC-23-1256-74) Avail: NTIS CSCL 01/3

The translation briefly reviews Soviet transport plane development and design. GRA

N74-26495# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

PROGRAM PLAN FOR INVESTIGATION OF MODEL E-11C-1 AIRPLANE CATAPULT AND HOLD-BACK OPERATIONS CAPACITY

Louis Berman 25 Mar. 1974 29 p refs
 (AD-777435; NADC-74058-30) Avail: NTIS CSCL 01/2

A laboratory fatigue test will be performed on an E-1 airframe to determine whether the airframe will sustain the effects of 3,000 catapult launches without structural failure. Author (GRA)

N74-26663*# Ohio State Univ., Columbus. ElectroScience Lab.

A STUDY OF KC-135 AIRCRAFT ANTENNA PATTERNS
 W. D. Burnside, R. J. Marhefka, and C. L. Yu Mar. 1974 22 p refs
 (Grant NGR-36-008-144)

(NASA-CR-138585; ESL-3001-9) Avail: NTIS HC\$4.25 CSCL 17B

Numerical solutions for the radiation patterns of aircraft antennas are evaluated. Designing and locating antennas in order to achieve the desired performance is discussed. The high frequency solutions presented in this report are based on fuselage antennas mounted on a general-type aircraft but applied specifically to the KC-135 aircraft. The roll and elevation plane patterns are computed for a monopole, axial slot, and circumferential slot mounted both over and forward of the wings. In each case the calculated patterns compare very favorably with the measured patterns. The precision pattern measurements were taken on a 1/25 scale model of the KC-135 aircraft at NASA (Langley, Virginia) with special emphasis on reducing the mount and background effects. Author

N74-26666*# Ohio State Univ., Columbus. ElectroScience Lab.

COMPUTER ANALYSIS OF AIRCRAFT AND SHUTTLE ANTENNAS Semiannual Status Report, 15 Nov. 1973 - 15 May 1974

W. D. Burnside and J. H. Richmond Jun. 1974 12 p ref
 (Grant NGL-36-008-138)

(NASA-CR-138605; ESL-2902-16) Avail: NTIS HC\$4.00 CSCL 17B

Progress on predicting the patterns of high-frequency antennas on aircraft and shuttles is reported. Patterns are presented for an axial slot antenna on a circular cylinder partially coated with a dielectric layer. Results are shown for Omega signal disturbance by a conducting vertical pole. Author

N74-26768 Utah State Univ., Logan.
DYNAMIC RESPONSE OF THE LANDING MAT TO AIRCRAFT LANDING Ph.D. Thesis

Kambiz Daftarian 1973 103 p
 Avail: Univ. Microfilms Order No. 74-13210

A method is presented for obtaining the dynamic response of landing mats to aircraft landing for the purpose of preventing the damage which occurs when a C-54 aircraft lands on temporary runways constructed of AM-2 landing mat panels. The model used consisted of discrete rigid masses. Springs and dashpots were used to simulate the joints and the mat-subgrade interface. Newtonian and Lagrangian mechanics were two independent ways to derive the equations governing the motion of the system. A computer program was written and numerical methods were used to determine the results of non-linear coupled differential equations that govern the motion of the system. The parameters used represent the constants associated with AM-2 landing mats which are used for C-54 Galaxy aircraft. The approximate values for parameters were found by some simple static and dynamic tests. The factors found to influence the stability of landing mats are described. Dissert. Abstr.

