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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 5

MAY 1971

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 5

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 April 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 570 reports, journal articles, and other documents originally announced in April 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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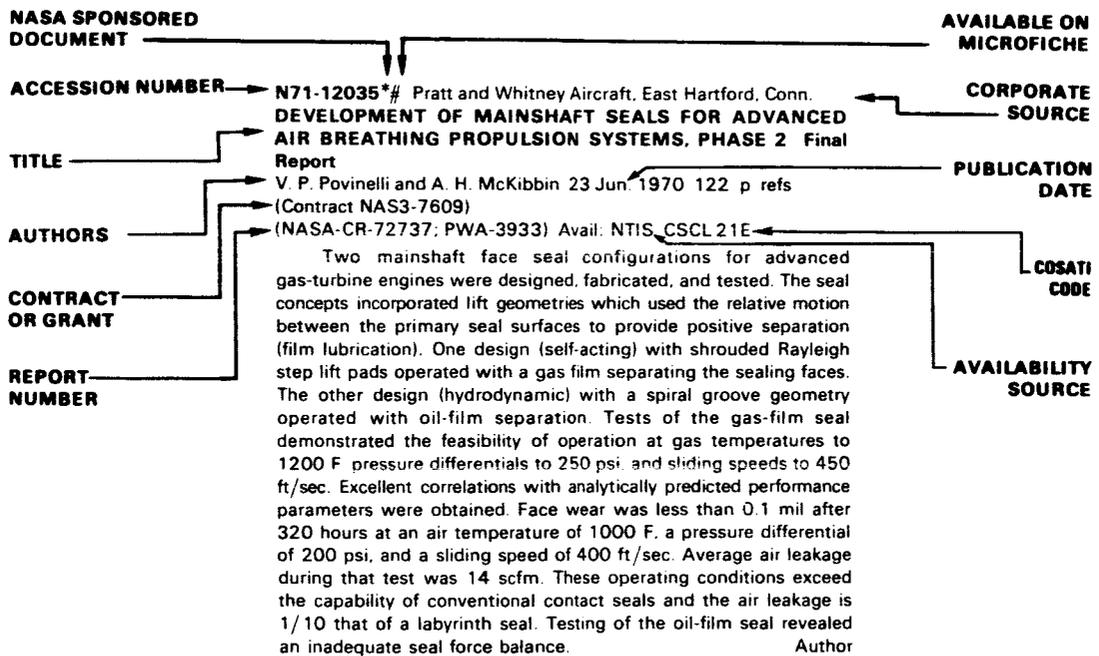
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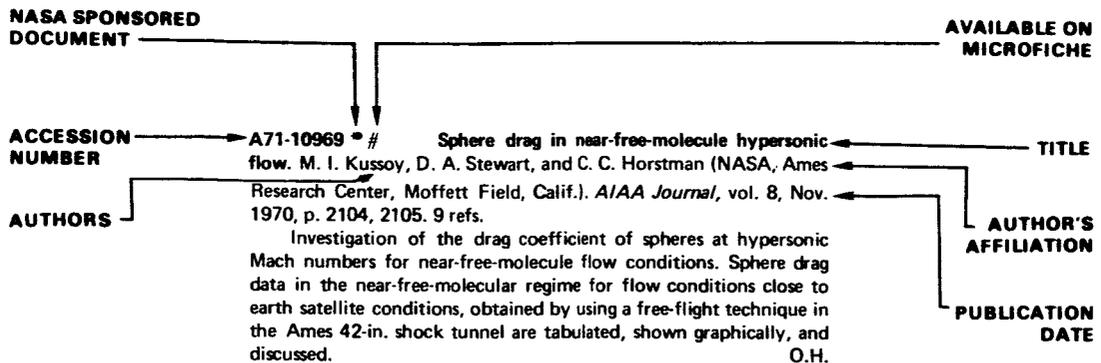
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TYPICAL CITATION AND ABSTRACT FROM IAA





AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 5)

MAY 1971

IAA ENTRIES

A71-18772 # Fully-developed flow in rectangular ducts of non-uniform surface texture. I - An experimental investigation. K. Hanjalić and B. E. Launder (Imperial College of Science and Technology, London, England). In: *Heat and mass transfer in turbulent boundary layers*; Boris Kidrič Institut za Nuklearne Nauke, International Summer School, 1st, Herceg Novi, Yugoslavia, September 9-21, 1968, Proceedings. Volume 2.

Edited by P. Anastasijević, N. Afgan, and Z. Zarić. Belgrade, Boris Kidrič Institut za Nuklearne Nauke, 1970, p. 393-410. 12 refs. Research supported by the Central Electricity Generating Board.

Experimental investigation of turbulent flow in a rectangular duct of large aspect ratio in which one of the principal sides was smooth and the other roughened with isolated square ribs aligned normal to the flow. The objectives of the study included the determination of the positions of maximum velocity and zero shear stress. The results obtained indicate that these two positions were not coincident, the velocity maximum lying farther from the smooth surface than the position of zero shear stress. Results pertaining to several other objectives of the study are discussed. M.V.E.

A71-18808 Communications, navigation and surveillance for aircraft and marine vessels operating in the North Atlantic region. Daniel L. Brandel, Stephen R. Cantor, Ronald M. Hershkowitz, and Franklin D. MacKenzie (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: EASCON '70; Institute of Electrical and Electronics Engineers, Electronics and Aerospace Systems Convention, Washington, D.C., October 26-28, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 66-76. 21 refs.

A baseline air traffic control surveillance model is discussed, and marine positioning requirements and marine communications in the North Atlantic region are considered. The model contains a number of simplifying assumptions. It treats the surveillance problem in only the lateral dimension. A static, strategic technique is proposed and analyzed. The model provides a complete probabilistic description of the system, rather than relying on a worst case analysis. Aspects of aircraft communication channel requirements are examined. Ship distribution in the North Atlantic, the determination of ship location, and high seas communication requirements according to the type of message used are considered. G.R.

A71-18827 * Integrated electro-optical systems for earth-oriented, environmental, and domestic applications. Frank E. Hoge

(NASA, Wallops Station, Wallops Island, Va.). In: EASCON '70; Institute of Electrical and Electronics Engineers, Electronics and Aerospace Systems Convention, Washington, D.C., October 26-28, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 295-301. 33 refs.

Recent applications of separate, single frequency microwave radar and laser (lidar) systems to various earth-oriented, environmental, and domestic areas are briefly surveyed. The advantages of the integration of a separate radar and lidar into a single radar/lidar system are discussed from the vantage point of collocated electro-optical systems. Attention is focused on the design of a hybrid or integrated radar/lidar system and its potential applications in such areas as geodesy, meteorology, oceanography, navigation, and communication. In comparison with separate systems, the radar/lidar configuration is shown to be economical to manufacture, operate and maintain. The economic attractiveness is further enhanced by the worldwide availability of numerous tracking radars. Other applications of radar and optical systems in earth survey, air pollution detection, monitoring and control, and air traffic control are proposed in addition to further study efforts into the utilization of airborne and ground-based coherent radar systems. (Author)

A71-18829 Avionics for aeronautical systems. Warren E. Swanson (North American Rockwell Corp., Aerospace and Systems Office, El Segundo, Calif.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Jan. 1971, p. 42-46.

Advancements in technology have led to increased demand for avionics in airborne applications. Although aeronautical system suppliers have implemented improved procedures and design approaches which are generally effective, challenges continue to exist. This paper explores several areas where overall aeronautical system design might be improved by proper emphasis on avionic subsystem design. The topics selected include standardization, weight impact, environmental control, maintainability, and avionic equipment growth. Comparisons are made in terms of ultimate cost to the aeronautical system user. (Author)

A71-18830 Improvement of automatic landing through the use of a space diversity ILS receiving system. James R. Fries (Boeing Co., Seattle, Wash.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Jan. 1971, p. 47-53. 7 refs.

A space diversity method of receiving and processing ILS localizer information has been developed and flight tested. Multiple laterally separated antennas are used which sense the ILS signal on and around the approach path. Combining these signals suppresses ILS beam distortion produced by multipath signal interference and provides much improved guidance information to the landing aircraft control system. (Author)

A71-18831 ILS localizer multipath analysis. S. L. Shih (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.:

IBM Communications and Engineering Sciences Center, Gaithersburg, Md.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Jan. 1971, p. 54-60. 5 refs. FAA-supported research.

The scattering effect of structures on Instrument Landing System localizer signals is analyzed in this paper. A generalized computer program results which can be used to determine the reflection from surfaces of most materials and orientations for which the radius of curvature is large compared with the wavelength. For most reflecting walls, a closed form solution is used and the computation time is short. The program will enable users to determine the placement of hangars, towers, etc., in airports and to find ways to reduce their effect on localizer facilities. (Author)

A71-18833 **Operating system reliability for the Navy advanced avionic digital computer.** Ronald S. Entner (U.S. Naval Air Systems Command, Washington, D.C.) and Edward H. Bersoff (Logicon, Inc., Falls Church, Va.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Jan. 1971, p. 67-72. 5 refs.

This paper discusses reliability aspects of a modular multi-processor currently under development by the Naval Air Systems Command. The operating system, or executive, of this computer may be implemented in various ways. These include a totally software 'floating executive,' one dedicated to a specific processor, or an executive consisting of special-purpose hardware. The objections to hardware executives, especially for avionic applications, include a supposed degradation in system reliability. This paper shows that under certain conditions this degradation need not occur. (Author)

A71-18835 **Nonlinear estimation via Kalman filtering.** J. J. Kappl (Hughes Aircraft Co., Culver City, Calif.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Jan. 1971, p. 71.

The extended Kalman-Bucy filtering algorithm is applied to the problem of estimating the system parameters of a single-channel missile attitude control system. In particular, noisy observations of body angular rate, normal acceleration, and control surface deflection are used in the algorithm to obtain estimates of body angular rate, angle of attack, control surface deflection, air density, and missile velocity. Computational results obtained for this problem are presented. These results are evaluated to determine the applicability of this estimator as a part of an adaptive control scheme. In addition, a general approach to the formulation of practical nonlinear estimation problems is suggested. (Author)

A71-18900 # **A new correlation of parachute weight data.** Kenneth E. French (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *Journal of Spacecraft and Rockets*, vol. 8, Jan. 1971, p. 71, 72. 5 refs. Research supported by the Lockheed Missiles and Space Independent Development Program.

Statistically treated correlations of weight, configuration, and strength for 59 various parachutes are presented in tables and a diagram in order to assist the parachute designer. The specific tasks for which they may provide help include (1) the rapid assessment of nominal parachute weight, (2) tolerance estimates on the nominal weight, and (3) calculation of weight tradeoffs with respect to variations in parachute size and strength parameters. M.V.E.

A71-18902 * # **Estimation of the maximum temperature of a swept leading edge for an equilibrium glide entry.** Davis H. Crawford (NASA, Langley Research Center, Space Systems Research Div., Hampton, Va.). *Journal of Spacecraft and Rockets*, vol. 8, Jan. 1971, p. 75, 76. 5 refs.

A simple relation for estimating the maximum stagnation line temperature on the wing leading edge during an equilibrium glide entry is derived. This relation, amenable to hand calculation, is based on a modified form of the Detra, Kemp, and Riddell (1957)

relationship for the laminar heating to the stagnation point of a sphere, and is useful for rapid estimates of maximum equilibrium temperatures. M.V.E.

A71-18916 # **Characteristics of the working flow in hypersonic shock tubes in the presence of solid-particle impurities (Osobennosti rabocheho potoka giperzvukovykh aerodinamicheskikh trub pri nalichii primesi tverdykh chastits).** B. I. Bakum. *Inzhenerno-Fizicheskii Zhurnal*, vol. 19, Oct. 1970, p. 698-704. 10 refs. In Russian.

The effects of solid-particle impurities on the flow in a typical hypersonic shock tube were studied from the viewpoint of determining possible sources of error in blunt-body measurements. Nitrogen was used as the working gas, and the particle diameters were 5, 50, and 500 microns. It is shown that the particle temperature reaches the gas temperature from 1 to 10 msec after the onset of the experiment, and the particles pass into the nozzle after being so heated throughout most of its duration. In the nozzle, there is a significant dynamic and thermal lag of the particles in comparison to the gas. As a result, supersonic flow can occur around the particles, leading to a shock wave and flow turbulence in the wake. Such supersonic flow around the particles can also occur in the shock layer ahead of the blunted model, causing additional turbulence. T.M.

A71-18924 # **Nature of the anomalous seeded flow past blunted bodies in hypersonic wind tunnels (O prirode anomal'nogo obtekaniia zatuplennykh tel zapylenym potokom giperzvukovykh aerodinamicheskikh trub).** B. I. Bakum, Iu. N. Shestakov, and V. N. Shmanenkov. *Inzhenerno-Fizicheskii Zhurnal*, vol. 19, Nov. 1970, p. 925-928. In Russian.

Experiments are described in which a cylinder with a small body (thread) in front of it was placed in a hypersonic air flow containing suspended particles. The observed 'anomalous' distortion of the separated shock wave at the cylinder is studied as a function of the spacing between the cylinder and the thread. It is shown that the distortion of the shock wave (usually in the form of one or more fluid cones in front of the wave) may be attributed to effects which occur when the end of an aerodynamic wake produced by lagging particles (the head of the wake travels at the particle velocity and its end at the gas velocity) catches up with the cylinder. V.P.

