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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 8

AUGUST 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PREVIOUS BIBLIOGRAPHIES IN THIS SERIES

Document	*Date*	*Coverage*
NASA SP-7037	September 1970	Jan.–Aug. 1970
NASA SP-7037 (01)	January 1971	Sept.–Dec. 1970
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NASA SP-7037 (08)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 8

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 July 1971 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.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 540 reports, journal articles, and other documents originally announced in July 1971 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. For previous bibliographies in this series, see inside of front cover.

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.

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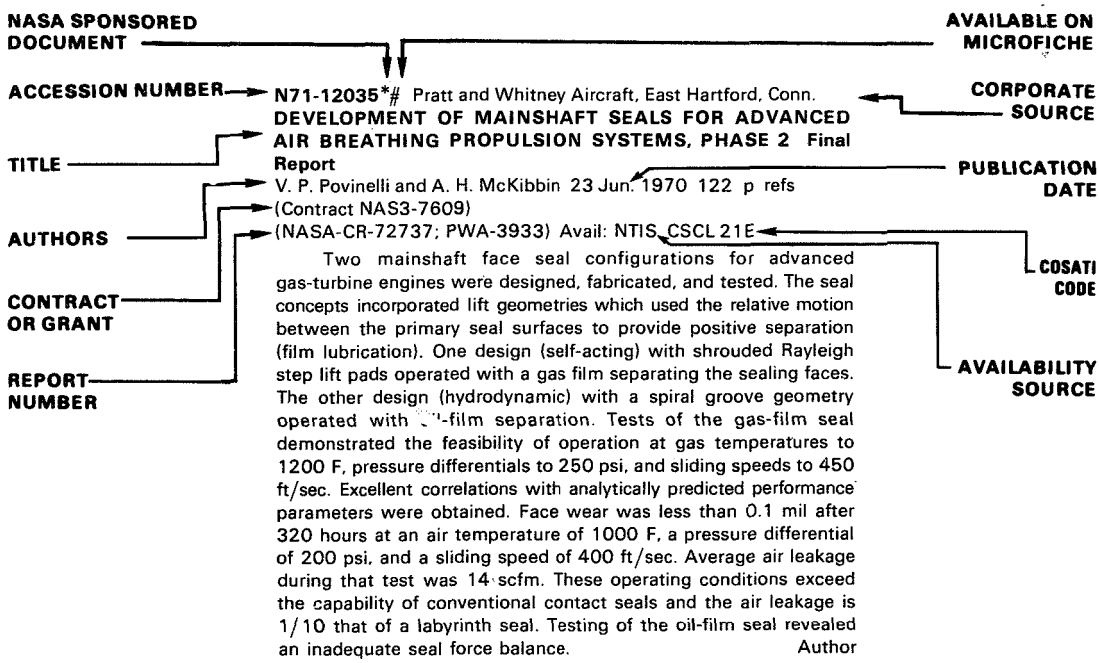

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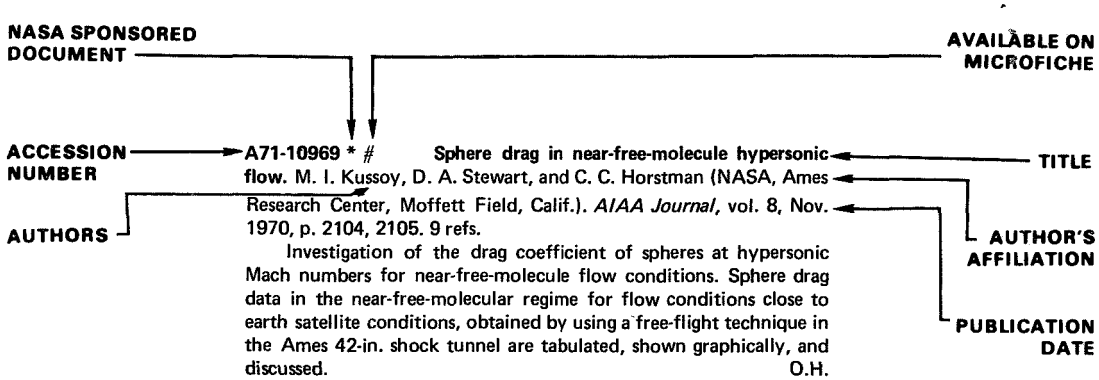

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 8) AUGUST 1971

IAA ENTRIES

A71-27819 # **Fatigue strength of aircraft skin elements affected by corrosion (Soprotivlenie ustalosti elementov obshivki samoleta, porazhennykh korroziei).** A. V. Karlashov, A. I. Radchenko, A. Ia. Zaika, and N. F. Voronkin (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *Fiziko-Khimicheskaia Mekhanika Materialov,* vol. 7, no. 1, 1971, p. 53-56. In Russian.

Study of the effect of a series of artificial corrosion pits, simulating local corrosion of the aircraft skin, on the fatigue durability of smooth samples and structural elements of duraluminum. It is shown that in the estimation of aircraft skin corrosion, the most important factor is the pitting density. Allowance must also be made for the effect of stress raisers formed by structural elements. This effect in many cases is much more important to the fatigue strength of the aircraft skin than are corrosion pits. Z.W.

A71-27838 # **VTOL propulsion - 1970 perspective.** E. P. Cockshutt (National Research Council, Ottawa, Canada). *(Canadian Aeronautics and Space Institute, Annual General Meeting, Ottawa, Canada, May 18, 19, 1970.) Canadian Aeronautics and Space Journal,* vol. 17, Apr. 1971, p. 117-129. 15 refs.

Review of the evolution of gas turbine technology over the past 15 years, with emphasis on the trends in pressure ratio, turbine inlet temperature, and weight as they bear on VTOL propulsion. A general system for cataloging VTOL powerplant systems based on a common gas generator is suggested, and the emerging predominance of lifting-fan systems is noted. It is shown that even high-bypass fans produce excess thrust under cruising conditions, hence some of the engines should be shut down in cruise. It is also shown that if high-bypass fans are to be used both in hover and cruise, then some form of variable geometry is needed to cope with the different operating conditions. It is considered that acceptable airworthiness for VTOL aircraft will only be achieved by significant engine reserve capacity to produce engine-out safety. F.R.L.

A71-28032 # **Development of high-response data analysis aids for inlet-engine testing.** Malcolm Rowe and Mark B. Sussman (Boeing Co., Seattle, Wash.). *Journal of Aircraft,* vol. 8, May 1971, p. 307-311. Contract No. AF 33(657)-69-C-0552.

The paper describes two data analysis aids recently developed to provide easy interpretation of high-response inlet flowfield information. A light bulb display is utilized as an analog simulation of the engine compressor face. Bulbs, on a one-to-one basis with high-response pressure transducers, provide flow visualization of high-frequency (to 1000 Hz) pressure fluctuations. A second analog device instantaneously sums the inputs of a select number of compressor face probes. Its output signal is used as an index to establish the degree to which the compressor face pulsations are one-dimensional. Data from a recently conducted inlet-engine test program are used to illustrate the operation of both devices. (Author)

A71-28033 # **Vortex wakes behind high-lift wings.** J. E. Hackett and M. R. Evans (Lockheed-Georgia Co., Marietta, Ga.). *Journal of Aircraft,* vol. 8, May 1971, p. 334-340. 17 refs.

At high wing lift coefficients pertinent to STOL operation, the conventional neglect of vortex roll-up effects can lead to errors when calculating downwash at the tail plane and in the presence of ground or wind-tunnel walls. A classical unsteady treatment in the cross-flow plane, which calculates the roll-up of an initial spanwise row of point vortices, has been modified to allow for the influence of the wing. Additional meaning is thereby given to the streamwise length dimension and hence to aspect ratio and sweep. The effects of height-above-ground and of various tunnel heights and widths are discussed. Under certain limited conditions, notably with part-span flaps or too narrow a tunnel, part or all of the trailing vortex system may move upwards. Consequent changes in the vertical velocity field are additional to conventional estimates involving only the appropriate image system. (Author)

A71-28145 **Vacuum heat treating of jet engine components.** R. F. Latchaw and D. J. Spillane (General Electric Co., Aircraft Engine Group, Evendale, Ohio). *Metals Engineering Quarterly,* vol. 11, May 1971, p. 24-26.

Vacuum heat treating of jet engine components is described with examples of some brazed and activated-diffusion-bonded hardware, including sheet-metal vanes, cast vanes, and blades. The problems connected with maintenance of the vacuum equipment are briefly reviewed with special reference to the problem of localized surface melting of René 80 high-pressure turbine blades during activated diffusion bonding. Z.W.

A71-28158 **A miniature turbulence gauge utilizing aerodynamic lift.** Thomas E. Siddon (British Columbia, University, Vancouver, Canada). *Review of Scientific Instruments,* vol. 42, May 1971, p. 653-656.

An advanced version of the aerofoil probe turbulence gauge is described. The new device uses an axisymmetric lifting body sensor of 2.4 mm diam coupled directly to a miniature preamplifier unit (6.35 mm diam). The output voltage varies linearly with the v or w component of turbulence. The device has uniform sensitivity and good signal-to-noise ratio over a nominal frequency range of 10 to 10,000 Hz. A discussion of calibration procedures and application considerations is included. (Author)

A71-28164 **Society of the Plastics Industry, Annual Western Conference, 28th, Coronado, Calif., May 5-7, 1971, Proceedings.** Los Angeles, Society of the Plastics Industry, Inc., 1971.

171 p. $7.00.

Recent advances in composite materials and filamentary-composite reinforcement of metal structures are reviewed, with special attention to their use in spacecraft and missiles. Polyimides, in particular, are considered for use in high temperature service, and potential structural applications to the space shuttle are discussed in the light of ongoing studies.

M.V.E.

A71-28168 * Filamentary composite reinforcement of metal structures. P. T. Sumida, L. J. Hart-Smith (Douglas Aircraft Co., Long Beach, Calif.), R. A. Pride, and W. Illg (NASA, Langley Research Center, Hampton, Va.). In: Society of the Plastics Industry, Annual Western Conference, 28th, Coronado, Calif., May 5-7, 1971, Proceedings. Los Angeles, Society of the Plastics Industry, Inc., 1971, p. 74-90. 18 refs.

A brief history of filamentary composite reinforced metal aircraft structural components is discussed. Trends in structural reinforcement concepts are enumerated for several different shapes and configurations. Test data are presented for boron/epoxy in combination with aluminum plus additional data on graphite/epoxy materials and hybrids with steel, titanium, and magnesium. The effect of thermally induced locked-in stresses arising from the differences in thermal coefficients of expansion of the various constituent materials is presented. Estimates of weight savings and projected costs of filamentary composite materials are included. Some basic problems which need further investigation and analyses are outlined. (Author)

A71-28176 Aircraft vortex wake. S. R. Cann (British Air Line Pilots Association, Hayes, Middx., England). *Shell Aviation News,* no. 394, 1971, p. 8, 9.

Consideration of the trailing vortices shed by the lifting surfaces of an aircraft. Vortex strength varies directly with the lift being produced by the wing and inversely as the speed and the span. Thus it is that at low speeds - i.e., in control zones - that wake effects become important. Encounters of aircraft with wakes produced by other aircraft can result in uncontrollability. Current UK separation standards are summarized. F.R.L.

A71-28177 Engine condition monitoring. John Towers (Aer Lingus Teo, Dublin, Ireland). *Shell Aviation News,* no. 394, 1971, p. 16-24.

Description of the methods by which engine condition monitoring (ECM) can be applied to airline operation. The engine parameters used for trend analysis are exhaust gas temperature (EGT); fuel flow (F); low- and high-pressure rotor speeds; and turbine (T) and diffuser (D) case vibration levels. Performance data are recorded by flight crews under steady-state cruise conditions, and the data are then transferred to punch cards at base. The program compares the performance of the gas path parameters for the engine being monitored to a standard engine of the same type at the same thrust setting. It is shown that trends appearing on the ECM printouts were effective in detecting defects and preventing secondary damage. F.R.L.

A71-28211 # Load estimation methods for preliminary design weight prediction. R. S. St. John (LTV Aerospace Corp., Dallas, Tex.). *SAWE Journal,* vol. 30, Mar.-Apr. 1971, p. 10-17. 12 refs.

Description of some preliminary load estimation methods used in performance and design concept trade studies required for arriving at candidate systems for detail analysis. These weight estimation techniques are shown to be accountable and at the same time adaptable enough to be useful in all phases of the advanced design environment. M.V.E.

A71-28249 # Measurement of geomagnetic components from moving platforms. A. Ia. Rotshtein and I. G. Zhurii (Akademiia Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia Radiovoln, Leningrad, USSR). (*Geomagnetizm i Aeronomiia,* vol. 10, no. 5, 1970, p. 883-887.) *Geomagnetism and Aeronomy,* vol. 10, no. 5, 1970, p. 696-699. 10 refs. Translation.

Discussion of direct and indirect methods of measuring geomagnetic components from ships or aircraft in a system of coordinates which is fixed in space. Direct and indirect methods of stabilizing the system of coordinates are also studied. It is shown that direct stabilization methods have the advantage of permitting direct measurement of any geomagnetic component in such a way that the results can be averaged without errors over an arbitrary period of time. V.P

A71-28250 # Aircraft refractometer. V. N. Bormotov, I. D. Gontar', and V. F. Shul'ga (Akademiia Nauk Ukrainskoi SSR, Institut Radiofiziki i Elektroniki, Kharkov, Ukrainian SSR). (*Geomagnetizm i Aeronomiia,* vol. 10, no. 5, 1970, p. 888-892.) *Geomagnetism and Aeronomy,* vol. 10, no. 5, 1970, p. 700-703. Translation.

Discussion of the design and principles of operation of an onboard refractometer operating at the 3.2 cm wavelength. Particular attention is given to the design of the resonator, on which the effectiveness of the instrument depends, and to a circuit by means of which the frequency of two klystron oscillators is phase locked to the resonator resonant frequencies. The block diagram for measuring the frequency difference of the two klystrons is examined. Mounted on an IL-18 aircraft, the device proved to be highly effective under adverse flight conditions at a height of 11 km. V.P.

A71-28282 # A flow about a low-aspect-ratio delta wing at large angles of attack (Obtikannia del'ta-krila malogo vidovzheniia pri velikikh kutakh ataki). R. O. Soroka (Akademiia Nauk Ukrains'koi RSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 32, Feb. 1971, p. 174-178. 5 refs. In Ukrainian.

A flow model proposed by Brown and Michel (1954) for a low-aspect-ratio delta wing is used to derive an expression for the lift coefficient as a function of the vortex-line-to-wing-plane slope. The expression is used in a delta wing design with an aspect ratio of 0.7. Good agreement is obtained between the lift coefficient of this design found from this expression and lift coefficients given for comparable wings by Brown and Michel, Mangler and Smith (1959), Johnes (1946), and other authors. V.Z.

A71-28304 The role of military aviation greases in subsonic commercial airplane design. Douglas C. Sullivan (Boeing Co., Commercial Airplane Group, Renton, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971; Paper 710411.* 6 p. Members, $1.00; nonmembers, $1.50.

The Boeing Co. subsonic commercial airplane design practice is to use military specification greases as preferred lubricants. This standardization practice originated with the 707 prototype, and has been continued throughout design and construction stages of all commercial jet models. Based on service experience and supplementary testing, this approach has proven economical and technically beneficial to the airlines. Preferred military specifications and brief details of supplementary tests are discussed. (Author)

A71-28305 Airport certification. Clyde W. Pace, Jr. (FAA, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710413.* 5 p. Members, $1.00; nonmembers, $1.50.

Discussion of data pertaining to the Airport Certification

Program, including the certification and safety inspection procedures, and a list of minimum safety standards that will be contained in the Federal Aviation Regulations (FAR). Airports served solely by air taxis will not be included in the program unless the air taxis provide contract service for regularly scheduled air carrier aircraft. The program is designed to help put the airport facilities in uniform, safe, and proper order for the present and future airport-oriented activities. M.M.

A71-28306 The National Airport System Plan - Its history and its potential. Robert F. Bacon and Elliott B. Perrett, Jr. (FAA, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710414.* 11 p. Members, $1.00; nonmembers, $1.50.

Discussion of the changes undergone by the National Airport Plan (NAP) since its inception. Since 1946, a document called NAP has been prepared annually to 'specify in terms of general location and type of development the projects considered by the Administrator to be necessary to provide a system of public airports adequate to anticipate and meet the needs of civil aeronautics,' throughout the U.S., including Puerto Rico and the Virgin Islands. The process of developing the NAP is conceived as a continuous planning process both from the standpoint of evolving and refining the criteria by which it comes into being and in the application of the criteria by the field elements of FAA's Airports Service to provide a continuous flow of data into Washington for evaluation and processing. A very essential part of this process is an increasing involvement of airport managements, various elements of FAA, and others having a direct interest in providing input to a plan which it is hoped, will reflect the best effort possible in defining a national system of airports. M.M.

A71-28307 Expansibility and economy of terminal structures. Jack D. Downey. *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710418.* 5 p. Members, $1.00; nonmembers, $1.50.

Discussion of criteria and problems connected with the future design of airport terminals. It is pointed out that, in planning terminal structures, it must be recognized that economy and expansibility are corequirements and must be mutually involved. Four dimensions of terminal planning and construction should be considered. In addition to the usual dimensions of length, height, and width, time is an equally important component. The linear/unit terminal concept tends to wed these dimensions into a superior facility. The extensive use of dimensional planning can make a facility long-lived. M.M.

A71-28308 Development progress on CF6 engines. B. H. Rowe (General Electric Co., Aircraft Engineering Group, West Lynn, Mass.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710421.* 14 p. Members, $1.00; nonmembers, $1.50.

The development of commercial engines requires adequate testing to assure reliable low cost operation in service. Problems experienced as a result of severe endurance testing, and the design changes which solved these problems, are described in detail. Adequate performance margin is essential to allow concentrated efforts in the area of reliability and long life. (Author)

A71-28309 Olympus 593 for Concorde updating of development position. M. H. Beanland (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710422.* 11 p. Members, $1.00; nonmembers, $1.50.

The development program on the Olympus 593 pure jet twin shaft engine has been in existence about 5-1/2 years. Throughout the program a policy of matching engine rating to aircraft requirements has been adopted. All engine standards have been checked out by extensive bench endurance testing. Performance requirements have been confirmed by testing in altitude cells and by subsonic flight. (Author)

A71-28310 The economics of subsonic transport airplane design, evaluation and operation. Donald D. Hufford, James A. Ross, and Kenneth W. Hoefs (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710423.* 12 p. 6 refs. Members, $1.00; nonmembers, $1.50.

The interactive and cyclical design, evaluation, and operational system that conceives transport airplanes is described. Some economic consequences of preliminary design variable choices are displayed, followed by an inspection of the 1967 ATA Method and actual direct operating costs. Uses and misuses of the formula costs, as compared to actual cost levels, are considered. Finally, the impact of airplane choice on airline profitability is examined. It is seen that the profit consequences are great enough to require careful attention to economic trades in every step of the design, evaluation, and operational process. ' (Author)

A71-28311 The MAC MADAR System - An AIDS model for commercial airlines. George C. Curtis and Charles F. Elgin (Lockheed-Georgia Co., Marietta, Ga.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710425.* 9 p. 9 refs. Members, $1.00; nonmembers, $1.50.

Review of the application of the MADAR (Malfunction Detection, Analysis, and Recording) System in the MAC (Military Airlift Command) environment. Some of the implications of applying a computerized system of this type to alleviate problems in the commercial aviation environment are examined. The MADAR System, an on-board monitor and processor, employs an 8192-word general purpose computer which affords an automatic monitoring capacity of 1024 data points. The system as currently configured monitors 800 signals, providing fault-isolation capability for 1894 LRUs (Line Replaceable Units). Go-no-go decisions relative to proper operation of black boxes, as well as assessment of engine condition by means of the mechanized gas-generator technique, are performed on board the aircraft, and the results are available in real time. This essentially reduces the response time to zero, eliminates dependence on ground computers, and allows the system outputs to be applied to short-term maintenance problems. M.M.

A71-28312 Development of the Lockheed L-1011's flying stabilizer. C. A. Whitmore (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710426.* 13 p. Members, $1.00; nonmembers, $1.50.

Longitudinal control on the Lockheed L-1011 is provided by a flying stabilizer. This is the first time such an approach has been used on a United States commercial jet transport. This paper presents the reasons for the choice of longitudinal control systems, and describes the mechanization of the control system with particular emphasis on how it meets Lockheed's safety standards and the Federal Airworthiness Requirements. The status of the ground and flight development tests is discussed. (Author)

A71-28313 Beryllium brake experience on the C-5A airplane. Robert D. Gilson (Lockheed-Georgia Co., Marietta, Ga.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710427.* 10 p. Members, $1.00; nonmembers, $1.50.

The critical design weight environment necessary to optimize load-carrying efficiency of the C-5A was such that breakthroughs in technology were needed. One such breakthrough was beryllium brakes. From the discovery of beryllium in 1798 its advantages - as

well as its disadvantages - were well known. These are discussed to indicate why beryllium was chosen as the brake heat sink material for the design configuration evolved. A review of current C-5A data is presented, including flight test experience, as well as expected life projection from limited normal operational experience. The re-use of beryllium elements, and cost effectiveness are also discussed. A consideration of the future use of beryllium is indicated, with the conclusion that it will become commonplace in the next decade. (Author)

A71-28314 Study of visible exhaust smoke from aircraft jet engines. John Stockham and Howard Betz (IIT Research Institute, Chicago, Ill.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710428.* 19 p. 13 refs. Members, $1.00; nonmembers, $1.50. Contract No. FA-69-2208.

Study of the relation between the visibility of in-flight jet exhaust and the AIA smoke number. A method based on photographic photometry was developed for measuring the optical density of smoke plumes. This method was related to visibility and to the smoke number through transmissometer measurements and visibility theory. A portable transmissometer, capable of operating over a wide range of optical pathlengths and under varying ambient light conditions, was fabricated for use in this study. A mathematical expression relating the transmission measurements to the smoke numbers was derived. Liminal visibility requirements of smoke trails, developed from light scattering theory, were correlated with actual visual observations and the transmissometer and photometry measurements. Test results, with the engines investigated, indicate that AIA smoke numbers below 23 were associated with invisible exhaust plumes. Samples of the exhaust smoke showed the particles to be composed of lacy agglomerates. At the nozzle, the geometric median particle diam was 0.052 micron. At a distance of 10 nozzle diam the geometric median particle diam was 0.13 micron at cruise condition. (Author)

A71-28316 FAA appraisal of aircraft design for maintainability. James E. Dougherty (FAA, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710431.* 10 p. 23 refs. Members, $1.00; nonmembers, $1.50.

This paper outlines an appraisal of aircraft design for maintainability as viewed by the Federal Aviation Administration. The basis for FAA's authority in the Act is set forth. The extent of the applicable requirements now in the Federal Air Regulations is traced. Maintenance concepts and examples of adverse airworthiness situations are described. Controls and procedures employed by FAA to account for maintainability of new designs, including MSG-2, are explained. Maintainability guidelines applicable to new designs are advanced. (Author)

A71-28317 One operator's look at maintainability. William A. Keeler (Eastern Air Lines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710432.* 6 p. Members, $1.00; nonmembers, $1.50.

Spiraling commercial airplane equipment costs will not tolerate operational inefficiency. The airline operator must keep his departure gates well-stocked with mechanically sound equipment if he is to realize a reasonable return on his investment. The role of maintainability in assuring equipment readiness is reviewed from the viewpoint of one airline operator, and six basic keys to good airplane equipment maintainability are discussed. (Author)

A71-28318 Development and service experience of the PT6A reduction gearbox. A. W. Stewart and D. Hollingworth (United Aircraft of Canada, Ltd., Montreal, Canada). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710433.* 7 p. Members, $1.00; nonmembers, $1.50.

This paper details PT6 reduction gearbox reliability problems as revealed by development testing and regular service. Initial bench tests showed that despite attempts to design within the state-of-the-art, the application was such as to require an extension of contemporary knowledge of gear design. Cavitation erosion of the planet gear bushings gave rise to some anxiety and excessive wear of coupling splines necessitated a redesign. These and other minor problems were largely resolved before certification and delivery of the first production units. Except for an incident with units operating in Arctic conditions, no significant reliability problems have occurred in regular service. Some wear problems have been corrected with subsequent benefit to overhaul costs but most complaints have been generated by weepage from the propeller shaft oil seal. This was not an operational hazard. Models in current production are little different from the initial production standard, although some have been certified for maximum powers nearly 50% greater than the first units and the minimum approved time between overhauls, for operation in the U.S., is now 3000 hr. (Author)

A71-28320 Microbiological contamination of aircraft fuel tanks - Airframe considerations. J. A. Scott (British Aircraft Corp., Ltd., Weybridge, Surrey, England). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710438.* 8 p. 17 refs. Members, $1.00; nonmembers, $1.50.

Discussion of microbiological contamination, which became a major problem when jet aircraft using integral fuel tanks began operations in tropical areas. Aircraft operating in such areas should be regularly inspected in order to detect contamination before it reaches serious proportions, and maintenance personnel should be trained to recognize and interpret warning signs. Maintenance practices should be adjusted where possible to minimize the amount of water collecting in fuel tanks. Biocides may be needed under certain conditions. Good fuel-quality control is extremely important, and particular attention is required at the smaller airports. Good results are being obtained with epoxy primer protective coats heavily pigmented with strontium chromate. F.R.L.

A71-28321 Electrical and physical nature of microbial membranes implicated in aircraft fuel quantity probe malfunction. W. B. Engel and R. M. Owen (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710439.* 10 p. 28 refs. Members, $1.00; nonmembers, $1.50.

Demonstration that microbial membranes have a low resistance and could easily short out a fuel quantity probe. To determine how microbial contamination can cause probe malfunction an artificial environment conducive to the rapid growth of microbial membranes was developed. Studies were conducted on membranes grown in this environment to determine their electrical conductive properties, and it was found that the membranes are sufficiently conductive to cause the malfunction. Prolonged association of microbial contamination on the probe surface will result in eventual coating penetration and pitting-type corrosion. F.R.L.

A71-28322 Salt driers assure really dry fuel to aircraft. H. R. Porter, G. R. Deits (Standard Oil Company of California, San Francisco, Calif.), J. A. Bert, and B. C. Anderson (Chevron Research Co., Richmond, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710440.* 8 p. Members, $1.00; nonmembers, $1.50.

Salt driers installed in an airport jet fuel delivery system reduced the fuel water content below saturation, lengthened filter life, and improved the performance of the downstream system components. Systems must be designed and operated to control salt carry-over. The high initial cost of salt driers compared with conventional filter-coalescers may be justified by low operating cost, improved microbial control, and customer satisfaction. Salt driers have a place in airport fuel treating. (Author)

A71-28323 **From automatic landing to Category III.** William Russell (Air Transport Association of America, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710441.* 7 p. 5 refs. Members, $1.00; nonmembers, $1.50.

Progress toward full all weather landing operation of transport aircraft is evaluated. Experience with Category II instrument approach operations in actual weather is reviewed. The disparity between the lagging implementation of ground facilities in the United States, and the extensive implementation of costly Category II airborne equipment is discussed. Actions needed to provide viable Category IIIa operations are examined, including discussion of procedures to aid in insuring integrity, and the need for implementing Category IIIa facilities in the United States. Implications of the proposed new landing guidance system and of possible independent landing monitors are also examined. Limitations of available weather surveys and a number of economic considerations are pointed out. Aggressive implementation of ground facilities is recommended. (Author)

A71-28324 **Development testing of the L-1011 Independent Landing Monitor.** Gerald Holliday and John A. Gorham (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710443.* 15 p. Members, $1.00; nonmembers, $1.50.

A new, completely independent monitor (capable of operation through Category IIIc weather condition) for use with automatic landing systems is undergoing development by Lockheed for possible use in L-1011 aircraft. Following intensive analysis, a K sub a band airborne radar was selected to provide pilot confidence through independent monitoring of the L-1011 (1) dual-dual, fail operative, automatic landing system's performance. Lockheed's airborne flying test bed (CV-240) program has so far provided evidence that the Independent Landing Monitor concept has a definite future in commercial automatic landing applications under reduced visibilities. Visual enhancement would improve the acceptability of near zero-zero operation and consequently reduce the number of unnecessary go-arounds. (Author)

A71-28325 * **Design criteria for selection of aircraft electric power generation and distribution systems.** C. H. Lee (AiResearch Manufacturing Co., Los Angeles, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710444.* 12 p. Members, $1.00; nonmembers, $1.50. Contract No. NAS 12-659.

Conventional aircraft use constant-speed drive to generate constant frequency 400-Hz power of relatively good quality and distribute it at 115/200 V. A detailed study revealed that this power type is not the optimal choice for present and future aircraft applications. This paper presents the advantages and disadvantages of various generation and distribution systems and the factors to be considered in selecting an electric power system. For medium and large size STOL aircraft, it appears that variable-frequency generation and high-voltage d-c distribution with secondary square wave a-c distribution may be superior to the conventional system. (Author)

A71-28326 **Optimization of military VTOL secondary power systems.** Dennis Stein (Boeing Co., Vertol Div., Philadelphia, Pa.) and Jules Vichness (U.S. Army, Air Mobility R & D Laboratories, Fort Eustis, Va.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710445.* 18 p. Members, $1.00; nonmembers, $1.50.

Military VTOL/VSTOL aircraft are required to operate in areas where it is impractical to provide ground support equipment to supply types of power needed for system checkout, emergency and standby power, and main engine starting. To provide this capability, the Secondary Power System must be considered on an integrated basis as a major aircraft subsystem which incorporates an auxiliary power unit (APU) that will provide an alternate source of power, in flight and on the ground, for aircraft hydraulics, pneumatic drives, APU starting, environmental control, main engine starting, electrical power generation, power transfer to accessory gearbox for shaft-driven accessories, plus the power distribution system to interconnect these components. This paper discusses the application of this integrated concept and the associated analyses of operating characteristics of major components. Appropriate interface and compatibility with the total air vehicle is illustrated. Significant parameters such as power, weight, efficiencies, product assurance characteristics, etc., are compared. (Author)

A71-28327 **Contemporary approach to commercial powerplant development.** G. W. Kleinert (General Electric Co., New York, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710449.* 8 p. Members, $1.00; nonmembers, $1.50.

Vital to the success of the turbine powered airplane is the degree to which the engine manufacturer can develop the entire powerplant to its fullest maturity early in the life of the airplane system. With increasing demands for shorter powerplant development cycles, to meet the needs of the shorter airframe development cycle, new techniques and methods are being employed to accelerate the development of contemporary powerplants. Equally important to the improved development techniques and methods is the ability to establish and monitor the technical progress early in the powerplant development program. This paper will describe the approach taken in the development of the CF6 family of engines, including techniques established to monitor technical progress. (Author)

A71-28328 **Propulsion testing from the aircraft manufacturers' point of view.** W. A. Reinhart (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710450.* 22 p. Members, $1.00; nonmembers, $1.50.

Consideration of aircraft propulsion systems in terms of the total aircraft system. The design requirements tend to become more demanding and the development and proof testing more exacting to assure that the test simulation of the critical operating environment is correct and that the instrumentation systems are adequate for accurately and quickly obtaining the required information. Careful judgment and ingenuity are required to obtain the data in a timely and cost-effective manner. Major areas which are becoming more critical with each generation of aircraft are noise reduction and inlet-engine-exhaust system compatibility. Examples of problems which have been faced in recent subsonic aircraft and some of particular interest in such aircraft as the SST are discussed. F.R.L.

A71-28329 **Powerplant testing from an operator's perspective.** R. E. Totman (United Air Lines, Inc., Chicago, Ill.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710451.* 8 p. Members, $1.00; nonmembers, $1.50.

Summary of airline engine performance testing by three precepts: (1) avoid release of engines which will be maintenance problems; (2) prevent rejection of engines which will operate satisfactorily until the next scheduled removal; and (3) reduce testing costs. The methods used most profitably to assign relative weights to the three guidelines are presented, and progress with an automated test cell data acquisition system is outlined. F.R.L.

A71-28330 **The costs/reliability relationships of development testing and demonstration.** Kirk G. Rummel and Robert B. Aronson (Boeing Co., Vertol Div., Philadelphia, Pa.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710452.* 10 p. Members, $1.00; nonmembers, $1.50.

This paper explores the relationships between the costs of

developmental testing and the derived benefits in reliability. The analysis quantifies this relationship for the components of the dynamic system of a specific future helicopter. Distinctions are drawn between test costs related to reliability requirements and those that are not related. Emphasis is placed on the decisionmaking process that is required when formal reliability and maintainability (R & M) demonstration tests are imposed. The statistical aspects of demonstration tests are examined and related to the program manager's informational requirements. (Author)

A71-28331 Analysis of transmission failure modes. C. W. Bowen (Bell Helicopter Co., Fort Worth, Tex.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710454.* 7 p. 8 refs. Members, $1.00; nonmembers, $1.50.

This paper presents a synopsis of an extensive failure mode investigation and analysis of Bell UH-1 and Vertol CH-47 transmissions. Correlation of these observed field experiences with conventional design stress analysis techniques and preliminary bench test data is presented. Lubrication states as defined by elastohydrodynamic film thickness calculations are shown to offer explanation for the existence of many failure modes which are not predicted by conventional analyses. Simple statistical methods for failure data analysis are employed as an aid to assessing relative gain in reliability afforded through correction of dominant failure modes. The premise is advanced that the key to successful design of advanced helicopter power transmissions featuring significant increases in operational reliability may be found in the application of these lessons. (Author)

A71-28332 Area navigation in the ATC environment. E. E. Glanz (Eastern Air Lines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710455.* 5 p. Members, $1.00; nonmembers, $1.50.

Aircraft equipped with computerized Area Navigation Systems have created the need for an entirely new air traffic control environment. This paper will highlight problems encountered as the ATC system begins its evolution toward area navigation, and will suggest operational techniques favorable to a total area navigation ATC environment. Conventional interfaces are no longer useful. Independent systems (computer, controller, pilot, route structure, and aircraft) meet in the cockpit, but satisfactory communications have not been established. Pilot reaction indicates that the information is not now properly presented in the cockpit. Attempts to solve these interface problems have indicated that the solution lies in comprehensive software programs and clear situation displays for the pilot. (Author)

A71-28333 Requirements, performance and integration of modern navigation aids. A. B. Winick and D. M. Brandewie (FAA, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710456.* 6 p. 9 refs. Members, $1.00; nonmembers, $1.50.

The need to improve the efficiency and capacity of the Air Traffic Control and Navigation System has placed greater emphasis on the functional integration of subsystems which have been treated independently in the past. This paper presents results of limited test programs designed to explore the relationship of terminal area navigation and the air traffic control system, and to show the benefits of an optimum combination of both functions. The need for further analysis is indicated with respect to carrying out the third generation system design postulated by the DOT Air Traffic Control Advisory Committee. It is concluded that functional integration of ATC and navigation in the terminal area presents the greatest challenge. In other areas, such as enroute, the availability of new, integrated avionics systems provides an expanded operational capability. (Author)

A71-28334 Coated columbium for gas turbine engine application. J. F. Holloway, H. A. Hauser, and E. F. Bradley (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710460.* 9 p. 9 refs. Members, $1.00; nonmembers, $1.50.

Application of coated columbium alloys to gas-turbine engine components operating at metal temperatures above 2000 F. This is a potentially viable alternative to more complex cooling schemes for present nickel-base and cobalt-base superalloys. The major deterrent to the use of this material centers around the performance and reliability of protective coatings such as slurry silicides. Turbine vanes so protected have successfully run in a turbine development engine for 100 hr of steady state and cyclic operation. A film-cooled burner liner of FS-85 columbium alloy sheet material coated with the Sylvania SiCrFe slurry coating has been fabricated and will be rig- and engine-tested. F.R.L.

A71-28335 High temperature turbine design considerations. S. N. Suciu (General Electric Co., New York, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710462.* 13 p. 14 refs. Members, $1.00; nonmembers, $1.50.

The major technological developments which have made possible the trend towards higher temperatures in modern aircraft gas turbine engines are discussed. The relative importance of manufacturing processes, material developments, cooling techniques, analytical design procedures, rupture and cyclic life considerations, and aerodynamic and mechanical design improvements are discussed along with illustrative examples and technical data. The need for a balanced design approach is stressed, and examples are given where trade-offs can be made. It is noted that the advances in aircraft engines during the last 10 years have been based on the evolution of sound engineering principles, extensive component and engine development, and careful consideration of the operational requirements rather than a tremendous breakthrough or revolutionary concept in any one area. (Author)

A71-28336 Military/commercial STOL transport commonality. Harold F. Kleckner (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710468.* 11 p. Members, $1.00; nonmembers, $1.50.

Military and commercial turbofan STOL transport work at the Douglas Aircraft Company during the past four years has led to the consideration of commonality between the USAF medium STOL transport and a short-range, medium-sized commercial STOL transport. General requirements for the two airplanes appear to be similar and include a cruise speed of Mach 0.75-0.80 for a 500-nautical mile range after takeoff from a 2000-foot airstrip. Both require a wide body; and the payload, furnishings, and equipment yield comparable STOL takeoff weights. Both can be designed with a high wing, a moderate wing loading, and the same STOL lifting concept. A common engine size appears feasible, and basic engine characteristics such as bypass ratio need not be different. Results of a preliminary commonality study are presented in which several cases with varying degrees of commonality are evaluated in terms of costs. The cost benefits of shared development and production were found to outweigh the penalties related to design compromises, resulting in lower costs for both military and commercial operators. (Author)

A71-28337 STOL engine systems and sensitivity factors. Joel Godston (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710469.* 11 p. 22 refs. Members, $1.00; nonmembers, $1.50.

The purpose of this paper is to list the possible competitive engine systems for the STOL aircraft likely to be operational in the

late 1970s or early 1980s. The importance of integrating the engine and airframe during the early design phase of the STOL aircraft system is outlined. A description of typical augmented wing and blown flap engine concepts under investigation and the system trade factors affecting aircraft gross weight and potential return on investment are presented. System trade factors including noise, weight, performance, and cost are evaluated to provide an overall view of the compromises that are, or must be made in order that the STOL aircraft engine system be a viable commercial product. The available and required engine technologies are reviewed. (Author)

A71-28338 **Prop-Fan - A high thrust, low noise propulsor.** George Rosen (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710470.* 12 p. 12 refs. Members, $1.00; nonmembers, $1.50.

The Prop-Fan is introduced as a new propulsor type, intermediate between ducted propellers and low bypass fans. Compared to today's fan engines, it offers approximately twice the takeoff thrust/hp at half the tip speed and consequently much reduced noise level. Furthermore, its controllable pitch feature provides more effective reverse thrust at about one-fourth the weight of current flow reversers. Prop-Fan characteristics are particularly well matched to the propulsion requirements of advanced STOL transport aircraft. Highlighted is the uniquely low noise signature of the Prop-Fan. This now permits the design of medium-to-long range STOL transports of high-productivity which will meet the stringent noise level limits for STOL-ports. The paper describes the development status of the Prop-Fan, examines potential aircraft installation arrangements, and presents some representative STOL transport effectiveness comparisons. (Author)

A71-28339 **Boeing 747 training developments and implementation.** B. M. Tate (Trans World Airlines, Inc., Kansas City, Mo.). *Society of Automotive Engineers, International Simulation and Training Conference, 4th, Atlanta, Ga., May 13, 1971, Paper 710473.* 5 p. Members, $1.00; nonmembers, $1.50.

A training program for crew members of the TWA 747 is described. The paper begins with the formulation of general policies and their translation into a ground training program, and continues with descriptions of the classroom, inertial navigation system, and cockpit trainers. The details of the training program are presented, as are a description of the TWA 747 simulator and discussion of anticipated problems. (Author)

A71-28340 **The use of simulation to promote safety and economy in flying training.** W. P. Moran (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, International Simulation and Training Conference, 4th, Atlanta, Ga., May 13, 1971, Paper 710475.* 6 p. Members, $1.00; nonmembers, $1.50.

The combination of simulation and improved training techniques ensures a safe and economical flying training program. In a 5-year period, American Airlines has reduced airplane training and flight check hours by more than 75%. There are strong indications that, for qualified airline crewmen, a goal of total simulation for all training and flight checks will become a reality. (Author)

A71-28467 **Effect of axial velocity variation in aerofoil cascades.** S. Soundranayagam (Indian Institute of Science, Bangalore, India). *Journal of Mechanical Engineering Science,* vol. 13, Apr. 1971, p. 92-99. 12 refs. Research supported by the North of Scotland Hydro-Electric Board.

The effect of the variation of axial velocity in the incompressible flow through a cascade of aerofoils is discussed and it is shown that changes take place in the flow angles and in the blade circulation. A method is proposed by which the effect of axial velocity variation on a known two-dimensional flow or alternatively the two-dimensional equivalent of a flow with axial velocity variation can be calculated. The method is very easy to apply. The deviation may increase or decrease depending on the change in blade circulation and the stagger. An increase in apparent deflection through the cascade can be accompanied by a reduction in the blade force. The method would be particularly useful for the interpretation of cascade wind tunnel data and in the design of impeller stages where three-dimensional flows occur. (Author)

A71-28489 # **Helicopters as cranes, and carrying external loads. II - The planning and the constructive design of 'crane helicopters' (Kran- und Aussenlastflug mit Hubschraubern. II - Die Auslegung und die konstruktive Gestaltung von Kranhubschraubern).** Michael Caspari. *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 7, no. 3, 1971, p. 133-142. In German.

The disadvantages of a use of multipurpose helicopters for flights with external loads are analyzed. The demand for helicopters designed exclusively for applications as a crane was found to be very limited in a market analysis. However, there appear to be good employment possibilities for a helicopter which in addition to serving as a crane can also transport external loads. A number of designs proposed for such a helicopter are described. The landing gear is designed in such a way as to make it possible for the helicopter to land in many cases above the load and pick it up. G.R.

A71-28582 # **Assessment of measurement errors in the testing of axial-flow compressors and turbines (K voprosu otsenki pogreshnostei izmerenii pri ispytaniiakh osevykh kompressorov i turbin).** A. P. Tunakov, Iu. A. Rzhavin, and S. G. Ibragimov. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 114, 1970, p. 3-17. 5 refs. In Russian.

Experiments performed with single-stage air-driven compressors and turbines with the aim of improving the methods of assessing the accuracy of the parameters measured are described. An analysis of the formulas conventionally used for calculating the rms error of indirect measurements (when the error of the direct measurements is known) shows most of the error involved in the determination of torque and temperature is due to the error contained in the approximating coefficients. The largest error in the determination of the flow rate may be attributed to the errors involved in the flow coefficient and in the coefficient of flow convergence in the measuring orifice. Improved formulas for calculating the principal parameters of turbomachines are proposed. V.P.

A71-28583 # **Investigation of the ideal cycle of a continuous-combustion gas turbine with stepwise heat release (overexpansion cycle) (Issledovanie ideal'nogo tsikla gazoturbinnoi ustanovki nepreryvnogo goreniia so stupenchatym otvodom tepla /tsikl s pererasshireniem/).** A. P. Tunakov and B. Kh. Perel'shtein. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 114, 1970, p. 18-30. In Russian.

The thermal efficiency of a cycle in which the gas is cooled after overexpansion and is then compressed in a low-density compressor to the ambient pressure is analyzed. The efficiency of an ideal cycle of this type is compared to that of the Brayton and Carnot cycles, and the parameters of the ideal cycle are evaluated on the basis of several numerical examples. V.P.

A71-28584 # **Gasdynamic verification calculations of multistage axial-flow compressors on a digital computer (Proverochnyi gazodinamicheskii raschet osevykh mnogostupenchatykh kompressorov na ETsVM).** A. P. Tunakov and S. G. Ibragimov. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 114, 1970, p. 31-47. 6 refs. In Russian.

An algorithm for testing the gasdynamic design of axial-flow compressors, particularly in the final adjustment phase, is proposed. Particularly well suited for calculating the parameters of blade rings, the procedure is suitable for use in the design phase if data on the loss coefficients in empirical formulas have been established. V.P.

A71-28586 # **Influence of bypass of air behind the compressor into a variable-area exhaust nozzle on gas turbine jet engine indices (Vliianie perepuska vozdukha posle kompressora v reaktivnoe soplo na pokazateli gazoturbinnykh reaktivnykh dvigatelei).** V. A. Kosterin, V. T. Dudkin, and L. V. Fadeev. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 114, 1970, p. 58-76. In Russian.

Formulas are derived which define the dependence of a turbojet engine on the energy losses in the afterburner in the case where small amounts of air behind the compressor are applied to the exhaust nozzle. By taking into account the coefficients defining the changes in the gas pressure and temperature behind the turbine owing to the added air, the formulas make it possible to obtain solutions for any energy losses associated with the expansion and the mixing of the added air with gas behind the turbine. V.P.

A71-28589 # **Heat and mass transfer in the turbulent flow of a chemically active gas in the manifolds of a hydro-jet engine (Teplomassoobmen pri turbulentnom techenii khimicheski aktivnogo gaza v kanalakh GRD).** A. V. Fafurin and Iu. D. Krechetnikov. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 114, 1970, p. 101-104. 5 refs. In Russian.

A method for calculating the ablation of a heat shield under the effects of a high-enthalpy chemically active gas flow is developed on the basis of boundary layer theory and the corresponding friction and heat transfer laws. The method is based on the assumptions that the components of the main gas flow which react with the wall material form a binary mixture with the reaction products; that all components of the mixture in the boundary layer obey the ideal gas laws; and that the chemical reaction rate is limited by the supply of the oxidizer to the surface rather than by the chemical reaction rate. A closed system of equations describing the flow in an axisymmetric channel in the presence of chemical reactions at the surface is derived. V.P.

A71-28739 **Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969.** Edited by E. R. Norster (Cranfield Institute of Technology, Cranfield, Beds., England). Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971. 397 p. $27.

The topics include the combustion system for the Olympus 593 engine, combustion chamber temperature profiles, the RB 162 combustion system for VTOL applications, annular vaporizing combustion chambers, ignition theory and its application to the altitude relighting, the air recirculation ratio in can-type gas turbine combustion chambers, assessment of flame tube temperatures in a combustor operating under SST conditions, radiation heat transfer, and corrosion testing of high-temperature gas turbine alloys. M.M.

A71-28740 **The combustion system for the Olympus 593 Concorde engine.** D. W. Harvey (Rolls-Royce, Ltd., Bristol, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969.
Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 3-17; Discussion, p. 18, 19.

Discussion of the operating conditions, combustion performance criticality, and altitude relight considerations of the combustion system of the Concorde SST throughout the Olympus engine series. The problem of flame tube wall temperatures is discussed, together with the smoke problem, the introduction of a lightweight fuel system, flame tube design, the use of fully machined cooling rings, and design modifications to improve the mechanical life of the combustion system. Combustion efficiency and pressure loss, and the low-pressure fuel sprayer are also treated. M.M.

A71-28742 **The evolution of the RB 162 combustion system for V.T.O.L. applications.** J. R. Poyser and H. B. Moxon (Rolls-Royce, Ltd., Derby, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 33-61; Discussion, p. 62.

Description of the design and development of the RB 162 combustor. The RB 162 combustor incorporated many of the features of the single-reversal chamber but differed in one or two interesting respects. The RB 162 was designed to achieve ignition with the aid of two pressure jet atomizers operative only during the starting cycle. Weight estimates of the complete starter system favored the latter arrangements. In conjunction with combustor rig tests, extensive use has been made of sectored, full-size perspex models to examine the aerodynamic behavior of the RB 162 combustion engine. Of the substantial volume of testing carried out on the perspex models, typical instances illustrating this approach are given.

A71-28743 **Some combustion aspects of plenum chamber burning.** A. Sotheran (Rolls-Royce, Ltd., Bristol, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969.
Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 63-86; Discussion, p. 87, 88.

A brief explanation is given of the manner in which aircraft performance improvements can be obtained by providing PCB on the high by-pass ratio turbofan engines of subsonic VTOL aircraft of the Harrier type. The necessity of PCB to supersonic developments is noted. An account is then given to the design considerations behind the choice of the 'staggered gutter colander' combustion system for PCB, and of the experimental development program which led, eventually, to the successful demonstration of PCB on an adapted Pegasus engine. (Author)

A71-28745 **Ignition theory and its application to the altitude relighting performance of gas turbine combustors.** A. H. Lefebvre (Cranfield Institute of Technology, Cranfield, Beds., England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969.
Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 105-116; Discussion, p. 117-119. 28 refs.

The various ignition theories fall into two groups: those in which diffusion is considered to be the dominant process in flame initiation; and those in which thermal mechanisms are considered more important. Two equations which show broad agreement with practical experience in regard to the effects of pressure, temperature and velocity, provide quantitative relationships between the main variables influencing the ignition process. The most significant factor influencing ignition performance, however, is velocity. It is suggested that these two equations could prove useful in assessing the relative importance of the various factors influencing ignition performance in practical combustion chambers and in the correlation of ignition data obtained from such systems. M.M.

A71-28748 **Cooled gas turbine blades.** J. F. Barnes and J. P. Edwards (National Gas Turbine Establishment, Farnborough, Hants., England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 167-181; Discussion, p. 182. 14 refs.

This paper is concerned with the prediction of metal temperatures in rotating blades and with the aerodynamics of coolant flow into and out of the blades. The section on blade temperatures includes a description of two complementary methods currently used at the National Gas Turbine Establishment. (Author)

A71-28749 **Theoretical assessment of flame tube temperatures in a combustor operating at typical S.S.T. conditions.** M. Whittaker (Rolls-Royce, Ltd., Bristol, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 183-204. 6 refs.

A typical annular vaporizing combustion chamber project with conventional film cooling has been analyzed around a datum supersonic cruise condition. The need for accurate prediction of metal temperatures and a better understanding of the processes involved has been demonstrated by reference to the rapid increase in compressor delivery temperature over the years. It has been shown that the dominant primary zone heat transfer process is flame radiation and every effort should be made to reduce the effective flame radiation temperature and flame emissivity subject to performance considerations. The gain in wall cooling is approximately 25-30 C for 100 C reduction in mean flame temperature and 30 C for 0.1 reduction in flame emissivity. M.M.

A71-28751 **Correlation of data and prediction of effectiveness from film cooling injection geometries of a practical nature.** G. J. Sturgess (General Electric Co., West Lynn, Mass.). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969.
Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 229-250. 24 refs.

The simple boundary layer theory of Stollery and El-Ehwany, which has been applied with some success to idealized injection slots, is extended to account for the velocity defect introduced into the injected film by the finitely thick slot lip and the boundary layers which exist on it. The resulting equations are used to provide a correlation group which is tested against the collected experimental data from nine practical injection geometries of greatly differing construction, over wide ranges of velocity and temperature ratios, and slot Reynolds number. For individual geometries effectiveness correlation to plus or minus 5% of unity is achieved; for geometries of the same general class a 'universal' correlation of plus or minus 10% is obtained. Equations are obtained which describe the data within these limits. These equations are shown to be valid for differing mainstream approach boundary layers and differing turbulence levels in both main and injected streams. In view of the present general uncertainties associated with adequately specifying the mainstream conditions for application to the gas-turbine combustion chamber, the present simple equations are both suitable and convenient for predicting film effectiveness for preliminary design work and thermal analysis. (Author)

A71-28754 **Fuels for aircraft gas turbine engines.** A. Lewis (Shell Research, Ltd., Thornton Research Centre, Chester, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969.
Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 309-323; Discussion, p. 324, 325. 11 refs.

Consideration of kerosene-type fuels meeting either the British D.Eng.R.D.2494 specifications or the ASTM Jet A or A-1 specifications. These fuels are produced mainly by straightforward distillation processes, with subsequent treatments to remove sulfur and trace components. Combustion problems with either type of fuel have been largely eliminated by the progressive development of the engines although there is a growing preoccupation with the formation and emission of smoke during takeoff and landing. The trend of fuel injection systems is towards greater use of air assistance in atomization and the possible use of fuel vaporization. The possibility of fuel additives for reducing smoke emission is discussed. The problems of bacterial or fungal contamination of aircraft fuel systems still exist. F.R.L.

A71-28756 **Some observations of the atomizing characteristics of air-blast atomizers.** R. Bryan, P. S. Godbole, and E. R. Norster (Cranfield Institute of Technology, Cranfield, Beds., England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 343-355; Discussion, p. 356-359. 21 refs.

An optical method of measuring mean droplet size of sprays due to Dobbins is described and has been used to assess the effect of operating variables on the characteristics of an air-blast atomizer. Simple variations in the design of the atomizer indicate ways in which its performance may be improved. Measurements of mean droplet size with ambient pressures ranging from atmospheric up to 200 lb/sq in abs and air-to-fuel ratios covering a wide range show some of the potential advantages of air-blast atomizers for high-pressure gas-turbine engine application. (Author)

A71-28757 **Some considerations of the measurement of temperatures within aircraft combustion chambers, using a calorimetric probe.** A. F. Schlader, P. Rouiller, and J. Odgers (Université Laval, Quebec, Canada). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 363-379; Discussion, p. 380, 381. 5 refs.

Use of a calorimetric probe to measure gas temperatures in excess of 1200 C, previously accomplished by gas analysis techniques. The device consists of three concentric tubes, the outer two comprising a water jacket around the center one, through which the gas is drawn. Sheathed thermocouples are situated at the entry and exit of the coolant and a further thermocouple is located in the gas stream immediately opposite to the one at the coolant outlet. Both gas and water flows are metered and the original gas temperature is computed by enthalpy balance. The probe design has been modified so as to be applicable to turbine gas combustors. In its present form the equipment should be satisfactory for combustion chamber applications under laboratory conditions. Consideration is also given to an improved design of probe obviating the need for mass flow determination and gas analysis measurements. F.R.L.

A71-28758 **The measurement of temperatures and radical concentrations in high-temperature, flowing-gas streams.** D. H. Cotton and C. G. Haupt (Shell Research, Ltd., Thornton Research Centre, Chester, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford,

Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 383-406. 18 refs.

