AERONAUTICAL ENGINEERING

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A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 68

MARCH 1976

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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

STAR (N-10000 Series)	N 76-11993	N 76-14017
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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 68

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in February 1976 in

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

Scientific and Technical Information Office   MARCH 1976
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington D C

INTRODUCTION

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

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 339 reports, journal articles, and other documents originally announced in February 1976 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*

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

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

Three indexes—subject, personal author, and contract number—are included

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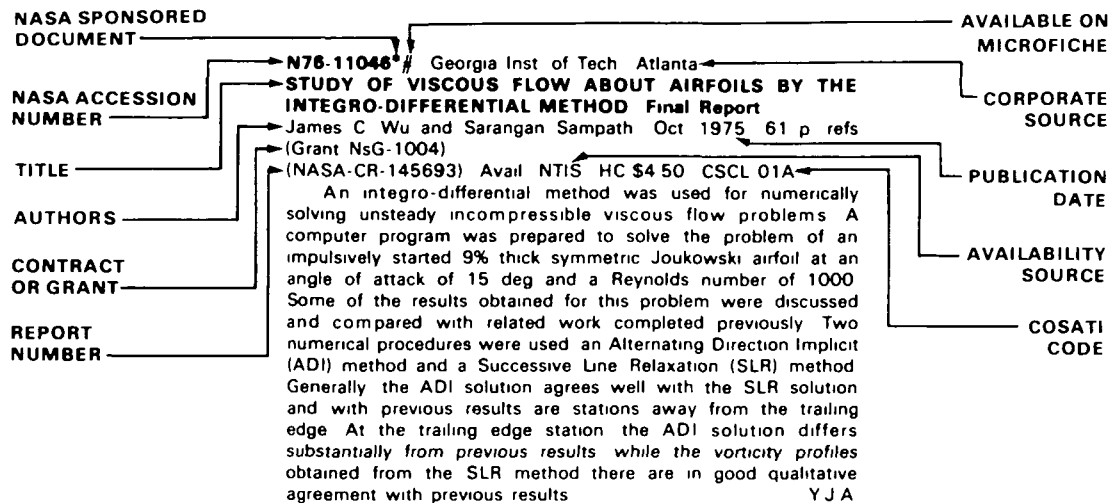345 Middlefield Road
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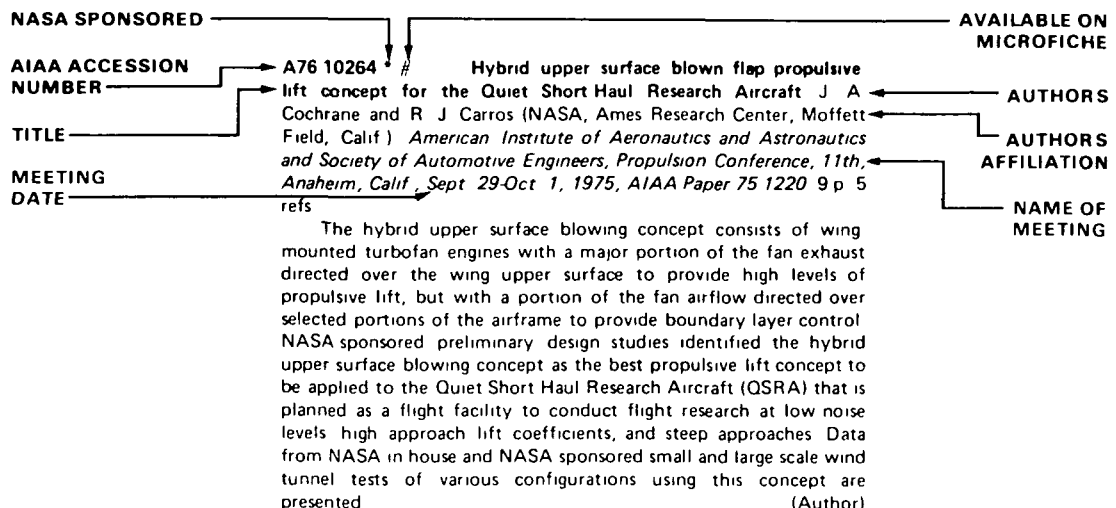8 Munchen 86
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N76-11046 # Georgia Inst of Tech Atlanta
STUDY OF VISCOUS FLOW ABOUT AIRFOILS BY THE INTEGRO-DIFFERENTIAL METHOD Final Report
James C Wu and Sarangan Sampath Oct 1975 61 p refs
(Grant NsG-1004)
(NASA-CR-145693) Avail NTIS HC $4 50 CSCL 01A
An integro-differential method was used for numerically solving unsteady incompressible viscous flow problems A computer program was prepared to solve the problem of an impulsively started 9% thick symmetric Joukowski airfoil at an angle of attack of 15 deg and a Reynolds number of 1000 Some of the results obtained for this problem were discussed and compared with related work completed previously Two numerical procedures were used an Alternating Direction Implicit (ADI) method and a Successive Line Relaxation (SLR) method Generally the ADI solution agrees well with the SLR solution and with previous results are stations away from the trailing edge At the trailing edge station the ADI solution differs substantially from previous results while the vorticity profiles obtained from the SLR method there are in good qualitative agreement with previous results   Y J A

TYPICAL CITATION AND ABSTRACT FROM *IAA*

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A76 10264 # Hybrid upper surface blown flap propulsive lift concept for the Quiet Short Haul Research Aircraft J A Cochrane and R J Carros (NASA, Ames Research Center, Moffett Field, Calif) American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 11th, Anaheim, Calif, Sept 29-Oct 1, 1975, AIAA Paper 75 1220 9 p 5 refs
The hybrid upper surface blowing concept consists of wing mounted turbofan engines with a major portion of the fan exhaust directed over the wing upper surface to provide high levels of propulsive lift, but with a portion of the fan airflow directed over selected portions of the airframe to provide boundary layer control NASA sponsored preliminary design studies identified the hybrid upper surface blowing concept as the best propulsive lift concept to be applied to the Quiet Short Haul Research Aircraft (QSRA) that is planned as a flight facility to conduct flight research at low noise levels high approach lift coefficients, and steep approaches Data from NASA in house and NASA sponsored small and large scale wind tunnel tests of various configurations using this concept are presented   (Author)

IAA ENTRIES

A76-12772 # Abatement of jet-aircraft noise (Snizhenie shuma samoletov s reaktivnymi dvigateliami) A M Mkhitarian, V G Enenkov, B N Mel'nikov, V I Tokarev, and I P Shmakov Moscow, Izdatel'stvo Mashinostroenie, 1975 264 p 177 refs In Russian

Existing noise abatement methods are reviewed, along with the experience obtained with some of these methods The characteristics of noise generation by turbulent gas flows and by air compressors are discussed and are used to construct mathematical jet noise generation models Problems of optimal aircraft control at take-off aimed at minimizing the noise level at airports are solved, and the economic efficiency of modern noise abatement methods is analyzed **V P**

A76-12773 # The assembly of riveted aircraft and helicopter parts (Sborka klepanykh agregatov samoletov i vertoletov) V P Grigor'ev Moscow, Izdatel'stvo Mashinostroenie, 1975 344 p 22 refs In Russian

The book details the requirements for designing the technological procedures for assembling riveted helicopter and aircraft parts Technical characteristics are presented for the most widely used riveting equipment and instruments, as are methods and initial data for technical cost analysis applied to the optimization of the assembly and riveting procedures, and of the equipment Several chapters are devoted to the processing of hermetic fuel chambers, and to that of assemblies made of various light alloys and steels Methods are proposed for controlling the quality of the products, procedures for raising their reliability are examined, and the effects of various technological processes on the mechanical properties of the finished products is analyzed **B J**

A76-12910 # Description of wakes by vortex sheets A R Oliver (Tasmania, University, Hobart, Australia) In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1 Christchurch, New Zealand, University of Canterbury, 1975, p 19-26 7 refs Research supported by the Weapons Research Establishment and Australian Research Grants Committee

The use of vortex sheets to describe boundary layers and wakes is discussed and it is shown that two is the least number of sheets which will allow both displacement thickness and momentum thickness to be modelled A wake can be described by four sheets (two from each boundary layer which forms it) The strength of each sheet is arbitrarily chosen as half the total vorticity, giving a velocity discontinuity of half the total velocity deficiency of a wake Some comparisons are made between measured and modelled flows around an inlet guide vane of an axial flow compressor (Author)

A76-12919 # Pressure drop in parallel plate rotary regenerators I L Maclaine-cross (New South Wales, University, Kensington, Australia) and C W Ambrose (Monash University, Clayton, Victoria, Australia) In Australasian Conference on Hydraulics and Fluid

Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1 Christchurch, New Zealand, University of Canterbury, 1975, p 124-131 14 refs

The flow in the passages of parallel plate rotary heat exchangers or regenerators is laminar and fully developed Laminar flow theory should allow an accurate prediction of heat and mass transfer and pressure drop Previously measured values of pressure drop have been up to 46% higher than predicted Revisions to both theory and experimental method appeared necessary Pressure drop is predicted here by considering the passage cross sections rectangular When heat or mass is transferred, corrections are made for acceleration or deceleration of the flow and for property variations in the flow direction and normal to it The inlet pressure drop is predicted using Bernoulli's equation and the outlet pressure drop conservation of momentum A new method of estimating the effective free flow area of the passages is used The pressure drops measured on a parallel plate sensible heat regenerator were within 3% of theory and on a prototype parallel plate total heat regenerator within 4% (Author)

A76-12921 # Effect of trailing edge thickness on the aerodynamic performance of aerofoils. I Lawrence (New Zealand Electricity Department, Hamilton, New Zealand) and D Lindley (Canterbury, University, Christchurch, New Zealand) In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1 Christchurch, New Zealand, University of Canterbury, 1975, p 165 174 14 refs

The flow around a two-dimensional airfoil with different trailing edge thicknesses was examined at Reynolds numbers between 690,000 and 1 1 million (based on the chord) Measurements were taken of the pressure distribution and the effect of the trailing edge thickness on these measurements is discussed Traverses, using a hot wire anemometer, along and across the wake were taken to investigate the vortex formation point These investigations showed that the vortex formation point varied between 0 75 and 1 2 times the trailing edge thickness downstream of the airfoil A comparison was made between blunt trailing edges and a round trailing edge The round trailing edge showed an increase in base pressure due to the separation point of the boundary layer rolling around the trailing edge and thereby reducing the effective edge thickness (Author)

A76-12925 # Effect on wind tunnel walls and afterbody shape on the pressure distribution around a wedge J T Turner (Manchester, Victoria University, Manchester, England) and B C Motson (New South Wales, University, Kensington, Australia) In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1 Christchurch, New Zealand, University of Canterbury, 1975, p 295-304 7 refs

The pressure distribution about a finite wedge in a subsonic two-dimensional ducted flow is examined Particular attention is given to the effect of the wind tunnel side walls and the shape of the afterbody Measured data is compared with values predicted by the analysis of potential flow about a forward facing wedge between parallel side walls The theory assumes an infinitely long rectangular afterbody Discrepancies are observed between the ideal flow predictions and the measured pressure distributions which appear to depend on the shape of the afterbody These differences are discussed in relation to methods of correction for the side wall constraints (Author)

A76-12926 # Blockage effect for single rows of bluff bodies A S Ramamurthy, P M Lee (Sir George Williams University,

Montreal, Canada), and C P Ng In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1
Christchurch, New Zealand, University of Canterbury, 1975, p 305-309 9 refs

Interference effects for flow past single bluff bodies and rows of bluff bodies are similar in character It is shown that the vortex shedding frequency on these two configurations can be normalized effectively by adopting the mean gap velocity and the contracted jet velocity as the relevant velocity scales to form the Strouhal number
(Author)

A76-12935 # On sonic boom propagation from aircraft at low supersonic speeds N W Page (Weapons Research Establishment, Aeronautical Research Laboratories, Melbourne, Australia) In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1   Christchurch, New Zealand, University of Canterbury, 1975, p 484-491 6 refs

An analysis has been made of the atmospheric and flight parameters which govern sonic boom propagation from aircraft flying at Mach numbers from 1 to 1 15 in an atmosphere with horizontal winds with velocity increasing linearly with altitude and the vertical temperature distribution of the ICAO Standard Atmosphere Ray path curvature and the vertical propagation distance for rays to be refracted horizontal were both found to depend on a non-dimensional parameter expressing the relative refractive effects of wind shear and temperature gradient in the troposphere It has been shown that sonic booms of appreciable intensity can reach the ground at large distances from their point of origin when sky-ward going rays are refracted down to the ground   (Author)

A76-12947 # Experimental investigation of subsonic coaxial jets N W M Ko and A S H Kwan (University of Hong Kong, Hong Kong) In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 1   Christchurch, New Zealand, University of Canterbury, 1975, p 609-616 9 refs
Research supported by the University of Hong Kong

Investigation was made within the first seven diameters (diameter of the primary jet) downstream of subsonic coaxial jets The velocity ratio, secondary jet to primary jet, is 0 5 Hot wire and microphone spectra inside the jets yield two pronounced peaks, suggesting the existence of two types of noise sources at different frequencies The noise sources are due to the two different mixing regions in the merging region of the jets, where the mixing of the two jet streams occurs The locations of these dominant noise sources are also estimated   (Author)

A76-12953 # On an anomalous result in linearised slender lifting surface theory P T Fink (New South Wales, University, Kensington, Australia) and W K Soh In Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974, Proceedings Volume 2
Christchurch, New Zealand, University of Canterbury, 1975, p 489-498 12 refs

Linearized slender lifting surface theory predicts zero loading downstream of the maximum span of a plane low aspect ratio lifting surface This result is based on use of Prandtl's assumption that trailing vorticity is coplanar with the surface in its immediate vicinity However the trailing vortex sheets roll up to a degree and that is known to cause the chordwise loading to be other than zero over the rear of the lifting surface The authors recently put forward a method of stepwise vorticity rediscretization which does not suffer the disadvantages of the classical Rosenhead/Westwater technique for calculating the development of vortex sheets in unsteady flow of incompressible fluid The new method is briefly reviewed and then applied to the calculation of some aero/hydrodynamic characteristics of a slender wing of rhombic planform The results include

calculations of chordwise loading which exhibit significant lift on the portion of the wing downstream of maximum span   (Author)

A76-13073 Rotors in reverse. D Videan Shell Aviation News, no 431, 1975, p 12 15

Helicopter rotor blade technology is utilized in the design of a wind-actuated power generating unit Available components are used in the secondary assemblies of the system, and new compact heat storage technology is exploited Rotor design and transmission system design are detailed, and rotor design features are compared to some traditional windmill sail design features A fully automatic maintenance-free low-cost system is offered for domestic space heating and direct heat conversion   R D V

A76-13074 Boeing 747 - An operational appraisal II - Operational performance and flight planning. L Taylor Shell Aviation News, no 431, 1975, p 23-27

The performance of the Boeing 747 in actual cargo and passenger service, with either Dash 7 engines or JT9D-3 engines, or both intermixed, is described in detail in an airline pilot's evaluation Performance in take-off, climb, cruise, descent, and landing is discussed, with detailed accounts of specific flights under different weather and climate conditions Attention is given to runway precipitation conditions to ground handling problems, and to flight planning and re-flight planning problems, including planning of fuel reserves and contingency or diversion fuel requirements   R D V

A76-13113 High speed flight tests with the Bo 105 A Teleki (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) Aeronautical Journal, vol 79, Oct 1975, p 425-430
Research sponsored by the Bundesministerium der Verteidigung

In-flight tests of the Bo 105 helicopter (West Germany) included addition of a 6 2 m span wing to test maneuverability at high speeds, rotor/wing interference, wing/tailplane interactions, and the effect of spoilers on the wing (undersurface or top, at different locations) Fairings and drag-reducing modifications in the cargo door were also tested Rotor blade design and behavior, and response to tilting, are analyzed, with no stability problems up to advancing blade tip Mach 0 08 Rotor/wing interference produced asymmetry in wing lift, and wing lift affected tailplane download appreciably Wing root and tail root flapping bending moments, pitch link load variations with azimuth, and turbulence were also investigated   R D V

A76-13114 Some aspects of aeronautical research M Morgan (Downing College, Cambridge, England) Aeronautical Journal, vol 79, Oct 1975, p 431-438

An overview of past and present aeronautical research and development practices and problems All-up weight at take off is singled out as the key parameter to keep track of, as an indicator of future unit production costs, and of the overall research and development bill Severe weight penalties in design, and the predominance of empirical design and testing, with models and full scale tests, are seen as features most peculiar to aeronautical engineering Hypersonic flight is viewed as not economically feasible unless benefiting from prior military research and development in that area V/STOL wing area and extra lift power will add to airborne operating costs New materials and composites, advances in avionics, computers, and automation will mean revolutionary advances in aeronautics irrespective of engine and airframe design Fuel resources and fuel costs, cockpit data display, subsonic and super sonic aircraft, and research and development funding are discussed   R D V

A76-13115 Why the airship failed P W Brooks (British Aircraft Corp, Ltd, Weybridge, Surrey, England) Aeronautical Journal, vol 79, Oct 1975, p 439-449

Proposals of a new role for lighter-than-air vehicles are weighed

against the large volumes required for aerostatic lift, design engineering man-hrs to first flight, hazards of weather, variable climate, sudden wind changes, mooring and landing damage, need to operate at low altitudes, static electrical discharge, and other factors The effect on overall cost of size, productivity in seat-miles or cargo ton-miles per time interval, and costs per ton-mile or seat-mile are estimated Tests and funding for materials research and development, aerodynamics, and new powerplant design are judged prohibitive and unlikely to win support Accidents and disasters in rigid airship history are analyzed and tabulated   R D V

A76-13116   **Some aerodynamic measurements in helicopter flight research** P Brotherhood (Royal Aircraft Establishment, Bedford, Hants , England) *Aeronautical Journal*, vol 79, Oct 1975, p 450-465 12 refs Research supported by the Ministry of Defence (Procurement Executive)

Tests concerned mainly with main-rotor aerodynamics are being carried out on a Wessex helicopter to identify and measure the complex phenomena at work in the rotor environment and to raise the aerodynamic limits of flow separation, stall, and reattachment on a rotating blade Simulation tests of erosion (due to heavy rain, sea spray, or sand) were run on unprotected light alloy blades, and blades with stainless steel or renewable bonded plastic leading edge strips The performance of two blade profiles in forward flight and in hover is measured and compared Wind tunnel measurements, in flight testing, computer ground replay of tests, and motion-picture recording of data are described   R D V

A76-13127   **Finite elements for the analysis of anisotropic plates in the presence of geometrical nonlinearities** (Elementi finiti per l'analisi di pannelli anisotropi in presenza di non linearità geometriche) P Mantegazza (Milano, Politecnico, Milan, Italy) *L'Aerotecnica - Missili e Spazio*, vol 54, Aug 1975, p 221-227 14 refs In Italian

On the basis of a general formulation, a technique for discretization into finite elements is set forth for anisotropic plates The technique is applied to flat plates in the presence of large normal displacements, nonnegligible shear, and coupling between bending and membrane forces due to nonuniform thickness of the plate Numerical results obtained with the aid of this nonlinear model are compared with static test results for wing boxes   P T H

A76-13131 #   **The fundamentals of helicopters** J E Fairchild (Texas, University, Arlington, Tex) *AIAA Student Journal*, vol 13, Fall 1975, p 10-15, 33

The design features which are responsible for the limitations and the unique flight capabilities of the helicopter are presented through a comparison with airplane design The forces and moments acting during vertical take-off and landing and during forward and hovering flight are outlined, and the means by which autorotation is achieved are discussed Factors affecting methods for the analysis of rotor motion are briefly considered, together with the problems of angle of-attack instability of the rotor and noise control   C K D

A76-13132 #   **The future of helicopters** B W McCormick (Pennsylvania State University, University Park, Pa) *AIAA Student Journal*, vol 13, Fall 1975, p 16-19

Factors contributing to the 40% annual growth rate in commercial helicopter sales include its expanding application in a variety of fields business, agriculture, emergency rescue, and highway patrol Data illustrating the recent growth of helicopter size and performance capabilities are given The characteristics of several helicopters currently under development with both military and civilian sponsorship are discussed   C K D

A76-13133 #   **Technical bibliography of helicopters** Edited by B W McCormick (Pennsylvania State University, University Park, Pa) *AIAA Student Journal*, vol 13, Fall 1975, p 20, 22, 24, 25 127 refs

A76-13145   **Fluid mechanics and the design of new slender aircraft.** D Kuchemann (Royal Aircraft Establishment, Farnborough, Hants , England) *Physics in Technology*, vol 6, Nov 1975, p 239-244 5 refs

The two fundamental aspects in fluid mechanics considered include flow separations in three dimensions and supersonic flows past bodies which cause only small perturbations Attention is given to the question whether there are any useful applications of three-dimensional vortex-sheet separations in aircraft engineering A variant of the highly-swept, slender, sharp-edged delta wing is investigated Slender wings for supersonic flight are discussed along with the prospects for future supersonic aircraft A description is given of the design of a slender aerobus for subsonic flight   G R

A76-13188 #   **The planar dynamics of airships** F J Regan and A M Morrison (U S Navy, Naval Surface Weapons Center, Silver Spring, Md) *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, 5th, Albuquerque, N Mex , Nov 17-19, 1975, Paper 75-1395* 7 p 5 refs

This paper will consider the forces and moments acting on a Lighter-Than Air Vehicle in order to develop parameters describing planar motion It is shown that making certain simplifying assumptions to these equations leads to expressions applicable to Heavier Than Air Vehicles It is also shown that for the case of vehicles where buoyancy may not be neglected, such as an airship, the mathematical model of the planar dynamics becomes more complex than for the case of vehicles where buoyancy may be neglected   (Author)

A76-13191 #   **Development and application of a mathematical model for use on the B-1 escape module** T D Morgan (USAF, Aeronautical Systems Div , Wright Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, 5th, Albuquerque, N Mex , Nov 17-19, 1975, Paper 75-1399* 8 p

The B-1 prototype aircraft incorporates a sophisticated crew escape module which includes several complex subsystems A mathematical model for use specifically on the module was developed This model is flexible enough to allow variations in all sybsystem timings and aerodynamic terms Limited amount of parachute dynamics are included The model was used to identify anomalies that occurred on launches such as a post thrust flow from the roll rocket motor which resulted in high roll rates The model was instrumental in affecting a major subsystem timing change that resulted in an increase in aerodynamic stability over the entire trajectory The model as used on the B 1 escape module has shown the importance of a simulation device that is flexible, easy to use, and is capable of rapid turnaround   (Author)

A76 13193 #   **An inexpensive, quick look data method for the B-1 Crew Escape System tests** C D Gragg and N W Haars (USAF, Holloman AFB, N Mex) *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, 5th, Albuquerque, N Mex , Nov 17 19, 1975, Paper 75-1402* 5 p 7 refs

Oscillograph records are often not adequate for quick look data analysis This was true in the case of a series of B 1 Crew Escape System tests conducted at the Holloman AFB Test Track Oscillograph record deficiencies are (1) they have rather rigid, practical limits on the expansion and contraction of both ordinate and abscissa, (2) the quantity measured is its only output and may not be of any direct interest, (3) all quantities measured have time as the abscissa, and (4) they are typically unsuitable for inclusion in reports All of these deficiencies were resolved by the imaginative use of a programmable calculator   (Author)

A76-13196 #   **Evolution of an in-flight escape system** H Horn (Boeing Co , Wichita, Kan) *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, 5th, Albuquerque, N Mex , Nov 17-19, 1975, Paper 75-1405* 7 p

Development of the forward facing, upward ejecting seats in the B-52 airplane is traced from the first appearance of the seats in the XB 52 in 1952 through the configuration that was proven satisfactory in sled testing conducted by San Antonio ALC in 1974 The design constraints imposed on the escape system by the early, high altitude mission are defined The impact on the escape system of a low level leg included in the flight mission are discussed, and system modifications made to accommodate the new mission are described Problems that remain to be defined and solved for a more effective system are noted   (Author)

A76-13197 #   Parameter identification technology used in determining in-flight airloads parameters G D Park (Gates Learjet Corp, Wichita, Kan) *American Institute of Aeronautics and Astronautics, General Aviation Technologyfest, 1st, Wichita, Kan, Nov 13, 14, 1975, Paper 75 1417* 8 p 5 refs

A parameter identification algorithm developed by NASA was used to determine Learjet Model 35 airloads parameters from time history response data recorded during an airloads flight test program Airload responses utilized in the investigation included the horizontal stabilizer rolling moment, the vertical tail side force, and the pilot rudder pedal force This paper discusses the procedures used in applying the method to extracting airload parameters and compares the results with wind tunnel data   (Author)

A76-13219 #   On the stability of three-dimensional motion of an aircraft (Ob ustoichivosti prostranstvennogo dvizheniia samoleta) V S Mechetnyi and V P Chirkin (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR) In Complex control systems   Kiev, Izdatel'stvo Naukova Dumka, 1975, p 134 139 9 refs In Russian

The effect of inertial coupling on the stability of three dimensional motion executed by a supersonic aircraft rotating about the longitudinal axis at variable roll rate is studied The nonlinear case is reduced to a system of linear differential equations amenable to study by matrix methods, and the bounded asymptotically stable solution of the system is sought, using the Hurwitz stability criterion   R D V

A76-13244   Backfire - Soviet counter to the B-1   G Panyalev *Interavia,* vol 30, Nov 1975, p 1193, 1194

The characteristics and major design features of the Soviet supersonic variable geometry bomber Backfire are presented The bomber is capable of carrying a maximum payload of 22,050 lb, including two externally-carried AS-6 air-to surface nuclear missiles with a warhead weight of 770 lb as the principal armament The maximum combat radius with one in-flight refuelling is 5400 mi The optimum cruising speed at altitude is Mach 0 82, with supersonic dash capability to Mach 2 0 The avionics fit includes a newly-developed terrain-following radar of unknown performance and long-range inertial navigation equipment, possibly working in conjunction with military satellites The fuselage cross section is basically rectangular, tapering aft of the wings The wing pivot placement is dictated by the undercarriage geometry and is not optimized aerodynamically   C K D

A76-13245   Simulation - A growth market in a contracting industry   D Boyle *Interavia,* vol 30, Nov 1975, p 1198 1201, 1215

The operation of the major types of visual simulation systems, including film derived systems, rigid-model TV-based systems, and Computer Generated Imagery (CGI) systems is described The basic features of current systems in each category are presented, and the cost and performance of the various types of systems are compared The relative advantages of daylight and night-only systems are considered   C K D

A76-13246   Concorde interior engineering   M Nibloe *Interavia,* vol 30, Nov 1975, p 1202, 1203

The cabin interior, furnishings and decor, and windows and seats of the Concorde have been designed with the major objectives of reducing weight while insuring maximum passenger safety and comfort The weight per passenger place has been reduced to two-thirds that of a typical narrow-bodied subsonic aircraft The trim panels are constructed of impregnated phenolic glass-cloth with Nomex honeycomb interior, the glass fiber insulation is contained between the trim panels in perforated bags which permit the drainage of water from condensation The air conditioning system comprises four independent conditioning groups utilizing bleed air from the final stage of an engine HP compressor The window size has been reduced to 1/3 that of a VC 10 window The evacuation system, consisting of emergency exits fitted with automatically actuated inflatable escape slides, is designed to permit the evacuation of 120 passengers within 90 seconds using exits on one side only in a variety of aircraft attitudes   C K D

A76-13247   MRCA development tempo quickens   D H Chopping *Interavia,* vol 30, Nov 1975, p 1212-1215

The Panavia 200 multirole combat aircraft (MRCA) flight test program is discussed, and results of the initial flight testing of four prototype aircraft are presented together with MRCA production model technical data The maximum payload of the production model is 16,530 lb, empty weight is 27,780 lb, maximum speed at 36,000 ft is Mach 2 2 Flight testing beyond Mach 1 4 and 650 knots IAS has revealed no serious defects in the flight envelope In the subsonic speed range and varying wing sweep angles the lift has been found to be higher, the drag less, and the airflow breakaway less harmful than predicted by computer calculations and wind tunnel tests Buffet characteristics were also better than expected The operation of the Command Stability and Augmentation System and its primary and secondary backup mode has been satisfactory C K D

A76-13279 #   Study of circular arc wing profiles with asymptotic critical Mach number III (Studio dei profili alari ad arco di cerchio con numero di Mach asintotico critico III) R Loiodice *Torino, Accademia delle Scienze, Classe di Scienze Fisiche, Matematiche e Naturali, Atti,* vol 108, May Aug 1974, p 445-454 11 refs In Italian

The paper attempts to match up the theoretical values for the local Mach numbers calculated by Gabutti (1972) for the central part of a symmetrical airfoil and those calculated on the basis of Leschiutta's (1970) procedure for the leading edge These results are compared with the graphical results of Spreiter and Alksne (1955) and of Cole (1970) for the same problem   P T H

A76-13303   Optimization of multi-cell wings for strength and natural frequency requirements R Katarya (Hindustan Aeronautics, Ltd, Lucknow, India) and P N Murthy (Indian Institute of Technology, Kanpur, India) *Computers and Structures,* vol 5, Nov 1975, p 225-232 14 refs

The present work determines the optimal number of cells for minimum weight design of an aircraft wing under strength and natural frequency constraints for the two cases (1) uniform loading and (2) a tip moment Two SUMT optimization algorithms with and without parameters have been used and suggestions for faster convergence for one have been given The importance of different starting design points and convergence criteria in getting the constrained minimum has been shown The variables considered are length, chord, skin thickness and various spar thicknesses The natural frequency has been obtained by the use of exact continuum theory of cylindrical tubes, and comparison with elementary theory has been made The optimization results indicate that increasing the number of cells beyond two does not lead to any substantial reduction or increase in weight Also, stringent convergence criterion and more than one starting point are necessary for better results
                                                                                (Author)

A76-13317 Static stability and aperiodic divergence in subsonic and supersonic flight (Statische Stabilität und aperiodische Instabilität im Unter- und Überschall) G Sachs (Dornier GmbH, Friedrichshafen, West Germany) *Zeitschrift fur Flugwissenschaften,* vol 23, Oct 1975, p 341-346 12 refs In German

The relation between static stability and aperiodic divergence is shown Due to the different conditions, the subsonic and supersonic regions are treated separately With regard to the subsonic region, it is shown which conditions lead to aperiodic divergence in spite of the fact that the aircraft is statically stable This gives the restrictions for the assumption commonly used according to which static stability is a sufficient criterion for avoiding aperiodic divergence With regard to the supersonic region it is shown that the current concept of static stability is inadequate A new concept is introduced which takes the conditions of supersonic flight properly into account Furthermore, the conditions for aperiodic divergence are shown as well as the role of static stability in this context   (Author)

A76-13318 A closed form variational solution of stratospheric cruise flights with minimum direct operating costs (Kostenoptimale Stratospharenflüge als geschlossenes Ergebnis einer Variationsrechnung). B Faber (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften,* vol 23, Oct 1975, p 346-356 15 refs In German Research supported by the Deutsche Forschungsgemeinschaft

For stratospheric quasi-steady cruise flight (supersonic or subsonic), optimal flight conditions for minimum operating costs are presented in a closed form Constant power setting and thrust variations proportional to air density are assumed It is shown when these assumptions are conform to practical conditions The drag polar may be of arbitrary shape Drag polar, thrust and fuel consumption depend on the Mach number in arbitrary but defined form A constant wind parallel to the flight path and the reduction of the aircraft weight due to fuel consumption are taken into account Minimum fuel as well as minimum time cruising trajectories are contained in the solution as special cases   (Author)

A76-13320 High speed wind tunnel TVM 150 of the Institute of Aeronautics of the Technical University Darmstadt (Hochgeschwindigkeitswindkanalanlage TVM 150 des Instituts fur Flugtechnik der Technischen Hochschule Darmstadt) M Strauber (Darmstadt, Technische Universitat, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften,* vol 23, Oct 1975, p 366, 367 In German

A description is given of a wind tunnel which has been designed for the conduction of investigations involving subsonic, transonic, and supersonic flows in the Mach number range from 0 5 to 4 0 The times of measurement are in the range from 20 to 50 sec The installation contains a Laval nozzle with supersonic and transonic measurement regions A variation of the Mach number in the supersonic region is obtained with the aid of changes in the nozzle contour It is pointed out that a change of the Mach number during the test is possible Attention is also given to computational facilities, aspects of wind tunnel control, and the storage of the experimental data   G R

A76-13321 The flight simulation installation of the Institute of Aeronautics of the Technical University Darmstadt (Die Flugsimulationsanlage des Instituts fur Flugtechnik der Technischen Hochschule Darmstadt) B Hechler (Darmstadt, Technische Universitat, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften,* vol 23, Oct 1975, p 368-371 In German

The installation described uses a hybrid computer which is connected with an analog computer, a noise and gust generator, data display and recording devices, and two types of simulator It is planned to represent the positional changes of the simulated aircraft with the aid of an aircraft model which is to be connected to the computer The installation is to be used in research applications involving the experimental study of aircraft approach methods which

are designed to reduce aircraft noise effects Other investigations are to be related to an improvement of aircraft flight characteristics
G R

A76-13401 Dynamic simulation in the wind tunnel (Dynamische Simulation im Windkanal) H Subke and K Wilhelm (Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Flugmechanik, Braunschweig, West Germany) *DFVLR-Nachrichten,* Nov 1975, p 677 679 In German

A description is given of the experimental facilities employed in dynamic simulation studies, taking into account an elastic model, equipment for providing an artificial lift, the simulation of gusts, and control devices Experimental studies in the wind tunnel have shown that the test installation considered provides an approach for preliminary investigations of novel control systems Satisfactory agreement was obtained between simulation results on a computer and the experimental data determined in the wind tunnel Planned extensions of the experimental facilities are also discussed   G R

A76-13402 The development of supplementary computational procedures for supercritical wings (Entwicklung von Nachrechnungsverfahren fur superkritische Flugel) H Korner, H Koster, and G Redeker (Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Aerodynamik, Braunschweig, West Germany) *DFVLR-Nachrichten,* Nov 1975, p 680-682 In German

The characteristics and advantages of a supercritical profile design for a wing are discussed Suitable computational procedures and wind tunnels are needed for the development of the desired wing profiles It is pointed out that experimental wind tunnel studies of the required characteristics are very expensive Improvements in the calculational approach are, therefore, very important for the solution of complex transonic problems Procedures are considered for the computation of the pressure distribution for a given wing geometry
G R

A76 13415 Hydrant fuelling for aircraft R Benstead (Petrofina /UK/, Ltd, London, England) *Airport Forum,* vol 5, Oct 1975, p 45, 46, 48 53, 55, 57 In English and German

Approaches of hydrant fuelling at London Airport were developed in connection with the introduction of wide bodied aircraft The hydrant system was designed to deliver 7,300 liters/min to each aircraft through two dispensers The advantages of dispensers over fuellers include reduced congestion at the aircraft, quicker fuelling times, and continuous availability The facilities at Perry Oaks are discussed Attention is given to aspects of hydrant layout, hydrant design criteria, the testing procedures used, and questions of security and quality control   G R

A76-13554 Modern developments in transonic flow J D Cole (California, University, Los Angeles, Calif) *SIAM Journal on Applied Mathematics,* vol 29, Dec 1975, p 763 787 38 refs

