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Supplement 74

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 74

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

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

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

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 295 reports, journal articles, and other documents originally announced in August 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.

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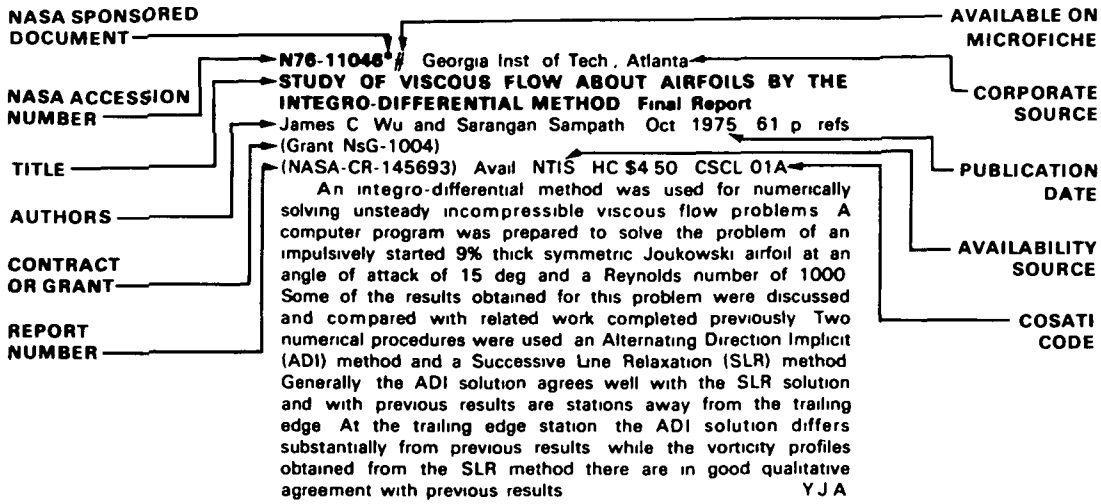

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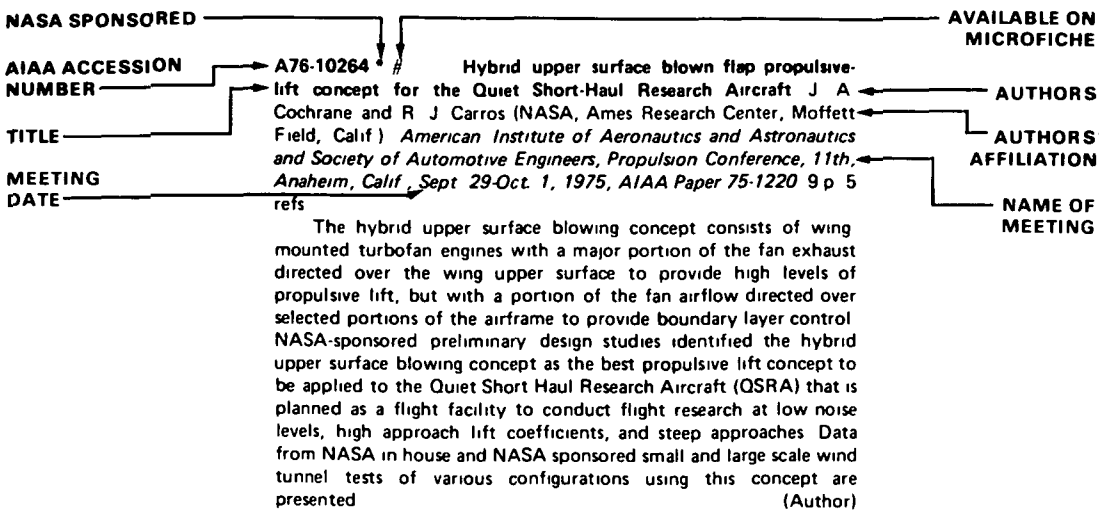

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 74)

SEPTEMBER 1976

IAA ENTRIES

A76-31953 **Fracture in thin sections** J A Alic (Wichita State University, Wichita, Kan) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-452* 23 p 54 refs Research supported by the Wichita State University Research Committee

The mechanics of fracture of thin sections of the type encountered in aircraft structures is currently less well understood than the fracture mechanics of thick sections Specialized methods of thin section fracture analysis are reviewed and critically discussed, with particular reference to crack growth resistance curves (R-curves) The dangers of assuming linear elastic behavior in thin section problems of various type are noted It is shown that a one-parameter fracture criterion is poorly suited for use in thin section problems The need for improved procedures is indicated V P

A76-31954 * **Progress report on propeller aircraft flyover noise research** F B Metzger, B Magliozzi (United Aircraft Corp , Hamilton Standard Div , Windsor Locks, Conn), and R J Pegg (NASA, Langley Research Center, Hampton, Va) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-454* 15 p 11 refs

Initial results of a program to investigate the sources of noise in unshrouded propellers under forward flight conditions are reported Tests were conducted using a three blade full scale instrumented propeller mounted on a twin-engine aircraft Measurements included (1) far field noise at fixed ground stations and at two aircraft wing tip locations, (2) blade surface pressures at seven locations on one of the propeller blades, (3) atmospheric turbulence encountered by the aircraft in flight, and (4) aircraft operating conditions The results confirm that significantly lower levels of propeller noise are produced in forward flight than at static conditions It is tentatively concluded that propeller noise generation in flight may be dominated by steady loading at blade passage frequency, but at higher frequencies unsteady loading due to interaction with natural atmospheric turbulence may be the dominant mechanism of noise generation Under static conditions the total noise signature appears to be the result of interaction of the propeller with persistent turbulent eddies passing through the propeller disk (Author)

A76-31955 **Noise level measurements on a quiet short haul turboprop transport** F Cicci and A F Toplis (de Havilland Aircraft of Canada, Ltd , Downview, Ontario, Canada) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-455* 10 p

The tests used to develop the propulsion system incorporated in the de Havilland Dash 7 STOL four engine turboprop aircraft are summarized The selected propeller is four-bladed and has elliptical tips NACA series 64A airfoils are used inboard, NACA series 16 airfoils are used at the tip The experimental procedures used to obtain initial aircraft noise measurements are described The aircraft has achieved the target noise level of 95 PNdB C K D

A76-31956 **Noise control - Blueprint for better community relations** G Gilbert (Business and Commercial Aviation, White Plains, N Y) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-456* 8 p 10 refs

The extent to which business aircraft meet the noise limitations imposed by Federal Aviation Regulations (FAR) Part 36 is discussed At present, 80% of the 25 models of business jets in use in the US meet noise specifications, either by incorporation of advanced noise reduction features or by use of hush kits and/or operational techniques such as the low-drag approch and noise abatement climb profiles Of a random selection of propeller-driven aircraft including turboprops under 12,500 lbs maximum takeoff weight, 67% fell within noise limits that will apply in 1980 Attention is being directed toward reducing noise from the fan tips and engine inlet in designing fanjet engines for business aircraft A new-generation business jet fan engine under development by Rolls Royce to meet 5000 6000 lb thrust requirements is expected to fall within FAR Part 36 noise limits with a margin of more than 10 EPNdB as the result of an advanced-technology core and a high bypass ratio C K D

A76-31957 * **NASA general aviation research overview - 1976** R L Winblade and J A Westfall (NASA, Washington, D C) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-458* 77 p

Recent accomplishments in the field of general aviation are reviewed which resulted from NASA's steadily improving communi cation with the industry and user community, both on a formal level and through more direct involvement in the research activities Several NASA programs are examined whose aim is to provide new technologies across the board for improvements in safety, efficiency, and reduction of the impact of general aviation on the environment The use of the results of some NASA programs in designing new aircraft is demonstrated A list of technical reports generated by the NASA program is given in an appendix V P

A76-31958 * **NASA study of an automated Pilot Advisory System** L C Parker (NASA, Wallops Flight Center, Wallops Island, Va) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-460* 8 p 7 refs

A Pilot Advisory System (PAS) concept for high-density uncontrolled airports is discussed where the general aviation pilots will be provided with automatic audio voice airport and air traffic advisories within two minute intervals and with mid-air collision warnings whenever such situations arise Free of manual inputs, the PAS includes the options of fixed-base operator runway select, automatic restart and self-test, and remote inquiry of system status and messages V P

A76-31960 **A data acquisition system for in-flight airfoil evaluation** G M Gregorek, M J Hoffmann, and S Weislogel (Ohio State University, Columbus, Ohio) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6 9, 1976, Paper 760-462* 19 p

Details of the design and development of an airborne data acquisition system for in-flight evaluation of airfoils are presented The system was designed to be flown aboard a single engine general aviation aircraft and to measure and record airfoil surface pressures, airfoil wake pressures, and aircraft angle of attack and airspeed

Included are descriptions of the instrumentation, calibration and data reduction techniques, illustrations of the raw data and comments on the operational experience gained during the flight evaluation of the GA(W)-2 airfoil (Author)

A76-31961 * Business jet approach noise abatement techniques - Flight test results T W Putnam and F W Burcham (NASA, Flight Research Center, Edwards, Calif) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-463* 16 p 5 refs

Operational techniques for reducing approach noise from business jet aircraft were evaluated in flight by measuring the noise generated by five such aircraft during modified approaches Approaches with 4-deg glide slopes were approximately 4 0 EPNdB quieter than approaches with standard 3-deg glide slopes Noise reductions for low-drag 3-deg approaches varied widely among the airplanes tested, the fleet-weighted reduction was 8 5 EPNdB Two-segment approaches resulted in noise reductions of 7 0 EPNdB to 8 5 EPNdB 3 nautical miles and 5 nautical miles from touchdown Pilot workload increased progressively for the 4-deg, low-drag 3-deg, and two-segment approach (Author)

A76-31962 * The impact of interior cabin noise on passenger acceptance A N Rudrapatna and I D Jacobson (Virginia, University, Charlottesville, Va) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-466* 10 p 12 refs Grant No NsG-1180

Based on flight test data gathered in general aviation aircraft, a composite motion-noise passenger comfort model has been developed which enables the assessment of cabin interior noise impact on passenger acceptance Relationships between special subject responses and passenger responses are given, as well as the effect of comfort on passenger acceptance The importance of comfort and noise on the overall passenger reaction is discussed (Author)

A76-31963 Design, development and flight test of the Cessna Citation thrust reverser A C Allen and R J Wickline (Rohr Industries, Inc , Chula Vista, Calif) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-468* 12 p

Design, development and testing thrust reversers for a business jet airplane are described from program conception through Federal Aviation Administration (FAA) Certification Mechanical design, reverser operation, failsafe features, actuation systems and aircraft integration are covered Model tests, developmental taxi tests, static ground tests and flight tests required for configuration development and FAA type certification are discussed (Author)

A76-31964 * New potentials for conventional aircraft when powered by hydrogen-enriched gasoline W A Menard, P I Moynihan, and J H Rupe (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-469* 15 p 11 refs Contract No NAS7-100

Hydrogen enrichment for aircraft piston engines is under study in a new NASA program The objective of the program is to determine the feasibility of inflight injection of hydrogen in general aviation aircraft engines to reduce fuel consumption and to lower emission levels A catalytic hydrogen generator will be incorporated as part of the air induction system of a Lycoming turbocharged engine and will generate hydrogen by breaking down small amounts of the aviation gasoline used in the normal propulsion system This hydrogen will then be mixed with gasoline and compressed air from the turbocharger before entering the engine combustion chamber The special properties of the hydrogen-enriched gasoline allow the engine to operate at ultralean fuel/air ratios, resulting in higher efficiencies and hence less fuel consumption This paper summarizes the results of a systems analysis study Calculations assuming a Beech Duke aircraft indicate that fuel savings on the order of 20% are possible An estimate of the potential for the utilization of hydrogen enrichment to control exhaust emissions indicates that it may be possible to meet the 1979 Federal emission standards (Author)

A76-31965 A ducted propulsor demonstrator D G M Davis (Dowty Rotol, Ltd , Gloucester, England) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-470* 8 p

A ducted propulsor unit based on a conventional 285 hp aircraft reciprocating engine has been designed and fabricated The seven bladed propulsor bolts on to the standard engine driving flange in the same manner as a propeller The propulsor is presently nonreversing but has a full feathering capability, adequate pitch range is available should reversing be required The mounting of the engine and cowling are described Testing of the completed unit was initiated in April 1976, to evaluate the cooling system, calibrate the powerplant thrust power rpm characteristics and powerplant noise characteristics, and determine performance characteristics at varying forward speeds The unit is expected to have diameter, weight, and cost advantages over propellers producing equivalent noise levels and better take-off thrust than propellers C K D

A76-31966 Laminar flow rethink - Using composite structure H E Payne (Bellanca Aircraft Engineering, Inc , Scott Depot, W Va) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-473* 12 p 9 refs

The use of composite structure in the design of the Skyrocket II, a general aviation aircraft capable of operating in the laminar flow 'drag bucket' on a normal service, is discussed The aircraft design utilizes a very stiff epoxy/fiberglass composite air-passage skin consisting of relatively few parts to eliminate air load stress ripples A zero-lift drag coefficient in the area of 0 15 has been obtained by design engineering specifically for low drag, maximizing the extent of laminar flow by use of the stiff composite skin, and minimizing protuberances into the air passage C K D

A76-31967 Minimum time flight profile optimization for piston-engine-powered airplanes H C Smith (Pennsylvania State University, University Park, Pa) and D E Creeden *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-474* 9 p 12 refs

A method is developed for determining the optimum cruising altitude to give minimum overall flight time for a given mission Variation in aircraft performance, atmospheric properties, and winds with altitude are taken into consideration The solution is performed by digital computer with remote typewriter terminals for input and output The input is data readily available from the aircraft flight handbook and standard weather service reports Results show a significant saving in flight time by use of this method over that of cruising at an arbitrary altitude This result is particularly true in the case of supercharged airplanes operating over stage lengths of about 100 statute miles (Author)

A76-31968 * General aviation design synthesis utilizing interactive computer graphics T L Galloway (NASA, Ames Research Center, Moffett Fields, Calif) and M R Smith (Michigan, University, Ann Arbor, Mich) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-476* 8 p 5 refs

Interactive computer graphics is a fast growing area of computer application, due to such factors as substantial cost reductions in hardware, general availability of software, and expanded data communication networks In addition to allowing faster and more meaningful input/output, computer graphics permits the use of data in graphic form to carry out parametric studies for configuration selection and for assessing the impact of advanced technologies on general aviation designs The incorporation of interactive computer graphics into a NASA developed general aviation synthesis program is described, and the potential uses of the synthesis program in preliminary design are demonstrated V P

A76-31969 * **Airfoil section drag reduction at transonic speeds by numerical optimization** R M Hicks, G N Vanderplaats (NASA, Ames Research Center, Moffett Field, Calif), E M Murman, and R R King *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-477* 16 p 11 refs

A practical procedure for the design of low drag, transonic airfoils is demonstrated The procedure uses an optimization program, based on a gradient algorithm coupled with an aerodynamic analysis program, that solves the full, non-linear potential equation for transonic flow The procedure is useful for the design of retrofit modifications for drag reduction of existing aircraft as well as for the design of low drag profiles for new aircraft Results are presented for the modification of four different airfoils to decrease the drag at a given transonic Mach number (Author)

A76-31970 **Feasibility study of propeller design for general aviation by numerical optimization** S Bernstein *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-478* 8 p 9 refs

A practical method for propeller design using optimization techniques is presented The propeller aerodynamics model incorporates blade element, momentum and vortex theories, and the optimization technique is based on a combination of the method of feasible directions and the conjugate gradient method A realistic design problem is formulated to maximize the propeller performance in terms of the distribution of thickness, camber, pitch and solidity along the blade, subject to simple structural and power constraints The application of this method for a general aviation propeller is illustrated by a computed example The results presented are considered preliminary and are intended only to illustrate this technique A discussion of the present aerodynamic model for the blade elements is included, and extensions to more elaborate aerodynamic models are considered (Author)

A76-31971 **A method for predicting the drag of airfoils** H L Chevalier (Texas A & M University, College Station, Tex) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-479* 10 p

A new approach is proposed to introduce a change in the physical model of the vorticity on the surface of airfoils which will provide a technique for determining the drag of an infinite span wing throughout the angle of attack range This approach could provide a method for developing and/or selecting airfoils with lower drag at higher angles of attack to obtain better aircraft maneuver and climb capabilities and can be used to extrapolate small scale wind tunnel tests results accurately to higher Reynolds numbers In addition, further studies could provide insight into the development of boundary layer control techniques for reducing wing drag (Author)

A76-31972 **Lightning protection of aircraft fuel caps** J Shaw (Shaw Aero Devices, Inc , East Hampton, N Y) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-486* 8 p 8 refs

An inspection of current practices in aircraft industries reveals that in many cases the lightning safety problem is considered to be solved by installing a lightning proof aircraft filler cap, whereas the installation of a lightning proof adapter (receptacle that the cap fits into) is disregarded The rules which should be followed to insure lightning safe installation are outlined, and it is pointed out that the use of a lightning safety cap without the adapter may lead to expensive redesign or retrofit of the aircraft in its production stage V P

A76-31973 **High altitude applications of the Gates Learjet** R D Neal (Gates Learjet Corp , Denver, Colo) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-491* 11 p 8 refs

Two existing applications at altitudes of 50,000 feet of the Gates Learjet are described In one application, the airplane was equipped (for space exploration purposes) with a 12 inch diameter infrared telescope The second application is the installation of single- and dual-camera pods for use in aerial mapping missions The single camera pod configuration could be converted to the original configuration, whereas the dual camera pod configuration was a permanent modification (due to the necessity of structural changes in the basic fuselage pressure vessel) The development of a high altitude research vehicle (HARV) from the original Learjet configuration is described which resulted in an airplane that should be capable of providing smooth flight at 60,000 feet V P

A76-31974 **GA/W/-2 Airfoil Flight Test Evaluation** S Weislogel, G M Gregorek, and M J Hoffmann (Ohio State University, Columbus, Ohio) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-492* 12 p 5 refs

A brief description of the GA/W/-2 Airfoil Flight Test Evaluation Program is presented Employing an economical approach to airfoil flight testing, the GA(W)-2 airfoil was 'gloved' on the existing wing structure of a Beech Model C23 'Sundowner' Program objectives, experimental approach, research aircraft modification and instrumentation, data acquisition and processing, flight operations, and preliminary flight test results are described (Author)

A76-31975 **Realistic evaluation of landing gear shimmy stabilization by test and analysis** R J Black (Bendix Corp , Energy Controls Div , South Bend, Ind) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-496* 17 p 23 refs Contract No F33657-70-C-0800

An experimental and analytical program for prediction of airplane landing gear shimmy stability is outlined The method makes use of laboratory shimmy tests on a flywheel which simulates the runway and a landing gear mounting structure which simulates the fuselage Differences between the laboratory tests and airplane tests are detailed Because of the latter differences, the prediction of airplane results is carried out by an experimentally verified analysis rather than a direct application of the laboratory test results The analytical model is outlined including the tire mechanics Samples of correlation between analytical results and experimental results (laboratory and airplane) are given (Author)

A76-31976 * **Preliminary flight-test results of an advanced technology light twin-engine airplane /ATLIT/** B J Holmes, D L Kohlman (Kansas, University, Lawrence, Kan), and H L Crane (NASA, Langley Research Center, Hampton, Va) *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan , Apr 6-9, 1976, Paper 760-497* 10 p 9 refs

The present status and flight-test results are presented for the ATLIT airplane The ATLIT is a Piper PA-34 Seneca I modified by the installation of new wings incorporating the GA(W)-1 (Whitcomb) airfoil, reduced wing area, roll-control spoilers, and full-span Fowler flaps Flight-test results on stall and spoiler roll characteristics show good agreement with wind-tunnel data Maximum power-off lift coefficients are greater than 3 0 with flaps deflected 37 deg With flaps down, spoiler deflections can produce roll helix angles in excess of 0 11 rad Flight testing is planned to document climb and cruise performance, and supercritical propeller performance and noise characteristics The airplane is scheduled for testing in the NASA-Langley Research Center Full-Scale Tunnel (Author)

A76-32149 # **Mechanical function and engine performance for the Army UH-1 H helicopter in the AIDAPS program.** L Plog and D Gann (U S Army, Aviation Systems Command, St Louis, Mo) In Symposium on Nondestructive Evaluation, 10th, San Antonio, Tex , April 23-25, 1975, Proceedings
San Antonio, Tex , Southwest Research Institute, 1975, p 303-309

An automatic inspection, diagnostic, and prognostic system (AIDAPS) which will automatically detect mechanical malfunctions and warn of impending failures is under development for the Army fleet of helicopters The Phase I design and testing of AIDAPS

systems for use with the UH-1H helicopter is discussed The diagnostic parameters serving as input for the automatic evaluation of the major systems and subsystems are outlined Two alternative systems are under consideration Both incorporate identical data acquisition units and flight line data analyzers One system includes a computer memory unit capable of real time inspection and diagnosis and inflight warning of systems failures, in the alternative system the computer memory unit is replaced by a digital data recorder Data acquisition hardware has been installed and successfully tested in four aircraft C K D

A76-32165 # **Fracture analyses involving materials of aircraft construction (Bruchanalysen an Werkstoffen des Flugzeugbaus)** M Bohmer and G Ziegler (Deutsche Forschungs- und Versuchs anstalt fur Luft- und Raumfahrt, Institut fur Werkstoff-Forschung, Porz-Wahn, West Germany) *Deutscher Verband fur Materialprufung, Sitzung des Arbeitskreises Rastermikroskopie, 7th, Wurzburg, West Germany, Apr 2, 1975, Paper* 12 p In German

The conduction of investigations involving aircraft components after aircraft accidents is considered Such investigations are undertaken to determine the cause of the accident With the aid of an example it is illustrated that in such an investigation certain difficulties have to be overcome in order to separate the actual cause of fracture from secondary effects appearing as a result of the accident Attention is also given to the effect of the crack propagation rate on the appearance of the fractured metal in the case of fatigue stresses and the effect of the microstructure on the appearance of the fracture in the event of forced rupture G R

A76-32167 **Fluid-dynamic lift Practical information on aerodynamic and hydrodynamic lift** S F Hoerner and H V Borst (Wayne, Henry V Borst and Associates, Wayne, Pa) Research supported by the U S Navy, Contracts No N00014-73-C-0354, No N00014-67-C-0357 Brick Town, N J , Hoerner Fluid Dynamics, 1975 505 p 2276 refs $28

The book represents an extensive compendium of basic engineering data on the aerodynamic and hydrodynamic characteristics of the chief types of lifting surfaces used in aircraft and marine craft The topics covered include the mechanism of circulation in foil sections, the lift of straight wings, maximum lift and stalling, lift characteristics of plain, split, and slotted trailing edge flaps, performance of wings with flaps including power-assisted wing flaps, influence of leading-edge flaps on lift, boundary layer control near the leading edge, the influence of compressibility at subsonic speeds, the characteristics of lifting hydrofoils and hydrofoil boats, the characteristics of airplane control surfaces, roll control of airplanes, longitudinal stability characteristics of airplanes, lift of propulsion systems, directional characteristics of airplanes, lift and stalling of swept wings, characteristics of delta wings, lift characteristics of streamline bodies and blunt bodies, and lift of airplane configurations The mathematics is kept to a minimum, and the text aims at explaining clearly the physical principles in an integrated and complete manner P T H

A76-32198 **An alternative to the helicopter** D Videan *Shell Aviation News,* no 434, 1976, p 22-25

The sidewall hovercraft is considered as an alternative to the helicopter in transporting personnel from a shore base to an offshore structure at a distance of 50 nautical miles or less The work capacity and cost of an HM2 hovercraft are compared with those of current helicopter types Average hourly cost assuming a per annum norm of 1,000 hours of use is less than half of the most economical helicopter considered, the Bell 212 C K D

A76-32199 **Energy management - An operational outline** T G Foxworth (Pan American World Airways, Inc , New York, N Y) *Shell Aviation News,* no 434, 1976, p 26, 27

An application of the Sperry Digital Avionics System in the NASA flight research Convair 990 is described The advanced autopilot/flight director system is based on a Sperry 1819A digital computer The computer is referenced to a landing point and recomputes the trajectory three times per second, taking into account potential energy (height), kinetic energy (speed), aircraft configuration, wind, and other factors A throttles closed-to-touchdown landing technique has been demonstrated which results in a 60% fuel saving and a 40% time saving over a conventional approach A similar system will be used to guide the Space Shuttle in its no-fuel final approach C K D

A76-32200 * **Energy management - The delayed flap approach** J S Bull (NASA, Ames Research Center, Moffett Field, Calif) *Shell Aviation News,* no 434, 1976, p 28, 29

Flight test evaluation of a Delayed Flap approach procedure intended to provide reductions in noise and fuel consumption is underway using the NASA CV-990 test aircraft Approach is initiated at a high airspeed (240 kt) and in a drag configuration that allows for low thrust The aircraft is flown along the conventional ILS glide slope A Fast/Slow message display signals the pilot when to extend approach flaps, landing gear, and land flaps Implementation of the procedure in commercial service may require the addition of a DME navigation aid co located with the ILS glide slope transmitter The Delayed Flap approach saves 250 lb of fuel over the Reduced Flap approach, with a 95 EPNdB noise contour only 43% as large C K D

A76-32230 **Pilot error and other accident enabling factors** R B Stone (Air Line Pilots Association, Washington, D C) In *Human factors in our expanding technology, Proceedings of the* Nineteenth Annual Meeting, Dallas, Tex , October 14-16, 1975 Santa Monica, Calif , Human Factors Society, 1975, p 92-94

In view of the pattern of ascribing airline accidents predominantly to pilot error, the Airline Pilot Association has asked that engineering professionals provide a new more objective assessment of the human operator in the complex man-machine environment Optimization of the decision maker's task has been poorly formed, pressures within the system degrade the level of safety Specific and general weaknesses of the airline cockpit environment are discussed, along with such issues as institutional vs command decision, positive training vs negative operation, expected vs accepted behavior, and carelessness vs boredom V P

A76-32231 **'Controlled flight into terrain /CFIT/' accidents - System-induced errors** E L Wiener (Miami, University, Coral Gables, Fla) In Human factors in our expanding technology, Proceedings of the Nineteenth Annual Meeting, Dallas, Tex , October 14-16, 1975 Santa Monica, Calif , Human Factors Society, 1975, p 95-101 11 refs

A review of the major recent accidents in U S commercial aviation leads to the conclusions that CFIT accidents are the result of system-induced errors and that these errors will continue to be generated by the unwieldy system of vehicles, traffic control, and terminals that have emerged as a result of component wise design Since rebuilding the system from the very foundations will never be possible, it must be improved the same way it was created, by patchwork The need for help from human factors specialists in this patchwork is indicated V P

A76-32232 **Video tape presentation of passenger safety information** D A Johnson (Douglas Aircraft Co , Long Beach, Calif), D I Blom (Tennessee, University, Martin, Tenn), and H B Altman (Interaction Co , Anaheim, Calif) In Human factors in our expanding technology, Proceedings of the Nineteenth Annual Meeting, Dallas, Tex , October 14-16, 1975 Santa Monica, Calif , Human Factors Society, 1975, p 102-107 8 refs

On the assumption that passenger safety can be increased by providing the passengers with information they need to know, nonverbal video tape information was presented to potential aircraft passengers (subjects) on what they should do, what they should not do, and the reason why Each of seven groups consisting of 10 men and 10 women from rural and urban areas saw information on 11 content areas (luggage storage, seat belt use, etc) but in different

combinations of 'Do', 'Don't', and 'Why' For each content area, one group that did not receive information was treated as a control group Significant improvements in knowledge of appropriate safety-related behaviors resulted from the experiment Do and Don't information combined was found to be more beneficial than either Do or Don't information alone V P

A76-32337 On the response of an aircraft to random gust M Kobayakawa (Kyoto University, Kyoto, Japan) In International Symposium on Space Technology and Science, 11th, Tokyo, Japan, June 30-July 4, 1975, Proceedings Tokyo, AGNE Publishing, Inc, 1975, p 253-258

A general theory of the random gust response of an aircraft is developed on the basis of a modified panel method The aircraft is divided into panels only for the gust force terms, while other force terms in the equations of motion are expressed by total derivatives The equations of motion are linearized and divided into two parts, i e, longitudinal equations and lateral equations The external forces are expressed by the sum of convolution integrals The method allows the investigation of the effect of interference on the interactive response among different parts (wing, tail and fuselage) of the aircraft B J

A76-32396 Model matching method for flight control and stimulation H Ohta (Nagoya University, Nagoya, Japan) In International Symposium on Space Technology and Science, 11th, Tokyo, Japan, June 30-July 4, 1975, Proceedings Tokyo, AGNE Publishing, Inc, 1975, p 691 696 9 refs

The paper describes Curran's model matching algorithm for the design of stability augmentation systems The model matching problem is to find a controller to apply to the plant so that the resulting compensated plant behaves, in an input-output sense, the same as the model The algorithm is applied to desirable longitudinal handling quality designs and both pitch attitude and normal acceleration control laws are derived analytically These control laws allow one to determine the effects of large changes of flight configurations on control gains A numerical example involving a STOL aircraft is used to illustrate the efficiency of the method B J

A76-32543 Supersonic flow past a slender delta wing An experimental investigation covering the incidence range from -5 to 50 deg I C Richards (Cranfield Institute of Technology, Cranfield, Beds, England) *Aeronautical Quarterly*, vol 27, May 1976, p 143-153 15 refs Research sponsored by the Ministry of Defence (Procurement Executive)

The flow past a delta wing of 70 deg sweep was studied at M = 2 45 by using surface pressure tubes, schlieren photography, vapor screening, and surface oil flow visualization, and the results were compared with characteristics predicted by thin-shock-layer theory The compression-surface pressure distributions were in very good agreement with half modified thin-shock-layer theory, even at low incidences where certain assumptions of the theory cannot be justified The thin-shock layer theory correctly predicts the trend of the shock-wave angle data but underestimates the magnitude of the shock angle by some 3 degrees The correlation between leading-edge separation and the movement of attachment lines on the compression surface was not proven The techniques employed all suggest that leading-edge separation occurs at very low incidences P T H

A76-32545 The far field of high frequency convected singularities in sheared flows, with an application to jet-noise prediction. T F Balsa (GE Power Generation and Propulsion Laboratory, Schenectady, N Y) *Journal of Fluid Mechanics*, vol 74, Mar 23, 1976, p 193-208 25 refs Research supported by the U S Department of Transportation

Expressions are derived for the pressure fields of various high-frequency convected singularities immersed in a unidirectional sheared flow These expressions include the simultaneous effects of fluid and source convection and refraction, they are combined to predict the far-field directivity of cold round jets It is found that the agreement between experiment and the present theory is quite good at a source Strouhal number of unity, but that this agreement deteriorates as the source frequency is increased The theoretical results show the explicit form of the 'refraction integral' and that convective amplification for the pressure of a quadrupole is increased by a certain factor over the classical results Thus, acoustic/mean-flow interaction not only implies refraction but also additional convective amplification due to fluid motion (Author)

A76-32587 # Calculation of compressible turbulent boundary layers on straight-tapered swept wings P Bradshaw, K Unsworth (Imperial College of Science and Technology, London, England), and G A Mizner *AIAA Journal*, vol 14, Mar 1976, p 399, 400 15 refs Ministry of Defence Contract No AT/2037/0133

The paper describes the extension of an infinite-wing program to the case of a straight-tapered wing for calculating compressible flow with or without heat transfer The heat transfer version of the boundary-layer calculation method of Bradshaw and Ferriss (1972) is programmed in Fortran language for straight-tapered wings The tapered-wing version appears to be competitive with integral methods needing several spanwise stations The program contains a large number of options for input, output, and physical effects, selected individually by choosing nonzero values of integer control parameters so that default operation is obtained with two essential control parameters and a row of blanks Advantages of the program are discussed S D

A76-32596 Flow around wings with inclined lateral jets E Carafoli and M Neamtu (Institutul de Mecanica a Fluidelor si Constructii Aerospatiale, Bucharest, Rumania) *Mechanics Research Communications*, vol 3, no 3, 1976, p 163 168

The aerodynamic theory of the lateral jet sheet states that the sheet, which provides a significant lift augmentation, issuing spanwise from the extremities of the wing, behaves like a fluid wing which is deformed by the pressure differences acting between the upper and lower surface In certain cases, the jet sheet has a definite geometrical shape and a negligible downstream deviation on a large portion of the slot vicinity and can be decomposed into elementary jets which preserve their slot outlet momentum magnitude and modify only their direction under the pressure differences This paper calculates the spanwise flow distribution of a 1 5 aspect ratio rectangular wing with lateral jet, the wing inclined under a certain angle to the horizontal It is shown that a small but supplementary lift augmentation is obtained due to the effect of inclining the wing B J