A71-19014 # **Problems of air navigation.** J. P. Hach (Deutsche Lufthansa AG, Hamburg, West Germany). In: Max-Planck-Institut für Aeronomie, Symposium on the Future Application of Satellite Beacon Experiments, Lindau über Northeim, West Germany, June 2-4, 1970, Proceedings. Symposium co-sponsored by the Deutsche Gesellschaft für Ortung und Navigation. Edited by W. Dieminger and G. K. Hartmann. Lindau über Northeim, West Germany, Max-Planck-Institut für Aeronomie, 1970, p. 14-1 to 14-6.

Discussion of systems used as aids in air navigation, in the final approach and landing of aircraft, and related navigational problems. The instrument landing system (ILS) is briefly described, together with a potential successor to it, as well as the vhf omnidirectional radio range (VOR), the distance measuring equipment (DME), and present long-distance aids. The potential of satellite systems for long-distance aircraft operation is briefly discussed. M.M.

A71-19049 # **Gas flows past blunt bodies. Part 1 - Methods of calculating and analyzing flows (Tcheniia gaza okolo tupykh tel. Part 1 - Metod rascheta i analiz tchenii).** A. N. Liubimov and V. V. Rusanov. Moscow, Izdatel'stvo Nauka, 1970. 287 p. 217 refs. In Russian.

A finite-difference method for studying inviscid gas flows past blunt bodies is developed and analyzed in this book. The method is

applied to two-dimensional, axisymmetric, and three-dimensional steady flow of an ideal gas, allowance being made for physico-chemical transformations. The analysis makes use of special algorithms developed on the basis of exact calculations of flows past spheres, paraboloids, ellipsoids, hyperboloids, truncated cones, and similar bodies. Intended for scientists and engineers dealing with computational mathematics, theoretical aeromechanics, and aerodynamic flight-vehicle design, the book should be useful also to teachers and students. V.P.

A71-19050 # Gas flows past blunt bodies. Part 2 - Tables of gasdynamic functions (Tebhenia gaza okolo tupykh tel. Part 2 - Tablitsy gazodinamicheskikh funktsii). A. N. Liubimov and V. V. Rusanov. Moscow, Izdatel'stvo Nauka, 1970. 379 p. In Russian.

The book contains tables compiled on the basis of systematic calculations of two-dimensional axisymmetric, and three-dimensional gas flows past blunt bodies. Mixed flows past small-aspect-ratio bodies were calculated by a finite-difference method developed in Part 1. Supersonic flows were calculated by a finite-difference method proposed by Babenko et al. (1964). The tables contain the values of gasdynamic functions for axisymmetric and two- and three-dimensional flows past spheres, cylinders, paraboloids, hyperboloids and similar bodies in the subsonic and supersonic regions. Results of calculations of axisymmetric flows with allowance for dissociation and ionization, as well as molecular gas compositions and thermodynamic functions for axisymmetric flows are also tabulated. The tables are compiled for a wide range of parameters. Accurate and convenient for use, they are intended for engineers dealing with gasdynamics and aerodynamics. V.P.

A71-19076 Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., September 24-26, 1970, Proceedings. *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970. 285 p.

Flight-test procedures, equipment, and experience for specific aircraft are described, including technical details of some aircraft, engines, and avionics systems. Development and certification tests are outlined for the F-15, Arava, Boeing 737, Yankee, DC-10, F-104D, and A-7 aircraft. A section on the manned space-flight program includes flight experience with the Apollo 12 and 13 spacecraft, space-shuttle and Skylab project reviews, and pilot evaluations of lifting-body requirements. A new approach to high-velocity helicopter testing is described, and control aspects of the Concorde power plant are explained. The material includes handling and performance evaluations, control system specifications, and recommendations for optimum test procedures. T.M.

A71-19077 # Navy testing in the next decade. John G. Wissler (U.S. Naval Air Test Center). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 1-7.

A realistic appraisal of the trends in Naval Aviation testing during the 70s has to consider the dynamically changing environment that has affected naval testing during the past two decades. The 50s were characterized by a relatively leisurely pace of prototype testing made possible by the world political scene, U.S. nuclear supremacy and a substantial inventory cushion of World War II and Korean War aircraft. Conversely, the 60s were characterized by quick reaction Southeast Asia programs, concurrent production and a disappointing number of expensive weapons systems failures. Navy testing in the 70s must satisfy the divergent requirements of accurate visibility during early development to guide major funding commitments, contrasted against long lead time Fleet outfitting schedules brought on by a sharply declining inventory of aircraft. This dichotomy of naval aviation testing requirements will be the dominant factor in

modifying the nature of the technical procedures, the time frames, and the contractual arrangements of the next decade. These changes will carry the seeds of serious management problems if they are not properly understood and addressed. (Author)

A71-19078 # The F-15 air superiority fighter. James W. Wood (USAF, Washington, D.C.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 9-15.

Description of the military requirements, program management procedures, and present developmental status of the F-15 fighter aircraft. The speed, maneuverability, acceleration, and weaponry considerations that led to the present configuration are outlined, and the program management structure is explained in terms of the major military decision making channels and contractor responsibilities. Emphasis is placed on the flight test programs envisioned for both categories of operation. T.M.

A71-19079 # The development of a collision avoidance system. Raymond D. Hunt (McDonnell Douglas Corp., St. Louis, Mo.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 17-22.

Discussion of test experience gained with the airborne Elimination Range Zero (EROZ) system for mid-air collision avoidance. EROZ operates as a cooperative system in which airborne units are synchronized by a master oscillator at the ground station. Each aircraft transmits a radio signal at a precise instant known to all other aircraft. The time delay between the transmission and reception tells the receiving system the distance between the two aircraft. The Doppler effect provides information on how fast the distance is closing. Maneuvering instructions are presented to the pilot automatically. Over 15,000 operational flights performed with this system testify to its effectiveness, and it is expected that initial cost would be \$1500 for a production run of 10,000 units. T.M.

A71-19080 # Airborne measurement, key to environmental management. W. L. Dowdy and R. L. Gorham (North American Rockwell Corp., El Segundo, Calif.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 23-35.

Airborne surveillance techniques and equipment are discussed for monitoring environmental parameters to provide initial data in a large-scale earth resources management program. Airborne sensors such as aerial cameras, IR scanners, side-looking radars, scatterometers, and spectrometers would be used to measure such diverse parameters as thermal water pollution, extent of crop disease, salinity, and geological structure. Specific tests conducted with a specially equipped D-18 Twin Beechcraft are reviewed, and some problems of pilot training, procedures, and data processing are considered. T.M.

A71-19081 # The Concorde powerplant. James Pollitt (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 43-58.

The design and operation of the Concorde powerplant is described in terms of main technical features of the Olympus 593 two-spool turbojet engine, the variable nozzle assembly, afterburners, the variable intake, and the engine control system. The use of a variable primary nozzle system allows control of the number one spool independent of the number two spool. The electronic engine control system does not require reversion to manual control and its

A71-19082

operation is based on three basic loops. A governing and a positioning loop (effective in the high and low power ranges, respectively) act upon the fuel throttle valve. An 'E' schedule control loop is effective throughout the power range and acts upon the primary nozzle. T.M.

A71-19082 # Flight test of the 'ARAVA' Israel STOL airplane. Avraham Hacoen (Israel Aircraft Industries, Ltd., Lod Airport, Israel). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 59-74.

Description of the design and handling of the Israeli ARAVA aircraft intended for short-haul STOL operations with payloads of 20 passengers or 4400 lbs of cargo. The ARAVA is a 12,500-lb gross takeoff weight, twin-turboprop aircraft characterized by a high-wing geometry and a hanging fuselage with a swinging aft section. A twin-boom tail and rudder structure is used together with a fixed landing gear arrangement. Flight test experience is quoted for longitudinal stability, lateral-directional stability, flap response, and landing characteristics. T.M.

A71-19083 # Developing the advanced 737 airplane. Raymond L. McPherson (Boeing Co., Seattle, Wash.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 75-97.

Test experience gained in evaluating configuration changes meant to improve the takeoff and landing performance of the Boeing 737 aircraft. Emphasis is placed on improvements in high-lift systems and stopping capability. Attention is given to the effects of BLC modifications, wider nacelle struts, extended Krueger flaps, increased slat chord and camber, increased main flap angles, and increased aft flap chord. Performance evaluations are given for an improved antiskid system, an automatic braking system, and softer main gear oleo struts. T.M.

A71-19084 # The development of the Yankee. Richard B. Kemper (American Aviation Corp., Cleveland, Ohio). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 99-104.

The Yankee is the result of considerable redesign and development of an aircraft known initially as the BD-1, which was built in late 1963 by Bede Aircraft, Incorporated in Columbus, Ohio. The BD-1 received substantial publicity at the time of its development since one version of the aircraft, stripped of all accessories and equipped with a low horsepower, remanufactured engine, was priced to the consumer at \$2500. The aircraft featured aluminum honeycomb in the fuselage, metal-to-metal bonding, and folding wings for towing and home storage. (Author)

A71-19085 # Flight testing the DC-10. Felix E. Blum (McDonnell Douglas Corp., St. Louis, Mo.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 105-107.

Brief outline of the DC-10 flight test program, with a description of the handling characteristics under typical test conditions. Takeoff and landing procedures are discussed, and comments are given on the flutter, stall, and stability characteristics. Reverser tests and antiskid braking system tests are also considered. T.M.

A71-19092 # F-104D side stick control system. Byron W. Theurer and Kenneth E. Staten (USAF, Aerospace Research Pilot

School). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 199-219.

Discussion, for the case of the F-104D aircraft, of side stick control system design and function, of curriculum maneuvers which have been verified in the aircraft on side stick, and the observed reliability of the electrical components. The major conclusions developed from the Aerospace Research Pilot School (ARPS) experience with an electrical fly-by-wire flight control system and a side stick controller are that a side stick is usable and offers improvements for aircraft control, that pilot selectable gains, force gradients, and viscous damping should be included in future side stick design, and that arm rest adjustment must be incorporated to account for size of pilot's hands and bulk of garments. F.R.L.

A71-19093 # A new approach to helicopter H-V testing with preliminary results from the OH-58A Kiowa and AH-1G Huey Cobra helicopters. John A. Johnston (U.S. Army, Washington, D.C.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 221-244. 14 refs.

Discussion of height velocity (H-V) testing, mathematical modeling, and the applicability of test results to service use. Attention is also given to two H-V aircraft programs presently being conducted. U.S. Army Aviation Systems Test Activity (USAASTA) established procedures have substantially improved the safety of helicopter H-V flight testing. While mathematical modeling is providing some insight into specific areas, it is not yet sufficiently developed to provide a basis for eliminating further H-V flight testing. F.R.L.

A71-19094 # Spinning the A-7. Donald D. Smith (U.S. Navy, Washington, D.C.). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 245-253.

Concise summary of the progress of the spin evaluation program of the A-7 low altitude tactical fighter, the mission of which calls for vigorous maneuvering capability as well as for the carriage of a wide variety of external stores. The aircraft is considered to have an unsatisfactory departure mode because there are departure characteristics which are, in fact, occurring within a reasonable maneuvering envelope of the aircraft, and which will limit the envelope of the aircraft at low altitude. The aircraft will spin readily when it is loaded asymmetrically, and will always spin away from the heavy store. F.R.L.

A71-19095 # Fighter testing - Spin test or spin prevention test. Burt Rutan (USAF, Flight Test Center). (*Society of Experimental Test Pilots, Symposium, 14th, Beverly Hills, Calif., Sept. 24-26, 1970.*) *Society of Experimental Test Pilots, Technical Review*, vol. 10, no. 2, 1970, p. 255-260.

Discussion of a philosophy of requirements for testing and aircraft improvement, in view of the severe operational limitations of high angle of attack, with summary of the results of the recent USAF F-4E Stall/Near Stall Investigation. It is suggested that a most important aspect of high angle of attack handling qualities is too often being overlooked - i.e., spin avoidance or spin resistance. F.R.L.

A71-19175 Fiber optic faceplates for contrast enhancement under high ambient light conditions for cockpit displays. Anthony M. Detarando (Bendix Corp., Mosaic Fabrications Div., Sturbridge, Mass.). In: *Fiber optics: Applications and technology*; Society of Photo-optical Instrumentation Engineers, Seminar-in-Depth, Dallas, Tex., January 28, 29, 1970, Proceedings. Seminar

co-sponsored by the U.S. Army, Redondo Beach, Calif., Society of Photo-optical Instrumentation Engineers (SPIE Seminar Proceedings, Volume 21), 1970, p. 103-108.

Discussion of the use of fiber optic faceplates to solve the problem which arises, particularly in cockpits of commercial and military aircraft, when visual displays such as cathode ray tubes and rear projection screens are viewed under high ambient light conditions. Optical phenomena responsible for a decrease in the display contrast, such as the ghost, halo, and especially the direct sunlight problem, are explained. Two techniques commonly used to improve the contrast - i.e., the use of a neutral density filter and a circular polarizer - are discussed. The principles underlying the method of using a fiber optic faceplate as a CRT screen are explained in detail, and the prerequisites for designing a fiber optic system for cockpit displays are specified. It is demonstrated that the system suggested eliminates all the problems considered; the ghost, halo, and direct sunlight problem is solved, and an increased display brightness and an improved color rendition and sharpness of image is achieved. O.H.