A survey is given of transonic small disturbance theory Basic equations, shock relations, similarity laws, lift and drag integrals are derived The airfoil boundary value problem is formulated Finite difference methods and computational algorithms are described Results are compared with other calculation methods and experiments   (Author)

A76-13643 Stability of a pair of co-rotating vortices J Jimenez (Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain) *Physics of Fluids,* vol 18, Nov 1975, p 1580, 1581 6 refs

The linear stability of a pair of co rotating vortex filaments is studied with a view toward clarifying the behavior of these pairs in the shear layer The configuration is found to be stable within the long wave approximation   (Author)

A76-13677 # On the characteristics of a wing with a tip clearance V - An experimental study on the effect of end-wall boundary layers Y Sugiyama (Nagoya University, Nagoya, Japan) *JSME, Bulletin,* vol 18, Sept 1975, p 984-991 8 refs

Experimental results show the lift and drag of a wing in low-velocity flow as functions of (1) the thickness of a boundary layer developed on an end wall facing the wing tip, (2) the size of the tip clearance, and (3) the wing angle of attack Correlations between local and total lift and drag forces are also examined The study contributes to knowledge of blade-tip losses in axial-flow machinery
T M

A76-13680 # Effect of side walls of wind-tunnel on flow around two-dimensional circular cylinder and its wake T Okamoto and M Takeuchi (Aoyama-Gakuin University, Tokyo, Japan) *JSME, Bulletin,* vol 18, Sept 1975, p 1011-1017 12 refs

This paper presents the effect of the side walls of a wind-tunnel on the flow around a circular cylinder and its wake in the N P L type wind-tunnel having the test section of 60 x 60 x 310 cm And the dimensions of Karman vortex-street are observed in the water tank The results are discussed by comparison with those of the investigations so far made (Author)

A76-13825 Design to Cost Conference, Palo Alto, Calif , June 2, 3, 1975 and Boston, Mass , June 19, 20, 1975, Abridged Proceedings Conference sponsored by the American Institute of Aeronautics and Astronautics and Electronic Industries Association Los Angeles, American Institute of Aeronautics and Astronautics, Inc , 1975 94 p $10 00

Objectives of design to cost are (1) to establish cost as a parameter equal in importance with technical requirements and schedules throughout the design, development, production, and operation phases, and (2) to establish cost elements as management goals in achieving the best balance between life cycle cost, acceptable performance, and schedule Papers contained herein describe efforts undertaken in the direction of the above objectives with specific aerospace and defense projects Attention is given to cost reduction programs followed with the NAVSTAR global positioning system, the F 16 air combat fighter, the B 1 electronics countermeasures system, NASA operations, a lightweight Doppler navigation system, and inertial navigation system maintenance T M

A76-13859 # Heat transfer in air-cooled turbine blades of high-temperature gas-turbine engines (Teploobmen v okhlazhdae-mykh vozdukhom turbinnykh lopatkakh vysokotemperaturnykh GTD) V I Lokai *Aviatsionnaia Tekhnika,* vol 18, no 3, 1975, p 60-68 20 refs In Russian

In the calculation of internally air cooled turbine blades, the boundary conditions of heat transfer from the gas and air are conventionally established on the basis of similarity equations derived from static test data In the present analysis, the necessity is demonstrated to take into consideration such factors as the influence of the rotor's rotational speed on heat transfer intensity, the emission from the gas, the angle of incidence, etc Expressions for evaluating these factors numerically are proposed It is shown that heat transfer characteristics obtained indirectly from measurements of the mean blade wall temperature are not reliable V P

A76-13868 # Experimental investigation of the effect of the constructive inlet angle on the effectiveness of the designed profile cascade (Eksperimental'noe issledovanie vliianiia konstruktivnogo ugla vkhoda na effektivnost' proektiruemoi reshetki profilei) B M Aronov, A G Bogatyrev, V M Epifanov, B I Mamaev, and I B Shkurikhin *Aviatsionnaia Tekhnika,* vol 18, no 3, 1975, p 111-115 8 refs In Russian

A76-13937 # Conical wings in subsonic flow (Obtekanie V-kryl'ev dozvukovym potokom) V V Kravets, N V Trifonova,

and A I Shvets *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekh-nicheskoi Fiziki,* July-Aug 1975, p 102-106 7 refs In Russian

The pressure distribution over a conical wing in subsonic flow was studied using models with variable wing-dihedral angle The wing dihedral angle could be varied from 0 to 180 degrees The behavior of the pressure with decreasing dihedral angle is determined, along with the flow characteristics behind the model The aerodynamic characteristics of 5 wing models are discussed and diagrammed V P

A76-13974 # Design considerations affecting performance of glass/plastic windshields in airline service. J B Olson (Sierracin Corp , Sylmar, Calif) *Aircraft Engineering,* vol 47, Nov 1975, p 4-12, 26 8 refs

Cost-effective lightweight design considerations for glass-faced plastic curved windshields used in large jet transport aircraft are examined The discussion covers the composite cross-section, mounting philosophies, and progressive design refinement for performance upgrading through a comprehensive review and analysis of all pertinent failures Design conclusions for curved composite windshields are summarized The curved shape imparts obvious aerodynamic, acoustic, and vision improvements, and additionally gives the designer further latitude in less obvious areas, such as providing more room for the installation of cockpit instrumentation S D

A76-13982 # Approximate shock-free transonic solution for lifting airfoils S K Chakrabartty *AIAA Journal,* vol 13, Aug 1975, p 1094-1097 10 refs

The simple approximate shock free transonic solution of the integral equation of Oswatitsch obtained by Niyogi and Mitra (1973) is extended to the lifting case Numerical results for parabolic arc profiles and the NACA 0012 profile at different angles of attack are compared with previous analytical, numerical, and experimental results G R

A76-13991 # Nonexistence of stationary vortices behind a two-dimensional normal plate J H B Smith and R W Clark (Royal Aircraft Establishment, Farnborough, Hants , England) *AIAA Journal,* vol 13, Aug 1975, p 1114, 1115 7 refs

A two dimensional irrotational flow of an inviscid incompressible fluid past an obstacle is considered It is assumed that a pair of counter rotating line-vortices lie symmetrically in the downstream flow, at rest relative to the body An investigation shows no stationary vortex position behind a flat plate with the Kutta condition imposed Attention is given to studies conducted by Riabouchinski (1922) and Coe (1972) in relation to the same problem G R

A76-13992 * # Cascade with subsonic leading-edge locus M E Goldstein (NASA, · Lewis Research Center, Cleveland, Ohio) *AIAA Journal,* vol 13, Aug 1975, p 1117-1119

The paper investigates a two-dimensional oscillating cascade with a subsonic leading edge locus in a supersonic flow The blades are assumed to be of small thickness and camber, and are undergoing small amplitude-harmonic oscillations The problem is reduced to the solution of a functional integral equation, and an expression is given for the kernel function B J

A76-14147 Silencing an executive jet aircraft J R Brooks (Rolls Royce /1971/, Ltd , Bristol, England) and R J Woodrow (Hawker Siddeley Aviation, Ltd , Hatfield, Herts , England) *Noise Control Engineering,* vol 5, Sept -Oct 1975, p 66-74

The development of a turbojet exhaust silencer for an executive jet aircraft is described The development program included static noise and aerodynamic tests at model and full size and the subsequent comparative flight trials of 7 candidate configurations, including 3 with a tailpipe acoustic lining An 8-lobed nozzle without acoustic lining was selected as the most cost-effective silencer It was found that a model can accurately predict the acoustic and

aerodynamic behavior of suppressor nozzles at high jet velocities where jet mixing noise predominates At lower jet velocities other engine exhaust noise sources become dominant Comparison of the results of flight and static tests indicate that internally generated turbojet engine exhaust noise may be reduced by an acoustically lined tailpipe and does not behave as though it were a source independent of jet mixing noise   C K D

A76-14148 Status of the JT8D refan noise reduction program J D Kester (United Technologies Corp , Pratt and Whitney Aircraft Div , East Hartford, Conn) *Noise Control Engineering,* vol 5, Sept -Oct 1975, p 75-79

It has been demonstrated that the JT8D engine can be modified to reduce noise without sacrificing engine performance and durability characteristics The two stage fan is replaced by a larger-diameter single-stage fan incorporating advanced acoustical design features Acoustic treatment is also used in the engine and nacelle Refanned engines provide about 13% more static thrust than the original JT8D turbofan engine Cruise thrust is increased 5%, and a 3% reduction of cruise fuel consumption is obtained, the service-proved core engine components are retained Results of static engine tests and of flight and ground testing of the refanned engine are presented   C K D

A76-14171 YC-15 - A STOL performer for the 'eighties. *Air International,* vol 9, Dec 1975, p 275-280

Design and performance of the lift controls are emphasized in a detailed study of YC-15 medium-duty transport structure, with two-page cutaway diagram Double-slotted externally blown titanium flaps extend into the jet efflux from the four forward-mounted underwing JT8D turbofans and utilize supercirculation to add extra lift The lift dumping function of wingtop-mounted spoilers in shortening landing runs and in fly-by-wire direct lift control for steep STOL approaches, foreplane and tailplane leading-edge slats, engine

A76-14172 First write your scenario, then choose your actors R M Braybrook *Air International,* vol 9, Dec 1975, p 293-297

Projections of the actual combat situation (scenario) likely to be faced by a nation, given the geography, terrain, and location of likely combat areas, and the standards of equipment and capabilities of the projected enemy, may be more important in purchase or development of combat aircraft by a particular country than performance criteria per se The author reviews costly misconceived scenarios of earlier wars, and concentrates on divergences in the USAF scenario (which he sees still fixated on Viet Nam) and the European NATO scenario in relation to Soviet and Warsaw Pact military offensive capabilities in Western Europe Soviet developments that would frustrate these scenarios are considered, and the F-15 fighter is viewed as an excellent performer for both USAF and European NATO scenarios   R D V

A76-14329 Analytic design of a monolithic wing M A Bogomol'nyi and T K Sirazetdinov *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 13-18) *Soviet Aeronautics,* vol 18, no 2, 1975, p 8-12 5 refs Translation

The problem is discussed of designing a beveled monolithic wing of uniform cross section for such technical constraints as weight, displacements, stresses, etc The stiffness characteristics of the wing cross-sections are controlled by varying the size of the sectional cut-outs. Numerical methods of solution are proposed, and the design of a minimum-weight wing for given stresses and deflections is demonstrated   V P

A76-14331 Low-aspect-ratio wing structural analysis by the discrete-continuous scheme - Matrix differential equation of axial displacements M B Vakhitov and N G Larionov *(Aviatsionnaia*

Tekhnika, vol 18, no 2, 1975, p 25-30) *Soviet Aeronautics,* vol 18, no 2, 1975, p 18-22 Translation

A76-14332 Calculation of flow around profile cascades with arbitrary kinematic parameter time dependence V V Guliaev *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 31 37) *Soviet Aeronautics,* vol 18, no 2, 1975, p 23-28 8 refs Translation

A numerical method is proposed for calculating the aerodynamic characteristics of an arbitrarily staggered blade cascade for an arbitrary time-dependence of the deformation or motion parameters An ideal incompressible medium is postulated The problem is solved in linear formulation, assuming a stepwise variation of the kinematic parameters The airfoil is replaced by a vortex layer, and the latter is modeled by a system of discrete vortices The continuous variation of the circulation in time is treated as a stepwise variation   V P

A76-14336 Mathematical description of wing surfaces. T V Koriaka *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 59-63) *Soviet Aeronautics,* vol 18, no 2, 1975, p 46-49 Translation

A method is proposed for obtaining the mathematical model of a wing surface The problem of calculating the wing profile is reduced to the determination of the coordinates of intermediate points that are required to determine the external configuration of the wing The line of the wing profile is determined with the aid of a cubic parabola given in vector-parametric form Analytical relations describing the upper and the lower surface of the wing are derived   V P

A76-14338 Solution of the inverse problem of hypersonic gas flow around a slender blunt body N M Monakhov *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 69-77) *Soviet Aeronautics,* vol 18, no 2, 1975, p 55 61 Translation

The flow of an ideal gas past a wing with a blunt leading edge and past a blunted body of revolution is analyzed in the case where the shock waves are similar to those generated by a strong detonation (self similar motion at a blunted plate or a blunted cylinder) An exact similar solution is obtained, using the classical perturbation method in combination with the Poincare-Lighthill Kuo method The equations derived describe the surface of the body situated in the flow and the density and pressure at this surface It is shown that the third approximation is sufficiently accurate even at small distances from the bluntness   V P

A76-14339 Vortex method for calculation of arbitrary profiles Z Kh Nugmanov *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 78 83) *Soviet Aeronautics,* vol 18, no 2, 1975, p 62 66 9 refs Translation

The potential flow of an ideal incompressible fluid at an angle of attack past an arbitrary wing profile with a sharp leading edge is analyzed The reduced velocity at the wing surface is determined, in series form, from the solution of a Fredholm integral equation of the second kind The series coefficients are obtained with the aid of the Bubnov-Galerkin method   V P

A76-14343 Empennage 'snap-through' oscillations V A Pavlov *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 99-105) *Soviet Aeronautics,* vol 18, no 2, 1975, p 80 84 6 refs Translation

The vibrations of an empennage whose rudder moves on more than two hinges are analyzed The equations of motion are derived and are reduced to a system of two nonlinear differential equations It is shown that, in addition to resonance vibrations, rudder buffeting, and flutter, there may arise vibrations leading to snap-

through of the rudder The conditions leading to snap-through are identified V P

A76-14344 Approximate calculation of aerodynamic characteristics of channel wings with spanwise constant sweep A I Pastukhov and G S Kudriavtsev *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 106-111) *Soviet Aeronautics,* vol 18, no 2, 1975, p 85 89 Translation

A76-14345 Stability conditions of flight vehicle programmed motion with initial coordinate deviations V A Sgilevskii *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 112-116) *Soviet Aeronautics,* vol 18, no 2, 1975, p 90 94 6 refs Translation

The paper considers some stability conditions for programmed flight and possibilities of selecting stable trajectories Flight in the vertical plane with allowance for mass loss as a result of fuel consumption is studied, it being assumed that the thrust vector coincides with the vehicle axis The first-approximation equations of perturbed motion are set up and investigated according to Liapunov's principle that programmed motion is stable if all the characteristic numbers of the solutions of the system of equations for perturbed motion in the first approximation are positive and the system is regular Stability conditions for ascending and descending flight and for concave and convex trajectories is discussed P T H

A76-14348 Differential equations of engine thrust variation in the unsteady operating regime G M Trakhtenberg *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 129-134) *Soviet Aeronautics,* vol 18, no 2, 1975, p 104 108 Translation

A procedure is developed for deriving nonlinear differential equations describing the unsteady thrust of an aircraft engine on the basis of its experimental and design characteristics The equations proposed are useful in the solution of flight dynamics problems V P

A76-14357 Calculation of aerodynamic characteristics of rectangular wing with endplates near a screen S D Ermolenko, Iu A Rogozin, and G V Rogachev *(Aviatsionnaia Tekhnika,* vol 18, no 2, 1975, p 168-171) *Soviet Aeronautics,* vol 18, no 2, 1975, p 141 143 Translation

A76-14371 # A study on the flow around bluff bodies immersed in turbulent boundary layers I H Sakamoto, M Moriya (Kitami Institute of Technology, Kitami, Japan), and M Arie (Hokkaido University, Sapporo, Japan) *JSME, Bulletin,* vol 18, Oct 1975, p 1126-1133 10 refs

In a flow field without pressure gradient, wind tunnel measurements of the pressure distributions on two-dimensional normal plates were carried out by eliminating the blockage effects to correlate with the characteristics of a smooth-wall boundary layer in which they are immersed The drag coefficients are found to be expressed as a logarithmic function of the ratio between plate height and thickness of undisturbed boundary layer A correlation is obtained between the variation of form drag and the plate height A method of calculating the pressure distributions on the front surface of the normal plate is proposed on the basis of a free-streamline theory The method involves four parameters which must be determined experimentally The velocity field is integrated to construct a flow pattern for the purpose of comparing with one obtained by the present analytical method (Author)

A76-14402 Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings Conference sponsored by RAeS, IEE, and SAE London, Royal Aeronautical Society, 1975 590 p

Papers are presented describing experimental and theoretical studies of lightning phenomena and their consideration in aircraft design Some of the topics covered include lightning strike point studies on scale models, flight test studies of electrification on a supersonic aircraft, charge generation by commercial aircraft fuels and filter separators, effects of simulated lightning strikes on mechanical strength of CFRP laminates and sandwich panels, passive potential equalization between the cargo handler and a hovering helicopter, radome protection, and electrical discharges caused by satellite charging at synchronous orbit altitudes P T H

A76-14403 # Lightning phenomena in the aerospace environment I - The lightning discharge R B Anderson (South African Council for Scientific and Industrial Research, National Electrical Engineering Research Institute, Pretoria, Republic of South Africa) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings London, Royal Aeronautical Society, 1975 9 p 13 refs Research supported by the Armaments Board

The paper reviews the basic lightning discharge modes and sets forth a likely mechanism for discharge This mechanism is explained in its three stages (1) the leader deposits negative charge during about 10 to 20 microsec, (2) on contact with the earth, the return stroke takes place and overdischarges the lightning channel within 100 microsec, leaving the channel positive, and (3) slow discharge takes place for some milliseconds, during which negative charge again moves into the channel from the cloud charge to neutralize the positive ionic charge After this, the field intensity in the cloud should still be sufficient to propagate streamers further into a pocket of negative cloud charge, thus recharging the channel and leading to breakdown at lower negative tip with a following component strike Some typical lightning parameters based on numerous observations are presented P T H

A76-14404 # Lightning phenomena in the aerospace environment II - Lightning strikes to aircraft. R B Anderson and H Kroninger (South African Council for Scientific and Industrial Research, National Electrical Engineering Research Institute, Pretoria, Republic of South Africa). In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 7 p Research supported by the Armaments Board

The paper presents some statistical data on lighting strikes to aircraft relating to (1) number of lightning strikes to aircraft, (2) flight phase when lightning strike occurred, (3) height of aircraft when struck by lightning, and (4) lightning damage to aircraft Some guidelines are suggested for minimizing the possibility of lightning strikes low-flying aircraft should avoid thunderstorms at all times, the time, especially the holding-on time, spent by high-flying aircraft below an altitude of 7 km should be kept to a minimum Detection and location of lightning occurrence in the neighborhood of airports would greatly assist in the control of take-off and landing procedures P T H

A76-14405 # Development and properties of positive lightning flashes at Mount S Salvatore with a short view to the problem of aviation protection K Berger (Eidgenossische Technische Hochschule, Zurich, Switzerland) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings London, Royal Aeronautical Society, 1975 16 p 8 refs

A76-14407 # Lightning strike point location studies on scale models J Phillpott, P Little (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England), E L White (Electrical Research Association, Leatherhead, Surrey, England), H

M Ryan, C Powell (Reyrolle and Co , Ltd , Hebburn, England), S J Dale, A Aked, D J Tedford (Strathclyde, University, Glasgow, Scotland), and R T. Waters (University of Wales Institute of Science and Technology, Cardiff, Wales) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 19 p 8 refs Research supported by the Ministry of Defence (Procurement Executive), British Aircraft Corp , and Electrical Research Association

The results of comprehensive strike tests on scale models of BAC 1-11 and H S Trident aircraft are presented Attention is given to the effect of impulse amplitude, the effect of model size, and the electric field distribution on the surface of the model suspended in the rod/plane gap Studies are discussed of the mechanisms of breakdown G R

A76-14408 # **Scale model lightning attach point testing.** D W Clifford (McDonnell Aircraft Co , St Louis, Mo) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 15 p 13 refs

To determine the location of probable lightning attach points and swept stroke lightning zones on new aircraft designs, designers often employ attach point tests of scale models This paper discusses the value of these tests and analyzes the effects of certain testing variables on the test results The variables examined include the size, accuracy and construction of the scale model, air gap spacing, electrode geometry and polarity, number of strikes at each position, high voltage waveshape, and the effect of grounding the model It is theorized on the basis of streamering tests and an analysis of flight attach point data that effective isolation of the model from ground is an essential factor in accurately duplicating inflight strikes with either fast or slow wave model tests (Author)

A76-14409 # **Natural lightning parameters and their simulation in laboratory tests** E T Pierce (Stanford Research Institute, Menlo Park, Calif) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 14 p 21 refs Contract No N00014 74 C-0134

Questions related to the determination of lightning incidence as a first step in evaluating operational lightning hazards are considered along with the statistics of lightning parameters Attention is given to positive flashes, the significance of flashes to tall structures, fields due to close discharges, lightning models, specifications, and simulation tests G R

A76-14410 # **Simulation of lightning currents in relation to measured parameters of natural lightning** J Phillpott (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 J7 p 30 refs Research supported by the Ministry of Defence (Procurement Executive)

The characteristics of natural lightning phenomena are examined, taking into account the types of lightning discharge, negative ground discharge, positive ground discharges, intracloud discharges, the frequency of occurrence of positive and negative ground discharges, and the frequency of occurrence of intracloud and ground stroke Attention is also given to airworthiness requirements, equivalent lightning waveforms, the establishment of test specifications, and energy requirements in the case of component tests An example concerning the evaluation of the probability of catastrophic loss is also discussed G R

A76-14412 # **Flight-test studies of static electrification on a supersonic aircraft** J E Nanevicz (Stanford Research Institute, Menlo Park, Calif) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975

15 p 18 refs Contract No F33615-68 C-1359 AF Project 6091

A brief description is given of the instrumentation employed in the reported supersonic flight test program The flight-test results are discussed, taking into account precipitation charging, engine charging, engine discharging, tailcap antenna corona noise measurements, and a flight during which the test aircraft was flown in conjunction with a KC-135 tanker aircraft The investigations showed that the charge deposited by individual precipitation particles tends to decrease with increasing speed in the supersonic speed range G R

A76-14414 # **Static electrification with liquid aviation fuels - Its occurrence and suppression** A Lewis and H Strawson (Shell Research, Ltd , Thornton Research Centre, Chester, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings London, Royal Aeronautical Society, 1975 9 p

Aspects of charge generation in pipelines are discussed along with problems of aircraft fuelling and approaches for achieving charge relaxation The effects of using a conductivity additive in fuel are examined and a description is presented of methods used to carry out conductivity measurements during fuel distribution Attention is also given to requirements to bond the fuelling vehicle electrically to the aircraft in order to equalize the static potential of each vehicle G R

A76-14415 # **Charge generation by U S commercial aircraft fuels and filter-separators** W G Dukek (Exxon Research and Engineering Co , Linden, N J), K H Strauss (Texaco, Inc , Beacon, N Y), and J T Leonard (U S Navy, Naval Research Laboratory, Washington, D C) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 14 p 10 refs

Following two static ignitions during the fueling of identical aircraft in May and December 1970, an intensive investigation was conducted to identify the causes for this coincidence The investigation included a study of the charging characteristics of the two fueling carts involved in the incident The study revealed the effect of a very active filter medium Filter effects on charge generation are discussed along with questions concerning the fuel effects in charge generation and the maximum surface voltage G R

A76-14416 # **Variables which influence spark production due to static electricity in tank truck loading** K C Bachman (Exxon Research and Engineering Co , Linden, N J) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 16 p 10 refs

It is pointed out that ignition due to static electricity in tank truck loading can only take place if a number of critical conditions are satisfied There must be a means of generating and accumulating an electrostatic charge, a means for discharging the accumulated charge in the form of an incendiary spark, and a flammable mixture within the spark gap The results of an investigation of the various factors are discussed G R

A76 14418 ‑ **Measurement of inner skin surface temperatures of aluminum honeycomb panels subjected to lightning strike** M J Walton and P H Bootsma (de Havilland Aircraft of Canada Ltd , Downsview, Ontario, Canada) In Conference on Lightning and Static Electricity, Abingdon, Oxon England, April 14 17, 1975 Proceedings London, Royal Aeronautical Society, 1975 15 p Defence Research Board of Canada Contract No DHC P72 16

An investigation was conducted involving the measurement of the instantaneous temperature across the inner face of a sandwich panel while it was being struck by simulated lightning on the outer face After a number of tests, temperature data were obtained that

are reasonably accurate The measurements provide a record of the temperature at any point on the inner skin of the panel, throughout the duration of the experiments Details of the measuring technique employed are discussed   G R

A76-14419   The development of an aircraft safety fuel R E Miller and S P Wilford (Royal Aircraft Establishment, Materials Dept , Farnborough, Hants , England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 13 p 11 refs

The most promising way of reducing the incidence of crash fires lies in modifying or containing the fuel The main advantage of a mist-suppressing additive will be found in cases in which a low volatility fuel such as Avtur is used Studies concerning the fire resistant properties of Avtur containing mist suppressants are discussed and attention is given to handling and general properties of Avtur containing antimisting additives   G R

A76-14420 #   Development of requirements for aircraft fuel tank explosion prevention R J Auburn (FAA, Propulsion Branch, Washington, D C) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 13 p 11 refs

After the Elkton accident, in which a lightning-induced ignition of the fuel/air mixture in a reserve fuel tank led to the loss of the aircraft, investigations were conducted to find methods to prevent similar accidents Technology was evolving which would enable an aircraft designer to provide protection that would eliminate the risk of accidental ignition of fuel vapors within the tanks and vent systems The development of regulations on the basis of this technology is discussed   G R

A76-14421 #   Lightning strike performance of thin metal skin L L Oh and S D Schneider (Boeing Co , Seattle, Wash) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 15 p 8 refs U S Department of Transportation Contract No FA 55 67 3

Simulated lightning stroke tests were conducted to determine the behavior of swept strokes on titanium, aluminum, and anodized aluminum surfaces under uniform and nonuniform airstream conditions Attention was also given to the fuel vapor ignition thresholds of aluminum and titanium sheets when struck by lightning It is pointed out that the technique developed to determine skin thickness requirements for fuel tank skins in swept stroke zones can be applied in the case of any hybrid construction utilizing metallic skins   G R

A76-14422 #   Swept lightning stroke effects on painted surfaces and composites of helicopters and fixed wing aircraft J D Robb, J R Stahmann, T Chen (Lightning and Transients Research Institute, Minneapolis, Minn), and C P Mudd (U S Army, Aviation Systems Command, St Louis, Mo) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 16 p 13 refs

Additives for paints over thin metal skins covering fuel tanks are considered, taking into account dielectric strength tests which showed that a very significant reduction of the puncture voltage could be obtained with the aid of aluminum powder Attention is given to damage produced in nonmetallic structures, swept stroke studies involving protected nonmetallic structures, and damage and protection in the case of composite helicopter blades   G R

A76-14423   Techniques of strike tests on structures, components and materials A W Hanson (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings London, Royal Aeronautical Society, 1975 13 p Research supported by the Ministry of Defence (Procurement Executive)

A description is given of methods of generating the agreed waveforms in the test facility Attention is given to the oscillatory waveform, the critically damped waveform, the diverted waveform, the clamped waveform, the fast bank, the intermediate bank, the high di/dt generator, the combined waveforms, the swept stroke simulator, and questions concerning the general layout The test rig is considered along with the test specifications and aspects of diagnostics   G R

A76-14424 #   Effect of simulated lightning strikes on mechanical strength of CFRP laminates and sandwich panels L N Phillips, A C Cornwell (Royal Aircraft Establishment, Farnborough, Hants , England), E L White, and E N Jones (Electrical Research Association, Leatherhead, Surrey, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings London, Royal Aeronautical Society, 1975 15 p

The experiments considered show that the damage caused by simulated lightning strike on carbon-fiber composites involves a characteristic 'burn' which volatilizes the resin from the fibers It is concluded that lightning strike on components made from carbon fiber reinforced plastics is unlikely to bring about serious and incapacitating structural damage The mechanism of the protection provided by 200 mesh aluminum is also discussed   G R

A76-14426 #   S-3A lightning protection program - Lightning effects analysis H Knoller (Lockheed Aircraft Corp , Burbank, Calif) and J A Plumer (General Electric Co , Fairfield, Conn) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings London, Royal Aeronautical Society, 1975 16 p Contract No N00019-73 A-0301

The S-3A is a new U S Navy antisubmarine warfare aircraft which is expected to operate also under weather conditions with a high lightning-strike probability Investigations were, therefore, started concerning the vulnerability of the aircraft to lightning A description is presented of important program planning aspects of Phase I of the investigative program Attention is also given to the results of model tests performed under varied test conditions to determine the significance of test conditions on predicted attachment points   G R

A76-14427 #   Passive potential equalization between the cargo handler and a hovering helicopter D G Douglas, J E Nanevicz (Stanford Research Institute, Menlo Park, Calif), and B J Solak (Boeing Co , Vertol Div , Morton, Pa) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 13 p 9 refs Army-sponsored research

A review and summary of various static electricity discharge techniques for cargo helicopters is provided Although the original study programs were oriented toward finding solutions for static electrification problems on the Boeing Heavy Lift Helicopter, the results of these studies can be scaled for a helicopter of any size The paper includes a discussion of several active and passive discharging schemes, as well as a discussion of the physiological response to the electrical shock from a charged, hovering helicopter   (Author)

A76-14428 #   Lightning protection of supersonic transport aircraft S T M Reynolds (British Aircraft Corp , Ltd , Filton, Bristol, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 14 p 17 refs

Special features of supersonic transport aircraft from the point of view of lightning-related hazards are examined and the distribution of strike point locations is considered Attention is given to test criteria for the Concorde lightning test program, the design and testing relationships, the radome protection cage, radome locking clamps, the hinge bearings of flying control surfaces, the fuel tank venting systems, and lightning discharge incidents during develop ment flying   G R

A76-14429 #   **General installation, bonding requirements and techniques** A Alric (Societe Nationale Industrielle Aérospatiale, Toulouse, France) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 11 p

Aspects of bonding concept definition are discussed and an investigation is conducted concerning questions regarding the necessity of bonding in specific cases When designing a particular bond, it is necessary to know the value of the conductivity to be achieved Maximum resistance values are listed for primary and secondary bondings Bonding techniques are considered, giving attention to structural bonding, the bonding of pipes, and the bonding of accessories   G R

A76-14430 #   **Conditions of lightning strikes on air transports and certain general lightning protection requirements** O K Trunov (Gosudarstvennyi Nauchno Issledovatel'skii Institut Grazh danskoi Aviatsii, Moscow, USSR) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 18 p

Statistics are presented regarding the damages produced in Aeroflot aircraft by electrical discharges, taking into account the rate and intensity of static electricity effects in the case of aircraft with different aerodynamic geometry It is recommended to base warnings concerning potential lightning hazards not only on thunderstorm forecasts but also on all environmental factors that may prove especially hazardous for a particular type of aircraft   G R

A76-14431   **Induced voltages, measurement techniques and typical values** B J C Burrows (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings
London, Royal Aeronautical Society, 1975 15 p 7 refs Research supported by the Ministry of Defence (Procurement Executive)

A classification of induced voltage problems is considered, taking into account induced voltages caused by lightning currents flowing through the airframe and producing voltages by resistive effects and by magnetic flux linking Attention is given to induced voltages in an idealized fuselage, induced voltages in idealized wings, a summary of a closed structure analysis, and magnetically induced voltages   G R

A76-14432 #   **Static electrification of windscreens and canopies** P J Sharp (Lucas Aerospace, Ltd , Luton, Beds , England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings
London, Royal Aeronautical Society, 1975 13 p Research supported by the Lucas Aerospace

The windscreen or the canopy of an aircraft may hold a charge of several thousand volts relative to its mounting structure The demonstration of a realistic discharge is discussed The tests showed that a puncture of the outer windscreen laminate could occur under certain conditions In some toughened glasses, such a puncture would result in a complete break up of the glass, with a consequent loss of vision Attention is given to approaches for eliminating or reducing static-electrification hazards   G R

A76-14433 #   **Radome protection techniques** D A Conti (British Aircraft Corp , Ltd , Stevenage, Herts , England) and R H J

Cary (Royal Radar Establishment, Malvern, Worcs , England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings
London, Royal Aeronautical Society, 1975 12 p Research supported by the Ministry of Defence (Procurement Executive) and British Aircraft Corp

The basic protection method considered involves an enclosure of the radome and/or the radar system with suitably distributed metallic elements Basic protection elements are discussed, taking into account internally grounded systems and external conductors Attention is given to approaches to improve the protection characteristics by suitable radome design features   G R

A76-14434 #   **Aircraft applications of segmented-strip lightning protection systems** M P Amason, G J Cassell, and J T Kung (Douglas Aircraft Co , Long Beach, Calif) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 15 p 9 refs

A segmented lightning strip consists of metal segments connected by means of an appropriate resistance material Lightning strike and electromagnetic characteristics of the segmented strip are examined Questions of system design are considered, taking into account radome lightning protection, pitot boom lightning protection, segmented strip and fitting design, and problems of rain erosion Aspects of lightning test evaluation are also discussed Attention is given to general test criteria, segmented strip configuration, and isolation/shielding design   G R

A76-14435 #   **An analysis of lightning strikes in airline operation in the USA and Europe** J A Plumer (General Electric Co , Fairfield, Conn) and B L Perry (Civil Aviation Authority, Airworthiness Div , London, England) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings   London, Royal Aeronautical Society, 1975 13 p 7 refs

The considered data make it possible to predict with reasonable accuracy the rate of incidence and the location of lightning strikes in the case of conventionally shaped aircraft It is pointed out that altitude limitations or unusual thunderstorm activity can very appreciably increase the incidence of strikes for a given aircraft Attention should be given to the effects of a use of nonmetallic materials in aircraft   G R

A76-14436 #   **APERTURE and DIFFUSION computer programs for prediction of lightning induced voltages** F A Fisher, K J Maxwell (General Electric Co , Fairfield, Conn), and R C Beavin (USAF, Systems Command, Andrews AFB, Washington, D C) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings
London, Royal Aeronautical Society, 1975 14 p Contract No F33615-74 C 3068

APERTURE and DIFFUSION are computer programs which evaluate the internal magnetic fields produced by the two most important mechanisms by which external magnetic fields are coupled to the inside of the aircraft These mechanisms include coupling through apertures and coupling through metal surfaces The programs are to enable an aircraft designer to evaluate the voltages and currents that would be induced in specific electrical circuits   G R

A76-14437 #   **Symmetry effects in electromagnetic shielding of aerospace vehicles** J D Robb, J R Stahmann, and T Chen (Lightning and Transients Research Institute, Minneapolis, Minn) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14 17, 1975, Proceedings
London, Royal Aeronautical Society, 1975 13 p

Electromagnetic shielding of aerospace vehicles may be arbitrarily divided into two basic aspects shielding by counter currents

induced in the shell by the incident currents or electromagnetic fields and by symmetry of current flow The power of symmetry shielding is illustrated by examples of fields inside open wire and closed metal cylinders with axial current flow Practical examples are presented, including measurements on an aircraft wing box geometry as an illustration of asymmetry and an aircraft fuselage as an example of nearly symmetrical construction These examples are correlated with experience in artificial lightning testing of full scale aircraft The differences are illustrated between the conclusions which might be drawn from the theoretical concepts only and what has been found to be of most importance in actual measurements in real operational aircraft tested with full scale average lightning current magnitudes of 20,000 amperes and with the electrical systems and engines operating   (Author)