A76-32626 Initial flight test phase of the Dassault-Breguet/Dornier Alpha-Jet D Thomas (Dornier GmbH, Friedrichshafen, West Germany) *(Society of Experimental Test Pilots, Annual Symposium, 7th, Munich, West Germany, Apr 24-26, 1975) Society of Experimental Test Pilots, Technical Review*, vol 13, no 1, 1976, p 5-13

The paper reviews planning and progress of the initial flight test phase of the Alpha-Jet Flight tests were planned for four test aircraft (1) aircraft one was used to open the basic flight envelope and, then, to evaluate handling characteristics, (2) aircraft two was first used for performances testing, now used for weapon trials, (3) aircraft three corresponds to the German ground attack version and is now used for weapon structural and systems testing, and (4) aircraft four corresponds to the French trainer version and is used for systems testing Onboard data are recorded on tape, photo paper and crash recorders and every flight is monitored from the ground using quick-look indications, a 75 parameter printer and real time plotting Various flight test results are discussed including those involving evolution of the wing camber, aileron effectiveness in the transonic region and elevator control characteristics B J

A76-32627 Advanced fighter control techniques W H Brinks (McDonnell Aircraft Co, St Louis, Mo) *(Society of Experimental Test Pilots, Annual Symposium, 7th, Munich, West Germany, Apr 24-26, 1975) Society of Experimental Test Pilots, Technical Review*, vol 13, no 1, 1976, p 14-22

A thirty flight investigation of the Control Configured Vehicle (CCV) design concept was conducted by McDonnell Aircraft Company (MCAIR) between June and August 1974 The test-bed aircraft was a Fly-By-Wire F-4, modified with two shoulder mounted, fully-powered canard surfaces and wing leading edge slats The thirty flight program consisted of performance and handling qualities investigations from near one hundred knots calibrated airspeed at 5000 feet to approximately 1 8 Mach at 35,000 feet Longitudinal static margins varied from a positive 3% to a negative 7 5% Mean Aerodynamic Chord (MAC) with constant control system gains The trim lift effect of the canard installation improved approach speeds by approximately seven knots and improved subsonic load factor available at constant angle of attack by approximately 25% Short period disturbance resulted in dead beat damping in all axes for all configurations and static margins in the test envelope Smooth aircraft response and lack of uncommanded motion at these conditions further indicated that CCV technology has significant operational potential (Author)

A76-32628 **B-1 flight test progress report** E Sturmthal (USAF, Washington, D C) *Society of Experimental Test Pilots, Technical Review,* vol. 13, no 1, 1976, p 23 26

The paper reviews progress in phase one (that prior to production decision) of the B-1 flight test program The plan for early flight test and envelope expansion was of a strongly operational nature conditioned by the requirement to demonstrate the B-1's ability to satisfactorily perform its intended mission The emphasis was put on the high-speed, low-altitude flight regime Flight simulation aspects using the TIFS (total inflight simulator) are considered Initial taxi tests - three runs scheduled to complete with a top speed of 50 knots - are described The review goes up to flight test five with following tests concentrating on envelope expansion aimed at clearing the aircraft for initial operation at 85M at 500 ft

B J

A76-32629 **Unusual pitch and structural mode testing of the B-1** T D Benefield (Rockwell International Corp , El Segundo, Calif) *Society of Experimental Test Pilots, Technical Review,* vol 13, no 1, 1976, p 27-29

Two fairly simple additions to the B-1 flight control and structural mode control systems have allowed an early determination of pitch response to simulated automatic control flight control system commands and bending vibration modes and damping A pitch exciter was added to the pitch stability and control augmentation system to provide a means of obtaining aircraft response data to the simulated flight control system commands and an adjustable amplitude and frequency sine wave excitation system was added to the structural mode control system (whose objective is to reduce bending vibrations in the vertical and lateral axes) B J

A76-32630 **Special problems in the flight testing of sailplanes** G Waibel *(Society of Experimental Test Pilots, Annual Symposium, 7th, Munich, West Germany, Apr 24-26, 1975) Society of Experimental Test Pilots, Technical Review,* vol 13, no 1, 1976, p 30-36 6 refs

The special features of flight-testing sailplanes are enumerated (1) there is no engine onboard which makes one dependent on towing aircraft, (2) there is little space for test equipment, (3) there is often no weight allowance for test equipment, (4) money for expensive flights is scarce, and (5) there is often poor flying weather In testing, the cycle of take-off, flight and landing will be repeated several times at a moderate speed (75-150 km/h) and in all configurations Stability measurements will be made right at the start It is urgent to determine controllable side and tail wind components during take-off and landing Aerodynamic stability aspects are discussed with particular emphasis on the flutter of plastic sailplanes B J

A76-32631 **Engine and jet induced effects of a lift plus lift-cruise V/STOL aircraft** L Obermeier (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) *(Society of Experimental Test Pilots, Annual Symposium, 7th, Munich, West Germany, Apr 24-26, 1975) Society of Experimental Test Pilots, Technical Review,* vol 13, no 1, 1976, p 37-47

The paper considers the secondary forces generated by a propulsion system and their effect on aircraft stability, control and performance, with particular reference to experience with the VAK 191 B V/STOL aircraft Hot gas recirculation is examined with attention focussed on the typical decay pattern of single exhaust jet impact with flow separating from the ground Ground effect is considered, investigating its effect on liftoff and constant throttle landing Jet induced downwash is discussed as is drag during outboard transition Three engine-induced effects on stability and control are discussed, intake momentum drag, rolling moment due to sideslip and rolling moment due to lift engine gyroscopic coupling

B J

A76-32632 **The Boeing Compass Cope Program** R L McPherson (Boeing Co , Seattle, Wash) *(Society of Experimental Test Pilots, Mini-Symposium, San Diego, Calif , Apr 4-6, 1975) Society of Experimental Test Pilots, Technical Review,* vol 13, no 1, 1976, p 48-55

The Boeing Compass Cope Program is an RPV system where the pilot remotely flies the vehicle from the command module using standard aircraft instruments and controls A modified AN/TPW-2 microwave command and guidance system provides air vehicle position tracking and data transmit and receive functions when the command module pilot is controlling the vehicle A Loss of Carrier Program will automatically take over control of the vehicle if the command and control link is interrupted for more than 1 5 seconds on the ground or 5 0 seconds during flight The flight testing and operation of two RPVs - XQM 93A and YQM-94A - are discussed

B J

A76-32633 **The development testing of a short-haul airframe/powerplant combination, the VFW 614/M45H** L Nielsen (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) and J Lewis (Rolls-Royce /1971/, Ltd , Derby, England) *(Society of Experimental Test Pilots, Annual Symposium, 7th, Munich, West Germany, Apr 24-26, 1975) Society of Experimental Test Pilots, Technical Review,* vol 13, no 1, 1976, p 56-60

The paper describes development flight testing of the short haul VFW 614, with particular emphasis on the performance of the M45H turbofan engine A general description of the aircraft is given, including dimensions, controls, flight system, auxiliary systems and cockpit In the first flight test the elevator aileron and rudder were operated via spring tabs, which caused a complicated mathematical model and made it impossible to calculate the flutter freedom for the whole envelope of the aircraft in the time available In the process of envelope extension, the following changes had to be made (1) hydraulic boosted elevators, (2) elevator operated by geared tabs, and (3) changes of mass balance on rudder and ailerons The design philosophy of the M45H engine was to minimize fuel consumption and noise and to ensure a long service life coupled with a modular construction which would enable units to be replaced very quickly

B J

A76-32634 **Hawker Siddeley Hawk T Mk 1 two-seat ground attack/trainer aircraft** D M S Simpson (Hawker-Siddeley Aviation, Ltd , Dunsfold, England) *(Society of Experimental Test Pilots, Annual Symposium, 7th, Munich, West Germany, Apr 24-26, 1975) Society of Experimental Test Pilots, Technical Review,* vol 13, no 1, 1976, p 61-69

The paper details the flight progress of the Hawker Siddeley Hawk, describes the aircraft, its main systems and the Adour engine The Hawk T Mk 1 is a low wing monoplane of conventional layout powered by a single Rolls-Royce Turbomeca Adour Mk 151 turbofan engine The various components and systems of the aircraft - fuselage, wing, equipment, cockpits, ejector seats, flight controls, hydraulic systems, electrical system, fuel system and engine - are described Particular attention is paid to the flight data recording system and the flutter test instrumentation The three phases of the

flight test program are considered (1) initial flight testing with handling and qualitative assessment up to 400 kts IAS and 0 8 IMN combination, (2) qualitative handling shake-down following installation of comprehensive instrumentation system, and (3) flutter clearance to limiting IAS and Mach number coincidental with handling assessment throughout flight envelope and optimization of wing configuration for low and high speed handling at all altitudes
B J

A76-32649 **Civil transport technology up to 2000 - NASA believes fuel consumption is the major consideration** J P Geddes *Interavia,* vol 31, May 1976, p 419-421

The recommendations of a NASA task force formed to establish goals in a comprehensive program for developing fuel conservation technology for the civil air transport industry are compared with typical industry views of the developments that are feasible in the near future A 9-year research program for an advanced turboprop engine cruising at Mach 0 8 at 9,500 m has been suggested, together with improved engine components for existing engines such as the JT8D, JT9D, and CF6, including mechanical mixers to mix the core and duct stream before discharge through a common nozzle, clearance control to improve compressor and turbine efficiency, and improved blade shapes Four possible aerodynamic approaches to fuel consumption were selected for future study drag clean up, improved aerodynamic design, laminar flow control, and the use of small vertical end plates on wing-tips to augment thrust Work in these areas would be divided between an Energy Efficient Transport program and a separate Laminar Flow Control program A greatly accelerated effort in the development of composite structures is urged The total cost of the proposed programs is $670 million, a fuel savings of 79% over a fleet incorporating current advanced technology is predicted for a fleet resulting from the suggested program in the year 2005
C K D

A76-32650 **The design and development of a military combat aircraft. II - Sizing the aircraft** B R A Burns (British Aircraft Corp , Ltd , Preston, Lancs , England) *Interavia,* vol 31, May 1976, p 448-450

The sizing of a military combat aircraft to meet mission requirements and minimize takeoff weight is discussed The effects of design requirements and configuration features on the airframe, powerplant, and fuel weight fractions are considered Attention is given to the tradeoff between fuel economy and the thrust/weight ratio in engine design and the advantages and disadvantages of external fuel carriage The importance of achieving aerodynamic and structural efficiency and preventing weight and drag growth as the design progresses is stressed
C K D

A76-32651 **Design of an advanced composites aileron for commercial aircraft** A M James and R L Vaughn (Lockheed-California Co , Burbank, Calif.) *Composites,* vol 7, Apr 1976, p 73-80

A detail design of a composite aileron suitable for long-term service on transport aircraft has been developed The design incorporates honeycomb sandwich covers with three interior ribs, two closure ribs, and a front and rear spar The design combines graphite/epoxy, Kevlar 49/epoxy and hybrids of graphite and Kevlar 49 A weight saving of 28% is predicted with a cost saving of 20% based on a production run of 200 aircraft The integrity of the design has been checked by analysis and from the results of static tests on two structural components
(Author)

A76-32655 **The use of carbon fibre-reinforced plastics in the construction of wings for testing in wind tunnels** D I T P Llewelyn-Davies (Royal Aircraft Establishment, Bedford, England) *Composites,* vol 7, Apr 1976, p 100-106

The methods developed for the manufacture of wings from cold setting carbon fiber-reinforced plastics (cfrp) are described On one particular aerodynamic design, wings were made from steel, glass reinforced plastics (grp) and cfrp and the relative behavior of these wings under load was obtained In addition it has been shown that it is possible to produce moulded wings in cfrp to high dimensional accuracy
(Author)

A76-32849 * # **Aeroelastic stability of trimmed helicopter blades in forward flight** P Friedmann and J Shamie (California, University, Los Angeles, Calif) *European Rotorcraft and Powered Lift Aircraft Forum, 1st, University of Southampton, Southampton, England, Sept 22-24, 1975, Paper* 30 p 14 refs Army-supported research, Grant No NGR-05-007-414

Equations for moderately large amplitude coupled flap lag motion of a torsionally rigid hingeless elastic helicopter blade in forward flight are derived Quasi-steady aerodynamic loads are considered and the effects of reversed flow are included By using Galerkin's method the spatial dependence of the problem is eliminated and the equations are linearized about a time dependent equilibrium position determined from the trimmed equilibrium position of the rotor in forward flight In the first trim procedure the rotor is maintained at a fixed value of thrust coefficient with forward flight and horizontal and vertical force equilibrium is satisfied in addition to maintaining zero pitch and roll moments The second trim procedure maintains only zero pitch and roll moment simulating conditions under which a rotor would be tested in the wind tunnel
(Author)

A76-32869 # **Random vibrations of a cylindrical shell due to an excitation with uniformly varying frequency** E Czogala (Slask, Politechnika, Gliwice, Poland) *Académie Polonaise des Sciences, Bulletin, Série des Sciences Techniques,* vol 24, no 2, 1976, p 71 (105)-78 (112) 6 refs

An analysis was performed on the forced vibrations of elastic closed cylindrical shells of finite length loaded axisymmetrically by unsteady homogeneous random fields which may be due to the action of the pressure of a far acoustic field with uniformly time varying frequency A combined Taylor series and asymptotic series approach was used to obtain variances of unsteady responses of shell displacements and it was found that maxima of displacement variances occur within certain time intervals
B J

A76-33022 # **The dynamics of aircraft spin (Dinamika shtopora samoleta)** M G Kotik Moscow, Izdatel'stvo Mashinostroenie, 1976 328 p 76 refs In Russian

The conditions and characteristics of spin initiation in an aircraft are examined The moments and forces acting on an aircraft in spin and the classification of spin regimes are discussed The characteristics and methods of investigation of spin in contemporary aircraft are described Analytical methods of calculating the trajectory parameters of an aircraft in spin are presented together with a comparison of the results of theoretical modeling with flight tests The mechanics of motion of an aircraft at high angles of attack and piloting techniques for spin recovery are outlined
C K D

A76-33100 **System complexity - Its conception and measurement in the design of engineering systems** D Sahal (Portland State University, Portland, Ore) *IEEE Transactions on Systems, Man, and Cybernetics,* vol SMC-6, June 1976, p 440-445 34 refs

This paper presents a theory of system complexity and its illustrative application to changes in the aircraft designs The proposed framework permits not only the measurement but also the segregation of complexity into various components those pertaining to organized, unorganized, short-term and long-term aspects of any given system's behavior The formulation permits grouping of variables on a priori grounds, thereby alleviating the problem posed by a large number of variables in systems analysis The formulation is capable of circumventing the problem of nonstationarity in the application of the tools of information theory The long-run redundancy of the phenomena underlying the changes in aircraft designs is estimated in the range of 48 to 60% The corresponding estimate in the state of short-run is in the range of 72 to 98% The latter is concluded to be solely due to the 'unorganized' aspects of the evolutionary process
(Author)

A76-33116 # **Experimental determination of improved aerodynamic characteristics utilizing biplane wing configurations** E C Olson (Cessna Aircraft Co , Wichita, Kan) and B P Selberg (Missouri, University, Rolla, Mo) *Journal of Aircraft,* vol 13, Apr 1976, p 256-261 11 refs

Improving the aerodynamic characteristics of an aircraft with respect to a higher lift coefficient C sub L, a lower drag coefficient C sub D, and a higher lift over drag L/D, as a function of angle of attack will make it more efficient, thus conserving energy and/or improving performance Investigations were carried out to determine if the aerodynamic characteristics of biplane wings systems could be made more efficient for low subsonic speeds than those of a monoplane of comparable area and similar aspect ratio A variable position three-dimensional biplane wing system and a fuselage that could be fitted with a monoplane wing or the variable position biplane wing system were tested in a subsonic wind tunnel at a Reynolds number of 8 7 x 10 to the 5/ft Lift, drag, and pitching moment characteristics of each configuration were investigated to determine the effect of changing the position of the biplane wings relative to each other and how the characteristics compared with those of the monoplane All the biplane wings tested were shown to have a significant decrease in lift coefficient over a wide range of angles of attack and a significant increase in lift to drag ratio for a large range of lift conditions with respect to the monoplane

(Author)

A76-33117 * # **Joint aircraft loading/structure response statistics of time to service crack initiation** J -N Yang (Virginia Polytechnic Institute and State University, Blacksburg, Va) and W J Trapp (USAF, Metals and Ceramics Div , Wright-Patterson AFB, Ohio) *Journal of Aircraft,* vol 13, Apr 1976, p 270-278 22 refs Grant No NsG-1099

A reliability analysis for predicting the statistical distribution of time to fatigue crack initiation for aircraft structures in service is presented The present analysis utilizes the statistical data of the specimen fatigue tests, the full-scale structure tests, and the statistical dispersion of aircraft service loads The statistical distribution of the time to fatigue crack initiation of the full-scale structure under laboratory loading spectrum is assumed to be Weibull The service loads for gust turbulences are modeled as Poisson processes for transport-type aircraft, while the maneuver loads are modeled as compound Poisson processes for fighter and training aircraft It is found that the statistical distribution of time to fatigue crack initiation for aircraft structures in service is not Weibull and that the prediction on the basis of the Weibull distribution is unconservative, in particular in the early service time (Author)

A76-33120 # **'Spilled' leading-edge vortex effects on dynamic stall characteristics** L E Ericsson and J P Reding (Lockheed Missiles and Space Co , Inc , Sunnyvale, Calif) *Journal of Aircraft,* vol 13, Apr 1976, p 313-315 16 refs

An analysis of the experimentally observed large effects of the 'spilled' leading-edge vortex on the dynamic stall characteristics of an airfoil describing large-amplitude oscillations around the quarter chord axis has shown that simple engineering analysis developed by Ericsson and Reding (1972, 1976) can be extended to include the 'spilled' vortex effects The initial transient phase during which the separation point overshoots its quasi-steady position can be described by including the moving separation point effect and the subsequent transient phase during which the 'spilled' vortex travels from the leading edge to the trailing edge can be described by application of the concept of equivalence between the time-dependent two-dimensional 'spilled' leading edge vortex and the stationary three-dimensional leading edge vortex on sharp-edged slender delta wings

B J

A76-33121 * # **Inlets for high angles of attack** B A Miller (NASA, Lewis Research Center, Cleveland, Ohio) *Journal of Aircraft,* vol 13, Apr 1976, p 319, 320 6 refs

Different inlet designs for high angle of attack STOL and VTOL applications were tested in a subsonic wind tunnel Three removable entry lips having contraction ratios of 1 30, 1 34 and 1 38 were tested with a single diffuser The internal contour of each entry lip was an ellipse with a major to minor axis of 2 0 Each lip and diffuser assembly was tested to determine its tolerance to angle of attack, first with a conventional centerbody and then with an extended centerbody Results indicate that a large improvement in separation angle (determined as a function of lip contraction ratio and inlet flow) was obtained for the extended centerbody for all contraction ratios Improved inlet tolerance to angle of attack was obtained by reducing the adverse pressure gradient downstream of the throat

B J

A76-33305 **Singular perturbation methods for variational problems in aircraft flight** A J Calise (Dynamics Research Corp , Wilmington, Mass) *IEEE Transactions on Automatic Control,* vol AC-21, June 1976, p 345-353 15 refs Contract No F08635-72-C-0191

The solution of variational problems by singular perturbation methods is discussed In addition to the benefits of order reduction, these methods also can serve as practical devices for treating the singularities arising in problems where the control appears linearly and/or in state-constrained control problems Furthermore, approximate feedback solutions can be derived for problem formulations that currently result in a nonlinear two-point boundary value problem To illustrate an application, a feedback solution for aircraft, three-dimensional minimum time turns is derived and discussed Numerical results are presented for an F-106 and an F 4E aircraft (Author)

A76-33361 **The structure of jets from notched nozzles** S S Pannu and N H Johannesen (Manchester, Victoria University, Manchester, England) *Journal of Fluid Mechanics,* vol 74, Apr 6, 1976, p 515-528

Notched nozzles such as those proposed for the Olympus 593 engine of the Concorde are obtained by cutting wedge-shaped notches in the originally conical nozzles This paper presents results of a comprehensive study, using schlieren photography and pitot-tube pressure traverses, of the fluid mechanics of jets from a wide range of notched nozzles It is shown that schlieren photographs give no clue to the most important feature of the flow mechanism, which is the persistence of the trailing vortices shed from the swept edges of the notches A mathematical model is proposed to explain this phenomenon The model replaces the transverse flow in any cross section by an incompressible two-dimensional potential flow due to four vortices of equal strength placed symmetrically with respect to the axis of the jet The development of the jet with distance is represented by the time variation of the shape of the jet contour in the two-dimensional flow B J

A76-33365 **A note on transonic flow past a thin airfoil oscillating in a wind tunnel** S D Savkar (General Electric Co , Schenectady, N Y) *Journal of Sound and Vibration,* vol 46, May 22, 1976, p 195 207 16 refs

The problem of a thin airfoil oscillating in a transonic flow duct is examined Asymptotic solutions valid at high frequency are derived which suggest that the degree of interference from the tunnel walls is weaker than would be thought at first More detailed calculations are then used to deduce the flutter characteristics of such airfoils It is predicted that the airfoil will suffer a torsional mode instability for a range of parameters (Author)

A76-33516 # **Investigation of the stressed state of panels subjected to wide-band acoustic loads (Issledovanie naprizhennosti panelei pri shirokopolosnom akusticheskom nagruzhenii)** L E Matokhniuk and Iu M Golovanev *Kosmicheskie Issledovaniia na Ukraine,* no 6, 1975, p 46 50 In Russian

Acoustic emission (with a noise intensity of 170 to 180 db) constitutes roughly 1% of jet engine power The influence of noise-induced resonance vibrations at frequencies ranging from 40 Hz to 10 kHz on the strength of aircraft panels was studied, using a single-rotor pneumatic siren to generate the noise The stress-strain states of panels, measured in strong acoustic fields were analyzed,

showing that the size of the panel cells has little influence on the stresses generated by vibrations Stresses can be reduced by 10 to 40% by placing insulating spacers between the sheet material and the underlying strengthening element Damping coatings proved to reduce the stresses by factors of 4 to 5 V P

A76-33660 The technological case for a supersonic cruise aircraft E Ulsamer *Air Force Magazine,* vol 59, June 1976, p 34-39

Major results of feasibility studies for military supersonic cruise vehicles and advanced commercial supersonic transports (SSTs), carried out by NASA with the participation of major producers of airframes and propulsion systems as part of the SCAR (Advanced Supersonic Technology/Supersonic Cruise Aircraft Research) program, are presented It is probable that fuel consumption in advanced designs could be reduced almost to the level of subsonic aircraft by use of aerodynamically efficient wing-body blending and advanced wing planforms such as the arrow wing Several means of improving low-speed lift, including the use of blown flaps and engines placed over the wing, appear promising Powerplant programs supporting SCAR include the Pratt & Whitney MCE-112B and VSCE-502B and the G E Double bypass VCE (DBE) variable cycle engines, which rely on variable fans and burners and incorporate inverter valve systems for airflow control Noise control in these research designs is accomplished by the dual-stream airflow concept Improved inlet stabilization techniques are under investigation Advanced composite materials technology and titanium fabrication techniques promise significant potential for weight reduction C K D

A76-33719 # Unsteady hypersonic flow over delta wings with detached shock waves W H Hui and H T Hemdan (Waterloo, University, Waterloo, Ontario, Canada) *AIAA Journal,* vol 14, Apr 1976, p 505 511 14 refs Research supported by the National Research Council of Canada

The problem of pitching oscillating slender delta wings with detached shock waves in hypersonic flow is studied using Messiter's thin shock-layer theory The amplitude of oscillation is assumed small and a perturbation method is employed Closed-form simple formulas are obtained for the unsteady pressure field and for the aerodynamic derivatives of the delta wings which are valid for general frequencies It is found that within the thin shock-layer approximation, the slender delta wings with detached shock waves pitching in hypersonic stream are always stable dynamically An accurate perturbation solution to Meissiter's functional differential equation, which is required in calculating the steady and unsteady flowfields, is also obtained (Author)

A76-33725 # Airfoil response to an incompressible skewed gust of small spanwise wave-number R K Amiet (United Technologies Research Center, East Hartford, Conn) *AIAA Journal,* vol 14, Apr 1976, p 541, 542 8 refs

An approximate solution for the response function of an infinite-span airfoil in a three-dimensional gust convecting with freestream incompressible flow is derived from results on parallel compressible gusts and similitude studies The gust wavefronts are assumed skewed relative to the airfoil leading edge The solution is limited to small spanwise wave number The approximate results are compared to numerical values and found satisfactorily close This technique, supplementing the solution found for large wave numbers, makes it possible to cover the entire wave number range of interest R D V

A76-33745 # Hydrodynamic visualization study of various procedures for controlling separated flows (Etude par visualisations hydrodynamiques, de divers procedes de contrôle d'écoulements decolles) H Werle and M Gallon (ONERA, Châtillon-sous-Bagneux, Hauts-de Seine, France) *La Recherche Aerospatiale,* Mar Apr 1976, p 75-94 34 refs In French

The paper presents qualitative results, including a large number of photographs of visualized flows, of some experiments conducted in a hydraulic test tunnel on the low-velocity flow past some simple airfoils employing various high-lift devices The tests investigated means of avoiding or eliminating flow separation, procedures employing jet flaps for elongating the models, and schemes for organizing turbulent separations in order to generate extra lift Some of the schemes studied included control of the boundary layer on a deflected flap by rotating the hinge, control by tangential blowing on the deflected flap (for a conventional airfoil and for a delta wing), flow past wings with lift augmented by a trailing-edge jet, flow past a semicircular wing and past a slender body with profiled nose lift augmented by jet flaps, and flow past various types of vortex generators attached to the wall or leading edge of the various profiles P T H

A76-33771 The assessment of noise, with particular reference to aircraft D W Robinson (Aeronautical Research Council, National Physical Laboratory, Teddington, Middx , England) *Aeronautical Journal,* vol 80, Apr 1976, p 147-160 46 refs

Steps leading from the physical assessment of noise to a subjective assessment of its impact on the human population in a given area are discussed in detail The use of common measuring techniques and their utility as models of the human auditory system are considered Technical data (oscillograms and results of spectrum analysis) are processed to obtain subjective results An on-going subjective measure representing the perceived strength of the sound in terms of loudness or noisiness can be obtained from the spectrum data by means of several different algorithms A subjective characterization of a sound 'event' is then derived from the time history of the subjective measure Individual events are assembled to provide an index of noise exposure over a period of time, and a summation of the noise exposure index over a given area is carried out to assess the global impact of noise on a population Progress toward standardization of units, scales, and indices for assessing aircraft noise is discussed C K D

A76-33772 Hawker Siddeley Hawk T Mk 1 two-seat ground attack/trainer aircraft D M S Simpson (Hawker Siddeley Aviation, Ltd , Kingston-on Thames, Surrey, England) *Aeronautical Journal,* vol 80, Apr 1976, p 162-171

The major design characteristics of the Hawker-Siddeley Hawk T Mk 1 fighter trainer aircraft are described, and its flight test program is discussed in detail The aircraft is a low wing monoplane of conventional layout powered by a single Rolls-Royce Turbomeca Adour Mk 151 turbofan engine Six production aircraft have been used in the flight test program Piezoelectric accelerometers with some signal conditioning circuiting built into the transducer base placed at the wingtips, tailplane tips, and fin tip were used to collect flutter test data The conditioned signals passed to a digital encoding unit where they were time multiplexed, digitized, and formatted for recording on magnetic tape The aircraft proved faster than predicted, and was eventually flutter cleared up to an estimated 1 1 True Mach number in a 30 deg dive from 40,000 ft The aircraft stability was excellent, with exceptionally high spin resistance C K D

A76-33778 On the parabolic method and the method of local linearization in transonic flow (Zur parabolischen Methode und zur lokalen Linearisierung bei schallnahen Stromungen) J T Heynatz *(Gesellschaft fur angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Gottingen, West Germany, Apr 1-5, 1975.) Acta Mechanica,* vol 24, no 3-4, 1976, p 239-252 5 refs In German

The parabolic method and the method of local linearization are employed to discuss various solutions for the transonic supersonic and the transonic subsonic flow around profiles In general, several methods for local linearization exist, the one using the first potential derivatives being the most favorable in all cases In the case of supersonic flow this means a deviation from the usually preferred form of the transonic expansion fan In the case of subsonic flow a satisfactory description of the upstream action of the profile results

As examples, the rhombic profile, the Guderley profile and the parabolic arc profile are treated The mathematical relations are supported by plausibility hints, and the possibility of improving the approximations by iteration is discussed (Author)

A76-33795 * # **A review of some tilt-rotor aeroelastic research at NASA-Langley** R G Kvaternik (NASA, Langley Research Center, Aeroelasticity Branch, Hampton, Va) *Journal of Aircraft,* vol 13, May 1976, p 357-363 10 refs

An overview of an experimental and analytical research program conducted within the Aeroelasticity Branch of the NASA Langley Research Center for studying the aeroelastic and dynamic characteristics of tilt rotor VTOL aircraft is presented Selected results from several joint NASA/contractor investigations of scaled models in the Langley transonic dynamics tunnel are shown and discussed with a view toward delineating various aspects of dynamic behavior peculiar to proprotor aircraft Included are such items as proprotor/pylon stability, whirl flutter, gust response, and blade flapping Theoretical predictions, based on analyses developed at Langley, are shown to be in agreement with the measured stability and response behavior (Author)

A76-33852 # **Characteristics of turbulent wakes behind rotating rotor blades (Kharakteristiki turbulentnykh sledov za vrashchaiushchimisia lopastiami vintov)** R Raj and J L Lumley *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Mar Apr 1976, p 51-59 8 refs In Russian

The characteristics of the decay of turbulence in axisymmetric wakes behind rotors are analyzed A flow model based on the discontinuity equations, the equations of averaged motion, and the Reynolds stress equations is proposed, and approximate solutions are obtained which define the radial and axial velocity profiles and their behavior in time Some interesting conclusions concerning the influence of rotation on the characteristics of the deformation and decay of turbulence in rotor wakes are deduced from the analysis V P

A76-33854 # **Law of cross sections for the three-dimensional boundary layer on a thin-section wing in hypersonic flow (Zakon poperechnykh sechenii dlia trekhmernogo pogranichnogo sloia na tonkom kryle v giperzvukovom potoke)** G N Dudin and V Ia Neiland *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Mar -Apr 1976, p 75 84 6 refs In Russian

The hypersonic flow of a viscous gas past a delta wing is analyzed A characteristic feature of such flows is the low density of the gas in the boundary layer It is shown that low density in the boundary layer can lead to the generation of high secondary-flow velocities in the direction of the wing span For low-aspect-ratio wings, this phenomenon makes it possible to expand the solution in series of a small parameter, and to reduce the three-dimensional equations to two-dimensional ones In any approximation, the equations depend on two variables, while a third variable (the longitudinal variable) appears as a parameter The zeroth approximation may be treated as the formulation of a law of plane cross sections for the three-dimensional boundary layer V P

A76-33869 # **Visual study of the three-dimensional flow pattern at a delta wing in subsonic flow (Vizual'noe izluchenie prostranstvennoi kartiny techeniia okolo treugol'nogo kryla v dozvukovom potoke)** V M Bozhkov, A S Mozol'kov, and V I Shalaev *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Mar -Apr 1976, p 190-194 6 refs In Russian

Three visualization techniques were used in a wind tunnel study of the flow past delta-wing models of symmetrical profile with a rounded leading edge over a range of free-stream velocities from 1 to 90 m/sec The techniques included local heating, high-speed photography, and tuft-grid surveys The physical characteristics of the formation of the flow leading to separation and formation of vorticity are studied, and the dynamics of the flow at three wing chords is illustrated by sequences of photographs V P

A76-33945 **The design and development of a military combat aircraft III - Longitudinal stability and control** B R A Burns (British Aircraft Corp , Ltd , Military Aircraft Div , Preston, Lancs , England) *Interavia,* vol 31, June 1976, p 553-556

Major considerations in designing a military combat aircraft for optimum handling qualities in terms of longitudinal stability and control are discussed The reasons and palliatives for the common stability minimum at high subsonic speeds in low-altitude flight are considered The relationship between stick forces and maneuver margin is described The sizing and placement of the tailplane is examined in detail Control approaches, including artificial stability, maneuver boost, maneuver demand, and autostabilization, are discussed C K D

A76-33946 **Sukhoi's swing-wing Su-17/20 Fitter C** G Panyalev *Interavia,* vol 31, June 1976, p 557, 558