A71-19183 # Study of inviscid flows of a radiating gas with the aid of differential approximations (Issledovanie neviaskikh techenii izluchaiushchego gaza s pomoshch'iu differentsial'nykh priblizhenii). S. D. Bezrukikh and V. N. Fomin. *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki*, vol. 10, Nov.-Dec. 1970, p. 1503-1511. 8 refs. In Russian.

Study of the P sub 3 and P sub 5 approximations of the method of spherical harmonics for solving problems of hypersonic inviscid gas flow past blunt bodies, and comparison of these approximations with the P sub 1 approximation. Owing to the unwieldiness of the P sub 3 and P sub 5 approximations, the study is performed on a comparatively simple gasdynamic model in which the flow of radiating gas in the vicinity of the forward stagnation point of the blunt body is considered. In addition, a study is made of a two-stage approximation with respect to frequency of the real absorption coefficients of air for the purpose of ascertaining the possibility of using such a model for an approximate calculation of the selectivity of the radiation. A.B.K.

A71-19203 Low profile optical system for an aircraft beacon. A. H. Schwartz (SCM Research and Development Laboratory, Palo Alto, Calif.). (*Optical Society of America, Annual Meeting, Chicago, Ill., Oct. 21-24, 1969.*) *Applied Optics*, vol. 10, Feb. 1971, p. 358-362. 8 refs.

An optical system producing an annular cone of radiation from a point source using a low profile front lens is shown to have application as a beacon for high speed vehicles. The system comprises a high pressure short arc light source with axial electrodes and integral collector, a conical reflector, and a divergent meniscus lens that has low protrusion over the surface of the vehicle. The system has minimal drag, and the radiation is distributed in directions close to the plane perpendicular to the optical axis. The influences of various parameters such as lens camber, lens aperture, source size, collector shape, collection efficiency, and beam divergence are discussed. A prototype was built at Eimac Division of Varian using a xenon short arc lamp with metal ceramic structure and integral collector. (Author)

A71-19245 A study of some factors influencing the ignition of a liquid fuel pool. R. J. Murad (Northern Research and Engineering Corp., Cambridge, Mass.), J. Lamendola, M. Summerfield (Princeton University, Princeton, N.J.), and H. Isoda. *Combustion and Flame*, vol. 15, Dec. 1970, p. 289-298. 9 refs.

Two particular problems concerning the ignitability of a pool of liquid fuel are considered. First is the problem of defining the domain of ignitability of a pool of fuel at a superflash temperature subjected to a cross wind. It is postulated that this domain is bounded by the lean mixture limit or by the blowoff limit of the

local fuel-air mixture, whichever is encountered first above the surface. This domain is calculated for a laminar boundary layer over a flat pool of fuel. The agreement between this predicted boundary and the boundary found here experimentally is generally quite good. Second is the problem of determining what factors control the ignitability of a liquid pool of fuel at a subflash temperature. The heating of such a pool to the point of ignition, by an energy source in the space above it, is retarded considerably by motion induced in the pool. Suppression of the motion enhances the ignitability markedly. The induced motion produces a vortex cell whose size depends on various fuel and igniter parameters. The driving force causing this fluid motion is postulated to be a combination of the forces resulting from buoyancy in the pool and surface tension gradient on the surface. (Author)

A71-19255 * # On the diffraction of a shock wave by general two-dimensional disturbances. Y. S. Pan (Tennessee, University, Tullahoma, Tenn.). *Quarterly of Applied Mathematics*, vol. 28, Jan. 1971, p. 539-552. 6 refs. Grant No. NGL-33-016-119.

Solutions for the diffraction of a plane shock wave by general two-dimensional weak disturbances caused by moving bodies are presented. The technique employed is the method reported by Ludloff (1953) for the aerodynamics of blasts. The solution shows that the flow fields behind the shock and the plane shock are disturbed not only by the portion of the body passed over by the shock but also by the portion of the body ahead of the shock. For a stationary body the present solution reduces to the corresponding solution reported by Ludloff. It is pointed out that the present solutions can be applied to many shock diffraction problems of practical interest, such as blast effects on aircrafts and on wings at angles of attack. G.R.

A71-19354 # A motion of a rapidly rotating body in air (Ob odnom dvizhenii bystrovrashchaishegosia tela v vozdukhie). B. Ia. Lokshin (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *Moskovskii Universitet, Vestnik, Seriya 1 - Matematika, Mekhanika*, vol. 25, Nov.-Dec. 1970, p. 93-98. In Russian.

Consideration of a gliding-type motion of a rapidly rotating axisymmetric body in air. It is assumed that the axis of symmetry of the body is horizontal and does not change its orientation, while the center of gravity velocity vector is perpendicular to the axis of symmetry and forms a certain angle with the vertical. Conditions of stability of such a motion are obtained, and the stability of plane motion is proved under certain assumptions regarding the aerodynamic coefficients. A.B.K.

A71-19355 # Ricocheting of a plate from the surface of an ideal incompressible fluid (Rikoshet plastinki ot poverkhnosti ideal'noi neszhimaemoi zhidkosti). V. A. Eroshin (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *Moskovskii Universitet, Vestnik, Seriya 1 - Matematika, Mekhanika*, vol. 25, Nov.-Dec. 1970, p. 99-104. In Russian.

Consideration of the problem of the ricocheting and nonself-similar landing of a seaplane step (a flat plate) on an ideal incompressible fluid. The effect of trailing vortices is taken into account, and the wetted length of the plate is determined by calculating the height of the fluid rising ahead of the plate. The shape of the free surface is determined. A.B.K.

A71-19361 # Synthesis of a multicomponent mechanism with transmission angles diverging minimally from ninety degrees (Sintez mnogozvonnogo mekhanizma pri uglakh peredachi, naimeene otkloniaushchikhsia ot devianosta gradusov). V. O. Fokin. *Mashinostroenie*, no. 11, 1970, p. 55-60. In Russian.

Consideration of the synthesis of a multicomponent plane flap mechanism with allowance for the most advantageous values of the transmission angles by using the method of least squares. The problem is reduced to the synthesis of a mechanism with respect to three positions with optimal transmission angles over the entire range of divergence of the working sections of the mechanism. For the purposes of the calculation the mechanism is divided into four closed vector contours, for each of which an additional condition is given which ensures a rigorous solution to the problem. A.B.K.

A71-19417 * To the moon and beyond. Robert R. Gilruth (NASA, Manned Spacecraft Center, Houston, Tex.). *Aeronautical Journal*, vol. 75, Jan. 1971, p. 1-17.

The history of manned flights from the ascent of the Montgolfier Balloon to the X-1 research aircraft is briefly considered, and the various phases of the space program are discussed. Aeronautical developments during the two world wars are examined, and the first steps in the area of manned space flight are reviewed. The various space ventures culminating in the Apollo space flights are described. The phases of lunar exploration are evaluated up to the Apollo 13 mission. Incentives for a return to the moon after Apollo are discussed giving attention to the establishment of a permanent lunar base. Aspects of the development of the space shuttle as the keystone to the practical age of space travel are considered. G.R.

A71-19421 Some notes on helicopter stability under constraint. P. E. Kumar (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). *Aeronautical Journal*, vol. 75, Jan. 1971, p. 48-52. 5 refs.

Some aspects of longitudinal stability under constraint as applicable to the flight of a helicopter in the forward and the hover modes are considered. The longitudinal equations of motion of a helicopter are examined. Questions of stability in forward flight under constraint are investigated taking into account attitude constraint, height constraint, and speed constraint. Stability in hovering flight is explored under conditions of attitude constraint, height constraint, and horizontal speed constraint. The need for suitable cyclic pitch control in view of the instabilities occurring during certain flight conditions when constraints are being applied is pointed out. G.R.

A71-19424 Static discharge. B. L. Perry (Air Registration Board, Redhill, Surrey, England). *Aeronautical Journal*, vol. 75, Jan. 1971, p. 70, 71.

An attempt is made to outline the hazards which can arise due to static electricity giving attention to cases involving light aircraft. Conditions under which static electrical build-up can occur are examined, and accidents caused by this build-up are discussed. Elements producing a dangerous situation are analyzed, and approaches to reduce accident hazards are investigated. G.R.

A71-19425 De-icing of runways from the air. John Briscoe (British Airports Authority, London, England). *Aeronautical Journal*, vol. 75, Jan. 1971, p. 71, 72.

Discussion of various approaches for de-icing runways taking into consideration the use of aircraft and of vehicles for spreading de-icing chemicals. The solution of heating runways is dismissed as impractical. Reasons are the high cost and the fact that flocks of birds are attracted to heated runways. The use of chemicals as de-icing agents is discussed. In Europe liquid mixtures of solvents and accelerators often diluted with water are used, while urea is employed in the U.S. The spreading of the chemicals by aircraft is discussed. It is pointed out that the spreading can also be done from a vehicle, which can be a trailer or a prime mover. G.R.

A71-19492 # Variation of the high-temperature properties of jet fuels during prolonged storage (Izmenenie vysokotemperaturnykh svoystv reaktivnykh topliv pri dlitel'nom khranении). Z. A. Sablina, A. A. Gureev, A. A. Kukushkin, N. I. Melent'eva, B. A. Englin, A. M. Fomina, and A. P. Griaznov. *Khimiia i Tekhnologiya Topliv i Masel*, vol. 15, no. 12, 1970, p. 39-42. 10 refs. In Russian.

Study of the thermal stability and corrosive properties of jet fuels stored for five years under normal conditions. The following general rules of fuel behavior in storage were established: (1) the initial temperature for extensive formation of nonsoluble products decreases by 10 to 20 C, (2) in the initial storage period, the thermal stability of fuels deteriorates faster than during further storage, and (3) the high-temperature properties of fuels vary depending on chemical composition and type of fuels. The mechanism of the deterioration of the high-temperature properties of fuels is briefly discussed. Z.W.

A71-19493 # Laboratory device for studying antiwear properties of jet fuels (Laboratornyi pribor dlia issledovaniia protivoiznosnykh svoystv reaktivnykh topliv). A. F. Aksenov and A. A. Litvinov. *Khimiia i Tekhnologiya Topliv i Masel*, vol. 15, no. 12, 1970, p. 47-49. 6 refs. In Russian.

Description of a device for measuring the antiwear properties of fuels under conditions of rolling friction. The results obtained for different fuels are presented in terms of relationships for the wear as a function of load cycles, rolling rate, contact load, and bulk fuel temperature. The accuracy of results obtained is estimated. Z.W.

A71-19494 Integrated drive generators for aircraft. R. J. Kennett (Rotax Aircraft Equipment, Ltd., Bradford, Yorks., England). *Electronics and Power*, vol. 17, Feb. 1971, p. 73-76.

Discussion of recent improvements in the power/weight ratio of aircraft ac generators. A 60 kVA integrated drive generator (IDG) is described which is designed to supply 400 Hz 3-phase power at 115 V (line to neutral) to the aircraft bus bars. The compact IDG harnesses to best effect the advantages of the direct liquid-cooled ac generator. It is of the 3-stage, rotating rectifier configuration. F.R.L.

A71-19556 The application of computer aids in the analysis of fault data generated by a large data handling system. M. J. Reynolds and T. V. Attwood (Plessey Co., Ltd., Liverpool, England). In: Reliability in electronics; Institution of Electrical Engineers, Conference, London, England, December 10-12, 1969, Proceedings. London, Institution of Electrical Engineers (IEE Conference Publication No. 60), 1969, p. 45-51.

Discussion of the development of the data logging, classification, analysis, and reporting methods currently in use in a large integrated air traffic control system now in course of commissioning. The first step towards automatic processing was taken when it became obvious that the amount of data to be analyzed would be greatly in excess of the capability of the available staff. A standard punched card was devised to hold all the basic data such as locations and serial numbers, types of component involved, number of hours in service, a terminal automation has and will be performed in an attempt to promote safety and relieve congestion in the nation's major terminal air traffic systems. This paper describes the work which has been, is being, and is intended to be pursued in this area. (Author)

A71-19557 Experience gained from reliability trials on an airborne radar. J. E. Green (Royal Radar Establishment, Malvern, Worcs., England) and P. H. Mead (Ferranti, Ltd., Hollinwood, Lancs., England). In: Reliability in electronics; Institution of Electrical Engineers, Conference, London, England, December 10-12, 1969, Proceedings. London, Institution of Electrical

Engineers (IEE Conference Publication No. 60), 1969, p. 52-56. 8 refs.

Review of reliability aspects of a terrain following radar designed for the TSR2 aircraft, with recommendations for future improvement in reliability. Reliability testing of subunits made the largest contribution to reliability. The MTBF was increased through reliability trials and subsequent modification by a factor of about five to over 90 hr and potentially much higher with further development work. The optimum burn-in time for this equipment appeared to be 150 to 200 hr. The general circuitry accounted for only 20% of the failures, and the transmitter, receiver, and certain special parts contributed the most failures. The average parts failure rate of the general circuitry reflected special efforts in initial design in such areas as selection, derating, and burn-in parts, in addition to the benefits of reliability trials. F.R.L.

aircraft regardless of means of propulsion or design speed regimes, including V/STOL types. Appropriate references for crew restraint, escape, flight deck interior doors, fire and smoke hazards, and personnel environmental protection are cited. F.R.L.