A76-14438 * #   Lightning effects on the NASA F-8 digital fly-by-wire airplane J A Plumer (General Electric Co , Fairfield, Conn) In Conference on Lightning and Static Electricity, Abingdon, Oxon, England, April 14-17, 1975, Proceedings
London, Royal Aeronautical Society, 1975 12 p
Contract No NAS4 2090

An investigation was conducted to evaluate the possible electromagnetic effects of lightning on a fly-by-wire flight control system which had been developed for an F8 aircraft A brief description is presented of the flight control system The test and measurement technique used in the investigation is discussed The results of the investigation are considered, taking into account the vulnerability of individual system components to lightning induced voltages   G R

A76-14449 #   Experimental and theoretical study of a two-dimensional turbulent incompressible reattachment (Etude expérimentale et théorique du recollement bidimensionnel turbulent incompressible) J -C Le Balleur and J Mirande (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *(NATO, AGARD, Réunion sur les Ecoulements Décollés, Gottingen, West Germany, May 27-30, 1975)* ONERA, TP no 1975-16, 1975 14 p 25 refs In French

An experimental study of turbulent incompressible reattachment was carried out on a simple two-dimensional model including essentially a descending step of variable height followed by a straight-line reattachment wall of adjustable inclination An analysis of pressure and velocity distributions helped derive general empirical laws for the case of an initial boundary layer that is thin at separation The calculations concerned the self-induced interaction of a dissipative wall layer with an inviscid and nonrotational external flow Experimental results are found to be consistent with theory as regards the prediction of pressure distribution at the wall and the characteristic thicknesses of the dissipative layers, provided the separating boundary layer is moderately thick (ratio of dissipative layer thickness to step height not exceeding unity)   S D

A76-14454   A model for the flow in a supersonic axial compressor (Schéma de l'écoulement dans un compresseur axial supersonique). J Fabri (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *(Association Technique Maritime et Aéronautique, Bulletin, no 75, 1975)* ONERA, TP no 1975-59, 1975 17 p 18 refs In French

An analysis of the flow at the outlet of a supersonic axial compressor reveals the existence of a high-speed jet stream and a swirling flow with almost no axial velocity at the periphery of the blades A theoretical model derived from an overexpanded rocket flow model is proposed to interpret experimental results The fluid, which is supersonic in its motion with respect to the moving blades at the mean radius of the inlet section, is susceptible to detach from one wall and attach to the opposite wall, as in the case of a supersonic jet in an overexpanded rocket nozzle The radial distributions of Mach number, flow angles, pressure, and efficiency are calculated Theoretical findings are found to be consistent with the experimental results for a freon supersonic compressor   S D

A76-14455   Possible applications of the airship (Les applications possibles des dirigeables) J Bouttes (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *(Association Technique Maritime et Aeronautique, Bulletin, no 75, 1975)* ONERA, TP no 1975-60, 1975 14 p In French

The most significant potential role for the dirigible is in the transport of large indivisible cargos from one fixed point to another at low speeds (100-120 km/hr) and over a limited optimum range (1000-1500 km) An airship suitable for this type of application is described, and technical obstacles to its realization are summarized The system comprises four helium-inflated flexible balloons with a volume of 250,000 cu m, fixed at the base to a pyramidal structure supporting a loading winch with a 500 ton capacity In accordance with a modification of Archemede's force based upon variations in the thermodynamic characteristics of the gases contained in the envelope and the atmosphere, it is estimated that a compensatory vertical force of about 80 tons is necessary for the maintenance of vertical equilibrium, supplemented by provision for the rapid modification of the vertical force by about 20 tons Problems confronting the production, aerodynamic qualification and inflation of large flexible balloons are discussed   C K D

A76-14456 #   Comparison of two-dimensional and three-dimensional transonic tests in several large wind tunnels (Comparison d'essais transsoniques bi- et tridimensionnels effectués dans diverses grandes souffleries) X Vaucheret, M Bazin, and C Armand (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *(NATO, AGARD, Réunion sur la Correlation entre Essais au Sol et en Vol, Valloire, Savoie, France, June 9-12, 1975)* ONERA, TP no 1975-61, 1975 15 p 15 refs In French

Comparative studies of models were conducted in several wind tunnels with emphasis on wall interference effects, boundary layer suction, and wall conditions (porous, perforated, or slotted walls, wall roughness, boundary layer trips with glass beads) Difficulties with sidewall boundary-layer effects, and the effect of a perforated throat section are noted in the two dimensional case Homothetical models of a transport aircraft were tested in twelve transonic wind tunnels in different countries in the three-dimensional case, with variations in wall roughness and porosity, wall venting, and sting diameter   R D V

A76-14457   Technologies for the air transport of tomorrow (Technologies pour le transport aérien de demain) P Poisson Quinton (ONERA, Châtillon-sous Bagneux, Hauts-de-Seine, France) *(Icare, no 72, 1975, p 81 100)* ONERA, TP no 1975-62, 1975 (p 81 100) 21 p 28 refs In French

A review of technologies essential to the future cost effective development and implementation of large transport aircraft is presented Emphasis is placed upon the importance of improved methods of design optimisation and qualification testing, including ground and flight simulation techniques Progress in optimisation of lift-drag ratios through reduction of transonic drag, skin friction drag, induced drag, wave drag, and casing/motor interference drag, is discussed The task of developing turbo-fan engines to meet requirements for economical operation (a by-pass ratio of the order of 10, a compression ratio of about 40/1, ability to sustain temperatures up to 1400 C) while minimizing noise by use of acoustic insulation and appropriate flight procedures is described The application of new construction techniques and the use of composites to reduce construction and maintenance costs are considered, together with advancements in systems integration and avionics   C K D

A76-14463 #   Unsteady pressure measurements in wing-with-store configurations (Mesures de pression instationnaire sur des configurations d'ailes equipées de charges) R Destuynder (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *(NATO, AGARD, Réunion, Ankara, Turkey, Sept 30, 1975)* ONERA, TP no 1975-102, 1975 19 p In French

The measurements are made at various Mach numbers on a semi-span model oscillating in pitch Several kinds of stores, differing in size and position, were mounted In each case, the characteristic values due to the store itself, those due to the interaction between wing and store, and lastly the values relative to the clean wing were measured Calculations were performed in order to compare theory and experiment Two methods are applied the first one, developed by ONERA, is a semi-empirical method making use of Mach number fields, the other one, used by the NLR Amsterdam, is more complete as it determines directly the interaction between wing and store, introducing source and doublet distributions on the store, the pylon and the wing In all cases, it appears that the main term is the interaction created by the store on the wing, which can entail a variation of up to 15 per cent of the lift coefficient   (Author)

A76-14564   The effects of maintenance actions on helicopter vibration signatures J A George and R M Andres (St Louis University, Cahokia, Ill) In Advances in test measurement Volume 12 - Proceedings of the Twenty-first International Instrumentation Symposium, Philadelphia, Pa , May 19 21, 1975 Pittsburgh, Pa , Instrument Society of America, 1975, p 571-577 Army-supported research

The effects of typical maintenance actions on the vibration signatures of the UH-1H helicopter powertrain and engine were investigated The signals from fourteen velocity and accelerometer transducers were recorded during a variety of flight modes from two helicopters and their power spectral densities were calculated via a Fast Fourier Transform The frequency range of analysis was 0 2 kHz and 0-5 kHz with 340 narrow band frequency points being calculated Baseline data indicated spectral dependence on flight condition, the particular aircraft, as well as the particular gearbox or engine A comparison of spectra subsequent to maintenance actions showed substantial differences from the baseline data   (Author)

A76-14565   American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc , 1975 674 p Members, $35 , nonmembers, $60

Recent studies on helicopter rotor aerodynamics, helicopter design, VTOL avionics, helicopter handling qualities, helicopter propulsion systems, and structures and materials for helicopters are presented A special section on rotor technology is also provided Some of the topics covered include aerodynamic design rationale for the fan-in-fin on the S-67 helicopter, application of a variable-diameter rotor system to advanced VTOL aircraft, heavy-lift helicopter primary flight control system, investigation of helicopter airframe normal modes, a remotely piloted vehicle/VTOL demonstration vehicle, the dynamic response of wind turbine systems, and aerodynamic design of optimum rotors for wind power generators
                                                        P T H

A76-14566 *   Laser velocimeter measurements of rotor blade loads and tip vortex rollup J C Biggers, S Chu, and K L Orloff (NASA, Ames Research Center, Moffett Field, Calif) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 7 p 9 refs

A method for obtaining and analyzing the instantaneous velocities of helicopter rotor flow fields through use of a laser velocimeter capable of simultaneously sensing two components of velocity is described Rotor blade aerodynamic loads may be computed from the velocity distributions near the blades The experiment was conducted with a 2 13 m (7 ft) diameter model helicopter rotor operating in a wind tunnel Velocity distributions are presented which document the flow field near the advancing blade Circulation is calculated from the velocity measurements, and the radial distribution of circulation is discussed The influence of the tip vortex from the preceding blade is apparent in this distribution Tip vortex rollup on the advancing blade was documented by making a series of measurements at various distances

behind the blade Effects of blade drag are evident in the velocities behind the blade trailing edge   (Author)

A76-14567   The development of transonic airfoils for helicopters J W Sloof (National Aerospace Laboratory, Amsterdam, Netherlands), F X Wortmann (Stuttgart, Universitat, Stuttgart, West Germany), and J M Duhon (Bell Helicopter Co , Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 16 p 20 refs

Two techniques of helicopter rotor airfoil design are set forth and compared the method of Wortmann - a three-step procedure for achieving shockless flow for low-lift, high Mach number and high-lift, moderate Mach number conditions - and a method based on analytic transonic hodograph theory The steps of the Wortmann method are (1) generate from a chosen velocity distribution an airfoil shape which nearly realizes the desired velocity in incompressible flow using a singularity method, (2) convert the flow field into a compressible one by a similarity rule, and (3) calculate local supersonic fields on the basis of information from the first two steps The second method consists in computing a series of shock-free shapes for high Mach and low lift by the hodograph method, estimating hover and maneuver performance of basic airfoil through potential flow calculations, and modifying the basic shape to optimize toward hover, maneuver, and pitching moment through potential flow and boundary layer calculations Design examples for both methods are presented   P T H

A76-14568   A model rotor performance validation for the CCR technology demonstrator. J B Wilkerson and D W Linck (U S Naval Material Command, Ship Research and Development Center, Bethesda, Md) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 15 p 7 refs

Circulation control technology has been further developed at the Naval Ship Research and Development Center by wind tunnel and hover stand evaluations of a second rotor model - the Circulation Control Rotor (CCR) This two-bladed model was preceded by the four bladed Higher Harmonic Circulation Control (HHCC) rotor The first model proved that circulation control could be used for cyclic lift control at forward speeds without the use of cyclic pitch An improved CCR design was accomplished with a theoretical prediction program which was revised by using the results obtained for the HHCC rotor The performance of both rotor models is compared and an explanation given of how the trends of the CCR data were used to refine the prediction programs The results of the extensive correlation effort are shown for forward flight and hover Knowledge gained from the two CC rotors is now being applied to the aerodynamic design of the full-scale technology demonstrator, the Kaman XH2/CCR   (Author)

A76-14569   Have we overlooked the full potential of the conventional rotor F J McHugh and F D Harris (Boeing Vertol Co , Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 23 p 7 refs

Early analytical studies and test data indicated that rotor stall prevented operating conventional rotors beyond an advance ratio of 0 5 at typical design lift levels as an efficient pure helicopter This led to the research and development of compound helicopters as well as advanced rotor concepts An in-depth study of stall was undertaken that provided understanding and a theoretical representation of the aerodynamic and aeroelastic response of the rotor when it encounters stall A reexamination of the high speed regime was made with this improved analytical capability and was followed by a preliminary model rotor test Rotor performance and blade load results were very encouraging and today indicate that efficient operation beyond an advance ratio of 0 5 is feasible   (Author)

A76-14570 **Aerodynamic design rationale for the fan-in-fin of the S-67 helicopter** D R Clark (United Technologies Corp, Sikorsky Aircraft Div, Stratford, Conn) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 11 p 12 refs Grant No DAAJ02-72-C-0050

The paper describes the development of the fan-in-fin antitorque system for the S-67 helicopter Particular attention is paid to the design of the fan duct with the way in which the ideal shape was modified (in its application to an existing aircraft originally configured for a tail rotor) being traced in detail The sucess of the design was validated with data taken during a small scale wind tunnel test, a full scale ground test which simulated low speed flight in all directions, and from the flight test program Selected data from these programs are presented (Author)

A76-14571 **The Bell YAH-63 advanced attack helicopter configuration, design considerations and development status.** C M Seibel and L D Kulik (Bell Helicopter Co, Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 10 p.

The paper discusses the Advanced Attack Helicopter requirements, including design-to-cost philosophy, survivability, visionics, reliability and maintenance, avionics, and deployability, and then reviews the main design features of the YAH-63 prototype helicopter and the status of its preflight tests The main rotor is a wide-chord, two-bladed rotor permitting spar separation for 23 mm HEI survivability To assure a more stable gun platform, less crew fatigue, and longer component life, rotor-induced 2/Rev vibrations are isolated from the fuselage by a nodalized pylon suspension system The twin T-700 engines are widely separated to increase ballistic survivability The tandem crew is housed in a four-plane, flat-surface canopy that produces 80% less glint signature than its predecessors All major bending and torsional loads are transmitted through the shell of the fuselage, precluding the necessity of heavy fore and aft beams and internal structure The Phase I development program is proceeding ahead of the current contract schedule P T H

A76-14572 **YAH-64 advanced attack helicopter design** J C Dendy and C L Landers (Summa Corp, Hughes Helicopters Div, Culver City, Calif) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 15 p

An overview of the YAH-64 Advanced Attack Helicopter aircraft and mission systems is provided In addition, the paper covers two basic areas (1) the impact of the design-to-cost (DTC) concept on air vehicle design, and (2) the status of the YAH-64 test program Test results to date are covered, including both design support tests and airworthiness qualification tests Results of engine abusive tests, engine inlet distortion, and cooling cross-flow tests are specifically described (Author)

A76-14573 **Navy/Marine 1980 rotary wing candidates** G Unger (U S Navy, Naval Air Systems Command, Washington, D C) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 12 p

This paper summarizes a Navy effort, with the participation of two manufacturers, that assessed the impact of Navy and Marine Corps mission requirements on several rotary wing concepts The concepts included the conventional and compound helicopters, the tilt rotor, and the Sikorsky ABC (Advancing Blade Concept) Airframe commonality, design speed, reliability, maintainability, and cost are discussed Mission effectiveness, and shipboard spotting are highlighted Quite unexpectedly, a compound helicopter with a common Navy and Marine airframe and a design speed of 225 knots proved to be the most cost-effective solution to the requirements (Author)

A76-14574 **Application of a variable diameter rotor system to advanced VTOL aircraft** E A Fradenburgh (United Technologies Corp, Sikorsky Aircraft Div, Stratford, Conn) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 15 p

The paper describes an in-flight variable-diameter rotor system designed to extend the capabilities and improve the performance of several categories of high-speed rotary wing aircraft Diameter changes are actuated by a differential gear mechanism that is as simple and reliable as an automobile differential In model tests, rotor performance characteristics in low-speed helicopter mode with fully extended blades were comparable to those of conventional helicopters Experimental lift and propulsive force values over the speed range from 60 to 150 knots were more than adequate for the assumed stopped/stowed rotor or compound helicopter envelopes Rotor diameter changes were demonstrated at forward speeds up to 150 knots at full rpm rotational speeds The changes were rapid, with positive control and low blade stresses Good results were also obtained in high-speed helicopter mode Application of the variable diameter rotor system to compound helicopters, and stowed rotor and tilted rotor aircraft is discussed P T H

A76-14575 **Design variables for a controllable twist rotor** D W Robinson, Jr, H E Howes (Kaman Aerospace Corp, Washington, D C), and W E Nettles (U S Army, Aviation Material Command, Fort Eustis, Va) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 15 p 7 refs

The controllable twist rotor features a torsionally-flexible helicopter blade with a dual control system Inboard pitch horns, swashplate, and actuators provide conventional primary control An aerodynamic trim tab near the blade tip, actuated collectively and cyclically, gives control over blade twisting The ability to optimize blade pitch distribution along the radius and around the azimuth promises improved performance, delayed retreating blade stall, and reduced bending moments and vibration levels Design of a test rotor is described, with discussion of the principal design variables and their influence on rotor performance, dynamics, and cost The procedure by which an efficient combination of design variables was developed, the resulting configuration, and its performance (under analysis and in whirl stand testing) are described (Author)

A76-14576 **New concepts for helicopter main rotors** R Mouille (Société Nationale Industrielle Aerospatiale, Marignane, Alpes-Maritimes, France) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 10 p

Within the scope of a research programme, different main rotor head design solutions have been tested, by Aerospatiale, on a trial aircraft, in this case a Gazelle helicopter having an all-up weight of 4000 lb By applying new technology and using new materials (such as glass/resin composites and laminated elastomers), very important progress has been made in the way of weight saving as well as in costs, flying qualities, reliability, and maintenance When compared to the Alouette II main rotor head or to the head fitted to the production Gazelle, a weight saving of about 40 per cent is possible with a corresponding cost reduction of approximately 50 per cent (Author)

A76-14580 **Heavy-lift helicopter primary flight control system** B L McManus and A J Niven (Boeing Vertol Co, Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings

New York, American Helicopter Society, Inc ,
1975 9 p 6 refs

The fly by-wire flight control system of the XCH-62A heavy lift helicopter is described giving attention to cockpit controls, the swashplate servoactuator, the redundant system, and hardware Flight safety was the prime consideration in design Three separate and independent channels, each capable of performing the full flight control function, are provided In line monitoring is employed so that each channel can detect its own failures without cross channel comparisons Active/on-line actuation concept assures that channels do not force flight in normal operation and that time-critical switchout is not required for first failures Hardware for the prototype aircraft is in the final stages of integration testing, first results indicate that performance specifications will be exceeded

P T H

A76-14583 **Pendulum absorbers reduce transition vibration** R Gabel (Boeing Vertol Co , Philadelphia, Pa) and G Reichert (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13 15, 1975, Proceedings
New York, American Helicopter Society, Inc , 1975 10 p

Transition vibration of small helicopters is an equal annoyance candidate to high speed vibration of larger helicopters Steady state levels over twice high speed levels occur, and descents and flares are higher than desired The BO-105 had these problems, but under a joint MBB-Boeing program, a cure was developed Pendulum absorbers in an unusual combination of flap and lag on each blade, together with improved blade tuning have greatly improved vibration levels (Author)

A76-14584 **Rotor stability prediction correlation with model and full scale tests** R A Johnston (United Technologies Corp., Sikorsky Aircraft Div , Stratford, Conn) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc , 1975 15 p 9 refs

An aeroelastic rotor stability analysis that provides a very complete description of the dynamics and aerodynamics of fully coupled rotor-airframe-control systems, representative of main or tail configurations is discussed The analysis, which gives system eigenvalues and eigenvectors, can be used to study the stability of rotors in conditions of pure axial flow or for forward flight studies at advance ratios up to about 0 5 Various examples of correlation with scale model and full scale tests are given and the capability of the analysis to predict certain unstable phenomena is demonstrated through correlation with test occurrences The importance of accurately defining the physical properties of the systems being analyzed is noted, and the need for continued development and comprehensive correlation studies is cited (Author)

A76-14585 * **An analytical study of a multicycle controllable twist rotor** J L McCloud, III (NASA, Ames Research Center, Moffett Field, Calif) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc , 1975 11 p 9 refs

A rotor employing a servo-flap to effect blade torsional deflections (the Kaman Controllable Twist Rotor) has been used in a theoretical study to assess the potential of multicyclic flap control, (i e , 1P, 2P, 3P, and 4P flap deflections) The results show that virtual elimination of pylon vibratory loads may be achieved with concurrent blade bending moments reduced by 50% The amplitude requirements of the higher harmonic deflections are of the order of 3 or 4 deg The study is in two parts, the calculation of rotor loads for specific combinations of multicyclic flap deflections by a typical rotor computer analysis, and an analysis of those results to determine optimum combinations of the multicyclic flap control The paper discusses the analysis and indicates the potentials of a multicyclic controllable twist rotor (Author)

A76-14586 **Investigation of helicopter airframe normal modes** R W White (Westland Helicopters, Ltd , Yeovil, Somerset, England) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings
New York, American Helicopter Society, Inc , 1975 11 p Research supported by the Ministry of Defence (Procurement Executive)

The research is part of a continuing long term investigation into the fundamental dynamic characteristics of helicopters The normal modes of a helicopter were isolated (using multi point excitation), quantified and compared with modes calculated from finite-element analysis Both sets of modes were used to predict forced response and were compared with measured response to rotor head excitation The experimental criterion for isolating and measuring normal modes was de Veubeke's Characteristic Phase Lag Criterion The mathematical model was based upon a minimum complexity finite element analysis of 114 degrees of freedom The modeling exercise was in itself part of a larger research effort in the finite element field and provides the basis for models that are increasing in refinement It was found that the successful use of coarse models depends in particular upon the use of consistent mass matrices (Author)

A76-14587 **Rotor blade wake flutter - A comparison of theory and experiment** W D Anderson and G A Watts (Lockheed California Co , Burbank, Calif) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13 15, 1975, Proceedings New York, American Helicopter Society, Inc , 1975 17 p 11 refs

During early whirl testing of the hingeless main rotor of the AH-56A Cheyenne helicopter, a high-frequency (7P), highly coupled, flap torsion inplane mode flutter occurred at rotor overspeed at a condition of near zero lift at the rotor tips The flutter disappeared at higher and lower values of rotor lift rather than being nearly lift independent as had been predicted by quasi steady aerodynamic theory Wake flutter was suspected and corroborated by subsequent analysis This discussion covers the theoretical flutter analyses and the effects on flutter of design changes made both to eliminate the flutter and to improve vehicle stability and control (Author)

A76-14588 **Synthesized unsteady airfoil data with applications to stall flutter calculations** R L Bielawa (United Technologies Research Center, East Hartford, Conn) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc , 1975 12 p 12 refs

A compact, semi-analytic method is presented for synthesizing and calculating unsteady two-dimensional airfoil data The results of synthesizing the unsteady data of a NACA 0012 airfoil in the form of certain nonlinear functions and appropriate constants are presented The method is sufficiently general to permit meaningful approximations to the unsteady data of airfoils for which only static data exist Preliminary results show the synthesized data to be as accurate as the established tabular form of the data (Author)

A76-14589 **Development of Heavy Lift Helicopter handling qualities for precision cargo operations** J M Davis, K H Landis, and J R Leet (Boeing Vertol Co , Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13 15, 1975, Proceedings
New York, American Helicopter Society, Inc , 1975 22 p 5 refs

The US Army Heavy Lift Helicopter is being designed to perform external cargo operations in all weather conditions A load handling capability has been developed to permit rapid and precise acquisition and deposit of containerized cargo within confined areas including moving ships The load handling system incorporates high-gain ground referenced velocity and position stabilization and

provides precise control capability for a load controlling crewman The design analysis, piloted simulation, and flight evaluations are discussed, emphasizing stability and control response characteristics, load stabilization impact, and pilot adaptability Flight testing of the system was successfully completed in October 1974 Comparisons between simulator design and flight results are presented (Author)

A76-14590 **Use of programmable force feel for handling qualities improvement in a helicopter velocity flight control system** W B Bryant and R B Trueblood (Charles Stark Draper Laboratory, Inc, Cambridge, Mass) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13 15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 10 p 6 refs Grant No DAAJ02-73-C-0070

Extensive flight experience with helicopter velocity flight control systems has shown that conventional thinking regarding pilot's control force feel characteristics must be modified for this type of control system Simpler control systems, including those with rate augmentation, require a relatively high level of pilot's control activity because the pilot must provide attitude and speed stability by control inputs Velocity control systems, on the other hand, provide full and continuous stabilization of attitude and speed so that no control manipulation is required to check divergences Control inputs with velocity control therefore are much less frequent and of relatively small amplitude Some premium is, however, placed on smoothness of control motion due to the nature of the transfer functions relating control motions to aircraft responses The paper presents an analysis in terms of these transfer functions, the analysis was used to develop the design of a programmable force feel system to improve the short term handling qualities of the control system Such a system applied to the longitudinal axis of the CH-47B TAGS system has been flight tested (Author)

A76-14591 **Designing to survive tail rotor loss** T J Horst and R J Reschak (Bell Helicopter Co, Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13 15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 10 p

The development and application of a mathematical model for predicting sideslip during flight without a tail rotor are described in this paper This method of analysis can be used to properly size a fin which will have sufficient static and dynamic stability to provide 'fly-back' capability if the tail rotor is lost, is damaged, or fails It is well suited for preliminary design since it requires only a limited knowledge of the aerodynamic characteristics of the helicopter airframe Sample calculations are shown for a modern attack helicopter (Author)

A76-14592 **Stability and control of the YUH-61A** B B Blake and I B Alansky (Boeing Vertol Co, Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13 15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 10 p

The design of the hingeless rotor YUH-61A helicopter is described from a flying qualities standpoint Contribution of various aircraft components to longitudinal stability in cruise flight are presented The longitudinal short period maneuver parameter, and static longitudinal stability are examined since these represent the largest influence on pitch stability The beneficial aeroelastic effects included in the YUH-61A hingeless rotor are blade sweep, c g -a c offset, and control system stiffness The influence of these parameters is shown Sizing of the horizontal tail and its use as a controllable surface was based on wind tunnel testing which showed the high dynamic pressure and angle of attack due to rotor downwash at the tail which occurs in transition By properly controlling the incidence of the stabilizer, hub moments and control trim change can be controlled throughout the forward flight envelope (Author)

A76-14594 **Application and control of a powdered coating** G M Van Deventer (Bell Helicopter Co, Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 5 p

Powdered epoxy coatings are reported to be effective barriers against fretting corrosion, they prevent wear and abrasion and provide protection in most severe corrosive environments For successful results in any given application, the surface preparation prior to coating, masking, preheating, timing and postheating operations must be controlled In applications where close dimensional control is required, machining must be performed after the coating has been applied The choice of a fluidized bed method of application or an electrostatic spray method of application depends upon the number and size of parts to be processed and upon coating thickness requirements Proper dimensioning of surfaces before and after coating, and final coating thickness requirements are extremely important This paper discusses a thermosetting epoxy powder presently used on helicopter parts The epoxy powder is applied by the electrostatic spray method (Author)

A76-14595 **Manufacturing technology applied to the prototype XCH-62 Heavy-Lift Helicopter airframe - The first all-honeycomb, primary-structure aircraft** L J Ralston and A C Haggerty (Boeing Vertol Co, Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 13 p

In the fall of 1975, the Army's prototype Heavy-Lift Helicopter (HLH) will roll out and begin ground-testing prior to its first flight early in 1976 The HLH prototype is the first military aircraft to have all of its primary structure fabricated from bonded-honeycomb assemblies The use of bonded-honeycomb panels for primary structure has reduced the parts count by 23 percent over conventional skin-and-stringer construction, with corresponding reductions in cost and weight This paper describes the tooling philosophy for the HLH prototype, including extensive use of the Boeing computerized master-dimensioning system for mathematical lofting, the unique design of single-contour, double-contour, and flat-panel bonding tools, and the problems and experience gained in the detail fabrication, processing, subassembly, and final assembly of the bonded structure (Author)

A76-14596 **Supplier-designed components - Quality assurance for user satisfaction** T G Hill (Bell Helicopter Co, Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings (A76 14565 04-05) New York, American Helicopter Society, Inc, 1975 6 p

This paper presents a quality assurance program for developing user satisfaction with supplier-designed components for helicopters The principal components in such a program are pumps, valves, oil cooler blowers, generators, actuators, flight instruments and other like items Examined are user expectations, designer objectives and a quality control program for supplier-designed components The quality control program applies a management by-objectives principle in a 0-0% program which defines guidelines for percent rejection during bench test and production flight test for selected components Also discussed are cases in which the user's expectations and designer's objectives were in conflict (Author)

A76-14597 **Diffusion bonded Ti-6Al-4V helicopter rotor hub and blade spar technology** J J Lucas, M J Bonassar (United Technologies Corp, Sikorsky Aircraft Div, Stratford, Conn), and P J Dayle (U S Army, Army Materials and Mechanics Research Center, Watertown, Mass) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society,

Inc, 1975 11 p 6 refs Grants No DAAG46-73-C-0126, No DAAG46 72-C-0175

The implementation of forge-diffusion bonding of large titanium-6Al-4V helicopter main rotor hubs and continuous seam diffusion bonding (CSDB) of Ti-6Al-4V main rotor blade spars was investigated in two stages basic process optimization on small-scale specimens, and fabrication and evaluation of a full-size risk reduction component For both processes, optimum conditions for producing high-quality parts with parent material mechanical properties were developed A high-quality risk reduction forge-diffusion bonded arm was produced, though it is considered that scaling-up the hardware necessary to accomodate a full-size H53 elastomeric main rotor hub is not cost effective Testing of the continuous seam diffusion bonded spar segment showed that CSDB has fatigue strength characteristics as good as or better than present fusion welded main rotor blade spar specimens   P T H

A76-14598   **Product assurance as viewed by the Army Aviation Systems Command** E J Hollman (U S Army, Aviation Systems Command, St Louis, Mo) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 8 p

The paper describes the organization, operating procedures, and policies of the Army Aviation Systems Command (AVSC) Product Assurance, which assesses today's weapons systems and quantifies the reliability and maintainability improvements desired in future systems The main divisions of the service are the systems performance assessment division, the reliability and maintainability division, the quality engineering division, the quality operations division, and the plans and program analysis division These are briefly described, and some areas for future improvements in methodology and procedures are indicated   P T H

A76-14599   **Navy shipboard trials of helicopters and V/STOL aircraft** D E Beck (Sub Board of Inspection and Survey, Patuxent River, Md) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 6 p

The mode of operation and mission varies widely between helicopters, tilt wings, or direct lift jet V/STOL aircraft However, the preparation and planning for shipboard trials are over 90 percent common for all types The planning phases can be broken into the following areas (1) basic flight restrictions, (2) shipboard restrictions, (3) operational goals, (4) shore based tests, (5) instrumentation data package, (6) shipboard indoctrination, and (7) contingency plans Naval Air Test Center (NATC) shipboard trials of the H-2, CX 84, and AV 8A are used to illustrate the required planning phases The helicopter 'dynamic interface' tests and subsequent promulgation of shipboard launch/recovery envelopes are the end result of the preparation and conduct of shipboard trials   (Author)

A76-14600   **Flight-test report on the Heavy-Lift Helicopter flight-control system** A J Hutto (Boeing Vertol Co , Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington,   D C ,   May   13-15,   1975,   Proceedings   New York, American Helicopter Society, Inc , 1975 9 p 5 refs

The paper describes the flight test program of the Heavy Lift Helicopter (HLH) primary flight control system, which is a doubly redundant direct electrical-linkage system (DELS) that accepts limited-authority signals from a digital automatic flight control system (AFCS) The triply redundant AFCS provides stability and control augmentation and selectable mission related control modes The system was tested on a modified CH-47 helicopter in three phases' open loop tests with DELS actuators disconnected and vehicle flown by mechanical controls, closed loop tests with control system configured for flight on DELS with automatic and manual

reversion to mechanical backup, and pure fly-by-wire testing The DELS and AFCS provided safe control and good to excellent flying qualities throughout the flight envelope, and precise load handling capability was demonstrated   P T H

A76-14601   **Army preliminary evaluation of the HLH ATC demonstrator fly-by-wire flight control system** D R Simon and J C Savage (U S Army, Air Mobility and Development Laboratory, Fort Eustis, Va) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13-15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 10 p

The paper gives the results of flight testing of the Heavy Lift Helicopter (HLH) demonstrator fly by-wire flight control system on a modified CH-47 test aircraft during 24 5 total flight test hours The modified aircraft had a rear-facing Load Controlling Crewman (LCC) station for evaluating the HLH LCC controls The LCC station equipped with a four axis sidearm controller was a very efficient work station The velocity control system provided a true hands-off hover capability However, an automatic or much simpler method of drift clearing is needed The hover hold mode gave the pilot a hands-off hover capability identical to that provided for the LCC, but the pilot lacked the ability to properly enter the control loop Tests showed the hover trim mode with appropriate gains would be a highly desirable selectable mode for speeds below about 40 knots, especially for IMC operations   P T H

A76-14602   **The design and testing of a tip to reduce blade slap** J L Tangler (Bell Helicopter Co , Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st Washington,   D C ,   May   13-15,   1975,   Proceedings   New York, American Helicopter Society, Inc , 1975 13 p 8 refs

Model rotor schlieren studies and full scale flight tests have been conducted to (1) show that blade slap during partial power descent can be substantially reduced by diffusing a blade's tip vortex before it intersects the following blade, and (2) develop a tip shape that rapidly diffuses the tip vortex without causing a large performance loss The first objective has been achieved with a tip spoiler and significant progress has been made toward the second objective A new tip shape designated the sub-wing divides the strong tip vortex into two smaller twin vortices which undergo a destructive interaction that results in one diffused vortex The experimental results indicate that this tip can substantially reduce blade slap during partial power descent without causing a large performance loss

(Author)

A76-14603   **Remotely piloted vehicle/vertical attitude take-off and landing demonstration vehicle** W H Eilertson (U S Navy, Naval Ship Research and Development Center, Bethesda, Md) In American Helicopter Society, Annual National Forum, 31st, Washington,   D C ,   May   13 15,   1975,   Proceedings   New York, American Helicopter Society, Inc , 1975 13 p

Launch and recovery of RPVs aboard ship has been identified by the Navy as a major design impact area Vertical attitude take off and landing offers attractive advantages to the Navy in that ship/RPV interface problems are alleviated A 560-lb demonstration vehicle has been designed and constructed to test these advantages This vehicle during 1975 will be flight tested to assess vertical hover capability of the RPV in the turbulent aerodynamic wake generated by a ships superstructure while underway The design incorporates a close coupled canard/delta wing configuration Components from the MQM74A target drone as well as the Harpoon missile are utilized Other Navy laboratories are cooperating in support of engine installation design and test (NWC), guidance and control (NUSC), power circuitry (NATC), and flight tests (PMR/NMC) Flight tests in hover, horizontal flight, transition (at safe altitudes) and ship docking are planned   (Author)

A76-14605 Integrated airflow concepts for helicopter engine and drive system R D Semple (Boeing Vertol Co, Philadelphia, Pa) and T Himka (Boeing Commercial Airplane Co, Seattle, Wash) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 12 p

Integrated engine/transmission/airframe conceptual designs are developed for a utility helicopter to meet projected airflow require ments of future Army aircraft These requirements include engine compartment cooling, drive train and transmission oil cooling, engine oil cooling, exhaust plume and hot metal infrared signature sup pression, and engine inlet foreign particle protection The baseline utilized in the investigation is a single main rotor, twin-engine utility helicopter with a design gross weight of 8500 pounds This paper presents six integrated concepts which are evaluated in comparison to the baseline aircraft propulsion system on the basis of overall system performance, complexity, aircraft weight, installation design, technical risk, and control requirements (Author)

A76-14606 The design and development of the Rolls-Royce Gem engine C H Buck (Rolls Royce /1971/, Ltd, Small Engine Div, Leavesden, Herts, England) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 14 p