This paper describes methods of measuring temperature and radical concentrations in a rig simulating conditions in a ramjet combustion chamber and nozzle. The line-reversal technique for measuring temperatures was not successful, and the errors are explained in terms of interference by chemiluminescence. Radical concentrations were measured by the lithium-lithium hydroxide method which is described in detail. The results of these measurements show that radical concentrations are frozen at or before the throat of the nozzle. The point of freezing correlates with that predicted by the Bray criterion of sudden freezing, and although the freezing is not instantaneous, these results provide experimental confirmation of the hypothesis and an indication of the limits of its validity. (Author)

A71-28767 High-speed flash photography of jets and study of noises of aerodynamic origin. Marie Merle and J. P. Fragassi (CNRS, Centre de Recherches Physiques, Marseille, France). *SMPTE, Journal*, vol. 80, Apr. 1971, p. 282-285. 9 refs. Translation.

In the study of noises coming from gaseous supercritical jets the waves were investigated by four separate methods in order to cross check the results. With the use of an electronic camera a film was made showing the evolution of acoustic waves. A sound analysis was made using a narrow passband analyzer and a microphone sensitive to high frequency. Schlieren photographs show that the waves on one side are out of phase relatively to those on the other side. Convergent-divergent nozzles were used giving Mach numbers from 1 to 4 comparable to sonic nozzles. The jet has a cellular structure at the exit as shown on shadowgraph pictures. 'Screeches' occur when the jet is overexpanded. A specific ratio of pressure exists for each nozzle which brings about maximum screech. Frequency of oscillation was determined from 16 views filmed by the schlieren and shadowgraph methods. Two schlieren photographs demonstrate that a reflector at the origination of the jet diminishes jet screech by 20 dB. (Author)

A71-28778 How VAST troubleshoots a doppler radar. Joseph J. Stanco (PRD Electronics, Inc., Syosset, N.Y.). *MicroWaves*, vol. 10, May 1971, p. 34, 35.

The application of the VAST (Versatile Avionics Shop Test) computer-controlled system, developed for performing automatic diagnoses and analyses of complete avionic units, to testing failures occurred in an airborne doppler radar receiver transmitter unit aboard a carrier is described. Features of the computer program written for this system are briefly characterized. A block diagram illustrating the system is presented. O.H.

A71-28831 * A comparison of minimum time profiles for the F-104 using Balakhrishnan's epsilon technique and the energy method. Lawrence W. Taylor, Jr., Harriet J. Smith, and Kenneth W. Iliff (NASA, Flight Research Center, Edwards, Calif.). In: International Federation for Information Processing, Symposium on Optimization, Nice, France, June 29-July 5, 1969, Proceedings. Edited by A. V. Balakrishnan, M. Contensou, B. F. de Veubeke, P. Krée, J. L. Lions, and N. N. Moiseev. Berlin and New York, Springer-Verlag (Lecture Notes in Mathematics. Volume 132), 1970, p. 327-335. 11 refs.

Balakrishnan's epsilon technique is used to compute minimum time profiles for the F-104 airplane. This technique differs from the classical gradient method in that a quadratic penalty on the error in satisfying the equations of motion is included in the cost function to be minimized as a means of eliminating the requirement of satisfying the equations of motion. Although the number of unknown independent functions is increased to include the state variables, the evaluation of the gradient of the modified cost is simplified, resulting in considerable computational savings. The unknown control and state variables are approximated by a functional expansion with unspecified coefficients which are determined by means of Newton's method. Typically 8 to 10 iterations are required for convergence when using the epsilon technique. Comparisons are made of solutions obtained by using this technique and the energy method. (Author)

A71-28841 Plug in relay - Panacea or Pandora's Box. I. Carol (U.S. Army, Electronics Command, Fort Monmouth, N.J.), J. Lerner (U.S. Naval Air Systems Command, Washington, D.C.), I. J. Soper (USAF, Logistics Command, Wright-Patterson AFB, Ohio), and E. U. Thomas (Grumman Aerospace Corp., Bethpage, N.Y.). In: National Asscciation of Relay Manufacturers, Annual National Relay Conference, 19th, Oklahoma State University, Stillwater, Okla., April 27, 28, 1971, Proceedings. Conference co-sponsored by the Oklahoma State University. Scottsdale, Ariz., National Association of Relay Manufacturers, 1971, p. 11-1 to 11-10. 8 refs.

Areas where plug-in relays may be used advantageously are suggested, and some hazards due to use of plug-in relays are examined. Once it has been decided that plug-in relays will be used consideration should be given to minimizing replacement problems in the field. A table listing approaches for minimizing plug-in hazards is provided. Attention is to be given to the fact that equipment which is acceptable for ground support equipment may not be acceptable for safety of flight applications in aircraft. G.R.

A71-28873 Interference criteria between space-borne and earthbound aeronautical services. B. A. Pontano (COMSAT Systems Integration Laboratory, Clarksburg, Md.). In: Institute of Electrical and Electronics Engineers, Regional Electromagnetic Compatibility Symposium, San Antonio, Tex., October 6-8, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. V-D-1 to V-D-15. 6 refs.

The feasibility of a VHF aeronautical satellite system which frequency shares the band presently used by the air traffic control (ATC) service is under investigation with the aim of securing efficient utilization of the spectrum. The proposed system will employ a combination of spacial separation, antenna directivity, and frequency offset (channel interleaving) for providing the required intersystem isolation. The geometrical aspects of spacial separation and antenna directivity have been reported elsewhere. The purpose of the present study was to investigate the protection ratios required for compatible intersystem operation. Protection ratios measured in the laboratory for the various operating parameters of detected signal to interference, channel separation, and receiver bandwidth correspond with world-wide usage. The objective measurements are converted to the subjective criteria of intelligibility through a calculation of the articulation index. Protection ratios are provided in tabular form for given intelligibility criteria and operating parameters. (Author)

A71-28880 # Game theory and the use of game planning techniques for aircraft evaluation (Spieltheorie und Planspieltechnik bei der Flugzeug-Evaluation). Andreas Paul Anton Pechota. Eidgenössische Technische Hochschule, Doktor der Naturwissenschaften Dissertation, 1970. 77 p. 16 refs. In German.

Evaluation of new tactical aircraft for the Swiss Air Force by means of extensive operations research studies. Following preevaluation the problem was to choose between a small fleet of high performance aircraft or a larger one of less efficient aircraft. A simple air war game was constructed and theoretically treated. The fleets were evaluated in terms of survival probability and hits obtained. A handplayed noncomputer game was developed which permits allocation of aircraft and other arms of two hostile forces under conditions similar to a hypothetical war. The results are evaluated by a modified Wilcoxon text. In order to use the game in conjunction with a computer, a model is described which can carry out the task of the umpires during a game. F.R.L.

A71-28883 # **Potential flow interaction between blade rows in axial-flow compressors.** Ching-Yee Ma. Swansea, University College, Doctor of Philosophy Dissertation, 1969. 212 p. 50 refs.

This Ph. D. thesis investigates the potential flow interaction effects between blade rows in an axial flow compressor, and a method of analysis for flow through such multiple cascades of blades having finite thickness with relative motion is presented. The flow is assumed to be incompressible, two-dimensional, and irrotational. The flow equation is formulated in terms of a velocity potential function and is solved by an iterative process based on finite difference approximations. Calculations for several inlet guide vane-rotor (IGV) combinations were carried out, and from these the velocity and pressure fluctuations at any point in the flow can be obtained. Experimental studies indicate that the magnitude of the fluctuation depends critically on the IGV-rotor spacing. At a small interspace the effect of interference between the pressure fields of the IGV and rotor is the major cause of discrete frequency pressure fluctuation and hence of discrete noise. The thesis includes the FORTRAN IV computer program that was written for the analysis and requires only the basic geometry of the blades plus upstream and downstream flow velocities as input. F.R.L.

A71-28884 **En route speed control techniques.** A. J. Kulikowski. *Journal of Air Traffic Control,* vol. 14, May 1971, p. 5-8.

Analysis of the speed range used in a typical flight profile of a turbojet in an effort to assess its impact on ATC procedures. It is suggested that a uniform range of airspeeds be used by all turbojets transitioning to and from en route altitudes via published directives. These indicated airspeeds should be mandatory unless otherwise authorized by the controller. F.R.L.

A71-28885 **A world wide synopsis of turbulence related accidents.** David D. Thomas (Flight Safety Foundation, Inc., Arlington, Va.). *(Federal Aviation Administration, Turbulence Symposium, Washington, D.C., Mar. 22, 1971.) Journal of Air Traffic Control,* vol. 14, May 1971, p. 16-21.

Review of turbulence-related accidents during the past few years in order to provide perspective on the frequency and severity of such accidents. It appears that turbulence accidents are rarely fatal in air carrier operations, but 50% of those occurring in general aviation is fatal. F.R.L.

A71-28886 **3-D radar is here.** Albert R. Fellin. *Journal of Air Traffic Control,* vol. 14, May 1971, p. 24, 25.

Discussion of 'beacon numerics,' presently employed in the Atlanta and Indianapolis centers on a common-usage radar site, as a means of using a radarscope net not only for target azimuth and distance but also for direct altitude readout. This equipment gives a numerical readout from any aircraft with the proper equipment. Simplicity of operation is its greatest asset. F.R.L.

A71-28910 **Interface circuits drive high-level switches from low-level inputs.** J. O. M. Jenkins (Siliconix, Ltd., Swansea, Wales). *Electronic Engineering,* vol. 43, May 1971, p. 45-49.

A universal need exists at present for switching-systems which can provide the interfacing required to drive 'high' voltage level transistor switches from 'low' level (0.5V) logic inputs. Furthermore, the degree of compactness and reliability needed in these systems can only be achieved with the use of i.cs. This is particularly so in avionics systems where switching is required at a 28 V d.c. level. (Author)

A71-28938 # **Selection of a cam profile for the computing-resolving unit of an altimeter (Vybor profilia kulachka schetno-reshaiushchego uzla vysotomera).** L. I. Simakov and A. F. Akhmerov. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Pribory i Avtomaty,* no. 121, 1970, p. 92-99. In Russian.

Discussion of the adjustment of cams of the resilient aneroid sensors of altimeters to make the altimeter readings more accurate. A procedure is described for obtaining cam sets facilitating a more efficient and less laborious cam adjustment process without the necessity of adjusting individual cams. This procedure can be used as a basis for producing precision-profile cams by a programmed process. V.Z.

A71-28940 # **Problem of position determination of the neutral layer and critical curvature radius in waffle panels under purely elastoplastic bending (K voprosu opredeleniia polozheniia neitral'nogo sloia i kriticheskogo radiusa krivizny pri chistom uprugo-plasticheskom izgibe vafel'nykh panelei).** A. G. Lukashov and M. I. Lysov. *Kazanskii Aviatsionnyi Institut, Seriia Aviatsionnaia Tekhnologiia i Organizatsiia Proizvodstva,* no. 120, 1970, p. 10-24. In Russian.

Refinement of the method proposed by Lukashov and Lysov (1969) for solving problems of locating the critical curvature radius in waffle panels while the latter are shaped into aircraft components. The improved method provides more accurate approximations and includes the following assumptions: (1) the panel material is isotropic in both the elastic and plastic regions, behaves uniformly under tension and compression, and is incompressible beyond the limit of elasticity; (2) cross-sections during bending remain flat; (3) the directions of the adopted coordinate axes coincide with the directions of the main stress and strain axes; (4) the linear dimensions of the component right up to buckling remain invariant; and (5) strain concentrations in the vicinity of stiffener intersections are neglected. M.V.E.

A71-28941 # **Research study of optimal treatment routines applicable to an automated orifice-making process (Issledovanie izyskaniia optimal'nykh rezhimov obrabotki primenitel'no k avtomatizirovannomu protsessu obrazovaniia otverstii).** A. P. Nazarychev. *Kazanskii Aviatsionnyi Institut, Seriia Aviatsionnaia Tekhnologiia i Organizatsiia Proizvodstva,* no. 120, 1970, p. 25-29. In Russian.

Investigations were performed of the parameters decisive in the optimization of orifice-drilling techniques aimed at obtaining the highest qualitative and quantitative machining performance in the use of drilling equipment operated with the aid of programmed numerical control systems and engaged in the production of long-shaped aircraft components out of elongate profiles and panels. Proper timing of cutting tool resting periods, during which effective heat rejection out of the drilling bit and processed component into the surrounding medium can take place, and adequate allowance for the total drilling depth are found to be the major optimization prerequisites. M.V.E.

A71-28943 # **Problem of gear link design for grinding-belt machines (K voprosu proektirovaniia kulisnykh mekhanizmov lentochno-shlifoval'nykh stankov).** V. G. Borisovich, F. S. Iunusov, A. U. Gubaidullin, and K. G. Iaushev. *Kazanskii Aviatsionnyi Institut, Seriia Aviatsionnaia Tekhnologiia i Organizatsiia Proizvodstva,* no. 120, 1970, p. 52-59. In Russian.

Surface finish requirements of helicopter components are briefly reviewed, and some design aspects of thereto applied grinding equipment are discussed. These components have external surfaces of complex three-dimensional curvature, are heavily loaded, and perform critical key functions. Their service circumstances put forth stringent demands upon the machining characteristics of their surfaces in terms of fine-finished smoothness and of the sign and magnitude of residual stresses. At present, these demands are met mostly through use of grinding-belt machines. The required uniformity and continuity in abrasive belt contact pressure during grinding are ensured by link gear mechanisms whose belt-applying elastic contact rollers are actuated by special hydraulic follow-up systems. The operation of these gear link mechanisms is described and some of their design parameters are analyzed. M.V.E.

A71-28944 # **Evaluation of the mechanical properties of alloys and components in aircraft engine production (K otsenke mekhanicheskikh svoistv splavov i detalei v proizvodstve aviadvigatelei).** E. N. Darchinov. *Kazanskii Aviatsionnyi Institut, Seriia Aviatsionnaia Tekhnologiia i Organizatsiia Proizvodstva,* no. 120, 1970, p. 60-65. 6 refs. In Russian.

Discussion of approaches intended to raise the reliability of design and production decisions based on evaluations of mechanical characteristics in products of mass processes. It is shown that this reliability can be improved through application of quantitative variables expressing the statistical differences among observed distributions and norms. M.V.E.

A71-28945 # **Determination problem of sound limit expenditures per parameter unit in civil transport aircraft design (K voprosu opredeleniia predel'nykh tselesoobraznykh zatrat na edinitsu parametra pri proektirovanii grazhdanskikh transportnykh samoletov).** M. K. Nasyrov. *Kazanskii Aviatsionnyi Institut, Seriia Aviatsionnaia Tekhnologiia i Organizatsiia Proizvodstva,* no. 120, 1970, p. 70-74. In Russian.

Formulas for calculating cost-efficient limit expenditures in new commercial aircraft designs are derived and discussed. The attempt is made to include, among other things, the effects of the functional interdependence of amortization amounts and those of additional capital investments. It is felt that the actual operation of the commercial-exploitation process is thereby more accurately reflected in the derived formulas. M.V.E.

A71-28954 **Combustion in a flow (Gorenie v potoke).** Edited by A. V. Talantov. Kazan, Kazanskii Aviatsionnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970. 204 p. In Russian.

Experimental and theoretical research on combustion processes in turbulent and laminar flows of kerosene and gasoline mixtures, with emphasis on problems encountered in gas turbine engines. Topics treated include measurement of flame propagation rates, effects of flow turbulence on flameout phenomena, effects of flame holder and stabilizer arrangements on combustion parameters, influence of initial combustion parameters on afterburning characteristics, formation of temperature fields in the exhaust ducts of gas turbine engines, gasdynamic stabilization of flames, use of boundary slipstreams for ignition of combustion products in afterburners, and minimization of combustion deposits by appropriate design of fuel injection systems. Numerous design procedures for gas-turbine combustion chambers are described.

T.M.

A71-28962 # **Role of turbulence intensity during the mixing of plane isothermal slipstreams in an enclosed flow (Rol' intensivnosti turbulentnosti v protsesse smesheniia sputnykh ploskikh izotermicheskikh strui v zakrytom potoke).** Iu. V. Vinogradov, V. N. Gruzdev, and A. V. Talantov. In: Combustion in a flow (Gorenie v potoke). Edited by A. V. Talantov. Kazan, Kazanskii Aviatsionnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970, p. 86-97. 5 refs. In Russian.

Experimental study of turbulence effects on the mixing of three plane parallel streams with equal velocities (30 to 70 m/sec) and temperature (313 to 323 K). The level of turbulence was varied by using different grids in the channels prior to entry into a transparent mixing chamber. The central flow contained smoke for photographic visualization of the mixing process in the transparent chamber. The results show that a simultaneous increase of turbulence in all three channels intensifies the mixing process in accordance with turbulent diffusion theory. The effects of increasing turbulence only in the central channel depend on the turbulence ratio between this channel and the outer channels. T.M.

A71-28968 # **Comparative estimation of start-up and breakdown characteristics of gas-turbine engine combustion chambers with mechanical and air-stream mechanical propellant atomization (Sravnitel'naia otsenka puskovykh i sryvnykh kharakteristik kamery sgoraniia GTD pri mekhanicheskom i vozdushno-mekhanicheskom raspylivanii topliva).** I. N. Diatlov. In: Combustion in a flow (Gorenie v potoke). Edited by A. V. Talantov. Kazan, Kazanskii Aviationnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970, p. 160-169. In Russian.

Theoretical and experimental study of the effectiveness of propellant atomization with and without air injection in the combustion chamber nozzle of a gas-turbine engine. Tests show that the start-up and burning performance of these combustion chambers can be improved by using air injection during the mechanical propellant atomization process. It is shown that the operational range of combustion chambers can be extended to poorer propellant mixtures by combined air-injection mechanical atomization of the propellant. V.Z.

A71-28969 # **Investigation of a gas turbine engine start-up igniter (Issledovanie puskovogo vosplamenitelia GTD).** I. N. Diatlov. In: Combustion in a flow (Gorenie v potoke). Edited by A. V. Talantov. Kazan, Kazanskii Aviatsionnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970, p. 170-177. In Russian.

An experimental gas turbine engine igniter with a modified propellant atomizer was designed in an attempt to improve the standard prototype with a mechanical propellant atomizer. The modified atomizer differed from the standard atomizer in that propellant atomization in it was enhanced by air injection. Tests showed that the combined propellant atomization technique improved substantially the igniter performance, expanding considerably the range of steady operation in terms of propellant flow rates and pressure. V.Z.

A71-28970 # **Effect of airstream-mechanical propellant atomization on the carbon deposition rates in a gas-turbine engine combustion chamber (Vliianie vozdushno-mekhanicheskogo raspylivaniia topliva na intensivnost' nagaroobrazovaniia v kamere sgoraniia GTD).** I. N. Diatlov and V. G. Semenov. In: Combustion in a flow (Gorenie v potoke). Edited by A. V. Talantov. Kazan, Kazanskii Aviatsionnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970, p. 178-185. 6 refs. In Russian.

Experiments are described in which carbon deposition rates in a combustion chamber with airstream propellant atomization were compared with those in a combustion chamber with mechanical propellant atomization. Conditions are found to minimize carbon deposition by improving the air-propellant mixing process. Air-propellant flows are indicated which produce almost no carbon deposits when airstream-mechanical propellant atomization is used. V.Z.

A71-28971 # **Effect of the penetrating ability of jets on the peripheral nonuniformity of a gas temperature field at the outlet of a gas turbine engine chamber (Vliianie probivnoi sposobnosti strui na okruzhnuiu neravnomernost' temperaturnogo polia gaza na vykhode iz kamery sgoraniia GTD).** Iu. A. Spiridonov, K. V. Kakhovskii, and A. V. Talantov. In: Combustion in a flow (Govenie v potoke). Edited by A. V. Talantov. Kazan, Kazanskii Aviatsionnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970, p. 186-192. In Russian.

Experimental study of the behavior of a gas flow temperature field at the outlet of a combustion chamber with flame tubes having circular cross sections. It is shown that there is an optimum in the dependence of the peripheral nonuniformity of the temperature field on the penetrating ability of air jets when air is injected into the gas flow through orifices in the flame tube walls. The point of optimum is shown to be a singular point at which the gas flow field undergoes a major structural change. V.Z.

A71-28972 # **Generalized characteristic of peripheral nonuniformity in the temperature field of a gas at the outlet of a gas-turbine engine combustion chamber (Obobshchennaia kharakteristika okruzhnoi neravnomernosti temperaturnogo polia gaza na vykhode iz kamery sgoraniia GTD).** Iu. A. Spiridonov and A. V. Talantov. In: Combustion in a flow (Gorenie v potoke).

Edited by A. V. Talantov. Kazan, Kazanskii Aviatsionnyi Institut (*KAI, Trudy, Seriia Aviatsionnye Dvigateli,* no. 124), 1970, p. 193-200. In Russian.

A procedure is given for obtaining this characteristic on the assumption that the airstream penetrating ability at the singular point does not depend on the jet momenta, that the air distribution in the ring channel is uniform, and that the orifice diameters in individual sections of the mixing zone are equal. Limiting conditions for the delivery of air jets into the mixing zone, for the hydraulic resistance factor and for the gas motion from the flame tube into the ring channel are discussed. It is shown that for each total orifice area there is an optimal air distribution in the mixing zone with a minimum peripheral nonuniformity of the flow temperature field. V.Z.

A71-28985 # **The effect of flow direction on combined convective heat transfer from cylinders to air.** P. H. Oosthuizen and S. Madan (Queen's University, Kingston, Ontario, Canada). *ASME, Transactions, Series C - Journal of Heat Transfer,* vol. 93, May 1971, p. 240-242. National Research Council of Canada Grant No. A-5573.

In combined forced and free convective heat transfer from cylinders, the Nusselt number is shown to depend on the Reynolds number, the Grashof number, the Prandtl number, and the angle alpha between the directions of the forced flow and the buoyancy force. Previous measurements of convective heat transfer for alpha = 0 deg were extended to investigate the effect of varying alpha, assuming alpha = 0, 90, 135, and 180 deg. O.H.

A71-29043 # **Principal characteristics of aircraft flight mechanics (Osnovnye osobennosti dinamiki poleta samoleta).** V. S. Pyshnov. *Aviatsiia i Kosmonavtika,* Apr. 1971, p. 13-15. In Russian.

The changes in the flight parameter as a function of the angle of roll and the angle of pitch are discussed, and the dependence of the angle of attack on the path inclination at a constant angle of pitch is illustrated. Indirect criteria from which a pilot can detect the banking of the aircraft in the absence of a visual or artificial horizon are outlined. V.P.

A71-29106 **Low stratus at Embakasi Airport Nairobi.** Dietrich Stranz. *Pure and Applied Geophysics,* vol. 86, no. 3, 1971, p. 118-139. 26 refs.

The relatively frequent occurrence of low clouds over the Embakasi Airport near Nairobi (Kenya) is a great hazard particularly to aircraft without an automatic landing device. Hence, the necessity for the flight direction and control staff to receive early and reliable information regarding low clouds from the meteorologist. The great difficulty is evident from the fact that low stratus can form and also disappear very suddenly. Considerable and sudden local and temporal variations prevent the meteorologist from exactly forecasting the phenomenon. The statistical results obtained from more than five years of observations should provide a means of tackling the problem, but they appear to be inadequate unless the actual state of the atmosphere in its lowest 200 meters near the airfield is taken into account as an additional aid for the forecast. It is pointed out that radiosounding from a site to the northeast and below the level of the airfield would be of more use than that from Dagoretti which lies downstream and at a greater altitude. M.M.

A71-29131 # **Commercial VSTOL and the jet VTOL transport.** Drury Wood (Dornier AG, Friedrichshafen, West Germany). In: V/STOL in civil aviation; British Air Line Pilots Association, Annual Technical Symposium, 11th, London, England, November 24-26, 1970, Proceedings. Hayes, Middx., England, British Air Line Pilots Association, 1970, p. 63-70; Discussion, p. 71-81.

Interpretation of results obtained in testing the Do 31 jet transport built to land and take off vertically. When full throttle is applied the aircraft lifts from the ground with zero roll and accelerates quickly. The takeoff profile is optional with the pilot or is as directed by traffic procedures. The landing approach is the same as that for any conventional jet aircraft with the exception of the lift engine start procedure. It is considered that there can be increased automation of air traffic control and the actual control of the aircraft by electronic systems during takeoff and landing. F.R.L.

A71-29132 # **Flight systems, flight deck display and automatic flight control.** R. W. Howard (Elliott Flight Automation, Ltd., Rochester, Kent, England). In: V/STOL in civil aviation; British Air Line Pilots Association, Annual Technical Symposium, 11th, London, England, November 24-26, 1970, Proceedings. Hayes, Middx., England, British Air Line Pilots Association, 1970, p. 123-137; Discussion, p. 138-141.

Discussion of the application of existing controls, instruments, and displays to the takeoff and landing operation of a V/STOL. The flying control system is considered to be essentially a problem of applications engineering rather than one requiring some new breakthrough in systems or hardware technology. Electronic displays have the ability to present data in any form or combination on any suitable display surface. F.R.L.

A71-29144 # **Helicopters as cranes, and carrying external loads. III (Kran- und Aussenlastflug mit Hubschraubern. III).** Michael Caspari. *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 7, no. 4, 1971, p. 192-196. In German.

Operational costs of helicopters and the economic value of their use are analyzed. The operational costs consist of direct and indirect operating expenses and overhead expenses. It is found that the employment of helicopters becomes more economical with increasing time of operation. Examples are presented of cases in which the employment of helicopters has great advantages when compared with the use of conventional equipment for load-lifting and transportation. Approaches for increasing the application possibilities of helicopters by decreasing operation costs are examined. G.R.

A71-29155 # **Measurement of light pressure forces and of aerodynamic forces acting on a body of complex shape in a free-molecule flow (Izmerenie sil svetovogo davleniia i aerodinamicheskikh sil, deistvuiushchikh na telo slozhnoi formy v svobodnomolekuliarnom potoke).** L. A. Vasil'ev, T. A. Kuramshin, L. P. Nazarova, and L. I. Travnikova. *Aerodinamika Razrezhennykh Gazov,* no. 5, 1970, p. 113-118. In Russian.

Description of an assembly designed to produce a distribution of light reflected from a body which is similar to the distribution of molecules reflected from this body in a free-molecule flow. The assembly consists of a frame rotating about its vertical axis and of a ring fixed to the frame and rotating about its horizontal axis, both axes intersecting at the center of the ring. A body of complex geometry is suspended at the intersection of the axes on thin steel filaments. A light beam is emitted onto the body from a collimator fixed to the ring, so that the relative positions of the body and the beam remain unchanged during the rotation of the frame and the ring. Radiation reflected from the body in any direction can be measured by photoelectric, bolometric, and photographic recording on this assembly. The theory of this technique is discussed. V.Z.

A71-29169 # **Similarity laws for three-dimensional steady separated liquid and gas flows past bodies (Zakony podobiia dlia trekhmernogo statsionarnogo otryvnogo obtekaniia tel zhidkost'iu i gazom).** A. A. Nikol'skii. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 1-7. 6 refs. In Russian.

Theoretical study of the behavior of ideal fluid flows past low-aspect-ratio bodies with flow separation. Conditions are obtained under which the plane cross section law is asymptotically applicable

to these flows. The conditions are used to reduce the three-dimensional problem to a two-dimensional problem of such flows past two-dimensional bodies. General and specific similarity laws are derived for the reduction process. A low-aspect-ratio wing in a flow consistent with the plane cross-section law is discussed specifically. V.Z.

A71-29172 # Similarity and variation of the aerodynamical characteristics in the transition region at hypersonic flow velocities (O podobii i izmenenii aerodinamicheskikh kharakteristik v perekhodnoi oblasti pri giperzvukhovykh skorostiakh potoka). V. N. Gusev, M. N. Kogan, and V. A. Perepukhov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 24-33. 37 refs. In Russian.

Analysis of the aerodynamic characteristics of simple bodies in hypersonic flows with structural characteristics ranging from those of a free-molecule flow to those of a solid medium. The Boltzmann equation is used as a basis for deriving a similarity criterion for such media. The basic gas dynamical similarity parameter is shown to be a Reynolds number whose viscosity factor is a function of the drag temperature. This parameter is used in a comparison of the theoretical and experimental results. V.Z.

A71-29175 # Flow in the inlet section of a supersonic diffuser channel when the boundary layer is separated by a shock wave (Techenie vo vkhodnom uchastke kanala sverkhzvukovogo diffuzora pri otryve pogranichnogo sloia golovnoi volnoi). A. V. Nikolaev. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 60-70. In Russian.

Theoretical study of a plane flow in an experimental air inlet with extended rectilinear generatrices. The air inlet design is used for simulation of a shock-wave-separated flow in supersonic diffusers. A jet with a free boundary behind the flow separation point is used as a flow prototype in the simulation experiments. Expressions are obtained for determining the pressure variation profile along the free boundary from data for a critical pressure gradient at the flow separation point. V.Z.

A71-29176 # Experimental study of heat transfer on spheres and sharp cones in a rarefied hypersonic gas flow (Eksperimental'noe issledovanie teploperedachi na sferakh i tonkikh konusakh v giperzvukovom potoke razrezhennogo gaza). Iu. V. Nikol'skii, G. E. Pervushin, and L. G. Chernikova. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 71-77. 7 refs. In Russian.

Wind tunnel vacuum experiments with heat transfer measurements on spheres and sharp cones in rarefied gas flows at zero angles of attack at hypersonic speeds are described. Heat transfer is studied on spheres at Mach numbers from 4.9 to 9.5 and Reynolds numbers from 35 down to 1, and on cones at Reynolds numbers from 100 down to 4, realizing the conditions of transition from a free-molecular flow to a continuous medium flow. Good agreement is obtained between the experimental results and theoretical results obtained by Nikolaev (1962) for viscous hypersonic flows and by Perepukhov (1967) for nearly free-molecular flows. V.Z.

A71-29182 # Minimum-drag wing-fuselage combination for supersonic speeds (Kombinatsiia kryla z fiuzeliazhem, obladaiushchaia minimal'nym soprotivleniem pri sverkhzvukovykh skorostiakh). Iu. L. Zhilin. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 134-139. 5 refs. In Russian.

The variational problem of determining a minimum-drag wing-fuselage combination for prescribed lifting force, longitudinal moment, and volume is examined. It is assumed that the wing thickness is zero at the supersonic leading and trailing edges. For a slender fuselage, the variational problem is solved by the method of successive approximations. In the first two approximations, the problem is reduced to certain variational problems for an isolated wing. The surface of the fuselage in the contact region with the wing is constructed from the lines of flow at the isolated minimum-drag wing. The third approximation takes an additional deformation of the fuselage surface into account. V.P.

A71-29183 # Investigation of means of increasing the lift/drag ratio of conical bodies (Issledovanie vozmozhnostei uvelicheniia aerodinamicheskogo kachestva konicheskikh tel). B. L. Zhirnikov and K. P. Petrov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 140-144. In Russian.

The aerodynamic characteristics of cones with a wedge-shaped nose are studied experimentally and theoretically as a function of their geometrical parameters. The experiments were performed for angles of attack ranging from 0 to 18 deg at a Mach number of 1.6 and a Reynolds number of 0.88 x 10 to the sixth power. The theoretical results were obtained within the framework of Newtonian theory. It is shown that for certain geometrical parameters, the configurations studied have a much greater lift and lift/drag ratio than circular cones. The configurations studied may be well suited for space vehicles reentering the atmosphere at speed above 7 miles/sec. V.P.

A71-29185 # Approximate calculation of a certain class of gliding trajectories (O priblizhennom raschete odnogo klassa traektorii planirovaniia). V. G. Koniaev. *TsAGI, Uchenye Zapiski,* vol. 1, no. 1, 1970, p. 149-157. In Russian.

Analysis of quasi-stationary gliding trajectories of an aircraft in a planetary atmosphere during constant control of attack and bank angles. Values of parameters are determined at which these trajectories are possible. Approximate formulas are obtained for calculating the longitudinal and lateral ranges of the gliding aircraft as a function of its characteristics. Z.W.

A71-29188 # Theory for the unsteady curvilinear motion of a lifting surface in a gas (K teorii nestatsionarnogo krivolineinogo dvizheniia nesushchei poverkhnosti v gaze). V. E. Baskin. *TsAGI, Uchenye Zapiski,* vol. 1, no. 2, 1970, p. 18-28. 5 refs. In Russian.

The velocities of gas flows induced by the unsteady curvilinear motion of a lifting surface are expressed in terms of vortex densities. These expressions generalize the Biot-Savart law in such a manner that it becomes valid (in the linear approximation) for arbitrary nonstationary vortices in a gas. The generalization involves an allowance for the delay (lasting on the order of the time required for the passage of the sound signal) in velocity formation when applying the usual Biot-Savart formula to the vortex elements. This yields certain supplementary wavelike components of the induced velocities. T.M.

A71-29189 # Hypersonic flow around a delta wing (Obtekanie treugol'nogo kryla giperzvukovym potokom). V. P. Kolgan. *TsAGI, Uchenye Zapiski,* vol. 1, no. 2, 1970, p. 29-35. In Russian.

Hypersonic flow around a delta wing at small angles of attack is examined by using the method of pressure sources. The problem is reduced to a singular integral equation which is regularized to yield a Fredholm integral equation of the second kind with a continuous kernel. The results are illustrated by example calculations of the pressure field for a disturbed flow region. T.M.

A71-29190 # Investigation of the aerodynamic characteristics of elevons on low-aspect wings (Issledovanie aerodinamicheskikh kharakteristik elevonov na kryl'iakh malogo udlineniia). V. G. Mikeladze. *TsAGI, Uchenye Zapiski,* vol. 1, no. 2, 1970, p. 36-45. In Russian.

Calculations of the subsonic and supersonic aerodynamic characteristics of elevons used as longitudinal and lateral control elements on low-aspect wings. The method used for the subsonic velocities is

based on a reciprocity theorem that establishes the relation between the wing's aerodynamic characteristics in forward flow and in reverse flow (where the direction of the oncoming flow's velocity is reversed). Calculations for supersonic velocities are based on the linear theory of supersonic flows. The effects of individual elevon parameters are explained systematically, and flow patterns are described for wings with highly deflected elevons at subsonic, transonic, and supersonic velocities. T.M.

A71-29191 # **Influence of the real properties of air on flow parameters around an elliptical cone - Aerodynamic characteristics of elliptical cones at large angles of attack (Vliianie real'nykh svoistv vozdukha na parametry techeniia okolo ellipticheskogo konusa - Aerodinamicheskie kharakteristiki ellipticheskikh konusov pri bol'shikh uglakh ataki).** A. P. Bazzhin, O. N. Trusova, and I. F. Chelysheva. *TsAGI, Uchenye Zapiski,* vol. 1, no. 2, 1970, p. 46-52. In Russian.

Calculations of flow around an elliptical cone having a cross-sectional major-to-minor axis ratio of 2 and a vertex angle of 30 deg in the horizontal plane. The cone was oriented at a 30-deg angle of attack in air flows with speeds of 2350, 3356, and 6713 m/sec. The air was treated as a three-component (nitrogen, oxygen, and nitrogen) gas, and its thermodynamic functions were calculated by a standard program. The results are graphically compared with those for a perfect gas, showing relatively small changes in shock-wave positions, pressure ratios, and density ratios when the real gas properties are taken into account. The second part of the study shows the calculated behavior of lift, drag, and pitch-moment coefficients in perfect gas as functions of vertex angles (20, 30, and 40 deg) and angles of attack (30 to 50 deg) at Mach 7. T.M.

A71-29201 # **Ballistic wind tunnel for drag measurements on models during free flight at supersonic speeds (Aeroballisticheskaia truba dlia izmereniia soprotivleniia modelei v svobodnom polete pri giperzvukovykh skorostiakh).** L. P. Gur'iashkin, A. P. Krasil'shchikov, and V. P. Podobin. *TsAGI, Uchenye Zapiski,* vol. 1, no. 2, 1970, p. 111-114. 6 refs. In Russian.

A brief description is presented of a wind tunnel, the underlying principle of operation of which is firing model bodies into an oncoming supersonic flow. The wind tunnel was designed for measurements of the drag coefficient and for studies of the characteristics of flow past axisymmetric bodies in the range of supersonic and hypersonic flight velocities. O.H.

A71-29204 # **Limiting flows of a viscous fluid with stationary separation zones at Reynolds numbers tending to infinity (O predel'nykh techeniiakh viazkoi zhidkosti so statsionarnymi sryvnymi zonami pri Re tending to infinity).** G. I. Taganov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 3, 1970, p. 1-14. 14 refs. In Russian.

Quantitative asymptotic results for nondegenerate flow within a separation region with a circulating core are obtained for Reynolds numbers tending to infinity. The global flow pattern at a two-dimensional body with an indefinitely increasing separation zone is analyzed, and the local flow pattern near the body studied in detail. Analysis of the local flow pattern leads to an asymptotic formula for the drag coefficient of a two-dimensional body in the presence of dissipation at Reynolds numbers tending to infinity. A qualitative analysis of the drag coefficient as a function of Re for a plate situated normal to a flow with a stationary separation zone leads to a paradoxical result, according to which the drag of plate normal to the flow becomes at a certain Reynolds number smaller than that of plate at zero incidence at the same Reynolds number. The configuration of the separation zone which corresponds to the limiting state of a flow at Reynolds numbers tending to infinity past a symmetrical two-dimensional body is determined. V.P.

A71-29205 # **Hypersonic self-similar flow past a cone moving according to a power law (Giperzvukovoe avtomodel'noe obtekanie konusa, dvizhushchegosia po stepennomu zakonu).** S. K. Betiaev. *TsAGI, Uchenye Zapiski,* vol. 1, no. 3, 1970, p. 15-29. 8 refs. In Russian.

The unsteady hypersonic asymmetric gas flow past a circular cone and wedge moving at a variable velocity is analyzed for the case where the piston analogy of Heus is not applicable. An elliptical zone with an isotropic expansion of weak disturbances and an entropy singularity is contained between the hypersonic regions of the flow. A solution to the problem is obtained with the aid of external and internal asymptotic expansions. Numerical results are obtained by the method of characteristics within the framework of small perturbation hypersonic theory. The theory of self-similar motion proposed can be used for calculating the wave drag coefficient as a function of time for a cone of finite dimensions. It is shown that for a cone accelerated according to a power law, the drag coefficient cannot increase more than twice. V.P.

A71-29207 # **Interference between a wing and a jet in cross wind (Interferentsiia kryla i strui v snosiashchem potoke).** V. N. Arnol'dov, M. G. Gordon, and A. A. Savinov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 3, 1970, p. 36-44. 7 refs. In Russian.

The influence of a jet expelled at an angle of 90 deg toward the lower wing surface on the aerodynamic characteristics of isolated wings close to and far from a wall is studied experimentally. The factors responsible for the changes in the effective thrust of the jet with an increase of the oncoming flow rate and a decrease of the distance from the wall is analyzed on the basis of experimental and theoretical data on the interaction between jets with initial cross sections of various shape and wings of various relative dimensions and planforms. It is shown that at large distances from the wall (ground), the external flow past the jet plays an important role in the changes of the aerodynamic characteristics of the wing when the oncoming flow rate is increased, while near the ground, the vortices created at the upper wing surface have a favorable influence of the interference between the wing and jet. V.P.

A71-29217 # **Phenomenon of vortex formation associated with the oblique flow past a rotor (O iavlenii vikhreobrazovanii pri obtekanii nesushchego vinta kosym potokom).** A. V. Larin. *TsAGI, Uchenye Zapiski,* vol. 1, no. 3, 1970, p. 115-122. 9 refs. In Russian.

The structure and shape of the vortex wake behind a multiblade hinged rotor in oblique flow is studied by the cavitation method for various flight loads and various flow conditions at the rotor. The results are analyzed and are illustrated by photographs and sketches. A new effect is observed which consists in the transformation of the outer cycloidal segments of trailing vortices into vortex filaments consisting of several helical loops. V.P.

A71-29222 # **Optimal distribution of wing thickness in supersonic flow (Optimal'noe raspredelenie tolshchiny kryla v sverkhzvukovom potoke).** I. I. Burakov and Iu. L. Zhilin. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 15-21. 5 refs. In Russian.

Determination of the surface shape of a wing having minimum wave drag at zero angle of attack in supersonic flow. The Mach number and the wing's planform are given, and the wing thickness becomes zero at the leading and trailing edges. For high Mach numbers, the problem has a simple solution since the drag does not depend on the planform, and for a given profile, is governed by the distribution of the relative thickness and local chord along the span. A parabolic-profile wing whose thickness varies in proportion to the local chord along the span exhibits minimum drag in this case. Solutions for lower Mach numbers are obtained by using the Ritz method which reduces the problem to the determination of a conditional minimum. T.M.

A71-29224 # **Wind-tunnel simulations of viscous hypersonic flows (O modelirovanii viazkikh giperzvukovykh techenii v aerodinamicheskikh trubakh).** V. S. Galkin and V. S. Nikolaev. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 26-33. 8 refs. In Russian.

Analysis of problems involved in direct wind-tunnel simulation of natural interactions between a hypersonic viscous flow and a laminar boundary layer on a plate positioned at zero angle of attack. Direct simulation implies the possibility of relating the experimental data directly to the natural conditions. This can be done when all the wind-tunnel similarity criteria coincide with the natural criteria or when differences between them cause only slight discrepancies in the aerodynamic characteristics. Calculated data are given for the effects of individual similarity parameters on the lift and drag coefficients, and practical recommendations are included for relating the results of wind-tunnel experiments to natural situations in cases where several similarity parameters diverge simultaneously. T.M.

A71-29228 # **Longitudinal stability criteria for a ground-effect airplane (Kriterii prodol'noi ustoichivosti ekranoplana).** R. D. Irodov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 63-72. In Russian.

Analysis of factors affecting the longitudinal stability of an airplane which relies on the ground effect for substantial enhancement of its lift properties and of the wing's aerodynamic quality. The advantageous influence of the ground effect increases with decreasing height of the wing's trailing edge over the surface, as measured in fractions of the chord. For a given wing surface area and a given height of the trailing edge (governed by the roughness of the surface), the influence of the ground effect increases with decreasing wing aspect ratio. Some new longitudinal stability criteria associated with these aerodynamic characteristics are defined and developed into supplementary aerodynamic design requirements. T.M.

A71-29229 # **Irregular optimal trajectories of a spacecraft during flight in the atmosphere (Nereguliarnye optimal'nye traektorii apparata pri polete v atmosfere).** V. V. Dikusar and A. A. Shilov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 73-83. In Russian.

The control of a spacecraft's angle of attack during atmospheric reentry for minimum flight distances is examined with allowance for load constraints in the case of local inefficiencies of control. This case involves a situation where the local influence of the lifting force on the loads becomes exhausted. The necessary optimality conditions are analyzed, and Pontriagin's maximum principle is used for numerical determination of the spacecraft's maneuvering capabilities. Attention is given to the methodological aspects of solving boundary value problems when calculating irregular optimal trajectories. T.M.

A71-29231 # **Allowance for the operational experience in the determination of the lifetime of a structure (Ob uchete opyta ekspluatatsii pri opredelenii sroka sluzhby konstruktsii).** V. D. Il'ichev. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 92-98. In Russian.

Calculation of the safe service life of currently used structures and its prolongation without increasing the failure probability in storage, taking into consideration the linear accumulation of fatigue damages. To this purpose, the utilization of current load measurements and laboratory fatigue testing is recommended, as well as the use of mileage statistics of aircraft in current operation, including the leader aircraft. Z.W.

A71-29234 # **Influence of the vortex system of a wing in the absence of lift on the flow past the wing at small angles of attack (Vliianie vikhrevoi sistemy kryla pri otsutstvii pod'emnoi sily na ego obtekanie pri malykh uglakh ataki).** K. K. Fediaevskii and N. N. Fomina. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 109-112. In Russian.

The flow characteristics at zero angle of attack and an angle of attack of 5 deg were studied for a small-aspect-ratio thick-section wing (NACA-0018) of rectangular planform with flat tips. A comparison of the transverse velocity fields at these angles of attack shows that the nature of the flow at zero angle of attack is very similar to that at an angle of 5 deg. The tip vortex closer to the lower surface of the wing intensifies in the transition from zero angle of attack to an angle of attack of 5 deg, while the tip vortex located closer to the upper wing surface hardly changes. It is shown that the flow at zero angle of attack has an influence of lift formation. V.P.

A71-29235 # **Investigation of the vortex system of a helicopter rotor (Issledovanie vikhrevoi sistemy nesushchego vinta vertoleta).** V. G. Kolkov. *TsAGI, Uchenye Zapiski,* vol. 1, no. 4, 1970, p. 113-117. In Russian.

A smoke visualization technique is applied to a study of the vortex system of a rotor and the induced velocity field over a wide range of positive and negative angles of attack, flight conditions, and unit loads. Expressions describing the dependence of the configuration of the vortex system on the velocity of the oncoming flow and on the unit load at the rotor are proposed. Vortex system configurations are determined for various modes of rotor operation. The range of applicability of existing vortex models is established. V.P.

A71-29256 Elevator-induced manoeuvring loads from the standpoint of airworthiness requirements for sailplanes. Piero Morelli (Torino, Università, Turin, Italy). *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.) Aero-Revue,* May 1971, p. 247, 248.

Modifications of International Airworthiness Requirements for Sailplanes are proposed on the basis of criteria previously defined and discussed. The proposed modifications pertain to loads on horizontal tail surfaces and to maneuvering loads. Results of sample calculations of loads for typical sailplanes (a single- and a two-seater) are presented in two tables. M.V.E.

A71-29257 Airfoils for the variable geometry concept. F. X. Wortmann (Stuttgart, Universität, Stuttgart, West Germany). *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.) Aero-Revue,* May 1971, p. 249-251.

Wind tunnel tests were run on a pair of geometrically compatible airfoils designed to implement a variable chord concept applicable to sailplanes. The experimental results obtained confirm the expectation based on theoretical calculations and suggest excellent performance probabilities for a variable-chord sailplane. M.V.E.

A71-29261 # **The operational proving of automatic flight control systems in the approach and landing phase.** R. H. Ashforth. *Aviation Review,* May 1971, p. 14-16.

For the Hawker Siddeley Trident aircraft the autopilot was conceived on the basis that automatic landings in blind conditions could be achieved with a safety margin one order improved from that of the human pilot when making landings. Clearance for fully blind automatic landings is to be achieved in a series of gradual stages. The Category 1 standard of certification is considered. For Category 2 it was necessary to design and develop a radio deviation and comparator system. Lessons learned in developing the Category 3B system could result in an easier operation if they were implemented on future aircraft. G.R.

A71-29262 # **Accessories for gas turbine APU's.** V. L. Benson. *Aviation Review,* May 1971, p. 18, 19.

The growing importance of the gas turbine Auxiliary Power Unit (APU) for aircraft and their electronic systems is considered. Accessories of the APUs consist of high energy igniters, cables and connectors, thermocouples, and equipment for speed and temperature monitoring. The accuracy and reliability of speed and temperature monitoring equipment is an important factor in the control of an APU. G.R.

A71-29265 # **Aerodynamic behaviour of bodies in the wakes of other bodies.** W. A. Mair and D. J. Maull (Cambridge University, Cambridge, England). *Royal Society (London), Philosophical Transactions, Series A,* vol. 269, May 13, 1971, p. 425-437. 21 refs.

Wakes of two-dimensional bluff bodies are described, with emphasis on the properties of the wake which influence the loads on other bodies placed in the wake. The unsteady irrotational flow outside the true wake is included in the discussion. Some limited information on the wakes of three-dimensional bluff bodies is also given. The interaction between two bodies is subdivided into two categories: (1) when the bodies are close together and the upstream body is influenced by the downstream one and (2) when the bodies are so far apart that only the downstream body is affected. Experiments are described in which the load on an aerofoil in the wake of a two-dimensional bluff body was measured. The results are presented in the form of an aerodynamic admittance, and these experiments are used to illustrate the type of problem associated with the determination of the loads on a bluff body in a wake. Experiments are also described which show the large variation of time-averaged load which can be developed on a body which is part of a closely packed complex of bodies, as the orientation of the complex to the wind is varied. (Author)

A71-29276 **The 'Mercure' - The first aircraft of a new generation (Le 'Mercure' - Premier avion d'une nouvelle génération).** Jean de Galard and Jacques Morisset. *Air et Cosmos,* vol. 9, May 15, 1971, p. 21-36. In French.

Review of the development of the Dassault Mercure short-range aircraft. An extensive study of world air traffic showed that the average distance traveled per passenger was less than 1000 km. Studies by Dassault indicated that aircraft currently in use were poorly suited to their purpose. Thus a twin-jet aircraft was conceived which is larger than the Caravelle, the BAC-111, and the Boeing B-737 now actually in line use. It is considered to be well adapted to short stages and capable of further development by use of new and more powerful engines. F.R.L.

A71-29281 **Fuel-optimal landings of jet-supported VTOL aircraft (Treibstoffoptimale Landetransitionen strahlgestützter VTOL-Flugzeuge).** G. Schmidt and A. Weimann (Dornier AG, Friedrichshafen, West Germany). *Ingenieur-Archiv,* vol. 40, no. 2, 1971, p. 96-106. In German.

The present paper considers an optimal control problem, namely fuel-optimal landings of a VTOL aircraft. The aircraft is approximated as a mass point. However, separate main and lift engines, main aerodynamic forces and jet inlet impulse are taken into account. The equations of motion are given for the case of static air mass and a two dimensional translational motion in a vertical plane with pitch attitude constant. Utilizing this mathematical model and Pontriagin's Maximum Principle the analytical equations for computing combined fuel-time-optimal landing transitions are derived. These equations were solved in an analog computer study assuming data of the VTOL jet transport DO 31. A survey and discussion of the results are given. (Author)

A71-29304 **An over-view of the airport noise problem.** Inder K. Sud (Stanford University, Stanford, Calif.). *Logistics Review,* vol. 6, no. 29, 1970, p. 12-31. 15 refs.

The main sources of aircraft noise on and near airports and the factors affecting its intensity are specified. Legal aspects of airport noise are examined. A detailed discussion is presented of some approaches to alleviate noise and thus improve the relationship between airport and its environs. These approaches include design changes of aircraft engines, nacelle, or airplanes themselves; operation procedures such as special takeoff and landing approaches for noise abatement and use of preferential runways; and compatible land use development around airports. The features of a method to obtain noise characteristics of an aircraft are outlined, and the method called Noise Exposure Forecast (NEF) for the delineation of noise affected areas is described in detail. Finally, the 'cost' of noise is discussed. O.H.

A71-29308 # **Propulsion guidance and stability of the ground effect vehicle with perimetric Coanda fluid boundary (Asupra propulsiei, dirijării şi stabilităţii vehiculului cu efect de sol cu frontieră fluidă Coandă perimetrală).** Clement Alecsandrescu. *Transporturi Auto, Navale şi Aeriene,* vol. 1 (18), Feb. 1971, p. 66-70. 6 refs. In Rumanian.

Two variants of the propulsion system are presented: (1) the shutter system which is only briefly described and (2) the system using the Coanda effect to obtain a directional change of the flow. Theoretical computations are given for the latter together with details on the braking and stability of the vehicle during turns and at upgrades. N.D.

A71-29309 **Roissy-en-France - New major airport for Paris.** Gerhard Scheuch (Verein Deutscher Ingenieure, Darmstadt, West Germany). *Airport Forum,* no. 1, 1971, p. 25-31, 33, 34, 36. In English and German.

The new airport is under construction since 1967. It is situated approximately 20 km to the north-east of the Notre Dame cathedral. In its final stage, the airport will be capable of handling 30 million passengers a year. Five separate terminals for six million passengers each will be built at a rate of one per year. The airport will have four runways: two to the north and two to the south. The maximum traffic volume which could be handled by this runway system would be 500,000 aircraft movements a year. The present state of construction is briefly described. Z.W.

A71-29310 **The new Melbourne/Tullamarine airport.** James M. Eames (Department of Civil Aviation, Melbourne, Australia). *Airport Forum,* no. 1, 1971, p. 39, 40, 42 (5 ff.). In English and German.

General description of the new airport, its facilities, and capacity. A three-story international and domestic passenger terminal with radiating passenger concourses was placed on a 200-acre site on the eastern side of the airport, with its road system connected to an express highway to the city. Five hundred acres to the south were reserved for airline maintenance bases and a future cargo handling area. The airport has two runways: a primary 8500 ft north-south runway to be extended to 12,000 ft, and a secondary east-west runway of 7500 ft, which is also capable of extension. The international departure lounge and its associated areas will be capable of handling up to about 4000 passengers over a peak hour. The domestic terminals are planned to accommodate about 12,000 people an hour in the busiest period. Z.W.

A71-29311 **Design principles for airport pavements.** Carl E. Gerlach (Stuttgart, Universität, Stuttgart, West Germany). *Airport Forum,* no. 1, 1971, p. 53-60. In English and German.

Analysis of the criteria for estimating the stresses exerted by different types of loads imposed during operation on an airport pavement. Load classification numbers are introduced which make it possible to represent the stress imposed on the pavement by a multiple-wheel landing gear in the form of an isolated single-wheel load of equivalent value. Factors affecting the stresses arising in the pavement on flight operation areas, runways, taxiways, apron and waiting positions, overrun areas, shoulders and strips, and airport roads are discussed, and the suitable type of pavement is recommended for each case. Z.W.

A71-29312 **Baggage conveyor system in the New Frankfurt terminal.** Karlhans Müller (Flughafen Frankfurt am Main AG, Frankfurt am Main, West Germany). *Airport Forum,* no. 1,

1971, p. 79-84. In English and German.

The new terminal building at Frankfurt's Rhein-Main airport is designed for a capacity of up to 30 million passengers a year, and the percentage of the transfer passengers is about 50%. An automatic luggage conveyor system to the aircraft positions is described. This system uses entirely new methods of luggage handling. Tray pallets which travel on a special wheel and belt track were used for each individual suitcase. The conveyor tracks have a total length of over 18 miles with differences in level of up to 16 ft. Z.W.

A71-29313 A new concept: UCAT - Ultra Compact Airport Terminal. Wendell E. Rossman. *Airport Forum,* no. 1, 1971, p. 91-102. In English and German.

The terminal described consists of a closed concourse ring as the link between externally parked aircraft and the internal ground approach. It constitutes an endless chain of segments, each consisting of the three elements: landside, link (terminal), and airside. Each segment is autonomous and as such is a model of the whole. The circular form of the passenger terminal constitutes an optimum solution. Compared to traditional systems, its economics are much more favorable due to the lesser expense of facilities and smaller land requirements. Z.W.