The design and performance characteristics of the Sukhoi Su-17/20 Fitter C combat aircraft are discussed The aircraft is a swing wing modification of the swept-wing Fitter A design introduced in 1959 Placement of the pivot point at half-span permits an aspect ratio change of only 3 0 to 4 9, indicating that swing wing outer panels were incorporated primarily to improve landing and take off performance The addition of leading-edge slats has significantly reduced landing speed over that of the Fitter A The Lyulka AL 7-F1 engine of the earlier aircraft has been replaced by a Lyulka AL-21-F3 turbojet powerplant rated at 25,000 lb thrust The Fitter C can function in battlefield interdiction, close air support, and air combat, and carries a built in armament of two 30 mm Nudelmann-Richter NR-30 cannons External loads include 100, 250, 500, or 1000 kg bombs, pod-housed unguided rockets, and guided missiles C K D

A76-34132 **Aircraft crashworthiness, Proceedings of the Symposium, University of Cincinnati, Cincinnati, Ohio, October 6-8, 1975** Edited by K Saczalski (U S Navy, Office of Naval Research, Arlington, Va), G T Singley, III (U S Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va), W D Pilkey (Virginia, University, Charlottesville, Va), and R L Huston (Cincinnati, University, Cincinnati, Ohio) Charlottesville, University Press of Virginia, 1975 710 p $15

The papers deal with the need for crashworthy aircraft, significant developments in crashworthiness research, and the state of the art in aircraft crashworthiness design, testing, analysis, and development Topics include a review of crashworthiness and biodynamic problems related to aircraft, techniques for investigating aircraft accidents, the validity of crashworthiness design concepts in general aviation, and the design of a crashworthy military helicopter Other papers consider regional biodynamic response to impact acceleration, general-aviation emergency water ditchings, crash injuries to the neck and spine, head-injury tolerance levels, mathematical modeling of head injuries, chest-injury simulations, the design and testing of restraint systems, and simulations of vehicle-structure crash response Attention is also given to three-dimensional crash victim simulations, the development of technology for the design of crashworthy light aircraft, scale modeling in crash analysis, commercial airline crashworthiness, the stabilization of a ditched helicopter by inflatable airbags, and the development of crashworthy fuels and fuel systems F G M

A76-34133 **An overview of aircraft crashworthiness research and development** N Perrone (U S Navy, Office of Naval Research, Arlington, Va) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 3-12 12 refs

Research into crashworthiness and biodynamics problems related to aircraft is reviewed The origin of crash-injury research is outlined, and it is argued that the essence of the crashworthiness problem in potentially survivable aircraft accidents is to define what the design should be so that the highest probability of occupant

survival with minimal injury will exist without significant weight penalty Occupant simultation techniques and human tolerance limitations are discussed, the use of protective systems in aircraft is noted, and the-state of the art of occupant simulation models, human impact-tolerance determination, and determinations of aircraft structural response to severe impact is summarized Fiscal trends in vehicle-crashworthiness and biomechanics research are described F G M

A76-34134 **General investigation of accidents** R R McMeekin (U S Armed Forces Institute of Pathology, Washington, D C) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6 8, 1975 Charlottesville, University Press of Virginia, 1975, p 13 28 52 refs

Techniques for investigation of aircraft accidents are described The multidisciplinary team approach to accident investigation is outlined, and the crashworthiness areas of the investigation generally covered by human factors are considered, with emphasis on injury patterns and injury tolerance The four phases of an investigation are discussed, accurate evaluation of observations at the crash scene is stressed, and the documentation of injury patterns is examined Effects of preexisting injuries on interpretations of injury patterns and the sequence of events in a crash are considered Ways are suggested for determining whether crash victims died from impact injuries or postcrash burns or drowning Information that can be extracted from correct diagnosis of head, extremity, vertebral, and internal injuries is summarized Factors determining injury tolerance are identified, and design recommendations are made for reducing or even eliminating fatalities in crashes at speeds of less than 200 knots F G M

A76-34135 **Crashworthiness observations in general aviation accident investigations - A statistical overview** G J Walhout (National Transportation Safety Board, Washington, D C) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 29-41 13 refs

The validity of crashworthiness design concepts in general aviation is examined by analyzing U S general-aviation accident data for the period from 1964 to 1973 Percentages of fatal and serious injuries experienced in aerial-application and general-aviation accidents are calculated and compared Similar comparisons are made for 'old generation' and 'new generation' aircraft of both types, and the effects of shoulder harnesses on injury rates is evaluated It is shown that 'new generation' aerial-application aircraft have the lowest percentage of fatal injuries due to their better crashworthiness design It is concluded that the combination of an 'island of safety' for the aircraft occupant, in the form of a crushproof structure, and adequately designed restraint appears to be the major factor in aircraft accident survivability F G M

A76-34136 **General aviation crashworthiness** G L Thompson and J C Clark (Beech Aircraft Corp , Wichita, Kan) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 43-50

The current status of general-aviation crashworthiness is considered by examining the state of the art of design, analysis, computer modeling, testing, and materials Crashworthiness criteria are defined in terms of structural design and cabin environment, with specific reference to cabin integrity, seating and restraint, fuel systems, static and dynamic computer simulations, and cabin safety Prospective improvements noted include high-G seating, breakaway instrument panels, widening of the survivable envelope, and crash-activated fire-suppression systems It is concluded that if all testing and design techniques are realized to their full potential, a design goal of a 25-G crashworthy aircraft may not be unreasonable F G M

A76-34137 **Crashworthiness design features for advanced utility helicopters** B L Carnell (United Technologies Corp , Sikorsky Aircraft Div , Stratford, Conn) In Aircraft crash worthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 51-63

The YUH-60A advanced utility helicopter was designed on the basis of statistics of U S Army utility helicopter accidents which occurred in the 1960s and has 40 specific design features to enhance its crash survivability by overcoming the 40 hazards found to be present in those accidents The major crashworthiness features include a cabin superstructure that retains the engines and transmission at high-load factors, energy-absorbing landing gear, self-sealing fuel tanks and lines, an inertial crash switch that activates the fire extinguishing system, load-limiting seats, extra emergency exits on both sides, and a tail wheel that protects the tail rotor in high flare landings The composite crash of an earlier type helicopter is described to illustrate the hazards found and the ways in which the present improvements overcome them A cost effectiveness study for a fleet of 1000 YUH-60A helicopters operating an average of 900 hr per aircraft per year yields a very conservative estimate that in 10 yr of operation, 80 serious injuries will be prevented, 200 lives will be saved, and total cost savings of $78 million will be realized F G M

A76-34138 **Crashworthiness of the Boeing Vertol UTTAS** R L Bainbridge, M J Reilly, and J E Gonsalves (Boeing Vertol Co , Philadelphia, Pa) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 65-80

The paper presents an approach to integrating the crashworthiness requirements of the Utility Tactical Transport Aircraft System (UTTAS) helicopter during the development phase while producing a minimum effect on weight and cost Problems which contribute to the hazardous nature of the crash environment in helicopters similar to UTTAS are discussed in terms of occupant injury causal factors and helicopter kinematics during a crash sequence The crashworthiness design approach is based on the observation that the airframe structure is a good energy absorber and retains a protective shell under adverse crash conditions, this approach involves the specific tailoring of airframe structure coupled with crashworthy systems to meet the design objectives of minimum weight and cost Crashworthiness features described include the landing gear, seats, and postcrash fire-avoidance system Crash load factors and airframe-structure energy absorbing characteristics are analyzed F G M

A76-34140 **Crashworthiness in emergency ditching of general aviation aircraft** R G Snyder (Michigan, University, Ann Arbor, Mich) and H L Gibbons (Salt Lake City Health Department, Salt Lake City, Utah) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 121-139 56 refs

Data on 306 general aviation emergency water ditching which occurred between 1964 and mid-1974 are analyzed to determine crashworthiness performance and occupant injury causation An historical review of aircraft ditching is presented, the analytical methods are outlined, and several specific ditching incidents are described The primary conclusions are that (1) ditching is a relatively safe emergency procedure with a high probability of occupant survival even under adverse conditions, (2) at least 50% of the fatalities were caused by drowning or exposure after a successful ditching and subsequent egress, (3) over 95% of the investigated ditchings were successfully conducted without impact or egress fatality, (4) fixed-gear aircraft are less successfully ditched than retractable-gear configurations, (5) occupants of high-wing multi-engine aircraft have a significantly lower chance of surviving a ditching than those of other configurations, (6) drowning, not

impact, is the major cause of fatalities in ditchings, and (7) emergency ditching in water appears to be a better alternative than forced landing off-airport under most circumstances F G M

A76-34154 Development of design criteria for crashworthy armored aircrew seats S P Desjardins (Ultrasystems, Inc., Phoenix, Ariz.) and G T Singley, III (U S Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 399-446 25 refs

A76-34156 Techniques for predicting vehicle structure crash impact response K J Saczalski (U S Navy, Office of Naval Research, Arlington, Va.) and W D Pilkey (Virginia, University, Charlottesville, Va.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 467 484 71 refs

Several critical problem areas are identified which inhibit the accurate, efficient, and economical simulation and prediction of vehicle-structure crash response It is noted that while numerical/analytical approaches offer the potential for conducting economical and efficient crash analysis and design synthesis in the early design stage, two critical areas inhibit accurate predictive capabilities (1) identification and understanding of structural collapse modes and failure mechanisms and (2) selection of appropriate material constitutive relations Difficulties associated with various inelastic constitutive relations employed in structural analyses are discussed, and past attempts at identifying collapse modes and mechanisms are reviewed Present directions of research aimed at improving structural crash-response predictive capabilities and understanding associated collapse mechanisms are described, including scale model destructive testing, numerical prediction of likely failure modes, and the use of optimization and sensitivity-analysis techniques F G M

A76-34157 * Simulation of aircraft crash and its validation E Alfaro Bou, R J Hayduk, R G Thomson, and V L Vaughan, Jr (NASA, Langley Research Center, Hampton, Va.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 485-497 6 refs

A joint FAA/NASA program is discussed which is aimed at developing a reliable technology for the design of crashworthy light aircraft This program encompasses the development of analytical methods, the definition of a survivable crash envelope, and the design of improved seat and restraint systems A facility for full scale crash-simulation testing is described along with the test method and results of five full-scale crash tests of twin engine light aircraft The major goals of the analytical portion of the program are outlined, including the development and validation of the analytical technique using simplified structural specimens that approximate aircraft components, as well as the mathematical modeling of the complete airframe and its subsequent dynamic analysis by substructuring and matrix reduction techniques F G M

A76-34158 Modeling and analysis techniques for vehicle crash simulation K C Park (Lockheed Structural Mechanics Laboratory, Palo Alto, Calif.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 499 515 31 refs Research supported by the Lockheed Independent Research Program, Contract No N00014-74-C-0355

The prediction technique of collapse, which utilizes pseudo-statistical information on the energy concentration pattern within a system, is proposed as an aid in finite-element modeling of vehicle structures with the minimum permissible degrees of freedom With this technique, the total vehicle structure is categorized into linear elastic elements, nonlinear elastic or elastic-plastic elements, and failure elements A general coupling technique for eliminating excessive degrees of freedom is introduced, and a method for identifying probable nonlinear regions of the vehicle structure under impact conditions is outlined along with specific reduction procedures for the excessive degrees of freedom The accuracy of the proposed approach is evaluated, sources of possible errors are identified, and some features of implementing the approach are discussed in terms of its potential Recent developments in improved time-integration methods and strategies are summarized F G M

A76-34159 Nonlinear finite element techniques for aircraft crash analysis H Armen, Jr., A Pifko, and H Levine (Grumman Aerospace Corp., Bethpage, N Y.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 517-548 76 refs

The paper describes the development and validation of advanced analytical techniques for the airframe design technology area of the joint FAA/NASA aviation crashworthiness program Four separate aspects of the analytical program are discussed mathematical simulation, inelastic material behavior, strain-rate effects, and the treatment of dynamic time dependency The finite-element simulation model is outlined, and procedures are proposed which attempt to develop rate dependent stress-strain laws heuristically A direct time-integration scheme for integrating the equations of motion is considered together with its application to nonlinear incremental equations of motion Some results are presented for a combined experimental/analytical program designed to verify the accuracy of the numerical techniques and to single out possible deficiencies in the analysis F G M

A76-34163 Crashworthiness and postcrash hazards from the airline flight attendant's point of view D R Mott (Association of Flight Attendants, Washington, D C.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 625-647 13 refs

Several recent commercial airline accidents are reviewed to demonstrate that most of the fatalities in these crashes occurred because the occupants were not able to evacuate the aircraft Emphasis is placed on crewmember survivability, passenger reactions to the crash environment, passenger inattentiveness to pre-takeoff briefings, passenger information pamphlets, and smoke and fire hazards associated with egress from crashed aircraft Specific postcrash hazards that contributed to fatalities in eight commercial airline crashes are identified, and it is noted that the basic survival difficulties stemmed primarily from the lack of structural integrity of such components as galley inserts, bulkheads, and overhead panels located within aircraft cabins A total of 24 recommended improvements are listed which have not been applied or initiated by commercial carriers and which would have improved survivability during and after impact F G M

A76-34164 Helicopter stabilization system R Sherman and R C DeHart (Southwest Research Institute, San Antonio, Tex.) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 649-667 Contract No N00014-70-C-0265

A test program is discussed which was undertaken to determine the feasibility of using inflatable airbags to stabilize a helicopter that has landed in water For the tests, a dynamic model patterned after a 33,500-lb gross weight helicopter was constructed and drop tested The calculations leading to the design of the model are outlined, and the test results are presented in photographs Application of airbag stabilization to the actual aircraft is examined It is concluded that the investigated helicopter or similar aircraft can be stabilized for considerable angles of roll by means of an inflatable airbag system F G M

A76-34165 **Crashworthy fuel systems** S H Robertson and T J Adamczyk (Robertson Research, Inc , Tempe, Ariz) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 669-682 22 refs

The state of the art in the development of crashworthy fuel systems is reviewed The postcrash fire environment is described, early developments in the design of crashworthy fuel systems are discussed, and crashworthiness programs pursued by the U S Army are outlined The standard fuel system used in the Army's UH-1D/H helicopter is compared with a crashworthy system, and accident data for aircraft with standard and crashworthy systems are contrasted Design features of a crash-resistant fuel system are described, including the tear-resistant fuel tanks, self-sealing breakaway valves, frangible connections, and high-strength flexible hoses It is noted that the knowledge gained in this research can be readily applied to the civilian aircraft industry F G M

A76-34166 **Research and development of modified fuels for reduction of the postcrash fire hazard** J G Horeff (FAA, Systems Research and Development Service, Washington, D C) In Aircraft crashworthiness, Proceedings of the Symposium, Cincinnati, Ohio, October 6-8, 1975 Charlottesville, University Press of Virginia, 1975, p 683-694 17 refs

The paper discusses the status of research being conducted to prevent fuel mist formation by means of fuel modification so that a coarse spray is created which will inhibit ignition and flame propagation, thereby decreasing the probability and severity of fire following a survivable accident Results are presented for a survey of impact-survivable accidents where modified fuel might have reduced the postcrash fire hazard Tests of emulsified and gelled fuels are described along with evaluations of four candidate antimisting fuels Demonstrations of the antimisting performance of modified fuel following a survivable crash are reported which were conducted in three actual full-scale crash tests of surplus military aircraft Tests of engine performance and fuel-system operation in the presence of modified fuel are also noted The outlook for antimisting fuels is evaluated F G M

A76-34233 **Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975** Symposium sponsored by the Society of Flight Test Engineers Lancaster, Calif , Society of Flight Test Engineers, 1975 470 p

Reports presented at the Sixth Annual Symposium of the Society of Flight Test Engineers are presented Some of the topics covered include reliability and maintainability testing, joint development testing of the B-1, F 16 flight tests, helicopter displays, air cushion landing systems, RPV antiship missile simulators, manned air combat simulators, ground proximity warning system, climatic laboratory, stall/post-stall testing, catapult launches, spin recovery parachute deployment, runway certification, multi-DME and flight testing, photoanalysis, integrated data systems, and the Swedish Viggen SAAB fighter flight tests R D V

A76-34234 **Joint contractor - Air Force flight test programs** C A Adolph (USAF, Flight Test Center, Edwards AFB, Calif) and R Abrams (Rockwell International Corp , Los Angeles, Calif) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 1-10

A tendency of independent sequential test programs conducted by the contractor and by USAF test agencies to be fused into concurrent joint test programs is noted, and the conduct of the B 1 development test and evaluation program is reviewed as an illustrative example Timing problems, handling of test data processing and test results, progress reports on test programs, and pretest planning and briefing are discussed The combined joint concurrent test program is discussed from the standpoints of engineering management, the role of the government test agency, the perspective of the contractor test agency, and the integration of the developmental and evaluation efforts The basic objectives of joint concurrent programs are enhanced visibility, direction, and evaluation during early stages of test programs, and minimized duplication of effort R D V

A76-34235 **The U S A F /Rockwell B-1 flight test program progress report - Relationship of test objectives to operational requirements** R Abrams (Rockwell International Corp , Los Angeles, Calif) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 11-27

A progress report on the four years of development and seven years of intensive studies of the B-1 project, culminating in the first fly-off (Dec 23, 1974), is presented The three phases of the B-1 development test and evaluation (DT&E) flight test program are outlined The unique fly-before-buy character of the DT&E program is stressed Landmarks in the test program from roll-out (October 1974) to first maximum gross weight takeoff (May 1975) are listed and charted Objectives of the phases of the flight test program (expanding the low-altitude high-speed flight envelope, capability of subsonic and supersonic operation, with conventional or nuclear payloads) are outlined, with emphasis on success-oriented and mission-oriented tests The flight test program is moving ahead on schedule, and testing of 0 85 M and 500 ft is expected as scheduled in the near future R D V

A76-34236 **The F-16 flight test program** K G Timpson (General Dynamics Corp , Fort Worth, Tex) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 29-43

Progress to date on the F-16 flight test program and a discussion of the planned program for the period ahead are presented The discussion covers instrumentation, operations, management, analysis and planning, and coordination of the test and management agencies Statistics on the YF-16 prototype flight tests, details on test planning and on the flight test program organization, data processing arrangements, the full scale development test program details, information on instrumentation and real-time monitoring of test processes and data, and progress in integrated planning are presented A bar graph for the F-16 flight test schedule is included R D V

A76-34237 **Reliability and maintainability testing of prototype aircraft** R E Stubbs (USAF, Flight Test Center, Edwards AFB, Calif) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 45-63 12 refs

Prototyping is a technique currently being used by the Department of Defense to verify operational suitability of a system concept and to reduce the potential risk in pursuing that system Reliability and maintainability (R&M) testing of prototype aircraft has been discounted by some elements of the development community as a premature endeavor Recent experiences with R&M testing of prototype aircraft show that if actual procurement of operational aircraft is to be pursued, then an R&M evaluation can make a very significant contribution to life cycle cost reduction This report documents the techniques and results of reliability and maintainability testing of prototype aircraft at the Air Force Flight Test Center (AFFTC) It is concluded that reliability and maintainability must be an integral part of prototype testing to realize the full benefit of the prototype concept (Author)

A76-34238 **Status of the Air Cushion Landing System flight test program** G C Hite (USAF, Wright-Patterson AFB, Ohio) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975
Lancaster, Calif , Society of Flight Test Engineers, 1975, p 65-87

The Air Cushion Landing System (ACLS) employs a toroidal trunk which replaces the conventional wheeled landing gear The trunk is continually inflated with an onboard air source during taxi, takeoff and landing This air flows through distributed nozzles on the bottom side of the trunk providing lubrication between the trunk and the ground A majority of the air coming from the nozzles flows into the trunk center cavity A cushion pressure, higher than atmospheric, is thus established which, acting over the cushion area, supports the aircraft The system permits operation over varied surfaces and obstacles The objective of the present flight test program is to demonstrate the ACLS application on a medium STOL transport aircraft This paper includes a discussion of the construc tion, installation and operation of the Air Cushion Landing System, the test objectives and initial flight test results (Author)

A76-34239 **Antiship cruise missile threat simulation utilizing a RPV** R J Gerrity and G Gevaert (Lear Siegler, Inc , Santa Monica, Calif) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 89-107

A digital/analog hybrid real time simulator system for simulating a cruise missile threat to ship targets in an open sea environment, in order to test antiship missile defense systems, is described, with testing equipment and test sequences A TACAN guidance augmentation system (TGAS) is developed and flight-tested on a drone aircraft for RPV simulation of the attacking missile The missile flight is executed with a surface or air launch beyond the horizon, and tracking of a programmed altitude/heading profile until a TACAN signal is intercepted Two basic RPV profiles are specified for the drone a straight-in descent profile and a steep descent profile (the pre-descent portions of the profiles are identical) Automatic backup mode switching and redundant abort functions add to mission success and safety Flight control hardware and simulator system hardware are described and illustrated R D V

A76-34240 **Simulation - A flight test complement** H Passmore (McDonnell Aircraft Co , Laboratory and Flight Div , St Louis, Mo) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 109-133

In the development of the F-15 the simulator played an important role A major aspect of this role is as an adjunct to the flight test program This paper gives a general description of a manned air combat simulator and its operation The purpose, approach and general results of three preflight training programs are described These include a pre-first flight program, a program conducted prior to the start of the structural loads flight test program, and a program conducted prior to the stall approach and high angle-of attack flight tests Two special operations that utilized the flight simulator are the technique development simulation that preceded the Streak Eagle program, and a special data reduction scheme which permits playback of tracking radar and onboard data from flight tests (Author)

A76-34241 **Effect on pilot performance with refined helicopter displays** F J Winter, Jr (USAF, Flight Dynamics Laboratory, Wright Patterson AFB, Ohio) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 135-157

A flight research effort has been established to evaluate recent developments of rotary wing instrument flight capability These developments center around vehicle controllability through advanced displays and stability augmentation systems The configuration to be first evaluated was designed from the results documented by actual pilot performance during typical rotary wing IFR maneuvers Several subject pilots flew designed profiles to establish in what areas improvements were required Each pilot's performance was then computerized to create the mean and standard deviation values of *pilot ability to perform prescribed tasks The analysis of the data* gathered determined in what areas pilot performance could most likely be improved through refined helicopter displays (Author)

A76-34242 **Ground proximity warning system testing** J R Combley (Boeing Commercial Airplane Co , Seattle, Wash) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975
Lancaster, Calif , Society of Flight Test Engineers, 1975, p 159-178

The development and testing of a ground proximity warning system (GPWS) meeting FAA requirements for handling of large turbine-powered aircraft are reviewed Development testing, certification tests, ground tests, flight tests, and system tolerances are covered System hardware and instrumentation are described Four modes trigger GPWS responses (1) excessive sink rate close to terrain, (2) excessive closure rate close to terrain, (3) negative climb after takeoff, and (4) descending into terrain with gear up A glide slope deviation mode, developed subsequently, has been incorporated into the FAA requirements Visible and audible alarm annunciations are included in the system R D V

A76-34243 **The T&E simulator - A comparison with flight test results** J M Rebel (U S Navy, Naval Air Test Center, Patuxent River, Md) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 181-187

A recent trend has developed in the normal cycle of aircraft testing in that research and development (R&D) type simulators have been utilized for the test and evaluation (T&E) portion of testing If successful, these T&E simulators could supplant a significant portion of the flight tests that are required for an aircraft development cycle Specifically, during development of the F 14A airplane automatic carrier landing system, a T&E simulator was used in such a manner Comparison of the F-14A flight test data with results of the simulation has shown that the simulator was a valid model of the F-14A and the automatic landing system and successfully reduced the flight test effort normally required at a savings of time and money (Author)

A76-34244 **Environmental tests of the F-15 in the Air Force Climatic Laboratory** J A Ford (USAF, Flight Test Center, Edwards AFB, Calif) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 189-205

A highly instrumented F-15 aircraft was evaluated under controlled environmental conditions Test objectives were to identify aircraft and peculiar ground support equipment problems likely to occur in arctic and tropic regions of deployment Testing consisted of operating engines and most subsystems of ambient temperatures from -65 to 85 F The climatic laboratory provided time-shared use of computer facility to supplement the F-15 on-board instrumentation system Cold start-up and subsystem operating characteristics were defined, and special procedures were developed for conducting safe and productive test flights in the natural arctic environment (Author)

A76-34245 **High angle of attack flight tests of the F-15** D N Walker (McDonnell Aircraft Co , St Louis, Mo) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 227-245

The evolution of operational tests from a flight test program designed to explore and document high-angle-of-attack flight characteristics of the F-15 is discussed, with detailed descriptions of the design and development of the spin recovery parachute system, pilot restraint system, and emergency hydraulic and electrical power systems Test program variables and priority of investigation are explained Stall characteristics, post-stall movements, stall maneuvers, and responses to aggravated and sustained flight control inputs are described The cockpit instrumentation configuration is illustrated and test sequences are indicated R D V

A76-34246 **YF-17 stall/post-stall testing** O A Levi (Northrop Corp , Aircraft Div , Hawthorne, Calif) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 247-266 5 refs

The prototype YF 17 flight test program included a stall/post-stall element whose broad objectives were expansion of the flight envelope as a prerequisite to air combat maneuvering (ACM) tests and evaluation of YF 17 departure resistance Schedule constraints dictated an accelerated one month program which conceivably could have resulted in imposition of arbitrary restrictions This paper presents a description of preliminary laboratory tests, design and qualification of emergency systems, and the high angle of attack flight test program A description of each test maneuver and results of the various tests are included After having demonstrated resistance to departure, a series of operational type maneuvers was performed These maneuvers are described and the resulting aircraft response is presented for comparison with the engineering test maneuvers (Author)

A76-34247 **Stall/post-stall/spin avoidance tests of the YA-10 aircraft** M O Schlegel and T A Martin (USAF, Flight Test Center, Edwards AFB, Ohio) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13 16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 267 286

Stall/post-stall/spin avoidance flight tests were performed with a specially modified YA 10 prototype aircraft The objectives of these tests were the verification of angle-of-attack limits and evaluation of out-of-control characteristics and recovery procedures The tests were conducted in various phases of severity of control misapplications, as defined by MIL-S-83691 Approximately 150 departures with 60 spins were obtained during a total of over 600 stalls All departures/spins required severely aggravated control misapplications of at least two seconds A simple recovery procedure is described that is effective for all out-of control situations at any airspeed, aircraft configurations, or store loading (Author)

A76-34249 **Determination of minimum catapult launch speeds** G E Clarke and A A Smith (U S Navy, Naval Air Test Center, Patuxent River, Md) In Toward more effective testing, Proceedings of the Sixth Annual Symposium, St Louis, Mo , August 13-16, 1975 Lancaster, Calif , Society of Flight Test Engineers, 1975, p 305-318.

Navy carrier based aircraft are catapult launched to maximize combat effectiveness To retain tactical flexibility of the aircraft carrier, the minimum aircraft launch speeds must be determined by flight testing Factors which establish minimum launch airspeeds include minimum longitudinal acceleration of 0 04 G, maximum vertical sink off the bow of 20 feet, 8 knots excess airspeed above the lockpoint, and minimum speed for acceptable flying qualities Test programs explore headwind and crosswind conditions on the bow catapults and verify the acceptability of bow minimums on the waist catapults The unique conditions of catapult launching have introduced several innovations to aircraft operation and design Included in these innovations are the tilt wing, oleo strut extensions, stored energy struts, nose-tail wheel ground gear, stick-straps, and full flap launches Despite the sophistication of computer simulations, shipboard launch tests are still the basis for establishing catapult launch minimums and fleet launch bulletins (Author)

A76-34313 **On the conception and measurement of trade-off in engineering systems - A case study of the aircraft design process** D Sahal (Portland State University, Portland, Ore) *Technological Forecasting and Social Change,* vol 8, no 4, 1976, p 371 384 18 refs

One of the most common forms of systems analysis is analysis of trade-off Studies have been made of longitudinal trade-off, i e , process of trade-off over time An understanding of the process of trade off would seem to be a prerequisite to development of a theory of the evolution of complex systems In the present study, an attempt is made in this direction An illustrative case of aircraft design process is studied The Pareto distribution is proposed as a relevant asymptotic model of the process of trade-off The constant-parameter (fixed-coefficient) assumption in the existing models of the evolution of complex systems is indicated to be a convenience that is not justified by the evidence The thesis is advanced that in many cases forseeing a breakthrough in systems design and engineering is possible by means of analysis of residuals in a 'properly specified' dimensional analytic framework More generally, it is suggested that evolution of complex systems is best understood in a dimensional analytic framework Implications of the results for the actual systems design, R & D project assessment, and establishing engineering standards are noted (Author)

A76-34314 **On the conception and measurement of technology - A case study of the aircraft design process** D Sahal (Portland State University, Portland, Ore) *Technological Forecasting and Social Change,* vol 8, no 4, 1976, p 385-399 28 refs

This study is aimed at the development of a theory of the measurement of technology The existing approaches to the measurement of technological change, including the economic theory of quality change, are concluded to be inappropriate A statistical version of dimensional analytic theory is presented as an alternative approach and is applied to the illustrative case of aircraft A dimensional analytic framework is proposed as an alternative to the neoclassical economic conception of the production function A theory is proposed and substantiated, stating that once the basic configuration is established, the evolution of technological systems proceeds in small steps The role of fundamental knowledge in the process of design appears to be relatively small, and fundamental shifts in individual production functions are far less frequent than is commonly believed It is shown that a dimensional analytic approach transforms the characteristics of different systems to a 'common domain' that also makes comprehensive measurement of inter technology change a possibility (Author)

A76-34481 **Determination of aerodynamic forces for aeroelastic analysis of lifting surfaces (Determinazione delle forze aerodinamiche per l'analisi aero-elastica delle superfici portanti)** P Mantegazza (Milano, Politecnico, Milan, Italy) *(Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 3rd, Turin, Italy, Sept 30-Oct 3, 1975) L'Aerotecnica - Missili e Spazio,* vol 55, Feb -Apr 1976, p 45-52 17 refs In Italian

A computer program is developed for determining nonstationary aerodynamic forces in aeroelastic analysis of subsonic aircraft The program is based on the doublet lattice method, backed up by practical experience and applicable to a variety of configurations The procedure described for solving the integral equation of a lifting surface oscillating harmonically in a subsonic stream yields acceptable results Improvements are made in the computational efficiency of the doublet lattice method for this application R D V

A76-34484 **On the aerodynamic design of airfoil cascades A new exact method based on conformal mapping (Sul progetto aerodinamico di profili alari in schiera - Un nuovo metodo esatto basato sulla trasformazione conforme)** L Polito and G Buresti (Pisa, Universita, Pisa, Italy) *(Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 3rd, Turin, Italy, Sept 30-Oct 3, 1975) L'Aerotecnica - Missili e Spazio,* vol 55, Feb -Apr 1976, p 68-74 10 refs In Italian

An exact method for solving the inverse problem in airfoil cascade design, based on conformal mapping techniques, is pre-

sented A major difficulty is that not all the functions dealing with velocity variation are compatible with the mathematical conditions of the problem The velocity distribution on the contour is solved for incompressible flow by assigning it directly as a function of the surface coordinate on the airfoil contour Modifications of the initial data are introduced in order to achieve consistency with the mathematical conditions required, and some improvements are made in computational simplicity A recommended computational sequence is given R D V

A76-34486 **Structural optimization in aeroelastic conditions** P Santini, L Balis Crema, and I Peroni (Roma, Universita, Rome, Italy) *(Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 3rd, Turin, Italy, Sept 30 Oct 3, 1975) L'Aerotecnica - Missili e Spazio,* vol 55, Feb-Apr 1976, p 83 93 9 refs

Minimum mass design for panel elements subject to a constraint on the lowest critical aerodynamic flutter parameter is studied An upper and a lower bound are imposed on panel structural thickness A variational approach to panel structural optimization with these constraints is developed for the aeroelastic problem The Pontriagin minimum principle is applied to the situation with an additional constraint confining the control variable (structural thickness) within a specified range Newton-Raphson computations are indicated A 'shooting' technique in which the whole set of equations, adjoint system included, is integrated and the initial conditions are adjusted is applied to the supersonic flutter optimization problem R D V

A76-34552 * **A complete second-order theory for the unsteady flow about an airfoil due to a periodic gust** M E Goldstein (NASA, Lewis Research Center, Cleveland, Ohio) and H Atassi (Notre Dame, University, Notre Dame, Ind) *Journal of Fluid Mechanics,* vol 74, Apr 22, 1976, p 741 765 15 refs

A uniformly valid second-order theory is developed for calculating the unsteady incompressible flow that occurs when an airfoil is subjected to a convected sinusoidal gust Explicit formulas for the airfoil response functions (i e , fluctuating lift) are given The theory accounts for the effect of the distortion of the gust by the steady-state potential flow around the airfoil, and this effect is found to have an important influence on the response functions A number of results relevant to the general theory of the scattering of vorticity waves by solid objects are also presented (Author)