The paper gives a description of the principal design features of the Gem Mk100 - turboshaft engine comprising a two-spool gas generator and a two-stage free power turbine, with a through shaft to a front-mounted integral reduction gear, providing a forward drive at 6000 rpm The gas generator has a four-stage axial-flow low pressure compressor driven by a single-stage axial turbine and a single-stage centrifugal HP compressor also driven by a single-stage axial turbine The combustion chamber is of the reverse flow type and employs a low pressure vaporizing fuel injection system The engine is con structed from seven self-contained modules, allowing easier repair in the field by direct substitution of module assemblies Allowance was made for subsequent growth of the engine beyond the original performance standard The port and starboard engines are inter changeable, and overhaul life is not less than 600 hours on entering service P T H

A76-14607 Design and development of a free planet transmission E R Givens (U S Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va), N A DeBruyne, and D J Folenta (Curtiss-Wright Corp, Wood Ridge, N J) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 9 p

This paper presents a brief description of an advanced tech nology power transmission arrangement designated as 'free planet transmission', and a summary of results obtained from testing two prototype free planetary transmission modules This new trans mission can be generally classified as a quasi-compound planetary containing such major elements as a sun gear, planet spindle assemblies, ring gears and rolling rings All internal gear forces are balanced between the free floating planet subassemblies and cylindri cal support rings Since the planet spindles are not restrained, the conventional planet carriers (spiders) are not required The elimina tion of this component and the associated planet bearings has numerous favorable implications on such parameters as weight, reliability, cost, and survivability The work accomplished to date, including endurance testing of two 500 HP 20 1 reduction ratio transmissions, indicates that the concept is stable, and that it has high mechanical efficiency and excellent load distribution (Author)

A76-14609 Titanium UTTAS main rotor blade P Arcidiacono and R Zincone (United Technologies Corp, Sikorsky Aircraft Div, Stratford, Conn) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975,

Proceedings New York, American Helicopter Society, Inc, 1975 9 p 6 refs

A description of the design philosophy leading to the develop ment of a high performance rotor blade for the Army UTTAS helicopter is presented The Army mission requirements of 550 FPM rate-of-climb at 4,000 ft, and a 1 75g maneuver at 150 knots translate into figure of merit and aeroelastic achievements beyond those of existing rotors The roles played by high blade twist, advanced airfoils, and swept tips in providing a rotor system having an unprecedented figure of merit of 0 75 is discussed The technology needed to successfully use a high twist blade and yet achieve forward flight and maneuvering requirements is embodied in the titanium spar, composite cover blade It is shown that titanium with an allowable bending strain 2 times that of aluminum and a torsional stiffness 2 5 times that of fiberglass best meets the weight, stiffness and life design requirements The composite cover provides the durability needed for the Army mission while Cockpit BIM meets the standards of safety demonstrated by aluminum blades

(Author)

A76-14610 Prediction of helicopter control load structural limits R B Taylor and R Gabel (Boeing Vertol Co, Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 11 p 6 refs

Helicopter control loads and the associated structural limits have long been important primarily because of their restrictions on flight envelope expansion To supplement direct analytical methods, a semi-empirical approach has been developed which predicts struc tural envelope limits based on control loads Model data are used in conjunction with scaling parameters to develop nondimensional control load limits Correlation of the theoretical results with flight data show close agreement of structural limits The prediction method is used to develop control load structural flight envelopes for a growth helicopter The method is also used to parametrically study certain blade characteristics for flight envelope optimization

(Author)

A76-14611 A composite pylon support structure for the JetRanger helicopter H Zinberg (Bell Helicopter Co, Fort Worth, Tex) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13-15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 7 p

This paper describes a program to design, fabricate, ground test, and flight test a prototype pylon support structure for the JetRanger helicopter The structure, a single plane truss made from unidirec tional S-glass prepreg and E-glass fabric, replaces a steel forging that is 2 4 times as heavy One part was static tested to failure at 310 percent of limit load On two fatigue tests, benign failures occurred at the number of cycles predicted by the S-N curve for the part A residual strength equivalent to 3 1g remained after the fatigue test A flight test program was conducted on a helicopter in which a pair of fiberglass mounts were installed Flight loads were comparable to those measured on the production part The program also investi gated a production type mount structure It weighs slightly more than the prototype, but should be competitive in cost with the present steel part (Author)

A76-14612 A study of helicopter landing behavior on small ships R M Tuttle (Kaman Aerospace Corp, Bloomfield, Conn) In American Helicopter Society, Annual National Forum, 31st, Washington, D C, May 13 15, 1975, Proceedings New York, American Helicopter Society, Inc, 1975 17 p

The paper describes a dynamic landing analysis program for prediction of landing parameters of helicopters in free landing on small platforms in moderately high seas under a variety of condi tions A program of experimental landings was also conducted to obtain correlations with the computer predictions For simple

landings, excellent correlations could be obtained, while as landings became more complex, the need for more precise knowledge of initial conditions increased   P T H

A76-14613   **Ballistic design support tests - A tool for helicopter vulnerability reduction** R E Rohtert (Hughes Helicopters, Culver City, Calif) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13 15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 13 p Grant No DAAJ01-73-3-0743(P40)

The importance to the designer and to stress, weights, and vulnerability analysts of ballistic design support tests early in a new attack helicopter program are discussed Such tests provide data for preliminary evaluations of various design approaches directed towards reducing helicopter vulnerability to ballistic impact The significant differences between design support tests and those ballistic tests contractually required under the Airworthiness Qualification Specification are noted A number of specific tests using 12 7mm API and 23mm HEI threat projectiles, in support of the YAH-64 Advanced Attack Helicopter, are discussed and illustrated These tests simulated the blast/fragment barrier separating the pilot and copilot/gunner, various critical control components, the tail rotor drive shaft, integral armor sleeves protecting bearings, main rotor control clevises, and the fuselage structure Some generalized statements on test results, to the extent they are supported by available data, are presented   (Author)

A76-14616   **A rigid body model for analysis of aerogenerator rotor dynamics** C E Smith, R W Thresher, R E Wilson, and R B MacDuff (Oregon State University, Corvallis, Ore) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13 15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 8 p

The paper proposes a fundamental but simple rigid body model of an aerogenerator in order to explore some of the dynamic problems of design and operation of large-scale wind turbines The model incorporates dynamic interaction among gravitational, kinematically induced, and elastic support forces Attention was focused on coupling of rotor flapping vibrational modes with tower translational motion Although the analysis does not include aerodynamic forces or output shaft coupling torques, it does give indications as to conditions under which resonant conditions may exist   P T H

A76-14619 *   **How big is a windmill - Glauert revisited** J L McCloud, III and J C Biggers (NASA, Ames Research Center, Moffett Field, Calif) In American Helicopter Society, Annual National Forum, 31st, Washington, D C , May 13 15, 1975, Proceedings   New York, American Helicopter Society, Inc , 1975 9 p 5 refs

The obvious similarities to propellers and helicopter rotors suggest that helicopter technology might be used to improve wind generator performance, perhaps including development of a windmill airfoil In a back-to-basics approach, this paper reviews the analyses of Glauert to determine basic size-power relations The energy method of Wheatley developed for helicopter/auto-gyro performance prediction is then incorporated into the basic theory Equations and charts are presented showing ratios of power output to the ideal power capability as functions of mean blade lift and drag coefficients, solidity, and rotor tip speed ratio It is found there is little possibility for improved performance by using improved airfoils The basic assumptions of the Glauert theory are reviewed and means are suggested for achieving the basic power capability indicated by momentum theory   (Author)

A76-14804 * #   **Shear flow aerodynamics - Lifting surface theory** C S Ventres (Princeton University, Princeton, N J) AIAA Journal, vol 13, Sept 1975, p 1183-1189 13 refs Grant No NGR-31-001 197

A lifting surface theory based on a parallel shear flow model is presented for steady, incompressible flows The theory is intended to account approximately for the presence of a boundary layer The method of Fourier transforms is used to calculate the pressure on a surface of infinite extent and arbitrary contour Immediately above the surface is a region of sheared flow (the boundary layer), outside of which the flow velocity is constant The Fourier transform of the pressure on this surface is used to derive the shear flow equivalent to the kernel function of classical potential flow lifting surface theory The kernel function provides an integral relation between the upwash at a given point on the surface and the pressure everywhere on the surface This relation is treated as an integral equation for the pressure, and is solved numerically Computations are presented for the lift and pitching moment on a flat plate in two-dimensional flow, and for flat, rectangular wings of aspect ratio 1, 2, and 5 As expected, the shear layer decreases the lift curve slope, however, the shear layer (whose thickness is constant along the wing chord) has little effect on the center of pressure   (Author)

A76-14811 #   **Hypersonic flow over concave surfaces with leading-edge bluntness** A V Murthy (National Aeronautical Laboratory, Bangalore, India) AIAA Journal, vol 13, Sept 1975, p 1230 1233 11 refs

Both Cheng's theory and its modified version using tangent wedge rule are studied for power-law concave surface flows with leading-edge bluntness It is shown that Cheng's theory yields highly oscillatory results for concave surfaces with blunt leading edge The tangent wedge analysis is found to predict a smooth transition from the leading-edge blast wave effect to the downstream asymptotic conditions The alternative use of the tangent wedge formula cannot be justified strictly from theoretical considerations, since it neglects the centrifugal pressure rise on the surface The good agreement with experimental results obtained for concave surfaces with sharp leading edge using the tangent wedge formula suggests that the analysis presented may be useful in making first estimates, since the effects of the nose bluntness and the boundary-layer displacement are similar   S D

A76-14818 * #   **Analytical formulas for conditions on blunt wedges in hypersonic flow** W L Bade (Avco Corp , Avco Systems Div , Wilmington, Mass) AIAA Journal, vol 13, Sept 1975, p 1245-1247 Contract No NAS9-9744

An analytical approximation is obtained to the solution of the equation describing the combined effects of bluntness and boundary-layer displacement on the hypersonic flow over a wedge for the case where the constant parameter in the governing equation, which is proportional to the angle of attack, is greater than zero It is shown that the approximation has good physical accuracy over the entire range of conditions to which the theory is applicable for positive angle of attack   S D

A76-14819 * #   **Boundary-layer effect in panel flutter** M E Goldstein (NASA, Lewis Research Center, Cleveland, Ohio) AIAA Journal, vol 13, Sept 1975, p 1247-1249 7 refs

The present note shows that if the supersonic Mach number is not too large, an analytical expression can be obtained for the generalized aerodynamic force relating the pressure fluctuation at the surface of a flexible plate to the plate displacement in the presence of an adjacent boundary layer The low supersonic Mach numbers are the ones of maximum interest since it is in this Mach number region that the boundary layer has the most influence In this respect, Dowell (1971) has already shown that the presence of a boundary layer causes about a 300% increase in flutter dynamic pressure at a Mach number of about 1 2, while it causes only about a 20% increase at a Mach number of 2   S D

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A76-14872 * #   A life study of ausforged, standard forged, and standard machined AISI M-50 spur gears D P Townsend, E V Zaretsky (NASA, Lewis Research Center, Cleveland, Ohio), and E N Bamberger (General Electric Co, Evendale, Ohio) *American Society of Mechanical Engineers and American Society of Lubrication Engineers, Joint Lubrication Conference, Miami Beach, Fla, Oct 21-23, 1975, ASME Paper 75-Lub-20* 8 p 24 refs Members, $1 50, nonmembers, $3 00

Tests were conducted at 350 K with three groups of 8 9 cm pitch diameter spur gears made of vacuum-induction melted (VIM), vacuum-arc remelted (VAR), AISI M-50 steel and one group of vacuum-arc remelted (VAR) AISI 9310 steel The pitting fatigue life of the standard forged and ausforged gears was approximately five times that of the VAR AISI 9310 gears and ten times that of the bending fatigue life of the standard machined VIM-VAR AISI M-50 gears run under identical conditions There was a slight decrease in the 10-percent life of the ausforged gears from that for the standard forged gears However, the difference is not statistically significant The standard machined gears failed primarily by gear tooth fracture while the forged and ausforged VIM-VAR AISI M-50 and the VAR AISI 9310 gears failed primarily by surface pitting fatigue The ausforged gears had a slightly greater tendency to fail by tooth fracture than the standard forged gears   (Author)

A76-14882 #   Linear transient response of a flexible rotor supported in gas-lubricated bearings J W Lund (Danmarks Tekniske Højskole, Lyngby, Denmark) *American Society of Mechanical Engineers and American Society of Lubrication Engineers, Joint Lubrication Conference, Miami Beach, Fla, Oct 21-23, 1975, ASME Paper 75-Lub-40* 9 p 16 refs Members, $1 50, nonmembers, $3 00

Assuming sufficiently small journal amplitudes, a rotor supported in gas-lubricated bearings represents a nonconservative, nonself-adjoint system with frequency dependent support coefficients A method is developed to compute the complex eigenvalues together with the associated modal and adjoint functions for such a system for use in establishing normal coordinates On this basis, the response to any arbitrary excitation is readily obtained The application of the method is illustrated by calculations of the response to shock excitation and external random vibration of a rigid rotor supported in tilting pad bearings   (Author)

A76-14957 #   Tunnel interference reduction on a finite airfoil C -F Lo (ARO, Inc, Arnold Air Force Station, Tenn) *Journal of Aircraft,* vol 12, Aug 1975, p 682, 683 9 refs

The concept of interference reduction has been demonstrated in an earlier paper (1972) in which a mathematical technique was presented to predict the interference on an airfoil represented by a single singularity in a Gaussian-type distribution of porosity The present paper extends the mathematical technique to the case of a finite-chord airfoil with a view to predicting the proper porosity distribution to eliminate interference The results of interference calculation are primarily for the improvement of a currently existing nonadaptive-wall wind tunnel The airfoil is located at the centerline of a perforated tunnel having walls with nonuniform distribution of porosities The tabulated influence coefficients can be used to calculate interference factors for any finite airfoil with a given loading and thickness distribution at a given angle of attack It is shown that a large gradient of porosity, especially in the neighborhood of the test model, is required to change significantly the value of interference factors of a tunnel   S D

A76-14958 * #   Effect of combined roll rate and sideslip angle on aircraft flight stability R F Stengel (Analytic Sciences Corp, Reading, Mass) *Journal of Aircraft,* vol 12, Aug 1975, p 683-685 6 refs Contract No NAS9 10268

The combined destabilizing effects of roll rate and sideslip angle are studied for a high angle-of-attack flight condition using a linear simulation of the coupled motions of a Space Shuttle like configuration Variations in the eigenvalues for a flight condition nominally identified by an angle of attack of 33 29 deg and a Mach number of 4 9 are examined with illustrations of the separate effects of body-axis roll rate and yaw rate, stability-axis roll rate, dynamic pressure, and sideslip angle It is shown that the stability of the free motion of the vehicle is sensitive to roll rate and that this sensitivity is enhanced by nonzero sideslip angle The results suggest that fully coupled linearized equations can be of value both for the study of Space Shuttle stability and for a better understanding of post-stall gyrations, incipient spin, and departure prevention for high performance aircraft   S D

A76-14959 #   Slide-valve-controlled vectoring nozzle J A C Kentfield (Calgary, University, Calgary, Alberta, Canada) *Journal of Aircraft,* vol 12, Aug 1975, p 685-687

This note presents experimental data on the aerodynamic performance, including vectoring capability, of a slide valve-controlled ventral outflow system A major factor complicating the design of ventral vectoring nozzles is the need for providing vector control with the entire engine flow passing through the ventral opening Major conclusions are that vectoring nozzle with a slide valve-controlled ventral opening is feasible from the standpoint of internal and external aerodynamics and that a range of vectoring between 10 deg forward to 30 deg aft of vertical with the entire flow passing the ventral exit is well within the capabilities of the device A prediction of the thrust coefficient of the most practical configuration featuring airfoil cross-section vanes and a sharp-edged slider yielded a value of 0 95   S D

A76-14961 #   Wave structure of exhausts. A E Fuhs (U S Naval Postgraduate School, Monterey, Calif) *Journal of Aircraft,* vol 12, Aug 1975, p 689, 690 Navy-supported research

An earlier paper (1971) has proposed a method whereby shock diamonds could be eliminated by suitable choice of exhaust Mach number Elimination of shock diamonds is desirable for reduced exhaust plume signature The present note examines the jet Mach number for ramjets, rockets, and gas turbines as a function of freestream Mach number It is shown that for practical rocket chamber pressures the shock diamonds will not be eliminated except for a high supersonic freestream Mach number and an insignificant transonic region, that a ramjet should operate without shock diamonds for freestream Mach number in excess of about 1 4, and that current supersonic aircraft should have shock diamonds whenever freestream Mach number exceeds unity by a slight amount However, advanced turbojet-propelled aircraft should not have shock diamonds whenever freestream Mach number exceeds about 2 6   S D

A76-14962 #   Comment on 'Advanced technology thrust vectoring exhaust systems' J A C Kentfield (Calgary, University, Calgary, Alberta, Canada) *Journal of Aircraft,* vol 12, Aug 1975, p 690, 691

Comments are presented on two of the nozzle types considered by Gill (1974) for the lift-cruise engine of a specific VTOL aircraft operating a prescribed mission With respect to the range of vectoring using only the ventral opening, the slide valve and trap-door concepts appear to be comparable A disadvantage of the slide valve concept, however, is the increased seal length compared with that of the trap-door nozzle For missions in which an unaugmented turbofan is the appropriate choice, especially if only a convergent nozzle is required, a compound-angle swivel, or rotary, cascade nozzle may be well worth consideration   S D

A76-14963 * #   Northrop F-5A aircraft transonic buffet pressure data acquisition and response analysis C Hwang and W S Pi (Northrop Corp, Hawthorne, Calif) *Journal of Aircraft,* vol 12, Sept 1975, p 714-720 18 refs Contract No NAS2-6475

Flight tests were performed on an extensively instrumented F 5A aircraft to investigate the dynamic buffet pressure distribution on the wing surfaces and the responses during a series of transonic maneuvers called the windup turns The maneuvers were performed at three Mach number-altitude combinations with a constant q of approximately 14,360 N/sq m (300 psf) The fluctuating buffet pressure data at 24 stations on the right wing of the F-5A were acquired by miniaturized semiconductor type pressure transducers mounted on the wing A new transducer mounting and wiring technique was applied where the interference with the natural flow condition was minimized The data acquired in this manner were found adequate to trace the shock origin, the movement of the shock front and the development of the separated flow (shock-induced or leading-edge induced) on the wing surface An analytical procedure, called a 'segmentwise stationary procedure', was introduced to compute the aircraft response spectra based on the measured buffet pressures The analytical response data computed in this manner are correlated with the test response data obtained in the same flights
(Author)

A76-14964 # **Calculation of vortex sheet roll-up in a rectangular wind tunnel** M Mokry (National Aeronautical Establishment, Ottawa, Canada) and W J Rainbird (Carleton University, Ottawa, Canada) *Journal of Aircraft,* vol 12, Sept 1975, p 750-752 12 refs

The concept of the influence (Green's) function for representing the boundary effect of wind tunnel walls is used in a calculation of the roll-up of a vortex sheet wake in a rectangular wind tunnel with solid walls The method is applied for simplicity to a vortex sheet in the time-dependent y, z plane Computations are performed by the discretization of the continuous vortex sheet model by finite length elements, which show more stable behavior than Westwater's (1935) array of point vortices For a suitable distribution of vortex sheet elements and for appropriate time increments, the roll-up process can be followed over sufficiently large times without the need to introduce artificial viscosity or smoothing   P T H

A76-14966 * # **Multiple slot skin friction reduction.** F G Howard, J N Hefner, and A. J Srokowski (NASA, Langley Research Center, High-Speed Aerodynamics Div , Hampton, Va). *Journal of Aircraft,* vol. 12, Sept 1975, p 753, 754 10 refs

The paper investigates analytically the effect of multiple slot injection on skin friction for a representative fuselage shape (ogive-cylinder body) and evaluates the potential of slot injection as a drag reduction system in subsonic flow Typical CTOL cruise flight conditions (Mach number equals 0 82 at altitudes of 11 km) were adopted for a fuselage 67 06 m in length and with maximum diameter of 7 32 m The numerical method of Price and Harris (1972) was used to calculate the boundary-layer characteristics up to the first slot, while the finite-difference method of Beckwith and Bushnell (1971) was used to calculate the velocity profile downstream of one, three, five, or ten slots An integral expression is proposed for characterizing skin friction reduction effectiveness, and it is seen that large reductions in viscous drag (50%) are available through slot injection Skin friction reduction is improved by increasing the number of injection slots but at a diminishing rate
P T H

A76-14967 * # **Supersonic inlet contour interpolation** N E. Sorensen and E A Latham (NASA, Ames Research Center, Aerodynamics Branch, Moffett Field, Calif) *Journal of Aircraft,* vol 12, Sept 1975, p 754-756

A method for designing supersonic inlet contours is described which consists in the interpolation of the contours of two known inlets designed for different Mach numbers, thereby determining the contours for a third inlet at an intermediate design Mach number Several similar axisymmetric inlet contours were interpolated from known inlets with design Mach numbers ranging from 2 16 to 4 0 and with design Mach numbers differing by as much as 1 0 The flowfields were calculated according to Sorensen's (1965) computer program Shockwave structure and pressure distribution charac-

teristics are shown for the interpolated inlets The validity of the interpolation is demonstrated by comparing the plots of the flowfield properties across the throat station of the interpolated inlet with the known inlets which were designed iteratively It seems possible to write a computer program so that a matrix of known inlet contours can be interpolated   P T H

A76-14976 # **Structural design of aircraft (Konstruktsiia samoletov)** A N Glagolev, M Ia Gol'dinov, and S M Grigorenko Moscow, Izdatel'stvo Mashinostroenie, 1975 480 p 16 refs In Russian

This manual is devoted to aircraft structural design and structural strength Topics treated include the mechanical and thermal loading of aircraft, reliability requirements of aircraft structures and materials, the principles behind aircraft structural mechanics, wing loading, fuselage design, aircraft control factors, structures for optimizing takeoff and landing, aircraft flutter, and the principles behind aircraft design   B J

A76-15007 # **Comparison of suboptimal control programs and the effect of aerodynamic forces on the time-minimal transition to takeoff of VTOL aircraft (Vergleich suboptimaler Steuerprogramme und der Einfluss der Luftkrafte fur zeitminimale Starttransitionen von VTOL-Flugzeugen)** K O Hub Munchen, Technische Universitat, Fachbereich fur Maschinenwesen, Dr Ing Dissertation, 1975 116 p 31 refs In German

Two optimal control programs a continuous control program and a step control program - for controlling the takeoff of VTOL aircraft are compared Some of the factors considered are equations of motion, initial and final conditions, and optimal phase velocity for time minimal transition to takeoff The effects of aerodynamic forces are taken into account   B J

A76-15009 # **Investigation of the stall behavior of T-tail aircraft - Contribution to the 'super-stall' problem (Untersuchungen zum Überziehverhalten von Flugzeugen mit T-Leitwerk - Ein Beitrag zum Problem 'super-stall')** W Siegler Darmstadt, Technische Hochschule, Fachbereich Maschinenbau, Dr -Ing Dissertation, 1975 162 p 57 refs In German. Research supported by the Deutsche Forschungsgemeinschaft, Deutsches Rechenzentrum Darmstadt, and Technische Hochschule Darmstadt.

Wind tunnel measurements were conducted on two aircraft models - a transport aircraft and a fighter aircraft - to determine the aerodynamic stall characteristics of T tail surfaces The models were at an angle of attack of 54 degrees and the effect of certain tail-surface geometrical parameters on stall characteristics was determined Damping derivatives were calculated and a flight mechanics analysis was performed   B J

A76-15011 # **Extension of the lifting line model of helicopter wings (Erweiterung des Traglinienmodells beim Hubschrauberrotor)** R Hille Hamburg, Universitat, Fachbereich Physik, Doktor Dissertation, 1974 72 p 11 refs In German

The lifting line model is used to investigate the flow distribution around helicopter wings Attention is paid to the calculation of induced velocities and to singularities in the integrands of induced velocities A existence theorem is demonstrated for the free-vortex integral, and the integral equation for the vortex distribution is solved Boundary conditions are investigated for the flow distribution around the wings of the S58 helicopter The flapping angle is determined from the oscillation equation   B J

A76-15047 **Helicopter technology and today's Army** N R Augustine (U S Army, Washington, D C) *Vertiflite,* vol 21, Sept -Oct 1975, p 4 9

U S Army helicopter capability is stressed as the major quantitative advantage over the USSR in tactical combat The

helicopter's indispensability in mobility, flexibility, economy of force, reduced troop exposure, and medical evacuation tasks is reviewed, with emphasis on low-altitude night combat operations, fully instrumented flight, terrain following, crashworthiness, and combat survivability The HYSAS hydrofluidic stability augmentation system, the Heavy Lift Helicopter, the COBRA/TOW heliborne antitank system, and regenerative gas turbine propulsive systems, are discussed R D V

A76-15154 **Composite jet engine frame** M F Grandey, L J Stoffer, and C L Stotler (General Electric Co , Cincinnati, Ohio) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975
Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p 28-42
Simulated advanced engine inlet frames utilizing epoxy/graphite have been produced and statically tested to maximum design loads with no evidence of damage The mechanical design incorporates three structural 'wheels' and eighty shear panels With the exception of anti-icing, the composite frame is capable of performing the major structural functions as a metal frame, with a 30% weight savings and 25% cost savings The subassemblies are compression or autoclave molded The tooling and fabrication of the subcomponents and frame are discussed The wheel components were die cut and filament wound The 20-spoked steel wheel die formed a female cavity 2 in deep The loose male components were individually inserted into the die cavity on top of the composite material prior to press curing In addition to its molding function, the die was used as an assembly tool in bonding the reinforcing L-flanges to the three spoked wheels After fabrication, frame components were post-cured at 350 F C K D

A76-15157 * **Fabrication methods for YF-12 wing panels for the Supersonic Cruise Aircraft Research Program.** E L Hoffman (NASA, Langley Research Center, Hampton, Va), L Payne (Lockheed-California Co , Sunland, Calif), and A L Carter (NASA, Flight Research Center, Edwards, Calif) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975
Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p. 68-82
Advanced fabrication and joining processes for titanium and composite materials are being investigated by NASA to develop technology for the Supersonic Cruise Aircraft Research (SCAR) Program With Lockheed-ADP as the prime contractor, full-scale structural panels are being designed and fabricated to replace an existing integrally stiffened shear panel on the upper wing surface of the NASA YF-12 aircraft. The program involves ground testing and Mach 3 flight testing of full-scale structural panels and laboratory testing of representative structural element specimens. Fabrication methods and test results for weldbrazed and Rohrbond titanium panels are discussed. The fabrication methods being developed for boron/aluminum, Borsic/aluminum, and graphite/polyimide panels are also presented (Author)

A76-15158 **Controlled flow structural adhesives for film reticulation** C D Weber, M E Gross, and H J Austin (B F Goodrich Co , Breckville, Ohio) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975 Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p 83-97 12 refs
The development and preparation of lightweight toughened controlled-flow epoxy resin bonding films are discussed, along with their mechanical and physical properties and the effects of aging on these properties The use of these adhesives in film reticulation for aircraft noise suppression honeycomb panels and in metal to metal

laminate bonding is examined It is shown that using these adhesives in the reticulating process, a light-weight bonded assembly of excellent durability can be obtained Provision of minimum hole blockage in honeycomb panels with perforated face sheets is another advantage of the technique V P

A76-15159 **Bonding development of improved adhesives for acoustic structures** D B Arnold (Boeing Commercial Airplane Co , Seattle, Wash) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975 Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p 98-117
This paper deals with structures suitable for use in the inlet and fan duct where temperatures are below 350 F and bonded aluminum structure may be used A test program was run to select a 350 F service temperature adhesive which was suitable for bonding perforated aluminum honeycomb sandwich acoustic panels Mechanical strengths, environmental durability and acoustic properties were tested on seven epoxy adhesives Two adhesive systems were selected after a screening phase Control specifications and design data have been developed on the systems Full scale engine test hardware and production parts have been fabricated using the adhesive systems (Author)

A76-15160 **Advancements in applications of adhesive to core cell edge and flat sheet material** G M Green (Hexcel Corp , Dublin, Calif) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975 Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p 118-125
The parameters of both hot melt and solution techniques of application of adhesive to honeycomb core and flat sheet materials are presented The advantages and practicality of the former relative to energy conservation and emissions control are highlighted Quantitative consideration is given to some key elements including open-assembly times, thermal windows, wastage and cost factors and metal to-metal bond and sandwich structure performance (Author)

A76-15161 **Metal-to-metal adhesive bonded aircraft structures** J Koetsier (Fokker-VFW, Schiphol-Oost, Netherlands) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975 Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p 126-140
The design of the Fokker F27 'Friendship' and Fokker F28 'Fellowship' was based on the use of metal-to-metal adhesive bonded structures throughout the aircraft A survey of these structures and service experiences gained after 10,500,000 flights is presented in this paper (Author)

A76-15186 **Application of advanced composites in place of conventional materials** H S Reinert (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio) and L E Meade (Lockheed-Georgia Co , Marietta, Ga) In Materials review '75, Proceedings of the Seventh National Technical Conference, Albuquerque, N Mex , October 14-16, 1975 Azusa, Calif , Society for the Advancement of Material and Process Engineering, 1975, p 475-487 22 refs
Cost figures taken from the 'Structural Fabrication Guide for Advanced Composites' data base show an overall trend to the reduction of cost per pound of composite structure. This trend makes composites increasingly attractive alternatives to conventional materials Several examples of applications of composite materials in the construction of airplane wings are given to illustrate a discussion of their increasingly cost-effective and cost-competitive use as a substitute or reinforcement for conventional materials C K D

A76-15362 # The passenger version of the aircraft C-212 Aviocar (La versión de pasajeros del avión C-212 'Aviocar') M Hernández Olmo and J D Lacalle Sousa (Construcciones Aeronáuticas S A , Madrid, Spain) *IAA/Ingeniería Aeronáutica y Astronáutica,* vol 27, Oct 1975, p 19 25 In Spanish

The aircraft considered, which is produced by a Spanish aerospace company, can transport 19 persons in addition to its flight crew The flight crew consists of one pilot and one copilot A description of the aircraft is given, taking into account the arrangement of the seats, the access to the aircraft for the passengers, the location of the emergency exits, and the storage compartment Attention is also given to details concerning the utilization of the aircraft in commercial air traffic operations between different points on the Canary Islands   G R

A76-15363 # Technology and flight safety (Tecnología y seguridad en vuelo) J Fernandez Palomero (Iberia, Ingeniería de Desarrollo, Madrid, Spain) *IAA/Ingeniería Aeronáutica y Astronáutica,* vol 27, Oct 1975, p 39-48 In Spanish

Official organizations entrusted with the supervision of matters related to flight safety are considered taking into account the approaches used to establish regulations which are required for the safe conduction of the air traffic operations Factors which affect the safety of the flight in an aircraft are examined Attention is given to aspects of communication between aircraft and ground, questions of aircraft systems reliability, navigation techniques, and the landing process The contribution of suitable maintenance procedures to flight safety is investigated and the effect of quality control measures on safety is discussed   G R

A76-15390 # Nonlinear characteristics of a thin-section wing for shock-free flow at the leading edge (Nelineinye kharakteristiki tonkogo kryla pri bezudarnom obtekanii noska) V S Pavlenko *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Sept -Oct 1975, p 183-185 In Russian

A76-15401 Symposium on the Changing Balance of Design Requirements and How Designers are Reacting to It, London, England, February 26, 1975, Proceedings Symposium sponsored by the Royal Aeronautical Society London, Royal Aeronautical Society, 1975 96 p $8 10

Selected problems regarding aircraft reliability and maintenance, their implications for design, and avionics economics are investigated Some of the topics covered include design and development for maximum reliability and minimum maintenance cost, design considerations for the minimum cost of ownership of avionics, engine early warning failure detection systems, and new technology and the organization of maintenance   P T H

A76-15402 # Design and development for maximum reliability and minimum maintenance costs R E Grigg (Hawker Siddeley Aviation, Ltd , Hatfield, Herts , England) In Symposium on the Changing Balance of Design Requirements and How Designers are Reacting to It, London, England, February 26, 1975, Proceedings   London, Royal Aeronautical Society, 1975 20 p

The paper examines some design aspects which must be considered when the design criteria are maximum reliability and minimum maintenance costs for modern subsonic transport aircraft Structure design and development to improve reliability and reduce costs and weight should progress parallel with requirements to improve safety levels and structural endurance Main lines to follow would be to simplify load paths to avoid diffusion problems which are difficult to analyze, minimize the number of stress concentration areas by reducing cutouts and joints, and working to generally lower allowable stress levels The design aim as far as system design is concerned is to enable the aircraft to complete its scheduled flight after a single failure has occurred without requiring any immediate

crew action New technology should only be used where a significant improvement is forseen that will bring real benefits, not problems Later types of fire detection systems, such as pneumatic loops, would be more reliable and less costly than the double electronic redundant system and would have delay rates at least as good Continuous monitor built-in test equipment has the advantage that faults are detected and displayed under actual operating conditions   P T H

A76-15403 # Maintainability by design J N Montgomery (British Aircraft Corp , Ltd , Commercial Aircraft Div , Weybridge, Surrey, England) In Symposium on the Changing Balance of Design Requirements and How Designers are Reacting to It, London, England, February 26, 1975, Proceedings London, Royal Aeronautical Society, 1975 11 p

The paper discusses the problem of providing the aircraft designer with an awareness of advances in philosophy, requirements, and techniques developed in reliability and maintenance (R & M) Experience has shown that reliability and maintenance cannot be treated in isolation from each other without incurring unnecessary and often unacceptable penalties, hence, the structural and systems designers must be responsible for satisfying both R & M requirements Three main activities of the R & M team within the design engineering organization are characterized (1) definition of R & M requirements for satisfying mandatory certification standards and those of economic viability, (2) establishing communication between airline engineering personnel and manufacturer, and (3) verification, commencing at the initial design stage and continuing through all stages of design, construction, flight testing, and in-service operation   P T H

A76-15408 Symposium on Designing from the Inside Out, London, England, February 6, 1975, Proceedings Symposium sponsored by the Royal Aeronautical Society London, Royal Aeronautical Society, 1975 106 p $6 60

Papers are presented dealing with design concepts for future aircraft systems in which emphasis will be on human factors in order to improve cost effectiveness, safety, and comfort Some of the topics covered include future flight deck design, data management within avionic systems, and improvements on freight and cargo areas   P T H

A76-15409 # Keynote address - Designing from the Inside Out. F H Hawkins (KLM-Royal Dutch Airlines, Schiphol Airport, Netherlands) In Symposium on Designing from the Inside Out, London, England, February 6, 1975, Proceedings   London, Royal Aeronautical Society, 1975 10 p

The paper calls attention to some aspects of aircraft design from the viewpoint of human factors to which, it is argued, some design emphasis must be shifted A review of the warning and caution system in the cockpit is seen as long overdue The pilot is becoming a manager of automatic and semiautomatic flight systems rather than an airframe driver, and his future place in the aircraft must be seen in this light Deficiencies in cabin area design and environmental control are also pointed out It is urged that human factor scientists be involved from the early design stage and that all engineers have some formal education in ergonomics as a part of their basic engineering studies   P T H