A71-29378 # Low Reynolds number turbulent flow in large aspect ratio rectangular ducts. G. S. Beavers, E. M. Sparrow, and J. R. Lloyd (Minnesota, University, Minneapolis, Minn.). American Society of Mechanical Engineers, Paper no. 71-FE-A, 1971. 4 p. 9 refs. Members, $1.00; nonmembers, $2.00. NSF Grant No. GK-13303.

Experiments are reported on fully developed turbulent flows at low Reynolds numbers in rectangular ducts of large aspect ratio. Six ducts, with aspect ratios between 15.5:1 and 35.0:1, were employed for the investigation, covering a Reynolds number range from 5000 to 27,000. A friction factor, Reynolds number relation expressed as 0.507 R to the -0.30 power was found to be an excellent representation of the experimental data when the equivalent diameter was used as the characteristic length dimension. The Blasius and Prandtl circular tube friction factor relations, generalized by use of the equivalent diameter, gave results within 5% or better of the aforementioned correlation over the Reynolds number range of this investigation. (Author)

A71-29382 'Third Chance' flight control system. Michael J. Burke (Grumman Aerospace Corp., Bethpage, N.Y.). *Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 3, 1971, p. 3-9.

The A-6 aircraft was equipped with a backup hydraulic system. The purpose of the system was to provide a means of egress from the combat zone following loss of both hydraulic systems due to battle damage. The system was to supply as a minimum, a control capability to allow ejection in a safe zone with the possibility of a field landing capability. Flight tests were conducted utilizing the 'Third Chance' system only. Aspects of basic navigation are discussed, and the results of an investigation of the landing capability are reported. G.R.

A71-29383 Yankee escape system. Ralph Richardson. *Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 3, 1971, p. 10-13.

The new system uses a tractor rocket which pulls rather than pushes, and, thus, solves the problem of crew escape for the low speed, low altitude conditions in which conventional ejection seats encounter formidable stability problems. Escape at higher subsonic speed is comparable to that afforded by the conventional but vastly heavier ejection seat. It is possible to lift the airman out of any seat. To maximize ease of his escape through small apertures, however, a seat is provided with a design which permits the airman to go through an opening much smaller than possible with the conventional system. G.R.

A71-29384 Special problems in helicopter handling qualities as influenced by ASW requirements. J. R. Williford. *Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 3, 1971, p. 31-34, 39.

The pilot is flying as much as 4 hours, sometimes more, on an antisubmarine warfare mission. On this mission he has to come to a hover at 40 feet, perhaps on complete instruments, as often as every 10 minutes. In anything other than a sea state of 2 or 3 the approach to, stability therein, and recovery from a hover at 40 feet on complete instruments is a challenge which is not yet adequately met. Substantial gains in a number of areas are needed if the use of the dipping sonar as prime sensor is to be continued. Needed improvements related to the control and use of the helicopter are discussed. G.R.

A71-29385 Ejection seat system performance, versus aircraft performance. Ulf Frieberg (Saab-Scania AB, Linköping, Sweden). *Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 3, 1971, p. 35-39.

The trajectories of open ejection seats under various conditions from the lowest flying speed up to maximum speed are examined and desired trajectories are shown in a graph. It is pointed out that it must be possible to reach ejection seat handles without any delay. Handles mounted at the seat side are recommended. A harness for normal flying should allow the pilot to move freely forward and laterally with the go-forward released while sitting on the survival pack. Leg fixation, head fixation and protection, parachute descent and landings are discussed. G.R.

A71-29387 The SST. A. W. Blackburn. *Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 3, 1971, p. 70-75.

Aspects of the worldwide leadership of the U.S. in providing air transport are examined. Threats to U.S. dominance in the air transport field are seen to arise because of the absence of a U.S. SST in the face of the Anglo-French Concord and the Soviet TU-144. The need for Federal funds in order to ensure that the necessary SST technology is in hand to maintain U.S. leadership in the world air transport market is discussed. G.R.

A71-29433 # On separation control of flow along curved wall by various forms of jets or suctions (Controlling characteristics and comparison of effects). Masayosi Sato and Kenji Matsuoka (Osaka Prefecture, University, Sakai, Japan). In: Japan National Committee for Theoretical and Applied Mechanics, National Congress for Applied Mechanics, 18th, Tokyo Metropolitan University, Tokyo, Japan, November 8, 9, 1968, Proceedings. Tokyo, Chuo Kagaku-Sha, 1970, p. 155-163.

Experimental investigation of the controlling characteristics of the separation position of the two-dimensional incompressible air flow from the turbulent boundary layer along a circular-cylindrical wall by various forms of jets or suctions. The results may be used to increase wing lift. It was found that there are stable, unstable, fluctuating, and uncontrollable zones, depending on the control condition. The optimum slit (or porous surface) position in which the control will be carried out most economically will not always coincide with the original separation position of the external flow. For the large attachment angle of the external flow, control by a tangential jet should be adopted; for the small attachment angle the distributed normal suctions should be adopted. F.R.L.

A71-29434 # **Fatigue of aircraft structures.** Fumio Shima (Nihon Aeroplane Manufacturing Co., Ltd., Tokyo, Japan). In: Japan National Committee for Theoretical and Applied Mechanics, National Congress for Applied Mechanics, 18th, Tokyo Metropolitan University, Tokyo, Japan, November 8, 9, 1968, Proceedings. Tokyo, Chuo Kagaku-Sha, 1970, p. 167-176.

Investigation of several fatigue problems involved in aircraft design. Safe-life and fail-safe concepts are explained with reference to an example of a twin-engine transport fatigue test conducted in the phase of initial design. The procedures and results of determining the weak point are shown, as well as the outline of a fail-safe test conducted to acquire data concerning fail-safe of the airframe, crack propagation rate, and residual strength, etc. Some problems for future investigation are suggested. F.R.L.

A71-29448 * # **On flow past a supercavitating cascade of cambered blades.** C. C. Hsu (Hydronautics, Inc., Laurel, Md.). *American Society of Mechanical Engineers, Fluids Engineering Conference, Pittsburgh, Pa., May 9-12, 1971, Paper 71-FE-6.* 6 p. 14 refs. Members, $1.00; nonmembers, $2.00. Contract No. NAS 8-20625.

A linearized theory of supercavitating flow past a straight cascade with arbitrary blade shapes is developed. From the analysis, it is possible to determine the lift and drag coefficients, cavitation number, cavity shape, and exit flow conditions for any given specific cascade geometry, blade shape, cavity length, and initial inflow conditions. The cavitating performance of the cascade is, in general, found to depend strongly on stagger angle, solidity, blade shape, and cavity length. G.R.

A71-29450 # **Some results on the heat transfer within resonant cavities at subsonic and supersonic Mach numbers.** R. A. White (Illinois, University, Urbana, Ill.). *American Society of Mechanical Engineers, Fluids Engineering Conference, Pittsburgh, Pa., May 9-12, 1971, Paper 71-FE-9.* 6 p. 15 refs. Members, $1.00; nonmembers, $2.00. Research supported by the Aeronautical Research Institute of Sweden; NSF Grant No. GK-2053.

An experimental investigation of the heat transfer within two cavities (L/D equal to 1.25 and 2.0) exhibiting self-induced pressure oscillations (commonly referred to as resonance) is discussed. The tests were conducted with free stream Mach numbers between 0.35 and 1.5. The approaching boundary layer and shear layer over the cavities were turbulent at all times. The pattern for the heat transfer coefficient distribution over the cavity walls is in good agreement with that found by other investigators. The effect of the self-induced pressure oscillations, however, is to cause large changes in the level of the heat transfer, with low values occurring at the distinctive peaks of the pressure oscillations. The ratio of the integrated heat transfer within the cavity to the heat transfer from a flat plate with area equal to the area of the cavity opening was found to vary from 1.10 to 0.40, depending on Mach number and cavity resonance conditions. (Author)

A71-29453 # **An experimental study of rectilinear jet-flap cascades.** T. J. Landsberg and E. Krasnoff (Ingersoll-Rand Research, Inc., Princeton, N.J.). *American Society of Mechanical Engineers, Fluids Engineering Conference, Pittsburgh, Pa., May 9-12, 1971, Paper 71-FE-14.* 8 p. 7 refs. Members, $1.00; nonmembers, $2.00.

The performance of two-dimensional jet-flap cascades is determined experimentally. Stream deflection angles are presented as a function of the ratio of jet to mainstream momentum flux at chord spacing ratios of 0.375 and 0.75. Results obtained with conventional jet-flap airfoils (normal blowing near trailing edge) are in good agreement with published theoretical results. Tangential blowing jet-flap airfoils (tangential blowing over a rounded trailing edge) are shown to approximately double the turning effectiveness of the cascade. (Author)

A71-29467 # **Skin friction drag and velocity profile measurement techniques in two-phase flow.** M. P. Boyce (Texas A & M University, College Station, Tex.) and E. F. Blick (Oklahoma, University, Norman, Okla.). *American Society of Mechanical Engineers, Fluids Engineering Conference, Pittsburgh, Pa., May 9-12, 1971, Paper 71-FE-32.* 11 p. Members, $1.00; nonmembers, $2.00. Contract No. DA-31-124-ARO(D)-349.

Two-phase flow in a circular pipe and in a subsonic wind tunnel is considered. The measurement of velocity profiles of particles suspended in a gaseous media is a very significant factor in calculating the drag and boundary layers encountered in such a flow. A detailed account of the flow visualization techniques is provided. The technique utilized was specially developed for gas-solid media. It consists of two strobe lights with color filters connected to each other through a time delay relay system. Measurement techniques of skin friction drag on a flat plate in a wind tunnel, in a gas-solid environment are explained in detail. The photographic and measurement techniques used in the investigation were perfected after a long trial-and-error period. G.R.

A71-29468 # **Circumferential traversing technique for intrastage analysis of axial flow compressors.** M. Christianson (United Aircraft Research Laboratories, East Hartford, Conn.) and J. Yustinich (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Fluids Engineering Conference, Pittsburgh, Pa., May 9-12, 1971, Paper 71-FE-33.* 11 p. Members, $1.00; nonmembers, $2.00.

The capability and application of the probe traversing instrumentation currently in use at the research laboratory of a U.S. aerospace company are considered, and the data reduction techniques which incorporate methods of mass-flow-averaging are presented. Compressor facilities and the automatic data acquisition system are discussed. Typical rotor and stator blade element performance parameters calculated by the data reduction program are provided. Typical overall compressor performance, at constant speed, based on fixed instrumentation data and circumferential traverse data is presented in a graph. It is concluded that the technique reported allows the flow field to be analyzed in greater detail while reducing the data acquisition time. G.R.

A71-29469 * # **High entrainment ejector design.** K. E. Hickman, G. B. Gilbert (Dynatech Co., Cambridge, Mass.), and J. H. Carey (American Standard Research Laboratories, Brunswick, N.J.). *American Society of Mechanical Engineers, Fluids Engineering Conference, Pittsburgh, Pa., May 9-12, 1971, Paper 71-FE-34.* 13 p. 9 refs. Members, $1.00; nonmembers, $2.00. Contract No. NAS 2-4824.

The use of ejectors is of increasing interest for boundary layer control or control force augmentation in V/STOL aircraft. This paper presents a simplified analytical model which can be used to estimate the performance of high-entrainment constant-area ejectors for such applications. Analytical results are given for ejectors with primary flow pressure ratios above 5 and entrainment ratios from 10 to 40. An experimental program, employing primary flows up to 350 psia and 1200 F, was performed to confirm the analytical model. Test results are reported for a multiple-nozzle ejector with two mixing tube lengths. (Author)

A71-29483 # **Visual flight simulation with high information density image storage media (Flugsichtsimulation mit Bildspeichern hoher Informationsdichte).** Joachim Wernicke. Berlin, Technische Universität, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1969. 117 p. 72 refs. In German.

The functional principles and performance criteria of visual flight simulation devices are analyzed. The representation of terrain optical textures is considered to be a very important factor for obtaining a realistic image; it creates, however, a major problem of storaging very considerable quantities of optical information. From

the point of view of information storage capacity, only two storage principles for general use in the terrain flight simulation are found to be worth considering - i.e., high-resolution photographic plates, and digital memories. A method is described that uses current technology to generate perspective views of a hilly terrain. The method is based on improvements of the television raster shape visual simulation principle. For information storage, a pair of photographic plates (brightness, elevation) is used. A study of digital methods for visual simulation of textured flight scenes reveals the negative result in that both the storage capacity and computing cycles of electronic digital computers will not be sufficient for this purpose in the near future. O.H.

A71-29524 # **Experimental aeromechanics (Eksperimental'naia aeromekhanika).** S. M. Gorlin. Moscow, Izdatel'stvo Vysshaia Shkola, 1970. 424 p. 19 refs. In Russian.

Explanation of the physical fundamentals, experimental methods, and significance of the results of aerodynamic research. Various types of wind tunnels and shock tubes are described for tests of subsonic, supersonic, and hypersonic velocities. The physical properties of liquids and gases are defined, together with laws governing the behavior of gas flows and the use of similarity criteria. Procedures and equipment for measuring flow parameters are outlined, including methods of introducing necessary corrections into the experimental data. Emphasis is on test methods for determining the aerodynamic characteristics of aircraft, rockets, various types of bluff bodies, surface transport vehicles, and ground-based structures. Flow in tubes, nozzles, and diffusers is also studied. T.M.

A71-29525 # **Electrical power supply systems of airplanes and helicopters (Sistemy elektrosnabzheniia samoletov i vertoletov).** I. I. Lukin and V. V. Liubimov. Moscow, Izdatel'stvo Transport, 1970. 360 p. 12 refs. In Russian.

The theory and practice of electrical power supply systems on aircraft are given in a systematic text intended for use in technical educational courses. Equipment considered includes storage batteries, dc generators, alternators, voltage regulators, current and frequency control systems, overload protection systems, converters, and power transmission and distribution systems. Principles of operation, structural features, circuit diagrams, design procedures, and operational specifications are included. The design procedures are illustrated by examples of electrical and thermal constraints; typical failure modes are demonstrated and various protective devices are explained. T.M.

A71-29529 # **Aircraft materials science and treatment of materials (Aviatsionnoe materialovedenie i obrabotka materialov).** D. A. Ryzhinskii and V. N. Romanchuk. Moscow, Izdatel'stvo Mashinostroenie, 1970. 328 p. 17 refs. In Russian.

The fundamentals of steel and cast iron processing are presented, together with the principles of metallography, heat treatment, and thermochemical treatments. The properties of the most important materials used in aircraft structures are examined. Methods used for surface protection of metals and alloys against corrosion are described. The foundry technology and working of metals by extrusion, machining, and welding are described. The requirements concerning the tolerances, fitting, and measurements of machine elements in the aircraft industry are presented. The properties and testing of nonmetallic materials are examined, including paints, resins, plastics, glues, and sound- and electric-insulators. Z.W.

A71-29530 # **Aircraft technician's handbook of electrical equipment (Spravochnik aviatsionnogo tekhnika po elektrooborudovaniiu).** V. F. Bliuger and V. G. Breslavets. Moscow, Izdatel'stvo Transport, 1970. 308 p. In Russian.

Structural details, circuit diagrams, and operational specifications of various aircraft electrical devices are given in a form intended for use in maintenance and overhaul operations. Direct current generators, alternators, starter generators, turbine-powered generators, starter motors, and battery systems are examined, and proper maintenance intervals, diagnostic clues, lubrication materials, and electrolyte requirements are described. Various types of cables, wires, insulations, electrical harness configurations, terminals, couplings, and connectors are outlined, and special attention is given to mechanical and electrical countermeasures against electromagnetic interference. T.M.

A71-29548 # **The role of aircraft in the intraurban transportation system for the Detroit metropolitan area.** L. A. Riedinger and E. G. Stout (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, International City Management Association, National League of Cities, and U.S. Conference of Mayors, Urban Technology Conference, New York, N.Y., May 24-26, 1971, AIAA Paper 71-504.* 9 p. Members, $1.50; nonmembers, $2.00.

Study of aircraft capabilities in intraurban transportation system in terms of selection and evaluation of aircraft concepts, using the Detroit metropolitan area as a specific example and computer models adaptable to any intraurban or interurban area. Vehicle design, fleet size, cost, terminal location, fares, and frequency are thoroughly considered and optimized on the basis of a realistic market scenario. The propeller-powered deflected-slipstream STOL is the preferred concept, the nearest competitors being the compound helicopter VTOL and the autogyro STOL. All vehicle concepts considered are believed to involve low technical risk in their respective time periods. Current technology is sufficient for the development of the intraurban transport system for the 1975 time period. M.V.E.

A71-29549 # **VTOL in the urban context.** M. W. Hellyar (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Institute of Aeronautics and Astronautics, International City Management Association, National League of Cities, and U.S. Conference of Mayors, Urban Technology Conference, New York, N.Y., May 24-26, 1971, AIAA Paper 71-507.* 7 p. Members, $1.50; nonmembers, $2.00.

Discussion of the merits of helicopter systems operation in, around, and between major metropolitan areas. The performance of New York Airways' metropolitan helicopter service in 1970 without subsidy of any kind indicates that mature management and reliable equipment make profitable operation possible. Larger and more economical helicopters are now emerging from experience with big, high-speed military transport aircraft. These helicopter technology advances make VTOL transportation economically competitive with alternative modes in terms of both cost and time. The helicopter's environmental advantages are also briefly reviewed. M.V.E.

A71-29550 # **STOL - An asset for Manhattan.** R. K. Ransone (American Airlines, Inc., New York, N.Y.). *American Institute of Aeronautics and Astronautics, International City Management Association, National League of Cities, and U.S. Conference of Mayors, Urban Technology Conference, New York, N.Y., May 24-26, 1971, AIAA Paper 71-508.* 7 p. Members, $1.50; nonmembers, $2.00.

The merits of an integrated short-haul transportation system are considered between centers of industry and commerce 100 to 300 miles apart in a makeup consisting of conventional jet aircraft, STOL aircraft, and high-speed ground transportation. It is felt that the STOL portion of this system can be designed from the outset to operate conveniently, reliably, and economically in congested urban and suburban areas without degrading neighborhoods in terms of noise, air pollution, safety, or ground congestion. M.V.E.

A71-29551 # **Operations research analysis of aircraft noise abatement.** Edward B. Ahlers (IIT Research Institute, Chicago, Ill.). *American Institute of Aeronautics and Astronautics, International City Management Association, National League of Cities, and U.S. Conference of Mayors, Urban Technology Conference, New York, N.Y., May 24-26, 1971, AIAA Paper 71-525.* 8 p. Members, $1.50; nonmembers, $2.00. Research sponsored by the Air Transport Association of America and the Aerospace Industries of America.

Methods are developed for computing relative costs of various combinations of countermeasures for reducing community noise exposures to various levels in a national system of airport communities by extrapolation from a statistically significant sample of airports. The procedures can be used to seek the minimum-cost of alternate near-minimum cost combinations of countermeasures. Measures for estimating the probable error of problem solutions are incorporated in the formulation. Printed output includes: total costs for reducing noise exposures to various levels and costs associated with engine modifications, airframe modification, operation changes, increments in direct operating costs, and land-use changes. M.V.E.

A71-29578 # **Supersonic combustion research techniques in a hypersonic shock tunnel.** Raymond John Parsons. Sheffield, University, Doctor of Philosophy Dissertation, 1969. 267 p. 91 refs. Research supported by the Ministry of Technology; Grant No. AF EOAR 67-5.

The use of a hypersonic shock tunnel in the simulation of combustor conditions at flight Mach numbers in excess of 10 is examined, with special reference to instrumentation techniques. The technique of using combustion heated helium as driver gas was shown to correctly simulate combustor conditions from Mach 10 to Mach 16. The starting transients in supersonic ducts were examined to establish criteria for minimizing the starting time and overpressure. These were achieved by evacuating the duct to between 1/10th and 1/30th torr of the running static pressure. The electromagnetic induction method for measuring gas velocity proved to be a novel and acceptable instrumentation technique. Z.W.

A71-29610 # **Plane jet of a conducting fluid in a slipstream (Ploskaia struia provodiashchei zhidkosti v sputnom potoke).** M. Z. Zhivov and Iu. A. Sokovishin. *Magnitnaia Gidrodinamika,* vol. 7, Jan.-Mar. 1971, p. 49-52. 5 refs. In Russian.

Partial differential equations are derived to describe the expansion of a plane jet of incompressible conducting fluid in a homogeneous slipstream of this fluid. An implicit difference scheme is used for solving these equations in a nonconduction approximation. The results are compared with an approximate asymptotic solution, showing that there is only an insignificant relation between the initial jet profile and the asymptotic drag which acts on the jet during expansion in the same fluid. V.Z.

A71-29633 Materials '71; Society of Aerospace Material and Process Engineers, National Symposium and Exhibit, 16th, Anaheim, Calif., April 21-23, 1971, Proceedings. Anaheim, Calif., Society of Aerospace Material and Process Engineers (Science of Advanced Materials and Process Engineering Series. Volume 16), 1971. 435 p. $28.50.

Experimental and theoretical studies of the high-temperature oxidation and ablation of superalloys and composites, and advanced processing, testing, and cost evaluation of nonmetallic materials and composites. The development of silane coupling agents for urethane adhesives is described, together with fabrication of hybrid boron-graphite filament composites, three-dimensionally reinforced felt composites, and advanced plastic composites. A description is presented of rain erosion resistant radomes for supersonic aircraft, protective coatings for supersonic flight which are resistant up to 3000 F, and corrosion protection for solid rocket propulsion systems.

Z.W.

A71-29635 Evaluation of coated alloys for turbine components of advanced gas turbine engines. Norman M. Geyer (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio) and Kenneth H. Ryan (General Motors Corp., Allison Div., Indianapolis, Ind.). In: Materials '71; Society of Aerospace Material and Process Engineers, National Symposium and Exhibit, 16th, Anaheim, Calif., April 21-23, 1971, Proceedings. Anaheim, Calif., Society of Aerospace Material and Process Engineers (Science of Advanced Materials and Process Engineering Series. Volume 16), 1971, p. 11-29.

A program to evaluate the effects of newly developed coatings on modern superalloys is being conducted by Detroit Diesel Allison Division for the Air Force Materials Laboratories. Hollow thin wall test specimens are employed so results can be related to air cooled turbine components. Phase I testing established correlation of laboratory testing with turbine engine and flight service test results. In Phase II a baseline of performance is established on current commercial coatings for comparison with advanced development coating systems being tested in Phase III. Evaluation includes room and elevated temperature tensile, stress rupture, hot corrosion, oxidation-erosion, ballistic impact, thermal fatigue and high cycle fatigue tests. Test results demonstrate the importance of using thin wall specimens to evaluate the effects of coating systems and thermal environments on alloy properties. (Author)

A71-29642 Aerospace materials selection and verification of structural designs developed by means of high velocity impact testing. John W. Noonan (National Aeronautical Establishment, Ottawa, Canada). In: Materials '71; Society of Aerospace Material and Process Engineers, National Symposium and Exhibit, 16th, Anaheim, Calif., April 21-23, 1971, Proceedings. Anaheim, Calif., Society of Aerospace Material and Process Engineers (Science of Advanced Materials and Process Engineering Series. Volume 16), 1971, p. 97-108. 8 refs.

Latest generation of large transport aircraft and high subsonic speed, low-level mission, military aircraft have high susceptibility to catastrophic bird impact damage. New materials and processes under development to cope with this hazard require extensive impact testing for verification of design. Current analysis techniques and standardized test equipment are inadequate for predicting impact strength of windshields and tail surface structures. A pneumatically powered bird gun has been developed at the National Aeronautical Establishment, Ottawa, Canada capable of simulating bird strikes at velocities up to 600 to 700 MPH using birds of 4 and 8 pounds body weight. Velocity prediction and aiming accuracy are considered to be of an unusually high order; unique packaging maintains bird intact up to the target. The gun, types of birds used and instrumentation are described and operational experience is related. (Author)

A71-29645 Rain erosion resistant radomes for supersonic aircraft. Glenn Wintermute (Goodyear Aerospace Corp., Litchfield Park, Ariz.). In: Materials '71; Society of Aerospace Material and Process Engineers, National Symposium and Exhibit, 16th, Anaheim, Calif., April 21-23, 1971, Proceedings. Anaheim, Calif., Society of Aerospace Material and Process Engineers (Science of Advanced Materials and Process Engineering Series. Volume 16), 1971, p. 138-161. Contract No. AF 33(615)-67-C-1349.

Materials and processing methods for forming rain erosion resistant ceramic coated plastic structures were studied and evaluated. Manufacturing techniques were developed and optimized for producing fiberglass reinforced polyimide radomes with a thin alumina protective coating. Several prototype radomes were fabricated and were tested by means of a rocket sled at Mach 3 through a simulated rainfield. The radomes successfully passed the test. (Author)

A71-29646 Protective coatings for a hypersonic flight load-bearing refractory alloy control surface. Robert H. Witt (Grumman Aerospace Corp., Bethpage, N.Y.). In: Materials '71;

Society of Aerospace Material and Process Engineers, National Symposium and Exhibit, 16th, Anaheim, Calif., April 21-23, 1971, Proceedings. Anaheim, Calif., Society of Aerospace Material and Process Engineers (Science of Advanced Materials and Process Engineering Series. Volume 16), 1971, p. 162-175K.

A materials effort was made in support of the design, fabrication, and testing of a full-scale control surface (elevon) test article. This paper concerns itself with two primary areas of the total effort, namely oxidation screening tests for coating selection at ambient and reduced pressures and hardware evaluations. It was found that R512C slurry silicide coating on Ta-10W substrate provides a system that has excellent protective and self-healing qualities up to 3000 F. This coating retains usefulness even after short overshoot exposures to temperatures near 3200 F. Final proof of the usefulness of the approach was demonstrated by cycling a full-scale elevon under extreme conditions with severe thermal shock prevailing in each run. Recommendations are included for future work along these lines.

(Author)

A71-29656 Advanced composite cost comparison. D. D. Dial and M. S. Howeth (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). In: Materials '71; Society of Aerospace Material and Process Engineers, National Symposium and Exhibit, 16th, Anaheim, Calif., April 21-23, 1971, Proceedings. Anaheim, Calif., Society of Aerospace Material and Process Engineers (Science of Advanced Materials and Process Engineering Series. Volume 16), 1971, p. 302-314.

Relative cost comparisons of advanced composite applications with conventional material components are presented. Specific detailed comparison studies are described for several components selected from a supersonic fighter-bomber. These comparisons include material and labor required to fabricate the wing trailing edge panel, wing pivot fitting doubler, and wing pivot fairings. The wing trailing edge components were manufactured on a research and development basis and did not prove to be cost-competitive. The other two components were produced with either boron-epoxy or graphite epoxy materials and are currently in production. Both of these applications are shown to be cost-competitive with other approaches using conventional materials. Z.W.

A71-29749 Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 453 p.

The topics deal with knowledge of the atmosphere based on scientific observation, stressing thunderstorms and clear air turbulence, considering then the nature and physics of the environmental wind field (including turbulence) from the theoretical point of view. Attention is given to operational aspects and experience, aircraft control and load alleviation, human factors, and structural loads and design.

F.R.L.

A71-29750 * # Atmospheric turbulence and the air transportation system. Philip Donely (NASA, Langley Research Center, Hampton, Va.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 14 p.

In regard to extreme rough air, the aim must be to increase the chances of survival of the aircraft. In the case of moderate turbulence, the aim is to provide the pilot with control and structural capability for safe operation on a day-to-day routine basis. Operational data on gust accelerations for turbine-powered aircraft are considered. Approaches involving the avoidance of turbulence are discussed giving attention to the detection system and to forecasting services required. The importance of pilot training, equipment, and pilot stress in mastering difficult situations is emphasized, and ways to reduce or alleviate deficiencies in these areas are investigated. The advisability of increasing structural design criteria for either static strength or fatigue is discussed. G.R.

A71-29751 # An assessment of atmospheric turbulence data for aeronautical applications. Jan N. Garrison (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 18 p. 35 refs.

Turbulence models currently used for aircraft design attempt to answer questions regarding the probability for the aircraft to encounter a gust input of any given magnitude, and the power spectral density of the gust input. The Low-Low Altitude Critical Atmospheric Turbulence Project is discussed. The data obtained in this project confirmed that lateral gusts are somewhat more severe than vertical gusts at very low altitudes. Turbulence in the free atmosphere is considered, and general conclusions regarding CAT activity are drawn. Aspects of turbulence in and around thunderstorms are examined. G.R.

A71-29752 # Comparison of thunderstorms over Oklahoma and Malaysia based on aircraft measurements. J. T. Lee (NOAA, National Severe Storms Laboratory, Boulder, Colo.) and A. McPherson (Royal Aircraft Establishment, Bedford, England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p.

A Canberra WH793 and the RB57F, a USAF weather reconnaissance aircraft, were used in the thunderstorm investigations. The results obtained for Oklahoma and for Malaysia were similar except for the longer duration of turbulence patches over Oklahoma. This difference corresponds to the differing echo patterns in the two areas. It appears that the energy of larger Malaysian thunderstorms is less than that of the larger Oklahoma thunderstorms, since the former evidences less overall vertical development, smaller top diameter, and, from analysis of soundings, less energy appears to be available for it. G.R.

A71-29753 # Flight studies of clear air turbulence - The current position and further research needs. G. K. Mather (National Aeronautical Establishment, Ottawa, Canada). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p. 7 refs.

A highly instrumented T-33 was used in the studies. Aircraft instrumentation was designed to measure the three orthogonal components of turbulence along the major aircraft axes and the fluctuating static temperatures. The mean horizontal wind and temperature fields could also be determined. The turbulence energy budget is discussed and the flight data are analyzed. It is pointed out that two aspects of the results reported may be applicable to the problem areas of CAT forecasting and airline operations. G.R.

A71-29755 # **Measurements of stratospheric airflow and clear air turbulence, up to 63000 ft, over and downwind of mountainous terrain.** J. M. Nicholls (Meteorological Office, London, England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p. 15 refs.

Two series of flights have been made over the Western USA. Important features of the flow patterns obtained on 4 days during the project are described. The results obtained indicate that clear air turbulence is associated with two distinct features of vertical cross sections of air flow over and downwind of mountains, namely large isentropic oscillations in the flow, and negative wind shear zones which were disturbed by orographically induced waves. The largest stratospheric oscillations in the flow patterns, in which turbulence was frequently found, were usually located almost over the mountain. G.R.

A71-29756 # **Measurement of extreme mechanical turbulence during low level flights by Mirage A3-76.** C. K. Rider, M. R. Thomson, and F. E. Verinder (Department of Supply, Aeronautical Research Laboratories, Melbourne, Australia). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 8 p.

On Sept. 11, 1969, an instrumented Mirage fighter-aircraft carried out three flights in an area of severe low level turbulence. Acceleration maxima of +3.5 g, -1.5 g were recorded. True gust velocities have been computed for 5400 sec of recorded data. Results presented apply to conditions experienced for more than five hours on the one day. All records were obtained on the same track, about 100 miles long at pressure-height levels between 2900 and 4200 ft. G.R.

A71-29763 # **Partially trapped waves.** F. H. Berkshire and F. W. G. Warren (Imperial College of Science and Technology, London, England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 8 p. 9 refs.

Consideration of atmospheric models which contain an upper layer above the tropopause in which the Scorer parameter (which depends on the undisturbed atmospheric parameters) becomes large. Waves which would be trapped in the troposphere by a neutral stratosphere are thus able to pass through the tropopause and propagate into the higher regions of the atmosphere. F.R.L.

A71-29764 # **Operational forecasting and analysis of turbulence.** W. Boynton Beckwith (United Air Lines, Inc., Chicago, Ill.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 13 p. 11 refs.

Consideration of turbulence as it affects transport aircraft, using the Fairchild or Lockheed accelerometer records as an indication that is quite consistent with the subjective evaluation assigned to an event by an experienced airline pilot. Moderate turbulence is defined as that which a transport aircraft registers on its recorder as an excursion from the 1.0g reference of plus or minus 0.50 to 0.75g. Severe turbulence is equivalent to an excursion of plus or minus 1.0g or more. The records cited are considered to be invaluable in obtaining a better understanding of the mesoscale structure of turbulence and its effect on airspeed, altitude and, indirectly, pilot reaction. Attention is given to thunderstorm turbulence, CAT and weather-induced turbulence, the forecasting of mountain waves, low level wind shears, and detection equipment. F.R.L.

A71-29765 # **Development of airborne remote clear air turbulence (CAT) detection equipment.** Andrew S. Carten, Jr. and Wilbur H. Paulsen (USAF, Cambridge Research Laboratories, Bedford, Mass.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 10 p. 16 refs.

Investigation of methods for detecting CAT ahead of an aircraft with the intent to achieve an operationally useful system. Major attention is given to laser and infrared techniques. It is pointed out that the pulsed Doppler laser is expensive and cumbersome, while the relatively inexpensive infrared systems are on the verge of practical use. F.R.L.

A71-29767 # **Stratospheric turbulence and temperature change measurements from the Coldscan program.** J. I. MacPherson (National Aeronautical Establishment, Ottawa, Canada) and E. G. Morrissey (Department of Mines and Technical Surveys, Meteorological Service, Ottawa, Canada). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 11 p. 8 refs.

Project Coldscan has been expanded to include the relationship of the nature and severity of the recorded phenomena to meteorological conditions and the underlying terrain. Eighty-three Coldscan flights to date have shown that moderate stratospheric turbulence occurred about 0.5% of the time above 40,000 ft and tended to be concentrated over mountains. More frequent, and perhaps more important to the SSTs, are the encounters with temperature waves and horizontal temperature gradients exceeding 2.5 C in 3 n mi. These averaged 0.8 encounters per 1000 n mi tended to show a peak in their distribution at 60,000 ft, and were associated with turbulence of at least moderate intensity only 1/6 of the time. Although the largest temperature changes have been encountered only over mountains to date, a considerable number of temperature changes with gradients up to this level have been measured on the SST routes off the east coast of North America. M.M.

A71-29768 # **Air turbulence - Hidden and revealed.** M. N. Morss (British Air Line Pilots' Association, Hayes, Middx., England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 6 p.

Discussion of primary and secondary effects of air turbulence and of criteria for avoiding it. It is pointed out that air turbulence might be better avoided by action in the following areas: (1) observation and forecasting over smaller scale sections of airspace; (2) detection of even moderate or light turbulence; (3) direct communications and more effective involvement of ATC personnel in the handling of data; and (4) provision of ATC techniques and equipment which recognize turbulent and turbulence-prone areas as nonvalid airspace. It is noted that the effects can also be minimized by a reexamination of aircraft design characteristics and automatic flight control modes. M.M.

A71-29770 # **Lessons to be learned from accidents attributed to turbulence.** Alan I. Brunstein (National Transportation Safety Board, Bureau of Aviation Safety, Washington, D.C.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p.

Analysis of air carrier accidents caused by air turbulence from 1964 to 1969 in the total number of 441 accidents, including 97 involving turbulence. The main lessons learned from turbulence-involved accidents are: (1) turbulence is one of the major in-flight weather problems; (2) airborne weather radar is an excellent thunderstorm-avoidance tool; (3) airborne weather radar must be maintained and operated properly; (4) training should be formalized in the use and interpretation of airborne weather radar; (5) recurrent airborne weather radar training is desirable; (6) CAT forecasts need considerable improvement; (7) CAT detection systems, airborne and ground-based, are needed; and (8) real-time weather data are needed on the ground, and most certainly in the cockpit. M.M.

A71-29771 # **Turbulence experience recorded by CAADRP.** J. R. Sturgeon (Royal Aircraft Establishment, Farnborough, Hants., England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 10 p. 8 refs.

Discussion of the characteristics of flight in severe turbulence, encountered during 23,000 flying hours, from an analysis of analog trace records of 65,000 hr of operational civil flying including airspeed, normal acceleration, height, air temperature, control surface and flight attitude parameters. Attention is drawn to variations in rate of climb of up to 8000 ft/min, maneuver accelerations of up to 0.7 g and rapid control surface movements recorded during automatic and manual flight in severe atmospheric disturbances. The possibilities of reducing structural loads by improved aircraft system design, maintenance and operational practices, are considered, and an example of variation in the performance of nominally identical aircraft is given. M.M.

A71-29772 * # **Control considerations in severe turbulence.** A. Gerald Rainey, William D. Grantham, and William P. Gilbert (NASA, Langley Research Center, Hampton, Va.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 16 p. 20 refs.

The intensive studies which seem to have solved the 'jet upset crisis' of the early 1960s are briefly reviewed. Some recent information adding to the primarily longitudinal results obtained previously, concerning the possible influence of lateral-directional characteristics, particularly an unstable spiral mode, is described. The need for a rational, quantitative method of estimating optimum turbulence penetration conditions and the results of initial attempts to provide such information is presented. The basic transonic aerodynamic characteristics of advanced transport aircraft have been reviewed and, although no immediate controllability problems are obvious, it is suggested that the characteristics of such transports in severe turbulence will need to be examined carefully prior to fleet operations. (Author)

A71-29773 # **Development of an approach and landing system with special reference to the effects of turbulence.** R. M. P. McManus (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 9 p.

Some investigation results are discussed about an automatic aircraft landing system's inadequate responses to air turbulence effects the system was supposed to neutralize. It was found that the largest disturbing input to the aircraft was turbulence. With hind sight it was determined that by modification of the original system it was possible to improve the response to turbulence. Buildings near airfields affecting the airflow in threshold areas probably cause the most significant gusts. M.V.E.

A71-29774 * # **Analysis of subjective ratings for the XB-70 airplane response to atmospheric turbulence and controlled inputs.** Ronald J. Wilson and L. J. Ehernberger (NASA, Flight Research Center, Edwards, Calif.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 11 p. 14 refs.

Description of the XB-70 crew's subjective evaluation of the aircraft's response in comparison with measured accelerations. The turbulence response of the crew station and other fuselage locations is evaluated, and the crew's reaction to controlled sinusoidal excitations of the airframe during flight is examined. Results show that the pilot subjective ratings of turbulence intensity in comparison to the accelerations measured at the pilot's station and the center of gravity caused some overlap of acceleration range. For a given acceleration range, 0.15 to 0.25g, the turbulence could have been rated from light to severe. The pilot ratings were also more severe for a given acceleration range than had been recommended by previous reporting criteria. M.M.

A71-29775 # **Gust effects on V/STOL aircraft.** Grant B. Skelton (Honeywell, Inc., Minneapolis, Minn.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 15 p.

Description of a mathematical gust model suitable for analyses of flight in the lowest 100 meters of the atmosphere. The model is useful for takeoffs and landings of all aircraft and for significant portions of typical V/STOL flight profiles. The model consists of eight gusts generated by eight white noise sources, eight filters, and three delay lines. It is based upon good mean wind profile data, spotty gust spectral data, and very sparse probability data. The model was grossly simplified in order to be convenient for aircraft gust response analyses without having to pay a severe approximation price. Hybrid simulation flights of the Ryan XV-5 V/STOL in turbulence showed that the wing-to-tail transport delay and the spanwise shear of head-on and vertical gusts were important and had to be retained in the gust model. The simulation tests also showed that the XV-5 flew nonlinearly at low airspeeds. M.M.

A71-29776 • # **Control of V/STOL aircraft in turbulence.** Robert L. Swaim (Purdue University, West Lafayette, Ind.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p. 18 refs. Grant No. NGR-15-005-069.

Description of the nature of flight path control (guidance and maneuvering) problem and the attitude control (stability augmentation) problem for V/STOL aircraft. An analytical approach and

design methodology, based on the state variable methods of modern control theory, and which structures the stability augmentation system required for satisfactory handling qualities, while simultaneously yielding minimum required values of stabilization control power, is described. The process uses power spectral density descriptions of the homogeneous turbulence environment. Additional stabilization control power is frequently required to counter the effects of heterogeneous or discrete turbulence typified by wind shears and vortex patterns generated by osbtacles such as trees, hills, and buildings. Such turbulence is nonstatistical in nature and generates nonlinear input disturbances to an aircraft which are best analyzed by a momentum transfer approach. M.M.

A71-29777 # **Some effects of designing for increased safety in turbulence.** M. W. Salisbury (British Aircraft Corp., Ltd., London, England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p.

The development of cruise altitude limitations to provide adequate buffet margins in turbulence is reviewed, and the problems facing the aircraft designer in establishing and improving the allowable operating altitudes are discussed. The effect of lags in flow separations due to the rapid change of incidence in a gust is illustrated by a read-out from a gust encounter. Finally it is shown that an autopilot mode designed for use in turbulence can reduce the pitch and 'g' excursions as well as improve the structural fatigue life. (Author)

A71-29779 * # **Simulation techniques used in investigating aircraft accidents.** Richard S. Bray and Seth B. Anderson (NASA, Ames Research Center, Moffett Field, Calif.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 10 p.

The use of simulation techniques is discussed, first for the general case of a typical turbulence 'upset' to show how simulation techniques can be used to uncover possible reasons for the upset. Next, the techniques are applied to two specific accidents to show the degree of simulator sophistication needed to match the accident conditions properly. Finally, several important factors are discussed that should be considered in using simulation techniques for accident investigations. O.H.

A71-29782 # **Commercial aircraft flying in turbulence - Some considerations.** Scott Flower (Pan American World Airways, Inc., New York, N.Y.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 9 p.

Factors that affect the pilot's ability to fly in turbulence - i.e., aircraft characteristics, instrumentation, procedures, pilot training, and kinesthetic cues - are discussed. They are confronted with the capabilities of the B747 aircraft and the efficiency of other tools provided by the airline industry to their pilots for successful flight in turbulence. O.H.

A71-29784 # **Gust loads for structural design.** J. Taylor (Royal Aircraft Establishment, Farnborough, Hants., England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 16 p. 9 refs.

An examination is made of the gust loads encountered by aircraft on research flights taking a large number of time intervals of about 1 minute. A simple means of describing the intensity of the turbulence and the number of gusts per kilometer is devised. The procedure is used to examine records from a few tens of thousand flying hours and to define the loads to be expected on different aircraft. The method allows an examination to be made of selected short traverses of turbulence either in research or operational flying and to appraise their intensity relative to average conditions. A combination of the data from research and operational flying can be made to give information that can be used to define design requirements. (Author)

A71-29785 # **Some results on gust alleviation.** Gabriel Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 12 p. 6 refs.

A method is described which provides gust alleviation without any change to the flight mechanics of the aircraft. In this method, the aircraft movement is corrected, assuming that the turbulent field is known. Turbulence is measured, in real time, aboard the aircraft with the aid of data supplied by vanes, gyrometers, and accelerometers. Orders to the controls are determined as a linear functional law of turbulence. The functional law is determined using Wiener's mathematical approach, in the case of a turbulent field characterized by a rational power spectrum. For actual power spectra which are no longer rational, an expansion in Laguerre functions is added to Wiener's solution. The validity of the theory was checked on an analog computer which was excited by actual records of in-flight measured turbulence. Some flight tests that have been performed are discussed. O.H.

A71-29786 # **Design for lateral gusts.** H. P. Y. Hitch (British Aircraft Corp., Ltd., Weybridge, Surrey, England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 8 p.

The dynamic response of aircraft with a T-tail configuration to lateral gusts is examined. It is shown that the conventional antisymmetric analysis is inappropriate and an analysis involving both antisymmetric and symmetric motion is needed. Values obtained by the current isolated gust procedure and those obtained by the proposed design envelope procedure are presented and compared. O.H.

A71-29787 # **The effects of atmospheric turbulence on handling qualities and structural loads.** William H. Austin, Jr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 11 p. 5 refs.

Traditionally, handling qualities and structural loads have been regarded as independent aeronautical engineering disciplines when, in fact, they are very closely interrelated, particularly when atmospher-

ic turbulence is considered. It is shown that lack of consideration of the two disciplines together can lead to unfortunate results. Use of a high authority stability augmentation system can yield results that will improve handling qualities and reduce structural loads, though similar results could be attained by careful attention to inherent stability, particularly Dutch roll damping. Recognition of the basic interaction of handling qualities and structural loads by engineering management is of utmost importance, and constant vigilance is required to insure that adequate consideration is given to the interactions during design of an aircraft. (Author)

A71-29788 # **The analysis of normal accelerations experienced by fleets of transport aircraft.** N. I. Bullen (Royal Aircraft Establishment, Farnborough, Hants., England). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 11 p. 6 refs.

An analysis of fatigue load meter records from a fleet of transport aircraft is made to examine the variation in the occurrence of loads and to determine whether differences between aircraft are significant. It is shown how the knowledge so gained can be applied to determine appropriate factors to allow for times when the fatigue load meter is inoperative. Seasonal variations of counting rates are discussed. (Author)

A71-29789 # **An analysis of gust velocities for application to aircraft design.** F. K. Atnip and J. Gault (Boeing Co., Seattle, Wash.). In: Royal Aeronautical Society, International Conference on Atmospheric Turbulence, London, England, May 18-21, 1971, Proceedings. Conference co-sponsored by the American Institute of Aeronautics and Astronautics and the Canadian Aeronautics and Space Institute. London, Royal Aeronautical Society, 1971. 11 p. 14 refs.

Factors necessary to establish appropriate gust criteria for the design and for monitoring the fatigue life of aircraft are examined. They include: frequency distributions of gust velocities in patches of turbulence; frequency distributions of the rms values of gust velocities for the patches; and the form of gust velocity power spectral densities and frequency distributions of associated integral scale lengths. Effects of aircraft speed on turbulence statistics are also examined. O.H.

A71-29811 **Trends in the development of aeronautical turbojet engines (Tendenze nello sviluppo dei turbogetti aeronautici).** Salvatore Caggiani. *Rivista Aeronautica,* vol. 47, Apr. 1971, p. 643-664. 11 refs. In Italian.

Survey of the current state of development of subsonic and supersonic turbojet engines. The engines considered are built by Pratt and Whitney, GE, and Rolls-Royce. Engines manufactured by smaller companies are also reviewed. The particular aspects considered are general engine architecture, dependable operation and reliability, specific weight and specific consumption. It is pointed out that all the innovations and refinements made to turbojet engines, besides requiring lengthy tests, necessitate expensive investments and a selection of materials which are ever more difficult to produce and purchase. M.M.

A71-29819 **A comparison of the performance of three model axial flow turbines tested under both steady and pulse flow conditions.** H. Daneshyar, J. H. Horlock (Cambridge University, Cambridge, England), K. J. Edwards (D. Napier and Son, Ltd., Liverpool, England), M. S. Janota (Queen Mary College, London, England), R. D. Pearson (Bath University of Technology, Bath, England), and R. Shaw (Liverpool, University, Liverpool, England). *Institution of Mechanical Engineers, Proceedings,* vol. 184, pt. 1, no. 61, 1969-1970, p. 1119-1131; Communications, p. 1132; Author's Reply, p. 1133. 10 refs.

Specifications are given and test performance analysis is made to determine the suitability of these turbine designs for turbocharger application. Test results are given in a form allowing the turbine efficiencies to be plotted vs mean dimensionless blade speed irrespective of the pulsation level. The test data displays can be directly used for design purposes and in matching calculations, permitting the assessment of the efficiency penalty due to pulse flow, of the effect of pulse flow on turbine size selection, and of the preferred degree of reaction under pulse flow. Further tests under modified pulse conditions with a significant windage period are suggested. V.Z.

A71-29826 **Testing of lubricants for the Olympus 593.** T. F. Blenkiron (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). *(Symposium on Lubricant Test Devices and Their Relation to Service Conditions, Paisley College of Technology, Paisley, Scotland, Sept. 7-11, 1970.) Wear,* vol. 17, May-June 1971, p. 367-379. Research supported by the Ministry of Technology.

Discussion of new types of lubricant and new methods of evaluating lubricants for the Olympus 593 supersonic engine. The main requirements for a lubricant for the Concorde engines are defined in terms of bulk thermal stability, resistance to breakdown in a hot bearing, oil mist coking, and gear load carrying. The rigs used to evaluate these various properties are described, and some of the reasons for the choice of these particular rigs are given. Problems which may arise on mainshaft bearings are split into two groups, fatigue at high load, and wear due to skidding at low load. The test rigs and methods used to explore these phenomena are described. It is noted that fatigue is relatively well understood but skidding at low loads is a much more complex matter. Minor lubricant problems have arisen on early standards of engine but these have now been overcome and performance of the oils is satisfactory. It is concluded that oil evaluation methods are successfully screening out unsatisfactory oils. M.M.

A71-29833 # **Measurements of static strains on titanium under rapid heating.** T. E. H. Lemon (British Aircraft Corp., Ltd., Guided Weapons Div., Bristol, England). *Strain,* vol. 7, Apr. 1971, p. 66-73. 7 refs. Research sponsored by the Ministry of Technology.

Resistance changes with temperature were measured for various types of strain gauges on a titanium specimen subjected to different conductive heating rates. The tests were conducted for the purpose of developing a practical strain measuring system for a triangular titanium wing heated to 520 deg C at a maximum rate of 40 deg C per sec. The results show that the Microdot SG 420 strain gauge was the only sensor suitable for this application. Gauge preparation and connection procedures are outlined. T.M.

A71-29860 **Thrust measurement of great accuracy of aircraft propulsion systems giving particular attention to a hydraulic force measurement device. II (Schubmessung grosser Genauigkeit an Flugtriebwerken unter besonderer Berücksichtigung einer hydraulischen Kraftmesseinrichtung. II).** Joachim Fruböse. *Archiv für technisches Messen und industrielle Messtechnik,* May 1971, p. 85-88. 7 refs. In German.

Relations between the displacement of the piston of the device on one side and the oil pressure and the pressure to be measured on the other side are investigated. Factors connected with diametrical clearance and roundness of the edges have an effect on these relations. The quantity of oil flowing through the device is determined, and questions of calibration and measurement accuracy are discussed. A sensitivity of 0.04 per cent was obtained. G.R.

A71-29868 * # **An evaluation of theories for predicting turbulent skin friction and heat transfer on flat plates at supersonic and hypersonic Mach numbers.** Edward J. Hopkins and Mamoru Inouye (NASA, Ames Research Center, Moffett Field, Calif.). *AIAA Journal,* vol. 9, June 1971, p. 993-1003. 65 refs.

An evaluation of existing theories is presented, which is restricted to flat plates, cones, and wind-tunnel walls on which the flow is essentially isothermal and isobaric. It is suggested that the Van Driest II theory (1956) be used to predict the turbulent skin friction for the design of supersonic and hypersonic vehicles until additional direct measurements of skin friction are made. This theory with an assumed Reynolds analogy factor of 1.0 should also be used to predict the heat transfer to surfaces exposed to hypersonic Mach numbers. For heat transfer predictions to near adiabatic surfaces exposed to supersonic and lower Mach numbers, the use of a Reynolds analogy factor of 1.2 is recommended. For the incompressible case, also required for compressible transformation theories such as that of Van Driest, additional direct measurements of skin friction are needed at extremely high and low Reynolds numbers before the Kármán-Schoenherr formula can be accepted without reservation. O.H.

A71-29887 * # **Effect of angle of attack on boundary-layer transition at Mach 21.** Michael C. Fischer and David H. Rudy (NASA, Langley Research Center, Hypersonic Vehicles Div., Hampton, Va.). *AIAA Journal,* vol. 9, June 1971, p. 1203-1205. 8 refs.

Boundary-layer transition at angles of attack in the range from 0 to 3 deg was studied on a slender cone in a nominal Mach-20 flow promoted on the leeward ray and essentially fixed on the windward ray. The obtained angle-of-attack transition results directly conflict with previously reported results with a cone of identical geometry tested in the same facility. The results obtained are believed to illustrate the correct trends as the results from the previous measurements were probably adversely influenced by the questionable method of detecting transition. M.V.E.

A71-29889 # **Pressures on boat-tailed afterbodies in transonic flow with a low-thrust jet.** D. M. Sykes (City University, London, England). *AIAA Journal,* vol. 9, June 1971, p. 1206-1208.

Extension of Sykes' (1970) previous base drag study of axisymmetric afterbodies to pressure distributions on a family of afterbodies at stream Mach numbers from 0.8 to 1.2 and to the effect of a low-thrust jet on these pressures. The base pressure coefficient change with jet flow and the afterbody drag coefficient variation for various afterbody geometries with jet flow are illustrated in diagrams and briefly discussed. M.V.E.

A71-29890 # **Effect of yaw of repose on ballistic match of similar projectiles.** H. R. Vaughn and G. G. Wilson (Sandia Laboratories, Albuquerque, N. Mex.). *AIAA Journal,* vol. 9, June 1971, p. 1208-1210. 6 refs. AEC-supported research.

Using a given aeroballistic axis system, the yaw of repose part of the motion of a shell is considered. In the light of yaw of repose theory, it is shown that the ratio of roll moment of inertia to the static margin predominates in controlling the yaw of repose angle magnitude in the usual projectile problem. Aside from the drag-to-weight ratio, which dominates any projectile ballistic match problem, the yaw of repose is shown to be the single most important projectile parameter. M.V.E.

A71-29910 # **Aerodynamic research on high lift systems.** F Mavriplis (Canadair, Ltd., Montreal, Canada). *Canadian Aeronautics and Space Journal,* vol. 17, May 1971, p. 175-183. 8 refs.

This paper describes two-dimensional flow research conducted at Canadair to develop high lift system technology for advanced STOL aircraft. First a theoretical method was developed which uses a vorticity distribution on the airfoil contour and can calculate the potential flow pressure distribution on multielement airfoils with deflected leading edge devices and slotted trailing edge flaps. Second, a wall blowing technique was developed which is essential for obtaining reliable two-dimensional wind tunnel data for airfoils in the high lift condition, and for testing effectively complex high lift models. Comparisons of calculated and experimental data obtained on some of the complex configurations tested at NAE using the wall blowing technique demonstrate the usefulness of the methods used and the approach to the design of future high lift systems. (Author)

A71-29911 # **The Yak-40 aircraft flight test procedures.** K. B. Bekirbaev, A. D. Miranov, and I. I. Sneshko (Iakolev Design Bureau, Moscow, USSR). *(Canadian Aeronautics and Space Institute, Flight Test Symposium, Montreal, Canada, Feb. 9, 1971.) Canadian Aeronautics and Space Journal,* vol. 17, May 1971, p. 185-188.