A76-34661 **Flying without doing harm (Voler sans nuire)** P Varloud (Direction de la Navigation Aerienne, Paris, France) *France Transports - Aviation Civile,* Spring 1976, p 54-57 In French

Noise abatement techniques in approach and takeoff in populated urban areas were studied, and tentative solutions are suggested for the Paris region A classification is made of types of urban areas subject to airport environment noise Placement of noise barriers and changing of approach paths are considered Close attention is given to a dual-slope landing approach experiment, in which the high-altitude approach leg (3000 ft) is retained for a longer time, followed by a steep drop (6 deg) to 1000 ft, then a gentler glide (3 deg) to ground level This variant is found appreciably less noisy than a steady approach glide of 3 deg from 3000 ft to ground level over the same approach path length R D V

A76-34693 # **On mathematical simulation of separated flow past a wing and breakup of a vortex sheet in an ideal fluid (O matematicheskom modelirovanii v ideal'no zhidkosti otryvnogo obtekaniia kryla i razrusheniia vikhrevoi peleny)** V A Aparinov, S M Belotserkovskii, M I Nisht, and O N Sokolova *Akademiia Nauk SSSR, Doklady,* vol 227, Apr 1, 1976, p 820-823 5 refs In Russian

Modified methods in nonlinear stationary airfoil theory describing stable vortex cores and rollup of vortex sheets are applied to the study of the entire pattern of flow around thin delta wings in the case of either stable vortex sheets (moderate angles of attack) or vortex sheets in the process of breaking up (high angles of attack) Successive approximations are applied to each fixed attack angle A delta wing of unit aspect ratio is used as concrete illustration This approach, based on an inviscid fluid model, aids simulating of basic features of separated flow around very slender airfoils with a bow vortex sheet forming and breaking up at high angles of attack Secondary separations of flow on the sharp leading edge (in the boundary layer) and displacement of flow detachment lines may occur R D V

A76-34926 # **Lift and drag characteristics of a supercavitating cambered hydrofoil with a jet flap beneath a free surface** T Take (Shiga Prefectural Junior College, Hikone, Shiga, Japan) and T Kida (Osaka Prefecture, University, Sakai, Japan) *JSME, Bulletin,* vol 19, Apr 1976, p 377-383 13 refs

The linearized problem of a supercavitating cambered hydrofoil with a jet flap, which is operated near a free surface, is solved by using the conformal mapping technique Analyses and discussions on the lift and drag coefficients, the cavity configuration and the jet sheet configuration are carried out It is shown that (1) there occurs a lift reduction with decrease in submerged depth, (2) the cavity considerably moves up on the hydrofoil due to the jet flap, so the hydrofoil thickness can be improved, (3) the drag can be decreased by taking into account the shape of a cambered hydrofoil (Author)

A76-35222 # **Jet fuel handling and safety** L Gardner (National Research Council, Fuels and Lubricants Laboratory, Ottawa, Canada) *Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin,* no 1, 1976, p 23-29, 31-35 13 refs

Basic considerations in the safe handling of jet fuels, including fire safety and maintenance of product cleanliness, are discussed A comparison of flammability characteristics shows that wide-cut fuel is more flammable than aviation kerosene over most ambient temperature conditions, however, the flammability limits apply only to conditions when the vapor/air mixture is at equilibrium with liquid fuel Due to the fact that nonequilibrated mixtures can pass through flammable zones and to the unpredictability of dynamic effects, it is recommended that the same safety standards be applied in the handling of both fuel types Hazards associated with electrostatic charging during aircraft refuelling can be reduced by use of a static dissipator additive Removal of water and solid contaminants from aircraft fuels is imperative to eliminate hazards presented by bacteria, yeast, and fungi C K D

STAR ENTRIES

N76-24144*# Lockheed-Georgia Co Marietta
STUDY OF THE APPLICATION OF ADVANCED TECHNOLOGIES TO LAMINAR FLOW CONTROL SYSTEMS FOR SUBSONIC TRANSPORTS VOLUME 1 SUMMARY Final Report
R F Sturgeon J A Bennett, F R Etchberger, R S Ferrill and L E Meade May 1976 63 p refs
(Contract NAS1-13694)
(NASA-CR-144975 LG76ER0076-Vol-1) Avail NTIS HC $4 50 CSCL 01A

A study was conducted to evaluate the technical and economic feasibility of applying laminar flow control to the wings and empennage of long-range subsonic transport aircraft compatible with initial operation in 1985 For a design mission range of 10 186 km (5500 n mi) advanced technology laminar-flow-control (LFC) and turbulent-flow (TF) aircraft were developed for both 200 and 400-passenger payloads and compared on the basis of production costs direct operating costs and fuel efficiency Parametric analyses were conducted to establish the optimum geometry for LFC and TF aircraft, advanced LFC system concepts and arrangements were evaluated and configuration variations maximizing the effectiveness of LFC were developed For the final LFC aircraft analyses were conducted to define maintenance costs and procedures manufacturing costs and procedures and operational considerations peculiar to LFC aircraft Compared to the corresponding advanced technology TF transports the 200- and 400-passenger LFC aircraft realized reductions in fuel consumption up to 28 2% reductions in direct operating costs up to 8 4% and improvements in fuel efficiency in ssm/lb of fuel up to 39 4% Compared to current commercial transports at the design range the LFC study aircraft demonstrate improvements in fuel efficiency up to 131% Research and technology requirements requisite to the development of LFC transport aircraft were identified Author

N76-24145*# Lockheed-Georgia Co Marietta
STUDY OF THE APPLICATION OF ADVANCED TECHNOLOGIES TO LAMINAR-FLOW CONTROL SYSTEMS FOR SUBSONIC TRANSPORTS VOLUME 2 ANALYSES Final Report
R F Sturgeon J A Bennett F R Etchberger R S Ferrill and L E Meade May 1976 471 p refs
(Contract NAS1-13694)
(NASA-CR-144949 LG76ER0076-Vol-2) Avail NTIS HC $12 00 CSCL 01A
For abstract see N76-24144

N76-24146# Advisory Group for Aerospace Research and Development, Paris (France)
UNSTEADY AERODYNAMICS
Mar 1976 91 p refs Presented at the Fluid Dyn Panel Round Table Discussion on Unsteady Aerodyn Goettingen, West Germany, May 1975
(AGARD-R-645) Avail NTIS HC $5 00

Five papers are presented covering such topics as calculation methods in unsteady aerodynamics recent research results in flutter suppression transonic flow unsteady rotor blade aerodynamics wind tunnel test techniques and recent research efforts in aeroelasticity and unsteady aerodynamics at the U S Air Force Flight Dynamics Laboratory These papers gave a succinct review of the present state of aeroelasticity-oriented unsteady aerodynamics

N76-24147 Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)
UNSTEADY AERODYNAMIC PREDICTION METHODS APPLIED IN AEROELASTICITY
B Laschka *In* AGARD Unsteady Aerodyn Mar 1976 31 p refs

A brief survey is given on the basic prediction methods in unsteady aerodynamics needed in aeroelasticity After an introductory outline of some of the most important aeroelastic phenomena some representative concepts applied to calculate unsteady aerodynamic forces in subsonic and supersonic flow are described Then attention is drawn to areas which are not yet covered adequately by the presently existing theories These aeas comprise effects of gap geometry between fixed wing and control surfaces of mean incidence about which a wing or control surface is oscillating of wing thickness of Reynolds number etc Furthermore some not yet published results related to interfering multiple lifting configurations are presented These results include thrust calculations on oscillating tandem wings in incompressible flow wing induced unsteady tail loads and some downwash evaluations behind wings in supersonic flow Author

N76-24148 National Aerospace Lab Amsterdam (Netherlands)
SOME REMARKS ON UNSTEADY TRANSONIC FLOW
H Tijdeman *In* AGARD Unsteady Aerodyn Mar 1976 11 p refs

A general discussion of unsteady transonic aerodynamics is presented A simple example of an airfoil having an oscillating trailing edge flap was chosen for the discussion Results are presented from wind tunnel tests performed on the airfoil to illustrate the interactions of steady flow fields on unsteady flow fields Topics discussed include (1) various calculation methods used to compute unsteady transonic flow (finite difference theory), and (2) boundary layer interactions, and shock wave interactions causing aerodynamic loading It is shown at high subsonic and transonic speeds that unsteady airloads are influenced considerably by steady and unsteady flow fields and shock wave interactions J R T

N76-24149 Office National d Etudes et de Recherches Aerospatiales Paris (France)
UNSTEADY AERODYNAMICS OF HELICOPTER BLADES
Rolland Dat *In* AGARD Unsteady Aerodyn Mar 1976 6 p refs In FRENCH ENGLISH summary

A method that predicts the unsteady periodic aerodynamic forces on helicopter blades in forward flight is described The blade sections are assimilated to airfoils the lift at high angle attack is given by a mathematical model and the three-dimensional interferences between blades and between separate sections of the same blades are given by the linearized lifting surface theory The comparison between theoretical and experimental results is satisfactory The range of applications of the method used to synthetize the three-dimensional theory and the experiments in two-dimensional flow is not restricted to helicopters Author

N76-24150 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany) Inst fuer Aeroelastik
WIND TUNNEL TEST TECHNIQUES FOR THE MEASUREMENT OF UNSTEADY AIRLOADS ON OSCILLATING LIFTING SYSTEMS AND FULL-SPAN MODELS
H Foersching *In* AGARD Unsteady Aerodyn Mar 1976 24 p refs

The main features of wind tunnel test techniques in current use for the measurement of dynamic stability derivatives flutter coefficients and unsteady aerodynamic pressure distributions are described The presentations are illuminated by some typical test results Author

N76-24151 Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio Vehicle Dynamics Div
BRIEF OVERVIEW OF SOME AIR FORCE FLIGHT DYNAMICS LABORATORY RESEARCH EFFORTS IN AEROELASTICITY AND AERO-ACOUSTICS
Walter J Mykytow *In* AGARD Unsteady Aerodyn Mar 1976 13 p refs

The feasibility of extending active feedback control technology to flutter suppression in wings and external stores is discussed Flight tests of a B-52 full scale model are described A computer program for flutter optimization is discussed The use of composite materials in flutter suppression is examined J R T

N76-24152*# Grumman Aerospace Corp Bethpage, N Y
DEVELOPMENT OF A COMPUTER CODE FOR CALCULATING THE STEADY SUPER/HYPERSONIC INVISCID FLOW AROUND REAL CONFIGURATIONS VOLUME 2 CODE DESCRIPTION Final Report
Frank Marconi and Larry Yaeger Washington NASA May 1976 153 p ref
(Contract NAS1-11525)
(NASA-CR-2676) Avail NTIS HC $6 75 CSCL 01A

A numerical procedure was developed to compute the inviscid super/hypersonic flow field about complex vehicle geometries accurately and efficiently A second-order accurate finite difference scheme is used to integrate the three-dimensional Euler equations in regions of continuous flow, while all shock waves are computed as discontinuities via the Rankine-Hugoniot jump conditions Conformal mappings are used to develop a computational grid The effects of blunt nose entropy layers are computed in detail Real gas effects for equilibrium air are included using curve fits of Mollier charts Typical calculated results for shuttle orbiter, hypersonic transport and supersonic aircraft configurations are included to demonstrate the usefulness of this tool Author

N76-24153*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
AERODYNAMIC PERFORMANCE OF 0 4066-SCALE MODEL TO JT8D REFAN STAGE
Royce D Moore, George Kovich and Edward R Tysl Washington Mar 1976 157 p refs
(NASA-TM-X-3356 E-8040) Avail NTIS HC $6 75 CSCL 01A

The aerodynamic performance of a scale model of the split flow JT8D rafan stage is presented over a range of flows at speeds from 40 to 100 percent design The bypass stage peak efficiency of 0 800 occurred at a total weight flow of 35 82 kilograms per second and a pressure ratio of 1 697 The stall margin was 15 percent based on pressure ratio and weight flow at stall and peak efficiency conditions The data indicated that the hub region of the core stators was choked at design speed over the entire flow range tested Author

N76-24154# Princeton Univ N J Dept of Aerospace and Mechanical Sciences
CALCULATION OF AERODYNAMIC DERIVATIVES IN UNSTEADY TWO-DIMENSIONAL TRANSONIC FLOW USING DOWELL'S LINEARIZATION METHOD
Paul H Park Sep 1975 77 p refs Backup document for AIAA Synoptic, Unsteady Two-Dimensional Transonic Flow Using Dowell's Method" scheduled for publication in AIAA Journal in Oct 1976
(AMS-1238-T) Avail NTIS HC $5 00

The Dowell s linearization method was applied to the calculation of pressure derivatives with lift and moment derivatives in unsteady two-dimensional sonic flow for a parabolic arc airfoil in heave and pitch The equations for the unsteady derivatives are developed following the manner of the steady derivatives as done by Dowell A computer program was written to carry out the integrations contained in the equations Solutions are presented for various reduced frequencies and, where possible, are compared with other theories and experimental data Author

N76-24166 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany) Inst fuer Stroemungsmechanik
A FINITE DIFFERENCE METHOD FOR THE CALCULATION OF THREE-DIMENSIONAL BOUNDARY LAYERS ON SWEPT WINGS
Gert R Schneider *In its* Boundary Layer Effects 1975 p 144-168 refs

A numerical method to calculate the three-dimensional incompressible turbulent boundary layer on swept wings for different angles of yaw and different pressure distributions is presented The governing turbulent boundary layer equations are integrated using an implicit finite difference procedure with variable step sizes in conjunction with the mixing length hypothesis for the distribution of the turbulent shear stress For the mixing length the formulas of Michel et al are used with a correction function for which the local value of shear stress is used instead of the wall value as originally recommended by Van Driest for his damping factor The two nonlinear turbulent momentum equations are linearized each in one direction The following linear equations are solved one after another in an iterative procedure for which the starting values are extrapolated from the last two stations The number of iterations is controlled by the velocity values normal to the wall As starting profile for the whole numerical procedure a two-dimensional turbulent boundary layer profile with zero pressure gradient is used
Author (ESA)

N76-24170# Technische Univ Berlin (West Germany) Inst fuer Luft- und Raumfahrt
CALCULATION METHOD FOR SEPARATED FLOW OF SLENDER ARROW WINGS [EIN BERECHNUNGSVERFAHREN ZUR ABGELOESTEN STROEMUNG AM SCHLANKEN PFEILFLUEGEL]
Klaus Huenecke 1975 68 p refs In GERMAN
(ILR-5-1975, ISBN-3-7983-0541-2) Avail NTIS HC $4 50

A method for calculating the flow around a lifting wing of small to moderate span which accounts for leading edge separation was developed The isolated vortex flow is described by the Navier-Stokes equations in quasicylindrical approximation, whereas the vortices on the lifting wing are calculated using a two-dimensional panel method Experimental knowledge of vortex distribution on similar wings was used for the calculation Good agreement is obtained between calculated and observed vortex distribution ESA

N76-24173# Royal Aircraft Establishment Farnborough (England)
WIND TUNNEL MEASUREMENTS AT M=1 6 OF THE AERODYNAMIC EFFECTS OF A ROOT GAP ON A CONTROL SURFACE OF SQUARE PLANFORM MOUNTED ON A BODY
K G Winter May 1975 34 p refs
(RAE-TM-AERO-1641 BR48386) Avail NTIS HC $4 00

Increasing the root gap from 0 4 to 9 9 % span reduces the normal force for small angles of incidence of the body and zero control surface deflection by between 5 and 10 % but has little effect for zero angle of incidence and small control deflection The center of pressure moves forward by about 0 5 % chord and outboard by about 5 % span with increase of the gap for small angles of either the body or the control surface though the spanwise change for zero control deflection differs for the two lengths of body tested Author (ESA)

N76-24175# Messerschmitt-Boelkow-Blohm G m b H Ottobrunn (West Germany) Unternehmensbereich Flugzeuge
FURTHER DEVELOPMENT OF THE PANEL METHOD PART 1 NONLINEAR PANEL METHOD CONSIDERING DISCRETE SEPARATED VORTEX SHEETS ON SWEPT SLENDER WING SHAPES
W Sonnleitner and W Kraus 21 Dec 1973 148 p refs In GERMAN, ENGLISH summary
(Contract T-0250-12510-11059)
(MBB-UFE-1070-0) Avail NTIS HC $6 00

A comprehensive literature search was conducted in order to find those publications which are best suited for the calculation of wings with a small aspect ratio and a complex planform The complex planform results from the application of strakes sawteeth flaps and slats on the aircraft A nonlinear panel method was developed which doesn t know any limitation as far as planform wing-shaping and fuselage considerations are concerned Vortex models according to Bollay Gersten and Belotserkovsky were tested Author (ESA)

N76-24176# Messerschmitt-Boelkow-Blohm G m b H , Ottobrunn (West Germany) Unternehmensbereich Flugzeuge
APPLICATION OF THE MBB PANEL METHOD TO CALCULATION OF WING-BODY CONFIGURATIONS WITH EXTERNAL STORE LOADS [ANWENDUNG DES MBB-PANEL-VERFAHRENS ZUR BERECHNUNG VON FLUEGEL-RUMPF-KONFIGURATIONEN MIT AUSSENLASTEN]
R Deslandes and A Eberle 6 Mar 1974 98 p refs In GERMAN
(MBB-UFE-1073-0) Avail NTIS HC $5 00

The method was used to calculate the aerodynamic characteristics of body-wing configurations with external store It is shown that the method produces results comparable to measurements for pressure distributions, sectional loads, jointing plane coefficients and total aerodynamic coefficients Special problems such as suspension of the external store and circulative components of the store are discussed ESA

N76-24177# Bristol Univ (England) Dept of Civil Engineering
ON THE VORTEX-INDUCED LOADING ON LONG BLUFF CYLINDERS Ph D Thesis
Roger Hollins Wilkinson Mar 1974 233 p refs
Avail NTIS HC $8 00

A rigid bluff cylindrical body in a flow with its axis perpendicular to the approach direction will experience periodic forces superimposed on the steady lift and drag These forces are associated with vortices shed from the body with their axes approximately parallel to that of the cylinder However the vortices are not truly parallel with the shedding cylinder the shedding process being of varying phase along the span An experimental study is made of the three-dimensionality of the shedding process and its effect upon the total dynamic loading on the cylinder It has been shown by previous workers that, if the shedding cylinder undergoes cross flow oscillation at a frequency similar to that of the vortex shedding from the stationary cylinder the vortex shedding process is modified The interaction between the flow field and structural movement is studied by measurement of the mean and dynamic pressure distributions on a long square cylinder whilst stationary and during forced vibration The dynamic pressure field is studied by measurement of the root mean square of the surface pressure distributions together with measurement of the normalized cross-correlation field to enable the total dynamic loads on the cylinder to be ascertained Author (ESA)

N76-24178# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany) Inst fuer Aerodynamik
FLOW INVESTIGATION ON WINGS WITH KINKED LEADING EDGES AND SWEPT OUTER WINGS AT MODERATE SUBSONIC SPEED
W Schroeder Jun 1974 60 p refs In GERMAN ENGLISH summary
(DLR-IB-151-74/11) Avail NTIS HC $4 50

Wind tunnel measurements at Reynolds numbers of Re = 0 4 x 1 million and 1 million were performed on two wings which consist of a highly swept (65 deg inner portion - strake), and a moderately swept (30 deg) or highly swept (65 deg) outer portion The experiments comprised of three component force measurements, oil flow visualization of surface streamlines, flow visualization by means of smoke and total pressure measurements in the flow field Additionally, the flow around the wings was observed with dye in a water tunnel at Reynolds numbers Re = 2 000 and 10,000 The investigations revealed that for small angles of incidence the wings exhibit linear characteristics corresponding to their aspect ratios At higher angles of incidence the aerodynamic behavior is governed by well defined flow separation on the inner and outer wing portions The wing with moderately swept outer portion behaves as a double-delta wing with two pairs of concentrated vortices over its inner and outer portions In the case of the wing with highly swept outer portion the concentrated vortices originating from the strakes maintain their straight direction along the outer wing portion The behavior of this wing is similar to that of a plain delta wing Author (ESA)

N76-24180# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abteilung Theoretische Aerodynamik
AIRFOIL DESIGN FOR A PRESCRIBED VELOCITY DISTRIBUTION IN TRANSONIC FLOW BY AN INTEGRAL METHOD
H Hansen Aug 1975 27 p refs Presented at the Symp Transsonicum II Goettingen, West Ger 8-13 Sep 1975
(DLR IB 151-75/8) Avail NTIS HC $4 00

A method is presented to calculate an airfoil contour for a prescribed subsonic free stream Mach number and a contour pressure distribution based on the K Oswatitsch integral method A reduced potential equation was derived for small perturbations in transonic flow which is also valid for flows in stagnation regions without restrictions concerning the magnitude of perturbations An integral method is developed for the solution This means that an integration has to be carried out for the design problem, which is performed partly analytically and partly numerically The integral relation reduces the design problem in nonlinear compressible flow to a corresponding one in linear incompressible flow which is solved by well-proven methods The method is applied to calculate airfoil contours for prescribed subcritical pressure distributions without and with lift as well as for nonlifting pressure distributions without and with weak shocks The results show acceptable agreement with those of inverse methods and exact solutions Author (ESA)

N76-24181# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abteilung Entwurfsaerodynamik
CALCULATION OF BUFFET ONSET FOR SUPERCRITICAL AIRFOILS
G Redeker Aug 1975 20 p refs Presented at the IUTAM Symp Transsonicum II Goettingen, West Ger 8-13 Sep 1975
(DLR-IB-151-75/12) Avail NTIS HC $3 50

The method of Thomas for calculating buffet onset was improved in such a way that supercritical airfoils as well as high angles of attack and high lift coefficients can be treated Calculated examples of buffet-onset boundaries for supercritical airfoils show a benefit in lift coefficient and Mach number compared with those of conventional airfoils Measured buffet onset for the Korn airfoil No 1 is well predicted by the calculation method Author (ESA)

N76-24182# European Space Agency, Paris (France)
THEORETICAL ANALYSIS AND PREDICTION METHODS FOR A THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER
Jean Cousteix Jan 1976 189 p refs Transl into ENGLISH of Anal Theorique et Moyens de Prevision de la Couche Limite Turbulente Tridimensionelle ONERA Paris Report ONERA-P-157, 1974
(ESA-TT-238 ONERA-P-157) Avail NTIS HC $7 50

A theoretical analysis of the behavior of a three-dimensional turbulent boundary layer is established by means of similarity solutions, using an improved mixing-length model Various comparisons show that these solutions provide a family of velocity profiles particularly for the transverse flow velocity which correcly represent the physical behavior The hypotheses which form the essential basis for an integral method of calculation can be defined Such a method is derived for the general case of an arbitrary coordinate-system and for a compressible flow on an adiabatic wall up to Mach numbers of about 4 0 This method is applied

to some experimental cases the results produced are compared with those from a method which solves the local equations applied to the special case of infinite swept wings Author (ESA)

N76-24184# European Space Agency, Paris (France)
INVESTIGATION OF THE MUTUAL INTERFERENCE OF WING/ENGINE COMBINATIONS
Manfred Wittmann et al Dec 1975 173 p refs Transl into ENGLISH of Untersuch der gegenseitigen Beeinflussung von Fluegel-Triebwerk-Kombinationen Tech Hochschule Aachen Report DLR-FB-74-32 22 Apr 1974 Original German report available from DFVLR Porz West Ger DM 60 20
(ESA-TT-217 DLR-FB-74-32) Avail NTIS HC $6 75

The mutual interference between wing and engine nacelle is significant since aircraft engines are often arranged either above or below the wing For theoretical calculations the wing is represented by a flat plate and the engine nacelle by a cylinder composed of source and vortex singularities The normal velocity components induced on the wing by the nacelle are simulated by additional singularities on the wing in order to obtain a first approximation of the modified pressure distribution Experimental results are represented for nine wing/nacelle combinations and three angles of attack Three different intake blockages are also considered For several cases the theoretical and experimental results are compared Author (ESA)

N76-24189# Air Force Inst of Tech Wright-Patterson AFB, Ohio School of Engineering
AERODYNAMIC FORCES ON A BLUNT STORE RELEASED FROM A SWEPT WING M S Thesis
Robert A Grow 19 Dec 1975 103 p refs
(AD-A019330, GAE/MD/75D-6) Avail NTIS CSCL 01/1

The analysis of the forces on a body released from an aircraft is separated into two categories The analysis of the flow around a wing and the analysis of a body in a non-uniform flow field The flow around a wing was determined using a vortex lattice on a flat plate wing with constant sweep angles The body was modelled by an ellipsoid of revolution forebody and a paraboloid of revolution afterbody The axial flow velocities were determined by using slender body theory for axial flow except in the region of the blunt nose and tail The cross flow velocities, and the axial flow velocities near the nose and tail were determined by computing the flow around spheres tangent to the body at every control point Drag was simulated for potential theory by artificially accelerating the flow on the leeward side of the spheres GRA

N76-24190# Naval Intelligence Support Center, Washington D C Translation Div
APPROXIMATE METHOD OF CALCULATING THE INTERACTION OF FINITE-SPAN AIRFOILS IN UNSTEADY MOTION ABOVE A SOLID SURFACE
V K Treshkov 26 Nov 1975 9 p refs Transl into ENGLISH from Tr Leningrad Korablestroitelnyi Inst (Leningrad) v 80 1972 p 87-92
(AD-A019222 NISC-Trans-3718) Avail NTIS CSCL 01/1

The interaction of the wing and tail assembly in unsteady motion is examined An approximate method developed to determine the aerodynamic characteristics of the system is presented J M S

N76-24208*# Calspan Corp Buffalo N Y
EVALUATION OF XV-15 TILT ROTOR AIRCRAFT FOR FLYING QUALITIES RESEARCH APPLICATION Final Report, Jun - Dec 1975
Robert C Radford Arno E Schelhorn Ralph J Siracuse Robert D Till and Richard Wasserman Apr 1976 132 p refs Sponsored in part by USAAMRDL
(Contract NAS2-8855)
(NASA-CR-137828 AK-5752-F-1) Avail NTIS HC $6 00 CSCL 01C

The results of a design review study and evaluation of the XV-15 Tilt Rotor Research Aircraft for flying qualities research application are presented The objectives of the program were to determine the capability of the XV-15 aircraft and the V/STOLAND system as a safe inflight facility to provide meaningful research data on flying qualities, flight control systems and information display systems Author

N76-24209# Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne (West Germany)
CONTRIBUTIONS TO HELICOPTER TECHNOLOGY
DFVLR 21 Nov 1975 185 p refs In GERMAN ENGLISH summary Proc of the Meeting of the DGLR Sci Comm 2A2 on Rotary Wing Aircraft Stuttgart 18 Oct 1974
(DLR-MITT-75-24) Avail NTIS HC $7 50 DFVLR Cologne DM 66 40

Developments in helicopter technology are discussed Topics covered are problems of transonic flow in rotor aerodynamics possibilities and problems of noise reduction, special problems with the identification of flight dynamic parameters of helicopters application of ground vibration test methods to the solution of aeroelastic problems of V/STOL-rotary wing aircraft, configuration and flight mechanics of a ship-based unmanned rotor platform and studies for a twin-rotor helicopter configuration with utilization of the aerodynamic potential of the advancing rotor blade

N76-24210 Messerschmitt-Boelkow-Blohm G m b H Ottobrunn (West Germany)
TRANSONIC PROBLEMS IN ROTOR AERODYNAMICS [TRANSSONIKPROBLEME DER ROTORAERODYNAMIK]

S Wagner *In* DGLR Contrib to Helicopter Technol 21 Nov 1975 p 11-52 refs In GERMAN

The rotor-blade supersonic regions and position of the compression shocks were determined for transonic flow over the circular rotor disk and over the advancing blade using a blade element theory The resulting aerodynamic problems and the technology for resolving these are discussed The following proposals are made for improving the present knowledge gap in this field investigation of feasibility of supercritical rotor profiles, construction of appropriate throughflow models in 3-D computation methods for more exact evaluation of local flow conditions, especially for transonic flow further development of the 3-D relaxation method for calculation of transonic aerodynamics of the rotor blade and pressure distribution measurements of rotors for better understanding of the physics especially at transonic flow ESA

N76-24211 Messerschmitt-Boelkow-Blohm G m b H Ottobrunn (West Germany)
POSSIBILITIES AND PROBLEMS OF HELICOPTER NOISE REDUCTION [MOEGLICHKEITEN UND PROBLEME DER LAERMMINDERUNG AM HUBSCHRAUBER]
V Langenbucher and E Laudien *In its* Contrib to Helicopter Technol 21 Nov 1975 p 53-100 refs In GERMAN

The generation mechanisms of helicopter noise radiation are discussed and possibilities for reduction of the essential mechanical and aerodynamic noise sources are surveyed External rotor noise can be reduced by a different layout of both rotors leading to a weight and performance penalty Also aerodynamic improvements of rotors are possible Mechanical noise sources are mainly responsible for internal noise Cabin noise can be reduced by reduction of the sound emission of individual noise sources structural measures, and the use of sound absorbing material in cabin linings ESA

N76-24212 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany) Inst fuer Aeroelastik
STATIC VIBRATION TESTS FOR RESOLVING AEROELASTIC PROBLEMS OF V/STOL ROTARY WING AIRCRAFT [ANWENDUNG DER STANDSCHWINGUNGSTECHNIK BEI DER LOESUNG AEROELASTISCHER PROBLEME VON V/STOL-DREHFLUEGELFLUGZEUGEN]

F Kiessling *In* DGLR Contrib to Helicopter Technol 21 Nov 1975 p 105-130 refs In GERMAN

Proposals are made for static vibration testing methods of V/STOL rotary wing aircraft A static vibration test was used to determine self vibration forms of a weakly damped elastic structure with the associated modal characteristics The principles of this test are detailed accentuating a phase resonance method For V/STOL rotary wing aircraft the rotation of the elastic rotors provokes additional effects such as gyroscopic coupling and variations of the blade stiffness by centrifugal forces These should be considered in often very complicated analytical models Proposals are based on these concepts Correction terms are given for the effects of the rotating parts which can be calculated from test results of nonrotating rotors ESA

N76-24213 Dornier-System G m b H Friedrichshafen (West Germany)
CONCEPTION AND FLIGHT MECHANICS OF A SHIP-SUPPORTED UNMANNED ROTOR PLATFORM [BEITRAEGE ZUR KONZEPTION UND FLUGMECHANIK EINER SCHIFFSGESTUETZTEN UNBEMANNTEN ROTORPLATTFORM]
G Engel *In* DGLR Contrib to Helicopter Technol 21 Nov 1975 p 131-144 In GERMAN

The conception of an unmanned rotor platform attached to a ship by means of a 300 m tetherline (umbilical connection), for reconnaissance and navigation, is discussed A captive rotor platform can carry not only sea radar but also other sensors and sensor combinations, such as data communication relay equipment The platform is compared to other air support, such as helicopters, the possibility of long flight durations is emphasized Flight mechanics of the platform are described ESA

N76-24214 Vereinigte Flugtechnische Werke-Fokker G m b H Bremen (West Germany)
ADVANCED SIDE-BY-SIDE CONCEPT
In DGLR Contrib to Helicopter Technol 21 Nov 1975 p 145-184 In GERMAN

The design of a helicopter with a side-by-side rotor configuration using the aerodynamic potential of the advancing rotor blade is discussed The object of such configurations is to increase helicopter maximum velocity and maneuverability using established technologies The concept is analyzed from the points of view of rotor aerodynamics forces and moments, stability controllability, geometry and weight The advantages of the design as compared to conventional helicopters are enumerated A proposal is made for an experiment using a modified Bell Jet-Ranger ESA

N76-24215# Messerschmitt-Boelkow-Blohm G m b H Ottobrunn (West Germany) Unternehmensbereich Flugzeuge
WEIGHT PREDICTION METHODS - GRUGEW PROGRAM
Dietrich Klein 21 Dec 1973 161 p refs In GERMAN, ENGLISH summary
(MBB-UFE-1072-0) Avail NTIS HC $6 75

A computer program for the calculation of group weights for structure, propulsion and equipment was developed for the purpose of weight prediction The take-off weight is compiled from the addition of weight for payloads hydraulic fluid and fuel to the above group weights The equations included in the existing program may be used for weight prediction in the preliminary design phase of an aircraft project The compiled group weight is printed out in accordance with MIL-STD 254/451 mod Group Weight Statement Author (ESA)

N76-24216# European Space Agency Paris (France)
GROUND SIMULATION OF FLUTTER ON AIRCRAFT WITH HIGH-ASPECT-RATIO WINGS
Perumal Rajagopal Feb 1976 54 p refs Transl into ENGLISH of Simulation au Sol du Flottement pour les Avions de Grand Allongement ONERA, Paris Report ONERA-NT-222 1974
(ESA-TT-263, ONERA-NT-222) Avail NTIS HC $4 50