A76-15411 # Cost effectiveness of systems D P Howlett (Hawker Siddeley Aviation, Ltd , Hatfield, Herts , England) and R W Howard (Marconi-Elliott Avionic Systems, Ltd , Rochester, England) In Symposium on Designing from the Inside Out, London, England, February 6, 1975, Proceedings   London, Royal Aeronautical Society, 1975 21 p , Discussion 2 p

The paper discusses the design of future aircraft systems from the viewpoint of optimal cost effective use of new technology, such as microelectronics, at the same time optimizing safety and performance. The first necessity in achieving maximum cost effectiveness will be the expansion of cross-discipline design thinking. Reducing the number of computers on the aircraft and providing greater centralization and integration of hardware is a future possibility that at present has serious drawbacks related to the complications of handling multiplexed digital data and interface complexity.   P T H

A76-15413 # **Passenger and crew considerations** K V Bonney (Hawker Siddeley Aviation, Ltd , Hatfield, Herts , England) and G R Allen (Royal Aircraft Establishment, Farnborough, Hants , England) In Symposium on Designing from the Inside Out, London, England, February 6, 1975, Proceedings
London, Royal Aeronautical Society, 1975 20 p , Discussion 2 p 10 refs
The paper discusses design concepts for comfort and safety of crew and passengers in transport aircraft. Standards and trends in design of passenger compartment, aircraft seats, baggage and coat areas, and environmental systems, are outlined. Some results of a study on passenger cabin noise levels in some turboprop and turbojet aircraft are given, showing that noise levels in the main central portion of the cabin are generally near the ideal, but are undesirably high at the front and rear.   P T H

A76-15426 **Smoke emission from burning cabin materials and the effect on visibility in wide-bodied jet transports** E L Lopez (Lockheed-California Co , Burbank, Calif) *Journal of Fire and Flammability,* vol 6, Oct 1975, p 405-450 5 refs U S Department of Transportation Contract No FA72NA-665
A study was made of the smoke emission of aircraft interior construction materials under various burning conditions. A wide-bodied mockup, 2774 cubic feet in volume was used to establish correlation with the NBS type smoke chamber. Additionally, materials were tested to relate visual acuity to optical density in a wide-bodied mockup. Results indicate that fair correlation exists between the NBS-type smoke chamber and the mockup for various sizes of materials tested. Visibility studies indicate the relationship of optical density to visual acuity with and without irritating gases and ventilation flow rate through a cabin mockup.   (Author)

A76-15430 * **Fire dynamics of modern aircraft from a materials point of view** J A Parker, D A Kourtides, R H Fish, and W J Gilwee, Jr (NASA, Ames Research Center, Moffett Field, Calif) *Journal of Fire and Flammability,* vol 6, Oct 1975, p 534-553 12 refs
A general approach for selecting polymers to increase fire safety in aircraft is described. It is shown that polymer flammability and thermal protection capability are related to the molecular structure of the polymer and its thermochemical properties. These criteria are used to develop advanced fire-resistant materials that can achieve increased survivability in both post-crash and in-flight fires. The degree of fire hardening of materials depends greatly on the available heat load and fire threat present. It is shown that improvements in fire safety can be achieved by the use of polymers possessing certain basic thermochemical parameters such as high char yield.   (Author)

A76-15623 # **Contribution to the study of material-strength and dynamics problems in the design of impellers for radial-flow compressors of aircraft turbine engines** (Prispevek k pevnostni a dynamicke problematice obezných kol radialnich kompresoru leteckych turbinovych motoru) M Holl and Z Hujecek *Zpravodaj VZLU,* no 4, 1975, p 137-146 10 refs In Czech
The influence of quasi static and dynamic strength at resonance on impeller stress and strain and the importance of the impeller-casing clearance in new turbocompressor designs are emphasized. The article discusses tuning of the blading in radial compressor impellers in order to minimize fatigue cracking hazards. The effect of blading

configurations on total stress is taken into account in impeller design. Computer handling of the data using the finite-element method is discussed   R D V

A76-15626 **The effects of recessed lower surface shape on the lift and drag of conical wings at high incidence and high Mach number** L C Squire (Cambridge University, Cambridge, England) *Aeronautical Quarterly,* vol 26, Feb 1975, p 1-10 6 refs Research supported by the Ministry of Defence (Procurement Executive)
For lifting reentry there may be advantages in using wings which give as high a lift coefficient as possible at the design value of the lift/drag ratio. This paper presents the results of an experimental and theoretical study of wings with recessed lower surfaces designed to give high values of lift coefficient. The calculations show that a wide range of wing shapes can be found that give values of lift coefficient which are much larger than those on a flat wing with the same lift/drag ratio.   (Author)

A76-15630 **The application of a lifting-surface method to large, steady or oscillating models in subsonic, closed, open or slotted wind tunnels** R A Streather (South African Council for Scientific and Industrial Research, Aeronautics Research Unit, Pretoria, Republic of South Africa) *Aeronautical Quarterly,* vol 26, Feb 1975, p 41-55 9 refs
A subsonic, lifting-surface method is extended to apply to low-frequency oscillations of wind-tunnel models, taking into account both longitudinal and lateral variations of tunnel lift interference. Rectangular sectioned tunnels with closed, slotted or open roof and floor and closed sidewalls are considered. A comparison is made between the aerodynamic derivatives obtained by this method and those calculated with the assumption that the model span is small compared to the tunnel width. Three models of aspect ratio 2 67 and different sweepback are considered in rigid pitching oscillations in tunnels of width/height ratio 2 5. The greatest differences between the results from the two methods occur for the tunnel with closed roof and floor and for the unswept planform. The least differences occur for the slotted tunnel and for the planform of greatest sweepback. The results indicate that, for models of conventional size (up to span/tunnel-width ratio of 0 4), the small-span assumption is satisfactory in tunnels with slotted roof and floor and closed sidewalls, but not in fully closed tunnels   (Author)

A76-15631 **A comparison of two integral equation methods for high subsonic lifting flows** D Nixon (Queen Mary College, London, England) *Aeronautical Quarterly,* vol 26, Feb 1975, p 56-58

A76-15632 **The evaluation of an integral equation method for two-dimensional shock-free flows** D Nixon and J Patel (Queen Mary College, London, England) *Aeronautical Quarterly,* vol 26, Feb 1975, p 59-70 18 refs
The numerical aspects of the integral equation method developed by Nixon and Hancock for two-dimensional steady shock-free flow have been rationalized. This numerically refined method is evaluated by calculating the pressure distribution around a wide range of airfoils. These test cases include airfoils in supercritical shock-free flow as well as subcritical flow and exact solutions are available for comparison. The computational time in the present method is significantly less than that required by the exact methods. The present results compare satisfactorily with the exact results
                                                      (Author)

A76-15634 **Analysis of high-lift wing systems** S H Goradia (Lockheed-Georgia Co , Marietta, Ga) and G T Colwell (Georgia Institute of Technology, Atlanta, Ga) *Aeronautical Quarterly,* vol 26, May 1975, p 88-108 20 refs
A method which can be used for the design of blown or unblown wing sections is described. A brief description of a variety of theoretical methods for computation of different fluid flow

phenomena encountered on high-lift wing systems is presented The most significant type of viscous flow - a confluent boundary layer flow, which is present on the upper surface of the flap, the vane and the main component of a high-lift system - is described, and its importance to the performance of high-lift systems is illustrated Results of computation of pressure distribution, boundary-layer characteristic, and lift coefficient for two-dimensional high-lift systems are compared with experimental data in order to establish the validity and limitations of the method. (Author)

A76-15638 Inviscid hypersonic source flow, over slender power-law bodies M Yasuhara and S Watanabe (Nagoya University, Nagoya, Japan) *Aeronautical Quarterly*, vol 26, Aug 1975, p 165-175 8 refs Research supported by the Ministry of Education of Japan

Hypersonic small-disturbance theory is applied to the source flow over power-law slender bodies with conical or wedge type asymptote The results for a point source flow with gamma = 2 over power-law cones of revolution show that the dominating equations in the first and second approximations are essentially the same as the ones for the parallel flow over power law bodies of revolution In the special case of a cone, results of a source flow and of a parallel flow are compared and it is shown that the surface pressure in a source flow at the nose is the same as the constant cone pressure in a parallel flow, but systematically decreases in the rear part This is confirmed by comparison with a shock tunnel experiment (Author)

A76-15639 A numerical method for calculating viscous flow round multiple-section aerofoils T Seebohm and B G Newman (McGill University, Montreal, Canada) *Aeronautical Quarterly*, vol 26, Aug 1975, p 176-188 15 refs Research supported by Canadair, Defence Research Board of Canada Grant No 9551-12

The method described can be used to predict incompressible attached flow about multiple-section airfoils at high Reynolds numbers In spite of neglecting wake/boundary-layer interaction, the method is suitable for optimizing design and take-off conditions Solutions are obtained in the following three steps calculation of the outer potential flow, using a conventional Kutta condition for each airfoil section, calculation of viscous boundary layers and wakes, and the use of the inviscid and viscous solutions in combination to effect proper matching at the edges of the boundary layers and wakes as well as a more accurate specification of the circulation in the inviscid flow V P

A76-15640 * The flow over a 'high' aspect ratio gothic wing at supersonic speeds K Y Narayan (Cambridge University, Cambridge, England, NASA, Langley Research Center, Hampton, Va) *Aeronautical Quarterly*, vol 26, Aug 1975, p 189 201 10 refs Research supported by the Ministry of Defence (Procurement Executive)

Results are presented of an experimental investigation on a nonconical wing which supports an attached shock wave over a region of the leading edge near the vertex and a detached shock elsewhere The shock detachment point is determined from planform schlieren photographs of the flow field and discrepancies are shown to exist between this and the one calculated by applying the oblique shock equations normal to the leading edge On a physical basis, it is argued that the shock detachment has to obey the two dimensional law normal to the leading edges From this, and from other measurements on conical wings, it is thought that the planform schlieren technique may not be particularly satisfactory for detecting shock detachment Surface pressure distributions are presented and are explained in terms of the flow over related delta wings which are identified as a vertex delta wing and a local delta wing (Author)

A76-15676 A contribution to the dynamics of aircraft with variable sweep during the process of changing wing sweep (Ein Beitrag zur Dynamik von Flugzeugen mit variabler Pfeilung wahrend des Schwenkvorgangs) X Hafer (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften*, vol

23, Nov 1975, p 377-382 7 refs In German Research supported by the Deutsche Forschungsgemeinschaft

For aircraft with variable sweep, additional inertial terms should be considered in the moment equations for the swivelling phase when the dynamic effects in the course of changing geometry are taken into account For an aircraft, the effects of the swivelling angle velocity on the modes of lateral motion are presented and compared with a quasi-steady calculation The quasi-steady calculation shows good results in quality and can be used for an estimation of dynamic effects of the swivelling process. (Author)

A76-15677 Flight mechanics studies concerning recovery procedures in the case of super-stall conditions (Flugmechanische Untersuchungen zum Ausleiten aus dem 'super-stall') X Hafer (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften*, vol 23, Nov 1975, p 382-388 7 refs In German

Dynamic recovery procedures from trimmed 'super-stall' condition are investigated for two aircraft with T-tail configurations These maneuvers are considered as problems of longitudinal motion of the aircraft with three degrees of freedom taking into account the nonlinearities of the aerodynamic coefficients and derivatives with regard to the variation of the angle of attack Recovery maneuvers with minimum loss of height are particularly discussed (Author)

A76-15678 The perturbation potential in the Trefftz plane of an inclined propeller with nonuniform disk loading (Das Storpotential in der Trefftz-Ebene einer schrag angestromten Luftschraube mit radial ungleichformiger Belastung) B Strater (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften*, vol 23, Nov 1975, p 389-394 7 refs In German Research supported by the Deutsche Forschungsgemeinschaft

The method used in the calculation of the perturbation potential in the Trefftz plane is similar to an approach employed by Levinsky et al (1968) The incompressible flow field of an ideal propeller is considered It is assumed that the propeller jet retains its circular characteristics at a great distance behind the propeller Aspects of symmetry and boundary conditions are discussed and the relations between the physical parameters of the propeller plane and the Trefftz plane are examined G R

A76-15679 The calculation of jet contours with the aid of a vortex ring model (Berechnung von Strahlkonturen mit Hilfe eines Wirbelringmodells) M Strauber (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Zeitschrift fur Flugwissenschaften*, vol 23, Nov 1975, p 394-400 20 refs In German

A model for the description of a lifting jet is developed for the general case of two jets with parallel axes The special case of a single jet is obtained by considering the limiting value of an infinite distance between the two propulsion systems Attention is given to the induced velocity, questions concerning the decrease of vorticity and turbulence effects The application of the considered computational approach is illustrated with the aid of examples involving specific jet flow characteristics G R

A76-15699 # Some optimization problems in identifying stochastic dynamic systems J Drexler and M K Ismail *Zprava VZLU*, no Z-24, 1975, p 1-11 9 refs

The paper considers the problem of identification of complex dynamic systems with stochastic inputs and outputs where the parameters of only one element of interest are to be determined on the basis of measurements of operational parameters This problem is divided into two stages (1) determination of the mathematical structure of the given element, and (2) determination of its parameters The input signals of the tested element can be obtained as the result of filtration by linear or nonlinear elements preceding in the system the tested element and having constant or time-dependent parameters Consequently, the general case requires step-by-step

A76-15736

identification of each preceding element The possibility of reducing time and cost of data processing when using an identification method based on the principle of conditional probability is shown Application of the method to a full-scale test of an aircraft structure is described   **P T H**

A76-15736 Transonic equivalence rule - A nonlinear problem involving lift H L Cheng and M M Hafez (Southern California University, Los Angeles, Calif) *Journal of Fluid Mechanics,* vol 72, Nov 11, 1975, p 161-187 50 refs Contract No N00014-67-A-0269-0021

The inviscid transonic flow past a thin wing having swept leading edges as well as smooth lift and thickness distributions is shown to possess an outer nonlinear structure determined principally by a line source and a line doublet Three domains (thickness-dominated, intermediate, and lift-dominated), representing different degrees of lift control of the outer flow, are identified, and a transonic equivalence rule valid in all three domains is established Except in one domain, departure from the Whitcomb-Oswatitsch area rule is significant, the equivalent body corresponding to the source effect has an increased cross-sectional area depending nonlinearly on the lift This nonlinear lift contribution results from the second-order corrections to the inner (Jones) solution, but produces effects of first-order importance in the outer flow An afterbody effect dependent on the vortex drag is noted which is not accounted for by the classical transonic small-disturbance theory   (Author)

A76-15745 On the numerical computation of the minimum-drag profile in laminar flow R Glowinski and O Pironneau (Institut de Recherche d'Informatique et d'Automatique, Rocquencourt, Yvelines, France) *Journal of Fluid Mechanics,* vol 72, Nov 25, 1975, p 385-389 6 refs

An approximation to the profile of given area with smallest drag in laminar flow is obtained for Reynolds numbers between 1000 and 100,000 It was shown previously by Pironneau (1974) that the skin friction on such a profile has to satisfy certain optimality conditions, the method used is based on these results It was found that the optimum profile is long and thin (thickness to chord ratio about 10%), the front end being shaped like a wedge of angle 90 deg and the rear end like a cusp The drag is very close to the drag on a flat plate of equal length   (Author)

A76-15749 Study of the sound emission from a single airfoil profile located in a hydrodynamic field induced by a mixing zone (Etude de l'emission sonore d'un profil isole place dans le champ hydrodynamique induit par une zone de melange) H Arbey, M Sunyach, and G Comte-Bellot (Ecole Centrale Lyonnaise, Ecully, Rhône, France) *Académie des Sciences (Paris), Comptes Rendus, Serie B - Sciences Physiques,* vol 281, no 20, Nov 17, 1975, p 489-492 In French

It is argued that there are two dominant components in the noise spectrum of an airfoil profile located near a mixing layer outside the turbulent boundary layer One component is associated with vortex shedding, and the other with the hydrodynamic irrotational motion induced by the mixing zone The distribution of equivalent dipole sources along the airfoil confirms the existence of these two emission mechanisms There is good agreement between measured sound intensity and that deduced from the distribution of equivalent sources   **B J**

A76-15822 # Hanging gliders II - Theory and practice (Lotnie II - Teoria i praktyka) T Wusatowski *Technika Lotnicza i Astronautyczna,* vol 30, Nov 1975, p 9-11 In Polish

Hanging glider designs of various type are examined, and some aspects of the aerodynamics and mechanics of these vehicles are discussed Particular attention is given to take-off and landing characteristics, behavior in slow flight, and stability standards The

influence of gusts on the redistribution of the load and lifting force during banking is analyzed   **V P**

A76-15825 # Windmilling of the rotor of a turbojet engine with an axial-flow compressor under flight conditions (Autorotacja wirnika silnika turboodrzutowego ze sprezarka osiowa podczas lotu samolotu) J Borgon *Technika Lotnicza i Astronautyczna,* vol 30, Nov 1975, p 34-36 In Polish

The concept of rotor windmilling is understood to mean rotation of the rotor caused solely by the energy of the air (not gas) streaming through the apertures between the blades (under conditions of power shut-off) under the action of dynamic pressure The concept of windmilling is analyzed for an engine with an axial flow compressor, showing that windmilling must be taken into account in such cases as in flight reignition of the engine A graph-analytic method for determining the range of windmilling is proposed   **V P**

A76-15830 Verification of various methods for fatigue notch effect estimations in case of aircraft materials A Buch (Technion - Israel Institute of Technology, Haifa, Israel) *Engineering Fracture Mechanics,* vol 7, no 4, 1975, p 661-671 19 refs

There is as yet no general agreement regarding the proper method of analyzing situations involving stress raisers, in conjunction with combined static and alternating loadings In this investigation fatigue tests were performed in pulsating tension and tension-compression on internally-notched sheet specimens for comparison of the fatigue notch factor and notch sensitivity index fatigue notch factor/stress concentration factor - $K(F)/K(T)$ - of aluminum-alloy sheet materials with and without cladding, and for verification of various methods of notch-effect estimation, especially in the case of pulsating tension The ratios $K(F)/K(T)$ showed, for all investigated specimens, some dependence on the notch radius r, which was more regular than the notch radius dependence of the notch sensitivity index $K(F)-1/K(T)-1$ An analytical formulation of the functions $K(F)/K(T) = f(r)$ permitted separate consideration of the investigated cases of tension-compression and pulsating tension   (Author)

A76-15831 Practical use of the 'equivalent' measured stress intensity factor to control fatigue crack propagation rates in aircraft full-scale fatigue tests - First assessment of the method in testing of a pressurized aircraft fuselage W Barrois (Société Nationale Industrielle Aérospatiale, Châtillon-sous-Bagneux, Hauts de-Seine, France) *(NATO, AGARD, Structures and Materials Panel Meeting, 39th, Munich, West Germany, Oct 6-12, 1974) Engineering Fracture Mechanics,* vol 7, no 4, 1975, p 673-688 17 refs

In the case of circumferential cracks in a cylindrical fuselage, the comparison of some analysis and test results shows that the theoretical stress intensity factor is a suitable correlation parameter of fatigue crack propagation rates, both in aircraft fuselages and in plane panels Values of the 'equivalent' stress intensity factor, computed by applying the Barrois-Bhandari method to slot-opening measurements performed under decreasing loading levels, agree well with the values computed from two-dimensional theory of elasticity, using the method of finite elements In the case of longitudinal cracks, the experimental values of the 'equivalent' stress intensity factor, i e , the stress intensity factor of the infinite plane sheet containing a center crack with the same elastic strain and stress distributions near the boundary of the plastically strained region around the crack tip, yield a good correlation of fatigue crack propagation rates of the cracked fuselage and of cracked plane structures The values of the 'equivalent' stress intensity factor are lower than those of the theoretical stress intensity factor, but are also far higher than the bidimensionally computed values   (Author)

A76-15836 A unified engineering approach to the prediction of multiaxial fatigue fracture of aircraft structures P M Toor (Lockheed Georgia Co , Marietta, Ga) *Engineering Fracture Mechanics,* vol 7, no 4, 1975, p 731-741 16 refs

The existing biaxial fatigue theories are reviewed The effect of isotropy, mean stress, phase angle, and notches on biaxial fatigue is discussed An approach based on equivalent stress is proposed The exactness and consistency of this approach is verified with experimental results of full scale test articles. The analysis indicates that this simple approach can be used with confidence in predicting the linear cumulative damage in full scale structural components, which are experiencing multiaxial stress loading   (Author)

A76-15977 #   Augmentor wing jet STOL research aircraft update and powered-lift vehicle certification standards S W Grossmith (Department of Transport, Ottawa, Canada) *(Canadian Aeronautics and Space Institute, Flight Test Symposium, Edmonton, Alberta, Canada, Mar 12, 1975)* Canadian Aeronautics and Space Journal, vol 21, Sept 1975, p 254 261

Modifications of the basic aircraft (DHC Buffalo C-8A) adopted for the program are presented The stability augmentation system, avionics systems, flight path control, flare and landing system, and STOL landing field length are described in detail as modified Operation with a single engine, stall behavior, ground effect behavior, all engines waveoff characteristics, behavior in the event of failure of propulsion engines or powered-lift units, and modified requirements and safety margins are also dealt with   R D V

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STAR ENTRIES

N76-11995* Old Dominion Univ, Norfolk, Va
GENERAL AVIATION COMPONENTS
In its Gen Aviation and Community Develop 1975 p 3-16 refs
CSCL 01B
An overview is presented of selected aviation vehicles The capabilities and performance of these vehicles are first presented, followed by a discussion of the aerodynamics structures and materials propulsion systems, noise, and configurations of fixed-wing aircraft Finally the discussion focuses on the history, status and future of attempts to provide vehicles capable of short-field operations Author

N76-11996* Old Dominion Univ, Norfolk Va
SHORT FIELD AIRCRAFT
In its Gen Aviation and Community Develop 1975 p 17-26 refs
CSCL 01B
Short, reduced and vertical takeoff aircraft are discussed in terms of technology development and the field length performance through the years is reviewed FOS

N76-12006*# United Technology, Inc Blue Bell Pa
PREDICTION OF SPAN LOADING OF STRAIGHT-WING/ PROPELLER COMBINATIONS UP TO STALL Final Report
M A McVeigh, L Gray, and E Kisielowski Washington NASA Oct 1975 208 p refs
(Contract NAS1-12238)
(NASA-CR-2602, UTR-004) Avail NTIS HC $7 75 CSCL 01A
A method is presented for calculating the spanwise lift distribution on straight-wing/propeller combinations The method combines a modified form of the Prandtl wing theory with a realistic representation of the propeller slipstream distribution The slipstream analysis permits calculations of the nonuniform axial and rotational slipstream velocity field of propeller/nacelle combinations This nonuniform field was then used to calculate the wing lift distribution by means of the modified Prandtl wing theory The theory was developed for any number of nonoverlapping propellers on a wing with partial or full-span flaps, and is applicable throughout an aspect ratio range from 2 0 and higher A computer program was used to calculate slipstream characteristics and wing span load distributions for a number of configurations for which experimental data are available and favorable comparisons are demonstrated between the theoretical predictions and the existing data Author

N76-12007 Cornell Univ, Ithaca, N Y
A STUDY OF THE FINITE ELEMENT METHOD FOR AERODYNAMIC APPLICATIONS Ph D Thesis
Wagdi G Habashi 1975 180 p
Avail Univ Microfilms Order No 75-24188
The application of the finite element method to incompressible and compressible subsonic and transonic potential flows is examined The infinite domain associated with flow over bodies is tackled using an asymptotic patching procedure Solutions to nonlifting and lifting bodies are presented A mapping concept

is used to transform airfoil shaped bodies into near circles The patching procedure is extended to geometrically complex problems such as the cascade and an airfoil inside a wind tunnel A method of solving subsonic flows over other multiple airfoil configurations is proposed The compressible case of potential flow problems with its associated nonlinear governing equation is solved by a novel linearization process The operator is linearized with respect to the average velocity in each element using the local Prandtl-Glauert approximation As an example, the case for a circular cylinder is analyzed using this method Dissert Abstr

N76-12008 Rutgers Univ, New Brunswick, N J
THE TURBULENT NEAR-WAKE OF AN AXISYMMETRIC BLUNT BASED BODY AT SUBSONIC SPEEDS Ph D Thesis
Richard Allan Mertz 1975 173 p
Avail Univ Microfilms Order No 75-24719
The subsonic near-wake of an axisymmetric blunt based cylinder was studied The experimental results were obtained over the entire range of subsonic Mach numbers in a uniform open jet test section The results indicate that the influence of separation at the blunt base extends at least three body diameters upstream of the corner The local adjacent flow accelerates as the base is approached The base pressure coefficient was found to be reasonably constant for Mach numbers between 0 0 and 0 8 and then dropped rapidly at near-sonic speeds The size of the near-wake region was dependent on Mach number The near stagnation point moved downstream with increasing Mach number A simple expression which adequately represents the near-wake centerline velocity distribution was found The experimental base pressures show excellent agreement with the results from a new theory for wake analysis Dissert Abstr

N76-12010# Aeronautical Research Labs Melbourne (Australia)
AN EXPERIMENTAL STUDY OF AXIAL FLOW IN WING TIP VORTICES
D H Thompson May 1975 30 p refs
(ARL/A-Note-355) Avail NTIS HC $4 00
Axial flow patterns in a tip vortex generated by a rectangular wing in a towing tank were studied using the hydrogen bubble flow visualization technique The distribution of axial velocity was found to depend on wing selection, tip shape, incidence and Reynolds number Both velocity excesses and velocity deficits were found Under some conditions a phenomenon similar to vortex bursting was observed occurring within a few chord lengths of the wing trailing edge The results from the towing tank tests were compared with wind tunnel and flight test results Author

N76-12011# Aeronautical Research Labs, Melbourne (Australia)
A WATER TUNNEL STUDY OF VORTEX BREAKDOWN OVER WINGS WITH HIGHLY SWEPT LEADING EDGES
D H Thompson May 1975 35 p refs
(ARL/A-Note-356) Avail NTIS HC $4 00
Vortex breakdown above a series of delta wings and modified delta wings was investigated in a water tunnel using dye to make the breakdown visible The hydrogen bubble flow visualization technique was used to study the structure of the spiral vortex sheets above some of the wings The effects of slight kinks in the leading edge, of conical camber and of trailing edge sweep were examined Angle of incidence and leading edge sweep (in particular, the sweep of the forward part of the leading edge) are significant in determining vortex breakdown position Positive conical camber displaces the breakdown position downstream, relative to the uncambered wing Forward sweep of the trailing edge has a similar effect Vortex breakdown over a hybrid wing (a highly swept strake ahead of a moderately swept main wing) and over a cropped delta wing was also studied Author

N76-12012*# New York Univ Westbury Aerospace and Energetics Lab
SKIN FRICTION REDUCTION BY SLOT INJECTION AT MACH 0 8 Final Report, 1 Apr 1974 - 31 Jul 1975
Victor Zakkay and Chi R Wang 1975 86 p refs
(Grant NsG-1049)
(NASA-CR-145715) Avail NTIS HC $5 00 CSCL 01A

Surface skin friction boundary layer profiles and turbulent intensity due to axially symmetric tangential slot injection into a transonic turbulent boundary layer were measured Effects of slot height, multiple slot injection and injection mass flow rate on the surface skin friction downstream of the slot were investigated Tangential slot injection was found less effective in reducing skin friction in a Mach 0 8 transonic flow than in hypersonic flow Surface skin friction was a function of the injection mass flow rate for x/s less than or equal to 40 Large normal pressure gradient and relatively large turbulent intensity were found near the slot with small injection mass flow rate the region of high turbulent intensity moved downstream with increasing injection mass flow rate The results with two slot injections indicated that the distance between slots should be less than 30 slot heights in order to achieve some benefits from the first slot   Author

N76-12013*# National Aeronautics and Space Administration
Langley Research Center, Langley Station, Va
UPWASH ANGLES NEAR ENGINE INLETS OF AN EXTER-NALLY BLOWN FLAP STOL TRANSPORT
Roger L Naeseth and Danny R Hoad (Army Air Mobility R/D Lab, Hampton Va) Washington Nov 1975 48 p refs
(NASA-TN-D-8091 L-10406) Avail NTIS HC $4 00 CSCL 01A

An investigation was conducted in the Langley V/STOL tunnel to determine the upwash flow angles in the region of the nacelle inlets of a representative powered-lift transport configuration operating at high lift coefficients The upwash angles were indicated by tufts and measured from photographs A potential-flow program was used to estimate these flow angles Large upflow angles exist near the inlets of the nacelles, the highest value (67 3 deg) occurred with flaps at 15 35 55 deg, an angle of attack of 25 7 deg, and a thrust coefficient of 4 The upflow angle was found to be strongly dependent on the circulation lift regardless of the flap deflection, angle of attack or thrust coefficient used to generate this circulation lift The potential-flow calculations away from the nacelle inlets agreed fairly well with the experimental data   Author

N76-12014*# Boston Univ Mass Dept of Aerospace Engineering
STEADY SUBSONIC FLOW AROUND FINITE-THICKNESS WINGS
Ching-Chiang Kuo and Luigi Morino Washington NASA Nov 1975 90 p refs
(Grant NGR-22-004-030)
(NASA-CR-2616, TR-73-02) Avail NTIS HC $5 00 CSCL 01A

The general method for analyzing steady subsonic potential aerodynamic flow around a lifting body having arbitrary shape is presented By using the green function method, an integral representation for the potential is obtained Under small perturbation assumption, the potential at any point P in the field depends only upon the values of the potential and its normal derivative on the surface of the body Hence if the point P approaches the surface of the body, the representation reduces to an integral equation relating the potential and its normal derivative (which is known from the boundary conditions) on the surface The question of uniqueness is examined and it is shown that for thin wings the operator becomes singular as the thickness approaches zero This fact may yield numerical problems for very thin wings However numerical results obtained for a rectangular wing in subsonic flow show that these problems do not appear even for thickness ratio tau = 001 Comparison with existing results shows that the proposed method is at least as fast and accurate as the lifting surface theories Author

N76-12015*# National Aeronautics and Space Administration
Langley Research Center Langley Station, Va
INVERSE SOLUTIONS FOR LAMINAR BOUNDARY-LAYER FLOWS WITH SEPARATION AND REATTACHMENT
James E Carter Washington Nov 1975 64 p refs
(NASA-TR-R-447 L-10336) Avail NTIS HC $4 50 CSCL 01A

Numerical solutions of the laminar incompressible boundary layer equations are presented for flows involving separation and reattachment Regular solutions are obtained with an inverse approach in which either the displacement thickness or the skin friction is specified, the pressure is deduced from the solution A vorticity-stream-function formulation of the boundary layer equations is used to eliminate the unknown pressure Solutions of the resulting finite difference equations in which the flow direction is taken into account are obtained by several global iteration schemes which are stable and have unconditional diagonal dominance Results are compared with Klineberg and Steger's separated boundary layer calculations and with Briley s solution of Navier-Stokes equations for a separated region In addition an approximate technique is presented in which the streamwise convection of vorticity is set equal to zero in the reversed flow region such a technique results in a quick forward marching procedure for separated flows   Author

N76-12017*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
EFFECTS OF UPPER-SURFACE BLOWING AND THRUST VECTORING ON LOW-SPEED AERODYNAMIC CHARAC-TERISTICS OF A LARGE-SCALE SUPERSONIC TRANSPORT
Paul L Coe Jr H Clyde McLemore and James P Shivers Nov 1975 78 p refs
(NASA-TM-X-72792) Avail NTIS HC #5 00 CSCL 01A

Tests were conducted in the Langley full-scale tunnel to determine the low-speed aerodynamic characteristics of a large-scale arrow-wing supersonic transport configured with engines mounted above the wing for upper surface blowing and conventional lower surface engines with provisions for thrust vectoring A limited number of tests were conducted for the upper surface engine configuration in the high lift condition for beta = 10 in order to evaluate lateral directional characteristics, and with the right engine inoperative to evaluate the engine out condition   Author

N76-12018*# National Aeronautics and Space Administration
Langley Research Center, Langley Station Va
PRESSURE DISTRIBUTION AT SUBSONIC SPEEDS OVER THE FOREPART OF TWO BLUNT CIRCULAR CYLINDERS
Vernard E Lockwood [1975] 141 p refs Supersedes Paper-645
(NASA-TM-X-72784 Paper-645) Avail NTIS HC $6 00 CSCL 01A

A wind tunnel investigation was made at subsonic speeds to determine the pressure distribution over the forward part of a circular cylinder The cylinder was equipped with interchangeable faces one having a flat face and one having a dome shaped face The investigation was made over angle of attack range from -1 deg to 26 deg and a Mach number range from 0 30 to 0 89 Pressure coefficients are presented in tabular form and plotted data are presented for some selected angles of attack about the surface of the cylinder   Author

N76-12019*# National Aeronautics and Space Administration
Langley Research Center, Langley Station Va
NORMAL- AND OBLIQUE-SHOCK FLOW PARAMETERS IN EQUILIBRIUM AIR INCLUDING ATTACHED-SHOCK SOLUTIONS FOR SURFACES AT ANGLES OF ATTACK, SWEEP, AND DIHEDRAL
James L Hunt and Sue W Souders Washington 1975 156 p
(NASA-SP-3093) Avail NTIS HC $6 75 CSCL 01A

Normal- and oblique-shock flow parameters for air in thermochemical equilibrium are tabulated as a function of shock angle for altitudes ranging from 15 24 km to 91 44 km in increments of 7 62 km at selected hypersonic speeds Post-shock

parameters tabulated include flow-deflection angle velocity Mach number compressibility factor isentropic exponent viscosity Reynolds number entropy difference, and static pressure temperature, density and enthalpy ratios across the shock A procedure is presented for obtaining oblique-shock flow properties in equilibrium air on surfaces at various angles of attack sweep and dihedral by use of the two-dimensional tabulations Plots of the flow parameters against flow-deflection angle are presented at altitudes of 30 48 60 96 and 91 44 km for various stream velocities   Author

N76-12021# Oceanics Inc, Plainview N Y
AN INTEGRAL APPROACH TO LIFTING WING THEORY AT MACH ONE Final Report
Theodore R Goodman Jun 1975 44 p refs
(Contract F44620-72-C-0079)
(AD-A011770 Rept-75-116 AFOSR-75-0822TR) Avail NTIS CSCL 20/4
    An approach to lifting wing theory at Mach one is presented that utilizes an integral method similar to the Karman-Pohlusen method in boundary layer theory As in any integral method the results obtained are approximate in nature   Nonetheless, comparison with experimental data shows good agreement in cases for which experimental data are available   The method can easily be used to determine the lift on wings of finite aspect ratio and also to solve transient lifting problems   The method is demonstrated by solving for the pressure distribution on a lifting airfoil of arbitrary symmetric cross-section, the lift on a wing of rectangular platform, and the transient lift on an airfoil due to a sudden change in angle of attack   GRA