The flight testing of the Yak-40 jet passenger aircraft for compliance with the Civil Airworthiness Requirements of the USSR was performed in the three stages of manufacturer's, government, and service tests. A series of special ground tests and investigations, such as wind tunnel tests, static structural and vibration tests, preceded the manufacturer's flight tests. The manufacturer's tests were carried out simultaneously on four experimental aircraft, together with government flight testing. Service tests were carried out on six production aircraft. The service tests, including some flights under special route conditions, amounted to 2,482 flights. The Yak-40 is undergoing certification tests by the Italian authorities to prove compliance with the technical standards of the U.S. Federal Aviation Regulations. Demonstration flights of the Yak-40 have been made in 36 countries in Europe, Asia and America. M.M.

A71-29925 * # **A review of the mass-flux probe.** Lloyd N. Krause and George E. Glawe (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Physics, American Society of Mechanical Engineers, Instrument Society of America, and National Bureau of Standards, Symposium on Flow - Its Measurements and Control in Science and Industry, Pittsburgh, Pa., May 9-14, 1971, Paper.* 28 p. 22 refs.

The mass-flux probe is used to measure the mass flow rate per unit cross-sectional area of supersonic streams. The probe consists of an aspirating tube with a supersonic inlet which 'swallows' the shock and ingests the stream flow tube. The mass flow rate per unit area of the stream is determined by measuring the flow rate of ingested gas through the probe at a convenient downstream station, and then dividing by the probe's inlet area. The instrument has been applied to studies of supersonic boundary layers, and of high-enthalpy, high-temperature gas flows, such as may occur in hypersonic flight. This review presents a description of the instrument, a historical review of work reported in the literature, and a discussion of the factors influencing performance. These factors include probe inlet geometry, angle of attack, and Reynolds and Mach number effects. (Author)

A71-29930 * # **Airbreathing nuclear propulsion - A new look.** Frank E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *U.S. Air Force Office of Scientific Research, Symposium on Advanced Propulsion Concepts, 6th, Niagara Falls, N.Y., May 4-6, 1971, Paper.* 23 p. 19 refs.

Aircraft with gross weights of at least one million pounds are necessary to make nuclear aircraft practical. However, the example of the Lockheed C-5 and the Boeing 747, which weigh almost one million pounds, has shown the practicality and profitability of very large subsonic aircraft. The major obstacle to the use of an aircraft nuclear powerplant is the problem of public safety in major aircraft accidents. An experimental investigation of techniques for prevention of reactor containment vessel rupture during impact has shown very encouraging first results. The safety problems of reactors for air cushion vehicles are small compared to aircraft because of the lower speeds of travel and because they would travel on the surface of the

earth and mainly over water. Nuclear powered air cushion vehicles are, therefore, potentially much closer to practical application. A good economic performance potential for nuclear air cushion vehicles is predicted. G.R.

A71-29938 Aspects of air law and civil air policy in the seventies. H. A. Wassenbergh (KLM - Royal Dutch Airlines, Shiphol Airport, Netherlands). The Hague, Martinus Nijhoff, 1970. 176 p. 295 refs. $7.55.

General characteristics of the international civil aviation policy and regulation, and the concepts of national versus international approach to civil aviation are first briefly outlined. Problems involved in the national control of the air traffic market, freedom traffic classification, exchange of routes and traffic rights, route specifications, and equal opportunity for carriers to compete are examined. The role of nonscheduled services in relation to scheduled services is investigated, inclusive tour traffic and noninclusive tour charter traffic are compared, and traffic rights for charter carriers are considered. The growing need of cooperative arrangements between air carriers is emphasized, and features of various agreements are dealt with. A short analysis is also presented of the 1970 U.S. international civil aviation policy. O.H.

A71-29944 # Helicopter designs (Konstruktsiia vetroletov). V. N. Dalin. Moscow, Izdatel'stvo Mashinostroenie, 1971. 275 p. 11 refs. In Russian.

This book contains a comprehensive coverage of modern helicopter technology including aerodynamic properties of these aircraft, their power plants and engines, rotor, wing and rudder designs, transmission and control systems, and manufacturing. Particular attention is given to component weight, fatigue and cost minimization and to strength analysis of the components working under variable loads. The book is written to assist students attending courses in helicopter design offered at schools for technicians in this field. V.Z.

A71-30014 Map presentations for future ATC displays. G. R. Beaumont (Computing Devices of Canada, Ltd., Ottawa, Canada). *CATCA Journal,* vol. 3, Spring 1971, p. 16-19.

The major points to be considered in the selection of a mapping technique for use in future air traffic control (ATC) radar display systems are outlined. Two techniques for presenting map information on radar displays - i.e., the Vector Drawn Map (VDM) and the Optically Projected Map (OPM) method - and the possibilities of their updating are considered. It is shown that for either method, a similar amount of effort will be required to achieve an update. In the VDM system, the update is essentially a computer program change which will generate a new map data list for storage in computer memory. For the OPM system, the map update will be a cartographic change followed by a film generation cycle. The OPM system is shown to offer significant advantages over the VDM system from the human factors viewpoint. The availability of bright colors, coupled with the correct choice of color selection for various classes of data, can greatly enhance operator interpretation of a radar-map composite image. O.H.

A71-30053 Dynamic testing; Society of Environmental Engineers, Symposium, Imperial College of Science and Technology, London, England, January 5, 6, 1971, Proceedings. Volumes 1 & 2. London, Society of Environmental Engineers, 1971. Vol. 1, 125 p.; vol. 2, 140 p. Price of two volumes, $19.20.

Various theoretical, technological and practical aspects, including impedance testing, flight instrumentation for Concorde, and vibration data analysis.

V.Z.

A71-30055 # The flight test instrumentation installation for the Concorde SST. B. Roantree (British Aircraft Corp., Ltd., Fairford, England). In: Dynamic testing; Society of Environmental Engineers, Symposium, Imperial College of Science and Technology, London, England, January 5, 6, 1971, Proceedings. Volume 1. London, Society of Environmental Engineers, 1971, p. B1-B18.

Description of Concorde SST flight test equipment for measuring a total of 3000 parameters tape-recorded continuously during a complete flight with the aid of the Pulse Code Modulation recording system backed up by FM tape decks, photographic paper records, direct display pen recorders, and 450 visual instruments. The measured values include pressures, temperatures, stresses, angular and linear positions, and accelerations. The test equipment also includes analog recording systems, an accident recording system, and a digital replay system. Details on the Pulse Code Modulation System are given. V.Z.

A71-30068 * The response of a simply supported plate to 'N' waves at oblique incidence. A. Craggs (Alberta, University, Edmonton, Alberta, Canada). *Journal of Sound and Vibration,* vol. 16, May 22, 1971, p. 293-307. 5 refs. Grant No. NGR-52-025-003.

A numerical method is used to compute the response of a simply supported plate to an 'N' wave arriving at oblique incidence. The factors influencing the response under these conditions are (1) the ratio of the pulse duration to the fundamental period of the plate and (2) the convection forcing terms which are different for each mode. Also, asymmetric modes are excited, which do not make any contribution when the wave is at normal incidence to the plate. The computed results show that both the convection terms and the asymmetrical modes make a significant contribution to the form of the response for the displacements, velocities and accelerations, though their effects are more dominant in the accelerations than for any other parameter. (Author)

A71-30070 # Pressure-altitude assembly for high-altitude balloons. Oscar L. Cooper (National Center for Atmospheric Research, Boulder, Colo.). *Facilities for Atmospheric Research,* Dec. 1970, p. 16-21.

A full-range pressure-altitude transducer assembly is described that has been developed for use in high-altitude balloon flights. The transducer is of the capacitive type, using a thin taut-diaphragm sensing element positioned between two stationary capacitor plates. The space between the diaphragm and one of the stationary plates is evacuated and sealed. The space on the other side of the diaphragm is exposed to ambient pressure. The capacitances change as the absolute ambient pressure changes. A diode rectifier circuit detects the capacitor current and develops a dc voltage across a resistor. This voltage is linear with pressure. The three transducers in the assembly cover the full ambient range expected in balloon flights. M.V.E.

A71-30158 Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 246 p.

Among the subjects treated are areas of growth in air transport, long haul air transport, V/STOL prospects for civil aviation, prospects for the development of air traffic in competition with other modes, and aviation within the total transport system.

F.R.L.

A71-30159 # The total transport demand. Gabriel Bouladon. In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 11 p.

Examination of the possibility that transport and travel demand will become a future economic constant, such as housing, clothing,

and food. It appears that in the USA transport consumption in miles per capita doubles every 24 years. The rate of travel expansion is even greater in Europe and Japan. The basic motivations for travel are psychological, sociological, and economic. A progressive price increase in air transport of around 15% over the next 12 years may be expected, due to the fight against pollution and other problems. F.R.L.

A71-30160 # **Areas of growth in air transport.** M. E. L. Spanyol (Hawker Siddeley Aviation, Ltd., Kingston-on-Thames, Surrey, England). In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 19 p.

Examination of the circumstances leading to growth in the different sectors of air transport. The mechanisms which generate traffic are outlined. Since scheduled air transport services are geared primarily to the requirements of the major urban communities, and urban populations travel more frequently than rural populations, it is considered more realistic to relate air traffic to urban populations than total populations. The cost and value of air transport, the capital requirement of aviation, business and leisure air travel, corporate aviation, and future developments are discussed. F.R.L.

A71-30161 # **Future prospects for air transport - Long haul air transport.** C. H. Jackson. In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 14 p.

Consideration of long haul air transport, which is essential to international affairs and commerce. Annual growth rates ranging according to area from 11 to 14% during the next 15 years, and from 7 to 10% thereafter are anticipated. The distribution of growth shows increases of average journey length, with eventually only about one third of the total traffic being over journeys of 3000 to 5000 mi. In general, the development prospect seems to be of continuing and painstaking effort to enable long haul operators to do what they are now doing in air transport, but on a bigger scale, more efficiently, and more acceptably to the public at large. F.R.L.

A71-30162 # **V-STOL - Prospects for civil aviation.** J. T. Stamper (Hawker Siddeley Aviation, Ltd., Kingston-on-Thames, Surrey, England). In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 43 p.

Reappraisal of what the customer, as exemplified by the operator, the passenger and the community, needs and expects from the aircraft industry. Customer needs are classified under the major headings of convenience, regularity, comfort, safety, community acceptance, low total cost, and flexibility. A number of the more promising types of STOL and V/STOL aircraft are briefly described, and various configurations are presented. F.R.L.

A71-30163 # **A B.A.C. view of V./S.T.O.L.** John H. Quick (British Aircraft Corp., Ltd., Weybridge, Surrey, England). In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 58 p.

Results of an extensive comparative study of VTOL and STOL aircraft. It is concluded that the STOL loses out on site area, but not by a sufficient margin to be decisive. The STOL is much less costly, and is at least equal to and possibly better than the VTOL on the basis of noise production. It should also produce less toxic gas, and is capable of being developed more quickly than the VTOL. F.R.L.

A71-30164 # **Prospects for the development of air traffic in competition with other modes.** J. R. Collingbourne. In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 19 p.

Review of evidence concerning the division of travellers among various modes of travel, followed by examination of the way scheduled passenger air transport has progressed in competition with other modes in the U.S. Attention is drawn to certain features considered to be of general application and indicative of future trends. Some estimates of the sensitivity of the demand for a VTOL service are presented. It is considered that the long term prospects for the growth of air travel are intrinsically good because an effect of increasing affluence is that people tend to take more and longer trips. F.R.L.

A71-30165 # **Aviation within the total transport system.** Keith Legg (Loughborough University of Technology, Loughborough, Leics., England). In: Aviation's place in transport; Royal Aeronautical Society, Two Day Convention, London, England, May 12, 13, 1971, Proceedings. London, Royal Aeronautical Society, 1971. 22 p. 13 refs.

Consideration of the broad transport issues that follow from detailed study of transport demand, communications and future air transport prospects, because it is here that the greatest difficulty seems to be encountered in making good decisions. It is suggested that transport policy, organization and decision must be coordinated and originate from the highest level within a framework of systematic overall studies which define the constraints and resource limitations within which the total transport system must operate. It is emphasized that the purpose of transport is to satisfy social demand and it must do this with the minimum of inconvenience to the nonuser. F.R.L.

A71-30200 **Sonic-boom analog for investigating indoor acoustical waves.** Sui Lin (Toronto, University, Toronto, Canada). *Acoustical Society of America, Journal,* vol. 49, May 1971, pt. 1, p. 1386-1392. 7 refs. Research supported by the National Research Council of Canada.

Acoustical waves induced by sonic booms in a room with an open window are investigated by using an electrical analog. The good agreement between the results from the electrical analog and those of Vaidya shows that the electrical analog is a suitable device for investigating the room response to sonic booms. (Author)

A71-30218 # **Universal equations of the laminar boundary layer on a rotating wing (Universal'nye uravneniia laminarnogo pogranichnogo sloia na vrashchaiushchemsia kryle).** V. V. Bogdanova. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Mar.-Apr. 1971, p. 84-93. 8 refs. In Russian.

The motion of an incompressible fluid in the boundary layer on a blade rotating uniformly about an axis perpendicular to the wing span is analyzed. A solution is obtained by a parametric method involving the introduction of the series in parameters that are functions of the boundary layer. A corresponding system of universal equations is derived and is integrated over a wide range of parameters. The influence of rotation on boundary layer separation and other boundary layer characteristics is determined. V.P.

A71-30227 # **Motion of a viscous gas in sectorial gas bearings (Dvizhenie viazkogo gaza v sektornykh gazovykh podshipnikakh).** B. S. Grigor'ev. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Mar.-Apr. 1971, p. 167-171. 5 refs. In Russian.

Investigation of the influence of clearance changes with time on the aerodynamic characteristics of a gas journal bearing where one of the surfaces is divided by axial grooves into a number of sectors. The groove widths are large in comparison with the clearance, and the

surface between each groove has a characteristic profile. If the rotating surface is the one that is grooved and profiled, the clearance is time dependent, and the problem is nonstationary. When the fixed surface is grooved and profiled, the clearance is independent of time, and the corresponding problem is stationary. A method is described for calculating the aerodynamic lift and drag coefficients of such bearings. The problem is studied in a two-dimensional approximation, and a sinusoidal surface profile is assumed T.M.

A71-30239 # **DC-10 airplane characteristics for airport planning.** Long Beach, Calif., Douglas Aircraft Co., 1971. 180 p.

DC-10 airplane specifications required by airport operators, airlines, and engineering consultant organizations for general airport planning information. Tables, graphs, and drawings illustrate general dimensions, ground clearances, interior arrangements, access clearances, payload-range characteristics, takeoff and landing distances, ground maneuvering space requirements, and parking requirements. Terminal servicing requirements, ground servicing connections, towing specifications, and ground pneumatic power needs are described, along with jet engine exhaust velocities, temperatures, and noise characteristics in terminal operating conditions. Pavement data include footprint diagrams, maximum pavement loads, landing gear loading characteristics on pavement, and flexible and rigid pavement requirements according to different design procedures. T.M.

A71-30264 # **Approximate method of calculating the aerodynamic characteristics of a wing in the presence of a cylindrical body (Priblizhennyi metod rascheta aerodinamicheskikh kharakteristik kryla v prisutstvii tsilindricheskogo tela).** V. A. Graivoronskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 23, 1970, p. 3-8. In Russian.

The attached steady flow of an ideal incompressible fluid past a low-aspect-ratio wing mounted on a cylindrical body is analyzed in a linear formulation of the problem. The wing is assumed to be slender and slightly warped, and its surface to be located close to the meridional plane. The wing is simulated by a system of horseshoe vortices, the free vortices trailing off at a certain angle to the plane of the wing chord. The cylindrical body is simulated by plane dipole with a vortex system obtained by mapping the wing vortices onto the cylinder. The direction of the free vortices is determined from the local velocities at points behind the wing, while the intensity of the vortices is determined from the boundary conditions at certain points behind the wing. V.P.

A71-30267 # **Differential method of manufacturing complex precision fuselage parts (Differentsial'nyi metod proizvodstva slozhnykh pretsizionnykh korpusnykh detalei).** V. Ia. Nevriuev and O. G. Korol'. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 23, 1970, p. 34-37. In Russian.

A method, based on the principles of group technology, is proposed which makes it possible, by way of differentiation, to increase the dimensions of complex structural parts even during the test-and-trial production phase. The method is based on subdividing classes of parts into elements, and selecting such groups of elements for which development and group production poses no problems. V.P.

A71-30300 # **Concorde power plant fire protection system.** R. A. Davis (Graviner /Colnbrook/, Ltd., Slough, Bucks., England). *Aircraft Engineering,* vol: 43, May 1971, p. 26-30.

The prototype Concorde is fitted with a Graviner high temperature Firewire Triple F.D. continuous element system for fire detection, and a similar medium-temperature system for engine bay overheat detection. On preproduction and production aircraft to comply with airworthiness requirements, these detection systems have been augmented by a new Graviner optical system that uses the UV radiation emitted by a fire to detect engine combustion chamber flame burn through. An automatic extinguisher is used, and a fuel tank vent pipe ignition protection system is provided. Operation of the system is only achieved if light in the wave band of 0.3 to 1.1 microns passes in front of the detector's silicon cell. G.R.

A71-30301 # **The Westland WG.13 Lynx.** *Aircraft Engineering,* vol. 43, May 1971, p. 32-36.

The WG.13 is a high performance helicopter, the general purpose version of which operates at a maximum all up weight of 8000 lb. It is powered by two Rolls-Royce BS.360.07.26 free turbines, which are mounted side by side, behind the main rotor and on top of the fuselage upper decking. Conformal gears are employed in the highly loaded output stage of the main gearbox and transmit the engine power to a four-bladed semirigid main rotor and a four-bladed tail rotor. The main rotor blades are constructed of stainless steel, aluminum honeycomb, and glass reinforced plastic. G.R.

A71-30302 The major development trends in air transport and European co-operation. H. Ziegler (Société Nationale Industrielle Aérospatiale, Paris, France). *Aeronautical Journal,* vol. 75, May 1971, p. 309-319.

Characteristics and aspects of air transport in the coming years are examined. Air transport will be used more and more both for passengers and freight, and the major trends are increased speed and capacity, development of STOL aircraft, and a third level transport serving small urban communities. The necessity of uniting the efforts of manufacturers and of a close European cooperation is emphasized. O.H.

A71-30303 The progress and economics of the aero-engine. M. Garnier (SNECMA, Paris, France). *Aeronautical Journal,* vol. 75, May 1971, p. 320-326.

Some of the outstanding features of technical progress in jet engines over the past 25 years are reviewed, and future prospects are briefly outlined. Possible ways of limiting the steadily increasing cost of engines, which represent about 30% of that of aircraft, are examined. Some examples of progress beneficial to the economics of aircraft industry are presented. O.H.

A71-30305 Some measured and calculated effects of runway unevenness on a supersonic transport aircraft. C. G. B. Mitchell (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Journal,* vol. 75, May 1971, p. 339-343. 9 refs.

Possible problems due to taxiing vibration on uneven runways are discussed. Two available methods of calculation of taxiing vibration are described and their accuracy is tested. The effect of landing gear on taxiing vibration is examined. O.H.

A71-30308 Fluidic cabin pressure control systems for military and civil aircraft. O. D. Furlong (Normalair-Garrett, Ltd., Yeovil, Somerset, England). *Aeronautical Journal,* vol. 75, May 1971, p. 361-374. Research supported by the Ministry of Aviation Supply.

The design, operation, and performance features of two new pneumatic systems developed to control cabin pressure automatically by throttling the outflow of the cabin conditioning air are discussed in detail. Both the systems are characterized by extensively employing - for the first time with this type of equipment - low-cost and robust integrated fluidic circuits. O.H.

A71-30309 Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May

10-12, 1971, Proceedings. Edited by B. Washburn (California, University, Los Alamos, N. Mex.). Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971. 391 p. $17.50.

The papers depict the application of aerospace instrumentation technology to environmental problems, aerospace computer applications, in-flight instrumentation, engine testing, optical instrumentation, wind tunnels, telemetry as related to integrated avionics and technology and applications, surface vehicle instrumentation, data processing and display, and advances in measurement techniques and measurement devices.

F.R.L.

A71-30311 * Airborne data acquisition system for atmospheric and meteorological research. Michael R. Smith (Mississippi State University, State College, Miss.) and Richard A. Johnson (Mississippi State University, NASA Mississippi Test Facility, Bay St. Louis, Miss.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 15-21. Grant No. NGL-25-001-32.

This paper presents the efforts of researchers at Mississippi State University to utilize space-age technology in the development of a self-contained, airborne data acquisition system for use in atmospheric and meteorological studies. The compact, lightweight airborne data acquisition system (ADAS) is capable of recording variables or transmitting eighteen variables in its present configuration and is suitable for use in a single-engine aircraft. Utilizing both an on-board analog recorder and a telemetry system for data acquisition, the prototype system has undergone extensive bench and flight testing at the MSU-MTF Research Center at the NASA Mississippi Test Facility. The prototype system has been utilized in several environmental science investigations associated with atmospheric diffusion processes and weather modification. (Author)

A71-30318 Realtime graphic flight test becomes a reality. L. D. Crowley (Douglas Aircraft Co., Long Beach, Calif.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 61-68.

An integrated Flight Test Data System has been developed which combines a digital airborne acquisition/recording system with a telemetry/microwave link to a computerized ground station featuring the latest cathode ray tube graphic display units. Data are processed in realtime via the telemetry link and postflight via the airborne recorded data tapes. Flight test engineers control data processing via special keyboards permitting them to output finished time plots or tabulations of data. Although many problems were encountered during the design, development, and implementation phases, the data system has been operational since the first flight of the DC-10 aircraft and is presently in use on four aircraft involved in developmental and FAA certification test programs. The performance of this new system has permitted DC-10 test programs to remain on or ahead of schedule and has gained widespread acceptance among flight crew, engineering, and administrative personnel. (Author)

A71-30319 Airborne Integrated Data System. D. D. Crompton (Douglas Aircraft Co., Long Beach, Calif.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971 Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 69-74.

Data obtained on a new Airborne Integrated Data System during flight testing of commercial aircraft are producing meaningful results. This report describes the capabilities of the system and traces the development program from receipt of equipment to its use on the aircraft. The system is modularly constructed in 400-channel units and is capable of handling a variety of inputs in the range of 5 millivolts to 30 volts, with a separate amplifier for each channel. On-board monitoring includes time-of-day, decimal displays, and bar chart displays. The airborne system is complemented by a telemetry-microwave link and a ground-based station having an on-line computer and displaying real-time graphic displays. (Author)

A71-30320 'Safe Weigh' - An accurate and economical on board weighing system. S. B. Moore (Vought Aeronautics Corp., Dallas, Tex.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 75-79.

An 'On Board' weighing system has been designed and prototyped to determine the gross weight and center of gravity location of a light helicopter. The system consists of load sensors, basic electrical circuitry, and visual indicators. The system components are described with particular emphasis on the unique sensor design and the total simplicity of the system. Operational performance of the prototype system is presented. Applications of the system to fixed wing aircraft are cited and benefits of increased efficiency and safety are highlighted. (Author)

A71-30321 High frequency rake probes for inflight intake airflow distortion measurements. Amnon Brosh and John C. Kicks (Kulite Semiconductor Products, Inc., Ridgefield, N.J.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 80-86. 10 refs.

The forthcoming application is discussed of the ultraminiature integrated sensor (IS) of the newly developed 'E' type, with high-temperature capability, to a family of high-frequency rake probes to be used in the intakes of high-performance airplanes. It is shown how solutions to severe problems associated with high temperature flight operations may be obtained from such IS applications. E-type IS calibration qualification testing and ground tests are in progress now. M.V.E.

A71-30322 Altimeter-airspeed and Mach number transducers. Sidney Herman and Stephen A. Hluchan (Bourns, Inc., Riverside, Calif.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 87-95.

An improved pressure transducer is described that is constructed around a unique diaphragm design which accepts nonlinear pressure inputs and provides an electrical potentiometer output linear with the desired variable. It consists of a diaphragm pressure sensor, a beam wiper actuator, and a continuous resolution potentiometric output element. The convolution design of the diaphragm sensor permits responses in an inverse relation to nonlinear inputs with a subsequently normalized element output. Inputs with slope deviations as great as 30:1 have been compensated for by combinations of mechanical and electrical devices and methods. This unique, patent-applied design results in inherent compensation for temperature and vibration effects. (Author)

A71-30323 Atmospheric temperature deviations from the International Standard and its effect on barometric altimeters. Peter

Holman Smith (Boeing Co., Seattle, Wash.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 96-102. 8 refs.

This paper describes airplane altimeter errors caused by atmospheric temperature deviations from the International Standard Atmosphere and suggests a system design to substantially reduce them. In particular, the problem of providing accurate height values for airplanes on approaches and at cruise altitudes in horizontal temperature gradients is discussed. A schematic diagram of a servo-operated altimeter with an integral temperature correction circuit is described. The method of correction is shown to be derived from a comparison between the actual Static Air Temperature (SAT) and the theoretical temperature value associated with the apparent altitude derived from the static pressure value sensed by the air data computer. Other atmospheric variables and the means by which they are accounted for in existing altimetry are briefly described. The basic equation for the tropospheric pressure-height relationship is quoted so as to demonstrate its dependence upon a standard temperature gradient. The appendix shows how curves of altimeter reading errors versus true altitude for temperature deviations were derived. Reference is made to an automatic temperature and pressure data transmission system that could continuously correct airplane altimeters according to values detected at the touch-down point. (Author)

A71-30324 The design and fabrication of transducers for the measurement of fluctuating pressures from DC to over 100 KHz in jet engine testing. Anthony D. Kurtz (Kulite Semiconductor Products, Inc., Ridgefield, N.J.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings.
Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 103-116.

This paper will deal with the design considerations .. volved in making miniature pressure transducers in a wide variety of dimensions and configurations for jet engine testing. Attention will be given to solid state fabrication considerations as the diaphragm diameter is changed from .200 in. to .030 in. In particular, frequency response, power dissipation, voltage capability, strain level, output and compensation for thermal effects will be discussed. (Author)

A71-30325 Fluctuating pressure measurements from DC to over 100 KHz in jet engine testing. John E. Fischer (General Electric Co., Evendale, Ohio). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings.
Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 117-123. 44 refs.

Fluctuating pressure measurements have become a very important and necessary tool in the development of advanced design jet engines at General Electric. Current miniature transducers used with very sophisticated calibration and data acquisition equipment cover an extremely wide range of frequencies and pressure levels. System design, calibration and limitations are discussed and typical applications are shown. In most applications measurement accuracy is now limited by errors introduced by interference effects from probes or rakes required for support and mechanical integrity in contrast to the limits which have been imposed by transducer capabilities in the past. (Author)

A71-30327 GO/NO-GO engine tester. John F. Moran and Harris P. Shay (General Electric Co., Utica, N.Y.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 131-134.

This paper describes a low cost, simply operated system for evaluation of the condition of an aircraft engine. The self-contained portable unit connected to engine mounted sensors automatically computes critical engine characteristics and compares them to absolute limits prestored as a function of corrected speed. Characteristics are also compared with values from previous tests to detect abnormal trends. Current values of characteristics are displayed and then punched on a card for use as reference in subsequent tests. (Author)

A71-30329 Holography and optical data processing in aerospace instrumentation. Otto M. Friedrich, Jr. and Arwin A. Dougal (Texas, University, Austin, Tex.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 141-153. 44 refs. Research supported by the Joint Services Electronics Program and the Texas Atomic Energy Research Foundation.

Recently developed holographic techniques, optical data processing principles, and laser properties beneficial for aerospace instrumentation are reviewed. High intensity, highly collimated or directional, spatial- and temporal-coherent optical beams are readily generated with present laser systems. In optical holography, both the phase and the amplitude of optical waves are recorded as intensity variations that are produced by the interference of two or more optical waves. Optical data processors usually employ the optical diffraction produced by a simple lens. The ability of an optical lens to perform two-dimensional Fourier transforms at the speed of light is an advantage which optical processors have over conventional electronic systems. Experimental and analytical investigations are being performed on several holographic techniques and on the following optical data processing systems: optical analyzers, filters, signal correlators, pattern recognition units, analog computers and simulators. (Author)

A71-30333 * The dynamic characteristics of a five component oscillating balance. Ping Tcheng (Old Dominion University, Norfolk, Va.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 184-190. Contract No. NAS 1-9434.

The dynamic characteristics of a five-component strain-gaged oscillating balance used in wind-tunnel stability testing are presented. An experimental investigation was performed to determine the frequency response of the balance. The results indicated that the balance response is like that of a multidegree-of-freedom vibrational system. It was found that the interactions and the component sensitivities are frequency dependent. Peak interactions were generally found to be one order of magnitude larger than the corresponding static values at the natural frequencies of the system. In view of this finding it becomes apparent that the dynamic nature of the balance should be considered in reducing dynamic stability data. (Author)

A71-30334 Application of a digital computer to the closed-loop control of a wind tunnel model trajectory simulation system. J. A. Wolfe (Vought Aeronautics Corp., Dallas, Tex.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 191-201.

A wind tunnel testing system, which obtains the motion of an aerodynamic body by moving a sting supported model in response to the aerodynamic loads acting upon it is in use at the LTV High Speed Wind Tunnel. The instrumentation, system servo controls, and the closed loop operating feature which includes a digital computer to solve the equations of motion are presented. Testing procedures, operating experience, and system accuracy are discussed. (Author)

A71-30337 Sensing and communications technologies for wayside headway control systems. Gerald P. Esmer (Bendix Corp., Ann Arbor, Mich.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 255-270. 9 refs.

The current status of sensors suitable for determining headway - i.e., the separation in time between two vehicles traveling on a guideway - was surveyed with interest focused on short headways of 10 to 500 ft. Technologies surveyed for applicable hardware included rapid railroad traffic control, industrial control, and military and aerospace instrumentation. Communication techniques and equipment applicable to personal rapid transit systems were also surveyed. Modulation techniques investigated included: amplitude modulation, frequency shift keying, and phase modulation. Tone signaling was also studied. Coding techniques were evaluated for personal transit systems, with a burst noise model assumed. The use of open wire, twisted pair, and coaxial cable for near term personal rapid transit applications was studied and the limits of applicability of each determined. The limits of applicability of baseband data transmission were also reviewed, and modems for modulated data transmissions were surveyed. O.H.

A71-30341 MODAPS - Advanced instrumentation for automated modal vibration testing. Ronald W. Budd (Hughes Aircraft Co., El Segundo, Calif.). In: Instrument Society of America, International Aerospace Instrumentation Symposium, 17th, Las Vegas, Nev., May 10-12, 1971, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 17), 1971, p. 327-338. 7 refs.

The design, capabilities, and utilization of MODAPS, a system designed to provide real-time engineering unit data to be used for timely decisions on mode acceptability and purity, are described. This includes engineering unit data, mode shape data, generalized mass term data, orthogonality check data, and orthographic view plots. The system comprises analog subsystems, digital interfaces, and an on-line miniature computer. It has a frequency response of 0.75 to 800 Hz and a dynamic range of 80 dB. The system provides more modes per day and more accurate data than was previously possible. A typical modal test is described and the advantages of using an automated approach are discussed. O.H.

A71-30382 # Air traffic control and data processing in France. J. Villiers and J. F. Vivier. *Eurocontrol,* vol. 3, no. 2, 1970, p. 16-22. Translation.

Review of the basic ideas behind the installation of automatic data processing equipment for the use of the French ATC services. The use of computers to process the large volume of flight plan data makes it possible to compensate for the limited processing capacity resulting from the badly coordinated intellectual activity of a team of air traffic controllers. For the development of the French system experiments were conducted under conditions to be found in an actual ATC environment. Details of methods and implementation are presented, and variations of the CAUTRA (Automatic Traffic Coordinator) systems are described. F.R.L.

A71-30383 # The MADAP air traffic control system as seen by Eurosystem. *Eurocontrol,* vol. 3, no. 2, 1970, p. 23-29. Translation.

Description of the Maastricht Automatic Data Processing and Display System (MADAP) which employs eight digital computers and is intended to facilitate the task of controlling aircraft in the upper air space of the Benelux countries and West Germany. The system aids the controller in this task of issuing instructions by relieving him of the effort involved in memorizing all factors of the air traffic situation; by presenting him with synthetic data enabling him to make decisions swiftly and efficiently; and by warning him in advance of decisions that must be taken. There is no communication of a digital nature between MADAP and the aircraft being controlled, thus the controller remains the master link in the chain. F.R.L.

A71-30394 A note on the optimum averaging time of wind information for conventional aircraft landings. W. R. Sparks and Barbara Keddie. *Meteorological Magazine,* vol. 100, May 1971, p. 129-134.

Anemometer measurements are averaged over a certain time interval, and the resulting average wind speed for this interval is used to estimate the average wind speed for some future period of 4 to 5 sec just before touchdown when the aircraft is descending from about 30 to 15 m. During this period, the aircraft would travel about 300 m. An attempt is made to evaluate the optimal averaging time for the anemometer measurements from the viewpoint of ensuring maximum accuracy of the extrapolated average wind speed value for the 300-m run. From a detailed analysis of wind measured by a single anemometer 10 m above open level ground and by consideration of Shiotani's (1966) observations with a horizontal array of anemometers, it is concluded that the optimal averaging time for wind measured by a single anemometer should not be less than four minutes. T.M.

A71-30395 Some aspects of wind information required in the landing of aircraft. Barbara Keddie. *Meteorological Magazine,* vol. 100, May 1971, p. 134-143. 5 refs.

Single-anemometer wind measurements were made each second over a period of about one hour for six independent wind regimes. A detailed analysis was made of the maximum difference between a mean wind speed U(t) measured over 4.5 min and the mean wind speed U(300) occurring 10 min later over a period during which the aircraft descends from 30 to 15 m and travels a distance of 300 m. The maximum value of U(300)-U(t) in various samples of sizes from 4 to 20 min was predicted by assuming a normal distribution. Theoretical curves were derived which were in reasonable agreement with curves drawn from the analyzed data. Comparisons were also made between the actual and predicted values of (1) the maximum deviation of U(300)-U(t) from the mean in various samples, and (2) the maximum difference in various samples. Finally, data from different sampling periods or runs of wind were compared so that if the maximum departure of one sample from the mean wind was known the maximum departure for other samples could be estimated. T.M.

A71-30398 # Computer aided design of civil transport plane. Jiro Kondo (Tokyo, University, Tokyo, Japan). *Japan Society for Aeronautical and Space Sciences, Transactions,* vol. 13, no. 23, 1970, p. 37-46. 8 refs.

Discussion of CAD (Computer Aided Design), a program by which it is possible to conduct a fundamental design of an aircraft meeting such specifications as number of passenger seats, maximum range, maximum cruising speed, and takeoff or landing run. It can also take account of future technical advances. Airframe configuration, aerodynamic performance, propulsion systems, weight, cost of construction, operating cost, and other capabilities are automatically obtained. In order to determine the accuracy of CAD, it was applied to civil transport aircraft of known specifications. Except for a rather large discrepancy in field length, agreement of CAD results with the specification of actual aircraft is satisfactory. F.R.L.

A71-30420 **V-12 has civil, military missions.** Donald C. Winston. *Aviation Week and Space Technology,* vol. 94, June 7, 1971, p. 14-19.

Description of the Soviet Mil V-12 heavy lift helicopter (88,000 lb maximum payload), which is powered with four turbine engines rated at 6500 shp each. The side-by-side rotor configuration is considered to offer the greatest stability and reliability. The two rotors are cross-shafted, hence the V-12 can maintain flight on any two engines. The cargo hold, entered by clamshells opening outward and upward, is more than 90 ft long. The civil missions of the V-12 include transport of oil and gas equipment and pipe into isolated areas, and supply of remote settlements north of the Arctic Circle.

F.R.L.

A71-30443 **Vortex theory for a propeller of constant aerodynamic pitch and study of the wake configuration with the aid of the smoke trail method (incompressible fluid) (Note sur la théorie tourbillonnaire de l'hélice à pas aérodynamique constant et sur l'étude de la configuration du sillage à l'aide de la méthode des filets de fumée /fluide incompressible/).** R. Pélissier (Aix-Marseille, Université, Marseille, France). *Journal de Mécanique,* vol. 10, June 1971, p. 191-203. 8 refs. In French.

Approximate analytical expressions are derived for the pitch of vortex streets in the rotational plane of a propeller as a function of the propeller's mode of operation and its geometrical characteristics. Smoke-trail visualization of the pitch of vortex streets in the wake is also described. The results are useful in studies of the pitch distributions of vortex streets along the length of the blade and can be utilized for evaluation of the propeller's aerodynamic efficiency.

T.M.

A71-30454 **The role of kinetics in engine emission of nitric oxide.** L. S. Caretto, L. J. Muzio, R. F. Sawyer, and E. S. Starkman (California, University, Berkeley, Calif.). *Combustion Science and Technology,* vol. 3, no. 2, Apr. 1971, p. 53-61. 27 refs. Research supported by the National Air Pollution Control Administration.

The use of chemical kinetic calculations to predict the formation of nitric oxide in spark ignition engines and gas turbine combustors is reviewed. Although the basic chemical kinetic mechanism is the same in both cases, differences in thermodynamics and fluid mechanics account for different NO emission levels. In spark ignition engines it is necessary to account for temperature gradients in the engine. In gas turbines the NO kinetics are frozen before the NO is formed in equilibrium amounts. (Author)

A71-30473 **French research on metallic matrix composites.** Michel Sindzingre (Paris, Ecole Nationale Supérieure des Mines, Corbeil-Essonnes, Essonne, France). *(Deutsche Gesellschaft für Metallkunde, Tagung Verbundwerkstoffe, Konstanz, West Germany, Oct. 23, 1970.) Zeitschrift für Metallkunde,* vol. 62, May 1971, p. 365-371. 19 refs.

The mechanical properties of composites consisting of an aluminum matrix reinforced by boron fibers are presented. The experimental and control techniques used are described. The different structures obtained by unidirectional eutectic solidification of nickel and cobalt based alloys are shown. The resistance to tensile deformation and creep of these alloys is reported. Finally some investigations of new composite materials which are not reinforced unidirectionally but rather isotropically within a plane are described. (Author)

A71-30517 # **Use of miniaturized microphones in the study of the sound radiation of vibrating modes in rotating machines (Utilisation de microphones miniaturisés à l'étude du rayonnement sonore de modes vibratoires dans les machines tournantes).** B. Baërd, P. Harel, J. Lambourion, and M. Perulli (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 19 p. 7 refs. In French.

Measurements of nonstationary pressures have been made at ONERA inside turbomachines by means of compact capacitive detectors. The characteristics of the pressure fields measured on stationary blades are compared with those of the sound field outside the machine in order to derive a first approximation of the location of the noise sources. The characteristics of the space-time structure of the various vibrating modes in the duct in cylindrical coordinates are studied. The propagation properties of the duct are derived and compared with theory. The measurements have been made partly in an experimental ONERA fan and then on a SNECMA compressor model. M.M.

A71-30518 # **Experimental studies on absorbent materials used in turboreactor ducts (Etudes expérimentales sur les matériaux absorbants utilisés dans les conduits de turboréacteurs).** J.-P. Bernard (SNECMA, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 17 p. In French.

Resonators, as the only type of absorbing structures capable of industrial utilization for the attenuation of sound produced by a turboreactor blower, have been investigated. A test installation in which the wall of an air duct situated between two reverberating chambers was clad with the absorbing structures was used for this purpose. Using this installation, the effects of the flow velocity, the characteristics of the absorbent structure, the transverse dimension of the duct, and the cladding of two opposite surfaces of the duct were examined. Results are presented and compared with those obtained using an experimental compressor, the ducts of which were lined with optimized absorbing structures taking into account the previously obtained parameters. A good agreement was achieved.

O.H.

A71-30519 # **Noise measurements in the large Modane wind tunnel (Mésures de bruit dans la grande soufflerie de Modane).** C. Broll (ONERA, Modane, Savoie, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 10 p. 5 refs. In French.

Study of noise produced during a series of aerodynamic tests on a helicopter rotor. It was found that at frequencies below 2500 Hz the noise level of the rotor is greater by several dB than the noise level of the wind tunnel and the driving motor. The results make it possible henceforward to correct rough measurements and to perform future acoustic tests on rotors and propellers under good conditions. F.R.L.

A71-30520 # **Preliminary results in a study of the infrared emission of a hot jet (Résultats préliminaires de l'étude de l'émission infrarouge d'un jet chaud).** J.-F. de Belleval, M. Perulli (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), G. Richter, and C. Schmidt (SNECMA, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 25 p. 9 refs. In French.

IR and acoustic measurements were compared, and it was found that the emissions of the electromagnetic and acoustic energies can be attributed to the same sources. On this basis, IR probing is used for investigating the aerodynamic parameters of a hot jet. Crossed-beam IR measurements are made by means of two mirrors whose axes are orthogonal to each other and perpendicular to the jet axis. The mirrors focus the IR emission from the jet onto lead sulfide IR

detectors. The results obtained up to the present are discussed, including axial and transverse profiles of the turbulence intensity and the axial profile and distribution of frequency. Z.W.

A71-30521 # **Determination of sound fields of aircraft in flight by treatment of noise measurements (Détermination des champs sonores des avions en vol par traitement des mesures de bruit).** Jean Gaudron (Société Nationale Industrielle Aerospatiale, Toulouse, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 30 p. In French.

Study of the sound field attached to an aircraft, which involves knowledge of the perceived noise level. Some test procedures involving the flight path of the aircraft and the acquisition of flight parameters are described. Flight parameters to be controlled are the engine operating conditions and the speed of the aircraft. It is shown that the attitude of the aircraft is of importance in the production of noise perceived on the ground. F.R.L.

A71-30522 # **Predictive calculations of attenuation of absorbing ducts adaptable to bypass jet engines (Calculs de prévision d'atténuation de conduits absorbants adaptables à des réacteurs double flux).** F. Haffner (Société Bertin et Cie., Plaisir, Yvelines, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Francaise, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 31 p. In French.

Classical Morse theory is used for calculating noise attenuation in the ducts of a compressor. According to this theory, a monochromatic acoustic wave propagating in a duct is composed of a series of elementary waves called modes. In the case of sound-absorbing duct walls, the modes are attenuated and their phase velocity is modified. Equations determining the attenuation of each mode are solved for rectangular, circular, and annular duct cross sections. Two hypotheses are assumed for the energy distribution over different modes at the duct inlet: (1) energy is uniformly distributed over different modes, and (2) the propagating wave is a plane one. The theoretical and experimental results are compared for different materials and for rectangular duct cross sections. Z.W.

A71-30523 # **Influence of the presence of a plane on the measurement of line-containing spectra (Influence de la présence d'un plan sur la mesure de spectres contenant des raies).** J. Jacques (CNRS, Centre de Recherches Physiques, Marseille, France) and P. Thomas (SNECMA, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 20 p. In French.

Study of complex noise emission spectra resulting from the superposition of a continuous component and peaks. Some applicable theoretical expressions are established which make it possible to calculate the level separations due to the presence of a perfectly reflecting plane and relative to either all the spectrum, or to frequency bands corresponding to a chosen analytical mode. Experimental confirmation was made in a soundproof room by measuring the influence of reflection interfaces for the synthetic noise spectra obtained either by means of electroacoustic sources or by use of a model jet and a compression chamber. The satisfactory agreement between the theoretical and experimental results shows that the spectrum of a sound source in the presence of a perfectly reflecting plane is predictable commencing with the knowledge of the free field spectrum. F.R.L.

A71-30524 # **Experimental verification and application of a method of calculation for the sound spectrum of jets on the ground and in the air (Vérification expérimentale et application d'une méthode de calcul du spectre sonore des jets au sol et en vol).** M. Kobrynski (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 14 p. 9 refs. In French.

The work discussed is a continuation of an investigation by Kobrynski (1969). The sound pressure level at a point of the ground during the overflight of an aircraft is considered, and a mathematical relation for expressing the sound pressure level observed with satisfactory approximation is derived. The studies discussed are based partly on theoretical results reported by Ribner (1969) and partly on experimental results. The method of calculations proposed utilizes a new expression which is representative for the directivity of jet noise. The theoretical results are compared with experimental data, and the areas of agreement are defined. G.R.

A71-30526 # **Fluctuation of sound pressures created by a fan in a very low speed subsonic wind tunnel test stream (0.10 less than V less than 20 m/sec) (Fluctuations de pressions sonores créées par un ventilateur dans une veine de soufflerie subsonique très bases vitesses /0,10 less than V less than 20 m/s/).** J. Moinard and C. Froger (Centre d'Etudes et Recherches des Charbonnages de France, Verneuil-en-Halatte, Oise, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 2nd, Paris, France, May 4, 5, 1971, Paper.* 21 p. In French.

Discussion of anomalies which can cause large errors in the calibration of anemometers at very low wind speeds. The anomalies are due to a region of acoustic waves, the principal noise source being the fan which moves the air in the wind tunnel. To construct a high quality wind tunnel aerodynamic studies must be supplemented by acoustic studies which do not exclude adjustments on the full-scale model. F.R.L.

A71-30527 **Development progress - New transport engines: JT9D.** G. P. Adamson (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710419.* 12 p. Members, $1.00; nonmembers, $1.50.

The means by which Pratt and Whitney Aircraft is bringing about improvements in its JT9D engine are described. The JT9D engine, having accumulated a year and a half of commercial service, benefits both from a product improvement effort aimed at developing fixes for current operating problems and from development work on advanced JT9D models designed to power future transport aircraft. An extended comparison between the current JT9D-3A engine and the first advanced JT9D (the JT9D-7) illustrates the product improvement process in detail. (Author)

A71-30528 **JT9D development for airline operation.** G. E. Woodger (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710434.* 13 p. Members, $1.00; nonmembers, $1.50.

The Pratt and Whitney Aircraft JT9D engine is described with respect to the ways in which it has been designed to meet the requirements of airline operators. Chief emphasis is placed on the engine's simplicity of construction, provisions for condition monitoring, and capability for maintenance, along with its improved noise and smoke emission characteristics. Specific maintenance problems and their solutions are presented. (Author)

A71-30529 **New developments in product support.** H. Bayer (Douglas Aircraft Co., Long Beach, Calif.) and J. Woodworth (National Airlines, Inc., Miami, Fla.). *Society of Automotive*

Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710437. 10 p. Members, $1.00; nonmembers, $1.50.

The use of maintenance cost data can be successfully employed as a design constraint for product support. This paper summarizes the process used in translating quantitative maintenance cost requirements into specific design criteria. It describes the airline operator's use of such data and how he then passes cost objectives on to the aircraft manufacturer. The various steps used in the design process are described from a manufacturer's standpoint. Examples are given to show the relationship of cost to resulting maintainability improvements. Finally, the airline operator's viewpoint is presented which calls for more stringent compliance with previously determined maintenance concepts and procedures. The paper closes with a look at future program requirements. (Author)

A71-30530 Powered wheels - A concept for parking and taxiing of commercial transport airplanes. B. C. Hainline, B. K. Sellereite, K. V. Swanke (Boeing Co., Commercial Airplane Group, Renton, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710446.* 14 p. 8 refs. Members, $1.00; nonmembers, $1.50.

The concept of powered wheels as applied here is the propelling of an airplane on the ground by direct traction of landing gear wheels using onboard power and under direct control of the pilot. This concept suggests an improvement in economic and ecologic factors associated with ground operation of commercial transport airplanes. For the concept to be economically feasible, penalties for addition of airborne equipment must be overbalanced by savings in fuel, engine operating time, ground equipment, ground personnel, and terminal space and by increased airplane productivity. The use of direct wheel traction can improve the airport and terminal environment by reducing air pollution, jet blast, and noise from main propulsion engines during taxi and parking. This paper is a preliminary look at requirements, configurations, and trades that require further investigation to establish the role of powered wheels in future air transportation. (Author)

A71-30531 Design integration - The key to effective engine condition monitoring. K. B. Kochanski and D. W. Leiby (General Electric Co., New York, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710447.* 12 p. Members, $1.00; nonmembers, $1.50.

As aircraft increase in size and required capital investment, the incentives for development and application of techniques and methods for optimizing the availability of the aircraft become increasingly attractive. Currently, a family of techniques, which can be broadly defined as engine condition monitoring, is being applied to reduce the downtime assignable to the aircraft power plant. The mechanical health of the engine is assessed through such techniques as parameter monitoring, vibration analysis, oil monitoring, borescope inspection, and radiography to provide problem detection, isolation, and trend monitoring. The effectiveness of a condition monitoring system depends upon the realization of a compatible interface between the basic engine design and installation, and the monitoring system, as well as the application of effective diagnostic logic to the acquired data. The purpose of this paper is to examine the design interface requirements for selected monitoring techniques and the analytical methods for data interpretation, and to recommend the design features needed to enhance the monitoring capabilities to approach the optimum overall condition monitoring system. (Author)

A71-30532 Electronic Engine Condition Analysis System. H. J. Moses (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710448.* 11 p. Members, $1.00; nonmembers, $1.50.

A new systems approach has been developed and applied to achieve the inspection, diagnosis, and prognosis of gas turbine engine health by electronic means. The approach combines the power of the special purpose digital computer together with advanced engine fault isolation techniques to achieve a complete operational and maintenance interface. System elements are described and typical examples discussed. Practical applications of the system to several engine models have been made with favorable results. (Author)

A71-30533 Area navigation systems and displays. Frank F. Wright, William R. Beckman (Lockheed-California Co., Burbank, Calif.), and T. J. Newman (AMBAC Industries, Inc., Arma Div., Garden City, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710457.* 20 p. Members, $1.00; nonmembers, $1.50.

Description of different classes of area navigation systems (RNAV), and review of the operational advantages of pilot displays. The use of National Airspace System ground radio navigation aids by airborne navigation receivers and other sensors forms the basis for the RNAV systems that, coupled with appropriate air traffic control techniques, promise to improve the movement of aircraft throughout the national airspace. Three classes of RNAV equipment are reviewed: the Mark I, simple yet requiring considerable pilot manual operation; the Mark II, virtually automatic with new cathode-ray tube multifunction/navigation displays for the pilot; and the Mark III, based upon use of self-contained inertial navigation systems installed in today's large jets. M.V.E.

A71-30534 INS projections and improvements - Capabilities in the future. Christopher L. Bearden (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710458.* 6 p. Members, $1.00; nonmembers, $1.50.

ARINC 561 Inertial Navigation Systems (INS) have received wide acceptance in the Commercial Air Transport Industry. Many innovative improvements to these systems have been developed in recent years. Increased functional capability is planned for the near future such as vertical navigation and accuracy improvement using radio navigation aids. (Author)

A71-30535 The future of STOL. Richard D. FitzSimmons and William E. Thurman (National Aeronautics and Space Council, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710464.* 6 p. Members, $1.00; nonmembers, $1.50.

Individual DOT, DOD, and NASA STOL roles and missions are discussed, including the supporting rationale that will allow the agencies to collectively address STOL systems implementation and create an environment in which the free enterprise system can assume its rightful role and provide a profitable, safe, environmentally satisfactory new air transportation service that is truly responsive to the desires of the public. It is felt that appropriate involvement of the Federal Government is essential for defining a STOL-development timetable. M.V.E

A71-30536 Comparison of STOL design criteria for commercial and military transport aircraft. Jesse C. Peaslee (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710465.* 13 p. Members, $1.00; nonmembers, $1.50.

The characteristics of STOL transport aircraft designed for military missions resemble those developed for commercial air transport. A military aircraft with approximately 30,000-lb payload capacity correlates reasonably well with 120-150 passenger commercial aircraft. When reasonable margins of safety are applied to takeoff and landing criteria, the military transport designed for

2000-ft landing and takeoff distances could probably be certified at about the same landing and takeoff distances for civil use. However, many STOL military design details are not defined well enough to assure that similar commercial aircraft would be economical in airline use. Conversely, the criteria for acceptable levels of noise for commercial STOL aircraft might result in a less than optimum aircraft for military service. (Author)

A71-30537 Lift ratings of V/STOL propulsion units. W. W. Thomas (General Electric Co., Aircraft Engine Group, West Lynn, Mass.) and E. G. Smith (General Electric Co., Cincinnati, Ohio). *Society of Automotive Engineers, National Air Transportation Meeting, Atlanta, Ga., May 10-13, 1971, Paper 710471.* 31 p. Members, $1.00; nonmembers, $1.50.

Lift ratings for V/STOL propulsion units are identified based on the requirements of the aircraft system. Typical V/STOL handling criteria are applied in the derivation of the lift rating method. Analytical techniques are presented for the evaluation of contributing factors associated with both the aircraft and propulsion system characteristics. Two typical aircraft systems are used to determine representative levels of lift ratings for the propulsion units. (Author)

A71-30538 Development of an individualized ground training program for DC-10 flight crews. W. P. Moran (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, International Simulation and Training Conference, 4th, Atlanta, Ga., May 13, 1971, Paper 710472.* 9 p. Members, $1.00; nonmembers, $1.50.

In an effort to reduce flight crew ground training time, while at the same time maximizing learning efficiency, American Airlines is making use of specialized, individualized, programmed instruction, with increased emphasis on the use of 'hands-on' training equipment, to transition experienced crewmen to the DC-10 airplane. This paper explains the concept of identifying the specific operating requirements unique to this airplane and the development of a program to train crewmen to proficiently perform these operating requirements. It also covers briefly the principal training hardware developed to support this program. (Author)

A71-30604 # Approximate transfer functions for large aspect ratio wings in turbulent flow. L. T. Filotas (Toronto, University, Toronto, Canada). *Journal of Aircraft,* vol. 8, June 1971, p. 395-400. 19 refs. National Research Council of Canada Grant No. A-2003; Grant No. AF AFOSR 67-0672A.

The fundamental aerodynamic problem associated with flight through atmospheric turbulence is calculation of the response of a wing flying through a single sinusoidal wave of upwash with lines of constant phase arbitrarily inclined to the flight path. Approximate closed form expressions for the 'gust transfer functions' relating the lift and moments to the upwash in such a wave are derived for large aspect ratio rectangular wings in incompressible flow. The lift transfer function is expressed as the usual two-dimensional Sears function multiplied by a factor to correct for finite span and a further factor to account for the spanwise gust wave number. Multiplying this expression by the chordwise (or spanwise) center of pressure leads to the pitching (or rolling) moment transfer function. Some simple scaling laws, based on these results, are then suggested for flight through large-scale turbulence. (Author)

A71-30605 # Designing jet aircraft wind-tunnel test programs with propulsion system simulation. James L. Grunnet (FluiDyne Engineering Corp., Minneapolis, Minn.). *Journal of Aircraft,* vol. 8, June 1971, p. 421-427. 8 refs.