A method is proposed for the simulation of the unsteady aerodynamic forces which act upon an aircraft in flight by means of an electromechanical apparatus The principle is as follows the aircraft being on the ground an electronic circuit is used to calculate the aerodynamic forces from the accelerations measured on the structure and to transmit the results of the calculations to exciters The analog computer linking the forces to the exciters includes a potentiometer on which the speed parameter may be set The evolution in the damping phenomena may readily be monitored on a cathode screen The advantage of this method is that it is not necessary to measure either the generalized aircraft parameters or its deformations Also implicit allowance is made for the nonlinearities of the structure, since the test takes place on the structure itself A test on a model is described and compared with a classical flutter calculation The results are very encouraging Author (ESA)

N76-24218# Dayton Univ Ohio Research Inst
DEVELOPMENT OF FLIGHT-BY-FLIGHT FATIGUE TEST DATA FROM STATISTICAL DISTRIBUTIONS OF AIRCRAFT STRESS DATA, VOLUME 1 Final Report
George J Roth AFFDL May 1975 138 p refs
(Contract F33615-73-C-3007 HF136703)
(AD-A016406, AFFDL-TR-75-16-Vol-1) Avail NTIS CSCL 20/11

Axially loaded specimens of 7075-T651 aluminum with a hole were fatigue tested using loading histories derived from strain gage data recorded on operational aircraft For the baseline data the magnitude and order in which the loads occurred during a flight were preserved The flight contained data from taxi takeoff, flight and landing strain histories The data were processed by several counting techniques to obtain statistical distributions of the cyclic and mean stress amplitudes as well as the number of stress cycles per flight for both the ground operations and the inflight operations These distributions were then used to generate a series of flight-by-flight test sequences Three different counting techniques were used to determine the statistical distribution of the cyclic stress for each of two aircraft types The report presents the results in terms of the number of flights to failure for 9 sequences of B-58 data and 6 sequences for the F-106 data A total of 91 specimens were tested The report concludes that simulated testing sequences can yield the same fatigue life as the original strain gage data recorded on operational aircraft GRA

N76-24219# Dayton Univ, Ohio Research Inst
DEVELOPMENT OF FLIGHT-BY-FLIGHT FATIGUE TEST DATA FROM STATISTICAL DISTRIBUTIONS OF AIRCRAFT STRESS DATA VOLUME 2 DOCUMENTATION OF THE B-58 AND F-106 FATIGUE SPECTRA SIMULATION PROGRAM Final Report, Oct 1972 - Jan 1974
Michael C Hill AFFDL May 1975 405 p
(Contract F33615-73-C-3007)
(AD-A016407 AFFDL-TR-75-16-Vol-2) Avail NTIS CSCL 20/11

This report documents the computer programs and subroutines written in support of the effort presented in Volume I The report describes and documents two aircraft simulation programs used to process flight loads data derived from B-58 and F-106 aircraft flying operational missions A simulation merge program is also included which combines the output tapes from the aircraft simulation programs and generates an output tape compatible with the hybrid computer The program listings and sample problems for the simulation programs are presented in the Appendices GRA

N76-24222# Naval Air Development Center Warminster Pa Air Vehicle Technology Dept
NAVY JET TRAINER (VTX) CONCEPTUAL DESIGN STUDIES
W E Becker 10 Dec 1975 76 p refs
(AD-A018779 NADC-75198-30) Avail NTIS CSCL 01/3

The VTX aircraft is intended to fill the future trainer role for basic and advanced flight training of Navy undergraduate jet pilots The vehicle design studies include definition of a baseline VTX configuration and examination of take-off gross weight sensitivity to six performance/design parameters (sustained

maneuvering load factor service ceiling avionics payload structural limit load factor, maximum speed and range) Vehicle design synthesis and performance estimation are accomplished with the aid of HIPERAC a tactical aircraft design tool developed by NAVAIRDEVCEN The VTX vehicle design serves principally as a tool for examining the design implications of preliminary requirements proposed for Navy jet trainer aircraft Initially three driving performance requirements (sustained maneuverability take-off distance and landing distance) and a fuel-critical mission (Low Level Operational Navigation) are identified then a vehicle configuration is developed to satisfy these constraints The take-off gross weight of this vehicle is 12 235 lbs and it is powered by two turbofan engines of 3 475 lbs rated thrust apiece Maximum Mach number is 0 84 at 30 000 ft altitude maximum sustained normal acceleration at 18 000 ft is 4g s service ceiling is 52 700 ft and maximum range is 1 573 n mi Takeoff gross weight is particularly sensitive to increases in sustained load factor maximum speed and service ceiling but much less sensitive to reductions in these parameters because reduced weight design solutions are bounded by the take-off distance constraint
Author (GRA)

N76-24223# Naval Air Development Center Warminster Pa Air Vehicle Technology Dept
CATAPULT LAUNCH FATIGUE INVESTIGATION OF THE MODEL E-1B/C-1 AIRPLANE Final Report
H D Lystad 19 Nov 1975 51 p
(AD-A019519 NADC-75310-30) Avail NTIS CSCL 01/3

A laboratory fatigue investigation was performed on an E-1B fuselage with a reinforced catapult keel to determine if it could sustain the loads associated with 3 000 catapult launches The bulkhead at fuselage station 135 failed after 8 420 test cycles of the catapult start of run condition Using a test scatter factor of 2 this is equivalent to 4 210 service catapult launches The holdback structure failed after 8,188 test cycles of the catapult release condition Again using a test scatter factor of 2 this is equivalent to 4,094 service catapult releases GRA

N76-24225# IIT Research Inst Chicago Ill
RELIABILITY ASSESSMENT OF MODIFIED FIELDED AIRCRAFT USING THE BAYESIAN TECHNIQUE Final Report, Feb - Nov 1975
Vernon D Allen and N Thomompoulos 15 Nov 1975 71 p
(Contract DAAJ01-75-C-0307)
(AD-A018890 USAAVSCOM-TR-75-50) Avail NTIS CSCL 01/3

This manual provides a detailed description of the methodology and computer code developed for the U S Army Aviation Systems Command (AVSCOM) which estimates reliability and mean-time-between-failure (MTBF) of an aircraft system using Bayesian methods The computer code calculates MTBF cost and reliability for each item of the aircraft system based on the historical data alone and by Bayes theory which combines the historical data with the test data Author (GRA)

N76-24227# Rockwell International Corp Columbus Ohio Columbus Div
T-28 SERVICE LIFE EVALUATION Quarterly Report
J G Hutcheson and J J Gruff 18 Aug 1975 61 p Revised
(Contracts N000156-73-C-0152 N062269-74-C-0718)
(AD-A018907 NR73H-35 QR-8) Avail NTIS CSCL 01/3

In this report a meeting at NARF-Pensacola on the NIFTS program is briefly reviewed wind lug crack propagation test results are re-evaluated to determine maximum periods between NDI inspections and procedures for evaluation of T-28B/C service lives are revised per previous discussions with NADC personnel In addition the report presents a statistical summary of T-28B/C landing data and an evaluation of recent USAF full scale fatigue tests on a T-28D-5 airplane in terms of Navy T-28 operations GRA

N76-24228# New Mexico Inst of Mining and Technology Socorro
MODIFICATION OF DRONE SAILPLANE INTO A SPECIAL PURPOSE TEST VEHICLE FOR ATMOSPHERIC RESEARCH Final Report, 1 Jan 1974 - 30 Jun 1975
C B Moore and J W Bullock 4 Nov 1975 52 p
(Contract N00014-67-A-0267-0009 NR Proj 211-194 RR0330301)
(AD-A019436) Avail NTIS CSCL 01/3

A powered sailplane drone excess to a U S Air Force program, has been converted into a special purpose piloted test vehicle for atmospheric research The converted aircraft was used in support of the Apollo-Soyuz space flight in July 1975 and in Navy-sponsored thunderstorm research GRA

N76-24229# Lockheed-California Co Burbank
THE DEVELOPMENT OF AN ADVANCED ANTI-ICING/DEICING CAPABILITY FOR US ARMY HELICOPTERS VOLUME 1 DESIGN CRITERIA AND TECHNOLOGY CONSIDERATIONS Final Report, 30 Jun 1973 - 30 Jun. 1975
J B Werner Nov 1975 255 p refs
(Contract DAAJ02-73-C-0107 DA Proj 1F2-62209-AH-76)
(AD-A019044 LR-27180-Vol-1 USAAMRDL-TR-75-341) Avail NTIS CSCL 01/3

The work which has been accomplished under this program is reported in two volumes Volume 1 discusses (1) icing severity level analysis and recommended design criteria (2) adverse weather protection technology (3) a trade-off comparison of different types of ice protection systems for various categories of helicopters and (4) a technology development program for an advanced electrothermal deicing system Volume 2, Ice Protection System Application to the UH-1H Helicopter describes the application of the recommended electrothermal deicing system to a UH-1H test aircraft It provides a detailed description of the modifications to the basic aircraft (including the flight test-instrumentation) and the results of the ground and flight test program for that aircraft conducted in the winter of 1975-75 GRA

N76-24230# Lockheed-California Co Burbank
THE DEVELOPMENT OF AN ADVANCED ANTI-ICING/DEICING CAPABILITY FOR US ARMY HELICOPTERS VOLUME 2 ICE PROTECTION SYSTEM APPLICATION TO THE UH-1H HELICOPTER Final Report, 30 Jun 1973 - 30 Jun 1975
J B Werner Nov 1975 222 p
(Contract DAAJ02-73-C-0107 DA Proj 1F2-62209-AH-76)
(AD-A019049, LR-27180-Vol-2, USAAMRDL-TR-75-34B) Avail NTIS CSCL 01/3
For abstract see N76-24229

N76-24233# Tennessee Univ Space Inst Tullahoma
INVESTIGATION OF FEASIBLE NOZZLE CONFIGURATIONS FOR NOISE REDUCTION IN TURBOFAN AND TURBOJET AIRCRAFT VOLUME 1 SUMMARY AND SELECTED MULTINOZZLE CONFIGURATIONS Final Report, Jun 1972 - Jul 1975
B H Goethert, J R Maus, W A Dunnill et al Jul 1975 336 p refs
(Contract DOT-FA72WA-3053)
(AD-A019645/1 FAA-RD-75-163-Vol-1) Avail NTIS HC $9 25 CSCL 17B

Techniques were developed for reducing the noise generated by high velocity jet streams exhausting from a wide variety of nozzle configurations In addition to exploring techniques for noise suppression and/or redirection emphasis was placed on investigating the physical mechanisms at work in the generation, suppression and redirection of aerodynamic noise An overall summary of the work, a description of the facilities used, and a description of the results obtained on linear arrays of circular nozzles and dual nozzles with shrouds are given Author

N76-24234# Tennessee Univ Space Inst Tullahoma
INVESTIGATION OF FEASIBLE NOZZLE CONFIGURATIONS FOR NOISE REDUCTION IN TURBOFAN AND TURBOJET AIRCRAFT VOLUME 2 SLOT NOZZLE CONFIGURATIONS Final Report, Jun 1972 - Jul 1975

B H Goethert J R Maus, W A Dunnill et al Jul 1975 342 p refs
(Contract DOT-FA72WA-3053)
(AD-A019646/9 FAA-RD-75-163-Vol-2) Avail NTIS HC $4 50 CSCL 17B

Results obtained for two dimensional rectangular slot nozzles without and with straight attached flaps are presented For vol 1 see N76-24233 Author

N76-24236*# General Electric Co Evendale, Ohio Advanced Engineering and Technology Programs Dept
SINGLE STAGE, LOW NOISE, ADVANCED TECHNOLOGY FAN VOLUME 1 AERODYNAMIC DESIGN
T J Sullivan, J L Younghans, and D R Little Mar 1976 145 p refs
(Contract NAS3-16813)
(NASA-CR-134801, R76AEG257-Vol-1) Avail NTIS HC $6 00 CSCL 21E

The aerodynamic design for a half-scale fan vehicle which would have application on an advanced transport aircraft is described The single stage advanced technology fan was designed to a pressure ratio of 1 8 at a tip speed of 503 m/sec 11 650 ft/sec) The fan and booster components are designed in a scale model flow size convenient for testing with existing facility and vehicle hardware The design corrected flow per unit annulus area at the fan face is 215 kg/sec sq m (44 0 lb m/sec sq ft) with a hub-tip ratio of 0 38 at the leading edge of the fan rotor This results in an inlet corrected airflow of 117 9 kg/sec (259 9 lb m/sec) for the selected rotor tip diameter if 90 37 cm (35 58 in) The variable geometry inlet is designed utilizing a combination of high throat Mach number and acoustic treatment in the inlet diffuser for noise suppression (hybrid inlet) A variable fan exhaust nozzle was assumed in conjunction with the variable inlet throat area to limit the required area change of the inlet throat at approach and hence limit the overall diffusion and inlet length The fan exit duct design was primarily influenced by acoustic requirements, including length of suppressor wall treatment, length, thickness and position on a duct splitter for additional suppressor treatment and duct surface Mach numbers Author

N76-24237*# General Electric Co Evendale, Ohio Advanced Engineering and Technology Programs Dept
SINGLE STAGE, LOW NOISE, ADVANCED TECHNOLOGY FAN VOLUME 2 STRUCTURAL DESIGN
J L Schoener, G R Black and R H Roth Mar 1976 50 p refs
(Contract NAS3-16813)
(NASA-CR-134802, R76AEG258-Vol-2) Avail NTIS HC $4 00 CSCL 21E

The structural design for a half-scale fan vehicle which would have application on an advanced transport aircraft, is described The single stage advanced technology fan was designed to a pressure ratio of 1 8 at a tip speed of 503 m/sec (1 650 ft/sec) This mechanical design report describes the fan rotor design and the design of various structures of the vehicle eg stators, casings, splitters seals, adapters, etc Author

N76-24238*# General Electric Co Evendale, Ohio Advanced Engineering and Technology Programs Dept
SINGLE STAGE, LOW NOISE ADVANCED TECHNOLOGY FAN VOLUME 3 ACOUSTIC DESIGN
S B Kazin and R B Mishler Mar 1976 56 p refs
(Contract NAS3-16813)
(NASA-CR-134803, R76AEG259-Vol-3) Avail NTIS HC $4 50 CSCL 21E

The acoustic design for a half-scale fan vehicle which would have application on an advanced transport aircraft is described The single stage advanced technology fan was designed to a pressure ratio of 1 8 at a tip speed of 503 m/sec (1,650 ft/sec) The two basic approaches taken in the acoustic design were (1) minimization of noise at the source and (2) suppression of the generated noise in the inlet and bypass exhaust duct Suppression of the generated noise is accomplished in the inlet through use of the hybrid concept (wall acoustic treatment plus airflow acceleration suppression) and in the exhaust duct with extensive acoustic treatment including a splitter The goal of the design was attainment of twenty effective perceived noise decibels (20 EPNdB) below current Federal Air Regulation noise standards for a full-scale fan at the takeoff cutback and approach conditions Predicted unsuppressed and suppressed fore and aft maximum perceived noise levels indicate that the cutback condition is the most critical with respect to the goal which is probably unattainable for that condition This is also true for aft radiated noise in the approach condition Author

N76-24239# Boeing Co , Wichita Kans
FAA JT3D QUIET NACELLE RETROFIT FEASIBILITY PROGRAM VOLUME 2, ADDENDUM A MODEL AND FULL SCALE PLUG NOZZLE TESTS Final Report, Jul 1974 - Mar 1975
J E Mayer, L L Linscheid and H F Veldman Apr 1975 220 p refs
(Contract DOT-FA71WA-2628)
(AD-A023037/5 FAA-RD-73-131-Vol-2-Add-A D3-9042-6) Avail NTIS HC $7 75 CSCL 20/1

Previous tests of plug nozzles resulted in conflicting evidence of acoustic suppression Model scale plug nozzles provided significant jet noise suppression limited or no noise suppression was observed during tests of full scale plug nozzles The tests reported in this addendum were performed to identify the reason for noncorrelation between model and full scale acoustic results Four one-sixth scale primary exhaust steam plug nozzle configurations were tested to determine acoustic performance A one-sixth scale conical nozzle was tested to provide an acoustic baseline The model scale revised Phase 2 plug provided acoustic suppression The model scale revised Phase 2 plug with a long conical afterbody provided additional suppression The revised Phase 2 plug and the plug with long conical afterbody were tested full scale on a 707/JT3D quiet nacelle Only slight suppression was observed with the revised Phase 2 plug no additional suppression was observed with the long conical afterbody configuration Analyses were performed to identify the reason for noncorrelation between model and full scale acoustic results It was found that the acoustic performance of the model scale plug nozzle was essentially independent of the fan stream, whereas full scale acoustic levels with fan flow were consistently higher than without fan flow A geometric comparison of model and full scale revealed that the primary exhaust stream of the model simulated full scale The fan stream of the model included an idealization which did not exactly replicate the full scale fan duct It is believed that the geometric configuration of the full scale fan duct provided an additional noise source which was not present in the scale model and that this additional noise effectively masked the suppression provided by the full scale plug nozzle Author

N76-24240*# General Dynamics/Fort Worth Tex
INLET SPILLAGE DRAG TESTS AND NUMERICAL FLOW-FIELD ANALYSIS AT SUBSONIC AND TRANSONIC SPEEDS OF A 1/8-SCALE, TWO-DIMENSIONAL, EXTERNAL-COMPRESSION, VARIABLE-GEOMETRY, SUPERSONIC INLET CONFIGURATION
J E Hawkins, F P Kirkland, and R L Turner Washington NASA Apr 1976 107 p refs
(Contract NAS2-7210)
(NASA-CR-2680) Avail NTIS HC $5 50 CSCL 21E

Accurate spillage drag and pressure data are presented for a realistic supersonic inlet configuration Results are compared with predictions from a finite-differencing, inviscid analysis computer procedure The analytical technique shows good promise for the evaluation of inlet drag but necessary refinements were identified A detailed description of the analytical procedure is contained in the Appendix Author

N76-24242*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
SMALL, LOW-COST, EXPENDABLE TURBOJET ENGINE 1 DESIGN, FABRICATION, AND PRELIMINARY TESTING
Robert P Dengler and Lawrence E Macioce Washington May 1976 51 p refs
(NASA-TM-X-3392, E-8590) Avail NTIS HC $4 50 CSCL 21E

A small experimental axial-flow turbojet engine in the 2 669-Newton (600-lbf) thrust class was designed fabricated, and tested to demonstrate the feasibility of several low-cost concepts Design simplicity was stressed in order to reduce the number of components and machining operations Four engines were built and tested for a total of 157 hours Engine testing was conducted at both sea-level static and simulated flight conditions for engine speeds as high as 38 000 rpm and turbine-inlet temperatures as high as 1 255 K (1 800 F) Author

N76-24243# European Space Agency Paris (France)
ENGINE NOISE
Feb 1976 276 p refs Transl into ENGLISH of Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21 1974 294 p Proc of DGLR Tech Comm for Airbreathing Propulsion Systems Symp Brunswick, 20-21 Feb 1974 Original German report available from ZLDI Munich DM 57 75
(ESA-TT-244 DLR-Mitt-74-21) Avail NTIS HC $9 25

Several aspects of aircraft noise are considered They include jet noise human reactions to aircraft noise in general, noise regulations, turbofan engine noise compressor noise wing and tail screening effects on engine noise and propeller aircraft noise

N76-24244 European Space Agency Paris (France)
OPTIMISED ENGINES FOR QSTOL APPLICATIONS
Joachim Kurzke *In its* Engine Noise (ESA-TT-244) Feb 1976 p 9-34 refs Transl into ENGLISH from Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21 1974 p 9-34

The requirements of QSTOL propulsion are discussed A typical example of a quiet two-shaft bypass engine with variable nozzle in the bypass duct was selected The calculation of fan and jet noise is discussed A performance calculation of the take-off and flight condition as well as assumptions for the determination of the engine size and the component efficiency are briefly described The selected engine is optimized taking eight free

N76-24247 European Space Agency Paris (France)
AIRCRAFT NOISE LIMITS
Friedrich Karl Franzmeyer *In its* Engine Noise (ESA-TT-244) Feb 1976 p 54-68 refs Transl into ENGLISH from 'Triebwerkslaerm' DGLR Cologne Report DLR-Mitt-74-21 1974 p 49-65

The effect of noise limit regulations upon the technical design of civil aircraft is discussed The noise limits were laid down as a function of weight because it was considered that a higher flying weight requires higher powered engines generating a higher noise level ESA

N76-24248 European Space Agency Paris (France)
ON THE CALCULATION OF FAN NOISE
Klaus Heinig *In its* Engine Noise (ESA-TT-244) Feb 1976 p 70-92 refs Transl into ENGLISH from 'Triebwerkslaerm' DGLR Cologne Report DLR-Mitt-74-21 1974 p 67-87

For high bypass ratio aircraft turbines the noise generated by the unsteady aerodynamic forces and the propagation of the noise inside and outside the fan can be calculated by means of the heterogeneous wave equation When determining the noise from engine fans whose cross section dimensions are greater than the wave length of the generated noise, the effect of the fan duct on the noise generation can be neglected Contrary to the calculation of the sound generation of the aerodynamic forces the calculation of unsteady aerodynamic forces is still in its infancy In spite of the factors neglected in the determination of the unsteady aerodynamic forces the measured and calculated fan noise levels agree well even at this stage Author (ESA)

N76-24249 European Space Agency Paris (France)
SOME TECHNICAL PROBLEMS OF QUIET AIRCRAFT TECHNOLOGY
Wolfgang Dittrich *In its* Engine Noise (ESA-TT-244) Feb 1976 p 94-121 refs Transl into ENGLISH from Triebwerkslaerm DGLR, Cologne Report DLR-Mitt-74-21 1974 p 89-117

Three problems peculiar to quiet aircraft technology were studied A vertical take-off procedure which could lead to extremely low noise reverberation on the ground is presented The relationships for the vortex noise from fans with subsonic air intake velocities were derived Bypass fans with subsonic tip speeds were studied so that the vortex contribution investigated gains in importance The application of atmospheric ion engines as quiet aero-engines is discussed Author (ESA)

N76-24250 European Space Agency, Paris (France)
ON THE REDUCTION OF COMPRESSOR NOISE BY MEANS OF HELICAL DETUNERS
Dieter Lohmann *In its* Engine Noise (ESA-TT-244) Feb 1976 p 123-137 Transl into ENGLISH from 'Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21, 1974 p 119-132

Tests were carried out on engine intake detuners whose configuration takes particular account of the qualitative properties of the compressor noise field The helical detuners generate a vortex flow in the intake duct which exerts a favorable effect on acoustic cutoff The solution of the wave equation yields damping and displacement of the natural frequencies as a function of the geometry of the detuners which it was possible to verify by means of noise field measurements in model ducts Other acoustic measurements in ducts with a flow passing through them show that the level of the noise field also decreases as a result of the flow Author (ESA)

N76-24251 European Space Agency Paris (France)
POSSIBILITIES OF NOISE REDUCTION FOR FAN ENGINES BY MEANS OF CONTROLS
Heinrich Dissen *In its* Engine Noise (ESA-TT-244) Feb 1976 p 138-148 refs Transl into ENGLISH from 'Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21, 1974 p 133-144

A significant reduction of fan noise or jet noise can be achieved by varying the area of the primary and secondary propelling nozzles with constant engine thrust For the engine with low bypass ratio the fan noise reduction was calculated as being 4 dB max and the jet noise reduction as approximately 5 dB max As the bypass ratio increases the fan noise reduction decreases while the jet noise reduction increases It is not possible to reduce both noise components simultaneously by means of coupling the controls The variation of the primary propelling nozzle has a significant effect on the generation noise as the bypass ratio increases, variation of the secondary propelling nozzle becomes less effective in reducing noise Author (ESA)

N76-24252 European Space Agency, Paris (France)
AIRCRAFT NOISE REDUCTION BY MEANS OF ACOUSTIC SCREENING AND ENGINE CONTROLS
Bernt-Hagen Gruenewald *In its* Engine Noise (ESA-TT-244) Feb 1976 p 149-178 refs Transl into ENGLISH from Triebwerkslaerm , DGLR Cologne Report DLR-Mitt-74-21 1974 p 145-172

With the arrangement of an engine above the wing it is possible to achieve sound screening for specific angles of radiation in relation to the ground A calculation method for the determination of the ground noise level is described taking into account the screening effect of the wing Calculations using the VFW 614 as an example show that the screening effect of the wing produces a reduction of the flyover noise level during the landing phase of approximately 3 EPNdB at a flyover altitude of approximately 240 m For fan engines having the same take-off and landing thrust (= 54 % of take-off thrust) but a different bypass ratio of 3 6 or 10, the effect on the radiation of the noise was mathematically investigated for a variation of the primary propelling nozzle area the secondary propelling nozzle area the fan blade angle of incidence and for water injection In each case only one of the four parameters was varied and the resulting thrust variation was rendered ineffective by appropriate movements of the throttle lever Author (ESA)

N76-24253 European Space Agency Paris (France)
SYSTEMATIC INVESTIGATIONS IN THE FIELD OF ACOUSTIC SCREENING
Hans-Heinrich Hoelscher *In its* Engine Noise (ESA-TT-244) Feb 1976 p 179-205 refs Transl into ENGLISH from Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21 1974 p 173-199

A series of tests was carried out on the screening effects of wings and tail surfaces on aircraft engine noise The object was to test the applicability of prediction methods from optics on a surface having only one diffraction edge which would conform as far as possible to the optimized condition The effect of an edge radius such as applies to aerodynamic surfaces and that of a sound absorbent coating on the noise screen on the source side, was also investigated the applicability of results to real surfaces with two and three diffraction edges was established Measurements were carried out at different distances from the surfaces on nonabsorbing and absorbent surfaces with one two and three straight diffraction edges and one radiused edge ESA

N76-24254 European Space Agency Paris (France)
INVESTIGATION INTO THE NOISE PROPAGATION BY PROPELLER AIRCRAFT IN GENERAL AVIATION
Eicke Schmidt *In its* Engine Noise (ESA-TT-244) Feb 1976 p 207-249 refs Transl into ENGLISH from 'Triebwerkslaerm, DGLR Cologne Report DLR-Mitt-74-21, 1974 p 201-241

A brief survey is given of the sources of noise in propeller-driven aircraft their engines and propellers together with the various mechanisms of noise generation The results obtained in carrying out noise certification tests are reported This showed that 11 % of the aircraft on which tests were requested did not satisfy the requirements The values obtained during noise measurements on propeller-driven aircraft are shown as functions of several parameters, i e of blade tip Mach number and blade loading The use of narrow band analyzers provides a means of estimating the engine and propeller noise components on specific aircraft and the spectral changes in the noise during flyover and at the time of the peak noise during the flyover Author (ESA)

N76-24255 European Space Agency Paris (France)
QUIETER PROPELLERS FOR GENERAL AVIATION PRESENT POSITION FUTURE EXPECTATIONS
Reinhard Hoffmann G Muehlbauer et al *In its* Engine Noise (ESA-TT-244) Feb 1976 p 251-265 refs Transl into ENGLISH from Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21, 1974 p 243-258

The reduction of propeller noise of small executive and business aircraft up to 5 7 t is dealt with Blade tips are the main noise source due to their circumferential speed Noise reduction measures include shortening of the propeller to its repair minimum and careful radiusing and profiling of the tip The design of a variable pitch propeller with wooden blades combined with glass fiber plastics and metal is described Future developments indicate large and low speed propellers necessitating engines with gearboxes ESA

N76-24256 European Space Agency Paris (France)
NOISE PHENOMENA WITH HELICOPTER ROTORS AND POSSIBILITIES OF NOISE REDUCTION
Volker Langenbucher *In its* Engine Noise (ESA-TT-244) Feb 1976 p 266-292 refs Transl into ENGLISH from Triebwerkslaerm DGLR Cologne Report DLR-Mitt-74-21 1974 p 259-274

Possibilities of reducing helicopter rotor noise are discussed Rotational noise is mainly determined by area loading while rotor noise is determined by blade loading The effects of area loading and circumferential speed blade loading and aerodynamic shape of the blade on noise generation were investigated and requirements were developed for the rotor configuration Experimental investigations of noise reduction of tail rotors are reported ESA

N76-24257# Scientific Translation Service, Ann Arbor Mich
EFFECT OF BLADE ASPECT RATIO ON THE PROPERTIES OF AN AXIAL COMPRESSOR STAGE
A D Gegin [1975] 28 p refs Transl into ENGLISH from Prom Aerod (USSR) v 29 1973 p 35-55
(K-Trans-77) Avail NTIS HC $4 50

An experimental and theoretical study of the performance of axial compressors with rotor blades having different aspect ratios shows an appreciable increase of the pressure coefficient and a decrease of stage efficiency when the aspect ratios of 1 13 or 0 55 are reached at relative hub diameters of 0 6 and 0 803 respectively in axial compressor stage designs The efficiency of blade rings with different blade aspect ratios was estimated The structure of pressure losses in low aspect ratio blade rings was analyzed and the losses were calculated A method is proposed for calculation of pressure losses Design recommendations are given for the enhancement of axial compressor efficiency Author (ERA)

N76-24258# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany) Zentralabteilung Luftfahrttechnik
CHARACTERISTIC JET ENGINE PARAMETERS FOR PROJECT COMPARISONS [CHARAKTERISTISCHE STRAHLTRIEBWERKSPARAMETER FUER PROJEKTVERGLEICHE]
A Licklederer Dec 1974 36 p In GERMAN
(DLR-IB-555-74/13) Avail NTIS HC $4 00

Characteristic parameters for 98 jet engines are depicted in graphs and listed in tables The main parameters considered are thrust weight, specific fuel consumption air mass flow rate, compression pressure, ratio, diameter, and length ESA

N76-24259# United Technologies Corp Windsor Locks, Conn
MULTIPLE FAULT GAS PATH ANALYSIS APPLIED TO A TWIN SPOOL, MIXED FLOW, VARIABLE GEOMETRY, TURBOFAN ENGINE Final Report
Joseph M Kos Oct 1975 108 p
(Contract N00140-75-C-0449)
(AD-A019183 HSER-6794) Avail NTIS CSCL 21/5

This report presents the results of a study made to develop a multiple fault diagnostic system for a complex twin spool, mixed flow variable geometry turbofan engine using Hamilton Standard s Gas Path Analysis Technique Engine data from a detailed nonlinear simulation of a paper engine was used A simple control mode is also presented Using a weighted least squared estimation procedure a number of possible diagnostic routines are developed taking into account sensor and control uncertainties A figure of merit is defined and used to isolate the acceptable diagnostic systems GRA

N76-24260# General Electric Co Cincinnati Ohio Aircraft Engine Group
DEVELOPMENT OF EMISSIONS MEASUREMENT TECHNIQUES FOR AFTERBURNING TURBINE ENGINES Final Technical Report, 1 Apr 1973 - 31 Mar 1975
T F Lyon W C Colley M J Kenworthy and D W Bahr Oct 1975 348 p refs
(Contract F33615-73-C-2047 AF Proj 1900)
(AD-A019094 R75AEG457 AFAPL-TR-75-52) Avail NTIS CSCL 21/2

Detailed emissions measurements were made throughout the plumes of J85-5 and J79-15 engines at military power and three afterburning power levels Calculations of integrated pollutant flow rates at various axial stations showed that hydrocarbons are most reactive in the plume with significant decreases observed at all afterburning power levels Carbon monoxide can either increase or decrease with axial distance in the plume, depending on the power level and the hydrocarbon contents No significant change in total oxides of nitrogen was observed at any power level A computerized analytical plume model was developed and verified which considers the simultaneous mixing and chemical reaction processes that can occur in the plumes of afterburning engines The model enables calculating local concentrations of the various exhaust gases at any axial or

radial location from initial values measured at the exhaust plane A procedure for afterburning engine emissions measurements was developed GRA

N76-24261# ARO Inc Arnold Air Force Station Tenn
CHRONOLOGY AND ANALYSIS OF THE DEVELOPMENT OF ALTITUDE PERFORMANCE AND MECHANICAL CHARACTERISTICS OF A TURBOFAN ENGINE AT THE ARNOLD ENGINEERING DEVELOPMENT CENTER Final Report, 15 Aug 1973 - 31 Mar 1975
Jack T Tate and T J Gillard AEDC Dec 1975 30 p refs (ARO Proj B434 08A)
(AD-A018691 ARO-ETF-TR-75-70 AEDC-TR-75-119) Avail NTIS CSCL 21/5

The chronology and analysis of the altitude development cycle of a typical current state-of-the-art turbine engine at the Engine Test Facility of the Arnold Engineering Development Center is reviewed to provide visibility and guidelines to improve the ETF/AEDC support capability to turbine engine test programs A critical review of the program is reported with respect to three salient areas (1) a comparison of the original test schedule with the achieved schedule (2) a chronology of the engine builds tested (3) and a resume of the test planning/coordination activities of the program GRA