N76-12023# Tennessee Univ Space Inst, Tullahoma
INVISCID FLOW ANALYSIS ON BODY OF REVOLUTION WITH SLENDER CRUCIFORM
N Uciyama and J M Wu Mar 1975 106 p
(Contract DAAH01-74-C-0183, DA Proj 1M2-62303-A-214)
(AD-A012770 RD-TR-75-32) Avail NTIS CSCL 01/1
    An analysis of the aerodynamic characteristics for a slender fin-body configuration at transonic speeds with an exhaust plume has been developed Sample calculations for small combined angles of attack, yaw and fin cant, are presented The analysis is limited to cases of subsonic fin leading edges   GRA

N76-12030# National Transportation Safety Board, Washington, D C   Bureau of Aviation Safety
INTERNATIONAL BUSINESS MACHINES, INC , GRUMMAN G-1159, N720Q, KLINE, SOUTH CAROLINA, 24 JUNE 1974 Aircraft Accident Report
14 May 1975 30 p
(PB-242811/8, NTSB-AAR-75-8) Avail NTIS HC $4 00 CSCL 01B
    At 1645 e d t June 24, 1974, a Grumman model G-1159, N720Q crashed near Kline South Carolina The aircraft was on a training flight in visual meteorological conditions The three crewmembers were killed and the aircraft was destroyed The National Transportation Safety Board determines that the probable cause of the accident was an unwanted extension of the ground and flight spoilers, which resulted in a loss of control at an altitude from which recovery could not be made The ground spoilers probably deployed because of a hot electrical short circuit in the spoiler extend circuitry   GRA

N76-12031# National Transportation Safety Board, Washington D C   Bureau of Aviation Safety
AIR FRANCE, BOEING 707-B-328B-FBLCA, NEAR O'NEILL, NEBRASKA, 13 MAY 1974 Aircraft Accident Report
15 Jan 1975 20 p
(PB-242806/8, NTSB-AAR-75-4) Avail NTIS HC $3 50 CSCL 01B
    About 2 36 a m c d t on May 13, 1974, Air France Flight 004, a Boeing 707-B-328B, entered an area of light turbulence near O Neill Nebraska About 3 to 5 minutes later the flight encountered moderate to severe turbulence which lasted about 4 1/2 minutes During the turbulence 2 passengers were injured

seriously and 11 were injured slightly Two flight attendants were injured one seriously The National Transportation Safety Board determines that the probable cause of the accident was the operation of the aircraft in an area of very strong thunderstorm activity which should have been easily detectable and which resulted in serious injuries to passengers because of the failure of the captain to warn the passengers and to turn on the fasten seatbelt sign   GRA

N76-12037 Illinois Univ Urbana
AN APPROXIMATE NUMERICAL METHOD FOR THE OPTIMIZATION OF FLAP DESIGN FOR MAXIMUM LIFT COEFFICIENT Ph D Thesis
Thomas Ewing Edwards 1975 150 p
Avail Univ Microfilms Order No 75-24297
    An approximate numerical method is developed for two-dimensional flap optimization in the sense of maximum section lift coefficient attainable without flow separation Optimizations of flap geometry and flap position relative to the main airfoil element are considered A potential flow model is developed based on a vortex representation of the flap element which effectively decouples the search for the optimum flap position from the determination of the optimum flap geometry Boundary layer separation constraints are established for the maximum lift problem and a numerical procedure based on a penalty function approach developed to solve the constrained optimization problem Numerical examples are presented for three different main airfoil elements an NACA 643-618 airfoil and NACA 4412 airfoil and an airfoil designed for maximum single-element lift coefficient   Dissert Abstr

N76-12038 Virginia Univ Charlottesville
THE EFFECTS OF AIRCRAFT DESIGN ON STOL RIDE QUALITY Ph D Thesis
Craig Ross Jones 1975 101 p
Avail Univ Microfilms Order No 75-26020
    Effects of aircraft dynamic characteristics on passenger ride quality are investigated to determine ride-quality isocontours similar to aircraft handling-qualities contours Measurements are made on a moving-base simulator while varying the aircraft short-period and Dutch Roll frequencies and dampings Both pilot ratings and subjective ride-quality ratings are obtained during flight Ride and handling qualities were found to be complimentary for the Dutch Roll mode but not for the short-period mode Regions of optimal ride and handling qualities are defined for the short-period mode, and the effects of turbulence levels studied   Dissert Abstr

N76-12039*# McDonnell-Douglas Astronautics Co, St Louis, Mo
ADDITION OF FLEXIBLE BODY OPTION TO THE TOLA COMPUTER PROGRAM PART 1. FINAL REPORT
J W Dick and B J Benda Oct 1975 416 p refs
(Contract NAS1-13259)
(NASA-CR-132732-1) Avail NTIS HC $11 00 CSCL 01C
    A flexible body option developed and added to the Takeoff and Landing Analysis (TOLA) computer program is described The addition of the flexible body option to TOLA allows it to be used to study essentially any conventional type airplane in the ground operating environment It provides the capability to predict the total motion of selected points on an aircraft including the effects of the elastic motion of the airplane The analytical methods incorporated in the program and operating instructions for the option are described A program listing is included along with several example problems to aid in interpretation of the operating instructions and to illustrate program usage   Author

N76-12040*# McDonnell-Douglas Astronautics Co, St Louis Mo
ADDITION OF FLEXIBLE BODY OPTION TO THE TOLA COMPUTER PROGRAM. PART 2 USER AND PROGRAMMER DOCUMENTATION
J W Dick and B J Benda Oct 1975 202 p refs
(Contract NAS1-13259)
(NASA-CR-132732-2) Avail NTIS HC $7 75 CSCL 01C

User and programmer oriented documentation for the flexible body option of the Takeoff and Landing Analysis (TOLA) computer program are provided The user information provides sufficient knowledge of the development and use of the option to enable the engineering user to successfully operate the modified program and understand the results The programmer's information describes the option structure and logic enabling a programmer to make major revisions to this part of the TOLA computer program   Author

N76-12041*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
SYSTEMS INTEGRATION STUDIES FOR SUPERSONIC CRUISE AIRCRAFT
Vincent R Mascitti Dec 1975 30 p refs
(NASA-TM-X-72781) Avail NTIS HC $4 00 CSCL 01C
Technical progress in each of the disciplinary research areas affecting the design of supersonic cruise aircraft is discussed The NASA AST/SCAR Program supported the integration of these technical advances into supersonic cruise aircraft configuration concepts While the baseline concepts reflect differing design philosophy, all reflect a level of economic performance considerably above the current foreign aircraft as well as the former U S SST Range-payload characteristics of the study configurating show significant improvement, while meeting environmental goals such as takeoff and landing noise and upper atmospheric pollution   Author

N76-12042*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
FLIGHT ASSESSMENT OF A LARGE SUPERSONIC DRONE AIRCRAFT FOR RESEARCH USE
Clinton V Eckstrom and Ellwood L Peele Washington Dec 1974 55 p refs
(NASA-TM-X-3259, L-10333) Avail NTIS HC $4 50 CSCL 01C
An assessment is made of the capabilities of the BQM-34E supersonic drone aircraft as a test bed research vehicle This assessment is made based on a flight conducted for the purpose of obtaining flight test measurements of wing loads at various maneuver flight conditions Flight plan preparation, flight simulation and conduct of the flight test are discussed along with a presentation of the test data obtained and an evaluation of how closely the flight test followed the test plan   Author

N76-12045# Aerotherm Acurex Corp Mountain View, Calif Aerotherm Div
EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS Final Report, 1 Apr - 30 Jun 1974
Bernard Laub, Edward Chu, and Kimble J Clark Feb 1975 78 p refs
(Contract F33615-74-C-5022, AF Proj 7320)
(AD-A011725, Aerotherm-74-116, AFML-TR-74-233) Avail NTIS CSCL 01/3
An analytical study was performed to evaluate potential improvements in the thermal survivability of parachutes upon exposure to aircraft crash fires Principal findings were that significant improvements in thermal survivability are achievable only through the use of advanced materials which, potentially, can provide survival into the flame zone The investigation of possible design modifications indicated that alteration of fabric weight and optical properties can improve material thermal performance whereas alterations of fabric permeability are ineffective   GRA

N76-12046# Naval Ship Research and Development Center, Bethesda, Md Aviation and Surface Effects Dept
EXPERIMENTAL INVESTIGATION OF THREE ROTOR HUB FAIRING SHAPES
Peter S Montana May 1975 89 p refs
(AD-A012537, ASED-333) Avail NTIS CSCL 01/3
A series of subsonic wind tunnel evaluations were undertaken to establish minimum drag fairings for helicopter hubs as part of the Helicopter drag Technology Program The data reported

were taken to investigate the flow phenomena affecting helicopter rotor hubs Three large 25 percent thick analytically faired hubs were evaluated (both with and without simulated rotor blade shanks) over a wide range of angles of attack at full scale Reynolds numbers Forces moments and pressures were measured on the hubs   GRA

N76-12047# Curtiss-Wright Corp Wood-Ridge N J
DEVELOPMENT TESTING OF FREE PLANET TRANSMISSION CONCEPT Final Report, 24 Apr 1974 - 9 Jan 1975
Neil A DeBruyne Jun 1975 33 p
(Contract DAAJ02-74-C-0041 DA Proj 1G2-62207-AH-89)
(AD-A012899, CW-WR-74-034 F, USAAMRDL-TR-75-24) Avail NTIS CSCL 01/3
This report presents the results of an experimental program to further demonstrate and evaluate the Curtiss-Wright free planet power transmission concept The program consisted of experimentally evaluating the effect of increased gear mesh backlash, cyclic endurance and transients GRA

N76-12048# Army Aviation Systems Command, St Louis Mo
MAJOR ITEM SPECIAL STUDY (MISS), UH-1H 42 DEG GEARBOX Interim Report, Jan 1964 - Jun 1974
Jun 1975 23 p
(AD-A012629 USAAVSCOM-TR-75-22) 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 distribution 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 GRA

N76-12050# Naval Postgraduate School Monterey, Calif
FY 75 EXPERIMENTAL HYDRAULIC RAM STUDIES Final Report, 1 Jul 1974 - 30 Jun 1975
H L Power 1 Jun 1975 52 p
(AD-A012598, NPS-57PH75061) Avail NTIS CSCL 01/3
This document is a report on the progress of FY 75 experimental Hydraulic Ram Studies The shock and drag phases of hydraulic ram were studied to understand this complicated phenomenum GRA

N76-12054# United Technologies Corp, Stratford, Conn Sikorsky Aircraft Div
NEW TAPERED COMPOSITE SPAR DESIGN Final Report
Edward C Poncia, Timothy A Krauss and George H Staab Jun 1975 117 p
(Contract DAAJ02-74-C-0049, DA Proj 1F2-62208-AH-90)
(AD-A012776, USAAMRDL-TR-75-17) Avail NTIS CSCL 01/3
The purpose of this study was to design and evaluate a filament winding approach to the fabrication of a spar which tapered in planform and thickness A cost and weight comparison was made with a conventional titanium spar design and an alternative composite design The design included the integration of a suitable root end retention fitting GRA

N76-12056# Army Aviation Engineering Flight Activity, Edwards AFB, Calif
HOT BRICK 3 AIRWORTHINESS EVALUATION OV-1D AIRPLANE Final Report
Donald F Macpherson, Jr and James S Reid Nov 1974 87 p refs
(AD-A012202 USAAEFA-74-20) Avail NTIS CSCL 17/4

The United States Army Aviation Engineering Flight Activity conducted an airworthiness evaluation of the OV-1D (Mohawk) airplane modified with a HOT BRICK III infrared countermeasure device from 11 to 22 February 1974 at Fort Rucker, Alabama, and from 17 July to 7 August 1974 at Edwards Air Force Base, California During the test program 20 productive hours were flown Structural and handling qualities tests were conducted, with emphasis placed on the low-speed high gross weight regime Structural testing was limited to flutter tests of the wing store that contained the 150-gallon fuel drop tank modified with the HOT BRICK III device, the wing at the HOT BRICK III store station and the right wing tip Handling qualities tests included a stall investigation determination of control margins with high asymmetric loads, single-engine minimum trim and control airspeeds, and static lateral-directional stability Other tests included takeoff performance and an airspeed system calibration A large discrepancy existed between the takeoff performance data presented in the operator's manual and that obtained with the test aircraft   GRA

N76-12063*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
GEOMETRY EFFECTS ON STOL ENGINE-OVER-THE-WING ACOUSTICS WITH 5 1 SLOT NOZZLES
U VonGlahn and D Groesbeck 1975 28 p refs Presented at 90th Meeting of the Acoust Soc of Am , San Francisco 4-7 Nov 1975
(NASA-TM-X-71820, E-8519) Avail NTIS HC $4 00 CSCL 20A

The correspondence of far field acoustic trends with changes in the characteristics of the flow field at the wing trailing edge caused by alterations in the nozzle-wing geometry were determined for several STOL-OTW configurations Nozzle roof angles of 10 to 40 deg were tested with and without cutback of the nozzle sidewalls Three wing chord sizes were used baseline (33 cm with flaps retracted), 2/3-baseline and 3/2-baseline Flap deflection angles of 20 and 60 deg were used The nozzle locations were at 21 and 46-percent of chord With increasing wing size the jet noise shielding benefits increased With increasing nozzle roof angle, the jet velocity at the trailing edge was decreased, causing a decrease in trailing-edge and fluctuating lift noise Cutback of the nozzle sides improved flow attachment and reduced far-field noise The best flow attachment and least trailing-edge noise generally were obtained with a 40 deg external deflector configuration and a cutback nozzle with a 40 deg roof angle   Author

N76-12065*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
REDUCTION OF NOISE FROM A FAN STAGE FOR A TURBOFAN ENGINE BY USE OF LONG-CHORD ACOUSTI-CALLY-TREATED STATOR VANES
J H Dittmar and J N Scott 1975 27 p refs Presented at 90th Meeting of the Acoust Soc of Am , San Francisco, 4-7 Nov 1975
(NASA-TM-X-71811, E-8331) Avail NTIS HC $4 00 CSCL 20A

A set of acoustically-treated long-chord vanes was designed to replace the vanes in an existing fan stage to investigate the noise reduction possibilities of both increased stator chord length and a method of incorporating acoustic damping material The vanes were tested with both active and inactive acoustic surfaces Results of the inactive tests show significant broadband noise effects with noise reductions in the middle to high frequencies and an increase at low frequencies No reduction in blade passage tone was observed, but decreases in the overtones were observed Results of the tests with the active acoustic treatment show large noise reductions over a wide frequency range   Author

N76-12066*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
ON THE EFFECTS OF FLIGHT ON JET ENGINE EXHAUST NOISE
James R Stone 1975 26 p refs Presented at 90th Meeting

of the Acoust Soc of Am San Francisco 4-7 Nov 1975
(NASA-TM-X-71819 E-8518) Avail NTIS HC $4 00 CSCL 20A

Differences between flight data and predictions of jet engine exhaust noise were reconciled by considering the combined effects of jet mixing noise and internally generated engine exhaust noise The source strength of the internally generated noise was assumed to be unaffected by flight, as experiments demonstrated The directivity of the internally generated noise was assumed to be the same statically as that given in the NASA interim predic-tion method for core engine noise However it was assumed that in flight internally generated noise is subject to the convective amplification effect of a simple source The absolute levels of internally generated noise were obtained from an empirical fit of some typical engine data The static and flight jet noise were predicted using the above prediction method It was shown that in many cases much of the flyover noise signature is dominated by internally generated noise   Author

N76-12067*# Pratt and Whitney Aircraft, East Hartford, Conn
PROGRAM FOR REFAN JT8D ENGINE DESIGN, FABRICA-TION AND TEST, PHASE 2 Final Report
J A Glass E S Zimmerman, and V M Scaramella Nov 1975 367 p refs
(Contract NAS3-17840)
(NASA-CR-134876 PWA-5299) Avail NTIS HC $10 50 CSCL 21E

The objective of the JT8D refan program was to design fabricate and test certifiable modifications of the JT8D engine which would reduce noise generated by JT8D powered aircraft This was to be accomplished without affecting reliability and maintainability at minimum retrofit cost, and with no performance penalty The mechanical design engine performance and stability characteristics at sea-level and altitude, and the engine noise characteristics of the test engines are documented Results confirmed the structural integrity of the JT8D-109 Engine operation was stable throughout the airplane flight envelope Fuel consumption of the test engines was higher than that required to meet the goal of no airplane performance penalty but the causes were identified and corrected during a normal pre-certification engine development program Compared to the baseline JT8D-109 engine the acoustically treated JT8D-109 engine showed noise reductions of 6 PNdB at takeoff and 11 PNdB at a typical approach power setting   Author

N76-12068*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
A BRIEF STUDY OF THE EFFECTS OF TURBOFAN-ENGINE BYPASS RATIO ON SHORT AND LONG HAUL CRUISE AIRCRAFT
Arvid L Keith, Jr Washington Dec 1975 43 p ref
(NASA-TN-D-7890 L-9898) Avail NTIS HC $4 00 CSCL 21E

A brief study of the effects of turbofan-engine bypass ratio on Breguet cruise range and take-off distance for subsonic cruise aircraft showed significant differences between short- and long-haul aircraft designs Large thrust lapse rates at high bypass ratios caused severe reductions in cruise range for short-haul aircraft because of increases in propulsion system weight Long-haul aircraft, with a higher fuel fraction (ratio of propulsion weight plus total fuel weight to gross take-off weight), are less sensitive to propulsion-system weight and, accordingly, were not significantly affected by bypass-ratio variations Both types of aircraft have shorter take-off distances at higher bypass ratios because of higher take-off thrust-weight ratios   Author

N76-12070# Williams Research Corp , Walled Lake Mich
LOW COST JET FUEL STARTER Final Report, 1 May 30 Nov 1974
David L Murray Dec 1974 186 p
(Contract F33615-74-C-2063, AF Proj 3145)
(AD-A012301, AFAPL-TR-74-105) Avail NTIS CSCL 21/5

Williams Research Corporation executed a five month design study of a small low-cost gas turbine engine assembly which can be used for on-board starting of aircraft propulsion engines

This report describes the low-cost starter, its performance and the development tasks required to convert the design of reality
GRA

N76-12073# Detroit Diesel Allison, Indianapolis, Ind   Diesel Allison Div
THE UNSTEADY AERODYNAMIC RESPONSE OF AN AIRFOIL CASCADE TO A TIME-VARIANT SUPERSONIC INLET FLOW FIELD Interim Report, 1 Apr 1974 - 31 Mar 1975
Sanford Fleeter, Allen S Novick, and Ronald E Riffel   Jun 1975   54 p   refs
(Contract F44620-74-C-0065 AF Proj 6813 AF Proj 9781)
(AD-A012695 DDA-EDR-8524 AFOSR-75-949TR)   Avail NTIS CSCL 21/5
A time-variant supersonic inlet flow with a subsonic axial component cascade experiment is described wherein the time-dependent phenomena are quantitatively determined   The cascade inlet unsteadiness was generated by harmonically oscillating the wedge which sets the inlet flow field to the cascade test section in a torsional mode through plus or minus 1 degree at frequencies ranging from 80 to 270 Hertz   Miniature high response pressure transducers mounted on the tunnel sidewall and imbedded in one of the cascaded airfoils were used to quantitatively measure the amplitude of the pressure disturbance its frequency and the phase difference between the unsteady pressures and the wedge motion
GRA

N76-12076 Texas Univ Austin
DESIGN AND ANALYSIS OF FLUTTER SUPPRESSION SYSTEMS THROUGH USE OF ACTIVE CONTROLS Ph D Thesis
Radhakrishnamurthy Pinnamaneni 1975 208 p
Avail Univ Microfilms Order No 75-24938
A theoretical study to utilize the recent advances in structural dynamic analysis unsteady-aerodynamic theories, control theories and optimization techniques in the design and analysis of flutter suppression systems was conducted Formulations for design study applications are presented One class of formulation presented is more suitable to a parameter optimization design approach in the frequency domain while the second is more suitable to optimal control design techniques For an example design application, a standardized Air Force Flight Dynamics Laboratory wing-tail flutter was considered The structural dynamic features of the model were represented by analytically computed natural frequencies and mode shapes The unsteady aerodynamic loads for oscillatory motion were computed from doublet lattice aerodynamic programs An approximate method of predicting aerodynamic loads for arbitrary motion was derived Two entirely different iterative design techniques in the frequency domain were developed, and are discussed
Dissert Abstr

N76-12077*# Princeton Univ , N J   Flight Research Lab
AN IN-FLIGHT SIMULATION OF LATERAL CONTROL NONLINEARITIES Final Report
David R Ellis and Narayan W Tilak Washington NASA Nov 1975 27 p refs
(Grant NsG-1078)
(NASA-CR-2625 Rept-126) Avail NTIS HC $4 00 CSCL 01C
An in-flight simulation program was conducted to explore, in a generalized way the influence of spoiler-type roll-control nonlinearities on handling qualities The roll responses studied typically featured a dead zone or very small effectiveness for small control inputs a very high effectiveness for mid-range deflections, and low effectiveness again for large inputs A linear force gradient with no detectable breakout force was provided Given otherwise good handling characteristics it was found that moderate nonlinearities of the types tested might yield acceptable roll control, but the best level of handling qualities is obtained with linear, aileron-like control
Author

N76-12078# Texas Univ Austin   Dept of Aerospace Engineering and Engineering Mechanics
DESIGN AND ANALYSIS OF FLUTTER SUPPRESSION SYSTEMS THROUGH THE USE OF ACTIVE CONTROLS
Ronald Oran Stearman and Radhakrishnamurthy Pinnamaneni Jan 1975 200 p refs
(Grant AF-AFOSR-1998-71 AF Proj 6813 AF Proj 9782)
(AD-A012687, Rept-75005, AFOSR-75-0964TR) Avail NTIS CSCL 01/1
A theoretical study to utilize the recent advances in structural dynamic analysis unsteady-aerodynamic theories control theories and optimization techniques in the design and analysis of flutter suppression systems was conducted At the present time the best formulation of the problem is still open to question therefore, the formulations that appear most promising for design study applications are presented One class of formulation presented is more suitable to a parameter optimization design approach in the frequency domain while the second is more suitable to optimal control design techniques Some of the inherent difficulties associated with casting the problem in the optimal control form are illustrated
GRA

N76-12079*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
AERODYNAMIC CHARACTERISTICS OF A HYPERSONIC RESEARCH AIRPLANE CONCEPT HAVING A 70 DEGREE SWEPT DOUBLE DELTA WING AT MACH NUMBERS FROM 1 50 TO 2 86
Jim A Penland, Roger H Fournier, and Don C Marcum Jr Washington Dec 1975 82 p refs
(NASA-TN-D-8065 L-10305) Avail NTIS HC $5 00 CSCL 01A
An experimental investigation of the static longitudinal lateral and directional stability characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing was conducted in the Langley unitary plan wind tunnel The configuration variables included wing planform, tip fins center fin and scramjet engine modules The investigation was conducted at Mach numbers from 1 50 to 2 86 and at a constant Reynolds number, based on fuselage length of 3 330,000 Tests were conducted through an angle-of-attack range from about -4 deg to 24 deg with angles of sideslip of 0 deg and 3 deg at elevon deflections of 0 -10 and -20 deg The complete configuration was trimmable up to angles of attack of about 22 deg with the exception of regions at low angles of attack where positive elevon deflections should provide trim capability The angle-of-attack range for which static longitudinal stability also exists was reduced at the higher Mach numbers due to the tendency of the complete configuration to pitch up at the higher angles of attack The complete configuration was statically stable directionally up to trimmed angles of attack of at least 20 deg for all Mach numbers M with the exception of a region near 4 deg at M = 2 86 and exhibited positive effective dihedral at all positive trimmed angles of attack
Author

N76-12086*# ARO, Inc, Arnold Air Force Station Tenn Propulsion Wind Tunnel Facility
AN EXPERIMENTAL STUDY OF SEVERAL WIND TUNNEL WALL CONFIGURATIONS USING TWO V/STOL MODEL CONFIGURATIONS Final Report, 10 Mar 1972 - 16 Apr 1974
T W Binion Jr AEDC Jul 1975 37 p refs Sponsored in part by NASA
(ARO Proj PW5214 ARO Proj PF211)
(NASA-CR-145562 AD-A012000, ARO-PWT-TR-75-4, AEDC-TR-75-36) Avail NTIS HC $4 00 CSCL 14/2
Experiments were conducted in the low speed wind tunnel using two V/STOL models a jet-flap and a jet-in-fuselage configuration to search for a wind tunnel wall configuration to minimize wall interference on V/STOL models Data were also obtained on the jet-flap model with a uniform slotted wall configuration to provide comparisons between theoretical and experimental wall interference A test section configuration was found which provided some data in reasonable agreement with interference-free results over a wide range of momentum coefficients
GRA

N76-12170# Boeing Commercial Airplane Co, Seattle Wash
**EXPLORATION OF STATISTICAL FATIGUE FAILURE
CHARACTERISTICS OF 0 063-INCH MILL-ANNEALED
Ti-6AI-4V SHEET AND 0 050-INCH HEAT-TREATED 17-7PH
STEEL SHEET UNDER SIMULATED FLIGHT-BY-FLIGHT
LOADING** Final Report, Aug 1972 - Mar 1974
J P Butler and D A Rees Wright-Patterson AFB Ohio AFML
Jan 1975 225 p refs
(Contract F33615-72-C-2003 AF Proj 7351)
(AD-A011717, AFML-TR-74-269) Avail NTIS CSCL 11/6
A total of 17 mill-annealed Ti-6AI-4V 0 063-in sheet and
14 heat-treated 17-7PH steel 0 050-in sheet unique multidetail
specimens were fatigue tested under a flight-by-flight loading
spectrum to develop a data base for investigating the statistical
materials/structures fatigue failure characteristics of these two
alloys Columnar buckling restraint was provided for specimens
by welded fixtures sandwiching the specimens A painted crack
detection circuit was applied to locate and control size of initiated
cracks In several cases, test specimens of the relatively hard
17-7PH steel fractured before initiated cracks or initial flaws
were detected At open hole structural simulators detected fatigue
cracks were removed by oversizing The initiation data were
examined by maximum likelihood methods for both log-normal
and Weibull distributional representation At a 0 50 reliability
level, the results did not show an obvious distributional representa-
tion At a 0 50 reliability level, the results did not show an
obvious advantage of either distribution but on increased levels
of reliability, the Weibull distribution was a significantly more
conservative simulation of the test data, which showed less
variability than that estimated in a previous study   GRA

N76-12177# Naval Air Development Center, Warminster Pa
Air Vehicle Technology Dept
**AERONAUTICAL ANALYTICAL REWORK PROGRAM
THIXOTROPIC CHEMICAL CONVERSION COATING FOR
THE CORROSION PROTECTION OF AIRCRAFT ALUMINUM
SURFACES** Final Report
P N Bellavin 6 Jun 1975 25 p
(AD-A012345, NADC-75024-30) Avail NTIS CSCL 11/3
This report covers processes for application and the use of
a sprayable/brushable thixotropic chemical conversion coating
for the corrosion protection of aircraft skin surfaces and
components Results of field evaluations specification perform-
ance and formulations are given Current application problems
encountered during rework operation in the control of rapid run-off
from vertical and curved aircraft surfaces are discussed   GRA

N76-12254# Mission Research Corp Albuquerque, N Mex
**COMPARISON OF MEASURED AND PREDICTED CUR-
RENTS ON PIPE MODELS OF AIRCRAFT STRUCTURES**
J Roger Hill and Peter A Swan Oct 1973 23 p refs
(Contract F29601-72-C-0165)
(AD-A012975, AMRC-R-14) Avail NTIS CSCL 20/14
The currents and charge densities induced on L-wire crossed
dipole and aircraft configurations due to the VPD environment
were calculated using the method of moments These quantities
were predicted both with and without the presence of a perfectly
conducting ground plane at the appropriate location The
predicted quantities were compared with those measured in the
pipe experiments and agreement was found to be quite good
in amplitude for both predictions, although the predictions without
a ground plane produce wave forms which agree more closely
with those measured It was concluded that the poorer quality
of predictions with the ground plane may be due to losses in
the actual ground plane at the VPD facility   GRA

N76-12322# Lockheed-Georgia Co, Marietta   Flight Sciences
Div
**THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF
JET PARALLEL TO WING IN CROSS FLOW   PART 1
NUMERICAL INTEGRATION OF THREE-DIMENSIONAL
FLOW   PART 2   EXPERIMENTAL-LASER VELOCIMETER
FLOW FIELD INVESTIGATIONS** Technical Report, 1 Mar
1974 - 28 Feb 1975

R M Scruggs and C J Dixon 30 Apr 1975 105 p refs
(Contract N00014-74-C-0151 NR Proj 215-233)
(AD-A012824 LG75ER-0028-Pt-1 LG75ER-0028-Pt-2) Avail
NTIS CSCL 01/1
Theoretical and experimental analysis of jet flow parallel to
a wing and in cross flow is presented A numerical model is
developed to integrate the three-dimensional flow field equations
A parabolic approximation is assumed and marginally stable
solutions are obtained It is concluded that stability problems
arise because of a combination of an incomplete theoretical model
and an inadequate numerical integration scheme Turbulence
parameters are obtained from laser velocimeter measurement of
the flow field Laser and surface pressure tests were conducted
Pressure tests include low and high angle of attack results of
spanwise blowing over a low aspect ratio semi-span model High
angle of attack data include the effects of leading edge vortex
control by spanwise blowing Only low angle of attack data are
presented for the laser flow field tests   GRA

N76-12342# Holosonics Inc Richland Wash
**AERONAUTICAL ANALYTICAL REWORK PROGRAM·
ACOUSTICAL HOLOGRAPHY SYSTEM DEMONSTRATION
ON A-6 WING SKIN STIFFENER ACOUSTIC IMAGE
INSPECTION** Interim Report
28 May 1975 28 p refs
(Contract N62269-75-M-6443)
(AD-A012584) Avail NTIS CSCL 14/2
The objective of the work reported in this document was to
demonstrate the applicability of acoustical imaging techniques
using the System 200 Acoustical Holography Inspection System
to inspect naval aircraft in particular the A-6 wing skin stiffener
The successful results obtained in this applicability test reflect
the capability of the System 200 Acoustical Holography Inspection
System to provide repeatable hard-copy evidence of the integrity
of structures such as the A-6 wing skin stiffener   GRA

N76-12828*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
**THEORY OF NOISE GENERATION FROM MOVING BODIES
WITH AN APPLICATION TO HELICOPTER ROTORS**
F Farassat (George Washington Univ) Washington Dec 1975
61 p refs
(NASA-TR-R-451 L-10379) Avail NTIS HC $4 50 CSCL
20A
Several expressions for the determination of the acoustic
field of moving bodies are presented The analysis is based on
the Ffowcs Williams-Hawkings equation Applying some proposed
criteria one of these expressions is singled out for numerical
computation of acoustic pressure signature The compactness of
sources is not assumed and the main results are not restricted
by the observer position The distinction between compact and
noncompact sources on moving surfaces is discussed Some
thickness noise calculations of helicopter rotors and comparison
with experiments are included which suggest this mechanism
as the source of high-speed blade slap of rotors   Author

N76-12983 European Space Agency, Paris (France)
**ON THE USE OF FIBER COMPOSITE MATERIALS IN
AVIATION**
Ulrich Huetter *In its* Environment Pollution Flight Safety Human
Reactions to Vibration, Reentry Vehicles Interplanet Trajectories
and Composite Mater (ESA-TT-176) Jul 1975 p 100-118
Transl into ENGLISH of DFVLR-Kolloquiums
am 8 Mai 1973 im Forschungszentrum Porz-Wahn DFVLR
Porz, West Ger Report DLR-Mitt-73-16 1973 p 111-129

The application of glass, carbon, and boron fiber composite
materials to aircraft construction is surveyed, and comparison is
made with conventional materials   ESA

N76-12984# European Space Agency Paris (France)
**AEROSPACE RESEARCH   BI-MONTHLY BULLETIN
NO 1974-4**
Sep 1975 176 p refs Transl into ENGLISH of La Rech

Aerospatiale Bull Bimestriel (Paris), no 1974-4, Jul -Aug 1974 p 175-246 Original French report available from ONERA Paris 20 F
(ESA-TT-190) Avail NTIS HC $7 50

Papers are presented on the following topics blade profiles for turbine engines, jet penetration and dilution in a combustion chamber mixed flow gasdynamic laser, effect of crystalline structure and chemical composition on stress corrosion resistance of aluminum alloys unsteady aerodynamic forces induced by the aeroelastic vibration of a jet engine in a pod, calculation of stress intensity factor for estimation of crack propagation casing shape effect on performance of an annular cascade of supersonic rotor blades and measurement of Schwarzschild exponent of Ilford Q2 plates by mass spectrography with secondary ion emission

N76-12985 European Space Agency Paris (France)
BLADE PROFILES FOR TURBINE ENGINES, ADAPTED TO REVERSIBLE TRANSONIC FLOWS
Robert Legendre In its Aerospace Research Bi-monthly Bull No 1974-4 (ESA-TT-190) Sep 1975 p 1-19 refs Transl into ENGLISH from La Rech Aerospatiale Bull Bimestriel (Paris) no 1974-4, Jul -Aug 1974 p 175-180

The integral method of calculating profiles for plane transonic flows is accurate and of general applicability but ponderous in its implementation As an alternative it is proposed to use the method of finite differences which is no less general but much simpler The accuracy is sufficient if the contour of the hodograph is represented exactly over the perimeter of a rectangle The transformation selected for this purpose is conformal It is defined as the solution of a Dirichlet problem in a rectangle
Author (ESA)

N76-12989 European Space Agency Paris (France)
UNSTEADY AERODYNAMIC FORCES INDUCED BY THE AEROELASTIC VIBRATION OF A JET ENGINE IN A POD

Jean-Jacques Angelini Suzanne Chopin Roger Destuynder et al In its Aerospace Research, Bi-monthly Bull No 1974-4 (ESA-TT-190) Sep 1975 p 82-103 refs Transl into ENGLISH from La Rech Aerospatiale, Bull Bimestriel (Paris) no 1974-4 Jul -Aug 1974 p 209-219

Calculations and measurements made in subsonic flow on a model fitted with an engine pod show that the interaction between the wing and pod is negligible but that the unsteady aerodynamic forces induced on the pod itself, by its own oscillation are important as regards flutter In the theoretical treatment the pod is dealt with separately and is represented by a cylindrical section having a thin wall with internal and external flow
Author (ESA)

N76-13000*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
DESIGN AND PRELIMINARY TESTS OF A BLADE TIP AIR MASS INJECTION SYSTEM FOR VORTEX MODIFICATION AND POSSIBLE NOISE REDUCTION ON A FULL-SCALE HELICOPTER ROTOR
Robert J Pegg, Robert N Hosier (Army Air Mobility R and D Lab), John C Balcerak (Rochester Appl Sci Associates Div, Rochester, New York), and H Kevin Johnson (Systems Res Labs, Inc, Rochester, N Y) Washington Dec 1975 39 p refs
(NASA-TM-X-3314, L-10428) Avail NTIS HC $4 00 CSCL 01A

Full-scale tests were conducted on the Langley helicopter rotor test facility as part of a study to evaluate the effectiveness of a turbulent blade tip air mass injection system in alleviating the impulsive noise (blade slap) caused by blade-vortex interaction Although blade-slap conditions could not be induced during these tests, qualitative results from flow visualization studies using smoke showed that the differential velocity between the jet velocity and the rotor tip speed was a primary parameter controlling the vortex modification
Author