This paper discusses the design of wind-tunnel force test programs for jet aircraft configurations where propulsion system aerodynamic effects must be evaluated in the testing. The simulation requirements of present day jet aircraft are discussed, as are the simulation problems. The potential tradeoff between individual model engine simulator complexity and test program complexity that will provide the required simulation is introduced. Various model support techniques and engine simulation techniques that might be used are described. Test program designs that could yield aircraft force coefficient data are presented, and finally, the choice of an engine simulator and test program design is considered for three specific aircraft configurations. (Author)

A71-30606 # Combined inertial - ILS aircraft navigation systems. James W. Burrows (Boeing Co., Seattle, Wash.). *Journal of Aircraft,* vol. 8, June 1971, p. 439-443. 7 refs.

Error models for the Instrument Landing System (ILS) and Inertial Navigation System (INS) are discussed. A method for combining the two systems using the theory of optimal linear estimation is given. Results of tests of the combined navigation system using a ground vehicle operating on runways and instrumented with an inertial navigator, radio receivers, and a computer are given with emphasis on the effects of initialization and unmodeled errors. The results indicate that use of the combined system during landing approach would simultaneously reduce the cross-runway position and velocity (track angle) errors. The combined system is relatively insensitive to the choice of initial values of certain parameters. Results are still good when the initial parameter values are chosen to approximate a real-time least square fit of INS position and velocity to the ILS localizer signal. The effects of the principal unmodeled error, platform tilt, are such that the tilt would have to be precorrected or included in the error model during approach if a poorer INS were to be employed. (Author)

A71-30607 # Flutter of clamped skew panels in supersonic flow. Somayajulu Durvasula (Indian Institute of Science, Bangalore, India). *Journal of Aircraft,* vol. 8, June 1971, p. 461-466. 28 refs.

The supersonic panel flutter problem of clamped skew panels with in-plane forces is formulated on the basis of the classical, small deflection, thin plate theory using oblique coordinates. The two-dimensional, static approximation is made use of for the aerodynamic loading. Galerkin method with the flutter mode represented in terms of a double series of beam characteristic functions is employed. Results of numerical calculations made for unstressed panels for different combinations of side ratio, angle of skew, and angle of yaw are presented here. The majority of the calculations were made using 16 terms in the series. Convergence is examined in a few typical cases. The dynamic pressure parameter for flutter is found to increase monotonically with the angle of skew for side ratio 1 and to decrease initially before beginning to increase for side ratio 0.5. The results are also compared with those obtained earlier for simply supported panels. (Author)

A71-30609 # Energy state approximation and minimum-fuel fixed-range trajectories. Nelson R. Zagalsky, Robert P. Irons, Jr., and Robert L. Schultz (Honeywell Systems and Research Center, Minneapolis, Minn.). *Journal of Aircraft,* vol. 8, June 1971, p. 488-490. 5 refs. Contract No. N 00014-69-C-0101.

Search for remedies to the limitations of the energy-state approximation in its performance optimization capability for supersonic aircraft. It is shown that for supersonic aircraft the velocity set is not convex and relaxed controllers are allowed that attain fuel economies superior to any control satisfying the principle of the maximum. This results in the failure of this principle to yield any solutions to the problem of maximum range cruise. It is also shown that, in default of an optimal control, there are suboptimal trajectories that contain a minimum fuel cruise segment, and achieve fuel economies very close to those of the optimum relaxed controller. An appropriate treatment of the minimum fuel problem with range constraints is derived therefrom. M.V.E.

A71-30610 * # **Sonic boom reflection factors for flight near the threshold Mach number.** Charles L. Thomas (NASA, Ames Research Center, Aerodynamics Branch, Moffett Field, Calif.). *Journal of Aircraft,* vol. 8, June 1971, p. 490.

Study of the reflection of a very weak shock wave off a smooth surface for the condition in which the incident shock wave is nearly perpendicular to the surface. It is found that in this situation the pressure rise across the reflected shock can be up to twice the pressure rise across the incident shock, indicating that sonic boom reflection factors as large as three are possible for aircraft traveling near the threshold Mach number. M.V.E.

A71-30681 * # **Installation and testing of strain gages for high-temperature aircraft applications.** Earl J. Wilson (NASA, Flight Research Center, Edwards, Calif.). In: Strain gages and extreme environments; Society for Experimental Stress Analysis, Technical Session, Huntsville, Ala., May 19, 1970, Proceedings. Edited by O. L. Gillette. Westport, Conn., Society for Experimental Stress Analysis, 1970, p. 1-7; Discussion, p. 7-10. 5 refs.

Survey of a research program conducted to define the optimal selection, installation, and calibration criteria for strain gages used in aircraft flight-load measurements in a high-temperature environment caused by aerodynamic heating. Tests have been made to determine apparent strain, hysteresis, gage factor, insulation resistance, and attachment methods. Most of the tests involved apparent strain for the purpose of matching the thermal expansion coefficients of the gage and structure materials. A setup for simulating the flight heating of an X-15 horizontal stabilizer is described, and measured temperature vs apparent strain curves are shown for two different free-filament types of gages and one weldable type of gage. As a result of the evaluation program, the weldable platinum-alloy strain gage was chosen for measurements in areas where the temperature was not expected to exceed 900 F. Some fatigue problems associated with using weldable gages are examined, and recommendations are given for strain gage installation. T.M.

A71-30710 **Guidance is forever.** C. S. Draper (Charles Stark Draper Laboratory, Cambridge, Mass.). *Navigation,* vol. 18, Spring 1971, p. 26-50.

Review of the fundamentals that are alike for all control, navigation and guidance problems, showing how the laws of nature lead to patterns of mechanization that may be generalized for equipment to satisfy the requirements of all missions. Similarities of function are stressed rather than differences in design details. Guidance translates deviations into correction commands and applies these as input to the control subsystem which changes vehicle velocity toward conditions for mission requirement. Application of earth reference coordinates for aircraft, missiles and spacecraft is described from the standpoint of initial orientation to earth coordinates. F.R.L.

A71-30711 **The development of long-range hyperbolic navigation in the United States.** J. A. Pierce (Harvard University, Cambridge, Mass.) and R. H. Woodward. *Navigation,* vol. 18, Spring 1971, p. 51-62. 19 refs.

Review of the development of navigation by the timing of radio signals, which must be accomplished with an accuracy of a very few microsec if positional accuracy comparable to other methods of navigation is to be achieved. Some details of the British Gee systems and the early developments which led to Loran are discussed. As Loran was perfected, many stations and many thousands of receivers were placed in operation. The major advantage of Loran is the long baseline possible. Several improved versions of Loran are described. Other systems discussed are Radux and Omega. F.R.L.

A71-30712 **Air navigation techniques.** E. W. Anderson (Smiths Industries, Ltd., Cheltenham, Glos., England). *Navigation,* vol. 18, Spring 1971, p. 77-92.

General discussion of navigation techniques as they have been developed since the earliest days of flying. Before WW II the radio range had become practical, and during the war radar and hyperbolic systems were developed which are briefly described. International agreements formulated after the war are discussed, as well as short-range aids, long-range navigation, and air traffic control. Position finding, automatic dead reckoning, automatic landing, the functions of computers and displays, and area navigation are reviewed. The future roles of Doppler and inertial navigation, and astronavigation by means of satellites are considered. F.R.L.

A71-30725 # **Evaluation of American Airlines' B747 prototype AIDS Engine Monitoring Program.** H. D. Kruckenberg (American Airlines, Inc., Tulsa, Okla.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-648.* 11 p. Members, $1.50; nonmembers, $2.00.

American is currently entering the evaluation phase of its B747 AIDS (Aircraft Integrated Data System) Program. Attention has been focused on expansion of the number of engine parameters to be monitored including parameter accuracy and repeatability. Depending upon the parameter, the sampling rate for a 4 second data frame varies from a minimum of 4 to a maximum of 32. The experience gained to date from this program is portrayed including the status of the B747 AIDS program objectives. Data utilization is briefly discussed. (Author)

A71-30726 # **Automatic inspection, diagnostic and prognostic systems for Army aircraft.** Joseph P. Poynton (U.S. Army, Aviation Systems Command, St. Louis, Mo.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-649.* 7 p. Members, $1.50; nonmembers, $2.00.

The U.S. Army Aviation Systems Command has been conducting two major pre-engineering development efforts into automated maintenance monitoring systems. Feasibility, technical approach, and effectiveness studies are now in progress. State-of-the-art test bed hardware has been applied to four UH-1 helicopters. The approach was premised on being able to establish a signature norm and discern detectable differences between this norm and discrepant component signatures. Degraded parts were implanted in the helicopter engines/power-trains and operated in test cells and in flight. Results will be discussed based on available data to date. (Author)

A71-30727 # **On-board checkout approach to engine diagnostics - It can work.** William Brenner (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-651.* 7 p. Members, $1.50; nonmembers, $2.00.

Description of the techniques required to use an on-board computer to provide coordinated testing, monitoring, data reduction, and analysis. Emphasis is placed upon the need and techniques for automatic in-flight recording (periodically and when limits are exceeded); individual baseline engine performance and vibration signatures; fault isolation; and trend analysis. The purpose is to provide post-flight displays in the aircraft for use by maintenance personnel. The results of implementing this design approach should culminate in an operational airborne engine diagnostic system that will provide the necessary information to determine a scheduled engine maintenance program. F.R.L.

A71-30728 # **A systems approach to engine condition monitoring.** K. B. Kochanski and D. W. Leiby (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint*

Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-652. 10 p. Members, $1.50; nonmembers, $2.00.

A condition monitoring maintenance concept is being considered or proposed for almost all new commercial or military aircraft. The complexity of jet engines, the engine/aircraft interfaces, and the marriage of airborne instrumentation and electronic equipment with ground based electronic/computer hardware requires the use of a systems approach for the development and implementation of a condition monitoring system. This paper describes how a systems approach has been used in developing condition monitoring techniques for the CF6 engine as a means of having a workable and effective condition monitoring capability available early in its service operation. (Author)

A71-30731 * # **Shuttle airbreathing propulsion.** Warner L. Stewart, Arthur J. Glassman, and Stanley M. Nosek (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-662.* 11 p. Members, $1.50; nonmembers, $2.00.

Airbreathing gas turbine engines to provide cruise, landing, go-around, and ferry capability for the shuttle vehicles face new requirements such as launch, space residence, and reentry. Also, hydrogen is being considered as an alternate fuel for the engines. It becomes necessary to determine which engines are most suitable and to examine them for modifications and technology required to meet the new requirements. This paper reviews the requirements imposed on the engine, the effect of fuel selection, and the design studies currently being conducted to assess candidate engine designs in light of the mission requirements. (Author)

A71-30733 * # **Instantaneous and dynamic analysis of supersonic inlet-engine compatibility.** James E. Calogeras, Paul L. Burstadt, and Robert E. Coltrin (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-667.* 11 p. 9 refs. Members, $1.50; nonmembers, $2.00.

An experimental wind-tunnel investigation was made to determine the effects of time-variant distortions produced in a supersonic inlet on a J85-GE-13 turbojet engine. Results are presented principally in terms of 'instantaneous' distortion amplitudes and contours measured through compressor stall. They indicate that although a time-averaged distortion may be far from a stall-inducing value, corresponding instantaneous distortion amplitudes can approach or exceed this value. A film made by combining instantaneous distortion contours demonstrates that severe total pressure fluctuations at the compressor face can result in an instantaneous distortion of a type completely different from the time-averaged distortion. (Author)

A71-30734 # **Compressor sensitivity to transient and distorted transient flows.** Willem Jansen, Michael C. Swarden, and Albert W. Carlson (Northern Research and Engineering Corp., Cambridge, Mass.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-670.* 18 p. 14 refs. Members, $1.50; nonmembers, $2.00.

The problem is treated with an analytical model which considers the inlet duct, compressor stages, and combustor up to the turbine nozzles. Results include compressor stalling sensitivity as a function of pressure and temperature amplitude, rotor-speed excursions, pulse duration, circumferential distortion extent, and pulse frequency, as well as blade geometry (such as blade chord length and solidity), and inlet duct geometry. Comparisons with some experimental results are included. The key conclusion is that delays in blade separation are too short to play a direct role but that delays in stage rotating stall development influence the transient compressor response. (Author)

A71-30735 # **Simulation and measurement of pressure transients in a mixed-compression supersonic intake during engine surge.** C. R. Dawson (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-671.* 12 p. 9 refs. Members, $1.50; nonmembers, $2.00.

The flow reduction associated with engine surge was simulated using a high speed mass-flow control coupled to an 1/18-scale wind tunnel model of the SST intake. The valve design and the experimental technique are discussed. Intake/airplane interference resulting from the transient was studied using a twin-intake/wing configuration. Test data indicated lower levels of internal overpressure than predicted by a theoretical analysis which used inviscid conservation equations. Transient pressure differences across internal doors were experimentally determined and used to establish full-scale SST intake load levels. Studies of external interference effects enabled a suitable fence to be defined to prevent mutual intake interference. (Author)

A71-30744 * # **Use of the gas generator method to calculate the thrust of an afterburning turbofan engine.** Frank W. Burcham, Jr. (NASA, Flight Research Center, Edwards, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-680.* 11 p. 11 refs. Members, $1.50; nonmembers, $2.00.

The feasibility of using the gas generator method to calculate the thrust of an afterburning turbofan engine was investigated. The NASA Flight Research Center's F-111A airplane, powered by TF30 afterburning turbofan engines, was used. Two variations of the gas generator method were utilized, one based primarily on the exhaust nozzle pressure and area and the other on the nozzle total temperature and weight flow. An influence coefficient study was performed for static and flight conditions. Results showed that the accuracy of the two calculation methods was about equal at static conditions, but for flight conditions the total temperature and weight flow calculation was superior. Two ground thrust stand tests were also performed, and the thrust calculated by using both methods was compared to the measured thrust; results using either method were generally within plus or minus 3 percent except at low power settings. High inlet flow distortion caused an additional scatter of as much as plus or minus 2 percent. (Author)

A71-30745 * # **Nozzle performance measurement on underwing nacelles on an F-106 utilizing calibrated engines and load cells.** Harold W. Groth (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-681.* 13 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A flight research program is underway at the Lewis Research Center to study installation effects on turbojet engine exhaust nozzles over a range of flight Mach number from 0.60 to 1.30. Two J85-13 afterburning turbojet engines were mounted in underwing nacelles. Exhaust nozzle propulsion efficiency is being measured using load cells, calibrated engines, and flight calibrated nacelle tare forces. Reference nozzles of known performance were used to determine nacelle tare forces. Analysis of flight calibration data shows that the system is capable of determining nozzle efficiency to a one-sigma random error of plus or minus 1.5 percent. (Author)

A71-30756 # **Systems aspects of augmentor combustion instability.** Kervyn D. Mach (USAF, Aero Propulsion Laboratory,

Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-697.* 4 p. 7 refs. Members, $1.50; nonmembers, $2.00.

The improved performance capability demanded of future turbopropulsion systems requires that the major engine components operate at increased levels of performance. Problems, hitherto easily overcome during engineering development, can now become major obstacles. Nearly all augmentor development programs have experienced combustion instability problems (for example, screech), often of destructive magnitude. Because combustion instability is an extremely complex phenomenon and not at all well understood, its elimination often entails performance compromises or expensive schedule slippages. Extensive research into its causes and behavior is necessary to reduce the element of uncertainty in augmentor development programs. (Author)

A71-30757 # **Combustion instability in turbojet and turbofan augmentors.** John M. Bonnell, Richard L. Marshall, and George T. Riecke (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-698.* 9 p. 9 refs. Members, $1.50; nonmembers, $2.00.

The state-of-the-art knowledge of high frequency transverse modes (screech) and low frequency longitudinal modes of combustion instability encountered in the development of modern turbofan and turbojet augmentors is presented. The operating conditions and design parameters conducive to combustion instability in turbojet afterburners, turbofan mixed-flow afterburners, and turbofan duct burners are discussed. The nature of screech and low frequency pressure oscillations, as well as possible mechanisms for sustaining the waves, are described. Methods of eliminating high frequency oscillations, either by utilizing wide bandwidth screech liners or by altering the flameholder design are described. Low frequency oscillations are attenuated primarily by tailoring the fuel-air ratio distribution and altering the flameholder design. (Author)

A71-30766 # **A mathematical model for jet engine combustor pollutant emissions.** Raymond Edelman and Constantino Economos (General Applied Science Laboratories, Inc., Westbury, N.Y.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-714.* 21 p. 24 refs. Members, $1.50; nonmembers, $2.00.

This paper presents a mathematical model based on a modular concept which describes the combustion and pollution formation processes in a jet engine combustor. The model includes turbulent mixing, and reaction kinetics appropriate to the coupled fuel oxidation and pollutant species formation process as well as the effects of two phase flow, recirculation and swirl. The modular concept is unique and permits each relevant process to be studied individually or coupled as a function of operating and geometric parameters. The importance of 'primary' zone parameters upon CO, NOx, CxHy, and soot formation are delineated. (Author)

A71-30770 # **Analytical and experimental evaluation of performance prediction methods applicable to exhaust nozzles.** E. R. Glasgow, J. S. Divita (Lockheed-California Co., Burbank, Calif.), P. C. Everling, and J. A. Laughrey (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-719.* 13 p. 29 refs. Members, $1.50; nonmembers, $2.00. Contract No. AF 33(657)-70-C-0511.

An evaluation was made of analytical and empirical methods suitable for predicting the performance of isolated jet engine exhaust nozzles operating in the subsonic, transonic and supersonic flight regimes. Among the methods examined were those for predicting internal thrust, ejector pumping, exhaust plumes, surface pressure distribution, boattail and base drags, and flow separation. The most promising methods were evaluated by comparison with data obtained from the testing of variations of convergent, convergent-divergent, and plug nozzles at Mach numbers ranging from 0.6 to 3.0 in the AEDC 16-Foot Propulsion Wind Tunnels. It was concluded that theoretical methods predict pressure distributions, thrust, supersonic boattail drag, and plume shapes, whereas, the empirical correlation methods provide good predictions of base drag, subsonic and transonic boattail drags, and flow separation. (Author)

A71-30771 # **Predicting airframe/exhaust nozzle interactions at transonic Mach numbers.** E. Grund, W. Presz, Jr., and M. Konarski (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-720.* 10 p. 10 refs. Members, $1.50; nonmembers, $2.00. Contract No. AF 33(657)-70-C-0511.

An analysis is presented which predicts pressure distributions and drags over arbitrary slender axisymmetric fuselages and afterbodies at transonic Mach numbers. Spreiter and Alksne's method of local linearization has been modified to obtain a more accurate and numerically stable flow field solution at all transonic Mach numbers. This inviscid solution is iteratively coupled with turbulent boundary layer and method of characteristic calculations thereby accounting for viscous effects and variations in jet plume shape. Analytical results are compared with experimental data for a variety of applications. After first showing the validity of the theoretical predictions for basic fuselage and afterbody shapes at approach velocities below and above the speed of sound, the effects of varying nozzle pressure ratio on boattail pressure distributions and drags are presented. Plume shapes for static conditions as well as those influenced by external transonic flow are defined. The analytic method is also used to predict the effects of different boundary layer characteristics and different forebody shapes on afterbody pressure drags. Finally, an example is provided that demonstrates how the analysis can be applied to point up the performance differences between a propulsion system in an isolated or airplane installed flow field. (Author)

A71-30775 # **Flowfields produced by multiple jets in a supersonic stream.** James M. Kallis (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-728.* 7 p. 20 refs. Members, $1.50; nonmembers, $2.00. Research supported by the McDonnell Douglas Astronautics Independent Research and Development Program.

The situation investigated occurs with jet control of a supersonic vehicle, with supersonic-combustion ramjets, and with fluid injection for thrust-vector control of solid-propellant rockets. The ultimate objective of the research is to develop a method or methods for predicting the effect on the control force of the interaction between flowfields produced by adjacent jets. The approach taken is to conceptually replace the jets by equivalent solid obstacles and to neglect boundary-layer effects. This makes it possible to reduce the problem to that of calculating the inviscid flowfield between multiple solid blunt bodies in a supersonic stream. The results of a three-part study of this problem are described. A method is developed for calculating the interference flowfield between bodies spaced far enough apart that the shock-wave pattern is regular reflection. This calculation is based on the method of characteristics. An evaluation is made of the suitability of available blunt-body methods for computing the input lines for the characteristics' calculations. M.M.

A71-30776 # **Aviation and environmental quality (A survey of the SAE/DOT Conference on Aircraft and the Environment).** Robert L. Paullin (U.S. Department of Transportation, Regulatory Policy and Standards Div., Washington, D.C.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-729.* 7 p. Members, $1.50; nonmembers, $2.00.

The SAE/DOT Conference on Aircraft and the Environment, held in Washington, D.C., Feb. 8-10, 1971, brought together for the first time those parties interested in problems associated with the environment, generated by aircraft and airports. This paper summarizes the results of that Conference, delineates conclusions and recommendations, and highlights future courses of action laid out by the Conference. The questions of noise pollution and the question of air and other types of pollution were directly reviewed during the course of the Conference. Technical papers were presented and workshop sessions were held on the source, distribution and receipt, as well as legal and economic aspects of broad problem areas. These subjects are surveyed in this paper. (Author)

A71-30777 # **The prediction of the spectral content of combination tone noise.** Gordon F. Pickett (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-730.* 7 p. 6 refs. Members, $1.50; nonmembers, $2.00. Contract No. FA-69-WA-2045.

The essential features of combination tone noise which is generated from turbofan engines when the relative tip speed of the fan blades is supersonic are examined. A method for determining the expected distribution of sound power among the harmonics of engine rotation frequency is presented. The distribution is found to depend on two statistical parameters representing the variations in shock strength and the intervals between successive shock waves. The spectral dependence is shown to be more critical on interval variance. Estimates for typical blade geometries are obtained. O.H.

A71-30778 * # **Theoretical and experimental analysis of acoustic linings for ducts with flow.** Walter Eversman (Boeing Co.; Wichita State University, Wichita, Kan.), M. Dean Nelsen, Denis Armstrong, and Orville J. Hall, Jr. (Boeing Co., Wichita, Kan.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-731.* 14 p. 26 refs. Members, $1.50; nonmembers, $2.00. NASA-supported research.

A theoretical and experimental program for the design of acoustic linings for the attenuation of fan generated noise in turbo fan engines is described. This program is based on an interaction between an extensive analytical lining performance prediction capability and flow duct testing. The theoretical basis for lining analysis in rectangular, circular, and annular ducts with either uniform or sheared flow is formulated and the results of the development of a lining mathematical model are presented. The predictive capability is employed in conjunction with a least attenuated mode lining optimization scheme to determine the lining impedance which will provide the required attenuation spectrum. A flow duct test facility is described and results of the testing of lining designs and the comparison with theoretical predictions is presented. Current developments for the improvement of the design capability are discussed. (Author)

A71-30780 # **On combustion generated noise.** Warren C. Strahle (Georgia Institute of Technology, Atlanta, Ga.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-735.* 11 p. 23 refs. Members, $1.50; nonmembers, $2.00.

A theory of combustion noise is developed in order to overcome the apparent lack of understanding of the mechanism by which this type of noise is generated. The theory follows rigorously from the principles of fluid mechanics. Lighthill's approach (1952), used in his studies of aerodynamic noise, is closely followed. The sound radiated from open, turbulent flames is found to depend strongly upon the structure of such flames; presently their structure is not well known. However, meaningful bounds and scaling rules for the sound power output and spectral content are derived, based upon the present limited knowledge. A framework is developed which explains past experimental work and the origin of combustion noise. O.H.

A71-30784 * # **Some experimental results on lift fan noise reduction.** M. J. Benzakein and S. B. Kazin (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-743.* 8 p. Members, $1.50; nonmembers, $2.00. Contract No. NAS 2-5462.

The results of an extensive experimental program on lift fan noise suppression are presented. The program was carried out on a tip turbine driven 36-in. lift fan research vehicle propelled by a J85 engine. The fan has a design pressure ratio of 1.3 and a design tip speed of 950 ft/sec. The comparative results on the relative benefits of vane/blade ratio, vane lean, rotor stator spacing, fan frame treatment and acoustically treated splitters on fan radiated noise are discussed. (Author)

A71-30785 * # **Blown flap noise research.** R. G. Dorsch, E. A. Krejsa, and W. A. Olsen (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-745.* 19 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Noise data were obtained with models of both internally and externally blown jet-flaps of the type currently being developed for STOL aircraft. The principal tests were conducted with an augmentor-wing model and with an externally-blown double-slotted-flap model. Secondary tests were conducted with a jet flap model. The interaction between the jet and the flap assembly caused both redirection and generation of noise. The data were extrapolated to representative full scale STOL airplane flap systems. It is shown that with a quiet engine the blown flap noise can be the major contribution to the total aircraft noise. Suppression techniques will therefore be required. (Author)

A71-30791 * # **Acoustic liner design from a fluid mechanics approach.** T. S. Tonon, W. A. Sirignano, D. T. Harrje (Princeton University, Princeton, N.J.), and P. K. Tang. *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-757.* 15 p. 13 refs. Members, $1.50; nonmembers, $2.00. NASA-supported research.

Design procedures and recommendations are presented for the construction of acoustic liners in the suppression of combustion instability in liquid and solid propellant combustors and of high intensity noise in air-breathing jet aircraft. The liner geometry may consist of Helmholtz resonators or quarter-wave tubes. Liner cross-flow effects as well as oscillatory pressure effects are considered in the methods presented. (Author)

A71-30792 # **Experimental correlation of installation effects for inlet/airplane integration.** W. H. Ball and P. A. Ross (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-759.* 10 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Results of a test of a closely related series of propulsion and aerodynamic wind tunnel models to investigate installation effects for a multimission strategic aircraft configuration. The tests were designed to yield, in a related fashion, flowfield definition; inlet internal performance; and inlet/aircraft drag as a function of inlet position, forebody shape, and orientation. A semiempirical analysis procedure was derived from the results to predict installed inlet performance. The cases examined with this approach show excellent correlation with measured installed performance. F.R.L.

A71-30799 Optimal and suboptimal control synthesis for minimum time VTOL transition. Louis R. Nardizzi, Ming Y. Tarng (Southern Methodist University, Dallas, Tex.), and Robert J. Parker (LTV Aerospace Corp., Dallas, Tex.). *IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-7, May 1971, p. 506-520. 7 refs. NSF Grant No. GK-5608; Contract No. AF 44(620)-68-C-0023.

Optimal open-loop and suboptimal closed-loop controls for a VTOL aircraft in a minimum climb-to-cruise time transition are presented in this paper. The optimal open-loop controls are synthesized by a proposed gradient technique which provides for the selection of desired changes in physically meaningful parameters during each iteration step. The suboptimal closed-loop controls are synthesized as integral mean-square approximations to the optimal open-loop controls over the minimum time-to-climb interval. Piecewise-constant feedback gains and switching times are synthesized for multidimensional control vectors which are linear combinations of observable states. Several computational results are presented for optimal and suboptimal minimum time controls with constrained and unconstrained terminal flight-path angles. (Author)

A71-30820 * Practical aspects of sonic boom problems (Aspetti pratici dei problemi del boom sonico). Antonio Ferri (New York University, New York, N.Y.). *L'Aerotecnica - Missili e Spazio,* vol. 50, Feb. 1971, p. 37-45. 15 refs. In Italian. Grant No. NGL-33-016-119.

Investigation of SST configurations selected from the standpoint of minimizing sonic boom. It is shown that, for an overall aircraft length of 300 ft and a total weight comparable to that of current U.S. SST designs, sonic booms having shock overpressures of the order of 0.6 lb/sq ft can be obtained. Values as low as 0.3 lb/sq ft are possible for aircraft designed for cross-country flights. M.M.

A71-30821 Shape of the fuselage of modern passenger transports (Sulla forma delle fusoliere dei moderni velivoli da trasporto passeggeri). Giuseppe Gabrielli (Torino, Politecnico, Turin, Italy). *L'Aerotecnica - Missili e Spazio,* vol. 50, Feb. 1971, p. 46-52. 6 refs. In Italian.

Due to the increased efficiency of modern wing flaps and the need for larger cargo and passenger spaces, the influence of wings on total aircraft drag has been reduced, while fuselage influence has increased in modern fast subsonic airliners. Some geometric characteristics of present fuselages are analyzed, and the reasons for new prospects regarding the fuselage shape of large airlines are outlined. The expediency of proceeding with the present philosophy of cylindrical fuselages with high aspect ratio, as compared with fuselages with a much lower aspect ratio, is discussed. The paucity of experimental data from individual fuselage models, primarily in the range of Reynolds numbers close to the real numbers, and the lack of experimental facilities are stressed. A proposal for a wind tunnel to be built as a European cooperative effort is advanced. M.M.

A71-30822 Aeronautical Institute of the University of Pisa - Activities of the 1960-70 decade: Projects currently under way (L'Istituto di Aeronautica dell'Università di Pisa - Attività nel decennio 1960-70: Programmi in atto). Lucio Lazzarino (Pisa, Università, Pisa, Italy). *L'Aerotecnica - Missili e Spazio,* vol. 50, Feb. 1971, p. 53-62. 63 refs. In Italian.

Brief description of the research projects concluded and initiated by the Institute in the 1960s. The results obtained so far are summarized, and a bibliography is provided for details. The projects deal with the interaction of supersonic and subsonic fluid streams, even at the boundaries of different surfaces, the fatigue strength of thin stiffened shells subjected to compressive or tensile loads, as well as preliminary, methodologic, theoretical, and experimental investigations on V/STOL aircraft and their use. The experimental equipment, partly original, which was designed and built to carry out the investigations, is briefly described. M.M.

A71-30824 Conceptual lines for the definition of an aeronautical project (Linee concettuali per la definizione di un progetto aeronautico). Gian Battista Nicolò (Napoli, Università, Naples, Italy) and Licio Giorgieri (Trieste, Università, Trieste, Italy). *L'Aerotecnica - Missili e Spazio,* vol. 50, Feb. 1971, p. 73-84. In Italian.

The criteria to be followed in order to convert operational targets into actual requirements and technical specifications are outlined, attaching the utmost importance to the achievement of optimal cost effectiveness. A rational scheme of research, which has been applied successfully to the definition of the multinational, multirole combat aircraft MRCA, is described in its general lines and complexities. The setting up of a parametric analysis, which constitutes the central phase of the research, through which requirements and specifications are correlated in the most feasible solution, is described in detail. M.M.

A71-30825 Influence of structural nonlinearities on panel flutter (Influenza delle nonlinearità strutturali sulle vibrazioni aeroelastiche dei pannelli). Paolo Santini (Roma, Università, Rome, Italy). *L'Aerotecnica - Missili e Spazio,* vol. 50, Feb. 1971, p. 85-90. 19 refs. In Italian.

Investigation of the problem of the flutter of a flat or curved panel, with emphasis on the effect upon it of structural and inertial nonlinearities. Geometrical nonlinearities, which can be treated with sufficient confidence, are discussed, and the lack of information existing in the area of physical nonlinearities is pointed out. Some methods of solution are briefly discussed. M.M.

A71-30855 # A solution for an axisymmetrical three-component flow of incompressible viscous fluid (Ob odnom reshenii trekhkomponentnogo osesimmetrichnogo techeniia viazkoi-neszhimaemoi zhidkosti). G. I. Nazarov and A. K. Ianko (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *Prikladnaia Mekhanika,* vol. 7, Apr. 1971, p. 123-126. In Russian.

Derivation of an exact solution to a system of equations describing the axisymmetrical motion of the components of an incompressible viscous fluid flow in a cylinder with a rotating disk of paddles and a mesh preventing the circular motion of the flow. The equations contain an arbitrary function which depends only on the axial coordinate of the mass forces. The solution can be used in calculating the parameters of an air flow in the cylindrical compressor cascade of a turbofan engine. V.Z.

A71-30874 # Hypersonic flow past a delta wing. A. L. Gonor. (*Prikladnaia Matematika i Mekhanika,* vol. 34, May-June 1970, p. 481-490.) *PMM - Journal of Applied Mathematics and Mechanics,* vol. 34, no. 3, 1970, p. 452-461. 6 refs. Translation.

Analysis of the flow pattern at the windward side of a wing with supersonic leading edges, with particular reference to the difficulties associated with obtaining a correct solution to the problem. These difficulties arise due to the fact that in the flow field behind a strong shock wave, there exist simultaneously uniform potential regions and vortex regions which must be smoothly joined. An analytical theory of hypersonic flow past a wing with an attached shock wave is

proposed which makes it possible to join the potential and vortex regions behind the shock wave. V.P.

A71-30888 Calculation of three-dimensional structures. Number 13 (Raschet prostranstvennykh konstruktsii. Number 13). Edited by S. A. Alekseev, V. V. Novozhilov, and A. A. Umanskii. Moscow, Izdatel'stvo Literatur po Stroitel'stvu, 1970. 295 p. In Russian.

Survey of the strength and stability of compound-curvature shells, bodies of revolution, and multilayer plates. Topics treated include (1) the use of analytic functions for solving three-dimensional problems in the theory of elasticity, (2) stability of plates, rods, and shells during creep, (3) new applications of photoelastic coatings for studying large and small deformations, and (4) determination of aerodynamic loads acting on spherical shells. T.M.

A71-30896 NTC '71; Institute of Electrical and Electronics Engineers, National Telemetering Conference, Washington, D.C., April 12-15, 1971, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971. 346 p. Members, $17.50; nonmembers, $20.

Theoretical and experimental research on transmission codes, data processing techniques, sensors, transmitters, receivers, and system design procedures for telemetry applications in medicine, industry, law enforcement, transportation, earth resources, and environmental monitoring. Detailed descriptions are given of systems used for satellite data collection, seismic data acquisition, weather observations, petroleum surveys, air traffic control, urban traffic measurement, image processing, emergency medical communications, and biological observations. FM threshold extension, random multiple access, asynchronous TDM, and color TV transmission systems are outlined. Some studies are directly concerned with increasing the efficiency of electromagnetic spectrum utilization in areas of high message traffic density. T.M.

A71-30898 * Results of an experiment to locate and read data from unmanned transponders using satellites. Roy E. Anderson (General Electric Co., Schenectady, N.Y.). In: NTC '71; Institute of Electrical and Electronics Engineers, National Telemetering Conference, Washington, D.C., April 12-15, 1971, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971, p. 15-28. Contract No. NAS 5-11634.

The vhf transponders of NASA's ATS-1 and ATS-3 satellites have been used to locate and communicate with ships and aircraft and to locate and read sensor data from a buoy moored at sea. The remote platforms have included a buoy moored in deep water near Bermuda, Coast Guard cutters in the Gulf of Mexico and Pacific Ocean, aircraft in flight over the continental United States and the North Atlantic, and a network of ground-based transponders at Ireland, Greenland, Iceland; Newfoundland, the state of Washington, and Argentina. Position fix accuracies were approximately 1 n mi, 1 sigma, using ordinary vhf band mobile communications equipment with simple, inexpensive tone-code responders connected between the receivers and transmitters. Much better accuracy would be obtained using wider bandwidth at higher radio frequencies. The tests confirmed that a network of remote, unmanned platforms can be interrogated at any time, in any sequence with the location of each platform and its sensor data immediately available at the ground station. (Author)

A71-30900 Design tradeoffs for HF and synchronous satellite data collection systems. Bernard A. Mitchell and Francis P. Cullen (Sanders Associates, Inc., Nashua, N.H.). In: NTC '71; Institute of Electrical and Electronics Engineers, National Telemetering Conference, Washington, D.C., April 12-15, 1971, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971, p. 37-45.

The results of a performance and cost tradeoff study between High Frequency (HF) and Synchronous Satellite Readout of remote data collection platforms is presented. The HF link analysis is concerned with surface wave transmission for path lengths less than 200 n mi and for ionospheric mode transmission for path lengths between 200 and 2000 n mi. The satellite link analyzed is the Synchronous Meteorological Satellite (SMS) currently being built by NASA/NOAA. Based on this analysis, platform transmitter power requirements are defined and required SNR margins delineated to combat the combined effects of high sea state variations and low elevation angle operation. Cost considerations based on the difference in platform requirements for each type of link are presented. (Author)

A71-31021 Wake induced flutter of circular cylinders - Mechanical aspects. Alan Simpson (Bristol, University, Bristol, England). *Aeronautical Quarterly*, vol. 22, May 1971, p. 101-118.

The class of cases wherein the mechanical support system for the leeward cylinder exhibits static coupling is studied using undamped flutter theory. It is demonstrated that the appearance of static coupling terms can lead to quite dramatic changes in the flutter characteristics and that considerable care must be exercised in the design and operation of wind-tunnel dynamic models if meaningful results are to be obtained. An Appendix deals with the general problem of mechanical coupling, using the normal coordinates approach, and aspects of the problem which bear on the sub-conductor oscillations phenomenon experienced on bundled overhead power transmission lines are highlighted. G.R.

A71-31022 Experimental study of the thermal wake interference between closely spaced wires of an X-type hot-wire probe. F. E. Jerome (British Columbia, University, Vancouver, Canada), D. E. Guitton (McGill University, Montreal, Canada), and R. P. Patel. *Aeronautical Quarterly*, vol. 22, May 1971, p. 119-126. 5 refs. Research supported by the Department of Transport of Canada; Defence Research Board of Canada Grant No. 9551-12.

A Disa X-type probe, with the wires 0.15 mm apart, is tested and found to have a static sensitivity to small angles of pitch, which is very significant for Reynolds numbers under 5 but becomes small for Reynolds numbers greater than 10. The experiments with the Disa X-wire probe were performed in the McGill 0.91 m x 0.61 suction wind tunnel. Two simple modifications were used in order to avoid the thermal wake effects of the X-wire probe in its original form. A modified probe, having the wires one wire length apart, is suggested. This probe was found to have no pitch sensitivity. G.R.

A71-31024 The strongly controlled aircraft. R. D. Milne and G. D. Padfield (Queen Mary College, London, England). *Aeronautical Quarterly*, vol. 22, May 1971, p. 146-168. 7 refs.

The analysis described shows how the motion of a strongly controlled aircraft can be described in terms of simpler subsystems. The sum of the dimensions of the subsystems is equal to the total dimension of the aircraft/control system. The technique, under suitable conditions, yields an approximation to all the modes of motion of the system. In the limit of infinitely strong control the results agree with Newmark's theory (1957). The theory of kinematic constraint serves as a useful indicator for the application of the approximation described. The role of the pilot in applying strong control is placed in the context of the general theory. G.R.

A71-31026 The dynamical behaviour of a flexible cable in a uniform flow field. R. R. Huffman (Whirlpool Corp., Benton Harbor, Mich.) and Joseph Genin (Purdue University, Lafayette, Ind.). *Aeronautical Quarterly*, vol. 22, May 1971, p. 183-195. 12 refs.

A nonlinear mathematical model for the study of the dynamics of an extensible cable subjected to aerodynamic forces generated by a uniform flow field is formulated. Solutions are found considering large displacement caused by suddenly applied loads (i.e., gusts, shock waves, turbulence) for a range of flow speeds and cable

lengths. Transition from overdamped to oscillatory motion is observed when flow speed and cable length are increased and decreased, respectively. The stability of the system is discussed.
(Author)

A71-31034 Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971. 286 p.

Details of satellite, aircraft, and rocket antenna systems intended for navigational, communications, and telemetry applications. Structural design features, materials specifications, and electrical characteristics are outlined for end-fed slotted waveguide arrays, blade antennas, omnidirectional cylindrical arrays of slot radiators, Luneberg lenses, conical spiral antennas, and various antennas developed to meet specific environmental and electrical requirements. Extensive theoretical and experimental research is described on the effects of radomes, polarization requirements, mechanical and electrical scanning procedures, numerical prediction of radiation patterns, and stabilization mechanisms.
T.M.

A71-31036 A high speed airborne scanning aerial with matched patterns. R. H. J. Cary and A. M. Munro (Royal Radar Establishment, Malvern, Worcs., England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 7-12.

Description of a navigational radar antenna consisting of an offset horn fed reflector and featuring choice of polarization and faster scanning for improved visual display. Right-hand and left-hand circular, vertical, and horizontal polarization modes are available, and the reception of cross-polarized components is possible in each case. The horn is so positioned as to reduce aperture blocking and to be of long focal length, enabling a minimum reflector curvature for minimum cross polarization. T.M.

A71-31038 An airborne electronically scanned X band narrow beam circular antenna array. R. H. J. Cary (Royal Radar Establishment, Malvern, Worcs., England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 19-24.

Three different electronically scanned, X-band, antenna array configurations which provide all-round coverage when mounted beneath the nose or fuselage of an aircraft are compared in order to evaluate the advisability of replacing a conventional, mechanically scanned 5-ft diam antenna. The configurations include (1) three separate planar arrays arranged in a triangular form, (2) a near-hemispherical sectional Luneberg lens antenna, and (3) a circular array of 240 radiators switched in a 120-deg arc of 80 radiating elements. The Luneberg lens antenna is the most suitable of the three configurations, but the overall conclusion is that none of the three offer enough advantages over the mechanically scanned system to be cost effective at present. T.M.

A71-31041 Antennas for sideways looking airborne radar. R. H. J. Cary (Royal Radar Establishment, Malvern, Worcs., England) and J. Thraves (EMI Electronics, Ltd., Feltham, Middx., England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 37-42.

Structural design concepts, mechanical stability requirements, and aircraft compatibility considerations are explained for airborne side-looking radar antennas consisting of end-fed slotted waveguide arrays. Control of the azimuth and vertical patterns is described in terms of slot positioning and spacing effects, the use of dielectric lenses and broadside horns, and the stacking of linear arrays. Methods used for indication of moving targets are outlined, together with mechanical solutions to the problem of compensating for aircraft roll, yaw, and other instabilities. T.M.

A71-31043 Flush mounted aeronautical antenna. G. A. Hockham (Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 49-53.

An experimental investigation has demonstrated that waveguide antennas are feasible at much lower frequencies than usual by using electrically small elements and without the necessity of completely loading the waveguide with high-permittivity material. A flush-mounted airborne antenna was designed which consists of a short length of waveguide with a thin dielectric plug in the aperture. The use of the plug results in a purely real input impedance which gives rise to complete energy transfer through the structure when matched to the feed. The plug also provides protection from the environment and provides continuity of the flange. Measured characteristics are given for operation at 5 GHz. T.M.

A71-31044 An airborne blade antenna for 26-100 MHz. C. E. Cooper (Chelton /Electrostatics/, Ltd., Marlow, Bucks., England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 54-59.

Description of a tunable antenna covering either 30-100 or 26-76 MHz by 35 or 45 individual bands, respectively. Individual bandwidth varies from less than 0.5 MHz up to 5 MHz at the low and high frequency extremes, respectively. Radiation is from an elevated plane whose capacitance is series-resonated by a combination of from one to six binary-related inductors, switched by miniature high-vacuum relays. The entire radiation-tuning-switching mechanism is contained within an aerodynamically shaped fiberglass shell. T.M.

A71-31046 An aerial module for the uhf band. G. Bagley (Royal Aircraft Establishment, Farnborough, Hants., England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 66-70.

Preliminary test results are given for an airborne communications system being developed in an attempt to determine the efficiency of a relatively low rf carrier power which is applied directly to the aerial. A composite aerial was mounted on the underside of a Hastings aircraft during the tests while rf drive, power supply and modulation were furnished by a modified 12 channel uhf equipment. Some field strength measurement data obtained on the ground for the communications system are given. V.Z.

A71-31047 Fincap communication aerials. J. Mahoney (Standard Telephones and Cables, Ltd., London, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 71-76.

An empirical approach to designing vhf/uhf fincap aerials is set forth and practical environmental tests of fincap aerials for vibration,

acceleration, waterproofness, salt corrosion, ice formation and compass safe distance are indicated. Radiation patterns and structural and impedance problems are covered. Simulation and scale models are essential in this fincap design technique. V.Z.

A71-31048 A review of helicopter aerial problems. W. A. Kelly (Ministry of Aviation Supply, London, England) and R. A. Burberry (Standard Telephones and Cables, Ltd., London, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 77-82.

Difficulties to be overcome for proper accommodation of all the required aerials on modern helicopters are discussed. The multiplicity of the aerials, their multiband designs, the extensive use of nonmetallic structures, and the increased complexity of airborne radio systems are noted as sources of aerial-siting problems. It is suggested that designers bear in mind the limitations of aerials and treat their siting problems not in isolation but as ingredients of helicopter designs as units. V.Z.

A71-31049 On the uncertainty limit of high speed electronic scanning. S. Cornbleet (Surrey, University, Guildford, Surrey, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 83-88. 5 refs.

Element error and angular error analysis for phase and frequency scanned arrays, covering linear arrays and static matrix-fed and monopulse arrays. An equation is given to show that an array element frequency discrepancy and thus an uncertainty in the beam position arise when the array pattern is scanned through an angle of 2 psi in T seconds. The nonexistence limit of angular uncertainty in the static case is shown to correspond to the classical time-frequency uncertainty relation T delta f = 1. V.Z.

A71-31053 Hf notch aerials for small aircraft. C. G. Fitzpatrick and R. A. Burberry (Standard Telephones and Cables, Ltd., London, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 112-117.

Investigation of notch antennas, which provide one solution to the problem of inefficient radiation at the lower end of the hf band. The notch antenna has the additional merit of minimal interference with primary aircraft structure. Work on a number of small (less than 50-ft length) high performance aircraft is described. F.R.L.

A71-31054 An airborne phased array for use in an ATC satellite system in L-band. W. M. Fraser and N. C. Williams (British Aircraft Corp., Ltd., Bristol, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 118-126.

Use of a phased array on board the aircraft to alleviate problems of power budget and vulnerability to multipath and interference. A phased array provides the required hemispherical coverage in a number of manually steered, high gain, narrow bandwidth steps. Major design constraints are aircraft mounting, airframe visibility, and pattern interference in addition to airline operator considerations. F.R.L.

A71-31055 A microstrip p.i.n. diode controlled L-band digital phase shifter. P. A. Matthews and D. Markopoulos (University College, London, England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 127-129.

Consideration of 3-bit phase shifters giving relative phase shifts of 180, 90, and 45 deg. Their purpose is to steer the beam from the phased array as the orientation of the aircraft relative to the satellite changes. Each phase shift bit uses a 3-dB coupler with two arms terminated by switching circuits. The 3-dB couplers considered are the two-branch line coupler and the hybrid ring coupler. Both these couplers may be fabricated by using thin or thick film techniques. F.R.L.

A71-31056 A high efficiency Cassegrain aerial design. C. Dawson (Elliott-Automation Radar Systems, Ltd., Borehamwood, Herts., England). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 130-135.

Description of a compact Cassegrain antenna which has a high efficiency/narrow beam characteristic which illuminates the horizon without excessive ground illumination. It has an oval-shaped aperture; only the central circular section has a uniform amplitude distribution. This configuration was chosen in order to make optimum use of radome space. F.R.L.

A71-31060 The antenna performance of the L-1011 Tristar. F. R. Zboril (Lockheed-California Co., Burbank, Calif.). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 157-163.

One-year test results are discussed for the antenna arrangement developed for the aircraft. The arrangement was found to be well consistent with weight, aerodynamic and structural design requirements. It is anticipated that the antenna arrangement will provide adequate radiation patterns in the complexity of the aircraft structure in compliance with the required performance of the L-1011 communication and navigation systems. V.Z.

A71-31062 Design of a linear array of blade antennas for aircraft-satellite communication. J. P. B. Vreeburg, O. B. M. Pietersen, and F. Klinker (National Luchtvaartlaboratorium, Amsterdam, Netherlands). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 176-185.

The power gain of an antenna system can be expressed in wave parameters by assuming that the system can be considered as a linear microwave network. Various simplifications are made resulting in an expression for the array factor which takes into account mutual effects of the elements. These mutual influences are determined by a small number of measurements on the array in its simulated electrical environment. Comparison with measured values shows that the side lobe levels of the radiation pattern of the array are predicted better than when mutual effects are neglected. It is expected that the information from an array consisting of a few elements is sufficient to predict the performance of a similar array with more elements. (Author)

A71-31074 The L band aircraft antenna of the 'Dioscures System' (Electronic scanning for satellite-aided navigation system). B. Dorier (SNECMA, Suresnes, Hauts-de-Seine, France). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings.
London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 259-264.

Discussion of an L band antenna which is based on the use of a convex array consisting of left- and right-hand circularly polarized radiating elements and of static electronic steering circuits. This makes it possible to scan two antenna beams independently in two directions. Such an aircraft-integrated equipment permits simultaneous L band radio links with two synchronous satellites. A ground station can then ensure accurate aircraft location by electronic methods. Practically worldwide coverage is possible with 6 synchronous satellites. F.R.L.

A71-31075 A circular slot aperture with arbitrary polarization for aerospace applications. Richard E. Herskind (Avco Corp., Systems Div., Wilmington, Mass.). In: Institution of Electrical Engineers, Conference on Aerospace Antennas, London, England, June 8-10, 1971, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication, No. 77), 1971, p. 265-275.

Description of a one-wavelength circular slot aperture radiation from the surface of a circular cylinder. It is shown that the single circular slot has radiation characteristics which offer a lower ellipticity ratio than that of a crossed linear slot radiating under similar conditions. It is suggested that a circular slot aperture can be used to approximate the pattern characteristics of an Archimedian or log spiral on a cylinder over a wide range of frequencies. F.R.L.

A71-31076 Army helicopter performance trends. Richard B. Lewis, II (U.S. Army, Edwards AFB, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 500.* 10 p. 15 refs. Members, $1.25; nonmembers, $2.00.

Performance data of seven different types of current Army rotorcraft, based on U.S. Army Aviation Systems Test Activity test experience, are summarized. Nondimensional presentations are employed to generalize the data. Several aspects of both hovering and forward flight performance are first discussed. Out-of-ground effect hover power required, compressibility effects on hovering performance, and the influence of ground proximity are examined. Level flight power required, drag effects, and compressibility trends in forward flight are shown. Finally, a discussion of autorotational descent performance is presented. O.H.

A71-31077 Full-scale proprotor development. Kenneth G. Wernicke and H. Kipling Edenborough (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 501.* 16 p. 27 refs. Members, $1.25; nonmembers, $2.00.

An advanced-design, 25-foot-diameter, flightworthy proprotor was tested in the NASA-Ames Large-Scale Tunnel, and reached a simulated speed of 408 knots. The tests were part of an Army/NASA Proprotor Technology Program, the objective of which is to develop technology for an aircraft which will meet the civil and military need for VTOL transportation. The proprotor, suitable for a demonstrator aircraft, displayed good stability and performance. Measured damping of the major coupled modes agreed with theoretical predictions and one-fifth-scale model tests. Propulsing efficiencies exceeding 90% were measured and agreed closely with theory. Operation of the proprotor, satisfactory in each flight mode, met or exceeded all design requirements. The proprotor is ready for flight test. O.H.

A71-31078 * Horizontal stoppable rotor conversion. George A. Watts (Lockheed-California Co., Burbank, Calif.) and James C. Biggers (NASA, Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 502.* 12 p. 6 refs. Members, $1.25; nonmembers, $2.00. Army-supported research; Contract No. NAS 2-5168.

The behavior of a specially stiffened hingeless rotor operating at discrete rpm, over a wide range of rpm, at airspeeds sufficiently high for conversion from helicopter to airplane flight to take place has been studied analytically and experimentally. The rotor shaft was fixed against pitching and rolling motion in both studies. Aeroelastic derivatives of the 33-foot, 3-bladed rotor with irreversible swashplate control were predicted analytically and verified by tests over an airspeed range of 50 to 120 knots in the Ames 40 x 80 foot wind tunnel. A constant speed gyroscope was introduced into the cyclic feathering system and the swashplate position control released so that the swashplate became free to take up positions dictated by rotor and gyroscope moment equilibrium. The system automatically trimmed hub moments to near zero. Rotor control was then introduced in the form of moments applied to the free swashplate, and the control effectiveness was measured. The control system is shown to be stable, to provide almost zero phase shift and to exhibit nearly constant hub moment to control moment gain over wide ranges of rpm and advance ratio. (Author)

A71-31079 HLH primary flight control system design. Richard W. Sanford, Peter R. Venuti, and Derek Wood (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 503.* 15 p. Members, $1.25; nonmembers, $2.00.

Demonstration that the most attractive primary flight control system for the Heavy Lift Helicopter (HLH) is a fly-by-wire electrical analog of the conventional mechanical control linkage. This type of system can be mechanized using known techniques, and in many cases identifiable components. It is pointed out that the only remaining step required for acceptance of this fly-by-wire system is construction and flight demonstration of a complete operational prototype. M.M.

A71-31080 Development of the ABC rotor. Robert K. Burgess (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 504.* 17 p. 6 refs. Members, $1.25; nonmembers, $2.00.

Description of the development of the ABC rotor from conception through small-scale model wind-tunnel testing, full-scale analysis, design, fabrication, and ultimate wind-tunnel testing of a 40-ft-diam rotor in a 40 x 80 ft wind tunnel. The principal design tradeoffs resulting from the early analyses and testing are discussed, along with their expected impact on the full-scale rotor characteristics. Materials and manufacturing methods employed are covered, including the more important difficulties surmounted during the development. The major test programs are outlined, including blade balancing, turbine test bed operation and full-scale wind-tunnel testing in the wind tunnel at speeds up to 180 knots and at advance ratios up to .91. A.B.K.

A71-31081 * Application of a lifting-surface theory to the calculation of helicopter airloads. Wayne Johnson (MIT, Cambridge, Mass.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 510.* 10 p. 14 refs. Members, $1.25; nonmembers, $2.00. Grant No. NGR-22-009-303; Contract No. N 00019-69-C-0219.