N76-24262# Pratt and Whitney Aircraft East Hartford Conn
APPLIED HIGH TEMPERATURE TECHNOLOGY PROGRAM, VOLUME 1 Final Technical Report, 1 Jun 1971 - 31 Jan 1975
Charles W Hayes and J J Jackson Oct 1975 269 p refs (Contract F33657-71-C-0789 AF Proj 668A)
(AD-A018637, PWA-5232-Vol-1 AFAPL-TR-75-44-Vol-1) Avail NTIS CSCL 21/5

The initial effort consisted of the development of aircooled columbium and thoria dispersed (TD) cobalt vanes for installation in an advanced development engine The redirected effort covered in the report continued this development by further characterizing the poor fatigue behavior of the coated SU-31 columbium alloy and substituting a directionally solidified eutectic alloy for the TD cobalt material The gamma/gamma +delta D S eutectic alloy was chosen for this program A technology base for design of gamma/gamma +delta D S eutectic hardware is presented This includes casting coating joining, hole drilling and material property evaluation Material laboratory tests are described and data presented Applications to aircooled turbine hardware is discussed GRA

N76-24263# Pratt and Whitney Aircraft East Hartford, Conn
APPLIED HIGH TEMPERATURE TECHNOLOGY PROGRAM VOLUME 2 EVALUATION OF COATED COLUMBIAN ALLOYS FOR ADVANCED TURBINE AIRFOILS Final Technical Report, 1 Jun 1971 - 31 Jan 1975
Charles W Hayes and J J Jackson Oct 1975 171 p (Contract F33657-71-C-0789, AF Proj 668A)
(AD-A018638 PWA-5232-Vol-2 AFAPL-TR-75-44-Vol-2) Avail NTIS CSCL 21/5

This report covers the columbium alloy evaluation The objective of these evaluations was to determine the applicability of coated columbium alloys for advanced gas turbine vanes The alloy SU-31 (Cb-17W-3 5 Hf-0 1C) was selected for evaluation following screening of wrought and cast alloys using the criteria of creep resistance at 2400F and fabricability Hi Temp Co R512E (Si-20Cr-20Fe) silicide coating was selected for this program Mechanical and physical properties were determined and oxidation resistance was evaluated Cast and wrought SU-31 vanes were fabricated and tested under simulated engine conditions Based on the results of these evaluations it was concluded that relatively poor cyclic oxidation and thermal fatigue properties are likely to prevent extended use of R512E coated SU-31 GRA

N76-24265*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
A TECHNIQUE USING A NONLINEAR HELICOPTER MODEL FOR DETERMINING TRIMS AND DERIVATIVES
Aaron J Ostroff David R Downing, and William J Rood (Vought Corp Hampton Va) Washington May 1976 96 p refs (NASA-TN-D-8159 L-10555) Avail NTIS HC $5 00 CSCL 01C

A technique is described for determining the trims and quasi-static derivatives of a flight vehicle for use in a linear perturbation model both the coupled and uncoupled forms of the linear perturbation model are included Since this technique requires a nonlinear vehicle model detailed equations with constants and nonlinear functions for the CH-47B tandem rotor helicopter are presented Tables of trims and derivatives are included for airspeeds between -40 and 160 knots and rates of descent between + or - 10,16 m/sec (+ or - 200 ft/min) As a verification the calculated and referenced values of comparable trims derivatives and linear model poles are shown to have acceptable agreement Author

N76-24266*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
SIMULATOR STUDY OF THE EFFECTIVENESS OF AN AUTOMATIC CONTROL SYSTEM DESIGNED TO IMPROVE THE HIGH-ANGLE-OF-ATTACK CHARACTERISTICS OF A FIGHTER AIRPLANE
William P Gilbert Luat T Nguyen and Roger W VanGunst Washington May 1976 156 p refs
(NASA-TN-D-8176 L-10545) Avail NTIS HC $6 75 CSCL 01C

A piloted, fixed-base simulation was conducted to study the effectiveness of some automatic control system features designed to improve the stability and control characteristics of fighter airplanes at high angles of attack These features include an angle-of-attack limiter a normal-acceleration limiter an aileron-rudder interconnect and a stability-axis yaw damper The study was based on a current lightweight fighter prototype The aerodynamic data used in the simulation were measured on a 0 15-scale model at low Reynolds number and low subsonic Mach number The simulation was conducted on the Langley differential maneuvering simulator and the evaluation involved representative combat maneuvering Results of the investigation show the fully augmented airplane to be quite stable and maneuverable throughout the operational angle-of-attack range The angle-of-attack/normal-acceleration limiting feature of the pitch control system is found to be a necessity to avoid angle-of-attack excursions at high angles of attack The aileron-rudder interconnect system is shown to be very effective in making the airplane departure resistant while the stability-axis yaw damper provided improved high-angle-of-attack roll performance with a minimum of sideslip excursions Author

N76-24277# Army Aviation Engineering Flight Activity, Edwards AFB Calif
PERFORMANCE AND HANDLING QUALITIES AH-1G HELICOPTER EQUIPPED WITH THREE HOT METAL/PLUME INFRARED SUPPRESSORS Final Report, 2 Sep - 14 Nov 1974
Albert L Winn and Robert L Stewart Apr 1975 60 p refs (AD-A019482, USAAEFA-75-01) Avail NTIS CSCL 01/2

The performance and handling qualities of the AH-1G helicopter were quantitatively and qualitatively evaluated with a standard exhaust duct and with Garrett Lycoming, and Bell infrared suppressors installed Twenty-one flights were flown for a total of 20 7 productive flight hours The effectiveness of the suppressors themselves in reducing infrared radiation was not a part of this test GRA

N76-24278# Air Force Inst of Tech Wright-Patterson AFB, Ohio School of Engineering
RECOVERY TECHNIQUES FOR AIRCRAFT IN SPINNING FLIGHT M S Thesis
William A Flanagan Dec 1975 132 p refs
(AD-A019323, GAE/MC/75-3) Avail NTIS CSCL 01/2

This study represents an attempt to use numerical solutions of the equations of motion to discover the most effective control surface deflections for use in a delta-winged fighter for recovery from a fully developed spin The recovery methods were tested upon stable spins since the stable flat spin is generally the most dangerous spin GRA

N76-24279# Air Force Flight Dynamics Lab, Wright-Patterson AFB Ohio

APPLICATION OF DESIGNS TO IMPROVE AIRCRAFT FLIGHT CONTROL SURVIVABILITY

Frederick R Taylor and John Schonowski 5 Sep 1975 44 p refs Presented at the Am Defense Preparedness Assoc Symp on Vulnerability and Survivability San Diego, Calif 21-23 Oct 1975 Prepared in cooperation with Navy

(AD-A018733) Avail NTIS CSCL 01/3

This paper is presented in two parts It summarizes the operational flight control survivability experience during the past decade and describes designs that have been implemented or developed to reduce the vulnerability of tactical aircraft flight control systems Presented are the results of analyses and evaluations of combat experience data wherein flight controls contributed disproportionately to approximately twenty-five (25) percent of aircraft losses while comprising only five (5) percent of total aircraft presented area The culprit components concepts and mechanizations have been identified and suggested designs are presented to minimize aircraft flight control system vulnerability Finally, the impacts that these designs can or have had on new weapon system developments are shown Also indicated is the extent, if any survivability enhancement is incorporated into newly acquired or developmental aircraft such as the A-10 F-14 F-15 F-16, F-18 and AAH Author (GRA)

N76-24365*# Boeing Commercial Airplane Co, Seattle Wash

DEVELOPMENT OF LIGHTWEIGHT FIRE RETARDANT, LOW-SMOKE, HIGH-STRENGTH, THERMALLY STABLE AIRCRAFT FLOOR PANELING Final Report

D B Arnold J V Burnside and J V Hajari Apr 1976 74 p (Contract NAS9-14753)

(NASA-CR-147750) Avail NTIS HC $4 50 CSCL 11D

Fire resistance mechanical property tests were conducted on sandwich configurations composed of resin-fiberglass laminates bonded with adhesives to Nomex honeycomb core The test results were compared to proposed and current requirements for aircraft floor panel applications to demonstrate that the fire safety of the airplane could be improved without sacrificing mechanical performance of the aircraft floor panels Author

N76-24368# Messerschmitt-Boelkow-Blohm G m b H Ottobrunn (West Germany) Unternehmensbereich Flugzeuge

GLASS FIBER REINFORCED PLASTICS FOR SMALL AIRCRAFT STRUCTURES ACTIVITIES OVER THE YEARS 1956 TO 1971 IN THE LIGHT AIRCRAFT DIVISION

Albert Mylius 5 Dec 1973 29 p In GERMAN ENGLISH summary

(MBB-UFE-1067-0) Avail NTIS HC $4 00

Examples are given of the application of glass fiber reinforced plastics to structural and nonstructural members of light aircraft developed by MBB ESA

N76-24370# Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio

STATIC AND FATIGUE TESTS OF F-111B BORON WING TIP

Murray N England Jun 1975 43 p

(AF Proj 698CW)

(AD-A018751 AFFDL-TR-75-27) Avail NTIS CSCL 11/4

This report describes the structural integrity tests of the F-111B boron-epoxy wing tip A single test specimen was subjected to static load tests static load plus internal pressure in the fuel cell tests a fatigue test simulating four service lifetimes and residual strength tests Results are discussed GRA

N76-24411# Royal Netherlands Aircraft Factories Fokker Schiphol-Oost Manufacturing Research and Product Development Dept

METAL-TO-METAL ADHESIVE BONDED AIRCRAFT STRUCTURES

Jannes Koetsier Jun 1975 16 p

(FOK-K-81) Avail NTIS HC $3 50

A survey of the Fokker F27 Friendship and F28 Fellowship structures was made and their structural approach discussed Adhesive bonding of the fuselages empennages and wings of the two aircrafts are detailed service experience is mentioned Materials (phenolic vinylic adhesive Redux 775 was mostly used) and processes are discussed and production and quality control are outlined ESA

N76-24435# National Aviation Facilities Experimental Center, Atlantic City N J

AIRCRAFT COMMUNICATIONS INTERFERENCE TESTS Final Report, Apr - May 1975

Jack Bernstein Mar 1976 19 p ref

(AD-A022954/2 FAA-NA-75-56) Avail NTIS HC $3 50 CSCL 17/2

Tests were conducted to determine aircraft VHF antenna isolation and VHF receiver response The tests show that isolation depends on the physical positioning of the antennas on the airframe and that existing isolation can realistically cause interference or quieting between transceivers even though they are operating at different frequencies up to 4 MHz apart It was also found that transceiver design affects the rejection of undesired received signals It was recommended that maximum isolation be maintained between aircraft antennas receiver design be optimized for rejection of undesired signals and cockpit communications discipline be used Author

N76-24455# Army Electronics Command Fort Monmouth N J *Communications/ADP Lab*

ROTOR EFFECTS ON L-BAND SIGNALS RECEIVED BY HELICOPTER ANTENNAS PART 3 MEASUREMENTS OF THE AMPLITUDE AND PHASE DISTORTIONS OF CW SIGNALS Final Experimental Report, CY 1973

C M DeSantis and F Schwering Dec 1975 37 p refs

(DA Proj 1T1-61102-B-31A)

(AD-A019506 ECOM-4383-Pt-3) Avail NTIS CSCL 17/7

An experimental study of rotor-blade-induced distortions of L-band signals has been carried out to verify the results of a previous theoretical investigation These signals were received by helicopter antennas mounted on the cabin roof below the rotor To verify the theoretical findings the effects of such distortions on horizontally and vertically polarized incident signals were measured for several directions of incidence The results of both the theory and experiments are in excellent agreement GRA

N76-24459# Naval Air Development Center Warminster Pa

ROLL PLANE COMPUTER PROGRAM

Oct 1975 143 p

(AD-A019000 NADC-75251-20A DOD/DF-75/003A) Avail NTIS CSCL 09/5

The Roll Plane program can be used to predict an antenna radiation pattern for a fuselage mounted antenna The aircraft s fuselage wings and horizontal stabilizers can be modeled in the program The program will compute information necessary for antenna pattern plots If the plots are desired a magnetic tape drive is necessary to run the program The generated tapes from the program can be used on a California Computer Products Inc CALCOMP pen plotter Model 763 to produce the desired antenna patterns GRA

N76-24483# Naval Electronics Lab Center, San Diego Calif

EIGHT-TERMINAL, BIDIRECTIONAL, FIBER OPTIC TRUNK DATA BUS Final Report, Jul 1974 - Jun 1975

Daniel E Altman 15 Nov 1975 45 p refs

(RF54545002)

(AD-A019429, NELC/TR-1969) Avail NTIS CSCL 09/1

Extension of a previously demonstrated fiber optic data transmission system to eight terminals and bidirectional operation is demonstrated to be within the state of the art At a 5MB/s data rate a worst-case SNR of 5 dB was demonstrated Improved optical couplers comprising a dual internal mirror mixing block mounted in a low-loss, all-metal holder and integral electronics are described GRA

N76-24598# Battelle Columbus Labs Ohio
INTERFERENCE-FIT-FASTENER INVESTIGATION Final Report, 26 Mar 1973 - 30 Jun 1974
Stephen C Ford, B N Leis, D A Utah, W Griffith, S G Sampath and P N Mincer Sep 1975 84 p refs
(Contract F33615-73-C-3121, AF Proj 1467)
(AD-A018804 AFFDL-TR-75-93) Avail NTIS CSCL 13/5

The report presents analytical and experimental techniques for defining the stress-strain and deformation states around holes filled with tapered shank interference fit fasteners A prescription for fatigue-life analysis and prediction is developed wherein the above noted data are used Stresses and plastic strains around fastener holes are determined analytically for two- and three-dimensional elastic and elastic-plastic cases using AXISOL and MARC computer codes These results are evaluated based on data obtained from the dislocation etching technique speckle photography experiments and electrical resistance strain gages A fatigue analysis technique is developed based on (1) a mechanics analysis to estimate local stress and strain and (2) a calculation of fatigue damage This analysis provides a good estimate of life to crack initiation Fastener installation variables are studied and critical ones selected Constant amplitude and spectrum loading fatigue tests are reported and the data used to verify fatigue life predictions GRA

N76-25017# Naval Postgraduate School Monterey, Calif
AN APPROACH TO THE ESTIMATION OF LIFE CYCLE COSTS OF A FIBER-OPTIC APPLICATION IN MILITARY AIRCRAFT M S Thesis
John Michael McGrath and Kenneth Ralph Michna Sep 1975 163 p refs
(AD-A019379) Avail NTIS CSCL 20/6

As significant technological advances in fiber optics and optical data transmission methods are being made it is necessary to develop appropriate methods for estimating life cycle costs for alternative coaxial/twisted pair wire and optical fiber avionics Measures of effectiveness are suggested for each alternative system An approach, which structures the technological and demand uncertainties of fiber optics is developed through scenarios as a means of relating cost and effectiveness It is suggested that Delphi and experience curve techniques be used in conjunction with ordered scenarios as a technological forecasting technique for estimation of life cycle costs of fiber optics In addition a review of the historical and technological background of fiber optics and their application to the Naval Electronics Laboratory Center (NELC) A-7 Airborne Light Optical Fiber Technology (ALOFT) Program is included GRA

N76-25143*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
WIND TUNNEL INVESTIGATION OF NACELLE-AIRFRAME INTERFERENCE AT MACH NUMBERS OF 0 9 TO 1 4-FORCE DATA
Daniel P Bencze Feb 1976 283 p refs
(NASA-TM-X-62489 A-4982) Avail NTIS HC S9 25 CSCL 01A

Detailed interference force and pressure data were obtained on a representative wing-body-nacelle combination at Mach numbers of 0 9 to 1 4 The model consisted of a delta wing-body aerodynamic force model with four independently supported nacelles located beneath the wing-body combination The model was mounted on a six-component force balance and the left-hand wing was pressure-instrumented Each of the two right-hand nacelles was mounted on a six-component force balance housed in the thickness of the nacelle while each of the left-hand nacelles was pressure-instrumented The primary variables examined included Mach number angle of attack nacelle position and nacelle mass-flow ratio Four different configurations were tested to identify various interference forces and pressures on each component these included tests of the isolated nacelle the isolated wing-body combination the four nacelles as a unit and the total wing-body-nacelle combination Nacelle axial location relative to both the wing body combination and to each other was the most important variable in determining the net interference among the components Author

N76-25144*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
WIND TUNNEL INVESTIGATION OF NACELLE-AIRFRAME INTERFERENCE AT MACH NUMBERS OF 0 9 TO 1 4-PRESSURE DATA, VOLUME 2
Daniel P Bencze Feb 1976 423 p refs 2 Vol
(NASA-TM-X-73088 A-4982) Avail NTIS HC $11 00 CSCL 01A

Detailed interference force and pressure data were obtained on a representative wing-body nacelle combination at Mach numbers of 0 9 to 1 4 The model consisted of a delta wing-body aerodynamic force model with four independently supported nacelles located beneath the wing-body combination The primary variables examined included Mach number angle of attack nacelle position and nacelle mass flow ratio Four different configurations were tested to identify various interference forces and pressures on each component these included tests of the isolated nacelle the isolated wing-body combination the four nacelles as a unit and the total wing-body-nacelle combination Nacelle axial location relative to both the wing-body combination and to each other was the most important variable in determining the net interference among the components The overall interference effects were found to be essentially constant over the operating angle-of-attack range of the configuration and nearly independent of nacelle mass flow ratio Author

N76-25145 Texas Univ Arlington
THE RELATIONSHIPS BETWEEN A WING AND ITS INITIAL TRAILING VORTICES Ph D Thesis
Corliss Wyatt Adams 1975 175 p
Avail Univ Microfilms Order No 76-11197

Velocity and pressure measurements were made of several trailing vortices in the near field of the wing utilizing a fivehole pressure probe Vortex variations involved different rectangular wing sizes and shapes downstream distances free stream velocities and angles of attack The experimental results generally substantiated that the overall circulation about a trailing vortex is equal to the mid-wing bound circulation A 25 per cent axial velocity excess was measured in the core of one vortex (Vortex 13) with the wing set at 12 degrees angle of attack The data for one vortex (Vortex 13A) were selected to use as a guide and check for theoretical development Dissert Abstr

N76-25146*# Boeing Commercial Airplane Co Seattle Wash
A PRELIMINARY DESIGN STUDY OF A LAMINAR FLOW CONTROL WING OF COMPOSITE MATERIALS FOR LONG RANGE TRANSPORT AIRCRAFT Final Report, Apr 1975 - Mar 1976
G R Swinford Apr 1976 125 p refs
(Contract NAS1-13872)
(NASA-CR-144950 D6-42967) Avail NTIS HC $5 50 CSCL 01A

The results of an aircraft wing design study are reported The selected study airplane configuration is defined The suction surface ducting and compressor systems are described Techniques of manufacturing suction surfaces are identified and discussed A wing box of graphite/epoxy composite is defined Leading and trailing edge structures of composite construction are described Control surfaces engine installation and landing gear are illustrated and discussed The preliminary wing design is appraised from the standpoint of manufacturing weight operations and durability It is concluded that a practical laminar flow control (LFC) wing of composite material can be built and that such a wing will be lighter than an equivalent metal wing As a result a program of suction surface evaluation and other studies of configuration aerodynamics structural design and manufacturing and suction systems are recommended Author

N76-25148*# Texas Univ Austin Dept of Aerospace Engineering and Mechanics
AN EXPERIMENTAL INVESTIGATION OF SUPERSONIC FLOW PAST A WEDGE-CYLINDER CONFIGURATION
Daniel W Barnette Apr 1976 63 p refs
(Contract NAS9-13707)
(NASA-CR-147741 AER-76002) Avail NTIS HC $4 50 CSCL 01A

An experimental investigation of supersonic flow past double-wedge configurations was conducted Over the range of geometries tested it was found that while theoretical solutions both for a Type V pattern and for a Type VI pattern could be generated for a particular flow condition (as defined by the geometry and the free-stream conditions) the weaker Type VI pattern was observed experimentally More rigorous flow-field solutions were developed for the flow along the wing leading-edge Solutions were developed for the three-dimensional flow in the plane of symmetry of a swept cylinder (which represented the wing leading-edge) which was mounted on a wedge (which generated the bow shock wave) A numerical code was developed using integral techniques to calculate the flow in the shock layer upstream of the interaction region (i e near the wing root) Heat transfer rates were calculated for various free stream conditions The present investigation was undertaken to examine the effects of crossflow on the resultant flow-field and to verify the flow model used in theoretical calculations Author

N76-25151# Northrop Corp Hawthorne Calif Aircraft Div
CALCULATION OF THREE-DIMENSIONAL SUPERSONIC FLOW FIELDS ABOUT AIRCRAFT FUSELAGES AND WINGS AT GENERAL ANGLE OF ATTACK
Chong-Wei Chu Mar 1973 34 p refs
(AD-A018715 NOR-72-182) Avail NTIS CSCL 20/4

A new algorithm for the three-dimensional method of characteristics is applied to the calculation of steady inviscid supersonic flow about aircraft fuselages and wings at general angle of attack After a brief discussion of the new method computed results of flow over an elliptic cone and a blunt circular cone at angles of attack are presented and compared with available experimental data Good agreement is observed Application to fuselage flow field calculation then follows Calculated examples of flow about typical fuselages under different flight conditions are presented discussed and compared with available experimental data with good agreement Finally the computed pressure distribution on a thin wing an elliptic cone of 20 1 axis ratio is presented and discussed The present method can be used to obtain flow field information for aircraft design or to provide inviscid solutions for boundary layer analysis Author (GRA)

N76-25152# Naval Postgraduate School Monterey Calif
THE DRAG AND LIFT CHARACTERISTICS OF A CYLINDER PLACED NEAR A PLACE SURFACE M S Thesis
Selahattin Goktun Dec 1975 115 p refs
(AD-A019286) Avail NTIS CSCL 20/4

Surface pressure drag and lift coefficients have been experimentally determined for a right circular cylinder located near a plane surface and placed in cross flow of air Parametric studies were carried out for Reynolds number varying from 90 000 to 250 000 three plate lengths and a variety of cylinder to plate spacings The variation of the drag coefficient as a function of gap size was found to exhibit an interesting and unexpected trend The drag was a minimum when the cylinder was resting on the plate and was a maximum at a gap size of approximately one cylinder radius Flow visualization studies together with detailed measurements of the vortex shedding frequency in the cylinder wake indicate that the plate interferes with the formation of the vortex street in the cylinder wake when it is located within a cylinder radius of the cylinder This interference disturbs the cylinder base pressure which in turn influences that magnitude of the drag coefficient Author (GRA)

N76-25154# Committee on Commerce (U S Senate)
EMERGENCY LOCATOR TRANSMITTERS
Washington GPO 1975 13 p Hearing on S 910 before Subcomm on Aviation of Comm on Commerce 94th Congr 1st Sess 18 Sep 1975
(GPO-60-520) Avail Subcomm on Aviation

Temporary operation of certain civil aircraft without operable emergency locator transmitter is considered Testimony portrays the delay experienced by aircraft owners when this homing device is being repaired or replaced and the hardship encountered by the required grounding of the aircraft G G

N76-25156*# Old Dominion Univ Research Foundation Norfolk Va
WIND TUNNEL DESIGN STUDIES AND TECHNICAL EVALUATION OF ADVANCED CARGO AIRCRAFT CONCEPTS Final Report
D M Rao May 1976 36 p refs
(Grant NsG-1135)
(NASA-CR-148149 TR-76-T11) Avail NTIS HC $4 00 CSCL 01C

In support of aerodynamic studies relating to the design and performance prediction of the National Transonic Facility the following main tasks were accomplished (1) estimation of aerodynamic losses of the tunnel circuits (2) refinement of the high-speed diffuser loss prediction method utilizing experimental data generated for the purpose, (3) model studies of flow in the second-turn and measurements of the fan inlet distortion and overall pressure loss (4) development of a shortened fan nacelle configuration of improved aerodynamic performance and (5) evolution through model studies of an efficient rapid-diffuser system as the key to a circuit-modification proposal to reduce volume and minimize liquid-nitrogen consumption at the same time saving on the shell cost Author

N76-25157*# Boeing Commercial Airplane Co , Seattle Wash
TECHNICAL AND ECONOMIC ASSESSMENT OF SPAN-DISTRIBUTED LOADING CARGO AIRCRAFT CONCEPTS Final Report
David H Whitlow and P C Whitner Jun 1976 218 p refs
(Contract NAS1-13963)
(NASA-CR-144963 D6-75776) Avail NTIS HC $7 75 CSCL 01C

A preliminary design study of the performance and economics resulting from the application of the distributed load concept to large freighter aircraft was made The study was limited to configurations having the payload entirely contained in unswept wings of constant chord with conventional tail surfaces supported from the wing by twin booms A parametric study based on current technology showed that increases in chord had a similar effect on the economics as increases in span Increases in both span and chord or airplane size had the largest and most favorable effect At 600 000 lbs payload a configuration was selected and refined to incorporate advanced technology that could be in production by 1990 and compared with a reference conventional airplane having similar technology Author

N76-25158# Naval Air Development Center, Warminster Pa Air Vehicle Technology Dept
EXPLOSION PROOFING H-53 RANGE EXTENSION TANK Final Report
Albert E Simkins 11 Nov 1975 28 p
(AD-A018353 NADC-75236-30) Avail NTIS CSCL 13/4

A kit composed of polyurethane reticulated foam MIL-B-83054 which provides protection against internal explosions from unknown sources that have occurred in the H-53 range extension fuel tanks was devised and tested Results of tests indicate that the kit arrests an explosion or fire initiated within the tank A loss of 8 7% of the usable fuel and a gain of 79 5 pounds are attributed to installation of the foam Author (GRA)

N76-25159# Boeing Commercial Airplane Co , Seattle Wash
APPLICATION OF ADVANCED AERODYNAMIC CONCEPTS TO LARGE SUBSONIC TRANSPORT AIRPLANES Final Technical Report, Oct 1974 - Sep 1975
Robert M Kulfan and Weston M Howard 17 Nov 1975 117 p refs
(Contract F33615-75-C-3013, AF Proj 1476)
(AD-A019956 D6-75748 AFFDL-TR-75-112) Avail NTIS CSCL 01/1

A preliminary design study has been made to identify the performance advantages obtained when advanced aerodynamic technology aircraft are used to perform subsonic military air missions requiring long range (10 000 nmi) or high endurance (24 hr) with heavy payloads (250 000 lb and 400 000 lb respectively) The study consisted of two phases the first included evaluating the performance benefits by individually

applying various advanced aerodynamic concepts and recommending areas where additional research and development work are necessary The second phase included configuring integrated advanced technology aircraft that incorporated the most promising compatible aerodynamic concepts Comparisons were made with conventional aerodynamic technology configurations designed for similar missions GRA

N76-25160# Army Aviation Engineering Flight Activity Edwards AFB Calif

ARMY PRELIMINARY EVALUATION YAH-1Q HELICOPTER WITH A FLAT-PLATE CANOPY Final Report

James R Arnold Aug 1975 41 p refs

(PRON Proj 21-5-R0124-01-21-EC)

(AD-A020111 USAAEFA-75-18) Avail NTIS CSCL 01/1

The United States Army Aviation Engineering Flight Activity conducted a limited evaluation of the level flight performance and handling qualities of a YAH-1Q helicopter with a flat-plate canopy from 17 through 19 June 1975 at the Bell Helicopter Company flight test facility at Arlington Texas During the test program eleven flights for a total of 4 4 productive hours were flown A loss in maximum airspeed for level flight was determined when compared to the AH-1G (Bell Helicopter Company data indicate 5 to 7 knots) The primary effect of the flat-plate canopy on handling qualities was a noticeable decrease in directional stability The one deficiency determined during the evaluation was the internal reflection from external light sources on the flat-plate canopy during night flight Five shortcomings were noted during the evaluation Further testing should be conducted to determine the effect of the decreased directional stability on the accuracy of rocket fire GRA

N76-25161# Army Aviation Engineering Flight Activity Edwards AFB Calif

ENGINEERING EVALUATION JOH-58A HELICOPTER WITH AN AUTOMATIC RELIGHT SYSTEM Final Report, 12 Feb - 11 Apr 1975

Tom P Benson Carl F Mittag and Robert M Buckanin Jun 1975 85 p refs

(PRON Proj EJ-4-H0044-00-EJ-EJ)

(AD-A019407 USAAEFA-74-22) Avail NTIS CSCL 01/3

The United States Army Aviation Engineering Flight Activity conducted a limited in-flight evaluation of an automatic engine relight system installed in an OH-58A helicopter at Edwards Air Force Base California from 12 February through 11 April 1975 During the program 33 test flights were flown for a total of 13 5 productive flight hours Results of the evaluation showed that established limitations may be exceeded if the automatic relight system functions at certain points within the current operating envelope Required additional limitations to the current operating envelope with the automatic relight system activated include in-ground-effect hover below 10 feet and specific combinations of airspeeds and engine power settings Two deficiencies and one shortcoming were noted during the evaluation GRA

N76-25166*# Kanner (Leo) Associates Redwood City Calif

RESEARCH ON AIRCRAFT NOISE TEST METHODS

G Casandjian Washington NASA Jun 1976 20 p Transl into ENGLISH from La Rech sur le bruit des avions - Methodes et Moyens d essais Assoc Aeronaut et Astronaut de France Congres intern astronaut 12th France (Paris) 29-30 Nov 1975 18 p

(Contract NASw-2790)

(NASA-TT-F-17090) Avail NTIS HC $3 50 CSCL 20A

Methods and facilities for measuring the basic types of aircraft noise--aerodynamic engine and duct noise--are described Various techniques for reducing noise are considered with emphasis on the development of absorber materials and jet noise silencers Methods for making fixed point engine noise measurements are examined as well as noise tests on turbine rotors Tables listing the test facility type of test noise performance and sponsoring organization are presented Author

N76-25168*# Lockheed-California Co Burbank

SONIC ENVIRONMENT OF AIRCRAFT STRUCTURE IMMERSED IN A SUPERSONIC JET FLOW STREAM Report Jun 1975 - Feb 1976

Wiley A Guinn Frank J Balena and Jaak Soovere Jun 1976 129 p refs

(Contract NAS1-13978)

(NASA-CR-144996 LR-27338) Avail NTIS HC $6 00 CSCL 20A

Test methods for determining the sonic environment of aircraft structure that is immersed in the flow stream of a high velocity jet or that is subjected to the noise field surrounding the jet were investigated Sonic environment test data measured on a SCAT 15-F model in the flow field of Mach 1 5 and 2 5 jets were processed Narrow band lateral cross correlation and noise contour plots are presented Data acquisition and reduction methods are depicted A computer program for scaling the model data is given that accounts for model size jet velocity transducer size and jet density Comparisons of scaled model data and full size aircraft data are made for the L-1011 S-3A and a V/STOL lower surface blowing concept Sonic environment predictions are made for an engine-over-the-wing SST configuration Author

N76-25171 Rolls-Royce Ltd Derby (England) Engine Div

INFLUENCE OF UNSTEADY FLOW PHENOMENA ON THE DESIGN AND OPERATION OF AERO ENGINES

R Hetherington and R R Moritz *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 18 p refs

Unsteady phenomena are examined in some detail with a view to both understanding and improving the operation of turbomachines in aero engines and improving design procedures by being more explicit concerning some of the time dependent flow phenomena that exist The following possibilities are discussed (1) improving the design point efficiency of a compressor through an understanding of internal unsteady flow effects and (2) selection of compressor configurations with minimum stall response to non axisymmetric and unsteady intake flow Author

N76-25188 Cincinnati Univ Ohio

TRANSMISSION OF CIRCUMFERENTIAL INLET DISTORTION THROUGH A ROTOR

W R Wells W Tabakoff and C J Savell (GE Co Cincinnati Ohio) *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 10 p refs

Analytical methods of predicting the propagation of stationary circumferential distortion patterns through a rotor are presented The analysis considers the effects of finite blade chord length and Mach number on the transmission by a semi-actuator disc theory In addition a more basic theory using the method of distributed singularities with thin airfoils is discussed to account for the effect of finite solidity on the distortion transmission This thin airfoil theory is limited to the case of no steady loading on the rotor The results of the analytical analysis is compared with existing experimental results Author

N76-25189 Pratt and Whitney Aircraft East Hartford Conn

MULTIPLE SEGMENT PARALLEL COMPRESSOR MODEL FOR CIRCUMFERENTIAL FLOW DISTORTION

Robert S Mazzawy *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 14 p refs