A71-19644 Aircraft indicating systems. SAE Aerospace Recommended Practice, ARP 1088, Dec. 15, 1970. 4 p.

Recommendation of certain basic considerations which the design engineer should observe when designing a visual warning indicating system. Categories of indicating systems are those displaying warnings, a need for caution, or indicators of advice. Design criteria, color and brightness recommendations, and standards for master indicators are outlined. F.R.L.

A71-19592 On the nature of fluctuating circulation, lift and flow-induced structural vibrations. T. L. Shaw (Bristol, University, Bristol, England). Journal of Sound and Vibration, vol. 14, Jan. 22, 1971, p. 251-261. 7 refs.

It is commonly considered that periodic oscillations of a structure in relative motion through a fluid result from vortices being shed into the wake of the body. It is contended that this concept accounts for the observed vibration of cables, stacks, towers, and the like, even though the similar behavior of other structures, such as sluice gates, may not similarly be explained. This paper reconsiders the fluid-mechanic phenomena accompanying flow past two-dimensional bodies of various forms, and concludes that vortex shedding is associated with, but not the cause of, pressure fluctuations and structural vibrations. (Author)

A71-19645 Design objectives for flying qualities of civil transport aircraft. SAE Aerospace Recommended Practice, ARP 842B, Nov. 30, 1970. 19 p.

This Aerospace Recommended Practice sets forth the design objectives for flying qualities for subsonic, transonic, and supersonic civil transport type aircraft. It is based on the military specification MIL-F-8785 (ASG) which comes closest to expressing the type of material and format desired. However, the content is modified, updated, and pointed toward desirable modern transport flying qualities. V.P.

A71-19628 Special purpose telemeter for a jet engine environment. Dominick Colangelo (GE Electronics Laboratory, Syracuse, N.Y.) and Fred Schlereth (Inficon, Inc.). Telemetry Journal, vol. 6, Feb.-Mar. 1971, p. 15-18. 5 refs. Research supported by the General Electric Co.

Problems involved in the design of special purpose telemeters are examined, with particular reference to a special telemeter intended to transmit strain and temperature data from the rotor of a jet engine. It is shown how a difficult design problem which arose out of the requirement to provide a large number of channels of information simultaneously while still providing a rather wide bandwidth in the strain channels could be solved by using a time division multiplex to transmit six temperature channels on a single RF channel, and then using separate RF channels in a manner indicated. V.P.

A71-19646 Escape provisions - Flight deck. SAE Aerospace Recommended Practice, ARP 808A, Dec. 15, 1970. 3 p.

The purpose of this Aerospace Recommended Practice is to establish criteria for the provision of crew escape facilities from the flight deck area of commercial transport aircraft. It applies to all transport category aircraft certificated under FAR 25, regardless of means of propulsion, design speed regime, or type of payload. V.P.

A71-19642 Electronic equipment cooling by the draw-through method in commercial jet transports. SAE Aerospace Information Report, AIR 64A, Oct. 26, 1970. 9 p.

Formalization of the applicable design concepts considered acceptable for draw-through cooling of electronic (avionic) equipment installed in subsonic and supersonic commercial jet transports. To improve the reliability of operation and to minimize operational penalties and dirt contamination caused by undercooling, uniform standards of providing adequate and effective 'draw-through' cooling of this equipment are set based on the described method of internal air circulation and collection. A sketch of a typical internal circulation system and design data for internal circulation are presented. O.H.

A71-19647 Gas turbine engine steady state performance presentation for digital computer programs. SAE Aerospace Recommended Practice, ARP 681B, Dec. 15, 1970. 16 p.

This Aerospace Recommended Practice provides a method for the presentation of gas turbine steady-state performance as calculated by means of digital computer programs. It is intended to facilitate such calculations without unduly restricting the method of calculation used by the program supplier. A general description of the engine is provided. The description includes the type of engine, general arrangement, and all general characteristics that are necessary to understand the performance and operation of the engine represented by the computer program. V.P.

A71-19643 Crew safety provisions for cargo aircraft. SAE Aerospace Recommended Practice, ARP 1139, Dec. 15, 1970. 1 p.

Recommendations of provisions for crew safety and survival which are intended to apply to cargo aircraft and equipment. This Aerospace Recommended Practice applies specifically to cargo

A71-19705 # Airplane high-lift system design by interactive graphics system. Aadu Karemaa (General Dynamics Corp., Convair Div., San Diego, Calif.). American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-227. 9 p. 17 refs. Members, \$1.50; nonmembers, \$2.00.

Description of equipment and procedures for the development of wing high-lift or flap designs using an interactive graphics system as the link between the computer and the user. The operator changes the high-lift section geometry on a display tube by means of a light pen. A high-speed digital computer calculates pressure distributions about the individual wing and flap sections and integrates the pressures to obtain forces and moments. The latter are displayed to the operator together with pressure distributions for each section. The operator can compare these aerodynamic data with the results of other data sets to obtain conclusions about the effects of geometric

changes on the lift, drag, pitching moments, and pressure distributions. The system is not intended to eliminate the classical wind tunnel, but can be used to reject nonoptimum configurations from the tunnel test scheme. A specific application is described which involves the design of a high-lift system for the Space Shuttle booster. T.M.

A71-19710 # A passive computer-augmented antenna-pointing system. Andrew P. Moll (RCA, Missile and Surface Radar Div., Moorestown, N.J.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-233.* 9 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

Description of an airborne antenna pointing system which accurately tracks communications satellites by computing pointing angles based on stored ephemeride data, time of day, aircraft position, and attitude. An error analysis is presented, showing that the limiting error component is aircraft position. Stabilization is carried out by a hybrid computer-gyro loop. Tradeoffs in bandwidth, sampling rates, and word length are discussed, and program flow charts are illustrated together with the input-output interrupt structure. Ground-based pointing errors of less than 30 arc minutes over a 4-hr period have been achieved. T.M.

A71-19711 # Automatic processing of multispectral observations. M. Y. Su (Northrop Corp., Huntsville, Ala.) and F. R. Krause (NASA, Marshall Space Flight Center, Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-234.* 13 p. 13 refs. Members, \$1.50; nonmembers, \$2.00.

Statistical methods for inventory boundary determination and data flow compression are examined in application to the automatic processing of multispectral remote earth observations from aircraft and spacecraft. A simple statistical method is developed for the subdivision of a strip map into inventory areas. The method employs a variance test for classification of individual resolution elements by analyzing the deviations of reflectance spectra. Training areas and reference spectra are not needed for this analysis. The automatic determination of inventory boundaries is illustrated for specific data obtained by a multispectral scanner. Data flow compression is accomplished by replacing all resolution elements of an inventory area with their area average. T.M.

A71-19714 # A project information and simulation system for aerospace management. A. C. Singhal, J. J. Rosati, and G. Doeh (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-238.* 9 p. Members, \$1.50; nonmembers, \$2.00.

An integrated system, requiring a dynamic data base, provides management decision data related to the overall effect of typical problems in aerospace vehicle development programs. Simulation models allowing management to determine the impact of engineering changes and delays on program and subprogram costs and schedules, with a technique for project status evaluation, are presented. Analytical simulation models permit design optimization, evaluation of competitive proposals, vehicle and system performance verification, configuration tradeoff studies, and identification of potential problems. Advantages of the system to project management are discussed and several examples of simulation model usage for a hypothetical helicopter program are given. (Author)

A71-19716 # A conceptual outline for ground-based collision avoidance. D. R. McMillan (Mitre Corp., Bedford, Mass.). *American Institute of Aeronautics and Astronautics, Integrated*

Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-240. 12 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

Basic features of the collision avoidance problem are summarized, and a three-phase time-ordered functional organization is proposed for Ground-Based Collision Avoidance. Information flows are identified, with particular emphasis on information provided to the controller through interactive displays. Three generic types of display capability are proposed, and alternative formats are discussed for each type. Experience gained with a dynamic simulation model incorporating some of these capabilities is discussed. Some specific problem areas are indicated which must be understood prior to further development of Ground-Based Collision Avoidance. (Author)

A71-19717 # Automation of terminal Air Traffic Control - Past, present and future. J. C. Nelson and R. P. Sunderman (Sperry Rand Corp., Univac Div., St. Paul, Minn.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-242.* 9 p. 11 refs. Members, \$1.50; nonmembers, \$2.00.

The intention of this paper is to provide an overview of the evolutionary process of system automation in the terminal Air Traffic Control environment. Most of the funding and work in the area of Air Traffic Control automation during the past 10 years has been directed toward the area of enroute Air Traffic Control, specifically toward the function of directing and controlling traffic between terminal air spaces. With the advent of the passage of the Airports and Airways Bill by Congress, much additional work in terminal automation has and will be performed in an attempt to promote safety and relieve congestion in the nation's major terminal air traffic systems. This paper describes the work which has been, is being, and is intended to be pursued in this area. (Author)

A71-19718 # Exploring future tactical air information distribution by simulation. Richard E. Zapolin (Mitre Corp., Bedford, Mass.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-243.* 7 p. Members, \$1.50; nonmembers, \$2.00.

PLRACTA is an advanced development program for a multiple-access, real-time tactical information distribution system. To reduce technical risks and to confirm that PLRACTA can enhance tactical air operation, the Mitre Corporation is designing and constructing a tactical air control system test facility. The use of cockpit simulators in this facility provides an economical, flexible means of examining the system's performance and evaluating capabilities provided by various design alternatives. This paper discusses factors considered in consolidating the information needs of tactical aircraft, how the design options are tested, and how the results influence the final integrated information system design. (Author)

A71-19719 # An overview of the National Airspace System. J. W. Rabb and K. P. Gray (FAA, National Airspace System Program Office, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-244.* 12 p. Members, \$1.50; nonmembers, \$2.00.

Description of the FAA program for modernization of the air traffic control system by increased automation of en route and terminal facilities. The program, when completed, will provide automation at each of the 20 air route traffic control centers and those terminals where automation is warranted. These facilities will be interconnected by data transmission links, and the entire complex will function as a single nationwide real-time automated system to ensure increased capacity and safety. NAS (National Airspace System) En Route Stage A is the term applied to the en route portion of the automation program, while ARTS III (Advanced

Radar Terminal System) covers the terminal automation program. These plans are outlined in terms of the required central computer complex, display subsystems, computer programs, and software and hardware design features. T.M.

A71-19721 # Displays in the National Airspace System. W. R. Sousa (Mitre Corp., McLean, Va.), H. I. Brody (FAA, Washington, D.C.), and R. W. Lanzkron (Raytheon Co., Lexington, Mass.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-247.* 16 p. Members, \$1.50; nonmembers, \$2.00.

The computer display channel (CDC) design is broadly described as a flexible real-time data processing and display subsystem for en route air traffic control. The CDC contains a general purpose central processor and special purpose wired processors coupled to modular buffer memories and refresh memories for servicing sixty alphanumeric display consoles. These consoles provide a plan-view air situation display composed of symbolic radar data, aircraft track identification and altitude data, weather data, and geographic map data. Display selection controls, data filtering keys, and message entry devices are provided for operator use. (Author)

A71-19722 # The role of communications in the National Airspace System. R. G. Nystrom (Mitre Corp., McLean, Va.) and K. F. Bierach, Jr. (FAA, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Integrated Information Systems Conference, Palo Alto, Calif., Feb. 17-19, 1971, Paper 71-248.* 6 p. Members, \$1.50; nonmembers, \$2.00.

The role of data communications is discussed as a vital part of the National Airspace System. The data communications subsystem provides for radar data and flight data acquisition, as well as for intersystem data transfer. In addition, data and voice communications play a major role in the present farflung Air Traffic Control System. A vast network provides for air-ground and intercontroller voice communications, as well as backup for data transmission. These roles are reviewed both as they exist today and as they will appear in the era of Automated Air Traffic Control across the next decade. M.V.E.

A71-19729 # Nonstationary low-density flows possessing symmetry (O nestatsionarnykh techeniakh razrezheniia, obladaiushchikh simmetriiei). O. V. Rysev. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 34-39. In Russian.

Analysis of the system of two equations describing nonstationary isentropic low-density flows possessing axial or central symmetry. By using a canonical form of the relations which are fulfilled along the characteristics, it is shown that in certain cases nonstationary low-density flows can contain a characteristic along which the rate of flow and the speed of sound vary in the same manner as in a flow from a stationary source. V.P.

A71-19730 # Role of radiation absorption in front of a shock wave in the hypersonic flow past a blunted body (O roli pogloshcheniia izlucheniia pered udarnoi volnoi pri giperzvukovom obtekanii zatuplennogo tela). V. K. Vertushkin and E. A. Romishevskii. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 40-47. 10 refs. In Russian.

Theoretical considerations are presented concerning the interaction between the radiation emitted from the shock wave region and the oncoming cold air flow, in the case of hypersonic flows past blunted bodies. The conditions at a strong shock front are derived with allowance for the absorption of the leading radiation. The role of the dimensionless parameters which occur in this case is identified, and the value of these parameters are evaluated for several reentry

conditions of a blunt body into the earth's atmosphere. The composition and parameters of a molecular nitrogen flow impinging on a shock wave are calculated. V.P.

A71-19732 # Transonic gas flow in axisymmetric Laval nozzles with steep walls (O tranzvukovom techenii gaza v osesimmetrichnykh soplakh Lavalia s krutymi stenkami). V. I. Kireev and Iu. B. Lifshits. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 55-58. 9 refs. In Russian.