A method is described for the application of a lifting-surface solution of a model problem for vortex-induced airloads to the calculation of the airloading on a helicopter rotor blade. A comparison of the loads calculated for a simplified vortex and rotor blade configuration, using the lifting-surface solution and the usual lifting-line theory, indicates that the former should be used for vortices closer than about five chord lengths to the blade. A comparison of the lifting-surface-theory results with experimental data shows good agreement. Some results of the calculation of helicopter airloads using the lifting-surface-theory solution are presented. These results indicate that a very accurate wake geometry model will be required to make full use of the accuracy of the

lifting-surface-theory solution. They also show that there is yet much more to learn about the phenomenon of vortex/blade interaction. (Author)

A71-31082 # A study of the effects of nonuniform swash-plate stiffness and out-of-blade track on rotor dynamics and stability. Vincent J. Piarulli (Rochester Applied Science Associates, Inc., Rochester, N.Y.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 511.* 12 p. Members, $1.25; nonmembers, $2.00.

This paper presents the results of a study directed at investigating the effects of an anisotropically mounted flexible swash-plate, including blade out-of-track, on the vibratory and mechanical stability characteristics of helicopter rotor systems. The analysis which has been developed is based on a combined Laplace transform and associated matrix approach. The program yields complex eigenvalues which indicate frequency and rate of growth or decay of a natural mode of the complex system. Blade modal response and swash-plate motion corresponding to a given eigenvalue are predicted. (Author)

A71-31083 * # The method of multiblade coordinates in the linear analysis of lifting rotor dynamic stability and gust response at high advance ratio. Sheng-Kuang Yin and Kurt H. Hohenemser (Washington University, St. Louis, Mo.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 512.* 14 p. 7 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 2-4151.

The dynamic linearized or perturbation problem of a lifting rotor with rigid flapping blades having elastic restraints, with rigid hub and with four types of control feedback is solved for high rotor advance ratio with the method of multiblade generalized coordinates, using the Floquet state transition matrix. Numerical examples assuming three and four blades per rotor show considerable differences in the modal function columns and in the gain factors at the stability limits depending on the number of blades. A rotor representation with constant coefficients in the differential equations for the multiblade coordinates gives for a rotor advance ratio of .8 a good approximation for some modes but does not account for the substantial effects of blade number and is in some cases unconservative. The method of multiblade coordinates is applied to the analysis of random blade flapping from continuous atmospheric turbulence to obtain the effectiveness of the various feedback systems in reducing the root mean square flapping amplitudes. (Author)

A71-31084 Prediction of control loads due to blade stall. F. J. Tarzanin, Jr. (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 513.* 14 p. 12 refs. Members, $1.25; nonmembers, $2.00.

Description of a semiempirical aerodynamic theory for eliminating the prime limitation to the operational boundaries of helicopters represented by the sharp growth of control loads due to retreating-blade stall. The theory includes unsteady aerodynamics with linear shed wake, stall hysteresis for lift, drag, and pitching moment, and three-dimensional flow. This theory was incorporated into an aeroelastic rotor analysis program that can now predict the high pitch link loads associated with blade stall. This aeroelastic rotor analysis was then used to study how the aerodynamic and structural characteristics of the rotor system influence the stall-induced high control loads. This investigation led to suggestions that may significantly reduce or eliminate stall flutter loads. M.M.

A71-31085 Preliminary development of an active transmission isolation system. Paul W. von Hardenberg and Paul B. Saltanis (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 514.* 11 p. Members, $1.25; nonmembers, $2.00.

An analytical/ground test program has succeeded in isolating vertical and in-plane main rotor-head vibratory forces from a helicopter fuselage without introducing static deflection. This was achieved by using a hydropneumatic, servo-centered isolation system installed at the transmission/airframe interface. Shake tests showed overall reductions of approximately 70% in fuselage response to main rotor 6p force excitations using a CH-53A test vehicle. These tests showed that significant reductions can be achieved over the complete range of excitation frequency above the isolator resonances. Step load and shake tests demonstrated that the isolated aircraft had near-rigid characteristics for transient and 1p excitations. The aircraft isolator modes were stable, and analysis established that aircraft mechanical stability characteristics remain unchanged. (Author)

A71-31086 Analytical investigation of the effects of blade flexibility, unsteady aerodynamics, and variable inflow on helicopter rotor stall characteristics. E. D. Bellinger (United Aircraft Research Laboratories, East Hartford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 520.* 14 p. 21 refs. Members, $1.25; nonmembers, $2.00.

An analytical study was conducted to investigate systematically the relative importance of blade flexibility, unsteady aerodynamics, and variable inflow (with and without wake distortions) in determining predicted helicopter rotor stall characteristics. The theoretical results of this study were compared with corresponding full scale wind tunnel results for the H-34 rotor system. Various levels of rotor stall were investigated at forward speeds of 117 knots and 194 knots. The classical theory (rigid blades, steady aerodynamics, and constant inflow) produced good correlation at nominally unstalled operating conditions. However, rotor lifts significantly lower than the test values were predicted at high blade angles of attack. The use of unsteady airfoil data provided the most significant improvement in correlation by allowing higher section lift coefficients to be reached due to the 'stall delay' phenomenon associated with unsteady operating conditions. The primary effect of blade flexibility was due to blade torsional deflections, which, as with blade pitch changes, had a direct effect on performance. It was found that the deflections, and therefore performance, were sensitive to the chordwise location of the mass axis, indicating the need for accurately defining this parameter. Variable inflow, although producing significant changes in the angle of attack distribution over the disk, did not appreciably affect rotor performance. (Author)

A71-31087 * Detailed aerodynamic measurements on a model rotor in the blade stall regime. Richard K. Fisher, Jr. (Boeing Co., Philadelphia, Pa.) and W. J. McCroskey (U.S. Army, Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 521.* 14 p. 13 refs. Members, $1.25; nonmembers, $2.00. Army-supported research; Contract No. NAS 2-5473.

An investigation of retreating blade stall on a model helicopter rotor has shown that a series of separate pressure distribution and boundary layer events lead up to complete blade stall. This experimental picture of the local flow field was gleaned from measurements of blade element pressure and skin friction distributions, surface streamline directions, and local angle of attack. The results of the experiment also demonstrate the limitations of contemporary empirical corrections in accounting for three-dimensional and unsteady effects on classical airfoil data after complete stall occurs. The measurements further indicate that some of the most significant unknowns in the problem are the local blade-element velocities and angles of attack. From the results of this test, it is postulated that the basic retreating blade stall mechanisms become increasingly dominated by dynamic vortex-shedding from the leading edge as advance ratio increases. (Author)

A71-31088 * Tip vortices - Velocity distributions. N. A. Chigier and V. R. Corsiglia (NASA, Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 522.* 14 p. 9 refs. Members, $1.25; nonmembers, $2.00.

Detailed measurements of velocity distributions have been made in vortices generated at the tip of a square-tip, 18-in.-chord, 48-in. semispan blade mounted in the NASA-Ames 7- by 10-foot wind tunnel. Time-mean-average velocity components were measured using a triple-sensor hot wire probe operated by three separate anemometers. With the blade at an angle of attack of 12 deg, traverses were made through the vortex centers at six axial stations, corresponding to x/c ratios of -0.75, -0.50, -0.25, 0.0, 2.0, and 4.0, where x/c equal to 0 is the trailing edge. The dimensions of the vortex increase with distance downstream over the blade surface, and at x/c equal to 4 the vortex core radius is 0.7% of the span. Maximum circumferential velocity of 42% of mainstream velocity was measured at x/c equal to -0.50, over the wing surface, followed by decay to 24.0% of mainstream velocity at x/c equal to 4. Axial velocity in excess of free-stream velocity was measured in the vortex core with maximum axial velocity of 140% of free-stream velocity at x/c equal to -0.25. The vortex center moved inboard from the tip at x/c equal to -0.75 to 2.9% of span at x/c equal to 4. A secondary vortex was located outboard of the main tip vortex. (Author)

A71-31089 * # A method for predicting helicopter wake geometry, wake-induced flow and wake effects on blade airloads. S. G. Sadler (Rochester Applied Science Associates, Inc., Rochester, N.Y.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 523.* 11 p. 16 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 1-8448.

Rotor wake geometries are predicted by a process similar to the start-up of a rotor in a free stream. An array of discrete trailing and shed vortices is generated. Vortex strengths correspond to stepwise radial and azimuthal blade circulations, and this array is limited to an arbitrary number of azimuthal steps behind each blade. The remainder of the wake model for each blade is an arbitrary number of trailed vortices. Vortex element end points are allowed to be transported by the free stream and vortex-induced velocities. Wake geometries, wake flows, and wake-induced velocity influence coefficients for use in blade loads calculations were determined and measured. Computed and measured average wake velocities are compared and indicate that the wake model is satisfactory for nonuniform inflow calculations. These velocities and the corresponding computed wake geometries are discussed. Wake geometries are presented and discussed for various rotor configurations, including rotor systems having shaftwise separations, nonuniform azimuthal spacing, counter rotating blades with different rotor lengths and other physical differences. (Author)

A71-31090 Forward flight performance of a coaxial rigid rotor. Vincent M. Paglino (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 524.* 16 p. 7 refs. Members, $1.25; nonmembers, $2.00.

A brief review is presented of basic aerodynamic principles differentiating conventional rotors and coaxial rigid rotors. Performance data obtained from a recent test of a full-scale coaxial rigid rotor (ABC) system in the NASA/Ames wind tunnel are given and discussed. These data, ranging to advance ratios of .91, are compared with conventional rotor data and with blade element rotor theory at various stages of refinement. A parametric study is presented to illustrate the influence of a number of blade geometric properties on ABC propulsive efficiency. At all advance ratios tested, the ABC system was aeromechanically stable; it had superior loading capability and more favorable stall characteristics when compared to an H-34 rotor. Of the geometric changes investigated, blade twist was found to have largest influence on predicted performance. O.H.

A71-31091 Day and night fire power of the Cheyenne. Bernard J. Merritt (U.S. Army, St. Louis, Mo.) and John C. Kirby (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 530.* 13 p. Members, $1.25; nonmembers, $2.00.

The Army/Lockheed Cheyenne attack helicopter, with its integrated complement of armament, fire control, and navigation equipment, has been designed to obtain high first round hit probabilities at long ranges. The fire control system has been developed to include a night capability with approximately the same accuracy as in daylight. The details of the Cheyenne weapon system and the system engineering tools used during the design/development process are discussed. O.H.

A71-31092 An attack helicopter weapons delivery computer. John A. Simpson (United Aircraft Corp., Radar Research Group, Norwalk, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 531.* 7 p. Members, $1.25; nonmembers, $2.00.

A system of computation suitable for both bombing and gun laying is described. It is based upon the use of the planar distributed function generator, and gives a general, closed-form, virtually instantaneous solution capability. It can provide an automatic or manual release for bombs, or laying cues for guns, in milliseconds. It is shown that by using the low-cost analog system described, mission tactics will not be constrained and the helicopter's guns and bombs can be deployed with full flexibility. The computer is essentially made of solid-state components and photoetched metal film resistors. It is thus inherently reliable, and the projected mean time between failure is 4,070 hr. G.R.

A71-31094 # AN/ASN-86 Inertial Navigation Set. J. B. Hughes (Litton Industries, Inc., Guidance and Control Systems Div., Woodland Hills, Calif.) and R. W. Creed (U.S. Army, Avionics Laboratory, Fort Monmouth, N.J.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 533.* 14 p. Members, $1.25; nonmembers, $2.00.

Description of a purely inertial navigation system consisting of an inertial platform, a digital computer, and a control-indicator unit. The computer has the necessary interface circuitry for interconnection to 11 other systems. The control-indicator unit provides capability to enter or read out position information in lat/long or UTM (universal transverse mercator) coordinates. It also contains controls for performing all navigation operations. The system has a built-in self test which is capable of isolating malfunctions to the unit level. Technical details of the system and a description of the system's operational application to both fixed-wing aircraft and helicopters are presented. It is considered that there should be many commercial applications of this equipment. F.R.L.

A71-31095 The night rescue terminal navigation problem. Cecil S. Richardson (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 534.* 11 p. 10 refs. Members, $1.25; nonmembers, $2.00.

In night rescue, visual contact has to be replaced by instrumented techniques that enable precise destination definition, approach, and hover. Initial efforts culminated in design, development, and test of the Limited Night Recovery System (LNRS), for the HH-53 aircraft. The functional requirements of improved sensors for homing and approach have been presented along with functional requirements for a positional hover sensor system. A currently available set of sensor systems has been described and a LORAN retransmission concept for solving some of

the remaining problem areas has been presented. Sufficient information has been provided to enable prospective manufacturers of terminal navigation sensor aids to initiate development of solutions to the night rescue terminal navigation problem as it applies to the current rescue helicopter system. G.R.

A71-31096 Synthesis of an electromechanical control system for a compound hingeless rotor helicopter. R. L. Heimbold (Lockheed-California Co., Burbank, Calif.) and C. D. Griffith (Sperry Rand Corp., Flight Systems Div., Phoenix, Ariz.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 536.* 13 p. Members, $1.25; nonmembers, $2.00.

A study was conducted to configure an electromechanical control system for a hingeless rotor compound helicopter. Emphasis was placed on control system synthesis using the root locus method with transfer functions derived from a linear model of the six airframe degrees of freedom and the fundamental rotor flapping modes. An attitude or quasi-attitude feedback is required to counteract the strong divergent tendency of hingeless rotor about the pitch axis. Feedback from both pitch rate and pitch hub moment were evaluated and the latter was chosen for use in the pitch axis because of its ability to relieve high airframe moments when in ground contact as well as to provide damping for the attitude feedback. The roll axis is stabilized with rate feedback alone. Effects of the control system feedbacks on loads and rotor stability are briefly covered. An analogue computer program was employed to refine control system parameters. (Author)

A71-31097 IFR hover for heavy lift helicopters with slung load. William P. Keane and R. Joseph Milelli (U.S. Army, Avionics Laboratory, Fort Monmouth, N.J.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 540.* 11 p. Members, $1.25; nonmembers, $2.00.

A man-machine simulation program has been completed which indicates the feasibility of developing an IFR hover capability with properly chosen sensors, controls and displays. Display alternatives included a simple hover indicator, a flight director and a fully integrated multicolored CRT display. IFR hover was shown to be a reasonable task from a pilot workload standpoint. A wide range of performance was achieved with the best systems providing a helicopter hover accuracy from 1 to 2 feet. All tests were performed under simulated gust conditions. The results obtained indicate the feasibility of accomplishing more precise construction and logistic tasks by the helicopter in the near future through the use of instrument hover. The unloading of containerized ships by the helicopter is a possible application with both commercial and military advantage. G.R.

A71-31098 A stability and control theory for hingeless rotors. H. C. Curtiss, Jr. (Princeton University, Princeton, N.J.) and N. K. Shupe (U.S. Army, Avionics Laboratory, Fort Monmouth, N.J.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 541.* 12 p. 10 refs. Members, $1.25; nonmembers, $2.00.

Some fundamental aspects relating to the prediction of the stability and control characteristics of hingeless rotor helicopters are discussed. In particular, areas are examined which require a different analytical treatment from the articulated rotor. Three areas are examined as having potential importance. First, the induced flow field of the rotor is considered. It is shown that the hingeless rotor will give rise to a first harmonic variation in the induced flow field which can be included in the analysis through an effective Lock Number. The second area involves consideration of the number of flapwise bending modes required to represent the hingeless rotor for stability and control studies. It is desirable to include at least two flapwise bending modes to predict hub moments. Third is the question of blade/fuselage dynamic coupling, which arises owing to the more powerful hub moments which are generated by a hingeless rotor. Blade/fuselage coupling can be of considerable importance. (Author)

A71-31099 Feel augmentation and sensitivity control in high speed helicopters. Sean J. O'Connor (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National..V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 542.* 8 p. Members, $1.25; nonmembers, $2.00.

Handling qualities problems associated with changing control sensitivity accompany the increased speed capabilities of high performance helicopters. Two approaches to the problems have been presented. In the case of the pitch control, a constant pitch stick force per resultant load factor characteristics has been implemented. This feel augmentation approach masks the sensitivity problem effectively. In the case of the collective control, the collective blade pitch vs stick displacement transient has been modified. This approach compensates for the increased sensitivity to changes in collective setting at high speeds. A number of conclusions are presented which have been gathered from extensive flight testing. G.R.

A71-31100 Rotor stability derivatives determined from wind tunnel tests of an instrumented helicopter. Robert E. Rohtert and Sally V. LaForge (Hughes Tool Co., Culver City, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 543.* 10 p. Members, $1.25; nonmembers, $2.00. Contract No. NOw-66-0657-f.

Tests of an operational prototype OH-6A helicopter were conducted in the Ames 40- by 80-foot wind tunnel. From these tests, experimental stability derivatives were obtained. Analytical studies were conducted using a simplified digital computing technique for comparison with these wind tunnel experimental data. The results of this investigation indicated that the simplified computer program can be used to predict rotor stability derivatives. The agreement between theory and test was excellent at advance ratios from 0.25 to 0.35, even though the theory used an assumed uniform induced velocity rather than a variable induced velocity. A limited amount of data was obtained at an advance ratio equal to 0.4, and the results are inconclusive. The numerical program, which also was simplified in not accounting for blade flexibility, predicted the blade flapping for unstalled conditions but did not predict the large increase in blade flapping due to retreating tip stall. However, comparison of data and theory indicated that retreating tip stall did not significantly change the rotor pitching moment about the aircraft center of gravity. Pitching moment derivatives, horizontal stabilizer on and off, were used to estimate the stabilizer effectiveness and downwash. (Author)

A71-31101 * Factors affecting handling qualities of a lift-fan aircraft during steep terminal area approaches. Ronald M. Gerdes and Charles S. Hynes (NASA, Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 544.* 9 p. Members, $1.25; nonmembers, $2.00.

The XV-5B lift-fan aircraft was one of four NASA V/STOL research vehicles recently used to explore the factors affecting handling qualities in the terminal area. The objectives of the program were to define the limitations of powered-lift VTOL aircraft that prevent full exploitation of their low-speed capabilities, and to develop operationally feasible techniques for performing simulated precision instrument landing approaches. A 10 deg ILS approach task was selected as representing a typical steep-angle approach with which to explore these problems. Three major phases of the approach were considered: (1) interception of the glide slope at 1500

ft, (2) glide-slope tracking, (3) deceleration along the glide slope to a spot hover. Variations in airplane deck angle, deceleration schedule, and powered-lift management were studied to assess their effects on handling qualities. The overall descent perfo nance envelope was identified on the basis of such operational limitations as fan stall, maximum comfortable descent rate, and controllability restrictions. The 'collective-lift' stick provided precise glide-slope tracking capability (to within plus or minus 20 ft) through direct control of fan lift, but the pilot tended to 'chase' glide slope if engine power (throttle) was modulated. The pilot preferred a deck-parallel (to glide slope) attitude, for which he used powered lift (collective) to control glide slope and pitch attitude (stick) to keep the angle of attack near zero, which minimized his workload. This technique also provided a greater angle-of-attack margin from fan stall. Workload was reduced when the deceleration schedule was delayed until the aircraft was well established on the glide slope, since thrust vector changes induced flight path disturbances. (Author)

A71-31102 Evaluation of rotor controls designed for increased safety. Lawrence D. Barrett and John C. Mack (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 550.* 10 p. Members, $1.25; nonmembers, $2.00.

Experience gained during analysis, design, and testing of failsafe helicopter rotor controls is reviewed. Analysis of field experience and accident and discrepancy reports emphasized the need for damage-tolerant mechanical components with special features that make maintenance errors less likely to occur. Flight control experience in transport aircraft and design requirements of current helicopter specifications also helped formulate design guidelines. A mechanically redundant rotor control system with inherent component failure warning is shown and discussed. From this design, four major components were selected. These components were designed, fabricated and fatigue-tested. Test results were measured against the criteria that secondary load paths should have fatigue ..ves many times that of the normal reinspection interval, and that load path condition should be determinable without special diagnostic equipment. The test specimens met these criteria. It is concluded that the designs represent practical approaches to failsafe and damage-tolerant rotor control components. (Author)

A71-31103 Fail-safety for the H-46 rotor blade. George H. Thompson and William L. Weiss (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 551.* 8 p. Members, $1.25; nonmembers, $2.00.

Description of a system to make the H-46 rotor blade fail safe which has been designed, fabricated, qualified, and placed in service. This system, designated ISIS (Integral Spar Inspection System), is a continuously functioning inspection system, integral to the rotor blade, which will detect spar cracks in the early stages. A ground inspection at each rotor shutdown will provide ample warning of impending blade fracture. This system has provided fail-safety for an existing structure with little modification. The developmental testing and analytical techniques resulting from this program have broad application to the achievement of structural fail-safety in existing as well as new helicopter component designs. F.R.L.

A71-31104 Size effects on the design of large rotor systems. Henry G. Smith (Hughes Tool Co., Culver City, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 552.* 12 p. 11 refs. Members, $1.25; nonmembers, $2.00.

Review of the fundamental effects of size upon the relationship of the rotor system structural and dynamic parameters to weight. Of particular concern are the significant deviations from structural and dynamic scaling similarity that occur as a result of the degree to which cube-square law weight growth is avoided. The effects of blade loading, disk loading, tip speed, number of blades, blade width/sq ft, etc., are discussed. Trends toward new types of rotor retention and component design configurations to avoid size-effect weight penalties, such as sandwich construction, multicell structures, advanced composites, and articulated hub/retention systems are reviewed. It is concluded that the changes in the structural and dynamic parameters of rotor systems due to large size increases are fundamental in nature and will require thorough investigation and understanding before it is possible to arrive at the optimum design. F.R.L.

A71-31106 Preliminary design methods of V/STOL prop/rotors. Warren K. Stratton and Richard B. Freeman (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 554.* 7 p. Members, $1.25; nonmembers, $2.00.

A method is presented for the rapid evaluation of the potential for composite materials applied to V/STOL prop/rotors. The results are displayed in a form suitable for easy comparison with criteria and for selection of those material options with the best potential. The parametric effect that material properties have on frequencies and weight is determined using Southwell coefficients. Blades which meet the frequency requirements are then evaluated in terms of strength requirements. O.H.

A71-31107 Factors affecting fuel control stability of a turbine engine/helicopter rotor drive system. C. Fredrickson (Boeing Co., Vertol Div., Philadelphia, Pa.), K. Rumford (Avco Corp., Lycoming Div., Stratford, Conn.), and C. Stephenson (AVSCOM, St. Louis, Mo.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 560.* 10 p. Members, $1.25; nonmembers, $2.00.

Despite positive results from all normal stability criteria, the interaction of rotor, engine and control on the Boeing/Vertol CH-47C helicopter resulted in unacceptable torque and fuel flow oscillation in early flight test aircraft. A flight test program was undertaken and analytical capability at Lycoming and Vertol was upgraded to determine the cause of the oscillations. To analytically reproduce the phenomenon, inclusion of the hydraulic spring effect of the rotor blade lag damper, in addition to its normal damping representation, was found to be necessary. Based on this analysis, fuel control gain and time constant changes were suggested, evaluated in flight test, and a solution found. (Author)

A71-31108 Turbofan engine considerations for reaction drive rotors. R. J. Sullivan (Hughes Tool Co., Aircraft Div., Culver City, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 561.* 7 p. 8 refs. Members, $1.25; nonmembers, $2.00.

Optimum combinations of major turbofan engine and rotor variables necessary to obtain a good helicopter design are examined. It is found that blade duct area must be large enough to permit flow at a reasonable duct Mach number. The resultant rotor solidity must not be so high as to cause excessive blade profile power and rotor weight. In addition, fuel consumption must be considered. An arbitrary family of turbofan engines is studied in a simplified manner to illustrate the relationship of the variables. It is shown that a value of rotor solidity that is a good compromise of aerodynamic, thermodynamic, and mission considerations can be obtained with the newer, high-compression turbofan engines of low (0.7 to 0.8) bypass ratio. O.H.

A71-31109 VTOL propulsion system development. Paul C. Setze, Jacob L. Browne, and Robert C. Turnbull (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C.,*

May 19-21, 1971, Preprint 562. 11 p. Members, $1.25; nonmembers, $2.00.

Several major aspects that have to be taken into account in designing VTOL propulsion systems powered by turboshaft engines are discussed. General features of these systems and their operation are outlined. Problems involved in the system development - i.e., design requirements, development program planning, component development, system integration development and qualification - are examined in detail. Detailed attention is also given to system vibration, in particular, to vibration analyses using a computer model, and to vibration testing. O.H.

A71-31110 Strain gauge torquemeters for use in helicopter transmission systems. Dennis P. Hames (British Hovercraft Corp., Ltd., Experimental and Electronic Laboratories, East Cowes, Isle of Wight, England). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 563.* 11 p. Members, $1.25; nonmembers, $2.00.

The use of a strain gauge torquemeter as the primary power indicating instrument in a helicopter gives the pilot a direct and accurate indication of the torque in the transmission system, and provides several advantages for the helicopter designer and operator. An accuracy of indication of plus or minus 1-1/2% of full load torque, under all operating conditions, has been achieved with production equipment. Resistance foil strain gauges are attached to the shaft transmitting torque. The electrical supply to the rotating shaft and the output signal from it are inductively coupled to an electronic amplifier unit through a rotating transformer assembly. The pilot is given an immediate audible warning of overtorque. Torquemeters operating at shaft speeds to 30,000 rpm are described. G.R.

A71-31111 Results of high-speed flight research with the high performance UH-1 compound helicopter. Walter O. Sonneborn and Louis W. Hartwig (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 570.* 18 p. 6 refs. Members, $1.25; nonmembers, $2.00. Contract No. DA-44-177-AMC-364(T).

This paper discusses a high-speed compound-helicopter flight research program. This program was conducted to determine the behavior of rotors at combinations of advance ratios and advancing-blade tip Mach numbers beyond those attainable in existing full-scale wind tunnels. A level flight speed of 274 knots was achieved with a two-bladed semirigid rotor. A four-bladed flexbeam rotor was also evaluated at speeds up to 220 knots. An integrated control system allowed inflight changeover from helicopter to airplane-type controls - i.e., from tail rotor and longitudinal cyclic control to a rudder and a stabilator with the longitudinal swashplate fixed. Results in the areas of structural loads, vibrations, performance, control and stability, and correlation of flight and wind-tunnel data are discussed. (Author)

A71-31112 The Boeing Model 347 advanced technology helicopter program. Frank H. Duke and W. Euan Hooper (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 571.* 10 p. Members, $1.25; nonmembers, $2.00.

This program consists of an integrated effort covering analysis, simulation, wind tunnel, whirl tower and bench test, plus the modification of a CH-47 airframe to permit flight verification and demonstration of advanced technology. The program consists of two phases. The first phase will explore the capability of the pure helicopter configuration, and the second phase will investigate the potentials of the winged helicopter. The prime objective of the 347 program is to integrate recent transport helicopter experience with the latest technology and demonstrate a helicopter with improved stability and control, reduced noise and vibration levels, and a flight path control system incorporating extended navigation and IFR (instrument flight rules) capability, resulting in a reduced pilot workload. M.M.

A71-31113 United States Coast Guard evaluates hovercraft. Thomas C. Lutton (U.S. Coast Guard, Air Cushion Vehicle Evaluation Unit, San Francisco, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 572.* 7 p. Members, $1.25; nonmembers, $2.00.

When three Navy SK-5 air cushion vehicles became available in late 1969, the Coast Guard commenced an expanded ACV evaluation program. The first two hovercraft were scheduled for operational evaluation in the San Francisco Bay area and the third for Arctic trials at Point Barrow, Alaska. Tentative results of the evaluation in a number of fields are discussed including search and rescue, aids to navigation, law enforcement/oil pollution, marine safety, and logistics. An analysis of the relative effectiveness of the ACV compared to helicopters and boats is also presented. The greater speed advantage of the ACV over the Coast Guard's patrol boats makes it particularly attractive in response time and search area covered in responding to search and rescue. G.R.

A71-31114 Army/Navy operational evaluation of offshore discharge of containerships. L. J. McConnell (U.S. Army, Washington, D.C.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 573.* 5 p. Members, $1.25; nonmembers, $2.00.

A detailed discussion of the offshore discharge of containerships by helicopter is presented. It is shown that while helicopters demonstrated a virtually all weather, day and night capability to transport the containers, the capability of the current helicopter is limited to containers of ten tons gross weight. Z.W.

A71-31115 AH-56A vehicle development. J. F. Johnston and J. R. Cook (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 27th, Washington, D.C., May 19-21, 1971, Preprint 574.* 11 p. Members, $1.25; nonmembers, $2.00.

The rotor stability and handling qualities of the AH-56A compound helicopter are discussed. Four different development areas are considered. The first two involve the dynamics of rigid or hingeless rotors: the 1P x 2P phenomenon of produced blade flapping and in-plane motions which compromised the blade feathering feedback at reduced rpm, and the 'hop' phenomenon at near one-half cycle per revolution which involves both the cyclic and the collective modes of rotor and body motion. The remaining two areas, in which new data were added, concern antitorque rotor effectiveness and pilot/vehicle matching for maximum roll rates in nap-of-the-earth flight. O.H.

STAR ENTRIES

N71-24351# Army Foreign Science and Technology Center, Charlottesville, Va.
PARACHUTE [PARASHYUT]
A. Khorobrykh 24 Sep. 1970 14 p Transl. into ENGLISH from Starshina-Serzhant (USSR), no. 8, 1969 p 20–22
(AD-719480; FSTC-HT-23-400-70) Avail: NTIS CSCL 1/3

Brief historical remarks concerning parachute development in the Soviet Union are followed by a functional description of the basic components of standard personnel parachutes. Devices and methods employed to open parachutes, including manual and automatic methods are discussed and illustrated. Specific attention is devoted to a device which is pressure-controlled, with automatic timing for canopy deployment. The application and role of the parachute in areas other than aviation are discussed briefly. Author (GRA)

N71-24357# IIT Research Inst., Chicago, Ill.
AVIONICS INTERFERENCE PREDICTION MODEL
G. Morgan Annapolis, Md. Electromagnetic Compatibility Analysis Center Nov. 1970 140 p refs
(Contract F19628-70-C-0291)
(AD-718997; ESD-TR-70-286) Avail: NTIS CSCL 20/14

An interference prediction model developed for use in evaluating expected interactions between avionics equipments on an airplane is described. The model is substantially automated and includes subroutines which calculate expected path losses between aircraft antennas and the rejection offered by the receivers to the undesired emissions from transmitters on the aircraft. An analysis of the interactions between the equipments installed on an FAA Sabreliner has been made using the prediction model and the results of the analysis are described. Requirements for expansion of the prediction model are established. Author (GRA)

N71-24369# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
NAVIGATION EQUIPMENT, AUTOMATIC Final Report
17 Dec. 1970 26 p refs
(AD-719096; MTP-6-3-205) Avail: NTIS CSCL 17/7

Procedures are identified for service test evaluations of Army aircraft navigation systems. Author (GRA)

N71-24375# Army Foreign Science and Technology Center, Charlottesville, Va.
VISIBILITY IN THE ATMOSPHERE
V. A. Gavrilov 28 Jan. 1971 390 p refs Transl. into ENGLISH of the publ. 'Vidimost v Atmosfere' Leningrad, Gidrometeorol. Izd., 1966
(AD-719502; FSTC-HT-23-052-71) Avail: NTIS HC $6.00/MF $0.95 CSCL 4/2

The author gives a description of present-day ways of determining visibility through the atmosphere. He explains how atmospheric transmissivity, the visibility of actual objects, and the range of visibility on landing an aircraft are measured. He emphasizes particularly the methods for determining the level of visibility. In a number of cases he concludes that problems which he regards as being important have not yet been satisfactorily solved. Author (GRA)

N71-24379# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
MAINTENANCE TOOL SETS, AVIATION Final Report
16 Dec. 1970 20 p
(AD-719103; MTP-7-3-057) Avail: NTIS CSCL 13/9

Procedures are described for evaluating the adequacy of maintenance tools sets. Considerations of tool set durability and compatibility with aircraft maintenance characteristics are discussed. (Author) GRA

N71-24385# Deutsche Gesellschaft fuer Luft- und Raumfahrt, Stuttgart (West Germany).
HELICOPTER FATIGUE TESTING [BETRIEBSFESTIGKEITSPROBLEME BEI HUBSCHRAUBERN]
Dec. 1970 187 p refs In GERMAN; ENGLISH summary Proc. of the DGLR Symp. on Helicopters and Propellers, Immenstaad, West Ger., 24 Jun. 1969
(DLR-MITT-70-01) Avail: NTIS; ZLDI Munich: 38,85 DM

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5. STRUCTURAL STABILITY INVESTIGATIONS OF THE HELICOPTER VFW-H3 W. Paul (Ver. Flugtech. Werke, Bremen) p 157–174

N71-24386# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
DETERMINATION OF THE LIFETIME OF HELICOPTER COMPONENTS [DIE ERMITTLUNG DER LEBENSDAUER VON HUBSCHRAUBERBAUTEILEN]
Rudolf Prinz *In* DGLR Helicopter Fatigue Testing Dec. 1970 p. 7-76 refs In GERMAN Avail: NTIS; ZLDI Munich: 38,85 DM

A survey is given of methods used for the determination of the fatigue life of helicopter rotor blades exposed to vibrational stresses, present during normal flight conditions. ESRO

N71-24387# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

STRUCTURAL STABILITY OF THE ROTOR SYSTEM OF THE HOT-GAS REACTION HELICOPTER DO 132 [BETRIEBSFESTIGKEITSBETRACHTUNGEN AM ROTORSYSTEM DES HEISSGAS-REAKTIONSHUBSCHRAUBERS DO 132]

L. Brenner *In* DGLR Helicopter Fatigue Testing Dec. 1970 p 77–96 refs In GERMAN

Avail: NTIS; ZLDI Munich: 38,85 DM

A survey is given of the operational demands made on the rotor system DO 132, especially the rotor blades, as well as the determination of the structural stability under special conditions. ESRO

N71-24388# Messerschmitt-Boelkow G.m.b.H., Ottobrunn (West Germany).

DYNAMIC TESTING OF HELICOPTER COMPONENTS [DYNAMISCHE ERPROBUNG VON HUBSCHRAUBERKOMPONENTEN]

H. Schumacher *In* DGLR Helicopter Fatigue Testing Dec. 1970 p 97–123 In GERMAN

Avail: NTIS; ZLDI Munich: 38,85 DM

A survey is given of the essential dynamic tests in connection with the development of the Messerschmitt-Boelkow BO 105 helicopter, as an example of a testing program, which may be more generally applied to helicopter development. ESRO

N71-24389# Messerschmitt-Boelkow G.m.b.H., Ottobrunn (West Germany).

EVALUATION OF FLIGHT MEASUREMENTS AND THE PLOTTING OF LOADING COLLECTIVES [AUSWERTUNG VON FLUGMESSERGEBNISSEN UND ERSTELLUNG VON BELASTUNGSKOLLEKTIVEN]

H. Strehlow and N. Mihalcea *In* DGLR Helicopter Fatigue Testing Dec. 1970 p 124–156 refs In GERMAN

Avail: NTIS; ZLDI Munich: 38,85 DM

Classification results and frequency analyses of flight load data of the Messerschmitt-Boelkow BO 105 helicopter are reviewed. The applicability to the solution of several structural stability problems is pointed out. The applied evaluation methods and the necessary use of electronic data processing are briefly described. ESRO

N71-24390# Vereinigte Flugtechnische Werke G.m.b.H., Bremen (West Germany).

STRUCTURAL STABILITY INVESTIGATIONS OF THE HELICOPTER VFW-H3 [BETRIEBSFESTIGKEITSUNTERSUCHUNGEN VON KOMPONENTEN DES FLUGSCHRAUBERS VFW-H3]

W. Paul *In* DGLR Helicopter Fatigue Testing Dec. 1970 p 157–174 In GERMAN

Avail: NTIS; ZLDI Munich: 38,85 DM

Structural stability tests of components of the Vereinigte Flug Werke helicopter family H3/H5 are reported on. One of the major problems during the development stage was the detection of a sufficient security against rotor blade fatigue, including the connections. ESRO

N71-24394 World Meteorological Organization, Geneva (Switzerland).

USE OF WEATHER RADAR FOR AVIATION

H. Treussart, W. B. Beckwith, S. G. Bigler, K. Otani, V. V. Kostarev et al 1970 92 p refs Its Tech. Note 110

(WMO-264-TP-148) Copyright. Avail: Issuing Activity

The existing aviation requirements for weather radar, either ground-based or airborne, in connexion with performance criteria, range and accuracy, are reviewed. The detection and identification of regions of hail and turbulence associated with thunderstorms, these being considered dangerous phenomena for aviation are discussed. It is shown through intensive surveys on hail detection that echo intensity, as an indicator of hail, observed using 10 cm wavelength radar exhibited a similar trend to that observed using 3 cm radar, but very little change in intensity with height. Several case studies of the probability of hail as a function of height are also illustrated for assessment of hail. Brief mention is made of the use of airborne radar for detection of hail and the avoidance of turbulence by aircraft in flight. The question of measuring the height of echoes observed by radar, which represents an index of storm activity is considered and the interpretation of echoes for different types of radar is discussed. The processing and transmission of radar information is discussed in detail and transmission of radar information to aircraft in flight is also considered. New techniques developed for radar observations are also presented. Author (ESRO)

N71-24433# Army Natick Labs., Mass.

A GENERAL THEORY OF PARACHUTE OPENING

Edward W. Ross, Jr. Jan. 1971 42 p refs

(AD-719698; USA-NLABS-TR-71-32-OSD) Avail: NTIS CSCL 1/3

A simple mathematical model of the opening behavior of parachutes is presented. The model predicts the drag and velocity as functions of time and also gives an estimate of opening time. The model is very general and applicable to almost any parachute. The characteristics of a specific parachute enter the model by means of certain constants that have to be chosen. Values of these constants are found for flat, circular parachutes, partly by estimation and partly by numerical experimentation. The resulting model of the opening behavior of flat, circular canopies gives reasonable agreement with experiments for several parachutes of different sizes. Insofar as generality and flexibility are concerned, this model seems to be superior to present methods of predicting opening behavior of parachutes. Author (GRA)

N71-24446# Glasgow Univ. (Scotland). Dept. of Aeronautics and Fluid Mechanics.

THE ROLE OF HEAT CONDUCTION IN LEADING EDGE HEATING THEORY AND EXPERIMENT

T. R. F. Nonweiler, H. Y. Wong, and S. R. Aggarwal London Aeron. Res. Council 1970 52 p refs Supersedes ARC-31445

(Contract PD/48/09/ADM)

(ARC-CP-1126; ARC-31445) Copyright. Avail: NTIS; HMSO: 75p; BIS: $3.00

The effect of heat conduction of material on the temperature distribution in the vicinity of a wing leading edge in hypersonic flight is investigated. The theory is based on a conducting plate subjected to aerodynamic heating. It is found that the role played by the conductivity of the material and the leading edge thickness in moderating the nose temperature is very significant. Detailed discussions of the numerical solutions for various shapes of leading edge are given. An experimental technique has been developed by which a number of models representing a wing leading edge can be tested and the results thus obtained are compared with those predicted by the theory. Author (ESRO)

N71-24447# European Space Research Organization, Paris (France).

EUROPEAN SPACE RESEARCH ORGANISATION General Report, 1969

1970 204 p

Avail: NTIS

This report summarizes the scientific results achieved by the ESRO satellites (IRIS, AURORAE, HEOS 1) and from the sounding rocket campaign. A status report is given of satellites under development, namely BOREAS, TD-1, HEOS-A2, and ESRO-4 and the feasibility studies presented on future satellites in the telecommunications, meteorological and aeronautical fields. A summary is also given of the management problems involving buildings, staff, and legal matters. ESRO

N71-24451# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
APPROACH SYSTEMS (TERMINAL AIR TRAFFIC CONTROL FACILITY) Final Report
15 Dec. 1970 24 p refs
(AD-719104; MTP-7-3-066) Avail: NTIS CSCL 17/7

A basic guide for preparation of test plans for terminal air traffic control facility equipment is given. Provides for testing shelters containing ground to air communication, acquisition equipment, and meteorological equipment. Compatibility of the shelter with associated transportation media are considered. Author (GRA)

N71-24452# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
AIRCRAFT DEFOGGER/DEFROSTER (TRANSPARENT AREAS) Final Report
25 Jan. 1971 18 p refs
(AD-719109; MTP-7-3-522) Avail: NTIS CSCL 1/3

Procedures are described for evaluating aircraft defogger/defroster equipment operated in conjunction with environmental control units, or as an independent electrical system. Author (GRA)

N71-24457# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
COMPATIBILITY OF AVIATION MATERIEL WITH RELATED EQUIPMENT Final Report
8 Dec. 1970 11 p refs
(AD-719107; MTP-7-3-509) Avail: NTIS CSCL 1/3

The document defines procedures for evaluating the compatibility of aviation materiel with related equipment. Compatibility aspects are physical and technical characteristics, installation and removal, operation and performance, and maintenance. Incompatibility ranges from a simple nuisance factor to complete negation of the item under test, and concerned aircraft, armament, avionics and personnel materiel. Author (GRA)

N71-24459# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
SERVICING UNITS (AVIATION) Final Report
10 Dec. 1970 18 p
(AD-719102; MTP-7-3-055) Avail: NTIS CSCL 1/3

Procedures are defined for evaluating the degree of effectiveness of both portable and self-propelled ground servicing units for Army Aircraft. This procedure is concerned with improvements and modification to existing equipment, as well as new types of heaters, auxiliary power, and servicing equipment resulting from change in aircraft configuration or methods of tactical operations. Author (GRA)

N71-24461# Army Test and Evaluation Command, Aberdeen Proving Ground Md.
ENVIRONMENTAL CONTROL UNIT (ECU) Final Report
25 Jan. 1971 18 p
(AD-719101; MTP-7-3-051) Avul: NTIS CSCL 13/1

Procedures are described for evaluating aircraft ventilation heating,, moisture and contamination control, cooling and heating equipment or any combination of these systems. The evaluation is described under simulated tactical conditions. Author (GRA)

N71-24479# Army Aviation Systems Test Activity, Edwards AFB, Calif.
EVALUATION OF FUEL FLOWMETER INSTRUMENTATION Final Report, 5 Aug. –20 Oct. 1970
Albert L. Winn and Robert P. Jefferis Jan. 1971 30 p refs
(AD-719280; USAAST-70-33) Avail: NTIS CSCL 14/2

Flight tests on the Flow Technology Inc. standard line turbine flow transducer were conducted between 5 August and 20 October 1970 to determine its acceptability as a test instrument. The evaluation was conducted at Edwards Air Force Base, California, by the US Army Aviation Systems Test Activity. Ground calibrations showed that the sensor can be used with precision equal to present flow measurement methods. The testing consisted of 2.9 flight hours with the measurement systems mounted in a UH-1C helicopter. The Flow Technology sensor performance was compared to that obtained with standard Potter and Revere flight test systems. Results show that the sensor is acceptable as a flight test instrument. The indicator sensitivity is excellent and there was no degradation of meter performance with variations in engine power or flight conditions. Although the indicator scale range was suitable for this test, the range is not large enough to be operable on all Army aircraft. Author (GRA)

N71-24482# National Physical Lab., Teddington (England). Aerodynamics Div.
THE BEHAVIOUR OF THE LEADING-EDGE VORTICES OVER A DELTA WING FOLLOWING A SUDDEN CHANGE OF INCIDENCE
N. C. Lambourne, D. W. Bryer, and J. F. M. Maybrey London Aeron. Res. Council 1970 47 p refs Supersedes NPL-AERO-1294; ARC-31056
(ARC-R/M-3645; NPL-AERO-1294; ARC-31056) Copyright. Avail: NTIS; HMSO: £1.25; BIS: $4.50

The transient behavior of leading-edge vortices over a delta wing subject to a sudden change of incidence is of importance in understanding the wing loadings that can occur in unsteady conditions of flight. In the experiments reported changes of incidence have been imposed on delta-shaped plates by application of a constant-velocity plunging motion for a limited time; other related unsteady motions are discussed in the appendix. Cine records of particle tracks and of dye filaments in a water tunnel have been analyzed to trace the time history of vortex centres in cross-flow planes following the application of step-changes of incidence. The flows for various combinations of initial incidence, planform, plunging velocity, and chordwise position have been examined. Results indicate that after the start of the plunge an effectively steady vortex system is established over the plate in a time approximately equal to that required for one chord length of relative forward travel. Where comparisons can be made, Dore's theoretical calculations of the manner in which the vortices move show fair agreement with the experiment. Effects of the transient movements of the vortices on lift distribution are discussed and the inference is drawn that the changes in the distribution of wing loading occurring for an increase of incidence are not simply reversed when the incidence is decreased. Author (ESRO)

N71-24483# National Physical Lab., Teddington (England). Div. of Numerical and Applied Mathematics.
NUMERICAL EVALUATION OF THE DOWNWASH INTEGRAL FOR A LIFTING RECTANGULAR PLANFORM

Valerie A. Ray and G. F. Miller Dec. 1970 24 p refs
(NPL-Ma-90) Copyright. Avail: NTIS

A method is described for the accurate evaluation of the downwash integral of Multhopp's lifting surface theory for wings of rectangular planform subjected to very general loadings. In the form in which it was originally derived the integral defining the downwash alpha(x,y) at points on the wing surface is unsuitable for numerical calculation because of the presence of a strong singularity of the integrand at the point (x,y). The basis of the present method is to transform the integral by removing certain terms which (subject to natural assumptions regarding the form of the loading function alternate theta(x,y) can be evaluated in closed form, while the remaining integral is only weakly singular and is amenable to numerical evaluation. The method has been embodied in a KDF 9 program which computes the downwash, for arbitrary values of the aspect ratio, to high precision. Tables and digrams are appended, giving values of the downwash at a representative set of points on the wing for several aspect ratios and loadings. A basic aim has been to provide a definitive set of results of substantial precision against which results obtained by other methods (possibly applicable to more general shapes) may be tested.
Author (ESRO)

N71-24488# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
THE TWO-DIMENSIONAL CHARACTERISTICS OF A 12.2 PERCENT THICK RAE 100 AEROFOIL SECTION
D. S. Woodward London Aeron. Res. Council, 1971 71 p refs Supersedes RAE-TR-68303; ARC-31374
(ARC-R/M-3648; RAE-TR-68303; ARC-31374) Copyright. Avail: NTIS; HMSO: £1.75; BIS: $6.30

The 12.2% thick RAE 100 airfoil section was chosen as being likely to fulfil the requirements for the basic airfoil section of a series of sweptback wings designed to provide fundamental information on the high lift and stalling behavior of swept wing aircraft. The choice was based upon previously published work on the stall characteristics of twodimensional airfoils, and the results presented show that the desired behavior at high lift has been obtained. The measurements of the airfoil characteristics were obtained by surface pressure plotting. Not only were the overall forces and moments obtained from these measurements, but also the pressure distributions were analyzed in three ways intended to provide information on the changes from the potential flow pressure distribution which are produced by the displacement thickness of the boundary layer.
Author (ESRO)

N71-24489# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Abteilung Aerodynamik.
SURVEY OF DIFFERENT MODELS FOR COMPUTING THE FLOW OF A LIFTING ROTOR [UEBERBLICK UEBER VERSCHIEDENE MODELLE ZUR BERECHNUNG DER ROTORDURCHSTROEMUNG]
Alfred Kussmann Dec. 1970 74 p refs In GERMAN; ENGLISH summary
(DLR-MITT-70-19) Avail: NTIS; ZLDI Munich: 13,70 DM

A survey of the essential features of several methods for computing the induced velocity field and blade loads of a lifting rotor is given, especially in the forward flight regime, with particular consideration of the different wake model configurations.
Author (ESRO)

N71-24491# Northrop Corp., Hawthorne, Calif. Aircraft Div.
A WIND TUNNEL INVESTIGATION OF JETS EXHAUSTING INTO A CROSSFLOW. VOLUME 4: ADDITIONAL DATA FOR THE THREE JET CONFIGURATION
Lynn B. Fricke, Peter T. Wooler, and Henry Ziegler Wright-Patterson AFB, Ohio AFFDL Dec. 1970 200 p
(Contract F33615-69-C-1602)
(AD-718123; AFFDL-TR-70-154-Vol-4) Avail: NTIS CSCL 20/4

A low speed wind tunnel test of a four-foot diameter circular plate model with up to three exhausting jets was conducted to determine surface static pressure distributions, jet paths, and jet decay characteristics in the presence of a crossflow. Three-jet configuration data were obtained with the jets exiting normal to the plate for a number of velocity ratios and sideslip angles. As a result of this investigation, several conclusions are deduced pertaining to the interaction of multiple jets exhausting into a crossflow.
Author (GRA)

N71-24492# Northrop Corp., Hawthorne, Calif. Aircraft Div.
A WIND TUNNEL INVESTIGATION OF JETS EXHAUSTING INTO A CROSSFLOW. VOLUME 1: TEST DESCRIPTION AND DATA ANALYSIS
Lynn B. Fricke, Peter T. Wooler, and Henry Ziegler Wright-Patterson AFB, Ohio AFFDL Dec. 1970 448 p refs
(Contract F33615-69-C-1602)
(AD-718122; AFFDL-TR-70-154-Vol-1) Avail: NTIS HC $6.00/MF $0.95 CSCL 20/4

A low speed wind tunnel test of a four-foot diameter circular plate model with up to three exhausting jets was conducted to determine surface static pressure distributions, jet paths, and jet decay characteristics in the presence of a crossflow. Data were obtained for the one-jet configuration with the jet exiting at a number of angles to the plate and at various velocity ratios and sideslip angles. Two-jet arrangements were tested with the jets exiting normal to the plate for three different spacings between the two jets and at a number of velocity ratios and sideslip angles. Three-jet configuration data were obtained with the jets exiting normal to the plate for a number of velocity ratios and sideslip angles. As a result of this investigation, several conclusions are deduced pertaining to the interaction of multiple jets exhausting into a crossflow. The test model, instrumentation, test procedure, and reduction and accuracy of the test data are discussed in this volume. A summary and discussion of the test results are also presented.
Author (GRA)

N71-24498# Glasgow Univ. (Scotland).
A NEW SERIES OF LOW-DRAG AEROFOILS
T. R. F. Nonweiler London Aeron. Res. Council 1971 107 p refs Supersedes ARC-30528
(ARC-R/M-3618; ARC-30528) Copyright. Avail: NTIS; HMSO: £2.70; BIS: $10

A series of low drag airfoils, modelled roughly on the NACA 6-series, is described. It appears to offer theoretical advantages over its progenitor, and allows flexibility in the choice of leading-edge thickness and trailing-edge angle. Airfoils of this series are specified by five parameters, and the aerodynamic and geometrical characteristics of about 1000 of the sections are listed. The mathematical derivation of their shape (by the Lighthill method) is described in detail, and an ALGOL 60 procedure for the computation of their ordinates is included; care has been taken to construct this procedure so that it may be of general use in other applications of the Lighthill method of design.
Author (ESRO)

N71-24500# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Raumfahrt-Aerodynamik.
AN INVESTIGATION OF A WAVE-RIDER AT LOW REYNOLDS NUMBERS [UNTERSUCHUNG EINES WELLENREITERS BEI KLEINEN REYNOLDSZAHLEN]
G. Hefer Sep. 1970 32 p refs In GERMAN; ENGLISH summary
(DLR-FB-70-46) Avail: NTIS; ZLDI Munich: 9,60 DM

A Nonweiler-wing was investigated at rarefied flow conditions

in order to determine the influence of small Reynolds numbers on the aerodynamic properties of wave-riders. The measurements, comprising pitot pressure surveys in the flow field, static pressure measurements, and force measurements, were performed in the slip flow region at Mach numbers of 11.5 and Reynolds numbers from 5000 to 50,000. Author (ESRO)

N71-24555# Litchford Systems, North Port, N.Y.
NEW DEVELOPMENTS IN SCANNING BEAM LANDING GUIDANCE SYSTEMS, PART 2 Final Annual Report
George B. Litchford Wright-Patterson AFB, Ohio AFFDL Dec. 1970 255 p refs
(Contract F33615-69-C-1110)
(AD-718972; L-AF-04-Pt-2; AFFDL-TR-69-107-Pt-2; AR-2) Avail: NTIS CSCL 17/7

Design details are given of a CW microwave scanning-beam system operating at C and Ku bands. Many of the available design options are noted that apply to the solution of certain engineering problems. One of the virtues of the plan is that several options exist for rapid validation of all critical matters. Consequently the total risks, both economically and technically, now appear much lower than previously. Possible designs of angle-data modulation, dual-band receivers, angle-data processors, etc., are reviewed as are several validation tests and experiments now needed to tie down engineering parameters before a firm national signals-in-space standard can be approved. The important advances in the last year toward planning a national system for aircraft landing in all environments suited to all physical types and operations of aircraft are identified. Author (GRA)

N71-24565# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
LOW-SPEED WIND-TUNNEL TESTS ON A SWEPTBACK WING MODEL (BUCCANEER MARK 1) WITH BLOWING AT THE WING LEADING EDGE AND BLOWING OVER THE FLAPS AND DROOPED AILERONS
S. F. J. Butler London Aeron. Res. Council 1971 54 p refs Supersedes RAE-TR-67223; ARC-29976
(ARC-R/M-3655; RAE-TR-67223; ARC-29976)

Low-speed longitudinal stability measurements are described on a fifth-scale half-model including some comparisons with complete-model tests and the measured aircraft performance. Shroud blowing over the trailing-edge flap, and drooped aileron nearly doubled the C sub l (lift coefficient) increment, to as much as 1.0, with adequate aileron roll control effectiveness at a mean aileron angle of up to 30 deg. Trimming reduced the lift increments by about 20 per cent. Despite considerable aerodynamic objections associated with the thin wing and small nose radii, and integral (nondeflecting) leading-edge blowing arrangement was specified for aircraft structural reasons. Although an acceptable arrangement was developed, this necessitated the selection of a safe compromise position for the blowing nozzle to avoid adverse compressibility effects at aircraft takeoff and landing speeds. Typically, a stalling incidence of 20 deg [C sub l max (maximum lift coefficient) = 1.8] was achieved for the proposed takeoff configuration 30 deg flap; 20 deg mean ail was achieved for the proposed takeoff configuration (30 deg flap; 20 deg mean aileron droop). With the prescribed integral leading edge, wing pitch-up at the stall was not avoided, although initial wing flow separations were confined to the inboard wing. In general, the aircraft high-lift performance confirms the results of the tests on this half-model. Author (ESRO)

N71-24569# National Physical Lab., Teddington (England). Aerodynamics Div.
MEASUREMENTS OF THE OSCILLATORY PITCHING-MOMENT DERIVATIVES ON A SERIES OF THREE DELTA WINGS IN INCOMPRESSIBLE FLOW (IN FOUR PARTS)
London Aeron. Res. Council 1971 78 p refs Part 1 supersedes NPL-AREO-1276; ARC-30359; Pt. 2, NPL-AERO-1274; ARC-30357· Pt. 3, NPL-AERO-1275; ARC-30358; and Pt. 4, NPL-AERO-1289; ARC-30955 Copyright. Avail: NTIS; HMSO: £2; BIS: $7.20
(ARC-R/M-3628-Pt-1-4; NPL-AERO-1276; NPL-AERO-1274; NPL-AERO-1275; NPL-AERO-1289 et al)

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3. PART 3: MEASUREMENTS OF THE OSCILLATORY PITCHING-MOMENT DERIVATIVES ON A SHARP-EDGED DELTA WING AT ANGLES OF INCIDENCE FOR WHICH VORTEX BREAKDOWN OCCURS L. Woodgate p 39–57 refs
4. PART 4: MEASUREMENTS OF LIFT, DRAG, AND PITCHING MOMENT ON A SERIES OF THREE DELTA WINGS L. Woodgate and A. S. Halliday p 58–75 refs

N71-24570# National Physical Lab., Teddington (England). Aerodynamics Div.
PART 1: MEASUREMENTS OF THE OSCILLATORY PITCHING-MOMENT DERIVATIVES ON A DELTA WING WITH ROUND LEADING EDGES IN INCOMPRESSIBLE FLOW
L. Woodgate *In its* Meas. of the Oscillatory Pitching-Moment Derivatives on a Series of Three Delta Wings in Incompressible Flow 1971 p 3–21 refs
Copyright. Avail: NTIS; HMSO: £2; BIS: $7.20

Oscillatory pitching-moment derivatives have been measured on a round-leading-edged delta wing of aspect ratio 1.484 and of thickness to chord ratio 0.06. Mean incidence was varied from 0 to 15 deg, and frequency parameter and Reynolds number, based on the mean chord, were varied from 0.2 to 0.1 and from 1.28 million to 2.56 million respectively. Comparisons are made with similar measurements on a sharp-edged delta wing of the same aspect ratio. Differences between the results for the two models are found for both pitching axes used in the tests. From the results for h = 1.5 mean chord and from surface flow patterns, it appeared that for low angles of incidence the round leading edge suppressed the development of vortex flow sufficiently for it to have no effect on either derivative. Above alpha = 5 deg, vortex flow was gradually established, giving a change in each derivative with incidence similar to that found on the sharp-edged model. Author (ESRO)

N71-24571# National Physical Lab., Teddington (England). Aerodynamics Div.
PART 2: MEASUREMENTS OF THE OSCILLATORY PITCHING-MOMENT DERIVATIVES ON A SLENDER SHARP-EDGED DELTA WING IN INCOMPRESSIBLE FLOW
L. Woodgate *In its* Meas. of the Oscillatory Pitching-Moment Derivatives on a Series of Three Delta Wings in Incompressible Flow 1971 p 22–38 refs
Copyright. Avail: NTIS; HMSO: £2; BIS: $7.20

Oscillatory pitching-moment derivatives have been measured by an inexorable forcing method on a delta wing of aspect ratio

0.654 in pitching motion. Mean incidence has been varied from 0 to 15 deg, frequency parameter from 0.2 to 1.0, and Reynolds number from 1.28 million to 2.30 million. The derivatives showed large and approximately linear variations with incidence. Comparisons are made with previous measurements on a delta wing of higher aspect ratio also with sharp edges. In general, the numerical values of the derivatives and the variation in the derivatives due to changes in the mean incidence, frequency of oscillation, and Reynolds number are smaller for the more slender wing. Author (ESRO)

N71-24572# National Physical Lab., Teddington (England). Aerodynamics Div.