N76-13001# Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne (West Germany)
SMALL GAS TURBINES
18 Jul 1975 164 p refs In GERMAN ENGLISH summaries Proc of the DGLR Air Breathing Eng Comm Meeting, Frankfurt, 11-12 Nov 1974
(DLR-Mitt-75-12) Avail NTIS HC $6 75, DFVLR, Cologne DM 59 30

Problems in the use of a small gas turbine as aircraft auxiliary power source and as automobile engine are discussed

N76-13002 Kloeckner-Humboldt-Deutz A G, Oberursel (West Germany)
MECHANICAL PROBLEMS IN THE DEVELOPMENT OF AIRCRAFT AUXILIARY POWER UNITS [MECHANISCHE PROBLEME BEI DER ENTWICKLUNG VON FLUGZEUG-HILFSGASTURBINEN]
A Witt In DGLR Small Gas Turbines 18 Jul 1975 p 9-24 In GERMAN

Some mechanical problems in the development of auxiliary gas turbines for the VFW-Fokker VAK 191 and MRCA Panavia 200 aircraft are considered Especially the compressor rotor bearings showed noticeable wear after a few hours running This problem is solved by optimizing the axial loading using strain gages The reliability of bearings used in aircraft is discussed Problems in screw fastures for auxiliary turbines, especially with magnesium casings, are outlined
ESA

N76-13004 Kloeckner-Humboldt-Deutz A G Oberursel (West Germany)
INVESTIGATIONS ON AN INLET ENCLOSURE FOR A SMALL GAS TURBINE [UNTERSUCHUNGEN AN EINEM EINLAUFGEHAEUSE FUER EINE KLEINGASTURBINE]

H Fricke In DGLR Small Gas Turbines 18 Jul 1975 p 47-60 refs In GERMAN

An air inlet enclosure configuration was investigated for a small gas turbine Several flow deflectors were built in to improve the strongly distorted flow in the compressor inlet The results of tests with suction and of performance tests after mounting the inlet enclosure to a turbine are presented A configuration was found which provided satisfactory performance over the overall operating range of the turbine
ESA

N76-13009# Deutsche Gesellschaft fuer Luft- und Raumfahrt Cologne (West Germany)
PIONEERS OF AVIATION HUGO JUNKERS, FERDINAND FERBER, ADOLF ROHRBACH [PIONIERE DER LUFTFAHRT HUGO JUNKERS, FERDINAND FERBER, ADOLF ROHRBACH]
Ernst Zindel, Raimond Josse (Armee de l'Air, Paris), and Hellmut Herb Feb 1974 123 p refs In GERMAN, ENGLISH summary Lectures presented at DGLR meetings Brunswick, 7 Dec 1972, 11 Jan 1973, 29 Nov 1973
(DLR-Mitt-74-15) Avail NTIS HC $5 50 ZLDI Munich DM 25,80

Lectures are presented on aircraft pioneers Hugo Junkers (1859-1935), a pioneer of technology and aviation and Adolf Rohrbach a pioneer of metallic aircraft structures
ESA

N76-13010 Illinois Univ Urbana
BASE PRESSURE PROBLEMS ASSOCIATED WITH SUPERSONIC AXISYMMETRIC EXTERNAL FLOW CONFIGURATIONS Ph D Thesis
Chi-Hsiung Weng 1975 118 p
Avail Univ Microfilms Order No 75-24433

The turbulent recompression and redevelopment flow processes associated with an axially symmetric supersonic flow over a rearward-facing step are studied The rehabilitation process after flow reattachment is characterized as relaxation of the pressure difference across the viscous layer The constant pressure mixing region is analyzed to provide the initial condition for the recompression process A system of ordinary differential equations is obtained within the respective flow regions and is integrated

numerically It is observed that the fully rehabilitated state behaves as a saddle point singularity of the system An interactive procedure is followed to determine the base pressure and illustrates the elliptic behavior of all separated flow problems Calculated results support the validity of the flow model and the method of analysis   Dissert Abstr

N76-13011 Stanford Univ , Calif
FINITE STATE MODELING OF AEROELASTIC SYSTEMS
Ph.D. Thesis
Ranjan Vepa 1975 190 p
Avail Univ Microfilms Order No 75-25623
Advanced techniques are applied for modeling three-dimensional lifting surfaces for active suppression of flutter Emphasis is placed on obtaining an accurate representation of the aerodynamic loads due to arbitrary motion of the lifting surfaces Aircraft wing structures are modeled either by the Finite-element technique or as a simple beam-rod performing bending and torsion oscillations The mode shapes are approximated as polynomials These approximate mode shapes are used to calculate the aerodynamic loads by the Kernel function and Doublet-lattice method in subsonic flow for a wide range of frequencies of oscillations From this frequency response data scalar and matrix transfer functions are obtained relating the displacement modal amplitudes and aerodynamic loads From the structural model and aerodynamic transfer function, a finite state realization is synthesized   Dissert Abstr

N76-13013*# Advanced Technology Labs Mountain View, Calif
EVALUATION OF VISCOUS DRAG REDUCTION SCHEMES FOR SUBSONIC TRANSPORTS
A Marino, C Economos, and F G Howard Nov 1975 114 p refs
(Contract NAS1-13286)
(NASA-CR-132718 ATL-TR-216) Avail NTIS HC $5 50 CSCL 01C
The results are described of a theoretical study of viscous drag reduction schemes for potential application to the fuselage of a long-haul subsonic transport aircraft The schemes which were examined included tangential slot injection on the fuselage and various synergetic combinations of tangential slot injection and distributed suction applied to wing and fuselage surfaces Both passive and mechanical (utilizing turbo-machinery) systems were examined Overall performance of the selected systems was determined at a fixed subsonic cruise condition corresponding to a flight Mach number of free stream M = 0 8 and an altitude of 11,000 m The nominal aircraft to which most of the performance data was referenced was a wide-body transport of the Boeing 747 category Some of the performance results obtained with wing suction are referenced to a Lockheed C-141 Star Lifter wing section Alternate designs investigated involved combinations of boundary layer suction on the wing surfaces and injection on the fuselage, and suction and injection combinations applied to the fuselage only   Author

N76-13014*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
DEVELOPMENT AND FLIGHT TESTS OF VORTEX-ATTENUATING SPLINES
Earl C Hastings, Jr, J C Patterson Jr, Robert E Shanks Robert A Champine W Latham Copeland, and Douglas C Young Washington Dec 1975 40 p refs
(NASA-TN-D-8083 L-10442) Avail NTIS HC $4 00 CSCL 01A
The ground tests and full-scale flight tests conducted during development of the vortex-attenuating spline are described The flight tests were conducted using a vortex generating aircraft with and without splines, a second aircraft was used to probe the vortices generated in both cases The results showed that splines significantly reduced the vortex effects, but resulted in some noise and climb performance penalties on the generating aircraft   Author

N76-13015*# Texas A&M Univ College Station Dept of Aerospace Engineering
INVERSE TRANSONIC AIRFOIL DESIGN METHODS INCLUDING BOUNDARY LAYER AND VISCOUS INTERACTION EFFECTS Semiannual Progress Report, May - Nov 1975
Leland A Carlson Nov 1975 24 p refs
(Grant NsG-1174)
(NASA-CR-145848 TAMRF-3324-7501) Avail NTIS HC $3 50 CSCL 01A
The results are reported of the research on the viscous interactions effects on transonic airfoil design and analysis The boundary layer methods and the design program are discussed   FOS

N76-13017*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
ADAPTATION OF THE THEODORSEN THEORY TO THE REPRESENTATION OF AN AIRFOIL AS A COMBINATION OF A LIFTING LINE AND A THICKNESS DISTRIBUTION
Raymond L Barger Washington Dec 1975 19 p refs
(NASA-TN-D-8117, L-10476) Avail NTIS HC $3 50 CSCL 01A
The theory provides a direct method for resolving an airfoil into a lifting line and a thickness distribution as well as a means of synthesizing thickness and lift components into a resultant airfoil and computing its aerodynamic characteristics Specific applications of the technique are discussed   Author

N76-13019*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
A PRELIMINARY STUDY OF THE EFFECTS OF VORTEX DIFFUSERS (WINGLETS) ON WING FLUTTER
Robert V Doggett, Jr and Moses G Farmer 3 Dec 1975 24 p refs
(NASA-TM-X-72799) Avail NTIS HC $3 50 CSCL 01A
Some experimental flutter results are presented for a simple flat-plate wing model and for the same wing model equipped with two different upper surface vortex diffusers over the Mach number range from about 0 70 to 0 95 Both vortex diffusers had the same planform, but one weighed about 0 3 percent of the basic wing weight, whereas the other weighed about 1 8 percent of the wing weight The addition of the lighter vortex diffuser reduced the flutter dynamic pressure by about 3 percent, the heavier vortex diffuser reduced the flutter dynamic pressure by about 12 percent The experimental flutter results are compared at a Mach number of 0 80 with analytical flutter results obtained by using doublet lattice and lifting surface (Kernel function) unsteady aerodynamic theories   Author

N76-13020*# Rockwell International Corp Los Angeles, Calif
VECTOR THRUST INDUCED LIFT EFFECTS FOR SEVERAL EJECTOR EXHAUST LOCATIONS ON A V/STOL WIND TUNNEL MODEL AT FORWARD SPEED
A D Sharon Aug 1975 39 p refs
(Contract NAS2-8864)
(NASA-CR-137733) Avail NTIS HC $4 00 CSCL 01A
The results and analysis of aerodynamic force data obtained from a small scale model of a V/STOL research vehicle in a low speed wind tunnel are presented The analysis of the data includes the evaluation of aerodynamic-propulsive lift performance when operating twin ejector nozzles with thrust deflected Three different types of thrust deflector systems were examined 90 deg downward deflected nozzle, 90 deg slotted nozzle with boundary layer control, and an externally blown flap configuration Several nozzle locations were tested, including over and underwing positions The interference lift of the nacelle and model due to jet exhaust thrust is compared and results show that 90 deg turned nozzles located over the wing (near the trailing edge) produce the largest interference lift increment for an untrimmed aircraft and that the slotted nozzle located under the wing near the trailing edge (in conjunction with a BLC flap) gives a comparable interference lift in the trimmed condition The externally blown flap nozzle produced the least interference lift and significantly less total lift due to jet thrust effects   Author

N76-13022°# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
COMPUTED LATERAL RATE AND ACCELERATION POWER SPECTRAL RESPONSE OF CONVENTIONAL AND STOL AIRPLANES TO ATMOSPHERIC TURBULENCE
Jacob H Lichtenstein Washington Dec 1975 123 p refs
(NASA-TN-D-8022, L-10018) Avail NTIS HC $5 50 CSCL 01C
    Power-spectral-density calculations were made of the lateral responses to atmospheric turbulence for several conventional and short take-off and landing (STOL) airplanes The turbulence was modeled as three orthogonal velocity components, which were uncorrelated, and each was represented with a one-dimensional power spectrum Power spectral densities were computed for displacements, rates and accelerations in roll, yaw, and sideslip In addition, the power spectral density of the transverse acceleration was computed Evaluation of ride quality based on a specific ride quality criterion was also made The results show that the STOL airplanes generally had larger values for the rate and acceleration power spectra (and, consequently, larger corresponding root-mean-square values) than the conventional airplanes The ride quality criterion gave poorer ratings to the STOL airplanes than to the conventional airplanes   Author

N76-13023°# Texas A&M Univ, College Station   Dept of Aerospace Engineering
FORCE AND PRESSURE MEASUREMENTS ON AN AIRFOIL OSCILLATING THROUGH STALL, PART 2 Final Report
A G Parker Aug 1975 67 p refs
(Contract NAS2-7917)
(NASA-CR-145877, TEES-3018-75-01A) Avail NTIS HC $4 50 CSCL 01A
    Details of force, moment, and pressure distributions on a two dimensional, four foot chord NACA 0012 airfoil oscillating in pitch through stall, in a 7 ft x 10 ft low speed wind tunnel, are presented Tests were run with the airfoil in a closed test section and also in a test section having four longitudinal slots in each sidewall set to provide minimum tunnel interference on the wing in steady flow In unsteady flow, differences between the results for the closed and 2% open case are small The dynamic stall process is not triggered by the bursting of a laminar separation bubble but rather by the separation of the turbulent boundary layer downstream of the bubble   Author

N76-13025# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany)   Inst fuer Aeroelastik
A NUMERIC METHOD TO CALCULATE THE UNSTEADY AERODYNAMIC PRESSURE DISTRIBUTION ON HARMONICALLY OSCILLATING WINGS IN SUBSONIC FLOW PART 1 THEORY AND RESULTS FOR INCOMPRESSIBLE FLOW
Wolfgang Geissler 6 Jan 1975 92 p refs In GERMAN, ENGLISH summary
(DLR-FB-75-37) Avail NTIS HC $5 00 DFVLR, Cologne DM 41 10
    A numerical method is given for calculating the unsteady pressure distribution on harmonically oscillating three-dimensional wings with control surfaces in subsonic flow Using the velocity potential for this panel method, instead of the acceleration potential the kernel function of the corresponding integral equation and the numerical calculation procedure are considerably simplified   Author (ESA)

N76-13031# McDonnell-Douglas Astronautics Co, Huntington Beach Calif
AERODYNAMIC COMPUTER CODE FOR COMPUTING PRESSURE LOADING ON WINGS FOR STRUCTURAL ANALYSIS Final Report, 30 Sep 1974 - 31 May 1975
Kenneth K Wang and Richard S Lee Jul 1975 120 p
(Contract N60921-75-C-0069)
(AD-A013314, MDC-G5982) Avail NTIS CSCL 01/1
    The report describes the development of an aerodynamic computer code for calculating the pressure distribution on wings

and to interpolate by surface fit at locations as specified for structural analysis using the NASTRAN computer code   GRA

N76-13032# McDonnell-Douglas Corp Long Beach, Calif
ANALYTIC STUDIES OF TWO-ELEMENT AIRFOIL SYSTEMS Final Report
R M James Mar 1975 85 p refs
(Contract N00014-72-C-0218, NR Proj 215-207)
(AD-A013264, MDC-J6825/01) Avail NTIS CSCL 01/1
    By using a general form of conformal mapping from the doubly-connected airfoil domain to the canonical ring domain, the problem of two interfering lifting airfoils is reduced to the solution of certain integral equations It is shown that the solutions of these equations appropriate to (a) direct boundary-value problems (given shape), (b) inverse boundary-value problems (given velocities), and (c) simply mixed boundary-value problems (given either shape or velocity on one airfoil and the converse on the other) conform to the same general velocity formula This formula consists of a singular part in terms of Theta functions and a Laurent series whose coefficients can be adapted to accommodate (a), (b), or (c) without further recourse to integral equations   GRA

N76-13033# West Virginia Univ, Morgantown   Dept of Aerospace Engineering
ANALYSIS OF CIRCULATION CONTROLLED AIRFOILS Ph.D Thesis
Edward H Gibbs and Nathan Ness Jun 1975 198 p refs
(Contract N00014-68-A-0512, NR Proj 215-163)
(AD-A013334, TR-43) Avail NTIS CSCL 01/3
    A self-contained analysis for arbitrary circulation controlled airfoils in incompressible flow is developed The analysis predicts the blowing slot conditions required to produce a specified lift coefficient on a given airfoil with given free stream conditions An iterative procedure is used to find the blowing slot conditions that allow the Thwaites condition of constant pressure in the separated region to be satisfied With the input given a potential flow analysis is performed using the Theodorsen method Boundary layer analyses for the lower and upper surfaces then yield the separation pressure on the lower surface and the boundary layer properties at the slot on the upper surface The flow is initially laminar and usually becomes turbulent The Cebeci Smith finite difference method is used and an eddy viscosity model is used for turbulent flow Blowing slot values are assumed and a turbulent wall jet analysis is performed to determine the wall pressure at separation on the upper surface   GRA

N76-13035# Nielsen Engineering and Research, Inc, Mountain View Calif
EXPLORATORY STUDY OF AERODYNAMIC LOADS ON A FIGHTER-BOMBER AT SPIN ENTRY Annual Report, 1 May 1974 - 1 Apr 1975
Selden B Spangler and Jack N Nielsen May 1975 72 p refs
(Contract N00014-74-C-0344, NR Proj 212-225)
(AD-A013246, NEAR-TR-87) Avail NTIS CSCL 01/1
    An exploratory investigation was performed to examine the distribution of forces on a modern fighter-bomber aircraft at incipient spin entry The flight condition considered is a high angle of attack (in the range of 30 to 40 degrees) at zero sideslip The loads of principal interest are side force, yawing moment and rolling moment The general approach involves the use of aircraft and missile nonlinear, potential flow, vortex interference methods to examine the loads on the nose, wing-body afterbody, and tail Calculations were made for the F-5 configuration because of the availability of static force data at flight conditions of interest   GRA

N76-13038°# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
AN OUTLOOK FOR CARGO AIRCRAFT OF THE FUTURE
Oran W Nicks, Allen H Whitehead, Jr and William J Alford, Jr 14 Nov 1975 42 p refs
(NASA-TM-X-72796) Avail NTIS HC $4 00 CSCL 01C
    An assessment is provided of the future of air cargo by

analyzing air cargo statistics and trends, by noting air cargo system problems and inefficiencies, by analyzing characteristics of air-eligible commodities, and by showing the promise of new technology for future cargo aircraft with significant improvements in costs and efficiency NASA's proposed program is reviewed which would sponsor the research needed to provide for development of advanced designs by 1985   Author

N76-13040*# National Aeronautics and Space Administration Lyndon B Johnson Space Center, Houston, Tex
REFURBISHMENT OF NASA AIRCRAFT WITH FIRE-RETARDANT MATERIALS
Daniel E Supkis Oct 1975 29 p refs
(NASA-TM-X-58165, JSC-09832) Avail NTIS HC $4 00 CSCL 01C
Selected fire-retardant materials for possible application to commercial aircraft are described The results of flammability screening tests and information on the physical and chemical properties of both original and newly installed materials after extended use are presented in tabular form, with emphasis on wear properties, strength, puncture and tear resistances, and cleanability   Author

N76-13041*# Tennessee Univ Space Inst, Tullahoma
ANALYSIS OF ATMOSPHERIC FLOW OVER A SURFACE PROTRUSION USING THE TURBULENCE KINETIC ENERGY EQUATION WITH REFERENCE TO AERONAUTICAL OPERATING SYSTEMS Final Report, Dec. 1973 - Dec. 1974
Walter Frost and W L Harper Washington NASA Dec 1975 77 p refs
(Contract NAS8-29584)
(NASA-CR-2630, M-154) Avail NTIS HC $5 00 CSCL 01C
Flow over surface obstructions can produce significantly large wind shears such that adverse flying conditions can occur for aeronautical systems (helicopters, STOL vehicles, etc) Atmospheric flow fields resulting from a semi-elliptical surface obstruction in an otherwise horizontally homogeneous statistically stationary flow are modelled with the boundary-layer/Boussinesq-approximation of the governing equation of fluid mechanics The turbulence kinetic energy equation is used to determine the dissipative effects of turbulent shear on the mean flow Iso-lines of turbulence kinetic energy and turbulence intensity are plotted in the plane of the flow and highlight regions of high turbulence intensity in the stagnation zone and sharp gradients in intensity along the transition from adverse to favourable pressure gradient Discussion of the effects of the disturbed wind field in CTOL and STOL aircraft flight path and obstruction clearance standards is given The results indicate that closer inspection of these presently recommended standards as influenced by wind over irregular terrains is required   Author

N76-13042# National Transportation Safety Board, Washington, D C Bureau of Aviation Safety
AIRCRAFT ACCIDENT REPORT EASTERN AIR LINES, INC, DOUGLAS DC-9-31, N8984E, CHARLOTTE, NORTH CAROLINA, 11 SEPTEMBER 1974
23 May 1975 40 p
(PB-243296/1, NTSB-AAR-75-9, File-1-0020) Avail NTIS HC $4 00 CSCL 01B
About 0734 e d t, on September 11, 1974, Eastern Air Lines Inc Flight 212, crashed 3 3 statute miles short of runway 36 at Douglas Municipal Airport, Charlotte North Carolina The flight was conducting a VOR DME nonprecision approach in visibility restricted by patchy dense ground fog Of the 82 persons aboard the aircraft 11 survived the accident One survivor died of injuries 29 days after the accident The aircraft was destroyed by impact and fire The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's lack of altitude awareness at critical points during the approach due to poor cockpit discipline in that the crew did not follow prescribed procedures   GRA

N76-13052*# National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
FIXED-RANGE OPTIMUM TRAJECTORIES FOR SHORT-HAUL AIRCRAFT
Heinz Erzberger John D McLean, and John F Barman Washington Dec 1975 32 p refs
(NASA-TN-D-8115, A-5874) Avail NTIS HC $4 00 CSCL 01A
An algorithm, based on the energy-state method, is derived for calculating optimum trajectories with a range constraint The basis of the algorithm is the assumption that optimum trajectories consist of, at most three segments an increasing energy segment (climb), a constant energy segment (cruise) and a decreasing energy segment (descent) This assumption allows energy to be used as the independent variable in the increasing and decreasing energy segments, thereby eliminating the integration of a separate adjoint differential equation and simplifying the calculus of variations problem to one requiring only pointwise extremization of algebraic functions The algorithm is used to compute minimum fuel minimum time, and minimum direct-operating-cost trajectories, with range as a parameter, for an in-service CTOL aircraft and for an advanced STOL aircraft For the CTOL aircraft and the minimum-fuel performance function, the optimum controls, consisting of air-speed and engine power setting are continuous functions of the energy in both climb and descent as well as near the maximum or cruise energy This is also true for the STOL aircraft except in the descent where at one energy level a nearly constant energy dive segment occurs yielding a discontinuity in the airspeed at that energy The reason for this segment appears to be the relatively high fuel flow at idle power of the engines used by this STOL aircraft Use of a simplified trajectory which eliminates the dive increases the fuel consumption of the total descent trajectory by about 10 percent and the time to fly the descent by about 19 percent compared to the optimum   Author

N76-13058 Minnesota Univ, Minneapolis
AIRCRAFT ENERGY MANAGEMENT Ph.D. Thesis
Nelson Ray Zagalsky 1975 113 p
Avail Univ Microfilms Order No 75-27197
The three dimensional flight path optimization problem is formulated using the energy state approximation and a generalized fuel/time performance criteria A solution procedure is developed and extended to a graphical construct technique The graphical construct specialized to vertical plane optimization problems, is used to explore the nature of minimum-fuel-fixed time solutions to (1) the nonconvex optimization problem that results when fuel flow is approximated as a linear function of thrust, and (2) the convex optimization problem that results when the actual nonlinear fuel flow data for a typical turbojet (i e, F4E aircraft engines operating at military and reduced power settings) is used   Dissert Abstr

N76-13059# National Aviation Facilities Experimental Center Atlantic City, N J
INVESTIGATION OF FACTORS INFLUENCING PROPELLER BLADE FAILURE Final Report, Jan 1971 - Jul 1974
Marvin J Walker Jul 1975 93 p refs
(AD-A013918/8 FAA-NA-75-1) Avail NTIS HC $4 75 CSCL 01/3
A flight and ground test program was conducted to examine vibratory and steady propeller blade operating stresses occurring in normal and transient abnormal operations of several types of reciprocating engine powered general aviation aircraft The objectives of the tests were to evaluate such stresses as a possible cause of early propeller blade fatigue failure and to determine whether they were inherent in the characteristics of the engine-propeller combinations, or attributable to such factors as tolerance spread between identical models or accumulated time in service The results also were considered in respect to current design and certification standards   Author

N76-13030*# Douglas Aircraft Co., Inc., Long Beach, Calif.
DC-9 FLIGHT DEMONSTRATION PROGRAM WITH REFANNED JT8D ENGINES. VOLUME 1. SUMMARY Final Report
Jul 1975 75 p refs
(Contract NAS3-17841)
(NASA-CR-134857; MDC-J4526-Vol-1)   Avail NTIS
HC $4 50 CSCL 01C

The design, analysis, fabrication, and ground and flight testing of DC-9 airframe/nacelle hardware with prototype JT8D-109 engines are discussed. The installation of the JT8D-109 engine on the DC-9 Refan airplane required new or modified hardware for the pylon, nacelle, and fuselage. The acoustic material used in the nose cowl was bonded aluminum honeycomb sandwich and the exhaust duct acoustic material was Inconel 625 Stresskin. The sea level static, standard day bare engine takeoff thrust, the cruise TSFC and the maximum available cruise thrust for the JT8D-109 engine were compared with those of the JT8D-9 engine. The range capabilities of the DC-9 Refan and the production DC-9 airplane were also compared. The Refan airplane demonstrated flight characteristics similar to the production DC-9-30 and satisfied airworthiness requirements. Flyover noise levels were determined for the DC-9 Refan and the DC-9 C-9A airplane for takeoff and landing conditions. Cost estimates were also made.   Author

N76-13031*# Douglas Aircraft Co., Inc., Long Beach, Calif.
DC-9 FLIGHT DEMONSTRATION PROGRAM WITH REFANNED JT8D ENGINES. VOLUME 2: DESIGN AND CONSTRUCTION Final Report
Jul 1975 133 p refs
(Contract NAS3-17841)
(NASA-CR-134858; MDC-J4510-Vol-2)   Avail NTIS
HC $6 00 CSCL 01C

The nacelle configuration selected for the DC-9 had a 1595 6 mm Refan length inlet and an 1811 8 mm exhaust duct. The inlet had 1234 4 mm of acoustic treatment and the tailpipe had 1305 5 mm of equivalent length acoustic treatment. The pylon was reduced in width from 425 5 mm to 204 5 mm. Fuselage frames and titanium skin panels in the area of the pylon were reinforced or replaced to support the higher loads and engine thrust. Experimental type tooling, fabrication and assembly were used on all hardware. The design is considered certifiable and representative of the hardware that would be built as retrofit kits.   Author

N76-13032*# Douglas Aircraft Co., Inc., Long Beach, Calif.
DC-9 FLIGHT DEMONSTRATION PROGRAM WITH REFANNED JT8D ENGINES. VOLUME 3 PERFORMANCE AND ANALYSIS Final Report
Jul 1975 239 p refs
(Contract NAS3-17841)
(NASA-CR-134859; MDC-J4519-Vol-3)   Avail NTIS
HC $8 00 CSCL 01C

The JT8D-109 engine has a sea level static, standard day bare engine takeoff thrust of 73 840 N. At sea level standard day conditions the additional thrust of the JT8D-109 results in 2,040 kg additional takeoff gross weight capability for a given field length. Range loss of the DC-9 Refan airplane for long range cruise was determined. The Refan airplane demonstrated stall, static longitudinal stability, longitudinal control, longitudinal trim, minimum control speeds and directional control characteristics similar to the DC-9-30 production airplane and complied with airworthiness requirements. Cruise, climb, and thrust reverser performance were evaluated. Structural and dynamic ground test, flight test and analytical results substantiate Refan Program requirements that the nacelle, thrust reverser hardware, and the airplane structural modifications are flightworthy and certifiable and that the airplane meets flutter speed margins. Estimated unit cost of a DC-9 Refan retrofit program is 1 338 million in mid-1975 dollars with about an equal split in cost between airframe and engine.   Author

N76-13033*# Douglas Aircraft Co., Inc., Long Beach, Calif.
DC-9 FLIGHT DEMONSTRATION PROGRAM WITH REFANNED JT8D ENGINES. VOLUME 4 FLYOVER NOISE Final Report
Jul 1975 400 p refs
(Contract NAS3-17841)
(NASA-CR-134860; MDC-J4518-Vol-4)   Avail NTIS
HC $10 75 CSCL 01C

Flyover noise tests were conducted to determine the noise reductions achievable by modifying the engines and nacelles of DC-9 airplanes. The two stage fan of the JT8D-9 engine was replaced with a larger diameter, single stage fan and sound absorbing materials were incorporated in the engines and nacelles. The noise levels were determined to be 95 3 EPNdB at the sideline 96 2 EPNdB for a full thrust takeoff, 87 5 EPNdB for takeoff with thrust cutback and 97 4 EPNdB for landing approach. The noise reductions relative to the hardwall JT8D-9 were 8 2 EPNdB for takeoff with cutback and 8 7 EPNdB for landing. The 90 EPNdB noise contour areas were reduced by 40% for missions requiring maximum design takeoff and landing weights. For typical mission weights, the reductions were 19% for full thrust takeoff and 34% for takeoff with cutback. The 95 EPNdB contour areas were reduced by 50% for takeoff and 30% for takeoff with cutback for both missions.   Author

N76-13034*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PERSPECTIVE ON THE SPAN-DISTRIBUTED-LOAD CONCEPT FOR APPLICATION TO LARGE CARGO AIRCRAFT
Allen H Whitehead, Jr Dec 1975 36 p refs
(NASA-TM-X-3320 L-10370) Avail NTIS HC $4 00 CSCL 01C

Results of a simplified analysis of the span-distributed-load concept (in which payload is placed within the wing structure) are presented. It is shown that a design based on these principles has a high potential for application to future large air cargo transport. Significant improvements are foreseen in increased payload fraction and productivity and in reduced fuel consumption and operating costs. A review of the efforts in the 1940's to develop all-wing aircraft shows the potential of transferring those early technological developments to current design of distributed-load aircraft. Current market analyses are projected to 1990 to show the future commercial demand for large capacity freighters. Several configuration designs which would serve different market requirements for these large freighters are discussed as are some of the pacing-technology requirements.   Author

N76-13035*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRELIMINARY ANALYSIS OF THE SPAN-DISTRIBUTED-LOAD CONCEPT FOR CARGO AIRCRAFT DESIGN
Allen H Whitehead Jr Dec 1975 28 p refs
(NASA-TM-X-3319, L-10473) Avail NTIS HC $4 00 CSCL 01C

A simplified computer analysis of the span-distributed-load airplane (in which payload is placed within the wing structure) has shown that the span-distributed-load concept has high potential for application to future air cargo transport design. Significant increases in payload fraction over current wide-bodied freighters are shown for gross weights in excess of 0 5 Gg (1,000,000 lb). A cruise-matching calculation shows that the trend toward higher aspect ratio improves overall efficiency, that is, less thrust and fuel are required. The optimal aspect ratio probably is not determined by structural limitations. Terminal-area constraints and increasing design-payload density, however, tend to limit aspect ratio.   Author

N76-13066*# McDonnell Aircraft Co, St Louis, Mo V/STOL
Aircraft Advanced Engineering
**DESIGN DEFINITION STUDY OF A LIFT/CRUISE FAN
TECHNOLOGY V/STOL AIRCRAFT VOLUME 1. NAVY
OPERATIONAL AIRCRAFT**
Jun 1975 134 p refs
(Contract NAS2-5499)
(NASA-CR-137678, MDC-A3440-Vol-1) Avail NTIS
HC $6 00 CSCL 01C
    Aircraft were designed and sized to meet Navy mission
requirements Five missions were established for evaluation
anti-submarine warfare (ASW), surface attack (SA), combat search
and rescue (CSAR), surveillance (SURV), and vertical on-board
delivery (VOD) All missions were performed with a short takeoff
and a vertical landing The aircraft were defined using existing
J97-GE gas generators or reasonable growth derivatives in
conjunction with turbotip fans reflecting LF460 type technology
The multipurpose aircraft configuration established for U S Navy
missions utilizes the turbotip driven lift/cruise fan concept for
V/STOL aircraft   Author

N76-13067*# McDonnell Aircraft Co, St Louis, Mo V/STOL
Aircraft Advanced Engineering
**DESIGN DEFINITION STUDY OF A LIFT/CRUISE FAN
TECHNOLOGY V/STOL AIRCRAFT VOLUME 2: TECHNOL-
OGY AIRCRAFT**
Jun 1975 108 p
(Contract NAS2-5499)
(NASA-CR-137698, MDC-A3440-Vol-2) Avail NTIS
HC $5 50 CSCL 01C
    Technology flight vehicles were defined for three different
approaches which demonstrate the concept and characteristics
of the multipurpose aircraft established for Navy missions The
propulsion system used for the various technology flight vehicles
was representative of that established for the multipurpose
aircraft Existing J97-GE100 gas generators were selected based
on cost availability and exhaust characteristics The LF459 fans
were also selected and are compatible with both technology
and operational vehicles To comply with the design guideline
safety criteria, it was determined that three gas generators were
required to provide engine out safety in the hover flight mode
The final propulsion system established for the technology aircraft
was three existing J97 gas generators powering three LF459
fans Different aircraft candidates were evaluated for application
to the three designated design approaches Each configuration
was evaluated on the basis of (1) propulsion system integration,
(2) modification required, (3) pilot's visibility, (4) payload volume,
and (5) adaptability to compatible location of center-of-gravity/
aerodynamic center and thrust center   Author

N76-13068*# National Aeronautics and Space Administration
Langley Research Center, Langley Station, Va
**WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC
PERFORMANCE, STEADY AND VIBRATION LOADS,
SURFACE TEMPERATURES AND ACOUSTIC CHARACTER-
ISTICS OF A LARGE-SCALE TWIN-ENGINE UPPER
SURFACE BLOWN JET-FLAP CONFIGURATION** An Early
Domestic Dissemination Report
Nov 1975 162 p refs
(Proj FEDD)
(NASA-TM-X-72794) Avail NASA Industrial Applications
Centers only to U S Requesters HC $6 75/MF $2 25 CSCL
01C
    Tests were conducted in the Langley full-scale tunnel to
determine the aerodynamic performance, steady and vibratory
aerodynamic loads, surface temperatures, and acoustic character-
istics of a large-scale twin turbofan engine, upper-surface blown
jet-flap configuration The tests were made for an angle of attack
range from -6 deg to 28 deg and a thrust coefficient range
from 0 to 4 for trailing edge flap deflections of 32 deg to
72 deg Results are presented   Author

N76-13069*# Rockwell International Corp, Los Angeles, Calif
Aircraft Div
**EFFECTS OF NACELLE SHAPE ON DRAG AND WEIGHT
OF A SUPERSONIC CRUISING AIRCRAFT**

Ellwood Bonner, Ronald Y Mairs and Ray M Tyson Oct 1975
109 p refs
(Contract NAS1-13906)
(NASA-CR-144893) Avail NTIS HC $5 50 CSCL 01C
    The quantitive relationship of cruise drag and nacelle shape
was investigated for a representative advanced supersonic
transport configuration Nacelle shape parameters were systemati-
cally varied, and the effects of these variations on wave and
friction drag were determined The effects of changes in vehicle
drag, propulsion weight, and specific fuel consumption on vehicle
takeoff gross weight were computed Generally, it was found
that nacelle shapes such that the maximum cross-sectional area
occurred at or near the nozzle exit resulted in the lowest wave
drag In fact, nacelle shapes were found that produce favorable
interference effects (drag reduction) of such magnitude as to
nearly offset the friction drag of the nacelle   Author