Numerical results obtained by several investigators for gas flows in the transonic region of a circular Laval nozzle with a small throat radius of curvature are analyzed for the case where the flow parameters vary appreciably in the transverse direction. It is found that, although hydraulic theory (in which the transverse distribution of the flow parameters is neglected) usually provides acceptable pressure distributions at the wall and in the flow core, this theory is not applicable in the case under consideration. V.P.

A71-19733 # Experimental determination of the magnitude of intensified molecular diffusion during the turbulent mixing of supersonic slipstreams (Eksperimental'noe opredelenie velichiny uskorennoi molekuliarnoi diffuzii pri turbulentnom smeshenii sputnykh sverkhzvukovykh potokov). A. I. Mal'tsev. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 59-65. 6 refs. In Russian.

A relation between the magnitudes of molecular diffusion and turbulent mixing is derived on the basis of experimental data obtained in a cylindrical mixing chamber by an optical-diffusion method proposed by Prudnikov. It is shown that the relative value of molecular diffusion increases when the absolute value of turbulent mixing decreases. V.P.

A71-19739 # Strong viscous interaction on a delta wing and on an oblique airfoil (O sil'nom viazkom vzaimodeistvii na treugol'nom i skol'ziaschem kryl'iake). I. G. Kozlova and V. V. Mikhailov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 94-99. In Russian.

Derivation of self-simulating equations for the flow of a viscous gas on a delta wing and on an oblique airfoil at incident-flow Mach numbers equal to infinity. It is shown that solutions for the flow in a state of strong viscous interaction are not unique for both wings. A condition is derived which must be satisfied by the solution at the symmetry axis of a delta wing with infinite span. A class of self-similar flows in the boundary layer on a thin delta wing is described. T.M.

A71-19740 # Nonlinear theory of a rotor in an axial regime (K nelineinnoi teorii vinta v osevom rezhime). M. M. Barshai. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 100-104. 9 refs. In Russian.

Aerodynamic synthesis of a helicopter rotor under hover and vertical ascent conditions, using a nonlinear vortex approach where the shape of the free vortex surface is determined in the process of calculation. One set of calculations is based on a rotor model in which the free vortex surfaces are determined from a set of rotor vortex lines whose pitch varies along the radius and depends on the induced velocity at a given blade radius in the rotor's rotational plane. This is in contrast to the linear vortex approach where the pitch is specified a priori. In another set of calculations, it is assumed that the pitch of the vortex lines varies along the vertical coordinate as well as along the radius, and allowance is made for jet contraction behind the rotor. The overall characteristics of the rotor are specified, and the load distribution along the blade radius is determined. T.M.

A71-19741 # Limits of applicability of one exact solution of the problem involving interaction of a shock wave with a wedge moving at supersonic speed (Granitsy primenimosti odnogo tochnogo reshenia zadachi vzaimodeistviia udarnoi volny s klinom, dvizhu-shchimsia so sverkhzvukovoi skorost'iu). G. M. Arutiunian. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 104-107. In Russian.

Analysis of the geometry of regions formed by intersecting wavefronts during the interaction of a bow shock wave with an incident shock wave whose front is parallel to a wedge surface. Emphasis is placed on the boundary between a region of undisturbed flow over the trailing portion of the surface and a region of disturbed flow caused by the interaction of the bow shock wave with the reflected front of the incident wave. Three different geometrical configurations of this boundary are defined as a function of shock wave velocities, gas parameters, and the bow shock wave's separation angle. T.M.

A71-19743 # Investigation of three-dimensional separation flow around half-cones mounted on a flat plate (Issledovanie trekhmernogo otryvnogo obtekaniia polukonusov, ustanovlennykh na ploskoi plastine). V. S. Avduevskii and V. K. Gretsov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 112-115. In Russian.

Experimental study of the influence of viscosity on the supersonic flow around circular half-cones mounted on a flat plate. The geometrical characteristics of the regions of turbulent boundary layer separation on the plate are determined along with the physical features of flow in these regions. The positions of the spreading and separation lines on the cones are specified as a function of the cone's orientation to the undisturbed flow direction. T.M.

A71-19744 # Similarity of supersonic separation regions (Podobie sverkhzvukovykh sryvnykh zon). M. G. Morozov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 115-118. In Russian.

Experimental study of supersonic air flow patterns over rectangular indentations on plane and axisymmetric surfaces. Static pressure and adiabatic temperature distributions were examined along the contours of notches with edges positioned both evenly and at different levels. Measured data are given for the drag of a conical-cylindrical body with a circular notch at different notch lengths and trailing-edge heights. T.M.

A71-19745 # Flow around an arbitrary star-shaped contour (Obtekanie proizvol'nogo zvezdnogo kontura). V. V. Pak. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 119-121. In Russian.

Analysis of the flow pattern around an arbitrary (closed or open) star-shaped contour. An expression is derived for the complex potential on the plane of a supplementary variable which is a function of velocity constructed in such a manner that the given contour passes into the abscissa axis when mapped onto the supplementary plane. The function mapping the supplementary plane on the desired flow plane is obtained by integration. T.M.

A71-19746 # Supersonic three-dimensional flow with heat supply and stream deflection (Sverkhzvukovoe prostanstvennoe techenie s podvodom tepla i otkloneniem potoka). V. S. Sadovskii and G. I. Taganov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 121-125. In Russian.

Analysis of flow conditions at large supersonic flight velocities where the mass of air participating in the formation of thrust per unit time is comparable to the mass of air deflected downward by the wing. Attention is given to the aerodynamic-force producing efficiency of a body characterized by the fact that the same mass of

gas to which heat is supplied participates in creating the lifting force as well as the thrust. This situation involves the tendency of the engine to participate in the lift formation process. T.M.

A71-19748 # Influence of the suppression of chemical reactions in a nonequilibrium laminar boundary layer on the heat exchange (O vlianii na teploobmen zamorazhivaniia khimicheskikh reaktsii v neravnovesnom laminarnom pogranichnom sloe). V. G. Voronkin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 127-129. In Russian.

Investigation of local heat flux values in a laminar boundary layer of multicomponent dissociating airflow over a two-dimensional blunted body of constant thickness whose surface has equal catalytic properties for oxygen and nitrogen. The pressure over the surface changes near the angular frontal regions, leading to a suppression of chemical reactions in the boundary layer. It is shown that the heat flux ratios can differ significantly from the nonequilibrium case due to a varying degree of suppression of the chemical reactions in different regions of the boundary layer. T.M.

A71-19750 # Experimental study of flow in the wake behind thin plates (Eksperimental'noe issledovanie techenia v slede za tonkimi platinami). A. N. Sekundov and O. V. Iakovlevskii. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1970, p. 131-137. 14 refs. In Russian.

Experimental data for the flow structure in the wake behind thin plates in a wind tunnel at free-stream velocities of 2 and 10 m/sec and Reynolds numbers between 155 and 730. Nonsimilar flow regions in the wake are analyzed for transient and turbulent flow conditions. Measured values of velocity fields, temperature, turbulence intensity, and the scale of turbulence are compared for different flow conditions in the wake behind plates. Comparison is also made with data available in the literature for wakes behind cylinders. It is shown that the most complex flow structure occurs in the wake behind a plate with a turbulent initial boundary layer. T.M.

A71-19773 # Investigations on the transonic flow around aerofoils. Bernardus Maria Spee. Delft, Technische Hogeschool, Afdeling der Technische Natuurkunde, Doctor in de Technische Wetenschappen Dissertation, 1969. 45 p. 40 refs. Research supported by the Nederlands Instituut voor vliegtuigontwikkeling.

A detailed description of the behavior of unsteady disturbances in transonic flows is given, and the results of an experimental investigation, set up as a verification of the theoretical potential flow around quasi-elliptical aerofoil sections are discussed. The development of the transonic flow around aerofoils is considered, and the nature of a local supersonic zone is described. The different arguments advanced against the existence of shock-free flow are summarized and discussed. A detailed analysis on the stability of transonic flows with respect to unsteady disturbances is given. Experiments which show clearly the physical significance of transonic potential flow solutions are discussed. G.R.

A71-19860 # Numerical methods for nonreacting and chemically reacting laminar flows - Tests and comparisons. Clark H. Lewis (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Journal of Spacecraft and Rockets*, vol. 8, Feb. 1971, p. 117-122. 10 refs.

Assessment of calculations of equilibrium, nonequilibrium, and ideal gas ($\gamma = 1.4$) laminar boundary layers and viscous shock layers over a 10 deg half-angle hyperboloid, 50 nose-radii long, for three 20,000-fps cases, one at 100,000-ft altitude and two at 250,000 ft. The predicted skin-friction and heat-transfer coefficients and displacement-thickness distributions over the body, as well as property profiles across the layer at the ends of the body, are

compared. The conditions were chosen to test the ability of the numerical methods to predict nonequilibrium viscous-layer flows near and far from chemical equilibrium and the applicability of boundary-layer theory at low-Reynolds-number conditions. Results show that recently developed finite-difference methods can be used to compute finite rate, chemically reacting flows near chemical equilibrium, and iterations of implicit finite-difference solutions are required for accurate results. At 250,000-ft altitude, higher-order boundary-layer theory is not adequate and a fully viscous shock-layer technique must be used. At the higher altitude, stagnation heat transfer is strongly affected by shock slip. (Author)

A71-19872 # Flight measurement of aerodynamic coefficients on a bomb. Neil Edmund Gilbert (Weapons Research Establishment, Salisbury, Australia). *Journal of Spacecraft and Rockets*, vol. 8, Feb. 1971, p. 186-189. 11 refs.

Free flight measurement of aerodynamic lateral force and static normal and side moment coefficients on bombs stabilized by fixed cruciform fins. In particular, one type of flight instability, namely the catastrophic yaw, was studied. The dependence of the derived aerodynamic forces and moments upon the total angle of incidence, angular orientation relative to the plane of incidence, and the angular velocity components, is determined by fitting the flight data to a mathematical model of the force and moment system developed by Maple and Synge. The instrumentation and experimental procedure is described. The free flight data recorded by the various instruments used are compared with those obtained in a wind tunnel and analyzed. O.H.

A71-19877 * # Flow coefficients for supersonic nozzles with comparatively small radius of curvature throats. L. H. Back and R. F. Cuffel (California Institute of Technology, Jet Propulsion Laboratory, Propulsion Research and Advanced Concepts Section, Pasadena, Calif.). *Journal of Spacecraft and Rockets*, vol. 8, Feb. 1971, p. 196-198. 20 refs.

Determination of the mass flow rate through supersonic nozzles, with emphasis on nozzles with comparatively small ratios of throat radius of curvature to throat radius (between 0 and 2.0) tested at relatively high Reynolds numbers (larger than 1,000,000). Measured values of the mass flow coefficient are presented for nozzles recently tested at the Jet Propulsion Laboratory and for those tested previously in other investigations. The measurements provide a basis on which to evaluate the effect of the throat radius of curvature/throat radius ratio on the flow coefficients and to appraise existing prediction methods for isentropic flow by other investigators. O.H.

A71-19879 # Electron thermochemical nonequilibrium effects in re-entry boundary layers. Doyle D. Knight (General Electric Co., Space Div., Philadelphia, Pa.). (*American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 7th, New York, N.Y., Jan. 20-22, 1969, Paper 69-82.*) *AIAA Journal*, vol. 9, Feb. 1971, p. 193-199. 19 refs.

Results of calculated nonequilibrium electron temperature and concentration characteristics in boundary layers are presented for reentry conditions of flight velocity from 27,500 to 34,000 ft/sec, and altitude from 110,000 to 150,000 ft. These results show the effects of reactions, collisions, electrical current, and electron reflection on the electron heat transfer and temperature. The electron conservation equations in boundary-layer form were solved in the quasi-neutral region with collisionless sheath boundary conditions or approximate boundary conditions derived from the collisionless sheath expressions and valid with collisions in the sheath. A numerical solution was obtained by a finite-difference technique after a similarity transformation and quasi-linearization of the equations. The solutions show significant temperature nonequilibrium. Electron current and reflection, combined into a single parameter, reduces electron temperature and increases conduction of energy but does not explicitly affect electron concentration. Diffusion of ionization energy is insensitive to electron reflection. (Author)

A71-19887 # Effects of rotary inertia on the supersonic flutter of sandwich panels. Frank A. Marafioti and E. Russell Johnston, Jr. (Connecticut, University, Storrs, Conn.). *AIAA Journal*, vol. 9, Feb. 1971, p. 245-249. 8 refs. NSF Grant No. GJ-9.

A theoretical analysis is presented for the supersonic flutter of a simply-supported isotropic sandwich panel. The aerodynamic loading is described by a static approximation valid for a wide range of Mach number. Small deflection theory for sandwich plates which considers transverse shear deformations and rotary inertia in addition to bending is used. The purpose of this study is to demonstrate the effect of the rotary inertia parameter on the critical flutter speed of simply-supported panels. Previous investigators have neglected this effect and results obtained are of an anomalous nature for certain plate parameters. The effect of such plate parameters as rotary inertia, transverse shear, and midplane stress resultants on the critical flutter speed are presented in graphical form. (Author)

A71-19890 # Computation of nonequilibrium merged stagnation shock layers by successive accelerated replacement. Thomas C. Dellinger (GE Fluid Mechanics and Chemistry Laboratory, Philadelphia, Pa.). (*American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-18, 1969, Paper 69-655.*) *AIAA Journal*, vol. 9, Feb. 1971, p. 262-269. 17 refs.