PART 3: MEASUREMENTS OF THE OSCILLATORY PITCHING-MOMENT DERIVATIVES ON A SHARP-EDGED DELTA WING AT ANGLES OF INCIDENCE FOR WHICH VORTEX BREAKDOWN OCCURS

L. Woodgate *In its* Meas. of the Oscillatory Pitching-Moment Derivatives on a Series of Three Delta Wings in Incompressible Flow 1971 p 39–57 refs

Copyright. Avail: NTIS; HMSO: £2; BIS: $7.20

Pitching-moment derivatives have been measured on a sharp-edged delta wing of aspect ratio 1.484 for a range of incidence from alpha = 20 to 35 deg. For alpha = 30 and 35 deg, vortex breakdown occurred above the wing surface. Some numerically-low values of both the stiffness and damping derivatives were obtained for alpha = 30 deg at low frequency parameters and these are attributed to vortex breakdown. Corresponding measurements at higher frequency parameters were practically unaffected. Flow visualization showed that the pitching oscillation led to an oscillation of the streamwise position of the vortex breakdown but, for the small amplitude of oscillation used, had no effect on the mean position of the breakdown. Author (ESRO)

N71-24573# National Physical Lab., Teddington (England). Aerodynamics Div.

PART 4: MEASUREMENTS OF LIFT, DRAG, AND PITCHING MOMENT ON A SERIES OF THREE DELTA WINGS

L. Woodgate and A. S. Halliday *In its* Meas. of the Oscillatory Pitching-Moment Derivatives on a Series of Three Delta Wings in Incompressible Flow p 58–75 refs

Copyright. Avail: NTIS; HMSO: £2; BIS: $7.20

The measurements were made on three 6 percent thick delta wings; wing (1) had an aspect ratio of 1.484 and all its edges were sharp, wing (2) also had an aspect ratio of 1.484 and the leading edges were rounded, and wing (3) had an aspect ratio of 0.654 with all edges sharp. The values of C sub l (lift coefficient), C sub m (pitching moment coefficient), and the derivative delta C sub m/delta alpha obtained are compared with values predicted by a theory of Garner and Lehrian which takes into account the effects of leading-edge flow separation. The values obtained for wing (1) were in good agreement with similar measurements from other sources, C sub l being slightly larger than theory and C sub m in reasonable agreement with theory. The round leading edge of wing (2) had the predictable effect of slightly reducing the value of C sub l and numerically increasing the value of C sub m for the mid-root-chord axis, as compared with the sharp-edged wing. Wing (3) produced values much lower than both theory and reported values for flat-plate deltas of similar aspect ratio. Author (ESRO)

N71-24581*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

VERTICAL-FIN LOADS AND RUDDER HINGE-MOMENT MEASUREMENTS ON A 1/8 SCALE MODEL OF THE M2F3 LIFTING BODY VEHICLE AT MACH NUMBERS FROM 0.50 TO 1.30

Ming H. Tang Washington May 1971 43 p refs

(NASA-TM-X-2286; H-650) Avail: NTIS CSCL 01A

Outboard fin loads and rudder hinge moment measurements were obtained from a 1/8 scale model of the M2-F3 lifting body vehicle tested in the 11 foot transonic wind tunnel. The tests were conducted at Mach 0.50 to 1.30. The effects of variations in rudder deflection, upper flap deflection, lower flap deflection, and angles of attack and sideslip were studied. The left outboard fin loads increased with increase in angle of attack, Mach number, rudder deflection, lower flap deflection, and negative sideslip and decreased with increasing upper flap deflection. The rudder hinge moment increased with increase in rudder dflection and, generally, with Mach number. Author

N71-24582*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE MEASUREMENTS FOR A THREE ENGINE TURBOFAN TRANSPORT AIRPLANE DURING CLIMBOUT AND LANDING APPROACH OPERATIONS

W. Latham Copeland and Lorenzo R. Clark Washington May 1971 54 p refs

(NASA-TN-D-6137; L-5994) Avail: NTIS CSCL 01B

Noise measurements have been made for a three engine turbofan transport airplane during climbout and landing approach operations in which the airplane operating procedures were carefully controlled. These controlled procedures included an orderly scheduling of operating variables such as engine power, speed, altitude, and flap settings. The results of these studies are presented for seven climbout operations involving various climb speeds, flap settings, and engine power settings and for three landing approach operations involving various glide-slope angles. In general, the results from the climbout studies indicated that the lower noise levels (6 dB to 14 dB) were associated with profiles employing lower engine powers during second-segment climb. It was also found that, for a given climb profile and climb rate, slightly higher noise levels are associated with operations employing fixed flaps than with a specified flap retraction schedule. The results from landing approach studies indicated that generally lower noise levels were associated with the steeper glide slopes. For these steeper glide slopes, noise reductions attained (4 dB to 9 dB) resulted from both the increased altitude and the lower engine powers. Author

N71-24586*# Boeing Co., Seattle, Wash.

LOW WING LOADING STOL TRANSPORT RIDE SMOOTHING FEASIBILITY STUDY Final Report

8 Feb. 1971 77 p refs

(Contract NAS1-10410)

(NASA-CR-111819; D3-8514-2) Avail: NTIS CSCL 01C

Results of an analytical study to determine the feasibility of providing satisfactory ride qualities using modern controls technology on a high performance, low wing loading STOL aircraft are given. The aircraft configuration was designed to be competitive with present high speed jet aircraft economics and block times and to meet proposed noise requirements. Author

N71-24603# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

FLIGHT LINE ANALYZERS

7 Jan. 1971 20 p refs

(AD-719675; MTP-6-3-090) Avail: NTIS CSCL 1/3

Maintenance of complex aircraft systems requires the ability to determine the completion of systems on the flight line. The document defines procedures for field testing analyzers utilized in testing systems and fault isolating components. Author (GRA)

N71-24651*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA SPACE SHUTTLE TECHNOLOGY CONFERENCE. VOLUME 3: DYNAMICS AND AEROELASTICITY

Washington Apr. 1971 448 p refs Conf. held at Langley Station, Va., 2–4 Mar. 1971

(NASA-TM-X-2274; L-7739) Avail: NTIS HC $6.00/MF $0.95 CSCL 20K

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17. PRELIMINARY VIBRATION DESIGN AND TEST CRITERIA CONSIDERATIONS FOR THE SPACE SHUTTLE H. J. Bandgren (NASA. Marshall Space Flight Center, Huntsville, Ala.) p 423–450 ref

N71-24659*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THICK HIGH ASPECT RATIO WING, PART 2

Larry L. Erickson, Bruno J. Gambucci and Phillip R. Wilcox *In its* NASA Space Shuttle Technol. Conf., Vol. 3 Apr. 1971 p 201–229 refs

Avail: NTIS HC $6.00/MF $0.95 CSCL 20K

Transonic flutter and buffet results are presented for two elastic models of a proposed space-shuttle straight wing. The models were tested at Mach numbers from 0.6 to 1.1 at various dynamic pressures and at angles of attack up to 18 deg. Zero degree angle of attack flutter occurred in a narrow Mach number range centered at about Mach 0.85. Stall flutter was not observed although several instances of low torsional damping were noted. At conditions of maximum buffet intensity, model peak dynamic bending moments ranged up to 80% of the corresponding static bending moments. Author

N71-24660*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPLICATION OF RECENT PANEL FLUTTER RESEARCH TO THE SPACE SHUTTLE. PART 1: BOUNDARY LAYER AND HYPERSONIC EFFECTS

Peter A. Gaspers, Jr. *In its* NASA Space Shuttle Technol. Conf., Vol. 3 Apr. 1971 p 231–245 refs

Avail: NTIS HC $6.00/MF $0.95 CSCL 20K

Published experimental and theoretical results concerning panel flutter are reviewed and some very recent and very significant theoretical results for large boundary layer thickness are presented. In addition, some theoretical results for panel flutter at hypersonic speeds which show nonlinear destabilizing effects are reviewed. Finally the significance of these results and their application to the space shuttle are discussed. Author

N71-24661*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

APPLICATION OF RECENT PANEL FLUTTER RESEARCH TO THE SPACE SHUTTLE. PART 2: INFLUENCE OF EDGE CLIPS AND FLOW ANGULARITY

Herman L. Bohon and Charles P. Shore *In its* NASA Space Shuttle Technol. Conf., Vol 3 Apr. 1971 p 247–264 refs

Avail: NTIS HC $6.00/MF $0.95 CSCL 20K

The parameters that are known contributors to aeroelastic problems in light of current TPS designs are examined. In particular, the nature of boundary conditions and flow angularity as they affect panel flutter are discussed. The data are not restricted to metallic panels but, in fact, may also apply to panels with external insulation. Emphasis, however, is placed on the orthotropy of the surface structure and the deflectional flexibility of the clips which connect it to the primary structure. Author

N71-24662*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

BUFFET RESPONSE OF SPACE SHUTTLE LAUNCH CONFIGURATIONS AS DETERMINED BY TESTS OF AN AEROELASTIC MODEL

Lado Muhlstein, Jr. *In its* NASA Space Shuttle Technol. Conf., Vol 3 Apr. 1971 p 265–291

Avail: NTIS HC $6.00/MF $0.95 CSCL 20K

Preliminary results of a series of tests designed to investigate

the buffet response of a typical straight wing and a delta wing space shuttle vehicle (SSV) launch configuration recently completed at the Ames Research Center are presented. The purpose of these tests was to determine what are some of the potential buffet problems of a typical SSV launch configuration. Author

N71-24663*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRELIMINARY MEASUREMENTS AND FLOW VISUALIZATION STUDIES OF PRESSURE FLUCTUATIONS ON SPACE SHUTTLE CONFIGURATIONS
Charles F. Coe, Jules B. Dods, Jr., Robert C. Robinson, and William H. Mayes *In its* NASA Space Shuttle Technol. Conf., Vol. 3 Apr. 1971 p 293–314 ref
Avail: NTIS HC$6.00/MF$0.95 CSCL 20K

Results of research in flow characteristics and pressure fluctuations on space shuttle launch and reentry configurations are reported. The investigations to date have consisted of pressure fluctuation measurements at transonic speeds on 0.01- and 0.025-scale models of straight- and delta-wing launch configurations and fluorescent oil flow tests of 0.008-scale models of straight- and delta-wing launch configurations over a Mach number range of 0.8 to 2.0. The Bolt, Beranek and Newman tests have been directed to the definition of unsteady pressures for reentry conditions. They consisted of flow visualization studies and measurements of pressure fluctuations on both 0.004-scale and 0.0077-scale models of a low-cross-range orbiter configuration at alpha = 60 deg for Mach numbers of 2.5 and 4.0. Author

N71-24664*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
THE EFFECTS OF PARAMETER VARIATION ON INFLIGHT WIND LOADING
Alden C. Mackey *In its* NASA Space Shuttle Technol. Conf., Vol. 3 Apr. 1971 p 315–332
Avail: NTIS HC$6.00/MF$0.95 CSCL 20/4

Performance, controllability, and structural loads were investigated to maximize the payload in space shuttle operation. The parameters: wing incidence angle, control system gains, commanded attitude history, and winds are considered to affect boost loads and performance. Their effects are presented in graphs. It is concluded that the means for reducing structural loads are available, and structural loading must be considered in payload maximization analyses. F.O.S.

N71-24669# Army Aeromedical Research Lab., Fort Rucker, Ala.
THE USE OF HIGH INTENSITY XENON LIGHTING TO ENHANCE US ARMY AIRCRAFT DAY/NIGHT CONSPICUITY
John K. Crosley, William E. McLean, Ronald G. Tabak, and Robert W. Bailey Jan. 1971 32 p. refs
(AD-718639; USAARL-71-13) Avail: NTIS CSCL 01/2

In-flight studies were performed to compare the effectiveness of aircraft-mounted, high-intensity Xenon flashtube lights for increasing the conspicuity of small trainer helicopters during both daytime and nighttime flights. Twenty-eight subjects rated both lighted and non-lighted aircraft visibility as viewed from the ground and from air to air in differing flight modes. Data are presented to indicate the increase in aircraft conspicuity available through the application of this type of lighting. Author (GRA)

N71-24675# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
THE IMPERIAL COLLEGE GRAPHITE HEATED HYPERSONIC WIND TUNNEL
J. K. Harvey, R. W. Jeffery, and D. C. Uppington Jan. 1971 46 p refs Sponsored by Min. of Aviation Supply
(IC-AERO-71-01) Avail: NTIS

The design and development of a graphite heated, continuous running, Mach 20 wind tunnel, which operates with Reynolds numbers between 6 x 10,000 and 5 x 1,000,000 per meter, are described. Preliminary calibrations are presented for a contoured and a conical nozzle and for the performance of the centerbody diffuser. An electron beam probe is used to measure test section conditions. Author (ESRO)

N71-24689*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN POINT CHARACTERISTICS OF A 15-TO-80 kWe NUCLEAR-REACTOR BRAYTON-CYCLE POWER SYSTEM
Paul T. Kerwin [1971] 9 p refs Proposed for presentation at the 1971 Intersociety Energy Conversion Engineering Conf., Boston, 3–6 Aug. 1971
(NASA-TM-X-67811) Avail: NTIS CSCL 18L

A study of 15-80 kWe nuclear reactor powered Brayton cycle power system is presented. The system has a design turbine inlet temperature of 1150 F based on the use of a zirconium-hydride reactor but is also required to be capable of operation at turbine inlet temperatures up to 1600 F with an advanced reactor. Considerations involved in the selection of cycle parameters, working fluid, pressure level, and turbomachinery rotational speed are discussed. Size and weight estimates, predicted design-point performance, and required radiator area are presented. Author

N71-24690*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PREDICTED PERFORMANCE OF A 15-80 kWe REACTOR BRAYTON POWER SYSTEM OVER A RANGE OF OPERATING CONDITIONS
D. C. Guentert and R. L. Johnsen [1971] 10 p refs To be presented at 1971 Intersoc. Energy Conversion Eng. Conf., Boston, 3–6 Aug. 1971; sponsored by SAE
(NASA-TM-X-67833) Avail: NTIS CSCL 18L

A computer simulation of a 15-80 kWe nuclear reactor Brayton cycle power system designed for a turbine inlet temperature of 1150 F was used to study the steady-state performance of the system at turbine inlet temperatures between 1050 and 1600 F. The low end of the temperature range is of interest in applications using a zirconium hydride reactor heat source, while the 1600 F temperature assumes the use of an advanced reactor. Cycle-parameter effects and predicted system efficiency and required radiator area are presented over a range of compressor inlet temperatures and turbine inlet temperatures. The performance over a range of power levels is also presented. Author

N71-24691*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MOTOR STARTING TECHNIQUES FOR THE 2-TO-15 kW BRAYTON SPACE POWER SYSTEM
L. J. Gilbert, J. S. Curreri, and D. A. Cantoni [1971] 12 p refs Proposed for presentation at the 1971 Intersociety Energy Conversion Engineering Conf., Boston, 3–6 Aug. 1971
(NASA-TM-X-67819) Avail: NTIS CSCL 18L

The 2-15 kilowatt Brayton space power system has been effectively started by motoring the rotating unit. This Brayton power system generates 120/208 volts, 1200 hertz electrical power at a rated speed of 36,000 rpm. The system is designed for a turbine inlet temperature of 1600 F (1145 K) and can be operated with a variety of heat sources such as a nuclear reactor or radioisotope. By applying 20 volts line-to-neutral, 400 hertz electrical power to the alternator terminals at standstill, the rotating unit can be motored to a speed of 12,000 rpm in about 20 seconds. Upon removal of the input electrical power, the system self-accelerates to its rated speed, provided that the turbine inlet temperature is 875 F (741 K) or higher. Author

N71-24692* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

TRAVERSING PROBE Patent

Edwin J. Saltzman, Meryl D. De Geer, Stanley C. Plamowski, and Robert Grant Green, inventors (to NASA) Issued 20 Sep. 1966 (Filed 25 Jun. 1964) 9 p Cl. 73-389

(NASA-Case-XFR-02007; US-Patent-3,273,399; US-Patent-Appl-SN-378080) Avail: US Patent Office CSCL 20D

An instrument which makes it possible to obtain an accurate boundary layer profile using only a limited number of probes, usually one or two, is described. The instrumentation required for recording and measuring is (1) an instrument for measuring and recording the pressure conditions encountered by each probe, and (2) an instrument for determining and recording the position of the probe with respect to the vehicle surface. Inasmuch as the probes are mounted in a fixed position to a single mast only one instrument is required for probe position even though two probes are employed. Two embodiments of a traversing mechanism for extending and retracting the probe are disclosed.

Official Gazette of the U.S. Patent Office.

N71-24702*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STABILITY AND CONTROL CHARACTERISTICS OF STOL AND V/STOL AIRPLANES

Joseph R. Chambers *In its* Performance and Dyn. of Aerospace Vehicles 1971 p 1-69 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 01A

Some of the stability and control characteristics common to most V/STOL airplanes are discussed. In particular, specific stability and control problems of deflected slip stream, tilt wing, ducted propeller, and jet powered vehicles are covered. The contents include a variety of experimental and analytical techniques presently used to analyze the stability and control characteristics of V/STOL airplanes. Author

N71-24703*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

METHODS OF OBTAINING STABILITY DERIVATIVES

M. J. Queijo *In its* Performance and Dyn. of aerospace Vehicles 1971 p 71-101 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20D

Various methods of obtaining aerodynamic derivatives are reviewed. These methods include wind-tunnel tests, aerodynamic theory, and extraction from flight tests, with the emphasis being on flight tests. Two techniques for extracting derivatives from flight are covered in sufficient detail to indicate the procedures involved. These methods are a strict least squares approach and an iteration technique. References are listed for additional background and details of various techniques. Author

N71-24704*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN OF BODIES FOR LOW DRAG AND HIGH PERFORMANCE IN PRACTICAL HYPERSONIC FLIGHT

E. S. Love *In its* Performance and Dyn. of Aerospace Vehicles 1971 p 103-174 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20D

Some topics related to body shaping for minimum drag and improved performance at hypersonic speed are presented. Implications of the most frequently assumed pressure laws are reviewed from the view of practical flight regimes, and solutions expressed in exponential residuals are presented for inviscid minimum drag power-law bodies (simple and complex) for a wide range of fineness ratio. Analytical results and comparisons with experiment are given for constraints of length and diameter and legnth and volume. Experimental results from Mach numbers of 6 to 20 are presented for a series of trapezoidal bodies; the cross section of the body giving best lift drag ratio differs from that indicated in earlier work. A simple sin(2) deficiency method is presented for predicting pressures on blunt shapes; the method appears to yield results comparable to more elaborate methods requiring machine computation. Author

N71-24706*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLUTTER AND UNSTEADY LIFT THEORY

E. Carson Yates, Jr. *In its* Performance and Dyn. of Aerospace Vehicles 1971 p 289-374 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20D

A brief introduction to the aeroelastic problems of aircraft is given. Emphasis is on the flutter of lifting surfaces, and the most commonly used technique for the theoretical determination of flutter stability boundaries is shown. Classical theoretical methods are presented for evaluating the required oscillatory aerodynamic forces in subsonic, supersonic, and hypersonic speed ranges. Some comparisons of theoretical and experimental results are included. Rigorous mathematical developments are not emphasized. Author

N71-24707*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF AEROELASTICITY ON STATIC AERODYNAMIC DERIVATIVES

John E. Lamar *In its* Performance and Dyn. of Aerospace Vehicles 1971 p 375-438 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20D

The effects of aeroelasticity on some static longitudinal derivatives are considered. Different solution techniques are presented and from these techniques; one, the force-slope method (called herein), is selected by which the effects of static aeroelasticity may be computed. In order to use the force slope method, the aerodynamic (only subsonic speeds are considered) and structural influence coefficient matrices must first be determined. These methods are developed in some detail, after which solutions for a typical configuration are given. Author

N71-24708*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

RESPONSE OF FLEXIBLE AIRPLANES TO ATMOSPHERIC TURBULENCE

Kermit G. Pratt *In its* Performance and Dyn. of Aerospace Vehicles 1971 p 439-503 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 01A

Current random process theory methods for the estimation of the theoretical average frequency of exceeding peak responses of various levels are described, and calculated results are compared with results from flight measurements. Contents include: (1) the statictical characteristics of the airplane responses and of the turbulence velocities, (2) the relationship of these characteristics in terms of power spectral density (PSD) functions and frequency responses to a sinusoidal gust field of various wavelengths, (3) the relation of PSD functions to random time functions and to statistical parameters, (4) methods of calculating frequency responses and aerodynamic forces due to gusts, and (5) the synthesis of the responses experienced during routine flight operations. Author

N71-24709*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

GUST ALLEVIATION

William H. Phillips *In its* Performance and Dyn. of Aerospace

Vehicles 1971 p 505-553 refs
Avail: NTIS HC $9.00/MF $0.95 CSCL 20D

A discussion is presented of the response of an airplane to turbulence, including techniques for the alleviation of lateral and longitudinal motions. A simplified theoretical treatment of the longitudinal response to vertical gusts, which allows calculation of the effects of various types of gust alleviation systems, is presented. Flight experiments on various gust alleviation systems are reviewed. A brief discussion is given of the application of these systems to different types of airplanes. Finally, methods of refinement of the simplified theory to include effects of horizontal gusts, unsteady lift effects, and isotropic turbulence are described. Author

N71-24849# Japan Atomic Energy Research Inst., Tokyo.
NONDESTRUCTIVE TESTING OF AIRCRAFT STRUCTURES BY RADIOISOTOPES
Oct. 1970 153 p refs In JAPANESE; ENGLISH summary
(JAERI-Memo-4163) Avail: AEC Depository Libraries

The preparation and radiological characteristics of Tm-170 and Ir-192 gamma sources, and the nondestructive testing of structural parts for aircraft using gamma sources, are discussed. Author (NSA)

N71-24869*# Massachusetts Inst. of Tech., Cambridge.
AN AIRSPACE UTILIZATION MODEL FOR V/STOL TERMINAL OPERATIONS
Dorian Albert DeMaio (M.S. Thesis) Jan. 1971 95 p refs
(Contract NAS12-2081; Grant NGR-22-009-010; Contract DOT-TSC-5)
(NASA-CR-118315; TE-45) Avail: NTIS CSCL 01B

A computer graphics display program is developed for use in terminal area studies and V/STOL approach and departure path synthesis. The computer processes inputs describing the terminal area and accompanying constraints and displays on a cathode ray tube the airspace utilization model, a three dimensional image representation of the constraints at a given altitude. Extensive machine operator interaction is provided to select various constraint criteria, to plan approaches and departures and to check the results through viewing and teletype output. The program is general and may be applied to a number of terminal areas. The programs' applicability and usefulness is demonstrated in the analyses of several proposed VTOL port sites in the Northeast Corridor. Author

N71-24882# National Aviation Facilities Experimental Center, Atlantic City, N.J.
TECHNICAL EVALUATION OF DUAL INPUT TRANSPONDER Final Report, Jul. 1969 - May 1970
Jules E. Blazej Apr. 1971 78 p refs
(FAA-NA-71-39; FAA-RD-71-18) Avail: NTIS

The Dual Input Transponder (DIT) was evaluated to determine if it, in conjunction with upper and lower aircraft antennas, could resolve existing Air Traffic Control Radar Beacon System (ATCRBS) antenna coverage problems by minimizing aircraft antenna shielding phenomena. Flight tests of the DIT and other comparative transponder-antenna configurations were conducted and included several types of manuevers intended to place the test aircraft in numerous shielding attitudes. Results of the test program indicated that the DIT effectively minimized the loss of transponder replies caused by shielding of the antennas and provided essentially uninterrupted antenna coverage. A limited number of tests with two independently operated transponders and two antennas indicated that this configuration resulted in less apparent shielding effects than the DIT system. Author

N71-24913*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A 1540 TO 1660 MHz PROPAGATION BETWEEN GEOSTATIONARY SATELLITES AND AIRCRAFT Summary Report
C. E. Wernlein (Westinghouse Elec. Corp., Baltimore, Md.) Nov. 1970 50 p refs
(NASA-TM-X-65508; X-490-71-72) Avail: NTIS CSCL 17I

The propagation and system factors influencing the validity of an L band communication system between geostationary satellites and aircraft terminals, are discussed. Also discussed are the effects of ionospheric and tropospheric absorption, scintillation, range bias, Faraday rotation, earth reflected multipath, and system noise. E.H.W.

N71-24914*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ABSORPTION EFFECT ON VHF PROPAGATION BETWEEN SYNCHRONOUS SATELLITE AND AIRCRAFT Summary Report
Edward J. Mueller (Westinghouse Elec. Corp., Baltimore, Md.) Dec. 1970 50 p refs
(NASA-TM-X-65507; X-490-71-44) Avail: NTIS CSCL 17B

Ionospheric and tropospheric absorption, in terms of geographical contour, are discussed for the very high frequencies in an aeronautical satellite system. The North Atlantic region was chosen as the test area. The system comprises two geostationary satellites. Conclusions indicate no allowances need be made for tropospheric absorption, but that auroral and ionospheric absorption should be considered in North Atlantic design. Results also show that aeronautical routing, operational procedures, and telecommunications systems design must be considered. E.H.W.

N71-24920# Air Registration Board, London (England).
CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAM: EN ROUTE USE OF FLAP
Apr. 1970 12 p ref
(ARB-TN-99; CAADRP-TR-18) Avail: NTIS

A survey of current practices relating to en-route use of flap indicates that flaps are used for descent or holding whether or not clearance for this has been obtained. On the two aircraft considered, the maximum indicated air speed for flap appears to be used as target speed and exceedances, though small, are frequent. Author

N71-24925# National Transportation Safety Board, Washington, D.C.
REPORT OF THE NATIONAL TRANSPORTATION SAFETY BOARD Annual Report to Congress, 1970
17 Mar. 1971 61 p refs
(AR-4) Avail: Issuing Activity

The activities of the Transportation Safety Board for 1970 are reported. Among the transportation safety's list of 10 worst enemies are: alcohol, ineffective 'packaging' of motorists and pilots, youth and highway fatalities, and induced pilot error. Safety in aviation and surface transportation is discussed. A summary of investigations and recommendations is included. F.O.S.

N71-24948* National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
SATELLITE AIDED VEHICLE AVOIDANCE SYSTEM Patent
Ernest R. Steele, inventor (to NASA) Issued 22 Dec. 1970 (Filed 28 Mar. 1969) 19 p Cl. 343-112; Int. Cl. G01s5/02
(NASA-Case-ERC-10090; US-Patent-3,550,129; US-Patent-Appl-SN-811542) Avail: US Patent Office CSCL 17G

A method and an apparatus for warning aircraft pilots of the proximity of another aircraft are detailed. The apparatus comprises a system including a satellite for transmitting a synchronizing signal and means onboard the aircraft for receiving said synchronizing

signal. Means are also included onboard said aircraft for generating a response signal in response to said synchronizing signal and for opening a gate upon the receipt of said synchronizing signal for receiving said response signal. The gate is maintained open for a predetermined period of time that establishes a threat detection zone so that a response signal from another aircraft passes through the gate only if the response signal is received during the predetermined period of time. The received response signal is applied to an indicator to indicate the proximity of the other aircraft or is used to compute the threat of collision and derive a display of a suitable avoidance maneuver.

Official Gazette of the U.S. Patent Office

N71-24954# Hawaii Univ., Honolulu. Information Sciences Program.

THE THEORY OF DIGITAL PROCESSING OF STOCHASTIC SIGNALS FOR USE IN AVIONIC SYSTEMS ON-BOARD AIR FORCE AIRCRAFT Final Scientific Report, 1 Jan. 1967–31 Dec. 1970

N. Thomas Gaarder Mar. 1971 17 p refs

(Grant AF-AFOSR-1251-67)

(AD-719822; CER-PRE-70101; AFOSR-TR-71-0494) Avail: NTIS CSCL 9/4

The report contains a description of the University of Hawaii research program in the theory of digital processing of stochastic signals for use in avionic systems on-board Air Force aircraft. The majority of new signal processors in avionic communication and control systems are being realized digitally. They are realized digitally because the advent of the present integrated circuit technology has led to inexpensive, reliable, flexible, and light weight systems. The discrete nature of these digital processors coupled with the stochastic nature of their input signals imposes constraints upon such systems that should be considered in the design of such systems. Author (GRA)

N71-24996 Kansas Univ., Lawrence.

EMPENNAGE LOADS ON T-TAIL TRANSPORTS IN CONTINUOUS ATMOSPHERIC TURBULENCE

Henry Morgan Dodd, Jr. (Ph.D. Thesis) 1969 104 p

Avail: Univ. Microfilms Order No. 70-11014

Empennage loads on T-tail transports were investigated for the case of response to continuous atmospheric turbulence. A real-time analog-digital computer simulated the airplane dynamics and determined the importance of nonlinear aerodynamic loads caused by simultaneous vertical and lateral gusts. These nonlinear aerodynamic effects were determined from wind-tunnel tests in a transonic dynamics tunnel. The simulated model was assumed to be a rigid airplane with five degrees of freedom (2 longitudinal, 3 lateral), and results were obtained for both yaw damper on and damper off flight conditions. Bending moments on the stabilizer, fin tip, and fin root were chosen as typical loads, with emphasis on how loads might be altered by the nonlinear effects. Dissert. Abstr.

N71-25024*# Techtran Corp., Glen Burnie, Md.

AVIATION AND ASTRONAUTICS IN THE USSR

A. A. Izmaylov, ed. Washington NASA May 1971 652 p refs Transl. into ENGLISH of the book 'Aviatsiya i Kosmonavtika SSSR Moscow, Mil. Press, 1968 p 1–599

(Contract NASw-1695)

(NASA-TT-F-13142) Avail: NTIS HC $9.00/MF $0.95 CSCL 05D

The history of the development of aviation in the U.S.S.R. is reviewed. Starting with aviation in prerevolutionary Russia, the stages during the periods of the civil war, building socialism, World War 2, and postwar period are discussed with the birth and development of astronautics. Lists of aviation heroes of the Soviet Union are also included. F.O.S.

N71-25032# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY AND CONTROLLABILITY OF SUPERSONIC AIRCRAFT, 1970

V. Lutskii et al 4 Dec. 1970 14 p Transl. into ENGLISH from Aviatsiya i Kosmonavtika (Moscow), no. 1, 1970 p 15–18

(AD-719804; FTD-HC-23-599-70) Avail: NTIS CSCL 1/3

To a great extent, the maneuverability of a supersonic fighter is determined by the value of the maximal available overloads which vary in relation to the flight speed and height. In its turn, the maximal available overload is affected by the maximally permissible value of lift coefficient and the reserve C(subscript y)--ranging from the balancing value in straight flight to the maximally permissible value. Satisfactory parameters of stability and controllability are retained in the delta-wing fighters under conditions of aerodynamic buffeting. Author (GRA)

N71-25048# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FIRST BORN OF SOVIET AVIATION SCIENCE

A. I. Makarevskii et al 15 Jan. 1970 29 p Transl. into ENGLISH from Priroda (USSR), no. 5, 1970 p 2–11

(AD-719802; FTD-MT-24-292-70) Avail: NTIS CSCL 1/2

The article briefly traces the role of the Central Aerohydrodynamic Institute im. Prof. N. E. Zhukovskiy (TsAGI) in the development of Soviet military and civilian aviation. It discusses some of the technical problems encountered in the development of subsonic, transonic, supersonic, and hypersonic flights and steps undertaken to solve them. Some of the TsAGI wind tunnels and their role in aircraft development are described. Author (GRA)

N71-25049# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY AND CONTROLLABILITY OF SUPERSONIC AIRCRAFT, 1969

V. Lutskii et al 4 Dec. 1970 10 p Transl. into ENGLISH from Aviatsiya I Kosmonavtika (USSR), no. 11, 1969 p 11–18

(AD-719803; FTD-HC-23-597-70) Avail: NTIS CSCL 1/3

During the piloting of supersonic aircraft with swept wings, it is important to take into account a reduction in the overload stability margin in the transonic range of speeds at relatively small angles of attack. This is connected with the unfavorable development of flow separation on the wing and the horizontal empennage under conditions of the formation and development of supersonic zones of flow and shock waves; such a condition sometimes leads to a spontaneous abrupt rise in the overloading at these speeds. Author (GRA)

N71-25050# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

FLIGHT TESTS TO INVESTIGATE THE PROBLEMS OF STEEP APPROACHES BY STOL AIRCRAFT

C. O. O'Leary and N. V. Slatter London Aeron. Res. Council 1970 43 p refs Supersedes RAE-TR-69277; ARC-31849

(ARC-CP-1138; RAE-TR-69277; ARC-31849) Copyright. Avail: NTIS; HMSO: 60p; BIS: $2.40

Steep approach tests with a Varsity and an Andover aircraft are described. Using the Varsity aircraft, 243 visual approaches were flown in a statistical experiment which included variations of approach angle, speed, height of entry to the approach, glide path guidance and pilots. A statistical analysis of the effects of the variables on various approach performance parameters was carried out and the significant results are illustrated and discussed. Tests with the Andover aircraft were on a smaller scale and were primarily concerned with the final phase of the approach and

landing. The most important results of the tests are that steep approaches can be accurately and consistently made using a simple form of glide path guidance and landing distances can be decreased without any apparent increase in variability of performance. Author (ESRO)

N71-25053# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SCANNING SYSTEMS FOR THERMAL VIEWERS
E. Ia. Karizhenskii et al [1971] 6 p Transl. into ENGLISH from Optiko-Mekh. Prom. (Leningrad), no. 9, 1970 p 39–42
(AD-719854) Avail: NTIS CSCL 17/5

Some questions associated with the development of scanning systems for thermal viewers are examined. Recommendations are made for the selection of such systems. Author (GRA)

N71-25060# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
MEASUREMENT AND ANALYSIS OF C-5A INTERIOR ACOUSTIC ENVIRONMENTS DURING FLIGHT OPERATIONS Final Report, Jul.–Aug. 1970
Justus F. Rose, Jr. Oct. 1970 11 p refs
(AD-719746; AMRL-TR-70-110) Avail: NTIS CSCL 20/1

Interior sound pressure levels produced by the C-5A aircraft were measured at sixty-six locations where crew/passenger personnel9would typically be located during operational missions. Conditions ranged from aircraft preflight through maximum endurance cruise at an altitude of 31,000 feet. These data were used to compute A-weighted and C-weighted overall sound levels, permissible exposure times with and without ear protection and preferred speech interference levels. The measured data were grouped by location/condition and each major compartment in the aircraft evaluated for human exposure to the environment. The major problem area is in the cargo compartment where the high noise levels are such that for any appreciable exposure time, ear protection must be worn to prevent risk of permanent hearing impairment. The public address system in the cargo compartment is inadequate as presently configured and coupled with the high noise levels cannot be effectively used to brief passengers during missions. Author (GRA)

N71-25065# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
A PILOTED SIMULATOR STUDY OF A JET VTOL AIRCRAFT IN PARTIALLY JET-BORNE FLIGHT
K. P. King and A. McPherson London Aeron. Res. Council 1971 67 p refs Supersedes RAE-TR-68301; ARC-31163
(ARC-R/M-3647; RAE-TR-68301; ARC-31163) Copyright. Avail: NTIS; HMSO: £1.75; BIS: $6.30

A simulation of a small jet VTOL aircraft has been used to examine the principles of controlling such aircraft in the partly jet-borne regime. An investigation of three alternative techniques for control at constant speed was made, from which the pilots were able to select a single control technique that was effective from the lowest speed simulated (40 kt) to the highest (150 kt). The preferred technique was to use thrust to control flight path and thrust vector angle to control airspeed while using attitude (controlled by the elevator) to make fine adjustments to both flight path and airspeed. A preliminary study of techniques for performing the transition between wing-borne and jet-borne flight was then made. Although computation limitations precluded transitions to speeds below 40 kt, some valuable information was gained. In particular, a number of transitions were performed successfully, and without great difficulty, while following an ILS beam. As a result of these tests, it is believed that jet VTOL aircraft with adequate stability may have a greater potential than had been anticipated for operating in poor weather, without the complicated flight-director systems and automatic controls that have generally been thought to be necessary. Author (ESRO)

N71-25073# Advisory Group for Aerospace Research and Development, Paris (France).
REPORT OF THE HIGH REYNOLDS NUMBER WIND TUNNEL STUDY GROUP OF THE FLUID DYNAMICS PANEL
Apr. 1971 24 p refs
(AGARD-AR-35-71) Avail: NTIS

The working group considered transonic wind tunnel performance and operating characteristics required to support evolution of military and civil, aeronautical and aerospace systems during the coming decade. These considerations, along with a review of experience on model testing at transonic speeds, led to the conclusion that the NATO nations should acquire, as soon as possible, two types of new wind tunnels. One tunnel should duplicate transonic flight Reynolds numbers and have a run time on the order of one second. The second should have a 16 ft test section and should provide Reynolds numbers that are 3 or 4 times the maximum presently available, with a run time on the order of 10 seconds. It was also concluded that AGARD should support current research and development in design, operation and test techniques in transonic tunnels of the continuous, conventional blowdown and Ludwieg tube type, and that AGARD should encourage expansion of these activities in the future. Author

N71-25080# Advisory Group for Aerospace Research and Development, Paris (France).
EXTREME VALUE ANALYSIS AND ITS APPLICATION TO c. g. VERTICAL ACCELERATIONS MEASURED ON TRANSPORT AIRPLANES OF TYPE C-130
Otto Buxbaum (Lab. fuer Betriebsfestigkeit) Mar. 1971 31 p refs Presented at 31st Meeting of the Panel on Environ. Statist. Data of AGARD, Tonsberg, Norway, 1-6 Nov. 1970
(AGARD-R-579-71) Avail: NTIS

The interpretation of cumulative frequency distributions of measured flight loads can be increased significantly by an additional extreme value analysis. This method not only leads to a higher reliability in fatigue design but may be used also for a prediction of extreme loading conditions and for a description of the effect of airplane and flight parameters on loads, as is demonstrated for c.g. vertical accelerations and gust velocities measured on airplanes of type C-130. Author

N71-25092# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Flight Dynamics Lab.
PROCEEDINGS OF THE AIR FORCE CONFERENCE ON FATIGUE AND FRACTURE OF AIRCRAFT STRUCTURES AND MATERIALS
Sep. 1970 898 p refs Conf. held at Miami, 15–18 Dec. 1969
(AD-719756; AFFDL-TR-70-144) Avail: NTIS HC $9.00/MF $0.95 CSCL 1/3

The document is comprised of papers presented at the Air Force Conference on Fatigue of Aircraft Structures and Materials, sponsored by the Air Force Flight Dynamics Laboratory (AFFDL) and the Air Force Materials Laboratory (AFML), Air Force Systems Command. The purpose of the Conference was to discuss technological advancements in fatigue and fracture theory. The Conference was comprised of ten technical sessions (including two panel discussions) entitled The Role of Materials in Structures; Fundamentals I + II; Criteria; Fracture I + II; Phenomena I + II; Analysis; Design and Service Experience. A total of fifty-six technical papers were presented. Author (GRA)

N71-25133# Army Foreign Science and Technology Center, Charlottesville, Va.
SOVIET HELICOPTERS [SOVETSKIE VERTOLETY]
18 Feb. 1971 11 p Transl. into ENGLISH from the Russian
(AD-719585; FSTC-HT-23-1063-70) Avail: NTIS CSCL 1/3

Brief descriptions are presented for the V-10(Mi-10), Ka-25K, KA-26 and KA-22 helicopters. Author (GRA)

N71-25196# Committee on Science and Astronautics (U.S. House).
NASA AUTHORIZATION, 1972, PART 4
Washington GPO 1971 325 p refs Hearings on H.R. 3981 (Superseded by H.R. 7109) before Comm. on Sci. and Astronaut., 92d Congr., 1st Sess., No. 2, 18 and 23 Mar. 1971
Avail: Subcomm. on Advan. Res. and Technol.

Statements and testimony are presented on NASA research and program management facilities, tracking and data acquisition, space research technology, and nuclear power and propulsion. Also documented are hearing materials on technology utilization and aeronautics research and technology. Sixteen prepared statements on these NASA programs are included. E.C.

N71-25209# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ASSEMBLY OF GAS TURBINE AIRCRAFT ENGINES (SELECTED CHAPTERS)
V. I. Sokolov et al 10 Dec. 1970 102 p refs Transl. into ENGLISH from the publ. 'Sborka Aviatsionnykh Gazoturbinnykh Dvigateley' 1969 p 257–343
(AD-719823; FTD-HC-23-635-70) Avail: NTIS CSCL 21/5

While the units and subassemblies can be assembled both in an assembly shop and in the assembly sections of the combined and machine-assembly shops, the overall assembly of an engine is done only in an assembly shop. The overall assembly of engines, just as the assembly of units, consists of the preliminary intermediate and final assembly operations. In the process of conducting these operations, a check is made of the mutual arrangement of the parts and units; the axial, radial and diametral clearances and fits are established. These must comply with the technical specifications for the overall assembly of engines. The report discusses the overall assembly of three types of gas-turbine engines (GTE), differing significantly in design of basic units; therefore the preliminary intermediate and final assembly processes differ in respect to the methods used in these processes. Author (GRA)

N71-25260*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OPTICAL PROPERTIES OF CLOUDS
Warren A. Hovis *In its* Significant Accomplishments in Sci. and Technol. at Goddard Space Flight Center 1970 p 19–22

Avail: NTIS HC$6.00/MF$0.95 CSCL 04B

Remote measurements of optical cloud properties by aircraft mounted spectrometers are described. Cloud reflectance measurements in the solar infrared region show that a two channel radiometer with bands centered at 1.7 microns and 2.1 microns can discriminate cloud type and determine to some degree the size of cloud particles. A third channel centered at 1.6 microns is able to distinguish between jet contrails and natural clouds. G.G.

N71-25359# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE WORK OF TURBINE AND INJECTION BURNERS ON A GAS VARIABLE COMPOSITION
B. P. Adinskov et al 1 Dec. 1970 15 p refs Transl. into ENGLISH from Gaz. Prom. (Moscow), v. 14, no. 11, 1969 p 35–39
(AD-719834; FTD-MT-24-273-70) Avail: NTIS CSCL 21/5

Combustion and aerodynamic installations are described which are used to determine amount of air (gas to air ratios) required to burn fuels of different compounds in turbojet or injection burners. Equations were developed to calculate the air requirements in turbojet and injection systems when changing feed gases of known density and compositions. Author (GRA)

N71-25362*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab
PERTURBATION AND HARMONIC BALANCE METHODS FOR NONLINEAR PANEL FLUTTER Technical Report, 11 Dec. 1969–15 Mar. 1971
Luigi Morino, Ching-Chiang Kuo, and John Dugundji Mar. 1971 107 p refs
(Grant NGR-22-009-387)
(NASA-CR-111907; ASRL-TR-164-1) Avail: NTIS CSCL 20K

Nonlinear panel flutter is examined by using the multiple time scaling method and the harmonic balance method. The two methods are applied to the analysis of: (1) simply supported two dimensional plates; and (2) clamped-clamped three dimensional plates. The effect of mass ratio and inplane loadings are analyzed in both bases. The influence of the aspect ratio is considered also for the three dimensional plate. The two methods yield very similar results. A comparison with existing methods shows that the results are in very good agreement with those obtained by straightforward direct numerical integration method. Author

N71-25384*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
POTENTIAL OF METHANE FUELED SUPERSONIC TRANSPORTS OVER A RANGE OF CRUISE SPEEDS UP TO MACH 4
John B. Whitlow, Jr. and Gerald A. Kraft Washington May 1971 39 p refs
(NASA-TM-X-228) Avail: NTIS CSCL 01B

A major factor restricting currently proposed SST's to a maximum cruise speed of Mach 2.7 is the limited heat sink capacity of kerosene-type fuels. Higher speeds may be possible with cryogenic liquid methane, which has up to seven times the heat sink and can be economically obtained from natural gas. In the analysis presented, methane was considered as the fuel for airplanes designed to cruise at speeds up to Mach 4. When a comparison was made at Mach 2.7 with a conventionally fueled SST, the use of methane improved both range and direct operating cost (DOC) by about 11 percent. Little range improvement was obtained by cruising faster than Mach 2.7, although certain assumptions made in this study should produce somewhat optimistic results at the higher speeds. Range peaked near Mach 3 and decreased from 6 to 13 percent as cruise speed was increased to Mach 4. The block time reductions obtained with higher cruise speeds are beneficial to DOC. Most of the possible DOC improvement was obtained by a speed increase to Mach 3.2, where a 20-minute time saving produced 7 percent improvement in DOC. Author

N71-25396# National Aerospace Lab., Tokyo (Japan).
A MODEL TEST ON THE HOVERING PERFORMANCE OF JET FLAPPED ROTOR
Masaki Komoda, Tohichi Oka, Kingo Takasawa, and Nobuhiro Toda 1970 18 p refs In JAPANESE; ENGLISH summary
(NAL-TR-211) Avail: NTIS

A model test was conducted to investigate the hovering performance of jet-flapped rotors with special attention to the comparison with that predicted theoretically. The jet-augumented thrusts and torques were measured for given sets of rotor rpm and mass flow rate. Except for the fact that considerably smaller rates of mass flow were measured than predicted, which is attributable to pressure loss within the nozzle area, the general dependence of measured thrust and torque coefficients upon mass flow and rotor rpm exhibits acceptable agreement with theoretical predictions

based on the annular momentum theory in conjunction with two-dimensional jet-flapped airfoil theory. Author

N71-25397*# Northrop Corp., Hawthorne, Calif.
RECIRCULATION CHARACTERISTICS OF A SMALL-SCALE VTOL LIFT ENGINE POD
Gordon R. Hall May 1971 112 p refs
(Contract NAS3-10498)
(NASA-CR-1774) Avail: NTIS CSCL 01B

Exhaust gas ingestion and recirculating flow field characteristics of a small-scale VTOL lift engine pod containing two simulated engines are reported. Results are presented for tests designed to investigate transient development of the recirculating flow field, steady state ingestion and recirculating flow field characteristics, and dynamic simulation of takeoff and landing. The steady state test results include effect of nozzle height and spacing, effect of inlet and exhaust flow conditions, and effect of wind speed and direction. Author

N71-25411*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY IMPACT SPEED AND ANGLE CRITERIA FOR DESIGN OF A NUCLEAR AIRPLANE FISSION PRODUCT CONTAINMENT VESSEL
Patrick M. Finnegan, Richard L. Puthoff, and James W. Turnbow (Dyn. Sci. Corp., Phoenix, Ariz.) Washington May 1971 37 p
(NASA-TM-X-2245; E-6025) Avail: NTIS CSCL 21F

Reports and photographs of 96 major accidents occurring before 1965 and involving multiengine jet aircraft were studied. Impact speed and angle are presented for landing and takeoff accidents, cruise accidents without in-flight structural failure, and in-flight structural failure accidents. The landing and takeoff accidents had an average impact velocity of 200 ft/sec from any direction and a maximum impact velocity of 300 ft/sec with a 10 deg solid angle about the roll axis. The cruise accident without structural failure had an average impact velocity of 400 ft/sec and a maximum possibly as high as 1000 ft/sec (305 m/sec), both within a 10 deg solid angle about the roll axis. The in-flight structural failure accident had an average impact velocity of 400 ft/sec (122 m/sec) from any direction and a maximum possibly as high as 1000 ft/sec (305 m/sec) within a 10 deg solid angle about the roll axis. The in-flight structural failure accident determines the most severe impact speed for all impact angles. Author

N71-25454*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
IMPROVED ALUMINIDE COATINGS FOR NICKEL BASE ALLOYS Final Report
M. A. Levinstein and J. R. Stanley 12 Mar. 1971 175 p refs
(Contract NAS3-11160)
(NASA-CR-72863) Avail: NTIS CSCL 11F

Improved aluminide coatings for the NASA 6A nickel-base superalloy, developed for high-temperature jet engine components, were investigated. Coatings involved modifications of a base system representative of three approaches to improve coating stability: 1) oxide particle embedment, 2) chromium enrichment, and 3) aluminum enrichment. Both single-step and duplex coating processes were used. Coatings were tested at 2000 F (1366 K) in dynamic oxidation using both high- and low-velocity cycle burner rigs and ballistic impact. Coating systems identified exceeded 660 hours life at Mach 0.5 and 2000 hours at low velocity. Tensile and stress-rupture properties of NASA 6A were not affected by the coatings. Author

N71-25460*# General Electric Co., Cincinnati, Ohio.
TASK 4 STAGE DATA AND PERFORMANCE REPORT FOR CASING TREATMENT INVESTIGATIONS. EVALUATION OF RANGE AND DISTORTION TOLERANCE FOR HIGH MACH NUMBER TRANSONIC FAN STAGES, VOLUME 1
W. A. Tesch May 1971 203 p ref
(Contract NAS3-11157)
(NASA-CR-82862; GE-R71-AEG-149-Vol-1) Avail: NTIS CSCL 20D

Two high-tip-speed compressor stages were tested with various rotor tip casing treatment configurations under conditions of undistorted inlet flow, tip-radial distortion and circumferential distortion. The first stage consisted of a 1400 ft/sec tip speed medium-aspect-ratio rotor plus a stator vane row; the second stage had a 1500 ft/sec tip speed medium-aspect-ratio rotor and a stator vane row. This second stage was tested both with and without zero-turning inlet guide vanes. Overall performance and stall margin were determined for each stage configuration and inlet condition at 70, 90, 100% of design speed. Extensive surveys of flow conditions were made for the case of circumferential distortion. In addition, blade element data were obtained when testing with undistorted and radial distortion inlet conditions. The techniques and procedure used to acquire the data are described and an analysis and discussion of the test results is included. Author

N71-25461*# General Electric Co., Cincinnati, Ohio.
TASK 4 STAGE DATA AND PERFORMANCE REPORT FOR CASING TREATMENT INVESTIGATIONS. EVALUATION OF RANGE AND DISTORTION FOR HIGH MACH NUMBER TRANSONIC FAN STAGES, VOLUME 2
W. A. Tesch May 1971 333 p ref
(Contract NAS3-11157)
(NASA-CR-82867; GE-R71-AEG-149-Vol-2) Avail: NTIS CSCL 20D

Tabulations are presented of blade element and circumferential distortion flow survey data. For description of test see N71-25460. Author

N71-25524*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRBREATHING NUCLEAR PROPULSION, A NEW LOOK
Frank E. Rom [1971] 23 p refs Presented at 6th Symp. on Advanced Propulsion Concepts, Niagara, N.Y., 4–5 May 1971; sponsored by AFOSR
(NASA-TM-X-67837) Avail: NTIS CSCL 21F

Aircraft that could fly anywhere on the surface of the earth or remain aloft for weeks at a time without refueling is discussed. Such an aircraft or air cushion vehicle would be nuclear propelled with complete radiation shielding for crew and passenger safety, and have safety provisions designed to prevent the release of radioactive material in the event of serious aircraft accidents. Other safety features include reactors for long operation without refueling, long life high temperature oxidation resistant heat exchangers, and light weight long life valves and pumps. The economics and practicality of such vehicles are also discussed. E.H.W.