N74-27171* Kanner (Leo) Associates, Redwood City, Calif.
SAFETY DURING AUTOMATIC LANDING WITH POOR VISIBILITY

J. P. DeBeauchene Washington NASA Jun. 1974 23 p
 Transl. into ENGLISH from Navigation (Paris), v. 22, Jan. 1974 p 31-46
 (Contract NASw-2481)
 (NASA-TT-F-15715) Avail: NTIS HC \$4.25 CSCL 17G

The performance of automatic pilot systems during aircraft approach and landing is discussed. Emphasis is placed on the flight safety aspects and limitations of the systems under low visibility conditions. The components and operating principles of the instrument landing system (ILS) are analyzed. Examples of automatic pilot systems installed in various transport aircraft are illustrated. Author

N74-27172# Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
NEW METHODS FOR COMMAND AND STABILITY AUGMENTATION VIA OPTIMAL CONTROL

Eliezer Kreindler (Technion - Israel Inst. of Tech.) and David Rothschild Apr. 1974 62 p refs
 (RE-472) Avail: NTIS HC \$6.25

An implicit model following design technique is presented based on linear optimal control, that is particularly effective for complicated flight control situations with many controls and with difficult design specifications. The procedure involves defining the quadratic performance index to be minimized in such a way that precludes on-board generation of desired handling quality model dynamics. This complex performance index yields feedback and feedforward control gain solutions which implicitly force the actual system to follow the desired response. It is shown that in addition to the advantage of reduced complexity with respect to implementation, the implicit approach leads to improved short period transient response. Resulting closed-loop eigenvalues can be forced arbitrarily close to those of the desired model. Author

N74-27300# Army Aviation Systems Command, St. Louis, Mo.
MAJOR ITEM SPECIAL STUDY (MISS), AH-1G GAS TURBINE ENGINE (T53-L-138) Interim Report, 1 Jan. 1964 - 1 Jul. 1973

Apr. 1974 22 p
 (AD-776939; USAAVSCOM-TR-74-20) Avail: NTIS CSCL 21/5

The report is designed to illustrate cost savings which would result from specific efforts in the areas of product improvement in quality and design. For the purpose of this study the cost savings produced in the area of product improvement are based on total elimination of a certain failure mode or modes. Appropriate modes are chosen because of their proportion of the total removals or their proportion in combination with other similar modes. These eliminated removals are then assumed to follow the distribution of the remaining removal modes. The actual cost savings are determined from the increase in the mean time to removal based on the new removal distributions. GRA

N74-27302# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STANDARDIZATION OF TESTING BENCHES
 P. Gourgeon, J. P. Badaroux, and A. Durollet 18 Mar. 1974 45 p
 Transl. into ENGLISH of Centre d'Essais de Propulseurs, Saclay, France, report no. 998, 1972 p 1-39
 (AD-777208; FTD-HC-23-700-74; Rept-998) Avail: NTIS CSCL 21/5

These tests are part of a program of tests scheduled in various SNECMA (National Company for Design and Manufacture of Aircraft Engines) facilities at Villaroche, TURBOMECA installations at Bordes and C.E.Pr facilities, in order to determine the acceptability. The account of the performances under the same conditions should make possible a comparative study among the different test stands. GRA

N74-27304# AiResearch Mfg. Co., Phoenix, Ariz.
PRODUCT SUPPORT PROGRAM (GROUND POWER SYSTEMS) Final Report, 1 Jan. - 31 Dec. 1973
 28 Feb. 1974 54 p
 (Contract N00019-27-C-0233)

(AD-777704; Rept-74-310545-2) Avail: NTIS CSCL 21/5

The report summarizes the work accomplished under U.S. Navy Contract N00019-73-C-0233 by the AiResearch Manufacturing Company of Arizona, A Division of The Garrett Corporation, during the period from January 1 through December 31, 1973. The following tasks, as authorized by the original contract and subsequent authorization letters, are applicable to AiResearch gas turbines currently in the Navy inventory. The work performed was assigned task numbers and grouped for reporting purposes in air or ground support affiliation, Report Nos. 74-310545-1 and -2, respectively. The units considered in this volume (-2), under contract, were the NCPP-105 ground power unit, the GTC85-72, -76, GTC100-54, and the GTC100-53, -56 gas turbine engines. Author (GRA)