Results for fully merged shock layer computations in the stagnation region of a hypersonic body. Numerical solutions are obtained with a new technique which avoids several troublesome aspects of previous methods. The effects of nonequilibrium chemistry are studied for a multicomponent air mixture, and the resulting electron concentrations are calculated. The analysis assumes a continuum approach and employs the well-known "locally similar" flow model. The governing system of equations constitutes a two-point boundary value problem which is solved using a simple finite difference method called successive accelerated replacement (SAR). Special attention is given to a singularity that appears in the continuity equation, and the importance of an acceleration factor on the convergence of the solution is discussed. The application of the numerical technique to solve the downstream flowfield is suggested. Solutions are obtained for a Reynolds number range of 814 to 4000 and for flight speeds from 15,000 to 26,000 ft/sec. Predicted results for the electron concentration are compared with experimental data, and good agreement is obtained. (Author)

A71-19891 # Anemometer measurements of velocity and density in projectile wakes. Jay Fox and Harald Rungaldier (TRW Systems Group, Redondo Beach, Calif.). (*American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, Los Angeles, Calif., June 24-26, 1968, Paper 68-701.*) *AIAA Journal*, vol. 9, Feb. 1971, p. 270-276. 24 refs. Contracts No. AF 04(694)-992; No. AF 04(701)-68-C-0041; No. AF 04(701)-69-C-0119.

Mean and fluctuating wake properties including both velocity and density (which is equivalent to inverse temperature in the constant-pressure far wake) were measured with hot-film anemometers. The projectiles were .22-in. blunt bullets at 4000 ft/sec, half-inch spheres at 6500 ft/sec, and slender cones at 6500 ft/sec. Simulated altitude was used during many tests, data being analyzed from 100 to 160,000 diameters behind the projectiles. Excellent agreement was obtained between the measured mean wake velocity and the analytical computations using the Lees-Hromas-Webb (LHW) theory. Agreement was obtained between the measured space correlation length and the predictions of the LHW theory. Thus the understanding of these important parameters has been increased by the verification of the LHW theory by laboratory measurements. (Author)

A71-19892 # Boundary layer on a hypersonic sharp cone at small angle of attack. H. A. Dwyer (California, University, Davis, Calif.). *AIAA Journal*, vol. 9, Feb. 1971, p. 277-284. 14 refs.

The compressible, laminar boundary-layer flow over a sharp cone has been calculated for an angle of attack slightly greater than the cone half angle. The calculations have been carried out with an inviscid flow based on an asymptotic inner and outer expansion of the flowfield. The asymptotic expansion has been carried out for both first and second order in the angle of attack, and the need for the second-order results in the boundary-layer calculations has been studied. The flow conditions were chosen so that the theoretical calculations could be compared with experimental results for important boundary-layer parameters, such as heat transfer and boundary-layer thickness. The results of the investigation show that the boundary-layer equations and the second-order inviscid flow describe well the boundary-layer characteristics, and that higher-order boundary-layer influences are not important for the flow conditions studied. The most important interaction effect between the boundary layer and inviscid flow was determined to be the displacement effect. (Author)

A71-19893 # Some experimental results on sphere and disk drag. Frederick W. Roos (McDonnell Douglas Research Laboratories, St. Louis, Mo.) and William W. Willmarth (Michigan, University, Ann Arbor, Mich.). *AIAA Journal*, vol. 9, Feb. 1971, p. 285-291. 35 refs. Army-supported research.

Measurements of the drag on spheres and disks moving rectilinearly through an incompressible fluid for Reynolds numbers (Re) from 5 to 100,000. Test models were mounted on a carriage which rode along a linear air bearing track system. Tests were performed by towing the models through a channel filled with glycerine-water mixtures. Forces and moments on the models were sensed by strain gauge transducers; hydrogen bubble flow visualization was utilized in relating these forces to the unsteady wake flows. Steady drag results agreed with existing data except for the disk at 100 less than Re less than 1000, in which the drag coefficient values were up to 50% below the level of existing data; drag force unsteadiness during steady motion was always less than 5% for the sphere and less than 3% for the disk. Sphere drag measurements under constant acceleration from rest showed the apparent mass concept to be valid (at high Re) until the sphere had traveled approximately one diameter, after which the quasi-steady drag (based on instantaneous velocity) showed good agreement with the actual drag. Interference effects of the sting supports used in these tests are discussed. (Author)

A71-19895 # Effects of nose bluntness, angle of attack, and oscillation amplitude on hypersonic unsteady aerodynamics of slender cones. Lars Eric Ericsson (Lockheed Missiles and Space Co., Sunnyvale, Calif.). (*American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 8th, New York, N.Y., Jan. 19-21, 1970, Paper 70-216.*) *AIAA Journal*, vol. 9, Feb. 1971, p. 297-304. 23 refs. Research supported by the Lockheed Missiles and Space Independent Development Program.

A previously developed analytic theory for the unsteady aerodynamics of moderately blunt slender cones has been extended to include the effects of large nose bluntness, nonzero angles of attack, and finite oscillation amplitudes. It is shown that the developed theory agrees well with available experimental data and correctly predicts the opposite effects of nose bluntness on static and dynamic stability including the highly nonlinear characteristics at angles of attack and oscillation amplitudes up to cone half angle magnitudes. A universal scaling law has been derived that gives the nose bluntness effects on static and dynamic characteristics for the above angle of attack and amplitude ranges with sufficient accuracy for preliminary design of conical reentry vehicles, flying ballistic or lifting reentry trajectories. (Author)

A71-19906 # Amplification by wave distortion in unstable combustors. M. F. Heidmann (NASA, Lewis Research Center, Cleveland, Ohio). *AIAA Journal*, vol. 9, Feb. 1971, p. 336-339. 5 refs.

Brief analysis that shows engine stability to be highly dependent

on some type of wave distortion which is almost invariably exhibited by acoustic mode instability in rocket and jet engines, even when the distortion is small and seemingly negligible. The analysis is based on a combustion model where the burning rate is simply related to a Reynolds number to the one-half power. The analysis shows wave distortion to be a crucial variable affecting combustion stability. It can amplify the response of a Reynolds number controlled process beyond that needed for unstable combustion. It is pointed out that harmonic distortion in combustors should be minimized because it is a cause of combustion instability. M.M.

A71-19908 # Vortex shedding from circular cylinders in an oscillating freestream. C. F. Chen and David B. Ballengee (Rutgers University, New Brunswick, N.J.). *AIAA Journal*, vol. 9, Feb. 1971, p. 340-342. Contract No. AF 44(620)-68-C-0018.

Description of wind-tunnel experiments on vortex shedding from cylinders in a free stream. The Reynolds number range tested was from 500 to $4 \times 10,000$, and the oscillation frequencies were 3 and 6 Hz. Some of the conclusions suggested by the results are: (1) in an oscillatory free stream of 3 Hz and Reynolds number up to $4 \times 10,000$, the vortex shedding from a circular cylinder responds instantaneously to free stream variations; and (2) in the instantaneous Reynolds number range of 500 to $4 \times 10,000$, the instantaneous Strouhal number stays sensibly constant at 0.20 plus or minus 0.01. M.M.

A71-19913 # Reduced-order modeling in aircraft mission analysis. Henry J. Kelley (Analytical Mechanics Associates, Inc., Jericho, N.Y.). *AIAA Journal*, vol. 9, Feb. 1971, p. 349, 350. 7 refs.

Derivation of an alternate third-order particle-dynamics model used for aircraft motion. The model features instantaneously variable speed by means of time-scale separation, further pursuing the approach taken by Kelley and Edelbaum (1970). The model is advanced merely as a slightly more realistic alternative to a constant-speed model, for analyses in which it is important to hold the order to three on account of other complicating factors - e.g., multiple aircraft. M.M.

A71-19916 # Lighter-than-air in Canada. B. Hval (Calgary, University, Calgary, Alberta, Canada). *Canadian Aeronautics and Space Journal*, vol. 17, Jan. 1971, p. 15-23.

Discussion of the various aspects of the potential use of unpowered balloons and, in particular, airships in modern aviation in Canada. A brief review of the lighter-than-air activities in Canada in the recent past is presented. Several commercial possibilities in using balloons are outlined. Particular emphasis is placed on the consideration of the advantages and possible areas of application of rigid airships, such as cargo, passenger, and military airships. The problem of planning airship development in Canada, the airship construction, and the project problems are examined. O.H.

A71-19923 # Design principles of a ground effect vehicle in which the limitation of volumetric dissipations is accomplished with the help of a fluid boundary obtained by means of the Coanda effect (Principii de proiectare a unui vehicul cu efect de sol la care limitarea disipațiilor volumice se face cu ajutorul unei frontiere fluide, obținută prin efect Coandă). Clement Alecsandrescu. *Revista Transporturilor*, vol. 17, Nov. 1970, p. 489-496. In Rumanian.

Brief survey of air cushion vehicles, and discussion of general criteria and structural diagrams proposed for the aerodynamic calculation of a system for limiting volumetric dissipations from the vehicle's air cushion and propulsion system. Theoretical considerations are made on the vehicle's propulsion, braking, steering, stability, compression system, and engine. M.M.

A71-19924 # NAE multi-source schlieren apparatus for 5-foot x 5-foot trisonic wind tunnel. A. Bowker (National Aeronautical Establishment, Ottawa, Canada). *Canada, National Research Council*,

Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin, no. 3, 1970, p. 27-49. 5 refs.

Description of the design, operation, and control of a multiple-source schlieren system developed for flow visualizing work in the trisonic wind tunnel of the Canadian National Aeronautical Establishment (NAE). Considerations leading to the choice of this particular type of schlieren system are discussed, and its advantages are emphasized. Detailed parameters of the various system elements, as well as system performance data, verified during the six month period of system operation, are presented. An overall evaluation of the system is made showing that under operational conditions it has proven convenient to use and very reliable. O.H.

A71-19926 Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970. 315 p. \$10.00.

The general characteristics of aircraft and rocket triggered natural discharges are defined, and experimental data are given for the charging mechanisms, electromagnetic noise effects, current transfer properties, and field distribution patterns. Some effects of lightning on the structural integrity of aircraft and rockets are examined, and new protection systems are described. Test and measurement facilities are outlined, and research reports are included for the structural and electrical damage sustained by advanced composite materials exposed to lightning. The protection of aerospace ground facilities from lightning strikes is considered, and the Apollo 12 lightning incident is analyzed. T.M.

A71-19928 # Model studies of stroke probability to selected points on aerospace vehicles. J. R. Stahmann (Lightning and Transients Research Institute, Minneapolis, Minn.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 13-16.

About sixty-six uniformly spaced fixed probed positions are usually used for a general study to determine the probability of lightning stroke contact to various points on a complete aerospace vehicle. More detailed studies are usually considered prohibitive because of the large number of discharges required. For estimating very low probability of contact for detailed studies of critical regions, probe positions can be restricted to the small solid angle from which contact is possible. Then, with a relatively small number of probe positions and enough discharges to measure statistical variations, a very low probability can be estimated with a limited number of discharges, typically about thirty. (Author)

A71-19929 # Lightning and static hazards relative to airworthiness. B. L. Perry (Air Registration Board, Redhill, Surrey, England). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings.

New York, Society of Automotive Engineers, Inc., 1970, p. 17-23. 11 refs.

The paper updates, and briefly extends, the statistical information on lightning strikes to aircraft given in the author's 1968 paper. The problem and potential dangers of both lightning strikes and static build-up on aircraft are discussed and illustrated with particular reference to airworthiness. Conclusions are drawn regarding problem and potential problem areas where further information is required and toward which research effort should be directed. In the light of the above, current and future airworthiness requirements are considered. (Author)

A71-19930 # Recent developments in lightning protection for aircraft and helicopters. J. D. Robb, J. R. Stahmann, and M. M.

Newman (Lightning and Transients Research Institute, Minneapolis, Minn.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings.

New York, Society of Automotive Engineers, Inc., 1970, p. 25-35. 6 refs.

The testing of aircraft components for new aircraft has introduced problems in trying to meet the specifications with new materials and construction techniques. Suggested is a more detailed analysis of the lightning characteristics in order that tests may be more precisely defined for specific aircraft components as illustrated in swept stroke studies. Of increasing concern is the performance of more vulnerable electronics systems for new aircraft, and guidelines are developed for simple calculation of approximate electric and magnetic fields to determine pulse penetration into the vehicle electrical and electronic systems. Requirements for testing of all plastic helicopter blades are also suggested. (Author)

A71-19931 # Lightning test facilities measurement techniques. J. D. Robb (Lightning and Transients Research Institute, Minneapolis, Minn.), R. F. Huber, and C. J. Kawiecki (Joslyn Manufacturing and Supply Co., Goleta, Calif.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 39-46. 5 refs.

The increasing use of small artificial lightning generation facilities for developmental testing of aircraft components by the manufacturer has required the measurements of the test currents in the presence of the strong electromagnetic fields associated with the high current discharges. Special techniques are presented for the set up of the facility high current paths and for the use of measurement equipment such as the oscilloscopes and high current sensors to assure that reasonably accurate measurements of the current waveforms are obtained. (Author)

A71-19933 # A study of some fundamental helicopter charging mechanisms. M. E. Rogers (Royal Aircraft Establishment, Farnborough, Hants., England). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 57-71. 16 refs.