A compressible nonlinear model for prediction of the flow field of a circumferentially distorted compressor has been developed by using multiple parallel segments and by accounting for deviations from undistorted compressor performance The model is applicable to large amplitude inlet circumferential distortions of total pressure and/or temperature as well as circumferential variations of exit static pressure with the restriction that the circumferential extent of the distortion is large relative to circumferential blade spacing The distorted compressor stability criterion is based upon the limit of static pressure rise capability for a single distorted flow segment This model requires the undistorted performance characteristics for each blade row

however, a modified version based upon the overall compressor performance gives an accurate approximation when detailed blade row characteristics are not available Author

N76-25190 Motoren- und Turbinen-Union Muenchen G m b H (West Germany)
THE EFFECT OF TURBULENT MIXING ON THE DECAY OF SINUSOIDAL INLET DISTORTIONS IN AXIAL FLOW COMPRESSORS
H Mokelke *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 30 p refs

A small perturbation actuator disc theory is presented for the prediction of the decay of sinusoidal flow distortions in high hub tip ratio axial compressors with steady circumferential inlet maldistribution The theory accounts for the turbulent mixing of the flow upstream and within the compressor Decay rates and circumferential phase shifts of first second fourth and eighth order cosine wave pressure and velocity perturbations are calculated for equal amplitudes and phases of the four total pressure disturbances upstream of the compressor The results are compared with interstage traverse data obtained from a 4-stage axial flow compressor A comparison between corresponding analytical results obtained from the same theory neglecting viscosity and the experimental data is also performed It is found that turbulent mixing has little influence on the development of the first order disturbance but that the influence grows rapidly as the order of the disturbance increases Author

N76-25191 National Research Council of Canada Ottawa (Ontario) Mechanical Engineering Div
THE RESPONSE OF A LIFTING FAN TO CROSSFLOW-INDUCED SPATIAL FLOW DISTORTIONS
Uwe W Schaub *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 14 p refs

During transition maneuvers from fan supported to wing supported flight VTOL lifting fans routinely encounter extremely large spatial crossflow distortions The variation in fan performance and the character of the flow distortions responsible for this variation were explored experimentally and on the basis of a simple analytical model of a lifting fan The inflow and exit plane distortions in this model were generated by potential flow models and the fan through flow was calculated on the basis of an arbitrary number of discrete circumferential fan segments The lifting fan performance was predicted and compared with experiments over a wide range of transition conditions and it is shown that while the crossflow causes large circumferential nonuniformities the overall performance becomes seriously degraded only at large crossflows and large fan speeds Author

N76-25192* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
SOME CURRENT RESEARCH IN UNSTEADY AERODYNAMICS A REPORT FROM THE FLUID DYNAMICS PANEL
W J McCroskey *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 13 p refs

The highlights of a recent discussion by representatives of the fluid dynamics and structures and materials panels are reported with emphasis on the fundamental aspects of unsteady fluid mechanics Topics include linearized potential flow theory transonic flow calculations unsteady boundary layers, dynamic stall transonic buffet and techniques for measuring unsteady pressures Author

N76-25193* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
SOME ASPECTS ON UNSTEADY FLOW PAST AIRFOILS AND CASCADES
B Satyanarayana (Cambridge Univ England) *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 11 p refs

The unsteady boundary layer due to a gust propagating past an isolated airfoil and on airfoils in cascade was measured with a hot wire anemometer in a low speed gust tunnel Coherent signals were obtained by a phase lock averaging technique that was implemented in an on-line analysis using a PDP 12 computer Changes in a boundary layer shape factor noise level and pressure gradient were correlated over a complete gust cycle It is concluded that the character of the boundary layer changes from laminar to turbulent and back to laminar during the course of a gust cycle at certain chordwise positions These measurements help explain certain anomalies that were observed during a previous study of the pressure fluctuations due to gust loadings on airfoils and cascades Author

N76-25194 Air Force Aero Propulsion Lab Wright-Patterson AFB Ohio
A CASCADE IN UNSTEADY FLOW
Francis R Ostdiek *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 13 p refs

A low speed atmospheric inlet cascade wind tunnel was constructed to obtain a flow which has a sinusoidal variation in flow direction A stationary five blade cascade was held in a 7 62 x 25 4 cm test section The wind tunnel inlet which included guide vanes was forced to oscillate by a motor driven crank about an axis transverse to the cascade The vanes guided the flow along the instantaneous axis of the inlet and thus achieved a variable flow direction at any prescribed frequency in the 0 to 16 Hz range while the flow magnitude was nearly constant Each surface of the center airfoil contained ten static pressure ports The pressure fluctuations over most of both surfaces were near sinusoidal and the cyclic average showed little dependence on frequency or velocity The pressure fluctuations decreased in amplitude along the chord on the pressure surface and changed phase on the suction surface near mid-chord The pressures on both surfaces were adjusted by slow moving waves and showed only a small change in phase angle with increased frequency The unsteady pressure profiles are in excellent agreement with theory near the leading edge Author

N76-25195 General Motors Corp Indianapolis Ind Detroit Diesel Allison Div
THE UNSTEADY AERODYNAMIC RESPONSE OF AN AIRFOIL CASCADE TO A TIME-VARIANT SUPERSONIC INLET FLOW FIELD
Sanford Fleeter Allen S Novick and Ronald E Riffel *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 14 p refs
(Contract F44620-74-C-0065)

The time dependent aerodynamic cascade phenomena related to the unsteady pressure disturbance and varying incidence in the cascade entrance flow field were investigated over a cascade inlet Mach number range of 1 53 to 1 63 with cascade static pressure ratios of 1 15 to 1 47 The range of the reduced frequency varied from approximately 0 03 to 0 12 The dynamic data obtained is presented in the form of the amplitude of the unsteady pressure and its phase as referenced to the sidewall transducer immediately downstream of the oscillating wedge This data demonstrated the effect of the reduced frequency cascade static pressure ratio and the cascade inlet Mach number on the time variant pressure as measured on the sidewall in the cascade entrance flow field and on the pressure and suction surfaces of one of the cascaded advanced design transonic airfoils Author

N76-25197 Naval Surface Weapons Center Dahlgren Va
ON THE ANALYSIS OF SUPERSONIC FLOW PAST OSCILLATING CASCADES
W R Chadwick J K Bell and M F Platzer (Naval Postgraduate School) *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 13 p refs

Supersonic flow past oscillating finite cascades with subsonic leading edge locus is analyzed by solving the nonlinear transonic small perturbation equation Using the properly approximated Rankine-Hugoniot equations for the oscillating head shocks and continuing by the method of characteristics the entrance flow field into the cascade is computed and the influence of blade thickness on the aerodynamic pressure distributions is determined

For the single oscillating wedge the solution is in good agreement with Carrier s exact solution and it is found that single blades exhibit a pronounced effect of blade thickness throughout the lower frequency range which appears to be alleviated by cascading For zero blade thickness the linearized characteristics theory is recovered Sample calculations with this theory for complete cascade configurations are in excellent agreement with recent results indicating the possibility of supersonic torsional cascade flutter over a wide range of parameters Author

N76-25198 Stevens Inst of Tech Hoboken N J Dept of Mechanical Engineering
PRELIMINARY RESULTS FOR SINGLE AIRFOIL RESPONSE TO LARGE NONPOTENTIAL FLOW DISTURBANCES
P V K Perumal and F Sisto *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 17 p refs

(Contract N00014-67-A-0202-0016 NR Proj 094-393)

The unsteady response of a flat plate airfoil to large nonpotential flow disturbances in the form of a translating rectangular grid of eddy array is evaluated A suitable stream function to represent the translating nonpotential vortex array is chosen The problem is solved in two stages namely auxiliary solution and time marching solution By auxiliary solution is meant the solution of the problem which completely neglects the presence of the wake vortex sheet and treats time as a parameter, this results in a steady flow type of analysis The time marching part of the analysis increments time by equal steps starting from zero time makes use of the auxiliary solution keeps track of the shedding and growth of the wake vortex sheet evaluates the unsteady response and continues along with time axis up to any specified maximum time limit Preliminary numerical results from a computer program are presented Author

N76-25199* National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
THE PASSAGE OF A DISTORTED VELOCITY FIELD THROUGH A CASCADE OF AIRFOILS
John J Adamczyk *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 11 p refs

An analysis has been developed to predict the unsteady force and moment generated by the passage of a timewise periodic total pressure distortion through an arbitrary cascade of airfoils The mathematical formulation of this analysis is based on the assumption that the magnitudes of the timewise fluctuations of the variables which describe the flow field are small compared to their time average values This assumption permits the development of a linear unsteady perturbation analysis about a steady flow field In addition to this linearization assumption the fluid medium is assumed to be incompressible and inviscid The mathematical development begins by decomposing the velocity field surrounding an infinite cascade of airfoils into its irrotational and rotational components The rotational component is associated with an upstream unsteady total pressure distortion and is defined in terms of the vorticity field associated with the distortion pattern The irrotational component is further decomposed into a steady and unsteady part A combined analytical and numerical procedure has been developed to solve the field equations which govern the rotational and irrotational velocity fields Results of this analysis show a strong influence of mean loading on the unsteady force generated by the passage of a one dimensional gust through a cascade of compressor blades Author

N76-25200 *Texas A&M Univ College Station Dept of Aerospace Engineering*
UNSTEADY AIRLOADS ON A CASCADE OF STAGGERED BLADES IN SUBSONIC FLOW
B M Rao and W P Jones In AGARD Unsteady Phenomena in Turbomachinery Apr 1976 10 p refs

The Jones-Moore numerical lifting surface technique is applied to predict the airloads and moments on an airfoil of a staggered cascade of rotor blades in subsonic flow Circumferential distortion due to inlet flow conditions is expressed as an interblade phase lag and both cases of oscillating airfoils and oscillatory inflow are considered Results are obtained for several values of frequency, stagger angle, blade spacing, and interblade phase lag Author

N76-25201 *Virginia Polytechnic Inst and State Univ , Blacksburg* Dept of Mechanical Engineering
AN ON-ROTOR INVESTIGATION OF ROTATING STALL IN AN AXIAL-FLOW COMPRESSOR
M R Sexton, W F OBrien, Jr , and H L Moses In AGARD Unsteady Phenomena in Turbomachinery Apr 1976 10 p refs
(Contract N00014-67-A-0226-0005 NR Proj 098-038)

Rotating stall is an unsteady phenomenon in axial flow compressors involving rapid pressure changes and lift variations on the rotating blades of the compressor Measurements of the surface pressures on the rotor blade provide information to study the variation of lift of the rotating blade, and to improve the general understanding of rotating stall Such on-rotor measurements require special pressure transducers, mounting techniques and data transmission systems A multichannel radio telemetry system was used in this investigation to transmit simultaneous pressure measurements from up to six transducers mounted on a rotating blade Measurements were made on both the pressure and suction sides of the blade, at different span locations Results include rotor blade surface pressure measurements for compressor flow rates up to and including stall Pressure variations during the dynamic stall event were used to determine the lift time variations on the blade Author

N76-25202 Cambridge Univ (England) S R C Turbomachinery Lab
DETAILED FLOW MEASUREMENTS DURING DEEP STALL IN AXIAL FLOW COMPRESSORS
Ivor J Day *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 10 p refs

Detailed measurements have been obtained for the flow in a stalled three stage compressor of high hub tip ratio which is operating deep in the rotating stall regime Using high frequency transducers and a conditional sampling procedure made it possible to obtain information on the detailed structure of the stall cells and to prepare an overall picture of the flow field in the compressor The results of the measurements show some new features which are at variance with conventional ideas about stall cells Author

N76-25203 Von Karman Inst for Fluid Dynamics, Rhode-Saint-Genese (Belgium)
THE PREDICTION OF THE BEHAVIOUR OF AXIAL COMPRESSORS NEAR SURGE
N Orner D Adler, and J Isenberg *In* AGARD Unsteady Phenomena in Turbomachinery Apr 1976 16 p refs

A new approach to the understanding of the problem of unsteady behavior of axial compressors near surge is developed This approach is based on the stability analysis of the equations of motion It takes into account the three dimensional character of the flow in an axial compressor A numerical solution procedure is described and its flow charts are given Results of calculation are compared with experiments for two cases The importance of some of the parameters influencing the phenomenon is discussed Author

N76-25204# Naval Air Test Center Patuxent River, Md
NAVY EVALUATION F-11A IN-FLIGHT THRUST CONTROL SYSTEM Final Report, 5 Nov 1973 - 1 Jul 1975
W R Simpson, M W Covey D F Palmer, and M D Hewett 15 Dec 1975 109 p refs
(AD-A019954, NATC-SA-75R-75) Avail NTIS CSCL 01/3

A Navy evaluation to determine the potential advantages and disadvantages of in-flight thrust control (IFTC) on a tactical airplane was conducted using a modified F-11A airplane as a testbed The conceptual development program also utilized a second unmodified F-11A for baseline data and pilot familiarization training Flying qualities, performance engine effects, durability and utility of IFTC to mission tasks such as air combat maneuvering (ACM), air-to-ground weapons delivery approach

and waveoff landing roll-out and infrared signature suppression were evaluated during the 6-month program The prototype IFTC in the configuration evaluated increased the tactical capabilities of the F-11A airplane despite the limited capability of the testbed indicating potential increases in tactical capabilities of future fighter/attack airplanes which incorporate thrust control capability GRA

N76-25207# Air Force Inst of Tech Wright-Patterson AFB, Ohio School of Engineering
APPROXIMATE CHANGES IN AIRCRAFT STABILITY DERIVATIVES CAUSED BY BATTLE DAMAGE M.S. Thesis
Michael G Chapman Dec 1975 93 p refs
(AD-A019843, GE/EE/75-19) Avail NTIS CSCL 01/3

Approximations of stability derivative changes, due to battle damage were made for the FDL-23 Remotely Piloted Vehicle This vehicle is being simulated by the Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base and uses decoupled linearized perturbation equations The location of the damage was determined by projectile trajectory characteristics, combined with range and target altitude information, and probability theory Changes in lift and the coefficient of lift were calculated using the geometry associated with an elliptical lift pattern distribution and the location of the damage Changes in drag and the coefficient of drag were calculated using a flat plate approximation for the damaged surface area The changes in the slopes of the nondimensional stability derivative curves were determined by analyzing the cause of each and then calculating how battle damage would change the slope of each curve GRA

N76-25209# Air Force Inst of Tech, Wright-Patterson AFB Ohio School of Engineering
AN INVESTIGATION OF RPV CONTROL CRITERIA VIA THE OPTIMAL REGULATOR PERFORMANCE INDEX M S Thesis
Stephen R Barnes Dec 1975 121 p
(AF Proj 7233)
(AD-A019846, GE/EE/75D-12) Avail NTIS CSCL 01/4

Remotely Piloted Vehicles (RPV's) have control requirements which differ, sometimes significantly, from the requirements for manned aircraft due to the fact that the pilot is not in the aircraft This thesis discusses various manned-aircraft handling qualities specifications such as MIL-F-8785B and the C criterion and examines their applicability to the RPV control problem The desired performance is analyzed from the points of view of mission requirements and the needs of the operator to control the vehicle The linear optimal regulator is then proposed as a means to minimize state errors and control magnitudes in the closed-loop response A quadratic performance index is used to investigate the effect on controller design of varying the relative importance placed on the various parameter errors The longitudinal mode of a typical existing RPV is used for the analysis and the resulting relationships between the performance index weighting factors and the resulting controller configurations are presented RPV flying qualities specifications and control console design are discussed and related to these relationships GRA

N76-25211*# Massachusetts Inst of Tech, Cambridge
THE STOCHASTIC CONTROL OF THE F-8C AIRCRAFT USING THE MULTIPLE MODEL ADAPTIVE CONTROL (MMAC) METHOD
M Athans, K P Dunn E S Greene W H Lee N R Sandel Jr et al Aug 1975 12 p refs Presented at IEEE Conf on Decision and Control 1975, Houston Tex Dec 1975
(Grants NGL-22-009-124 AF-AFOSR-2273-72)
(NASA-CR-148100, AD-A019556 AFOSR-75-1600TR, ESL-P-622) Avail NTIS HC $3 50 CSCL 01/2

The purpose of this paper is to summarize results obtained for the adaptive control of the F-8C aircraft using the so-called Multiple Model Adaptive Control method The discussion includes the selection of the performance criteria for both the lateral and the longitudinal dynamics the design of the Kalman filters for different flight conditions, the identification aspects of the design using hypothesis testing ideas, and the performance of the closed loop adaptive system GRA

N76-25228 National Aeronautical Establishment, Ottawa (Ontario)
INFLUENCE FUNCTION METHOD IN WIND TUNNEL WALL INTERFERENCE PROBLEMS
M Mokry *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 10 p refs

A new general method is described for computation of wind tunnel wall interference effects in subsonic linearized flows The influence function, introduced as a fundamental solution satisfying the prescribed wind tunnel boundary conditions plays the central role in the present analysis The method is applied to subsonic flow past an airfoil between perforated walls and compared with measurements from the 15 in x 60 in test section of a 5 ft blowdown wind tunnel Further examples concern a multi-component airfoil finite cascades of blades and the vortex sheet rollup behind a wing in a wind tunnel Author

N76-25232 Royal Aircraft Establishment Farnborough (England) Aerodynamics Dept
THE COMPUTATION OF TRANSONIC FLOWS PAST AEROFOILS IN SOLID, POROUS OR SLOTTED WIND TUNNELS
D Catherall *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 10 p refs

A method is described for computing two dimensional inviscid flows at transonic speeds in wind tunnels in which the transonic small perturbation equation is solved Because of the use of coordinate transformations which transform the infinite physical plane into a finite computing one far field boundary conditions are relatively easy to obtain and apply The effect of tunnel walls on the flow has been modelled by using the usual homogeneous wall boundary condition Comparisons are made with some experimental results and the free air and tunnel versions are used to assess the ability of linear subsonic theory to predict tunnel interference corrections when the flow is transonic Author

N76-25233 National Aerospace Lab Amsterdam (Netherlands)
TWO-DIMENSIONAL TUNNEL WALL INTERFERENCE FOR MULTI-ELEMENT AEROFOILS IN INCOMPRESSIBLE FLOW
O DeVries and G J L Schipholt *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 7 p refs

A singularity method has been applied to calculate two dimensional tunnel wall corrections for multi-element aerofoils The calculations show that the well known corrections due to Glauert can be applied for a single aerofoil except the pitching moment correction above 15 deg angle of attack but that the Glauert approach fails in the case of trailing edge flap deflections The results of the calculations agree with the strong non linear results found by De Jager and Van de Vooren for a hinged flat plate at zero incidence Author

N76-25234 British Columbia Univ Vancouver Dept of Mechanical Engineering
A LOW-CORRECTION WALL CONFIGURATION FOR AIRFOIL TESTING
C D Williams and G V Parkinson *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 7 p refs

The reduction of wind tunnel wall corrections in airfoil testing by a transversely slotted wall opposite the suction side of the test airfoil and by a solid wall opposite the pressure side is considered The solid elements of the slotted wall are symmetrical airfoils at zero incidence This geometry permits the flow to assume closely the streamline pattern for unconfined flow without degrading the flow quality through shear layer mixing near the test airfoil The theory uses the potential flow surface source/element method with Kutta conditions satisfied on the test airfoil and the wall slats In experiments using a range of sizes of

airfoils of three different profiles good agreement with the predictions of the theory has been obtained It appears that uncorrected lift coefficients and pressure distributions, accurate to within one percent can be obtained for a wide range of airfoil shapes sizes and lift coefficients using a slotted wall of open area ratio between 60 and 70 percent Author

N76-25238 Boeing Commercial Airplane Co Seattle, Wash
NACELLE-AIRFRAME INTEGRATION MODEL TESTING FOR NACELLE SIMULATION AND MEASUREMENT ACCURACY
R Decher W B Gillette and D C Tegeler *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 14 p refs

Techniques necessary to achieve high accuracy in simulation and in force data for better subsonic airplane nacelle airframe integration are discussed The selection of the appropriate nacelle simulation is covered together with experimental data obtained with flow blown, and turbopowered nacelle models operated at wind tunnel flow conditions The thrust calculation and the simulator calibration procedure are described To guide test instrumentation and test procedures an error analysis is reported which shows that predicted error levels of under 1% of model airplane drag can be achieved in the wind tunnel Data from an isolated and an installed test with flow blown, and turbopowered simulator models of a high bypass engine nacelle on a four engined subsonic transport are shown to verify the validity of the test procedures Author

N76-25239 British Aircraft Corp Warton (England) Military Aircraft Div
AIR DRIVEN EJECTOR UNITS FOR ENGINE SIMULATION IN WIND TUNNEL MODELS
R Whitaker A W Matthews P G Knott, R Angel and D J Stewart *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 15 p refs

The air driven ejector as a means of providing engine flow simulation is discussed The characteristics of the ejector and its ability to simulate a wide range of engine types and flight conditions are outlined It is shown that one dimensional theory with empirical loss factors now permits accurate performance predictions to be made Recent experimental work has extended the scope of the empirical knowledge, demonstrated the merits of supersonic primary nozzle ejectors and improved the state of the art of ejector design In low speed tunnel testing it has been demonstrated that for a high bypass ratio engine simulator good exit velocity profiles can be obtained and the installed performance well predicted under varying external conditions Also correct exhaust and intake momentum coefficients can be achieved at acceptable tunnel speeds even when using relatively low drive pressures Author

N76-25248 General Dynamics Corp San Diego Calif Convair Div
MODEL SYSTEMS AND THEIR IMPLICATIONS IN THE OPERATION OF PRESSURIZED WIND TUNNELS
Stanley A Griffin *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 13 p refs

The feasibility of designing multi-piece flow through models for high Reynolds number transonic wind tunnels is considered Six component high capacity balances are investigated and a comparison is made of model aeroelastic characteristics in a pressurized tunnel in reference to the aeroelastic nature of the flight vehicle Methods of matching model/airplane deformation are shown, together with a system for measuring model deformation in a wind tunnel Selected configurations are reviewed with respect to model loads distortions, and stress and a summary of recommended fabrication materials is presented Cost comparisons are made between models for testing in proposed high Reynolds number transonic wind tunnels and present day transonic wind tunnels The study concludes that models and strain gaged balances capable of running in these facilities can be designed and fabricated at a reasonable cost with present techniques The study also indicates that options are available to produce close similarity of the model/airplane wing deformation over a broad range of operating conditions Author

N76-25249 Dornier-Werke G m b H Friedrichshafen (West Germany)
DESIGN AND CONSTRUCTION OF THE ALPHA JET FLUTTER MODEL
Peter Esch and Theo Windeck *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 9 p refs

In order to prove flutter safety for the Alpha jet, a flutter model (scale 1 8) was designed and constructed for experimental investigations in the transonic wind tunnel For each component of the aircraft an adequate structural solution had to be found in order to fulfill the correct stiffness distribution The construction was carried out using advanced techniques, e g electron beam welding chemical milling and bonding The static vibration tests of the complete model were in good agreement with the corresponding test results of the original aircraft Ahead of the main tests preliminary tests with the wing and tail isolated were performed in a blowdown wind tunnel For the tests with the complete model a rigid wire suspension was used In the course of one year several configurations with and without external stores were investigated The experimental results agreed reasonably with the theoretical calculations Author

N76-25250* Virginia Univ , Charlottesville Dept of Engineering Science and Systems
MAGNETIC SUSPENSION TECHNIQUES FOR LARGE SCALE AERODYNAMIC TESTING
Ricardo N Zapata *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 14 p refs

(Grant NsG-1010)

The potential utility of magnetic suspension techniques is discussed in the context of current efforts towards realistic aerodynamic simulation in wind tunnels Design parameters are defined and problems of constructing large size facilities identified A three stage strategy towards realizing a truly large scale magnetic suspension and balance with full research capability is outlined Stage one consisting of building and testing a prototype superconductor coil system to establish the feasibility of the concept has been completed successfully and its principal results are briefly described This proven feasibility of using superconductors for magnetic suspensions together with the successful demonstration of the cryogenic wind tunnel concept appear to have opened the way to clean tunnel high-Re aerodynamic testing Results of a comparative analysis of scaling of several coil technologies for a specific magnetic suspension configuration, from the prototype size to a size compatible with the projected high Reynolds number cryogenic wind tunnel facility, are discussed in some detail Author

N76-25251 Von Karman Inst for Fluid Dynamics Rhode-Saint-Genese (Belgium)
INTERFERENCE PROBLEMS IN V/STOL TESTING AT LOW SPEEDS
Mario Carbonaro *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 21 p refs

When testing V/STOL models at low speeds several problems arise, in connection with the sharp downward deflection of the wake originating from the highly loaded lifting systems It is the purpose of this paper to define the various problems and to summarize and compare the obtained results First the inclined wake may impinge on the wind tunnel floor and cause a breakdown in the wind tunnel flow uniformity The testing limitations associated with the occurrence of such phenomenon are discussed for the different cases of a rotor a jet flap wing, or a single or multiple lifting jet configuration Wind tunnel boundary corrections account for the real behavior of the wake and an upper limit of their validity has to be assessed The various existing theories of wall corrections which take into account the deflection and eventually the curvature of the wake are summarized in the various cases of closed open or ventilated test sections, and comparisons with existing experimental data are made The limits proposed in the literature for the validity of wall corrections are discussed Author

N76-25252 Westland Helicopters Ltd Yeovil (England) Aerodynamics Research Dept
THE REMOVAL OF WIND TUNNEL PANELS TO PREVENT FLOW BREAKDOWN AT LOW SPEEDS
R E Hansford *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 8 p refs

A model rotor was tested at low speed in a wind tunnel to study the problem of flow breakdown This condition arises from the wake impingement on tunnel floor and wall panels to induce a recirculatory flow upstream The phenomenon was first reproduced in the closed tunnel for various disc loadings and limiting operating conditions were established Panels were then selectively removed and it was subsequently shown that it was possible to obtain a representative tunnel flow free from recirculatory interference at lower advance ratios compared to closed tunnel operation By careful venting of a working section it is concluded that a substantial increase in maximum allowable downwash angle can be obtained Author

N76-25253 Hawker Siddeley Aviation Ltd Hatfield (England) Wind Tunnel Dept
VSTOL WIND TUNNEL MODEL TESTING AN EXPERIMENTAL ASSESSMENT OF FLOW BREAKDOWN USING A MULTIPLE FAN MODEL
M J Cull *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 8 p refs

Tests have been made with a multifan VSTOL model in two different sized closed test section wind tunnels to investigate the problem of tunnel flow breakdown The boundary condition of incipient stagnation where the high energy jet exhaust first penetrates the tunnel wall boundary layer has been identified for a range of model conditions Correlation of results in both tunnels and with other work is good and the technique of establishing a flow breakdown boundary by investigating the behavior of the floor vortex formed by the interaction of the model jet efflux and the tunnel mainstream flow has been used successfully for a multifan configuration In addition model forces and moments are recorded in an attempt to estimate minimum testing conditions and to indicate the magnitude of wall constraint effect Direct comparisons are made of longitudinal forces and moments using results from both wind tunnels and a sample of results are presented Author

N76-25254 Aircraft Research Association Ltd Bedford (England)
FURTHER EVIDENCE AND THOUGHTS ON SCALE EFFECTS AT HIGH SUBSONIC SPEEDS
A B Haines *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 12 p refs

Recent evidence from tests at high subsonic speeds in existing tunnel facilities are reviewed to illustrate the difficulties in extrapolating the data to full scale The uncertainties can be considerable even for wings currently being developed, the report stresses that these uncertainties affect not only the flow separation characteristics but also the drag in conditions where the flow is attached None of the evidence detracts from the arguments which lead to the conclusion that there is a need in Europe for a new large pressurized transonic tunnel, but comments are also made as to whether the new theoretical tools flight tests, further experimental research in existing facilities and modified experimental techniques could be partly used to offset the lack of such a facility in the next decade Author

N76-25256 National Aerospace Lab Amsterdam (Netherlands)
THE CHARACTER OF FLOW UNSTEADINESS AND ITS INFLUENCE ON STEADY STATE TRANSONIC WIND TUNNEL MEASUREMENTS
R Ross and P B Rohne *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 7 p refs

Flow unsteadiness in wind tunnels has been separated into three modes free stream turbulence convected by the flow sound wave type disturbances travelling with the speed of sound with respect to the flow and temperature spottiness convected with the flow It was found, using the hot wire technique and microphones that sound wave type disturbances are the most important type of unsteadiness in some transonic tunnels Tests carried out on a supercritical airfoil with noise levels of 0 35% and 0 6% did not change trailing edge and shock induced separation The additional noise caused transition to occur more forward by about 4% of the chord Author

N76-25259 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany)
SYSTEMATICAL INVESTIGATIONS OF THE INFLUENCE OF WIND TUNNEL TURBULENCE ON THE RESULTS OF MODEL FORCE-MEASUREMENTS
H Otto *In* AGARD Wind Tunnel Design and Testing Tech Mar 1976 9 p refs

The influence of wind tunnel turbulence especially on the maximum lift of aircraft models, has been studied by systematical investigations in five low speed wind tunnels In each wind tunnel the free stream turbulence was altered by two different grids which could be fixed at the nozzle exit The test program included hot wire and sphere measurements to determine the free stream turbulence as well as force measurements on wind body models with different flap deflection angles The results show that the maximum lift coefficient is not simply a function of the effective Reynolds number but depends also on the scale of the turbulence grid This correlation is approximated by a simple formula Author

N76-25267 Office National d'Etudes et de Recherches Aerospatiales, Paris (France)
COMPARATIVE TWO AND THREE DIMENSIONAL TRANSONIC TESTING IN VARIOUS TUNNELS
Xavier Vaucheret and Maurice Bazin *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 14 p refs In FRENCH ENGLISH summary

Testing conditions at transonic speeds and the validity of the data obtained in various wind tunnels were studied In two dimensional flow two models of NACA 0012 and supercritical profiles were tested in ONERA S3 Modane and NAE 15x60 in tunnels for Reynolds number 4 to 40 million from Mach 0 3 to 0 9 Three homothetical profiles of NACA 0012 were also tested Wind tunnel wall interferences were studied and recommendations on relative dimensions of models to test sections were made In three dimensional flow, four homothetical models of a typical transport aircraft were tested in twelve transonic tunnels used for tests in various countries The data were compared in a broad range of Reynolds number (0 3 to 7 million) between Mach number 0 7 and 0 96 Discrepancies can be reduced with corrections due to the free tunnel and wall interference The effect of tripping the transition by grits was also analyzed, and comparisons were made with an axisymmetric body near Mach 1 Author

N76-25268 Aeronautical Research Inst of Sweden, Bromma
COMMENT ON RESULTS OBTAINED WITH THREE ONERA AIRPLANE CALIBRATION MODELS IN FFA TRANSONIC WIND TUNNELS
S E Gudmundson and S-E Nyberg *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 7 p refs

Some test results are presented from three-component measurements for three of the ONERA Airplane Calibration Models (designated M1 M2, M3) The tests were performed in the FFA transonic wind tunnels HT S4 and TVM 500 in the Mach number range 0 7 to 0 96 and at Reynolds numbers based on the mean chord of the wing, in the range 0 2 to 1 0 million Comparisons are made for small angles of attack with results obtained with a small model (M1) in a large wind tunnel (ONERA S2MA in Modane) The agreement between the different tunnels is fairly good when the Reynolds number is the same The Reynolds number effects are relatively large especially on the pitching moment in the lower Reynolds number range, which might mask some wind tunnel interference effects Author

N76-25270 ARO Inc Arnold Air Force Station Tenn
SPECIAL WIND TUNNEL TEST TECHNIQUES USED AT AEDC
T W Binion, Jr *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 13 p refs
(Contract F40600-75-C-0001)

In recent years requirements have developed to investigate (1) captive loadings and trajectories of external stores, (2) maneuver and departure characteristics of aircraft and (3) static stability characteristics of missiles at angles of attack up to 180 deg Test techniques in use and being developed to satisfy these requirements are discussed Author

N76-25275 Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)
DYNAMIC SIMULATION IN WIND TUNNELS, PART 1
H Hoenlinger and O Sensburg *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 27 p refs

Dynamic simulation techniques and wind tunnels used to investigate flutter characteristics and flutter suppression techniques are described Two cases where active flutter suppression was successfully applied are demonstrated One case deals with the flutter of a wing with a store and the other with an ampennage flutter case Author

N76-25278 Royal Aircraft Establishment, Farnborough (England) Aerodynamics Dept
SOME AEROELASTIC DISTORTION EFFECTS ON AIRCRAFT AND WIND TUNNEL MODELS
G F Moss and D Pierce *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 11 p refs

Aspects of the aeroelastic distortion of wings in flight and in the tunnel are discussed The effects of such distortion could be of prime importance when correlating flight and wind tunnel data particularly when supercritical flows are present which tend to be comparatively sensitive to small geometric changes It is suggested that as transonic facilities operating at higher stagnation pressures come into more general use as a means of achieving higher Reynolds numbers better means of making allowances for the aeroelastic distortion of wind tunnel models will be necessary In flight the full benefits of advanced-wing technology will probably be achieved if similar improvements can be made to the techniques used by the aircraft designer In the long term methods need to be found to control and use aeroelastic distortion to enhance aerodynamic performance in flight Reference is made experimental and theoretical data obtained with respect to these problems Author