N74-27359# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

SPECIFIED FINITE SERIES CONTROL FOR THREE-DIMENSIONAL, MULTI-PHASE, OPTIMAL REENTRY M.S. Thesis

Ralph W. Holm Dec. 1973 114 p refs
 (AD-777266; GA/EE/73A-2) Avail: NTIS CSCL 22/3

An optimal, three-dimensional, multi-phase reentry problem is based on NASA's Mission 1 with a vehicle like the Nr-ATP delta-wing vehicle's equations of motion include earth rotation but are developed for relative velocity and express the vehicle's position relative to a reference trajectory plane which is fixed to the earth. The reentry trajectory is divided into two phases. An entry phase from reentry at 400,000 ft to first pullup is optimized with respect to pullup heat rate by maintaining 0 degree roll angle. An equilibrium-glide phase from pullup to termination at 143,000 ft is optimized by varying roll angle to minimize terminal errors, total heat absorbed, and functions of heat rate and flight path angle rate. The roll control function is formulated as a specified finite series of terms, with each term being a function of system states and having a constant coefficient. (Modified author abstract) GRA

N74-27412* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

GRAPHITE-POLYIMIDE COMPOSITE FOR APPLICATION TO AIRCRAFT ENGINES

Morgan P. Hanson and Christos C. Chamis Washington Jun. 1974 27 p refs
 (NASA-TN-D-7698; E-7700) Avail: NTIS HC \$3.25 CSCL 11D

A combined experimental and theoretical investigation was performed in order to (1) demonstrate that high quality angleplied laminates can be made from HT-S/PMR-RI (PMR in situ polymerization of monomeric reactants), (2) characterize the PMR-PI material and to determine the HT-S unidirectional composite properties required for composite micro and macromechanics and laminate analyses, and (3) select HT-S/PMR-PI laminate configurations to meet the general design requirements for high-tip-speed compressor blades. The results of the

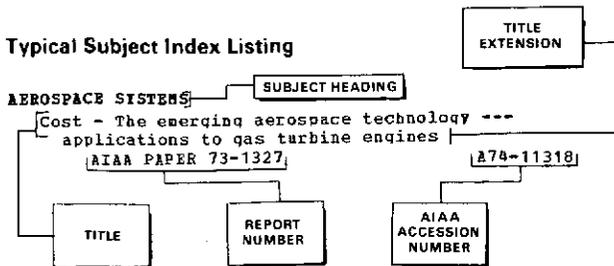
investigation showed that HT-S/PMR laminate configurations can be fabricated which satisfy the high-tip-speed compressor blade design requirements when operating within the temperature capability of the polyimide matrix. Author

N74-27436# Civil Aeronautics Board, Washington, D.C.
LOCAL SERVICE AIR CARRIERS' UNIT COSTS.
VOLUME 2: UNIT COSTS, COMPUTATIONS AND
HISTORICAL DATA, YEAR ENDED 30 SEPTEMBER 1973
30 Sep. 1973 409 p refs
Avail: NTIS HC \$23.50

The cost of local service air carriers is reported for various commercial transport aircraft. The subjects discussed are as follows: (1) aircraft performance and operating expenses for 15 types of commercial transport aircraft, (2) servicing expenses, (3) hourly depreciation rate and hourly rates for return on investment and tax allowance, and (4) the cost of aircraft and equipment purchased by certificated carriers and the percentage rate for return on investment and tax allowance. Author

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Typical Subject Index Listing



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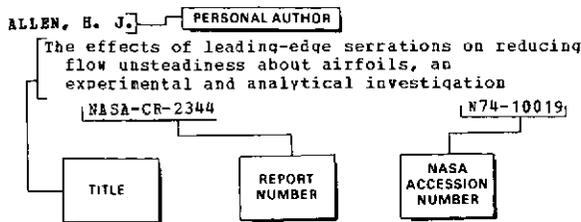
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