N76-13070*# Rockwell International Corp, Los Angeles, Calif
**DESIGN DEFINITION STUDY OF NASA/NAVY LIFT/CRUISE
FAN V/STOL AIRCRAFT VOLUME 1 SUMMARY REPORT
OF NAVY MULTIMISSION AIRCRAFT**
Robert L Cavage et al Jul 1975 76 p refs
(Contract NAS2-6564)
(NASA-CR-137695) Avail NTIS HC $5 00 CSCL 01C
    Results are presented of a study of lift-cruise fan V/STOL
aircraft for the 1980-1985 time period Technical and operating
characteristics and technology requirements for the ultimate
development of this type aircraft are identified Aircraft individually
optimized to perform the antisubmarine warfare, carrier onboard
delivery, combat search and rescue, and surveillance and surface
attack missions are considered along with a multi-purpose aircraft
concept capable of performing all five missions at minimum total
program cost It is shown that lighter and smaller aircraft could
be obtained by optimizing the design and fan selection for specific
missions   Author

N76-13071*# Rockwell International Corp, Los Angeles Calif
**DESIGN DEFINITION STUDY OF NASA/NAVY LIFT/CRUISE
FAN V/STOL AIRCRAFT VOLUME 2 SUMMARY REPORT
OF TECHNOLOGY AIRCRAFT**
Robert L Cavage et al Jun 1975 69 p refs
(Contract NAS2-6564)
(NASA-CR-137696) Avail NTIS HC $4 50 CSCL 01C
    For abstract, see N76-13070

N76-13072*# Douglas Aircraft Co, Inc, Long Beach Calif
**STOL AIRCRAFT TRANSIENT GROUND EFFECTS PART 1
FUNDAMENTAL ANALYTICAL STUDY**
M I Goldhammer, J P Crowder, and D N Smyth Nov 1975
60 p refs
(Contract NAS2-8653)
(NASA-CR-137766) Avail NTIS HC $4 50 CSCL 01C
    The first phases of a fundamental analytical study of STOL
ground effects were presented Ground effects were studied in
two dimensions to establish the importance of nonlinear effects,
to examine transient aspects of ascent and descent near the
ground and to study the modelling of the jet impingement on
the ground Powered lift system effects were treated using the
jet-flap analogy The status of a three-dimensional jet-wing ground
effect method was presented It was shown, for two-dimensional
unblown airfoils, that the transient effects are small and are
primarily due to airfoil/freestream/ground orientation rather than
to unsteady effects The three-dimensional study showed
phenomena similar to the two-dimensional results For unblown
wings, the wing/freestream/ground orientation effects were
shown to be of the same order of magnitude as for unblown
airfoils This may be used to study the nonplanar, nonlinear,
jet-wing ground effect   Author

N76-13073*# Douglas Aircraft Co, Inc, Long Beach, Calif
STOL AIRCRAFT TRANSIENT GROUND EFFECTS PART 2
EXPERIMENTAL TECHNIQUES FEASIBILITY STUDY
J P Crowder, M I Goldhammer, and D N Smyth Nov 1975
154 p refs
(Contract NAS2-8653)
(NASA-CR-137767) Avail NTIS HC $6 75 CSCL 01C
Procedures for simulating transient effects associated with
STOL aircraft landings and takeoffs were examined and a basis
was developed for selection of an experimental approach based
on consideration of simulation requirements, experimental
techniques, facilities, and costs The results are generally applicable
to STOL aircraft employing any of the following powered lift
systems externally blown flap upper surface blown flap,
augmentor wing or internally ducted jet flap Scaling re-
lationships were developed to apply the simulation requirements
to model test situations Procedures for the derivation of
aerodynamic forces from the measured data were discussed
Various means of expressing the aerodynamic data in forms
convenient for use in performance or stability and control
applications were described Five different experimental techniques
were presented that depend on two different types of experimental
facilities, wind tunnels and test tracks, and involving different
types of model motion, and factors pertinent to selection were
summarized   Author

N76-13075# Deutsche Forschungs- und Versuchsanstalt fuer
Luft- und Raumfahrt Brunswick (West Germany)   Abteilung
Flugzeugsteuerung und Regelung
ON THE PERFORMANCE CRITERIA FOR THE DYNAMIC
BEHAVIOR OF AIRCRAFT
Manfred Rodewald   Mar 1974   39 p   refs   In GERMAN,
ENGLISH summary
(DLR-FB-74-30) Avail NTIS HC $4 00, DFVLR, Porz West
Ger DM 12
To improve the correspondence between the performance
indices for flight control system synthesis and the (dynamic)
handling qualities criteria on the one hand and pilot opinion on
the other it is suggested that a generalized quadratic cost function
be determined by least squares fitting to pilot ratings It is shown
by an illustrative example taken from literature that this approach
can lead to a considerable improvement   Author (ESA)

N76-13076# Deutsche Forschungs- und Versuchsanstalt fuer
Luft- und Raumfahrt, Goettingen (West Germany)   Inst fuer
Stroemungsmechanik
DESIGN OF SUPERCRITICAL WING SECTIONS WITH THE
AID OF RHEOELECTRICAL ANALOGY
Helmut Sobieczky 26 May 1975 52 p refs In GERMAN
ENGLISH summary
(DLR-FB-75-43) Avail NTIS HC $4 50, DFVLR, Cologne
DM 23 70
The method of rheoelectrical analog flow is applied to the
re-design of a known shockfree lifting airfoil Results of the design
are compared with those of analysis Variations of the pressure
distribution due to local deformations of an airfoil were studied
                                                    Author (ESA)

N76-13078# Army Aeromedical Research Unit, Fort Rucker
Ala
THE USE OF OPAQUE LOUVRES AND SHIELDS TO
REDUCE REFLECTIONS WITHIN THE COCKPIT   A
MATHEMATICAL TREATMENT Final Report
Wun C Chiou and Frank F Holly Jun 1975 28 p
(AD-A012655, USAARL-75-22) Avail NTIS CSCL 01/3
Opaque shields can be used to channel light and thereby
reduce reflections in the cockpit These shielding devices range
from the standard glare shield on top of the instrument panel
to the more experimental use of Light Control Film and Micromesh
for this purpose Because of the need to determine the best
position width spacing etc of these shielding devices, it was
felt that a systematic approach would be highly desirable This
work shows a mathematical approach to this problem and includes
derivations, examples, and a suggested figure of merit   GRA

N76-13079# Army Aviation Systems Command, St Louis, Mo
MAJOR ITEM SPECIAL STUDY (MISS), UH-1H MAIN
DRIVESHAFT ASSEMBLY (FSN 1615-068-6635, PN
205-040-004-3) Technical Report, Jan - Jun 1974
Jul 1975 22 p refs
(AD-A013375 USAAVSCOM-TR-75-25) Avail NTIS CSCL
13/9
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)

N76-13081# Army Aviation Systems Command, St Louis Mo
MAJOR ITEM SPECIAL STUDY (MISS), UH-1H SWASH-
PLATE AND SUPPORT ASSEMBLY FSN 1615-060-1032 PN
204 Technical Report, Jan - Jun 1974
Jul 1975 22 p
(AD-A013376 USAAVSCOM-TR-75-26) 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)

N76-13082# Delaware Univ, Newark   Dept of Mechanical
and Aerospace Engineering
HINGELESS ROTOR SERVO-AEROELASTICITY Final
Report
Maurice I Young 24 Jul 1975 65 p refs
(Grant DA-ARO(D)-31-124-71-G112)
(AD-A013574, ARO-9549 10-E) Avail NTIS CSCL 01/3
Research on hingeless rotors is summarized Topics discussed
include the Coriolis coupled bending vibrations of hingeless
helicopter rotor blades, scale effects in the bending vibrations of
helicopter rotor blades the influence of pitch and twist on
blade vibrations, the dynamics of blade pitch control open and
closed loop stability of hingeless rotor helicopter air and ground
resonance stability and control of hingeless rotor helicopter ground
resonance and optimizing the cyclic control response of helicopter
rotors   M J S

N76-13084# Naval Air Development Center, Warminster Pa
Air Vehicle Technology Dept
LOW ANGLE-OF-ATTACK LONGITUDINAL AERODYNAMIC
PARAMETERS OF NAVY T-2 TRAINER AIRCRAFT EX-
TRACTED FROM FLIGHT DATA   A COMPARISON OF
IDENTIFICATION TECHNIQUES   VOLUME 1   DATA
ACQUISITION AND MODIFIED NEWTON-RAPHSON
ANALYSIS Final Report
A J Schuetz 23 Jun 1975 146 p refs
(AD-A013181, NADC-74181-30-Vol-1) Avail NTIS CSCL
01/3

A Navy T-2 jet trainer aircraft was instrumented to measure and record all motion variables. Motion time histories were recorded for a variety of carefully selected pilot inputs. A unique problem with the data was the high noise level in the measurement of the control input. Longitudinal motion data were analyzed with three digital computer parameter identification techniques. modified Newton-Raphson, Kalman filtering/smoothing and maximum likelihood. Reported in Volume I are data gathering and modified Newton-Raphson analysis. GRA

N76-13085# Army Aviation Systems Command, St Louis, Mo
MAJOR ITEM SPECIAL STUDY (MISS), UH-1H MAIN ROTOR DAMPER ASSEMBLY Interim Report, Jan 1964 - Jun. 1974
Apr 1975 21 p
(AD-A012229, USAAVSCOM-TR-75-2) 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 distribution 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. GRA

N76-13089*# Pratt and Whitney Aircraft, East Hartford, Conn
RESULTS OF ACOUSTIC TESTING OF THE JT8D-109 REFAN ENGINES
E A Burdsall, F P Brochu, and V M Scaramella Nov 1975 369 p refs
(Contract NAS3-17840)
(NASA-CR-134875 PWA-5298) Avail NTIS HC $10 50 CSCL 20A

A JT8D engine was modified to reduce jet noise levels by 6-8 PNdB at takeoff power without increasing fan generated noise levels. Designated the JT8D-109, the modified engines featured a larger single stage fan, and acoustic treatment in the fan discharge ducts. Noise levels were measured on an outdoor test facility for eight engine/acoustic treatment configurations. Compared to the baseline JT8D, the fully treated JT8D-109 showed reductions of 6 PNdB at takeoff, and 11 PNdB at a typical approach power setting. Author

N76-13091# Hamilton Standard Div, United Aircraft Corp, Windsor Locks Conn
A COMPREHENSIVE REVIEW OF HELICOPTER NOISE LITERATURE Final Report
B Magliozzi, F B Metzger, W Bausch, and R J King Jun 1975 193 p refs
(Contract DOT-FA74WA-3477)
(AD-A014640/7 FAA-RD-75-79) Avail NTIS HC $7 00 CSCL 01/3

The state-of-the-art in helicopter noise is reviewed. A bibliography is included of reports on all components of helicopter noise including main rotor, tail rotor engine, and gearbox. Literature on helicopter noise reduction and subjective evaluation of helicopter noise are also included. Capsule summaries of important reports are given which describe the purpose of the report summarize the important results, compare the report with others on the same subject and provide a critical evaluation of the work presented. It is concluded that the available prediction methodology provides a means for estimating helicopter noise sources on a gross basis. However the mechanisms of noise generation are still not fully understood although the experimental and theoretical tools are now available to conduct the definitive experiments and establish the mathematical models needed for accurate definition of helicopter noise generation mechanisms.

Spectrum analyses of helicopter noise show that main rotor, tail rotor, and engine sources contribute significantly to annoyance. In cases where these sources have been heavily suppressed, gearbox noise will also appear as a significant contributor to annoyance. Therefore quieter helicopters must include suppression of all of these components. For certification the literature indicates that a new noise unit is required. This unit may use the effective perceived noise level concepts but should include corrections for impulsive noise correctly address the influence of tones throughout the frequency spectrum extend the spectrum of interest to very low frequencies, and correctly address the annoyance of noise components below 500 Hz. Author

N76-13093# Boeing Commercial Airplane Co, Seattle, Wash
AIRCRAFT NOISE DEFINITION INDIVIDUAL AIRCRAFT TECHNICAL DATA-MODEL 737 Final Contractor Report
B G Williams and R Yates Dec 1973 119 p refs
(Contract DOT-FA73WA-3254)
(AD-A014964/1 FAA-EQ-73-7-4, D6-42141-3) Avail NTIS HC $5 75 CSCL 01/2

Technical data are presented for graphically determining takeoff, cutback and approach performance and noise under the flightpath for various Boeing Model 737 aircraft currently in operation. Data are included for all certified flap positions and cover operations from airports from sea level to 6000 ft altitude at temperatures from 30 to 100 F with winds from -10 to +30 kn over the entire operational weight range. Noise data are shown for units of effective perceived noise and peak overall A weighted sound level from takeoff to low approach thrust and for aircraft altitudes between 200 and 12,000 ft. Author

N76-13094# Boeing Commercial Airplane Co Seattle, Wash
AIRCRAFT NOISE DEFINITION INDIVIDUAL AIRCRAFT TECHNICAL DATA MODEL 707 Final Report
B G Williams and R Yates Dec 1973 78 p refs
(Contract DOT-FA73WA-3254)
(AD-A014642/3, D6-42141-1 FAA-EQ-73-7-2) Avail NTIS HC $4 75 CSCL 01/3

Technical data are presented for graphically determining takeoff, cutback, and approach performance and noise under the flightpath for various Boeing Model 707 aircraft currently in operation. Data are included for all certified flap positions and cover operations from airports from sea level to 6000 ft altitude at temperatures from 30 to 100 F with winds from -10 to +30 kn over the entire operational weight range. Noise data are shown for units of EPNdB and dB(A) from takeoff to low approach thrust and for aircraft altitudes between 200 and 12,000 ft. Author

N76-13099*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
RESEARCH NEEDS IN AIRCRAFT NOISE PREDICTION
John P Raney Nov 1975 38 p refs Presented at 3d Interagency Symp on Univ Res in Transportation Noise
(NASA-TM-X-72787) Avail NTIS HC $4 00 CSCL 20A

Progress needed in understanding the mechanisms of aircraft noise generation and propagation is outlined using the focus provided by the need to predict accurately the noise produced and received at the ground by an aircraft operating in the vicinity of an airport. The components of internal engine noise generation jet exhaust airframe noise and shielding and configuration effects and the roles of atmospheric propagation and ground noise attenuation are presented and related to the prediction problem. The role of NASA in providing the focus and direction for needed advances is discussed, and possible contributions of the academic community in helping to fulfill the needs for accurate aircraft noise prediction methods are suggested. Author

N76-13100*# Pratt and Whitney Aircraft, East Hartford Conn
ADVANCED SUPERSONIC PROPULSION STUDY, PHASE 2 Final Report, Jan 1974 - Jun 1975
R A Howlett Sep 1975 198 p refs
(Contract NAS3-16948)
(NASA-CR-134904 PWA-5312) Avail NTIS HC $7 50 CSCL 21A

A continuation of the NASA/P and WA study to evaluate various types of propulsion systems for advanced commercial supersonic transports has resulted in the identification of two very promising engine concepts They are the Variable Stream Control Engine which provides independent temperature and velocity control for two coannular exhaust streams and a derivative of this engine, a Variable Cycle Engine that employs a rear flow-inverter valve to vary the bypass ratio of the cycle Both concepts are based on advanced engine technology and have the potential for significant improvements in jet noise, exhaust emissions and economic characteristics relative to current technology supersonic engines Extensive research and technology programs are required in several critical areas that are unique to these supersonic Variable Cycle Engines to realize these potential improvements Parametric cycle and integration studies of conventional and Variable Cycle Engines are reviewed, features of the two most promising engine concepts are described and critical technology requirements and required programs are summarized   Author

N76-13101*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
PRELIMINARY EVALUATION OF A HEAT PIPE HEAT EXCHANGER ON A REGENERATIVE TURBOFAN
Gerald A Kraft Dec 1975 23 p refs
(NASA-TM-X-71853, E-8591) Avail NTIS HC $3 50 CSCL 21E
   A preliminary evaluation was made of a regenerative turbofan engine using a heat pipe heat exchanger The heat exchanger had an effectiveness of 0 70, a pressure drop of 3 percent on each side, and used sodium for the working fluid in the stainless steel heat pipes The engine was compared to a reference turbofan engine originally designed for service in 1979 Both engines had a bypass ratio of 4 5 and a fan pressure ratio of 2 0 The design thrust of the engines was in the 4000 N range at a cruise condition of Mach 0 98 and 11 6 km It is shown that heat pipe heat exchangers of this type cause a large weight and size problem for the engine The penalties were too severe to be overcome by the small uninstalled fuel consumption advantage The type of heat exchanger should only be considered for small airflow engines in flight applications Ground applications might prove more suitable and flexible   Author

N76-13102*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
THE EXPERIMENTAL CLEAN COMBUSTOR PROGRAM DESCRIPTION AND STATUS TO NOVEMBER 1975
Richard W Niedzwiecki Dec 1975 129 p refs Submitted for publication
(NASA-TM-X-71849, E-8581) Avail NTIS HC $6 00 CSCL 21E
   The generation of technology was studied for the development of advanced commercial CTOL aircraft engines with lower exhaust emissions than current aircraft The program is in three phases Phase 1, already completed, consisted of screening tests of low pollution combustor concepts Phase 2, currently in progress, consists of test rig refinement of the most promising combustor concepts Phase 2 test results are reported Phase 3, also currently in progress, consists of incorporating and evaluating the best combustors as part of a complete engine Engine test plans and pollution sampling techniques are described in this report Program pollution goals, specified at engine idle and take-off conditions are idle emission index value of 20 and 4 for carbon monoxide (CO) and total unburned hydrocarbons (THC), respectively, and at take-off are an oxides of nitrogen (NOx) emission index level of 10 and a smoke number of 15 Pollution data were obtained at all engine operating conditions Results are presented in terms of emission index and also in terms of the Environmental Protection Agency's 1979 Standards Parameter   Author

N76-13103*# Naval Air Propulsion Test Center, Trenton, N J
ROTOR BUST PROTECTION PROGRAM STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN US COMMERCIAL AVIATION DURING 1974
Final Report, 1973 - 1974
R A DeLucia and G J Mangano Sep 1975 28 p
(NASA Order C-41581-B)
(NASA-CR-134855, NAPTC-PE-67) Avail NTIS HC $4 00 CSCL 21E
   Statistics based on data compiled from the Flight Standards Service Difficulty Reports were studied to develop criteria for designing devices to protect passengers and aircraft structures from fragments generated by gas turbine engine rotor bursts It is concluded that disk and fan blade fragments continue to be a major threat to the welfare and safety of commercial aircraft passengers, and that causes beyond the control or scope of present technology, such as FOD, structural life and integrity prediction are primarily responsible for the rotor failures   F O S

N76-13105# Avco Lycoming Div, Stratford Conn
T53-L-703 MILITARY QUALIFICATION TEST PROGRAM
Final Status Report, Sep 1974 - 31 May 1975
Jun 1975 16 p refs
(Contract DAAJ01-73-C-0390)
(AD-A012657 LYC-74-17 3) Avail NTIS CSCL 21/5
   New engine models require testing to evaluate design concept to endurance and flight test hardware so as to insure satisfactory mission effectiveness and to demonstrate adequacy for release to production The report describes the results of these tests on two modified turboshaft engines   GRA

N76-13106# Wyle Labs Inc, El Segundo Calif Wyle Labs
NATIONAL MEASURE OF AIRCRAFT NOISE IMPACT THROUGH THE YEAR 2000 Final Report, Apr 1974 - Apr 1975
Carroll Bartel, Larry Godby and Louis Sutherland Apr 1975 107 p refs
(Contract EPA-68-01-2449)
(PB-243522/0 WCR-74-13) Avail NTIS HC $5 50 CSCL 13B
   Operations at three airports-Los Angeles International, St Louis and Washington Dulles were examined Primary noise reduction alternatives were applied at each of the facilities for the 1987 and 2000 time periods Secondary abatement alternatives were evaluated for 1987 only The effectiveness of the various alternatives was measured in terms of the total area impacted under the NEF 30 and 40 coontours at the three airports This area was then increased by a constant factor to obtain an estimate of the impact at the national level   GRA

N76-13108# Rocketdyne Canoga Park Calif
EMERGENCY POWER SUPPLY Final Technical Report, 25 Feb 1974 - 15 Jan 1975
R Spies Feb 1975 205 p refs
(Contract F33615-74-C-2020 AF Proj 3145)
(AD-A013168, R-9660, AFAPL-TR-75-9) Avail NTIS CSCL 01/3
   The objective of this program was to study advanced technology for aircraft emergency power systems for near-term (1975-1980) and far-term (post 1980) aircraft for the Air Force and Navy With information supplied by aircraft prime contractor, the requirements were defined and typical solutions investigated It was concluded that Emergency Power should be integrated with other auxiliary power functions e g starting and standby power, and that an integrated unit using onboard fuels is possible A typical design was produced The report is issued with a Supplement which contains proprietary data supplied for this program   GRA

N76-13109 Stanford Univ Calif
AUTOPILOT LOGIC FOR THE FLARE MANEUVER OF STOL AIRCRAFT Ph D Thesis
Thomas Lynn Trankle 1975 110 p
Avail Univ Microfilms Order No 75-25621

Multiple control feedback logic using both altitude and range-to-touchdown information is not implemented by current flare autopilots Such control logic may be useful to STOL (short takeoff and landing) aircraft which must have a small longitudinal touchdown dispersion and which have several longitudinal controls A systematic technique, using state variable optimal control methods for the design of a practical flare autopilot incorporating these features is developed and used to design automatic flare logic for the NASA Augmentor Wing Jet STOL Research Aircraft (AWJSRA) The relative merits of several simple nominal altitude functions during the transition are examined, including the common exponential form, as well as parabolic and highly damped sinusoidal forms Two methods of optimal control logic design are used to develop control laws to track the exponential altitude profile   Dissert Abstr

N76-13111# Systems Technology Inc Hawthorne Calif
IDENTIFICATION OF MINIMUM ACCEPTABLE CHARACTERISTICS FOR MANUAL STOL FLIGHT PATH CONTROL VOLUME 2 STOL AIRCRAFT CHARACTERISTICS AND GENERIC MODEL Final Report
Samuel J Craig Wayne F Jewell, and Robert L Stapleford Jul 1975 102 p refs
(Contract DOT-FA73WA-3276)
(AD-A013588/9 TR-1035-3R-Vol-2, FAA-RD-75-123-Vol-2) Avail NTIS HC $5 25 CSCL 01/3

The fundamental aspects of manual flight path control are reviewed as they relate to existing STOL aircraft concepts The interrelationship between performance capability, represented for example by the glide slope polar and path dynamic stability and control are identified Several examples of path control problems are illustrated to substantiate the analytical discussion A review of contemporary STOL propulsive lift concepts is given and the design features including augmentation aspects affecting manual path control are examined briefly A mathematical model is defined which is suitable for simulation of flight path properties of the various STOL concepts   Author

N76-13112*# North American Rockwell Corp Los Angeles, Calif
DYNAMIC STABILITY TEST RESULTS ON AN 0 024 SCALE B-1 AIR VEHICLE
R R Beeman 17 Mar 1972 147 p refs Sponsored in part by NASA
(Contract F33657-70-C-0800)
(NASA-CR-145903, NA-72-82) Avail NTIS HC $6 00 CSCL 01C

Dynamic longitudinal and lateral-directional stability characteristics of the B-1 air vehicle were investigated in three wind tunnels at the Langley Research Center The main rotary derivatives were obtained for an angle of attack range of -3 degrees to +16 degrees for a Mach number range of 0 2 to 2 16 Damping in roll data could not be obtained at the supersonic Mach numbers The Langley 7 x 10 foot high speed tunnel, the 8 foot transonic pressure tunnel, and the 4 foot Unitary Plan wind tunnel were the test sites An 0 024 scale light-weight model was used on a forced oscillation type balance Test Reynolds number varied from 474 000/ft to 1 550 000/ft through the Mach number range tested The results showed that the dynamic stability characteristics of the model in pitch and roll were generally satisfactory up to an angle attack of about +6 degrees In the wing sweep range from 15 to 25 degrees the positive damping levels in roll deteriorated rapidly above +2 degrees angle of attack This reduction in roll damping is believed to be due to the onset of separation over the wing as stall is approached   Author

N76-13113*# Massachusetts Inst of Tech Cambridge Decision and Control Sciences Group
CONTROL OPTIMIZATION, STABILIZATION AND COMPUT-

ER ALGORITHMS FOR AIRCRAFT APPLICATIONS Status Report, 1 Jun - 1 Dec 1975
2 Dec 1975 25 p refs
(Grant NGL-22-009-124 MIT Proj OSP-76265)
(NASA-CR-145862 Rept-18, ESL-SR-634) Avail NTIS HC $3 50 CSCL 01C

Research related to reliable aircraft design is summarized Topics discussed include systems reliability optimization, failure detection algorithms, analysis of nonlinear filters, design of compensators incorporating time delays, digital compensator design, estimation for systems with echoes, low-order compensator design descent-phase controller for 4-D navigation, infinite dimensional mathematical programming problems and optimal control problems with constraints, robust compensator design numerical methods for the Lyapunov equations, and perturbation methods in linear filtering and control   M J S

N76-13114# United Technologies Corp, Stratford, Conn Sikorsky Aircraft Div
FLIGHT TESTING OF A FAN-IN-FIN ANTITORQUE AND DIRECTIONAL CONTROL SYSTEM AND A COLLECTIVE FORCE AUGMENTATION SYSTEM (CFAS) Final Report, Apr. 1972 - May 1974
Wilfried H Meier, William P Groth, David R Clark and David Verzella Jun 1975 204 p refs
(Contract DAAJ02-72-C-0050, DA Proj 1F1-63204-D-157)
(AD-A013407, SER-67015, USAAMRDL-TR-75-19) Avail NTIS CSCL 01/3

A research flight test program was conducted to determine the characteristics of the fan-in-fin antitorque and directional control concept compared with a conventional tail rotor in the areas of stability, control, power requirements, aerodynamics, and overall aircraft performance For the program, the tail rotor of Sikorsky's S-67 Blackhawk helicopter was replaced by a ducted fan, mounted in a new vertical tail The modified aircraft was flight tested under a test plan that provided direct comparison with the baseline aircraft The fan-in-fin demonstrated that its advantages in compactness and increased safety in ground operation can be realized without significant performance penalty or unpredictable impact on handling qualities Although some shortcomings were experienced, test results confirmed that the fan-in-fin is an acceptable alternate to the tail rotor in applications where the reduction in operational hazards provided by the fan is essential A collective force augmentation system (CFAS) was also evaluated on the S-67 helicopter The purpose of CFAS is to keep main rotor loads within acceptable limits during high-speed maneuvering flight by introducing a force-feel cue to the pilot's collective control stick Flight tests proved the CFAS capable of providing the pilot with the proper force cues to maneuver the helicopter to the boundary of the main rotor load limit   GRA

N76-13115# Army Electronics Command, Fort Monmouth, N J
PRELIMINARY GUIDE FOR THE ASSESSMENT OF FLY-BY-WIRE HIGH RELIABILITIES
Charles A Pleckaitis and David C Kandra Jul 1975 198 p refs
(DA Proj 1X1-63203-D-156)
(AD-A013366, ECOM-4337) Avail NTIS CSCL 17/7

The problem of demonstrating and verifying the flight safety reliability of a helicopter Fly-By-Wire (FBW) system through laboratory and/or flight tests is investigated The objective is to provide preliminary recommendations as to the method of demonstrating the flight safety reliability Acceptance test methods based upon classical parametric statistics, classical nonparametric statistics, and Bayesian statistics are investigated The following topics are discussed component reliability predictions, nonparametric examples, confidence, parametric and nonparametric sequential tests, parametric examples, exponential and normal distributions, failure terminated and time terminated tests, Bayes Theorem, Bayesian discrete reliability example, and various prior reliability distributions   Author (GRA)

N76-13127# Naval Postgraduate School Monterey Calif
A REMOTELY CONTROLLED WIND TUNNEL MODEL FOR

THE DEMONSTRATION OF AIRCRAFT STABILITY AND CONTROL CHARACTERISTICS M S Thesis

John Christian Merrill Jun 1975 88 p refs
(AD-A013467) Avail NTIS CSCL 01/1

A remotely controlled wind tunnel model with degrees of freedom in roll pitch, and yaw was designed and constructed to demonstrate some of the major dynamic stability and control characteristics of a full scale aircraft The longitudinal characteristics of the model were examined and it was found that the response to a step function input deflection of the horizontal tail could be predicted accurately   GRA

N76-13225# General Motors Corp Indianapolis Ind   Detroit Diesel Allison Div

BERYLLIUM METAL MATRIX COMPOSITE COMPRESSOR BLADE PROGRAM Final Report, 15 Jan 1971 - 15 Oct 1972

Robert W Stusrud, Marvin Herman, and George R Sippel Dec 1972 72 p refs
(Contract N00019-71-C-0242)
(AD-A013007, DDA-EDR-7704) Avail NTIS CSCL 11/4

The objective of this program was to develop beryllium reinforced titanium matrix composite blading for gas turbine fans and compressors Ten TF-41 LP3 composite compressor blade airfoil forgings were produced by isothermal forging of coextruded Be rod Ti (6AI-4V) preforms Monolithic Ti 6AI-4V root blocks were diffusion bonded to six of the composite airfoils by hot isostatic pressing Two blades were completely machined on production type tooling to dimensionally acceptable configuration Resonant bending and torsional frequencies of the composite blades were increased up to 32% over production Ti 6AI-4V monolithic blades with blade weight savings up to 20% Ballistic impact behavior of coextruded Be rod - Ti (6AI-4V) composites with other titanium matrix composites was determined   GRA

N76-13300# Army Natick Labs, Mass   Clothing Equipment and Materials Engineering Lab

DEVELOPMENT COMPOUNDING AND EVALUATION OF PHOSPHAZENE RUBBER FOR HELICOPTER SEAL APPLICATIONS Technical Report, 28 Feb 1972 - 31 Aug 1973

Angus Wilson Oct 1974 42 p refs
(AD-A013373, CE/MEL-136 USA-NLABS-TR-75-38-CE) Avail NTIS CSCL 11/1

A polyphosphazene copolymer, (NP (OCH2CF3)2 - NP (OCH2C3F6CF2H)2) sub x was compounded with a variety of black and non-black reinforcing fillers, curing agents and other rubber additives Optimum properties were obtained using silicas silane treated clays, or combinations of these, in conjunction with peroxide curing agents Tensile strengths of 116 Kg/cm (1650 psi) were achieved and lip seals were molded and gave evidence of potential use The cured rubber was flexible to -54C and showed good resistance to temperatures up to 150C
                                                        Author (GRA)

N76-13314# Naval Postgraduate School, Monterey Calif

FY 1974 NPS INDEPENDENT DEVELOPMENT PROGRAM Summary Report, 1 Jul 1974 - 30 Jun 1975

Robert R Fossum Jul 1975 31 p refs
(AD-A013562 NPS-02375071) Avail NTIS CSCL 05/1

Thirteen summaries of exploratory development work carried out under a grant to the Naval Postgraduate School Research Foundation are included This research was carried out in the areas of electrical engineering (slot lines, phase lock loops), aeronautics (aircraft survivability, composite materials for structures), material sciences (relation between high temperature compressive behavior and microstructure) mechanical engineering (fatigue life of ferrocement hull structures, flow fields), economics (hazardous employment incentives for DoD personnel), operations research (missile allocation modeling combat dynamics, shipboard tank designs) oceanography breakwater construction effects on ecology) and physics (evaluation of an underwater acoustic parametric source)   GRA

N76-13315# Stevens Inst of Tech Hoboken N J

PROPELLER-DUCT INTERACTION DUE TO LOADING AND THICKNESS EFFECTS Final Report

S Tsakonas, W R Jacobs, and M R Ali Apr 1975 117 p refs

(Contract N00014-67-A-0202-0037)
(AD-A013281 SIT-DL-75-1722) Avail NTIS CSCL 13/10

This study is a continuation of an earlier investigation dealing with the interaction of a propeller and its enshrouding nozzle when both are operating in a nonuniform inflow field The present investigation complements the previous one by introducing thickness of both lifting surfaces and camber of the duct Thus a complete analysis is available which takes into account the true geometry of the propeller and duct including the propeller and duct thickness and duct camber distributions along with the camber and flow angle of the propeller and the conicity angle of the duct A computer program adaptable to a high-speed digital computer has been developed which evaluates the steady and time-dependent pressure (loading) distributions on both lifting surfaces and the resulting hydrodynamic forces and moments generated by the propulsive device Provision has also been made in the analysis and program to deal with a nonaxisymmetric nozzle and a tilted nozzle   GRA

N76-13882*# Bolt, Beranek and Newman Inc Canoga Park, Calif

A STUDY OF NOISE SOURCE LOCATION ON A MODEL SCALE AUGMENTOR WING USING CORRELATION TECHNIQUES

John F Wilby and Terry D Scharton 10 Nov 1975 67 p refs
(Contract NAS2-8382)
(NASA-CR-137784 BBN-2955) Avail NTIS HC $4 50 CSCL 20A

An experimental investigation, conducted on a model-scale augmentor wing to identify the sources of far-field noise, is examined The measurement procedure followed in the investigation involved the cross-correlation of far field sound pressures with fluctuating pressures on the surface of the augmentor flap and shroud In addition pressures on the surfaces of the augmentor were cross-correlated The results are interpreted as showing that the surface pressure fluctuations are mainly aerodynamic in character and are convected in the downstream direction with a velocity which is dependent on the jet exhaust velocity However the far field sound levels in the mid and high frequency ranges are dominated by jet noise There is an indication that in the low frequency range trailing edge noise associated with interaction of the jet flow and the flap trailing edge, plays a significant role in the radiated sound field   Author

N76-13883*# Graham Associates, Shaw Island, Wash

THEORETICAL STUDY OF REFRACTION EFFECTS ON NOISE PRODUCED BY TURBULENT JETS Final Report

E W Graham and B B Graham Washington NASA Dec 1975 92 p refs
(Contract NAS1-12834)
(NASA-CR-2632) Avail NTIS HC $5 00 CSCL 20A

The transmission of acoustic disturbances from the interior of a jet into the ambient air is studied The jet is assumed infinitely long with mean velocity profile independent of streamwise location The noise generator is a sequence of transient sources drifting with the local fluid and confined to a short length of the jet In Part 1, supersonic jets are considered Numerical results for mean-square pressure versus angle in the far-field show unexpected peaks which are very sharp Analysis of simplified models indicates that these are complex quasi-resonant effects which appear to the stationary observer in a high frequency range The peaks are real for the idealized model, but would be smoothed by mathematical integration over source position, velocity, and frequency Subsonic jets were considered in part 2 and a preliminary study of the near-field was attempted Mean-square radial displacements (or mean radial energy flow or space-time correlations of radial pressure gradient) are first found for very simple cases The most difficult case studied is a sequence of transient sources at the center of a uniform-velocity circular cylindrical jet Here a numerical triple integration is required and seems feasible although only preliminary results for mean square radial displacement are now available These preliminary results show disturbances decreasing with increasing radial distance, and with increasing distance upstream and downstream from the source A trend towards greater downstream disturbances appears even in the near field   Author

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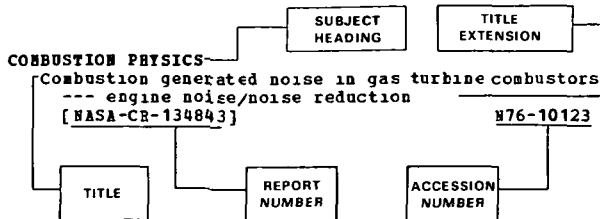
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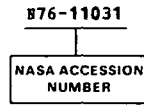   A76-14609
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