Discussion of two fundamental helicopter charging mechanisms: 'engine' and 'rain precipitation' charging. In each case collected data are critically examined and working hypotheses are advanced to account for the generation process. In engines the process is seen as one of preferential trapping of ions previously separated by thermal ionization. For Whirlwind 10 helicopters where net positive currents are observed it is considered likely that this largely results from positively charged hydrocarbon nuclei colliding with the turbine blades. The rain precipitation process is believed to be an induction effect which occurs when drops are shattered by impact with the rotor leading edge in the presence of an electric field. It is argued that such a process could explain the large variations in charging currents measured in these conditions, as well as the frequent changes in polarity. F.R.L.

A71-19934 # Studies of supersonic vehicle electrification. J. E. Nanevicz and E. F. Vance (Stanford Research Institute, Stanford, Calif.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings.

New York, Society of Automotive Engineers, Inc., 1970, p. 73-88. 19 refs.

Theoretical and experimental studies of airborne vehicle electrification processes are described. Laboratory experiments with projectiles fired through an ice-fog cloud were used to study the

variation of frictional charging with air speed at supersonic speeds. These experiments demonstrated that the charge imparted by each particle decreases with increasing speed at supersonic speeds, apparently because of ice crystal melting on impact. Flight instrumentation has been designed and fabricated to measure electrification parameters and effects on a supersonic test aircraft. The instrumentation measures, charging rate, discharging rate, charge per particle, aircraft potential, streamer current and number of streamer pulses, variation of effective frontal area, and noise spectrum. The philosophy of the design and construction of the flight test experiments and equipment are discussed. The flight test instrumentation has been installed on an F-4 aircraft, and test flights are being conducted. (Author)

A71-19935 # Lightning current transfer characteristics of the p-static discharger installations. M. P. Amason and J. T. Kung (Douglas Aircraft Co., Long Beach, Calif.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 99-109. 12 refs. Research sponsored by the McDonnell Douglas Independent Research and Development Program.

This paper presents the results of p-static discharger installation lightning tests conducted by the Douglas Aircraft Co. at its Long Beach, Calif. facilities and the facilities of the Lightning and Transients Research Institute at Miami Beach, Fla. The paper discusses the lightning current transfer characteristics and lightning protection design considerations for the p-static discharger, the discharger retainer, and the aircraft installation. Laboratory lightning test results are also discussed in relationship with the in-service experience associated with natural lightning stroke incidents. (Author)

A71-19936 # The effects of lightning attachment phenomena on aircraft design. R. O. Brick, L. L. Oh, and S. D. Schneider (Boeing Co., Commercial Airplane Group, Renton, Wash.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 139-156. 7 refs. Contract No. FA-SS-67-e.

A working knowledge of swept lightning strikes has become a necessity for the aircraft designer involved in lightning protection of aircraft incorporating new structural concepts that depart from the conventional riveted aluminum airframe. Swept strokes have been simulated in the laboratory to determine realistic protection criteria for components. Measurements of the maximum swept stroke dwell time on titanium and aluminum sheet are reported as well as an analysis of various techniques to improve the resistance of fuel tank skin panels to swept stroke effects. (Author)

A71-19937 # Electrostatic charging and noise quieting. Robert L. Truax (Dayton Aircraft Products, Inc., Fort Lauderdale, Fla.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 157-174.

Use of a system approach to identify noise sources due to electrostatic charging, to measurement of charging levels, application of noise reduction techniques, and flight test verification. Steps taken to reduce noise generation when the aircraft became charged electrically included installation of quiet dischargers, conductive coating of plastic frontal surfaces, and use of dc sealed antennas. Actual flight tests demonstrated that with proper application of

corrective measures, useable navigation procedures and communications could be retained in the most severe conditions encountered.

F.R.L.

A71-19938 # Influence of lightning and static electricity as applied to helicopter design. B. John Solak (Boeing Co., Vertol Div., Morton, Pa.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 179-187. 11 refs.

Review of three basic domains of static electricity affecting helicopters. These are (1) protection of the rotor blades against the effects of lightning strikes, (2) cargo hook operation and the related problem of active equalization of potential between the cargo and the cargo handler, and (3) passive static electricity dischargers as a method of reducing radio interference. All three domains affect the whole blade design, with emphasis on the design of the blade tip. F.R.L.

A71-19939 # Lightning protection for non-metallic rotor blades. J. R. Stahmann (Lightning and Transients Research Institute, Minneapolis, Minn.) and G. I. Hackenberger, Jr. (Kaman Aerospace Corp., Bloomfield, Conn.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 189-194.

This paper discusses general approaches to the design of lightning protection system for nonmetallic helicopter rotor blades. Possible effect of stroke currents on conducting parts external and internal to the blade are mentioned, and general recommendations are made for disposition of protective materials. Testing of any such design is considered a necessity. A specific example is described, tracing the development of the protective system for one particular nonmetallic rotor blade. (Author)

A71-19940 # Lightning protection on advanced fighter aircraft. G. L. Weinstock (McDonnell Aircraft Co., St. Louis, Mo.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 195-205.

Study of the design challenges and protective measures against lightning being used or considered for use on late models of the F-4 Phantom II aircraft, advanced air superiority aircraft, and electronic flight control systems. For practical aircraft protection lightning discharges must be prevented from entering the aircraft interior and damaging electrical and electronic systems, causing possible fuel system explosions, and affecting crew capabilities. Openings in the aircraft skin such as radomes, canopies, camera windows, navigation lights, fuel vents, composite materials, atmospheric sensors, and unbonded sections all reduce the capability of the aircraft to withstand lightning strikes. Additional lightning protection requirements have been necessitated by the introduction of electronic flight control systems. F.R.L.

A71-19941 # Lightning and surge protective devices for survivability of electrical systems. C. J. Kawiecki, W. H. Kapp, W. T. Pranke, H. J. Steinhoff, and R. E. Thompson (Joslyn Manufacturing and Supply Co., Goleta, Calif.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive

Engineers, Inc., 1970, p. 207-211.

The proper functioning of an aircraft depends upon the reliability of its electrical systems. Circuit pollution by foreign electrical pulses endangers the survival of essential systems. Natural surges such as lightning, and equipment self-generated surges cannot be avoided entirely, but their effects can be minimized using appropriate lightning and surge protective devices. The surge problem is difficult to cope with; designers often ignore or postpone the problem for lack in knowledge both as to its definition and what to do about it. A cursory treatment of one kind of protector, using sparkgap devices, is presented here for protection against direct and induced lightning strikes, electromagnetic pulses, static charges and equipment self-generated surges. (Author)

A71-19942 # Lightning protection for dielectric composites. J. D. Robb (Lightning and Transients Research Institute, Minneapolis, Minn.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 215-221. 9 refs.

Dielectric composites are analyzed in terms of direct damage from shock waves, damage from longer duration slower pressures from vaporization of dielectric or metallic solids, direct magnetic forces and burning from long duration low current continuing components. Studies have included piezo blast gage pressure measurements and schlieren photography of the shock waves in the laboratory and pressure measurements of triggered natural lightning discharges. Theoretical and experimental analysis of probable maximum shock pressures, magnetic forces and slower pressures indicate that the principal problem is introduced through long arcs developed inside sections and that the best general solution for providing lightning protection is still to keep the lightning discharge currents on the aircraft exterior or provide conductors with sufficient cross sectional area to carry the current where the currents must penetrate the aircraft. (Author)

A71-19943 # Lightning protection for advanced composite aircraft structures. G. T. Woodrum (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 223-231. 5 refs.

Consideration of the hazard of lightning strikes to composite materials (boron/epoxy, graphite/epoxy, and fiberglass/epoxy), and of means of minimizing the effects. In these materials, the plastic matrix acts as a nonconductive material, and the fibers, which are imbedded, but do not touch each other in the matrix, act as conductive materials. The use of metal filled coatings, plasma sprayed coatings, and metal foil coverings is described. F.R.L.

A71-19944 # Lightning protective coatings for boron and graphite fiber reinforced plastics. John G. Breland, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), John T. Quinlivan, and C. J. Kuo (Boeing Co., Seattle, Wash.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 233-251.

Coatings and thin conductive overlays for protecting boron fiber reinforced plastics and graphite fiber reinforced plastics from structural damage by simulated lightning strikes were investigated. Laboratory tests were made in which test panels, with and without coatings, were exposed to currents as high as 200,000 amperes. The

greatest protection of the panels from damage, combined with minimum coating weight, was achieved with aluminum wire fabric and aluminum foil overlays. Other protective coatings which had merit were: plasma sprayed aluminum; conductive paints used with aluminum foil strips; and conductive coatings applied over high dielectric strength plastic films. (Author)

A71-19946 # Voltages produced by transient currents flowing upon shields of cables. F. A. Fisher (GE High Voltage Laboratory, Pittsfield, Mass.). In: Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., December 9-11, 1970, Proceedings. New York, Society of Automotive Engineers, Inc., 1970, p. 299-308.

Electromagnetic disturbances to aircraft and to aerospace and industrial ground facilities often produce large circulating currents in the shields of electrical cables. The electromagnetic disturbances may be caused by lightning, switching of high voltage circuits or by other electromagnetic effects. This paper presents experimental data showing how surge voltages are related to the type of construction of the cable, to the material of the cable shield, to magnitude and waveshape of the shield current and the type of termination of the shield. Special attention is given to industrial grade metal conduit since conduit, particularly the rigid steel variety, can have very effective shielding properties. (Author)

A71-19959 Acoustic spectra from turbulent jets. William C. Meecham (California, University; Bolt Beranek and Newman, Inc., Los Angeles, Calif.). *Acoustical Society of America, Journal*, vol. 49, Jan. 1971, pt. 2, p. 334-338. 8 refs.

Determination of the spectrum of the acoustic radiation from turbulent jets. To solve this theoretical problem, two assumptions are used. First, it is supposed that the turbulent fluid has approximately Gaussian statistical characteristics. Then, it is supposed that the space-time characteristics for the needed second-order velocity correlation can be obtained by assuming that the fluid is approximately in 'frozen flow.' From these assumptions, the higher-frequency sound-power spectrum is obtained in terms of an integral over the turbulence energy spectrum. O.H.

A71-19961 Propagation, distortion, and shock formation of pressure pulses in a nonviscous fluid of constant state. G. M. Schindler (Douglas Aircraft Co., Long Beach, Calif.). *Acoustical Society of America, Journal*, vol. 49, Jan. 1971, pt. 2, p. 344-351. 9 refs. Research supported by the Douglas Aircraft Independent Research and Development Program.

Plane simple compression waves of finite amplitude are studied as they propagate into a fluid medium of constant state. Shock formation and subsequent expansion, as well as rise and decay of shock strength, are determined from a boundary-value problem of mixed type involving a fixed boundary (source) and a moving boundary (shock surface). At the source, an overpressure is arbitrarily prescribed as a function of time; at the shock surface, the simple wave solutions are shown to satisfy the exact shock-transition conditions within an accuracy including second powers of shock strength, while the shock speed is determined precisely. Shock speed and rise and decay of shock strength are shown to be strongly dependent on the particular form of the overpressure generated at the source in the course of time. Approximation formulas are derived for weak shocks and are used in a detailed discussion of two examples. (Author)

A71-19997 The coming of age of the associative processor. J. A. Rudolph, Louis C. Fulmer, and Willard C. Meilander (Goodyear Aerospace Corp., Akron, Ohio). *Electronics*, vol. 44, Feb. 15, 1971, p. 91-96. 10 refs.

Description of the design and operation of associative processors used in applications requiring high-speed searches of large, rapidly changing data bases with simultaneous arithmetic operations on many pairs of numbers. In the associative processor, the single arithmetic unit of the conventional digital computer has been eliminated, and the location-addressed sequentially-accessed memory has been replaced by an associative array, which is a modified associative memory otherwise known as a constant addressed memory, search memory, or parallel search memory. Because the associative array can simultaneously compare all the items it contains against some input item, it takes only one memory cycle to locate any data item or portion of an item. The logic and arithmetic cells are attached on a one-to-one basis to each word. An associative processor system is scheduled for use by the FAA to track aircraft in potentially dangerous situations at busy airports. T.M.

A71-20015 Experimental investigations of caret wings in hypersonic flow (Experimentelle Untersuchungen an Wellenreiter-Flügeln im Hyperschallbereich). Klausdieter Kipke. *Braunschweigische Wissenschaftliche Gesellschaft, Abhandlungen*, vol. 21, 1969, p. 407-428. 16 refs. In German.

Investigation of a series of caret wings in a hypersonic gun tunnel in the Mach number range from 8 to 15 at corresponding Reynolds numbers from 2,700,000 to 1,400,000. The design Mach number of the wings was between 6 and 10 and the aspect ratio between 0.8 and 1.6. The tests included three-component force measurements, pressure distribution measurements in spanwise direction, and determination of shock wave angles by flow visualization. The experimental coefficients of lift, drag, and pitching moment were compared with the simple wedge theory and, in general, a good agreement between theory and experiment was obtained. The experimental pressure distributions were also compared with the simple wedge theory and additionally with an extended Newtonian theory. In both cases, the experimental data are fairly well predicted by these theories. Experimental shock wave angles show that viscous effects have a significant influence on the shape of the shock, especially near the leading edges of the wings. A simple method was used to calculate the shock wave angles in the plane of symmetry including viscous effects. The agreement between theory and experiment is good. Due to viscous effects, a severe decay of maximum lift-drag ratios occurs with decreasing Reynolds numbers. The order of magnitude of the maximum lift-drag ratio is about 4 to 6. O.H.