N76-25279 United Technologies Research Center East Hartford Conn
DEVELOPMENT OF THE UNITED TECHNOLOGIES RESEARCH CENTER ACOUSTIC RESEARCH TUNNEL AND ASSOCIATED TEST TECHNIQUES
William M Foley and Robert W Paterson *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 10 p refs

Design and development of an acoustic research tunnel is described Its operating experience is discussed relative to the design of new acoustic test facilities Experimental noise research programs conducted in the tunnel are described with attention given to the correlation of model studies with full-scale engine and helicopter rotor noise Author

N76-25280 Societe Nationale d Etude et de Construction de Moteurs d Aviation Villaroche (France)
CURRENT RESEARCH ON THE SIMULATION OF FLIGHT EFFECTS ON THE NOISE RADIATION OF AIRCRAFT ENGINES
Jean-Michael Fitremann and Mariano Perulli (Office Natl d'Etudes et de Recherches Aerospatiales Paris) *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 3 p In FRENCH, ENGLISH summary

Design problems related to the development of an anechoic wind tunnel in France were described Typical results were presented, dealing with fundamental research on refraction scattering and diffusion studies with the following goals (1) to define an accurate method of transposing noise measurements made in an anechoic wind tunnel to real flight conditions, and (2) to understand the possibilities of full scale silencers from model tests analysis Author

N76-25281 Royal Aircraft Establishment, Farnborough (England) Aerodynamics Dept
PROBLEMS OF NOISE TESTING IN GROUND-BASED FACILITIES WITH FORWARD-SPEED SIMULATION
John Williams *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 14 p refs

An overview of the design and operational problems associated with ground-based facilities for performing noise experiments with forward-speed simulation was presented Various facilities were described It was concluded that it is unlikely that one type of facility will be able to cater effectively for the whole range of simulated flight aero-acoustic measurements needed in aircraft noise R and D studies, towards the evolution of quieter military and civil aircraft without operational or economic penalties Modified wind-tunnel type facilities are seen as providing the best approach for noise-model research work The role of aircraft flight experiments was described, with the application of carefully controlled flight experiments using research-oriented modifications of small aircraft The functions of large low-speed tunnels in noise testing was described, in relation to the development and exploitation of small acoustic tunnels Author

N76-25282 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany)
STATUS OF METHODS FOR AIRCRAFT STATE AND PARAMETER IDENTIFICATION
P G Hamel *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 16 p refs

The report of a meeting on aircraft system identification for flight test engineers and pilots, handling qualities and simulation experts, and aircraft and control system designers was presented It was shown that in recent years several identification procedures have evolved for obtaining aircraft parameters from inflight measurements These approaches have been shown to have good success for conventional (winged) aircraft and have become practical to apply The parameter identification problem becomes a much more complicated task for large and slender body aircraft where the elastic deformations at high dynamic pressure can no longer be neglected For helicopters simplifying assumptions are also, in general, considerably more difficult due to the strong coupling of the rigid body degrees-of-freedom, because of the different flexible motions introduced by the rotor blades and because of the shortness of the test period which can be recorded due to the inherent instability of these vehicles Author

N76-25283* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
PERSISTENCE AND DECAY OF WAKE VORTICITY
Leonard Roberts *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 10 p

CSCL 01A

Some recent research relating to the nature of the lift-induced vortex wakes behind large aircraft was reviewed and the scaling laws that permit a comparison of results from ground facilities with those from flight test were provided The maximum rotational velocities in the wake are shown to depend on a span loading shape parameter and on a characteristic length of persistence behind the aircraft The effects of Reynolds number are also shown Author

N76-25284 Royal Aircraft Establishment, Bedford (England)
FLIGHT MEASUREMENTS OF HELICOPTER ROTOR AEROFOIL CHARACTERISTICS AND SOME COMPARISONS WITH TWO-DIMENSIONAL WIND TUNNEL RESULTS
P Brotherhood *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 15 p refs

The performance of airfoil sections designed specifically for

helicopter rotor blades was investigated These effect a better compromise of performance characteristics in the widely varying conditions of incidence and Mach number in which they operate A technique of section comparison using appropriate airfoil fairings or gloves' each on opposing blades of a helicopter rotor, has been developed In this way the helicopter is used as a test vehicle with the rotor providing the necessary environment for the airfoil tests Results obtained in flight are compared with those from wind tunnel tests The adverse effects of leading-edge roughness, simulating erosion have also been investigated

Author

N76-25285 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany)

SOME INFORMAL COMMENTS ABOUT THE RESEARCH AIRCRAFT IN THE DFVLR

Hans-L Meyer *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 3 p

An informal comment about the research aircraft of the DFVLR and some flight test systems was presented The objective is to present an overview about the flight research activities at the DFVLR The flight research activities of the DFVLR are concentrated at the Oberpfaffenhofen and Braunschweig research centers Oberpfaffenhofen conducts activities in the field of electronics and physics of the atmosphere while Braunschweig is mainly concerned with flight mechanics and guidance and control Presently, 12 aircraft are assigned at Oberpfaffenhofen and 6 at Braunschweig with which the divisions fly annually about 2 000 and 1 000 flight hours respectively These research aircraft can be classified into the following groups Jet Canberra HFB 320 T-33, 2-prop 2 Do 28 D-1, 1 Queen Air 1-prop 5 Do 27, 2 P 149D, 1 C 207 1 C 182 3 powered gliders gliders 1 Ka-6 E 1 Cirrus 1 ASW 15

Author

N76-25286* National Aeronautics and Space Administration Langley Research Center, Langley Station Va

ROTOR SYSTEMS RESEARCH AIRCRAFT (RSRA)

Gregory W Condon and Robert Letchworth *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 20 p ref

CSCL 01C

A description of the Rotor Systems Research Aircraft (RSRA) was presented with particular emphasis on the unique systems that provide the potential for good flight/ground test facility correlation These flight research vehicles are designed specifically with the capabilities necessary for the effective and efficient in-flight test and verification of promising new rotor concepts and supporting technology developments The research mission and unique features of the RSRA will provide the capability to measure and separate the flight loads of the airframe and rotor thereby allowing direct flight/ground test facility correlation of rotors as well as correlation with analytical models

Author

N76-25287* National Aeronautics and Space Administration Flight Research Center, Edwards Calif

A NEW EXPERIMENTAL FLIGHT RESEARCH TECHNIQUE THE REMOTELY PILOTED AIRPLANE

Garrison P Layton *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 7 p refs

16-09)

CSCL 01C

The results obtained so far with a remotely piloted research vehicle (RPRV) using a 3/8 scale model of an F-15 airplane to determine the usefulness of the RPRV testing technique in high risk flight testing including spin testing were presented The program showed that the RPRV technique including the use of a digital control system is a practical method for obtaining flight research data The spin stability and control data obtained with the 3/8-scale model also showed that predictions based on wind-tunnel tests were generally reasonable

Author

N76-25288 Institut de Mecanique des Fluides de Lille (France)

FLIGHT SIMULATION USING FREE-FLIGHT LABORATORY SCALE MODELS [SIMULATION DE VOL PAR MAQUETTES DE VOL LIBRE EN LABORATOIRES]

Jean Gobeltz *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 16 p refs In FRENCH ENGLISH summary

Two operating procedures related to the laboratory testing of free-flight models are defined the direct similarity' testing where tests have to predict directly the results of the flight tests of the full scale aircraft and the indirect similarity testing where tests are used first for analysis of the phenomena, secondly for its modelling which is later applied to the aircraft itself Dynamic stall and spin results are given as examples of direct similarity' testing Use of indirect similarity is shown to be a broader and more scientifically fertile testing procedure Examples quoted are relative to the longitudinal dynamic behavior and vertical atmospheric gust response of aircrafts It is shown how for phenomena modelling both stationary aerodynamic characteristics and aerodynamic derivatives data of the model are extracted of purposely designed flights These data are then used for computation Piloting methods of the models are given Other types of tests relative to landing or cross-wind landing ditching transversal gusts and active controls are also mentioned Author

N76-25289 Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost

EXPERIENCE IN PREDICTING SUBSONIC AIRCRAFT CHARACTERISTICS FROM WIND TUNNEL ANALYSIS

J H D Blom *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 15 p

Some examples of experience gained in the field of subsonic aircraft characteristics using illustrative material from aircraft development experience in the Netherlands were presented The accuracy in predicting aircraft characteristics from wind tunnel analysis not only depends on the quality of the wind tunnel facilities used but also to a large extent on the experience of the aircraft designer in converting wind tunnel information into the appropriate conclusion for the full-scale aircraft Direct comparison of wind tunnel data with flight test results is useful in the interest of providing further insight into the interpretation and nature of the corrections to be applied to wind tunnel test data

Author

N76-25290 British Aircraft Corp Weybridge (England) Commercial Aircraft Div

COMMENTS ON WIND TUNNEL/FLIGHT COMPARISONS AT HIGH ANGLES OF ATTACK BASED ON BAC ONE-ELEVEN AND VC10 EXPERIENCE

M W Salisbury *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 4 p

The flight test and wind tunnel measurements made at high incidence on the BAC 111 have been used to find the effects of Reynolds number and Mach number on the maximum value of the lift coefficient It is shown that the effect of Mach number changes in the range 0 18 to 0 27 are of the same order as the effect of the Reynolds number change between wind tunnel and flight The flight/tunnel comparison on the VC10 is used to show the importance of representing the geometry of the slat and wing profile in great detail in order to achieve a satisfactory correlation Examples are also given of the type of modification which has to be made to wind tunnel data in order to achieve agreement between flight and simulator handling characteristics at the stall and of the use of a simple end plate model to investigate the effect on drag of detail configuration changes

Author

N76-25291 Bell Helicopter Co Fort Worth Tex

THE ART AND SCIENCE OF ROTARY WING DATA CORRELATION

Jan M Drees *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 11 p refs

An overview of the correlation of helicopter rotor performance and loads data from various tests and analyses was presented Information is included from free-flight full-scale tests in a 40 x 80 wind tunnel one-fifth scale tests in a Transonic Dynamic Tunnel and small-scale tests of a rotor in air These test data are compared with each other where appropriate and with calculated results Typical examples illustrate the state of the

art for correlation and indicate anomalies encountered It is concluded that a procedure using theoretical analyses to aid in interpretation and evaluation of test results is essential to developing a science of correlation Author

N76-25292* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
COMPARISON OF MODEL AND FLIGHT TEST DATA FOR AN AUGMENTOR-WING STOL RESEARCH AIRCRAFT

W L Cook and D C Whittley (De Havilland Aircraft Co Ltd Downsview Ont) *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 12 p refs

CSCL 01C

The major areas of confidence derived from wind tunnel tests performed on the Augmentor-Wing jet-STOL research aircraft were delineated and it was shown that for the most part tunnel results compare favorably with flight experience Since the model differs in some respects from the actual aircraft, precise correlation between tunnel and flight tests results were not expected in some areas the model tests were known to be non-representative so that a degree of uncertainty remained these areas of greater uncertainty are identified and again discussed in the light of subsequent flight tests Author

N76-25293* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
CORRELATION OF LOW SPEED WIND TUNNEL AND FLIGHT TEST DATA FOR V/STOL AIRCRAFT
Woodrow L Cook and David H Hickey *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 10 p refs

CSCL 01C

The availability of wind tunnel test data for correlation purposes of the same V/STOL aircraft tested in flight is very limited This is due in a large part to size limitations of wind tunnels and the number of wind tunnels available for testing of full-scale aircraft Wind tunnel tests are described for two research aircraft - the XV-5B fan-in-wing aircraft and the YOV-10 RCF (rotating cylinder flap) aircraft - in the NASA Ames 40- by 80-foot wind tunnel The tests were conducted specifically to provide for correlation between wind tunnel and in-flight aerodynamics and noise test data Correlation between aerodynamic and noise data are presented and testing techniques that are related to the accuracy of the data, or that might affect the correlations are discussed The correlation of noise measurements made with a J-85 engine mounted on a F-106 aircraft during low altitude flyovers with the same J-85 engine mounted on a model and tested in the Ames 40- by 80-foot wind tunnel are also reported Author

N76-25294 Royal Aircraft Establishment Bedford (England)
A BRIEF FLIGHT-TUNNEL COMPARISON FOR THE HUNTING H 126 JET FLAP AIRCRAFT
D N Foster *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 7 p refs

Flight measurements of the variation of lift with angle of incidence for an aircraft with an internal-flow jet flap were compared with results deduced from wind-tunnel tests of the aircraft itself and of a one-seventh scale model of the aircraft The correlation is shown to be unsatisfactory for large flap deflection and high values of the jet momentum The effects of the wind-tunnel wall corrections and of some uncertainties in the position error correction were investigated in order to suggest areas where further work could lead to improvements in the flight-tunnel correlation Author

N76-25295 Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France)
COMPARISON OF AERODYNAMIC COEFFICIENTS OBTAINED FROM THEORETICAL CALCULATIONS, WIND TUNNEL TESTS, AND FLIGHT TESTS DATA REDUCTION FOR THE ALPHA JET AIRCRAFT [COMPARAISON DES COEFFICIENTS AERODYNAMIQUES ISSUS DES CALCULS THEORIQUES, ESSAIS EN SOUFFLERIE ET DEPOUILLEMENTS D'ESSAIS EN VOL EFFECTUES SUR L'ALPHA JET]
Remi Guiot and Horst Wunnenberg *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 15 p refs In FRENCH

The techniques used to obtain the aerodynamic coefficients for the Alpha jet aircraft by theoretical calculations results from wind tunnel tests, and reduction from flight tests data were described Comparison of these various results was made and showed in general a good correlation between them
Transl by Y J A

N76-25296 Royal Aircraft Establishment Bedford (England)
FLIGHT MEASUREMENTS OF THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A VECTORED THRUST AIRCRAFT (HS-P1127) THROUGHOUT THE TRANSITION
C J Thorpe and A A Woodfield *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 21 p refs

At low speeds the aerodynamic force and moment coefficients on a vectored thrust jet V/STOL aircraft are primarily functions of the three variables - incidence angle thrust deflection angle and the ratio of free stream to jet momentum per unit area (effective velocity ratio) To obtain an indication of the influence of each variable and obtain data requiring a minimum of correlation for comparison with model results quasi-static non-equilibrium flight test techniques were developed The principles underlying aerodynamic lift, drag and pitching moment measurements on jet V/STOL aircraft are examined Test and analysis procedures used for flight tests on the P1127 prototype at the RAE are described Examples of results from the flight tests are used to illustrate the various test techniques Author

N76-25297 Hawker Siddeley Aviation Ltd Kingston upon Thames (England)
COMMENTS ON SOME WIND TUNNEL AND FLIGHT EXPERIENCE OF THE POST-BUFFET BEHAVIOUR OF THE HARRIER AIRCRAFT
S F Stapleton and B V Pegram *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 11 p

The design background of the Harrier wing is briefly reviewed indicating the philosophy of design for controlled buffet penetration to achieve high usable lift Some wind tunnel techniques for evaluation of high incidence behavior are described and problems of interpretation are discussed Some results of flight trials concerned with establishing high incidence/Mach number limits of operation are discussed and comments are made on the difficulties of prediction of flight behavior from wind tunnel data on the basis of correlations on the Harrier
Author

N76-25298 Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio
EFFECTS OF BUFFETING AND OTHER TRANSONIC PHENOMENA
William E Lamar *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 32 p refs

Buffeting and other transonic phenomena are viewed in the context of highly maneuvering fighter aircraft The fighter combat problem is first discussed from the viewpoint of the pilot with emphasis on the effects of buffeting and stability and control problems which occur during highly maneuvering flight The current state of knowledge and available data relating to the tolerance and performance of the pilot in this flight regime is then reviewed to sum up the assessment of buffeting effects on piloting capabilities Basic transonic flow separation phenomena structural dynamics, and relevant aspects of flight control are viewed from the standpoint of the technologists to provide understanding of the basic effects Various aspects of buffeting are reviewed to aircraft design and development, and means of improving aircraft design to reduce buffeting and flight control problems The

situation regarding correlation of ground wind tunnel and flight tests is reviewed and the need of improvements in such correlations is noted Gaps in capabilities and needs for research and development are given emphasis Author

N76-25299 Saab-Scania Linkoping (Sweden) Aero-Space Div
SWEDISH EXPERIENCE ON CORRELATIONS OF FLIGHT RESULTS WITH GROUND TEST PREDICTIONS
Svein Teige Gunnar Straeng and Karl-Erik Staeke *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 10 p ref

Some of the wind tunnel data and flight test data obtained during the development work on the SAAB 37 Viggen aircraft are compared Three different areas of testing were selected (1) spin tests (2) inlet tests and (3) measurements of aerodynamic derivatives The main spinning and recovery characteristics of the aircraft are in good agreement with those predicted from wind tunnel tests one exception being that the inverted spin mode has not been found in flight tests Generally the agreement between uncorrected inlet scale model tests and full scale is fair, but with a tendency of model flow measurements to be a conservative prediction of the aircraft performance By correcting the model data for Reynolds number effects and probe sizing influence an almost perfect correlation was achieved The aerodynamic derivatives measured in flight tests are in good agreement with data predicted from wind tunnel tests and calculations No important Reynolds number effects have been found Author

N76-25300 Hawker Siddeley Aviation Ltd Brough (England)
FLIGHT/TUNNEL COMPARISON OF THE INSTALLED DRAG OF WING MOUNTED STORES
A J Grundy *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 16 p refs

Installed drags for a range of stores mounted on the outboard wing pylon (mid semi-span) of a Hawker Siddeley Buccaneer S Mk 2 were measured in full scale flight and on a 1/12th scale wind tunnel full-model This initial comparison covers several types of stores including a simple tank a rocket pod and twin side-by-side carriage of iron bombs up to 0 86 Mach number The flight results were obtained using quasi-steady flight test techniques excess thrust was derived from triple-axis accelerometer measurements and thrust from an altitude test facility engine final nozzle calibration using jet pipe pressure The comparison of incremental drag shows that agreement is satisfactory Clean stores show good agreement but dirty stores generally have lower drag in flight Data on changes in lift and pitching moment are also presented Author

N76-25301 British Aircraft Corp Preston (England) Aerodynamics Dept
COMMENTS ON MATHEMATICAL MODELLING OF EXTERNAL STORE RELEASE TRAJECTORIES INCLUDING COMPARISON WITH FLIGHT DATA
G A Cox and K Carr *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 19 p

The ability to reproduce wind tunnel and flight store jettison trajectories using a mathematical modelling technique is demonstrated A correlation is shown between flight trajectories and predictions using mathematical models incorporating data from (1) matching of wind tunnel jettisons with corrections to full scale conditions (2) wind tunnel measurements of installed store loads and store free-air aerodynamic forces and moments The potential of the mathematical modelling technique to minimize wind tunnel and flight store jettison programs is demonstrated Author

N76-25302 Aeritalia, Turin (Italy) Wind-Tunnel Dept
COMMENTS ON WIND TUNNEL/FLIGHT CORRELATIONS FOR EXTERNAL STORES JETTISON TESTS ON THE F 104 S AND G 91 Y AIRCRAFT
A Garrone, G Bucciantini, and E Barbantini *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 11 p ref

Comparisons are shown of wind-tunnel/flight jettison test results for significant stores on the aircraft F 104 S and G 91 Y Relevant techniques of jettison tests are illustrated Moreover a computer program is examined for the theoretical estimation of the jettisoned stores trajectories in support of wind-tunnel and/or flight tests Author

N76-25303 Aerospatiale Usines de Toulouse (France)
ANALYSIS OF THE COMPARISON BETWEEN FLIGHT TESTS RESULTS AND WIND TUNNEL TESTS PREDICTIONS FOR SUBSONIC AND SUPERSONIC TRANSPORT AIRCRAFT [ANALYSE CRITIQUE DES COMPARAISONS DES RESULTATS DE VOL AUX PREVISIONS DE SOUFF-LERIE POUR DES AVIONS DE TRANSPORT SUBSONIQUE ET SUPERSONIQUE]
C Pelagatti, J C Pilon, and J Bardaud *In* AGARD Flight/Ground Testing Fac Correlation Apr 1976 23 p refs In FRENCH

The problems of comparing results obtained from wind tunnels with those derived from actual flight tests were discussed It was pointed out that corrections must be made to relate these results directly, due to aeroelastic effects and the effect of Reynold s number differences For instance high aerodynamic loads may alter significantly the general aerodynamic shape of aircraft as compared to that of the corresponding scale models corrections must then be made to the coefficients measured with wind tunnels, making predictions more difficult In addition certain problems arise in the measurement of aerodynamic coefficients over the transonic regime Using results obtained with the Airbus and Concorde aircraft an attempt was made to point out the accuracy that may be expected from aerodynamic coefficients derived from wind tunnel measurements and the parameters that effect that accuracy Transl by Y J A

N76-25322*# Chrysler Corp New Orleans La Data Management Services
RESULTS OF AN AERODYNAMIC INVESTIGATION OF A SPACE SHUTTLE ORBITER/747 CARRIER FLIGHT TEST CONFIGURATION TO DETERMINE SEPARATION CHARACTERISTICS UTILIZING 0 0125-SCALE MODELS (48-0/AX1318I-1) IN THE LTV 4 x 4 FOOT HIGH SPEED WIND TUNNEL (CA26), VOLUME 1 Aerothermodynamic Data Report
R L Gillins (Rockwell International Downey Calif) Apr 1976 742 p refs 5 Vol
(Contract NAS9-13247)
(NASA-CR-144612, DMS-DR-2273-Vol-1) Avail NTIS HC $18 75 CSCL 22B

Results of tests conducted on a 0 0125-scale model of the Space Shuttle Orbiter and a 0 0125-scale model of the 747 CAM configuration in a 4 x 4-foot High Speed Wind Tunnel were presented Force and moment data were obtained for each vehicle separately at a Mach number of 0 6 and for each vehicle in proximity to the other at Mach numbers of 0 3 0 5, 0 6 and 0 7 The proximity effects of each vehicle on the other at separation distances (from the mated configuration) ranging from 1 5 feet to 75 feet were presented, 747 Carrier angles of attack from 0 deg to 6 deg and angles of sideslip of 0 deg and -5 deg were tested Model variables included orbiter elevon, aileron and body flap deflections, orbiter tailcone on and off, and 747 stabilizer and rudder deflections Author

N76-25323*# Chrysler Corp New Orleans, La Data Management Services
RESULTS OF AN AERODYNAMIC INVESTIGATION OF A SPACE SHUTTLE ORBITER/747 CARRIER FLIGHT TEST CONFIGURATION TO DETERMINE SEPARATION CHARACTERISTICS UTILIZING 0 0125-SCALE MODELS (48-0/AX1318I-1) IN THE LTV 4 x 4 FOOT HIGH SPEED WIND TUNNEL (CA26), VOLUME 2 Aerothermodynamic Data Report
R L Gillins (Rockwell International Downey Calif) Apr 1976 750 p refs 5 Vol
(Contract NAS9-13247)
(NASA-CR-144613, DMS-DR-2273-Vol-2) Avail NTIS HC $18 75 CSCL 22B
For abstract see N76-25322

N76-25324*# Chrysler Corp, New Orleans La Data Management Services
RESULTS OF AN AERODYNAMIC INVESTIGATION OF A SPACE SHUTTLE ORBITER/747 CARRIER FLIGHT TEST CONFIGURATION TO DETERMINE SEPARATION CHARACTERISTICS UTILIZING 0 0125-SCALE MODELS (48-0/AX1318I-1) IN THE LTV 4 x 4-FOOT HIGH SPEED WIND TUNNEL (CA26), VOLUME 3 Aerothermodynamic Data Report
R L Gillins (Rockwell International, Downey Calif) Apr 1976 752 p refs 5 Vol
(Contract NAS9-13247)
(NASA-CR-144614, DMS-DR-2273-Vol-3) Avail NTIS HC $18 75 CSCL 22B
For abstract, see N76-25322

N76-25325*# Chrysler Corp New Orleans, La Data Management Services
RESULTS OF AN AERODYNAMIC INVESTIGATION OF A SPACE SHUTTLE ORBITER/747 CARRIER FLIGHT TEST CONFIGURATION TO DETERMINE SEPARATION CHARACTERISTICS UTILIZING 0 0125-SCALE MODELS (48-0/AX1318I-1) IN THE LTV 4 x 4 FOOT HIGH SPEED WIND TUNNEL (CA26), VOLUME 4 Aerothermodynamic Data Report
R L Gillins (Rockwell International, Downey, Calif) Apr 1976 798 p refs 5 Vol
(Contract NAS9-13247)
(NASA-CR-144615, DMS-DR-2273-Vol-4) Avail NTIS HC $18 75 CSCL 22B
For abstract, see N76-25322

N76-25326*# Chrysler Corp New Orleans, La Data Management Services
RESULTS OF AN AERODYNAMIC INVESTIGATION OF A SPACE SHUTTLE ORBITER/747 CARRIER FLIGHT TEST CONFIGURATION TO DETERMINE SEPARATION CHARACTERISTICS UTILIZING 0 0125-SCALE MODELS (48-0/AX13 18 1-1) IN THE LTV 4 x 4 FOOT HIGH SPEED WIND TUNNEL (CA26), VOLUME 5 Aerothermodynamic Data Report
R L Gillins (Rockwell International Downey Calif) Apr 1976 758 p refs 5 Vol
(Contract NAS9-13247)
(NASA-CR-144616 DMS-DR-2273-Vol-5) Avail NTIS HC $18 75 CSCL 22B
For abstract see N76-25322

N76-25331*# *Lockheed Missiles and Space Co Sunnyvale* Calif
UNSTEADY AERODYNAMIC FLOW FIELD ANALYSIS OF THE SPACE SHUTTLE CONFIGURATION PART 4 747/ORBITER AEROELASTIC STABILITY
J Peter Reding and Lars E Ericsson Mar 1976 53 p refs
(Contract NAS8-30652)
(NASA-CR-144335 LMSC-D057194-Pt-4) Avail NTIS HC $4 50 CSCL 22B

A quasi-steady analysis of the aeroelastic stability of the lateral (antisymmetric) modes of the 747/orbiter vehicle was accomplished The interference effect of the orbiter wake on the 747 tail furnishes an aerodynamic undamping contribution to the elastic modes Likewise the upstream influence of the 747 tail and aft fuselage on the orbiter beaver-tail rail fairing also is undamping Fortunately these undamping effects cannot overpower the large damping contribution of the 747 tail and the modes are damped for the configurations analyzed However significant interference effects of the orbiter on the 747 tail have been observed in the pitch plane The high response of the 747 vertical tail in the orbiter wave was also considered Wind tunnel data points to flapping of the OMS pod wakes as the source of the wake resonance phenomenon Author

N76-25333*# Chrysler Corp New Orleans La Space Div
RESULTS OF AN EXPERIMENTAL INVESTIGATION TO DETERMINE SEPARATION CHARACTERISTICS FOR THE ORBITER/747 USING A 0 0125-SCALE MODEL (48-0 AX1318I-1 747) IN THE AMES RESEARCH CENTER 14-FOOT WIND TUNNEL (CA23B), VOLUME 1
V Esparza (Rockwell Intern Downey Calif) Apr 1976 630 p refs
(Contract NAS9-13247)
(NASA-CR-144603 DMS-DR-2275-Vol-1) Avail NTIS HC $16 25 CSCL 22B

Separation data were obtained at a Mach number of 0 6 and three incidence angles of 4 deg 6 deg and 9 deg The orbiter angle of attack was varied from 0 to 14 degrees Longitudinal lateral and normal separation increments were obtained for fixed 747 angles of attack of 0 deg 2 deg, and 4 deg while varying orbiter angle of attack Control surface settings on the 747 carrier included rudder deflections of 0 deg and 10 deg and horizontal stabilizer deflections of -1 deg and +5 deg Photographs of tested configurations are shown Author

N76-25334*# Chrysler Corp New Orleans La Space Div
RESULTS OF AN EXPERIMENTAL INVESTIGATION TO DETERMINE SEPARATION CHARACTERISTICS FOR THE ORBITER/747 USING A 0 0125-SCALE MODEL (48-0 AX1318I-1 747) IN THE AMES RESEARCH CENTER 14-FOOT WIND TUNNEL (CA23B)
V Esparza (Rockwell Intern Corp Downey, Calif) Apr 1976 741 p refs
(Contract NAS9-13247)
(NASA-CR-144604 DMS-DR-2275-Vol-2) Avail NTIS HC $18 75 CSCL 22B

Aerodynamic separation data obtained from a wind tunnel test of an 0 0125-scale SSV Orbiter model of a VC70-000002 Configuration and a 0 0125-scale 747 model was presented Separation data was obtained at a Mach number of 0 6 and three incidence angles of 4 6 and 8 degrees The orbiter angle of attack was varied from 0 to 14 degrees Longitudinal lateral and normal separation increments were obtained for fixed 747 angles of attack of 0 2 and 4 degrees while varying the orbiter angle of attack Control surface settings on the 747 carrier included rudder deflections of 0 and 10 degrees and horizontal stabilizer deflections of -1 and +5 degrees Author

N76-25354*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
A COMPOSITE SYSTEM APPROACH TO AIRCRAFT CABIN FIRE SAFETY
Demetrius A Kourtides John A Parker William J Gilwee Jr Narcinda R Lerner Carlos J Hilado (San Francisco Univ) Lisa A LaBossiere (San Francisco Univ) and Ming-ta S Hsu (San Jose State Univ) Apr 1976 46 p refs
(NASA-TM-X-73126 A-6555) Avail NTIS HC $4 00 CSCL 11D

The thermochemical and flammability characteristics of two polymeric composites currently in use and seven others being considered for use as aircraft interior panels are described The properties studied included (1) limiting oxygen index of the composite constituents (2) fire containment capability of the composite (3) smoke evolution from the composite (4) thermogravimetric analysis (5) composition of the volatile products of thermal degradation and (6) relative toxicity of the volatile products of pyrolysis The performance of high temperature laminating resins such as bismaleimides is compared with the performance of phenolics and epoxies The relationship of increased fire safety with the use of polymers with high anaerobic char yield is shown Processing parameters of one of the baremaleimide composites are detailed Author

N76-25375*# Martin Marietta Corp Orlando Fla
HYDROGEN EMBRITTLEMENT OF STRUCTURAL ALLOYS A TECHNOLOGY SURVEY
James L Carpenter Jr and William F Stuhrke Jun 1976 133 p refs
(Contract NAS3-19530)
(NASA-CR-134962 OR-14178) Avail NTIS HC $6 00 CSCL 11F

Technical abstracts for about 90 significant documents relating to hydrogen embrittlement of structural metals and alloys are reviewed Particular note was taken of documents regarding hydrogen effects in rocket propulsion, aircraft propulsion and hydrogen energy systems, including storage and transfer systems Author

N76-25389# Northrop Corp Hawthorne Calif Norair Div
FATIGUE PROPERTIES OF K01 CAST ALUMINUM
D C Atmur 31 Jul 1969 27 p
(AD-A018714 NOR-69-107) Avail NTIS CSCL 11/6

Fatigue specimens of K01 aluminum T-6 heat treat condition K01 aluminum T-7 heat treat condition and 357 aluminum were fatigue load cycled to failure at two stress ratios, R = 20 and R = 1 0 All specimens were notched for a stress concentration of 3 0 The K01 aluminum T-6 heat treat condition material has the best fatigue properties of the materials tested The majority of T-6 specimens sustained 10 to the 7th power cycles at 7,000 pounds per square inch maximum stress for R = 20 and 3 000 pounds per square inch maximum stress for R = -1 0
Author (GRA)

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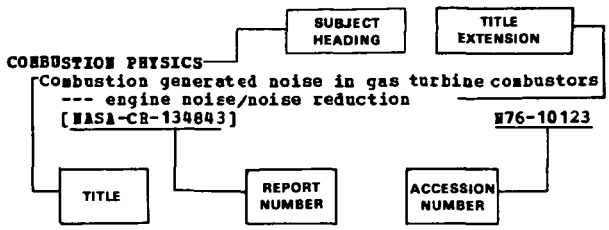

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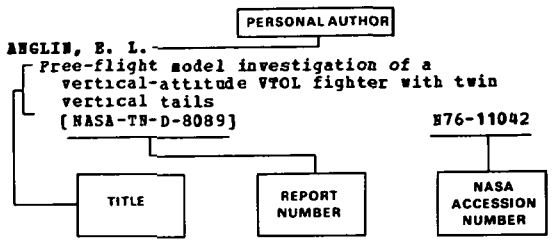

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