N71-25537*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
IN-FLIGHT EVALUATION OF THE LATERAL HANDLING OF A FOUR-ENGINE JET TRANSPORT DURING APPROACH AND LANDING
Euclid C. Holleman and Glenn B. Gilyard Washington May 1971 31 p refs
(NASA-TN-D-6339; H-642) Avail: NTIS CSCL 01B

The lateral handling of a typical jet transport was evaluated during up-and-away and approach flight in the landing configuration. Sidestep maneuvers to a landing were performed with several levels of lateral control power in smooth-air conditions. A roll control

power capability of about 15 degrees per second was required for satisfactory lateral control, 200-foot lateral offsets to the runway could be safely corrected with very low levels of lateral control power, approximately 2 to 5 degrees per second, using altered piloting techniques. The pilot evaluation results were in general agreement with results from other studies. Author

N71-25604# Naval Civil Engineering Lab., Port Hueneme, Calif.
AIRFIELD PAVEMENT CONDITION SURVEY, USNS ADAK, ALASKA
David J. Lambiotte and Robert B. Brownie Jan. 1971 63 p refs
(AD-719889; NCEL-TN-1138) Avail: NTIS CSCL 1/5

The results of a condition survey of the airfield pavements at the U. S. Naval Station, Adak, Alaska are presented. The survey established statistically-based condition numbers (weighted defect densities) which were direct indicators of the condition of the individual asphaltic concrete and portland cement concrete pavement facilities. Additional evaluation efforts included photographic coverage of defect types, preparation of the construction history of the station, compilation of data on current aircraft traffic and aircraft types using the station, performance of runway skid resistance tests, and a study of the requirements for future pavement evaluation efforts. Author (GRA)

N71-25621# Center for Naval Analyses, Arlington, Va. Inst. of Naval Studies.
GENERAL AVIATION, NAVAL AVIATION AND CONGESTION WITH AN EXAMPLE FROM SOUTHERN CALIFORNIA
Stuart G. Schmid Jan. 1971 32 p refs *Its* INS Res. Contrib. No. 154
(Contract N00014-68-A-0091)
(AD-719906) Avail: NTIS CSCL 1/2

Federal Aviation Authority projections of general aviation activity for 1980 show a 75 percent increase over 1969 levels. Such growth will cause a substantial increase in general aviation traffic in airspace over metropolitan areas, creating difficulties for present users of airspace including the Navy. This paper describes a simple computational model used to translate projected general aviation growth into implied densities and aircraft interaction frequencies. The model is applied to Southern California and a case study is made of Miramar NAS at San Diego. The study shows that Navy operations there will be seriously hampered by general aviation traffic within the decade unless stricter air traffic controls are imposed. Such controls are probably justifiable considering the costs of moving Navy operations out of Miramar in comparison to the costs to general aviation of staying clear of prescribed Navy airspace. Author (GRA)

N71-25622# Army Foreign Science and Technology Center, Washington, D.C.
AIRCRAFT ANTI-ICING SYSTEM: PRINCIPLES OF DESIGN AND TEST METHODS
V. S. Savin et al 26 Jan. 1971 380 p refs Transl. into ENGLISH of the book "Protivoobledenitelnye Sistemy Letalelnykh Apparotov: Osnovy Proektir. i Metody Ispytanii" Moscow, Mashinostr., 1967 p 1-320
(AD-719922; FSTC-HT-23-411-69) Avail: NTIS HC $6.00/MF $0.95 CSCL 1/3

Theoretical fundamentals and practical methods of calculating and testing anti-icing systems (AIS) of aircraft and helicopters are described. Based on generalizations of results of experimental research, the meteorological conditions under which icing of aircraft and power plant is possible are pointed out, and the conditions that must be taken as calculation basis in designing AIS are set forth. The unfavorable effect of various forms and types of icing on stability and control of aircraft and engine performance is discussed. Approximation methods of calculating the dimensions of icing zones are presented. Present-day mechanical, physico-chemical, and thermal anti-icers are briefly examined and criteria for evaluating them when designing AIS are proposed. Principal attention is paid to electro-thermal and preheat-air systems, for which detailed methods of heat calculations are spelled out. Methods and techniques of testing AIS under full-scale and artificial icing conditions are described and tests with icing simulators are analyzed. Author (GRA)

N71-25714# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON TRANSONIC FLOW PERTURBATIONS CAUSED BY VORTICITY
G. B. Ilinskaya et al [1971] 4 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza (USSR), no. 1, 1971 p 168-170
Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

Plane vortical gas flows in the neighborhood of a point of orthogonality of the sonic line to the velocity vector are studied. Such points originate in the transonic flow over a wing profile in the external boundary layer region, where there is a transverse velocity gradient. Flows in which the acceleration is negative ahead of the sonic point are investigated. They can originate in the flow around a wing profile with a peak pressure distribution, when intense compression waves starting from the sonic line retard the flow in the local supersonic zone. The gas motion is described by the continuity, vortex, and Bernoulli equations. Author

N71-25746# Joint Publications Research Service, Washington, D.C.
STUDY OF CLEAR SKY TURBULENCE IN THE STRATOSPHERE
N. K. Vinnichenko et al 14 May 1971 12 p refs Transl. into ENGLISH from Tr. Tsentr. Aerolog. Observ. (Moscow), no. 100, 1970 p 86-98
(JPRS-53133) Avail: NTIS

Theoretical and experimental studies of clear air turbulence are reviewed. The topics include the following areas of investigations: large and small scale pulsations, statistical hydromechanical study of synoptic scale movements, characteristic features distinguishing turbulent motion from wave motion, turbulence affecting supersonic passenger and transport aircraft, energy transfer rate in the presence of turbulence, distribution of turbulent zones, correlation and spectral characteristics of lower stratospheric turbulence, and problems associated with creating a physical model of turbulence in the free atmosphere. N.E.N.

N71-25772*# Aerojet Liquid Rocket Co., Sacramento, Calif.
INVESTIGATION OF THE SUITABILITY OF GELLED METHANE FOR USE IN A JET ENGINE Final Report, 15 Jun. 1970-15 Feb. 1971
E. M. Vander Wall Mar. 1971 97 p refs
(Contract NAS3-14305)
(NASA-CR-72876) Avail: NTIS CSCL 21D

The results are presented of an investigation that involved: (1) evaluation of suitable particulate gelants for liquid methane, (2) characterization of the resulting gels with respect to inhibition of nitrogen absorption, sloshing behavior, venting behavior, and effects of boil-off, and (3) heat exchanger tests to determine potential problem areas in utilizing the gels in jet engines. Both water and methanol were found to be suitable gelants for liquid methane. Liquid methane gelled with water was successfuly evaluated in the heat exchanger tests. Author

N71-25783*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NUCLEAR POWERED AIR CUSHION VEHICLES FOR TRANSOCEANIC COMMERCE

Frank E. Rom and Charles C. Masser Washington May 1971 52 p refs

(NASA-TM-X-2293; E-6152) Avail: NTIS CSCL 21F

Large air-cushion vehicles (ACV's) greater than 3620 metric tons (4000 tons) gross weight, have the potential for hauling transoceanic cargo at rates in the range of $0.006 to $0.012 per metric ton-kilometer ($0.010 to $0.020/ton-n mi) at speeds of 185 kilometers per hour (100 knots). It theoretically would take a fleet of over 1000 10,000-metric-ton-gross-weight ACV's to handle 10 percent of the world transoceanic trade projected for 1985. ACV's using compact lightweight nuclear reactors show clearly superior performance for ranges of 3710 kilometers (2000 n mi) or greater. For a range of 7420 kilometers (4000 n mi) the total operating cost for chemical ACV's is three times that for nuclear ACV's. The nuclear ACV performance is less sensitive than the chemical ACV to the operating and cost assumptions used. Relatively large variations in any of the important assumptions had a relatively small effect on nuclear ACV performance. Author

N71-25784*# Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.

RESULTS OF INITIAL PROP-FAN MODEL ACOUSTIC TESTING. VOLUME 2: APPENDICES B THRU F

F. B. Metzger and T. G. Ganger 4 Dec. 1970 305 p

(NASA Order L-60739)

(NASA-CR-111842-2; HSER-5787-Vol-2) Avail: NTIS HC $6.00/MF $0.95 CSCL 20A

Stationary microphone test data from the prop-fan model test are presented along with an evaluation of the accuracy of the data. Appendices contain: the one-third octave band data for the far-field tests conducted with the static shroud installed; the narrow band data for the far-field tests conducted with the static shroud installed; the one third octave band data for the near-field tests conducted with the static shroud installed; and the one third octave band data for the far-field tests conducted with the compromise shroud installed. Author

N71-25785*# Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.

RESULTS OF INITIAL PROP-FAN MODEL ACOUSTIC TESTING. VOLUME 1: DISCUSSION

F. B. Metzger and T. G. Ganger 4 Dec. 1970 58 p refs

(NASA Order L-60739)

(NASA-CR-111842-1; HSER-5787-Vol-1) Avail: NTIS CSCL 20A

Results are summarized of a test program conducted to explore the low noise potential of the prop-fan, a high bypass ratio, low pressure ratio, variable pitch propulsor. Far field noise data and directional character of a 21-inch diameter prop-fan model were determined for two shroud configurations, a bellmouth test shroud and a takeoff/cruise shroud. In addition, near field data were obtained for the bellmouth test shroud. Review of the data reinforce earlier conclusions that a large STOL aircraft powered by prop-fans has the potential to meet the objective of 95 PNdB at 500 feet with modest acoustic treatment. Author

N71-25808# Army Foreign Science and Technology Center, Charlottesville, Va.

PRINCIPLES OF THE THEORY OF AVIATION GAS TURBINE ENGINES [OSNOVY TEORII AVIATSIONNYKH GAZOTURBINNYKH DVIGATELEI]

I. I. Kulagin 15 Dec. 1970 307 p Transl. into ENGLISH from the Russian report

(AD-719913; FSTC-HT-23-539-71; RA-017-68) Avail: NTIS CSCL 21/5

The book reviews the principles of the theory of gas turbine engines. The main attention is devoted to the physical significance of the phenomena and behavior patterns reviewed, and especially to those questions of theory directly associated with engine operation in the aircraft, and with bench testing. Author (GRA)

N71-25822*# Translation Consultants, Ltd., Arlington, Va.

SHORT TERM CREEP OF METALS AND ALLOYS UNDER CONDITIONS OF AERODYNAMIC HEATING [KRATKOVREMENNAYA POLZUCHEST METALLOV I SPLAVOV V USLOVIYAKH AERODINAMICHESKOGO MAGREVA]

I. N. Bogachev et al Washington NASA May 1971 10 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Chern. Met. (USSR), no. 4, 1970 p 142–147

(Contract NASw-2038)

(NASA-TT-F-13633) Avail: NTIS CSCL 11F

A method of testing metals and alloys for short-term creep under conditions of aerodynamic heating (in dynamic contact with high velocity air flows in the test apparatus) is described. Tests on Ni, Co, Armco Fe, Ti alloys, and various types of C and alloy steel at 500–1000 C show that the nature of the creep process under aerodynamic conditions differ sharply from that characterizing static creep. The change is attributed to thermal, erosive, and corrosive effects, and in some cases to the alternating stresses arising from high-speed air flows. Author

N71-25846# General Precision, Inc., Binghamton, N.Y. Link Group.

A COMPARISON OF PILOT PERFORMANCE USING A CENTER STICK vs SIDE ARM CONTROL CONFIGURATION Technical Report, May – Oct. 1968

Richard Geiselhart, Paul Kemmerling, James E. Cronburg, and David E. Thorburn Wright-Patterson AFB, Ohio AFSC Nov. 1970 54 p refs

(Contract F33615-68-C-1097)

(AD-720846; ASD-TR-70-39) Avail: NTIS CSCL 1/3

Six Air Force pilots having current flying status flew a series of forty-minute missions to compare pilot performance with the conventional center stick, dual side stick, and single side stick configurations. An F-111 flight simulator with three degrees-of-motion was employed as the test-bed for the experiment. The missions, which included climbout, a terrain following portion, two banking turns, and five Instrument Landing System (ILS) approaches, were designed to test the feasibility of side stick controllers under low-altitude, high-speed conditions. Course steering deviation, airspeed deviation, pitch deviation, and ILS evaluation scores were obtained using the computer to compare pilot performance using the three stick configurations. From the evaluation of the performance data and opinion questionnaires filled out by the pilots, it was concluded that side stick controllers are feasible for use in a relatively high-speed aircraft flying a low-altitude, high-speed mission, and that dual side sticks are preferable to single side sticks. Recommendations were made for further studies in several areas. Author (GRA)

N71-25872*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MACH 2.5 PERFORMANCE OF A BICONE INLET WITH INTERNAL FOCUSED COMPRESSION AND 40 PERCENT INTERNAL CONTRACTION

Joseph F. Wasserbauer and David A. Choby Washington May 1971 58 p refs

(NASA-TM-X-2294; E-6079) Avail: NTIS CSCL 20D

The inlet was designed to have the minimum internal contraction consistent with high total-pressure recovery and low cowl drag. Without a bypass system the inlet provided a critical pressure recovery of 0.880 and a steady-state distortion of 0.185 when the supercritical bleed flow was 0.032. With a bypass system in operation the critical pressure recovery increased to 0.903 and the steady-state distortion dropped to 0.10. Maximum angle of attack before an inlet unstart ranged as high as 9.4 deg. Author

N71-25876# Aluminum Co. of America, New Kensington, Pa. Alcoa Research Labs.

INVESTIGATION TO DEVELOP A HIGH STRENGTH STRESS-CORROSION RESISTANT NAVAL AIRCRAFT ALUMINUM ALLOY Final Report, 16 Dec. 1969 – 16 Sep. 1970

J. T. Staley 20 Nov. 1970 114 p refs

(Contracts N00019-70-C-0118; N00019-69-C-0292)

(AD-720398) Avail: NTIS CSCL 11/6

The report presents the results of an evaluation of three tempers of commercially fabricated alloy MA15 plate in 1 in. to 6 in. thickness. Compared at equal strengths, MA15 developed higher resistance to stress-corrosion cracking, greater resistance to exfoliation corrosion, higher toughness, and better fatigue performance than established commercial aluminum alloys. Compared at equal resistance to stress-corrosion cracking, MA15 developed substantially higher strength than established commercial aluminum alloys. Field testing of this material is recommended. Author (GRA)

N71-25920*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

RADIO FREQUENCY UTILIZATION IN THE BANDS OF PRINCIPAL INTEREST FOR AERONAUTICAL SATELLITES

John J. Bisaga, Earl J. Holliman, and Allan Schneider Dec. 1970 128 p refs

(NASA-TM-X-65527; X-490-70-447) Avail: NTIS CSCL 17B

Radio frequencies examined are those allocated and assigned in the frequency bands 118.0 to 136.0 MHz (VHF) and 1535 to 1660 MHz (UHF or L band). The frequency areas were considered as possible candidates for aeronautical communications using satellite techniques because of their current allocation to the aeronautical service. The present utilization, future trends which would affect frequency availability with projected growth, and pertinent factors influencing frequency assignment for the time frame to 1980 were studied. Since the ability to meet increased utilization also depends upon channelization and performance characteristics, the parametric relation of these factors for a range of values were included. Author

N71-25955# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TECHNICAL MAINTENANCE OF AIRCRAFT [TEKHNICHESKAYA EKSPLUATATSIYA LETATELNYKH APPARATOV]

A. I. Pugachev et al 15 Jan. 1971 633 p refs Transl. into ENGLISH from the Russian

(AD-720366; FTD-MT-24-110-70) Avail: NTIS HC $9.00/MF $0.95 CSCL 1/3

Basic questions on the theory, practice and organization of technical maintenance of aircraft of civil aviation are stated. Application of methods of flow planning, the theory of mass servicing and the theory of reliability in solving problems of technical servicing are considered. Basic rules are started for the maintenance of aircraft and special features of their servicing under various climatic conditions. Questions regarding provision of operational technical facilities for aircraft and foreign experience in the organization of technical servicing are elucidated. Data regarding methods and means of control and mechanization of processes of technical servicing are set forth. In the book questions of flight operations of aircraft are stated: the organization and provision of flights, maintenance of aircraft at various stages, under specific conditions and cases of flight, methods of determination of load, and centering, and of fuel consumption, and methods of analyzing flying accidents. Author (GRA)

N71-25998*# Translation Consultants, Ltd., Arlington, Va.

VARIABLE AERODYNAMIC FORCES IN A TURBINE STAGE INDUCED BY A VANE CASCADE IN THE WAKE OF A PRECEDING CASCADE [PEREMENNYYE AERODINAMICHESKIYE SILY V TURBINNOY RESHETKE, VOZBUZHDAYEMYYE POSLEDUYUSCHCHIM LOPATOCHNYM APPARATOM]

A. S. Laskin et al Washington NASA May 1971 6 p refs Transl. into ENGLISH from Energomashinostr. (Moscow), v. 16, Jul. 1970 p 45–46

(Contract NASw-2038)

(NASA-TT-F-13631) Avail: NTIS CSCL 20D

Experimental and theoretical study of the aerodynamic forces produced in a turbine stage by each subsequent vane cascade of a cascade series. Experimental oscillograms are given to show the pressure pulsations and pulsation amplitude variations on the concave and convex surfaces of a cascade sequence. The complex nature of variations in the aerodynamic forces resulting from the interaction between the successive vane cascades is discussed. Author

N71-26032# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: COMPANIA ECUATORIANA DE AVIACION DOUGLAS C-54D, REPUBLIC OF ECUADOR, HC-AON: MIAMI INTERNATIONAL AIRPORT, MIAMI, FLORIDA, 14 APRIL 1970

Dec. 1970 27 p ref

(NTSB-AAR-71-2) Avail: NTIS

A Douglas C-54D, of Ecuadorian registration, crashed at Miami International Airport, Miami, Florida, at approximately 0724 e.s.t., April 14, 1970. The aircraft was being operated as an international cargo flight by Compania Ecuatoriana de Aviacion. The accident occurred during the initial climb, following an instrument takeoff at Miami International Airport. The flight was en route from Miami to Panama City, Panama, the first leg of a flight which was to terminate at Quito, Ecuador. The two pilots, the only occupants of the aircraft, were killed, and the aircraft was demolished by impact and postimpact ground fire. Author

N71-26052*# National Aeronautics and Space Administration, Washington, D.C.

CURRENT SHUTTLE STATUS

C. J. Donlan *In its* NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 1–15

Avail: NTIS HC $9.00/MF $0.95 CSCL 05A

Space shuttle cost trends per pound of payload are defined for current transportation systems ranging in size from the Scout to the Saturn V. Technical performance requirements, engine size, and vehicle configurations are assessed, mobilization of people and resources and a broad technology program are outlined, and a current space shuttle planning schedule involving a delta-type orbiter with single vertical tail and associated canard-type booster configurations is presented. G.G.

N71-26053*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FLOW FIELDS AND AERODYNAMIC HEATING OF SPACE SHUTTLE ORBITERS

J. G. Marvin, W. K. Lockman, G. G. Mateer, H. L. Seegmiller, C. C. Pappas et al *In its* NASA Space Shuttle Technol. Conf., Vol. Apr. 1971 p 21-73 refs

Avail: NTIS HC$9.00/MF$0.95 CSCL 20D

Flow fields and heating environments that the space shuttle orbiter will encounter are investigated in hypersonic wind tunnel simulations in order to obtain data for evaluating performance prediction techniques and for extrapolating ground based facility data to flight conditions. Photographs of streamline oil flow patterns, pressure distribution data, and heating data on the windward surface of low and high cross-range orbiters are presented and comparisons with theory are made. G.G.

N71-26054*# McDonnell-Douglas Co., St. Louis, Mo.

AN ANALYSIS OF PREDICTED SPACE SHUTTLE TEMPERATURES AND THEIR IMPACT ON THERMAL PROTECTION SYSTEMS

R. V. Masek and J. Alan Forney (NASA. Marshall Space Flight Center) *In* NASA, Washington NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 75-96

Avail: NTIS HC$9.00/MF$0.95 CSCL 20M

Aeroheating prediction methods for the space shuttle configuration are evaluated by comparing evolved time-temperature histories computed at five lower centerline locations for various combinations of flow field method, transition criterium, turbulent heating method and trajectory analysis. Considered are a metallic heat shield and a surface insulation concept, low and high cross-range missions, and a conical flow field with normal shock expansion to Newtonian pressure. The low cross-range mission peak temperature was found to be most sensitive to flow field assumption and the high cross-range mission was most affected by transition criteria. A conical flow assumption produces temperatures 166 C - 222 C higher than the normal shock assumption; the effects of transition criteria are noticeable about 111 C. For the low cross-range mission, the thermal protection system unit weight for one aeroheating methodology proved 32.1 N/sq m lighter than for another prediction method. G.G.

N71-26056*# Grumman Aerospace Corp., Bethpage, N.Y.

A NUMERICAL PROCEDURE TO CALCULATE THE INVISCID FLOW FIELD ABOUT A SPACE SHUTTLE ORBITER TRAVELING AT A SUPERSONIC/HYPERSONIC VELOCITY

B. Grossman, F. Marconi, Jr., and G. Moretti *In* NASA, Washington NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 157-184 refs

Avail: NTIS HC$9.00/MF$0.95

A technique for computing the complete inviscid, three dimensional flow field about a vehicle flying at supersonic speed at an angle of attack is reported. The flow field in the vicinity of the stagnation point at the nose of the body is determined using a three dimensional, time dependent blunt body program. The asymptotic steady state values of this flow field are then used as starting conditions for a supersonic, steady state numerical calculation. This computation utilizes a three dimensional, finite difference marching technique which determined the flow field downstream of the nose of the vehicle where the flow is supersonic. Within the physical model of an inviscid, perfect gas, the complete coupled calculation provides an approximation which uniformly converges to the exact solution. Agreement with experimental results is excellent and applications of the program are made for a typical shuttle orbiter delta lifting body configuration at angle of attack. Author

N71-26057*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SHOCK INTERFERENCE HEATING AND DENSITY-RATIO EFFECTS. PART 1: FLOW FIELD VISUALIZATION, THERMOCOUPLE MEASUREMENTS, AND ANALYSIS

H. Lee Seegmiller *In its* NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 185-215 ref

Avail: NTIS HC$9.00/MF$0.95 CSCL 20M

Flow field visualization techniques, thermocouple measurements, and analyses of shock interference phenomena about a model of the straight wing orbiter established: (1) wing fuselage shock interference heating effects for low sweep wing at angles of attack from 20 deg to 70 deg; (2) stagnation region and shock boundary layer interference effects at small angles of attack; (3) stagnation region interference effects only at large angles of attack; (4) suitability of the local angle of attack theory for predicting stagnation region interference effects provided the stagnation streamline is known; (5) significant wing root interference effects; and (6) peak interference temperature similarities at Mach = 7.4, Re = 1.10 times 1 million and at Mach = 15, Re = 0.03 times 1 million. G.G

N71-26058*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SHOCK INTERFERENCE HEATING AND DENSITY RATIO EFFECTS. PART 2: HYPERSONIC DENSITY RATIO EFFECTS

James L. Hunt and Theodore R. Creel, Jr. *In* NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 217-243

Avail: NTIS HC$9.00/MF$0.95 CSCL 20M

Ground test data obtained at hypersonic Mach numbers and at various values of specific heat-gas ratios are used to simulate the trends of equilibrium real gas effects expected for low cross-range shuttle flight. Applied are data on shock shape, surface oil flow patterns, and for the location of the body shock/wing shock intersection location obtained at various angles of attack and with normal shock density ratios of 3.9, 5.6, and 12, respectively. Primary conclusions show that significant shock-density-ratio effects are strongly configuration and angle-of-attack dependent and that a high cross-range shuttle configuration which reenters at lower angles of attack is essentially a best choice. G.G.

N71-26059*# General Dynamics/Convair, San Diego, Calif. Aerospace Div.

SHOCK INTERFERENCE HEATING ON THE SPACE SHUTTLE BOOSTER DURING ASCENT

O. Brevig and C. Young *In* NASA, Washington NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 245-266

Avail: NTIS HC$9.00/MF$0.95 CSCL 20M

Paint phase-change and thermocouple test results from space shuttle booster ascent wind tunnel simulations show that: (1) interference heating on the booster top surface is caused by shock impingement due to orbiter and booster bow shocks in the gap region; (2) interference heating in the gap region increases with free stream Mach number; (3) a reasonable correlation between paint phase-change and thermocouple heat transfer rate test data is obtained; and (4) paint phase-change test data cannot be used accurately to measure peak heat transfer rates in areas of highly localized heating due to shock impingement. G.G.

N71-26060*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LEE SIDE HEATING INVESTIGATIONS. PART 1: EXPERIMENTAL LEE SIDE HEATING STUDIES ON A DELTA WING ORBITER

Jerry N. Hefner and Allen H. Whitehead, Jr. *In its* NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 267-287 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20M

The effects of Reynolds number and angle of attack on the magnitude and distribution of lee surface heating at Mach 6 on a delta wing orbiter establish that: (1) the growths of lateral body dimensions in addition to nose shape and bluntness have a strong influence on the nature of vortical flow and leeside heat transfer; and (2) the flow about a cylindrical body is essentially two dimensional at the 55 deg angle of attack with reference to the body axis. G.G.

N71-26061*# Grumman Aerospace Corp., Bethpage, N.Y.
LEE SIDE HEATING INVESTIGATIONS. PART 2: LEE SIDE HEATING INVESTIGATIONS OF SIMPLE BODY LIKE CONFIGURATIONS
George Maise *In* NASA, Washington NASA Space Shuttle Technol. Conf. Vol. 1 Apr. 1971 p 289–309 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20M

The leeside aerodynamic heating of various shapes flying hypersonically at an angle of attack was investigated. Intense heating resulting from reattachment of leading-edge vortices on the lee side of the bodies was analyzed by: (1) correlation and comparison of available leeside heating data, and (2) an experimental program to clarify some questions related to the vortical flow phenomenon. In the correlation of available data on circular cones, a strong Reynolds number dependence has been observed. In the wind tunnel study, the effect of increase in cross sectional area on vortical heating was examined, and an attempt was made to establish the angles of attack at which the flow about elongated bodies becomes two dimensional in the cross-flow plane, i.e., negligible axial components. Heat transfer and oil flow models were tested in a hypersonic wind tunnel. Author

N71-26062*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STATIC AND DYNAMIC AERODYNAMICS OF SPACE SHUTTLE VEHICLES
Victor L. Peterson, Elliott D. Katzen, John A. Axelson, Jack J. Brownson, Donald L. Ciffone et al *In its* NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 311–373 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 22B

Effects of Mach number, as well as chine radius and Reynolds number, on the aerodynamics of space shuttle vehicles at high angles of attack are considered for delta wing configurations having single and twin vertical tails. Resulting aerodynamic criteria for a wide range of shuttle configurations and test conditions show that: (1) aerodynamic stability designs must consider the effects of varying dynamic pressure and Mach numbers. Computer simulations can be utilized to determine which of the many derivatives have the greatest influence on flight behavior of space shuttle configurations. G.G.

N71-26065*# McDonnell-Douglas Astronautics Co., St. Louis, Mo.
CONSIDERATION OF REYNOLDS NUMBER SIMULATION FOR SUBSONIC SHUTTLE TESTS
Thomas B. Sellers *In* NASA, Washington NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 423–453 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 20D

The Reynolds number simulation requirements for conducting subscale wind tunnel tests of space shuttle aerodynamic configurations are reviewed, and conclusions are reached that apply to the acquisition of data at angles of attack from zero to 90 degrees. Methods for qualitatively evaluating effects of simulation deficiencies are presented. It is shown that uncertainties inherent in high angle of attack stability data may be greatly reduced by extending the existing two-dimensional cross-flow coefficient data base. At low angles of attack, requirements for developing methods for predicting the onset of discernible viscous components, and relating the strength of that component to Reynolds number, are cited. Author

N71-26066*# McDonnell-Douglas Astronautics Co., St. Louis, Mo.
CORRELATION OF SPACE SHUTTLE APPLICABLE EXPERIMENTAL HYPERSONIC AERODYNAMIC CHARACTERISTICS WITH THEORY
Richard K. Hamilton *In* NASA, Washington NASA Space Shuttle Technol. Conf., Vol. 1 Apr. 1971 p 455–492 refs

Avail: NTIS HC $9.00/MF $0.95 CSCL 22B

Hypersonic theoretical-experimental correlations of aerodynamic characteristics pertinent to straight and blended delta wing shuttle designs are presented. The results substantiate the usefulness of the theoretical techniques in supporting the assessment of the hypersonic aerodynamic coefficients for delta wing shuttle designs. The use of the Hypersonic Arbitrary Body Program (HABP) also provides confidence in configurations as they are entered into the wind tunnel program. Emphasis is placed on those aerodynamic characteristics which are influential with respect to the shuttle design. Characteristics correlated are shown on the slide. Areas of exceptional agreement will be noted as well as instances where deviations exist. Oil flow visualization studies complement the analysis. Author

N71-26110* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DIRECT LIFT CONTROL SYSTEM Patent
Joseph W. Stickle, inventor (to NASA) Issued 27 Apr. 1971 4 p Filed 20 Jun. 1969 Cl. 244-42; Int. Cl. B64c21/08
(NASA-Case-LAR-10249-1; US-Patent-3,576,301; US-Patent-Appl-SN-835060) Avail: US Patent Office CSCL 01C

A direct lift control system is proposed which is associated with existing control mechanism on most aircraft, and particularly applicable to light-weight aircraft. This is accomplished by forming a slot through to the flap associated with the wing. When the flap is deflected, air is forced through the slot opening in the lower surface of the flap and discharged at the slot opening at the upper surface of the flap, this spoils the airflow over the flap thus reducing lift. Tests have shown that this arrangement has little effect on drag, since the actual shape of the airfoil flap combination has not been changed to any degree. In addition, closure mechanisms are introduced for varying the size of the slots to regulate the degree of spoiling of the flap induced lift and the resultant direct lift control. Author

N71-26129# Royal Aircraft Establishment, Farnborough (England).
AERODYNAMIC FORCES ON AUTOCABS, APPENDIX M
K. T. Shaw *In its* Cabtrack Studies: Assessment of Autotaxi Urban Transport Systems Jan. 1969 p 123–128 refs

Copyright. Avail: NTIS

Autocabs may be subject to substantial aerodynamic forces when operating in windy conditions although the cab speed may be relatively low. These forces can have a considerable effect upon the power required to maintain particular acceleration profiles and upon the vehicle track required for lateral stability. The effect of the yawing moment on longitudinal stability could limit the types of guidance system which are acceptable. Some preliminary estimates of the aerodynamic forces and moments to which an Autocab may be subjected, over a range of cab and wind speeds within which a Cabtrack system in Central London may operate

are presented. The estimates refer to an idealized cab running on a flat road surface of unlimited width and do not take into account the effects of flow disturbances produced by particular track configurations. Author

N71-26150# Research Inst. of National Defence, Sundbyberg (Sweden).
ANTENNA FOR SPEECH COMMUNICATION SET FPL37 MEASUREMENTS OF IMPEDANCE ON THE PRODUCTION VERSION IN LIGHT METAL [TALKOMMUNIKATIONSANTENN TILL FPL 37. IMPEDANSMAETNINGAR PA SERIEVERSION I LAETTMETALL]
Viggo Westerlin Oct. 1969 8 p refs In SWEDISH
(FOA-3-C-3602-61) Avail: NTIS

The earlier antenna put forward has undergone certain alterations in changing to the production version made in light metal. The report briefly reviews impedance measurements for the new design. Desirable alterations of the basic design are stated. Author

N71-26170*# Princeton Univ., N.J.
TURBULENCE AND LATERAL-DIRECTIONAL FLYING QUALITIES
James A. Franklin Washington NASA Apr. 1971 344 p refs
(Contract NSR-31-001-104)
(NASA-CR-1718; Rept-890) Avail: NTIS CSCL 01B

Trends in pilot rating obtained in the test program for variations in turbulence disturbances and airplane dynamics are explained in terms of measures of precision of task performance, pilot control workload, and pilot compensatory behavior derived from time histories of the flight evaluations. Pilot-vehicle systems analyses substantiate the performance-workload data and provide a more fundamental understanding of the heading control task in turbulence The significant influence of turbulence on the evaluation task was found to be the rms disturbance magnitude, with yaw disturbances having a more profound effect than roll disturbances. Spectral bandwidth had less bearing on flying qualities than disturbance magnitude. Reductions in either roll damping or directional stability adversely affected flying qualities. Additional roll damping and directional stability were desired when the level of turbulence was increased. Data obtained for variations in aileron yaw indicate that favorable yaw is detrimental to the heading tracking task, particularly for low directional stability and when roll disturbances due to turbulence are large. Author

N71-26183*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LOW SPEED AERODYNAMIC CHARACTERISTICS OF A LARGE SCALE STOL TRANSPORT MODEL WITH AN AUGMENTED JET FLAP
Anthony M. Cook and Thomas N. Aiken Mar. 1971 89 p refs
(NASA-TM-X-62017) Avail: NTIS CSCL 01A

An investigation was made to study the aerodynamic characteristics of a large scale model equipped with an augmented-jet flap and underwing cruise engines with deflectable thrust capability. The augmented-jet flap is a jet flap with the primary jet thrust increased by means of a spanwise ejector system installed in the wing trailing-edge flap. The flap installation was on the inboard part of the wing, with blown ailerons outboard. Primary configurations tested were those selected previously for landing approach and takeoff, for direct application of the data to a proposed flight research aircraft. Assessment was made of the effects of the underwing engines and nacelles with variations in thrust magnitude and direction. The effects of fuselage BLC were also measured. In addition, several methods of lateral control were investigated to obtain measurements of lateral derivatives and roll control power. The tests were made with and without the horizontal tail at a wind tunnel dynamic pressure of 383 newtons per square meter (8 pounds per square foot), corresponding to a Reynolds number of 2.9 million. The range of jet momentum coefficients was 0 to 1.07. Author

N71-26194# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
AVIATION EQUIPMENT AND AIRCRAFT ARMAMENT Final Report
29 Jan. 1971 28 p refs
(AD-720570; MTP-7-4-005) Avail: NTIS CSCL 1/3

Procedures are described for determining the ability of aviation equipment and aircraft armament to withstand storage and operate effectively in a tropic environment. Author (GRA)

N71-26195# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
RESCUE EQUIPMENT, AIRCRAFT CRASH Final Report
27 Jan. 1971 25 p refs
(AD-720563; MTP-7-3-090) Avail: NTIS CSCL 6/7

Procedures are identified for evaluation of aircraft borne aircraft crash rescue equipment under simulated tactical conditions. Helicopter mounted rescue hoists and accessories are also included. Author (GRA)

N71-26298# National Aerospace Lab., Tokyo (Japan).
GAS TURBINE COMBUSTORS
Kunio Suzuki, Takasi Tamaru, Shoji Horiuchi, and Takashi Saito Sep. 1970 82 p refs In JAPANESE; ENGLISH summary
(NAL-TR-208) Avail: NTIS

A design method for lift engines is proposed for applying recent data and experience. Various flame holders and their characteristics, the admission of air and its distributions, and flow patterns in the combustion chambers are investigated. However, on account of lack of fundamental knowledge concerning the phenomena occurring in a combustion chamber, the design details still must be dependent on the practical data and model experiments. Therefore, design data which had been experienced in many practical engines, especially those of vaporizing types, are considered. Experimental techniques necessary for developing or improving combustion systems such as temperature measurement by thermocouples, and gas analysis by means of sampling probes, are also described. Author

N71-26301# Consortium of Universities, Washington, D.C. Urban Transportation Center.
DULLES INTERNATIONAL AIRPORT ACCESS
Robert G. Baxter [1970] 44 p refs Prepared in cooperation with Md. Univ.
(PB-194094) Avail: NTIS CSCL 13B

An examination of the growth potential and requirements for continued improvement of Dulles International Airport is presented. An analysis of the relationship between the daily vehicular volumes on the Dulles Airport access road and the number of daily departing passengers is used as a basis for determining the adequacy of access routes to the airport. Author

N71-26303# Hydrospace Research Corp., Rockville, Md.
AIRCRAFT NOISE TYPE CERTIFICATION ORIENTATION SESSIONS: FAA PRESENTATIONS, SUPPLEMENT 1 Final Report
Oct. 1970 70 p refs Presented in Washington, D.C., 5 Aug. 1970. Conf. held in Washington, D.C., Rockville, Md., and Atlantic

City, 5–12 Aug. 1970; sponsored by FAA
(Contract DOT-FA70WA-2446)
(HRC-TR-300-Suppl-1) Avail: NTIS

The proceedings of a conference to train personnel in techniques for conducting aircraft noise certification are presented. Subjects discussed are: (1) development of noise rules, (2) aircraft noise measurements, (3) aircraft noise evaluation, (4) data reduction, and (5) flights to determine maximum sideline noise measurement points. Author

N71-26304# Hydrospace Research Corp., Rockville, Md.
AIRCRAFT NOISE TYPE CERTIFICATION ORIENTATION SESSION Final Report
John F. Waters and Ray E. Glass Oct. 1970 29 p refs Conf. held in Washington, D.C., 5 Aug. 1970, in Rockville, Md., 6–7 Aug. 1970, and in Atlantic City, 10–12 Aug. 1970; sponsored by FAA
(Contract DOT-FA70WA-2446)
(HRC-TR-300) Avail: NTIS

During the period 5 through 12 August, 1970, an aircraft noise type certification measurements orientation session was conducted for the Federal Aviation Administration (FAA). The purpose of the orientation session was to familiarize FAA personnel with the acoustic measurement techniques and procedures involved in the noise certification of aircraft under Federal Aviation Regulations. Personnel from the FAA regional offices are actually involved in aircraft noise type certifications. Author

N71-26305# Hydrospace Research Corp., Rockville, Md.
AIRCRAFT NOISE TYPE CERTIFICATION ORIENTATION SESSION: LECTURE NOTES, SUPPLEMENT 2 Final Report
John F. Waters, John V. McFadden, and Ray E. Glass Oct. 1970 98 p ref
(Contract DOT-FA70WA-2446)
(HRC-TR-300-Suppl-2) Avail: NTIS

Details of the techniques and procedures for measuring the effective perceived noise level (EPNL) during aircraft noise type certifications are presented. EPNL values are averages based on at least six takeoff and six landing measurements. Allowable EPNL values are given as a function of maximum aircraft weight. Several EPNL tradeoffs are allowed to provide some margin for excesses. Author

N71-26334* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRECIPITATION DETECTOR Patent
Harold R. Long, Martin J. Menges, and Samuel W. Mugler, inventors (to NASA) Issued 20 Apr. 1971 4 p Filed 5 Feb. 1969 Cl. 317-153; Cl. 317-DIG3; Cl. 340-235; Int. Cl. H01h47/36
(NASA-Case-XLA-2619; US-Patent-3,575,641;
US-Patent-Appl-SN-796691) Avail: US Patent Office CSCL 09C

A precipitation detector and mechanism used to shut down a load during precipitation and activate a load upon completion of precipitation is described. The detector has thermistors in a bridge circuit. One of the thermistors is exposed to the elements and cooled upon being contacted with precipitation. This causes an imbalance in the bridge circuit the output of which actuates a relay that shuts down the load. Termination of precipitation allows the thermistor to warm up balancing the bridge circuit and the relay closes activating the load.
Official Gazette of the U.S. Patent Office

N71-26354*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HYPERSONIC AERODYNAMIC CHARACTERISTICS OF DL-4 LIFTING ENTRY VEHICLE
Charles L. Ladson Washington Apr. 1970 44 p refs
(NASA-TM-X-1994; L-6592) Avail: NTIS CSCL 01A

Aerodynamic forces on a representative, high-performance, entry configuration with a lift-drag ratio of about 3 have been obtained at Mach numbers of 6 and 10 in air and 20 in helium. These data are compared with theory to identify areas in which the theoretical methods are adequate and the areas in which improvement is necessary. Experimental results of Mach 10 tests of tip-fin and body modifications are also presented to show the attempts that have been made to develop a configuration which is stable about all axes. Author

N71-26355*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSES OF COOLED TURBINE AIRFOIL CONFIGURATIONS AT CONDITIONS OF SUPERSONIC FLIGHT
Francis S. Stepka Washington Apr. 1969 77 p refs
(NASA-TM-X-1782) Avail: NTIS CSCL 01A

The results of an analysis of various first stage turbine stator vane and rotor blade cooling designs which would have application to engines of aircraft for high-speed flight such as a supersonic transport are presented. Also summarized are the influence of various factors on cooling design and performance of turbine vanes and blades. These included use of future high-temperature materials, use of higher material thermal conductivity, changes in design geometry, changes in combustor gas temperature profiles, foreign object damage, and the effects of steady-state and transient engine and flight conditions. Author

N71-26383# Air Force Systems Command, Wright-Patterson AFB, Ohio. Materials Lab.
APPLICATION OF PHOTOCHROMIC COATINGS FOR NONDESTRUCTIVE INSPECTION Final Technical Report, Jan. 1969–Jul. 1970
Sidney Allinikov Dec. 1970 61 p refs
(AD-720239; AFML-TR-70-246) Avail: NTIS CSCL 14/2

The application of a photochromic compound to provide a nondestructive inspection (NDI) technique for aerospace materials and structures is discussed. The photochromic compound, incorporated into a paint formulation, is converted from a white to a bright violet color upon a brief irradiation from an ultraviolet source. The colored paint surface is then heated by any suitable means, such as a hot air blower. Heat serves to bleach the paint to the original white color. Defects are disclosed because heat conductivity at the defect site is different from that of the rest of the area under inspection. The defect thus appears as a colored or white area dependent upon the nature of the defect and originating direction of the heat source. Some of the types of defects and kinds of structures to which the NDI paint has been applied are discussed, along with advantages and limitations of the paint. Author (GRA)

N71-26387* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INSTRUMENT FOR MEASURING THE DYNAMIC BEHAVIOR OF LIQUIDS Patent
David G. Stephens and Clemans A. Powell, Jr., inventors (to NASA) Issued 21 Oct. 1969 5 p Filed 26 Jan. 1968 Cl. 73-301; Int. Cl. G01f23/00
(NASA-Case-XLA-05541; US-Patent-3,473,379;
US-Patent-Appl-SN-700986) Avail: US Patent Office CSCL 20D

An instrument to determine the dynamic behavior of liquid in a tank is described including a pipe fixed to the tank and

extending throughout its height. An inlet of the pipe allows liquid to enter the pipe. A tube placed inside the pipe carries a plurality of pressure transducers, one being exposed to the liquid in the tank, a second exposed to liquid within the pipe, and a third located at the end of the tube below the other transducers. Outputs from the transducers are computed, and indicate the simultaneous acceleration of the tank, the amplitude of liquid slosh in the tank, and the depth of liquid in the tank.

Official Gazette of the U.S. Patent Office

N71-26416* + Boeing Co., Renton, Wash. Commercial Airplane Div.

STATIC TESTS OF A 0.7 SCALE AUGMENTOR WING FLAP FOR THE MODIFIED C-8A AIRPLANE: TEST RESULTS AND ANALYSIS

D. L. Harkonen, C. F. Wintermeyer, and F. L. Wright May 1971 296 p refs

(Contract NAS2-6025)

(NASA-CR-114315; D6-24850) Avail: NTIS CSCL 01C

A static test investigation was made of an augmentor-wing flap system for the modified C-8A jet STOL research airplane. Tests were conducted using a 0.7 scale model which had a wing span of 95 inches, a flap chord of 30 inches, and a full span double slot nozzle. Flap surface static pressures and total pressures within the augmentor were measured. The augmentor performance was found to be sensitive to the flap coanda surface position and flow blockage within the augmentor. Nozzle total pressure ratio was also an important parameter. The optimum flap pivot point for the aircraft was determined. The augmentation ratios with this pivot point location were near the maximum measured for flap angles from 30 to 65 degrees. The maximum augmentation ratio, based on isentropic thrust at the duct entrance, was 1.27 at 30 degrees flap angle. The corresponding augmentation ratio based on actual nozzle performance was 1.39. As the augmentor passage was blocked off by a moveable segment of the flap, the thrust of the augmentor decreased until slightly negative thrust occurred with the passage completely blocked. Author

N71-26417*# Boeing Co., Seattle, Wash. Commercial Airplane Group.

PARAMETRIC STUDIES OF THE ACOUSTIC BEHAVIOR OF LINED DUCTS AND DUCT LINING MATERIALS FOR TURBOFAN ENGINE APPLICATIONS

J. Atvars Mar. 1971 216 p refs

(Contract NAS1-10272)

(NASA-CR-111887) Avail: NTIS CSCL 01C

A flow-duct test facility was developed to simulate turbofan engine bypass duct geometry and noise environment in the laboratory. The facility was used to study the effects of various parameters of sound-absorbent wall liners. The liners consisted basically of a honeycomb sandwich and a porous face sheet. A description is given of the flow-duct test facility and the data reduction techniques, along with a listing of the reduced test results. Analyses of the test data showed that the significant design parameters are the face sheet impedance, treatment length, treatment depth, honeycomb cell dimensions, duct size, number of walls lined, number of layers in the linings, air velocity, and direction of flow with reference to sound propagation. The influence of these parameters is discussed. For simple single-layer linings, a design technology was developed by means of empirical equations. Experimental results show that this technology is valid for duct sizes (or lining separations) from 4 to 12 in., lining depths of 0.25 to 1 in., and duct airflow Mach numbers from −0.4 to +0.4. It is concluded that the flow-duct facility is a useful tool for investigating the basic properties of acoustically lined ducts. Author

N71-26466# Air Line Pilots Association, International, Chicago, Ill.

ALPA: A SURVEY OF AIRPORT FIRE AND RESCUE FACILITIES, 1971, NORTH AMERICA

B. V. Hewes, P. R. Robinson, and A. L. Couch 1971 154 p

Avail: NTIS

A survey of airports in the United States in order to determine the status of the crash fire and rescue equipment available for use in case of an accident involving a scheduled trunk or local service air carrier aircraft is discussed. Only those airports receiving daily service are included and only fire and rescue equipment located within the airport boundaries is reported. Off airport equipment is not considered capable of meeting the response time requirement of 2 to 3 minutes considered a maximum by expert authorities and, therefore, can only be utilized for back up purposes. When this survey was first conducted 4 years ago, almost 50% of airports in the United States had no fire and rescue capability whatsoever. This number has now been reduced to 25 percent. Author

N71-26516# Northrop Corp., Hawthorne, Calif. Aircraft Div.

A WIND TUNNEL INVESTIGATION OF JETS EXHAUSTING INTO A CROSSFLOW. VOLUME 2: ADDITIONAL DATA FOR THE ONE JET CONFIGURATION

Lynn B. Fricke, Peter T. Wooler, and Henry Ziegler Wright-Patterson AFB, Ohio AFFDL Dec. 1970 508 p

(Contract F33615-69-C-1602)

(AD-720232; AFFDL-TR-70-154-Vol-2) Avail: NTIS HC $6.00/MF $0.95 CSCL 20/4

A low speed wind tunnel test of a four-foot diameter circular plate model was conducted to determine surface static pressure distributions; jet paths, and jet decay characteristics in the presence of a crossflow. Data were obtained for a one-jet configuration with the jet exiting at a number of angles to the plate and at various velocity ratios and sideslip angles. The report is the second of four volumes. The test model, instrumentation, test procedure, and reduction and accuracy of the test data were discussed in Volume 1. Author (GRA)

N71-26517# Northrop Corp., Hawthorne, Calif. Aircraft Div.

A WIND TUNNEL INVESTIGATION OF JETS EXHAUSTING INTO A CROSS FLOW. VOLUME 3: ADDITIONAL DATA FOR TWO-JET CONFIGURATIONS

Lynn B. Fricke, Peter T. Wooler, and Henry Ziegler Wright-Patterson AFB, Ohio AFFDL Dec. 1970 504 p

(Contract F33615-69-C-1602)

(AD-720233; AFFDL-TR-70-154-Vol-3) Avail: NTIS HC $6.00/MF $0.95 CSCL 20/4

A low speed wind tunnel test of a four-foot diameter circular plate model with up to three exhausting jets was conducted to determine surface static pressure distributions, jet paths, and jet decay characteristics in the presence of a crossflow. Two-jet arrangements were tested with the jets exiting normal to the plate for three different spacings between the two jets and at a number of velocity ratios and sideslip angles. Three-jet configuration data were obtained with the jets exiting normal to the plate for a number of velocity ratios and sideslip angles. As a result of this investigation, several conclusions are deduced pertaining to the interaction of multiple jets exhausting into a crossflow. The report is the third of four volumes. The test model, instrumentation, test procedure, and reduction and accuracy of the test data were discussed in Volume 1: The present volume contains additional data pertaining to the two-jet configurations. Author (GRA)

N71-26526# Peat, Marwick, Mitchell and Co., Washington, D.C.

TRAFFIC CIRCULATION STUDY, NATIONAL AIRPORT. BALTIMORE-WASHINGTON AIRPORT ACCESS STUDY: IMMEDIATE ACTION IMPROVEMENTS

Jun. 1970 24 p refs Prepared for Metropol. Wash. Council

of Govt.
(Rept-3) Avail: Issuing Activity

The problem of surface transportation access and circulation at Washington National Airport, District of Columbia, is discussed. Recommendations for improving airport access and reducing traffic congestion are presented. Author

N71-26528# Civil Aeronautics Board, Washington, D.C.
AIR PASSENGER TRAFFIC IN SHORT-HAUL MARKETS
Max H. Burstein and Donna M. Kaylor Mar. 1971 106 p
Avail: Issuing Activity

The magnitude, growth, and carrier participation of passenger traffic in major short-haul markets (those under 500 miles) are analyzed. Concise and manageable information relating to growth, competition, and concentration of passenger traffic in short-haul markets, by distance intervals and individual markets, is presented. Author

N71-26538# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STABILITY AND CONTROLLABILITY OF SUPERSONIC AIRCRAFT
V. Lutskii et al 4 Dec. 1970 10 p Transl. into ENGLISH from Aviatsiya i Kosmonavtika (Moscow), no. 5, 1970 p 34–35
(AD-720740; FTD-HC-23-601-70) Avail: NTIS CSCL 1/3

A general description is given of methods by which a pilot can control the lateral motion of a supersonic aircraft. GRA

N71-26567# Forsvarets Forskningsanstalt, Stockholm (Sweden). Avdelning 2.
MEASUREMENT OF A HELICOPTER'S GYRO DISPLACEMENTS IN SOME DIFFERENT FLYING CONDITIONS [MAETNING AV HELIKOPTRARS GIRROERELSER I NAGRA OLIKA FLYGFALL]
C. Borg and B. Hoegman Nov. 1969 43 p refs In SWEDISH
(FOA-2-C-2356-49-(72)) Avail: NTIS

Measurements of rotations recorded at the helicopter school in Boden are reviewed as a basis for building a simulator for the study of the helicopter's pilot's capacity to guide collimation guided ATGW from helicopters. The measurements were made with the rate gyro giving angular acceleration and were registered on tape. These signals were later integrated to give the angular deflection. Results are presented in tables and curves for angular rate and deflection. Author

N71-26583 Rochester Univ., N.Y.
A MODEL FOR THE WAKE GEOMETRY OF THE LIFTING ROTOR IN FORWARD FLIGHT AND AN EVALUATION OF THE SENSITIVITY OF COMPUTED BLADE LOADS TO THE WAKE GEOMETRY
Mukund Madhav Joglekar (Ph.D. Thesis) 1969 241 p
Avail: Univ. Microfilms Order No. 70-2877

Assuming that a helicopter rotor in forward flight can be represented by a flat circular disk with an appropriate steady pressure discontinuity across it, expressions were developed for relating the pressure field to: (1) the total aerodynamic thrust and the total steady pitching and rolling moments experienced by the rotor; or, (2) the time dependent aerodynamic flapping moments at the roots of the blades as they rotate. The selected pressure field satisfies: (1) the requirement of a loss of lift at the center and periphery of the disk, (2) accounts for first and second azimuthal harmonic variations in the lift density, and (3) satisfies Laplace's equation. A digital computing program was written for calculating the velocity field from the selected pressure field and for calculating the streamlines emanating from points above the disk. Two sample cases were chosen, corresponding to the UH-1 two-bladed teetering rotor at advance ratios of 0.26 and 0.08 respectively. Dissert. Abstr.

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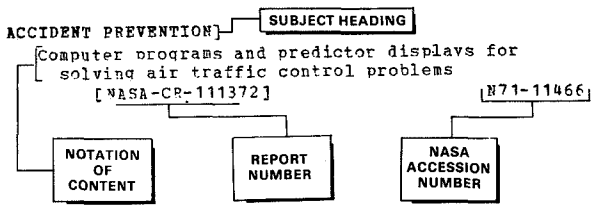

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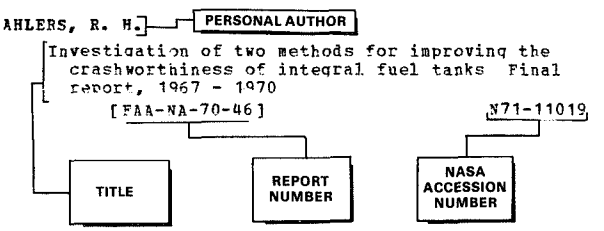

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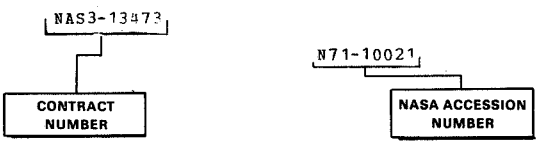

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