A71-20044 The employment of plastics and metals in aeronautical design comparatively considered using some practical examples (Einsatz von Kunststoffen und Metallen, gegenübergestellt an praktischen Beispielen, ausgehend vom Flugkörperbau). G. Fauner. *Technische Akademie Wuppertal, Berichte*, no. 2, 1970, p. 85-104. 21 refs. In German.

The materials used in the design of various types of aircraft, and in rocket and spacecraft design are discussed giving attention to applications of plastics and of metals. The significance of plastic materials for applications requiring extremely light construction elements is discussed taking into consideration the advantages of resin-impregnated materials. The characteristics of a variety of structural materials is considered, and the use of these materials in various components of aircraft structures and missiles is examined. The use of adhesives, the employment of titanium alloys, and design materials for spacecraft are discussed. Materials developed for special design problems involving helicopters are described. Newly developed plastic materials for high-temperature applications are considered, and changes in plastics characteristics produced by the addition of metallic and nonmetallic powders is reported. G.R.

A71-20063 Aeroelastic and related problems for aircraft and spacecraft (Aeroelastische und verwandte Probleme bei Flugzeugen und Raumflugkörpern). Hans Försching (Deutsche For-

schungs- und Versuchsanstalt für Luft- und Raumfahrt, (AVA) Abteilung Aeroelastik, Göttingen, West Germany). *DFVLR-Nachrichten*, Oct. 1970, p. 101-104. In German.

An aeroelastic triangle of forces with elastic, inertial, and aerodynamic forces is considered. Aeroelastic problems are investigated taking into account static and dynamic problems. Changes in lift produced by the elastic deformation of the aircraft structure are examined, and effects on the dynamic flight stability are explored. An aerothermoelastic tetrahedron of forces for supersonic and hypersonic velocities is discussed. Aeroelastic and related problems occurring in connection with the launching of spacecraft and with the development of a space shuttle are described. The present state of development of aeroelastic research is critically examined, and aerodynamic problems which are not yet solved are pointed out. G.R.

A71-20064 Electronic controls for aircraft (Elektronische Steuerungen für Flugzeuge). Walter Metzendorf (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *DFVLR-Nachrichten*, Oct. 1970, p. 105-109. In German.

The history of the development of control systems for aircraft is examined taking into consideration aspects of hydraulic servo-control, questions of the simulation of the forces required in the control process, and problems of automatic control. Aspects of the reliability of mechanical control systems and of electronic control systems are investigated, and questions of the technical realization of a reliability model for the electric control are explored. Approaches for changing present aircraft control systems by making use of new developments in the field of electronic controls are discussed, and advantages obtained by such changes are pointed out. G.R.

A71-20065 Problems of the acceptance check of airliners (Aufgaben beim Nachfliegen von Verkehrsflugzeugen). Ferdinand Schatt and Gerhard Puhlmann (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Zentralabteilung Luftfahrttechnik, Oberpfaffenhofen, West Germany). *DFVLR-Nachrichten*, Oct. 1970, p. 114-119. In German.

The characteristics of acceptance checks conducted as a prerequisite for the official licensing of an airliner in a state are discussed. During these flight tests the operational characteristics of an airliner are checked for compliance with data obtained by the manufacturer. Thus, in the western world it is to be expected that the airliner meets the pertinent requirements of the Federal Aviation Regulations or the British Civil Air Regulations. Aircraft characteristics to be investigated in a simplified acceptance test are discussed giving attention to the various phases of preliminary work and to the final flight test. Performance checks related to takeoff, landing and ascent are considered, and requirements with regard to the control of an aircraft, its stability, and its behavior under various conditions are examined. Particular attention is given to questions of the control of an aircraft in critical situations. G.R.

A71-20066 Demonstration system for two-dimensional aircraft motions (Demonstrationssystem für zweidimensionale Flugzeugbewegungen). H. Gerd Schlüter (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *DFVLR-Nachrichten*, Oct. 1970, p. 120, 121. In German.

Approaches for solving problems of control processes for aircraft are discussed giving attention to the importance of simulation methods. A new approach for the investigation of methods of automatic landing control is described. This approach makes it possible to examine the parameters of motion of the aircraft without the use of expensive equipment as for instance a moving cockpit simulator. Only the longitudinal motion of the aircraft is considered. A two-dimensional sequence of pictures is electronically generated on a television screen in order to indicate the position of the aircraft during the landing maneuver. G.R.

A71-20075 # Closed-die forgings for the aircraft industry. I. J. A. Carver (British Steel Corp., Sheffield, England). *Special Steels Review*, Spring 1970, p. 17-24.

Description of the procedure and advantages of closed-die forging from the viewpoint of a purchaser. Closed-die forgings are classified with respect to the tolerances required into four main types: (1) coarse tolerance forgings, (2) commercial tolerance die forgings, (3) close tolerance die forgings, and (4) precision die forgings. It is indicated that, in general, closer tolerances reduce material and machining costs, but increase die and forging costs with a corresponding lengthening of time required for dies and tooling. Die costs increase rapidly as more precise tolerances are required. It is shown that there is an optimum tolerance for a minimum total cost per given part. The materials used for closed-die forgings in the aircraft industry are reviewed. Z.W.

A71-20076 All-Union Scientific Conference on Boundary Value Problems and Their Applications in Fluid and Gas Mechanics, Kazan, USSR, May 28-31, 1969, Reports (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969, Doklady). *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970. 304 p. In Russian.

The results of studies of direct and inverse boundary value problems of the theory of analytical and generalized analytical functions, boundary value problems for equations of mixed type, and their applications in hydroaeromechanics and filtration theory are summarized. The application of the Riemann boundary value problem in classes of single-valued and multivalued functions on a Riemann surface to the study of certain complete singular integral equations is considered. Solutions to a number of boundary value problems for differential equations of mixed type are obtained by the integral equation method. Problems related to the existence and uniqueness of the solutions of certain boundary value problems for equations of mixed type are examined, as well as the problem of univalence of the solutions of inverse boundary value problems. Linear and nonlinear problems concerning the motion of a heavy fluid with a free surface are analyzed, as well as unsteady problems of the theory of smooth and cavitation flows, direct and inverse problems of the theory of airfoils and airfoil arrays, and problems involving flows in channels or nozzles at subsonic and supersonic velocities. Approximate methods of solving gasdynamics equations are described, as well as analytical methods of solving certain direct and inverse boundary value problems of filtration theory in homogeneous soil. A.B.K.

A71-20078 # Inverse boundary value problems and their applications in hydroaeromechanics (Obratnye kraevye zadachi i ikh prilozheniia v gidroaeromekhanike). M. T. Nuzhin and G. G. Tumashev. (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 18-27. 28 refs. In Russian.

Summary of work done on the theory of inverse boundary value problems by mathematicians at the University of Kazan. The formulation of inverse boundary value problems of the theory of analytical functions is reviewed. Inverse boundary value problems involving the construction of profiles from given velocity or pressure distributions are considered. Other types of problems related to fluid mechanics are cited, including problems involving the determination of the boundaries of a supersonic flow. A.B.K.

A71-20083 # Certain new approximations of the Chaplygin function in the subsonic range of gas flow (Nekotorye novye approksimatsii funktsii Chaplygina v dozvukovoi oblasti techeniia gaza). V. A. D'iachenko and V. M. Fomin. (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v

Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.) Seminar po Kraevym Zadacham, Trudy, no. 7, 1970, p. 122-128. 6 refs. In Russian.

Consideration of an approximate method of integrating gas-dynamics equations and of the application of this method to the solution of certain boundary value problems. An approximate method is developed for solving the equations for a plane subsonic motion of an ideal gas in an adiabatic flow regime. The proposed method is applied to a study of the discharge of a subsonic gas flow from a flat channel with a contraction. A.B.K.

A71-20084 # Solution of certain jet problems by the coupling method (Reshenie nekotorykh struinykh zadach metodom sopriazheniia). A. V. Kosterin. (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 148-152. 6 refs. In Russian.

Development of an approximate method of solving certain problems of gas jet theory on the basis of a two-link approximation of the Chaplygin function. The proposed method, which involves the coupling of functions to integral equations, is applied to the solution of the problem of separation flow of an ideal gas jet past a symmetrical arc according to Kirchhoff's scheme. A particular case of this problem, involving jet flow past a symmetrical wedge with a stagnation zone, is also considered. A.B.K.

A71-20085 # Sonic flow past a wedge according to Kirchhoff's scheme (O zvukovom obtekanii klina po skheme Kirkhgofa). A. V. Kosterin. (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 153-159. 6 refs. In Russian.

Derivation of an approximate solution to the problem of sonic flow of an ideal gas jet past a wedge according to Kirchhoff's scheme. After showing that the problem has a unique solution, a solution is obtained in the form of series, the convergence of which is investigated. It is shown how this method of solution can be extended to the case of a jet of infinite width. A.B.K.

A71-20086 # Motion of a cavitating foil with a jet flap under the free surface of a fluid (Dvizhenie kaviruiushchego profilisa reaktivnym zakrytkom pod svobodnoi poverkhnost'iu zhidkosti). L. M. Kotliar and V. A. Lazarev. (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 168-177. In Russian.

Consideration of the problem of cavitation flow of a fluid with a free surface past an underwater wing with a jet flap in the case of an arbitrary cavitation number. Equations of motion are derived and solved for a thin, slightly bent foil, from the trailing edge of which a jet emerges at a small angle into a steady flow of an ideal weightless fluid with a free surface. Using a linear approximation, a calculation is made of the hydrodynamic characteristics of the flow. The results of some numerical calculations of this type of flow are presented graphically. A.B.K.

A71-20087 # Flow of a heavy fluid past a plate with partial cavitation (Obtekanie plastiny s chastichnoi kavitatsiei potokom tiazheloi zhidkosti). L. M. Kotliar and A. G. Terent'ev. (Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniiam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 178-182. In Russian.

Consideration of the problem of a partially cavitating plate in a heavy fluid according to Riabushinski's scheme. According to this

scheme, the cavity is closed by a fictitious plate perpendicular to the main plate. To solve the problem, the physical plane is mapped onto a semicircle of the parametric plane. It is shown that the presence of gravity in this problem increases the lifting force of the plate and the length of the cavity. A.B.K.

A71-20088 # An unsteady problem of flow past a solid foil (Nestatsionarnaia zadacha obtekaniiia telesnogo profilii). A. V. Kuznetsov. (*Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.*) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 198-204. 10 refs. In Russian.

Solution of the problem of small oscillations of a solid foil in an incompressible fluid flow. The problem is solved with the aid of a method previously used by the author in studying problems involving small oscillations of obstacles in flows with jet separation. The problem consists in determining the forces acting on a closed foil which is located in a steady infinite incompressible fluid flow and describes small oscillations about its main position. To solve the problem, the physical plane and the region of the complex potential corresponding to it are mapped onto a curvilinear half-strip with known boundaries. A formula is obtained for the force of the unsteady fluid pressure on the foil. A.B.K.

A71-20089 # Construction of a body of revolution in a supersonic gas flow from a given chord diagram (Postroenie tela vrashcheniia, obtekaemogo sverkhzvukovym potokom gaza, po zadannoi khordovoi diagramme). L. L. Lebedev. (*Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.*) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 205-209. In Russian.

Construction of the surface of a body of revolution from the distribution of the modulus of the velocity vector along the generatrix of the body, this distribution being given as a function of the longitudinal coordinate of the generatrix. It is assumed that the body has a pointed nose and is located in a supersonic axial gas flow with a given velocity, density, and pressure. Using the method of characteristics developed by Frankl, the surface of the body and the surface of the shock wave are constructed, starting from the nose of the body, and taking into account the formation of vortices behind the shock wave. The generatrices of the body and the shock wave are constructed approximately, in the form of broken lines consisting of rectilinear segments. A.B.K.

A71-20090 # Multilink approximation of the Chaplygin function in subsonic and supersonic flow regions (Mnogozvennaia approksimatsiia funktsii Chaplygina v dozvukovoi i sverkhzvukovoi oblastiakh techeniia). V. M. Fomin. (*Vsesoiuznaia Nauchnaia Konferentsiia po Kraevym Zadacham i ikh Prilozheniam v Mekhanike Zhidkosti i Gaza, Kazan, USSR, May 28-31, 1969.*) *Seminar po Kraevym Zadacham, Trudy*, no. 7, 1970, p. 275-282. 10 refs. In Russian.

Construction of a method of approximating the Chaplygin function in subsonic and supersonic flow regions on the basis of the well-known Krtistianovich-Sauer approximate method. Coupling conditions are derived relative to a modified stream function at the approximation nodes. Graphs showing the good agreement between the exact and approximate curves are presented. The proposed method is applied to the solution of certain boundary value problems. A.B.K.

A71-20098 # Response of skin friction to the angle parameter in flow past an axisymmetric body moving in the direction of its axis. G. N. Sarma and T. R. Gupta (Roorkee, University, Roorkee,

India). *Indian Journal of Pure and Applied Mathematics*, vol. 1, Oct. 1970, p. 594-607. 9 refs.

Unsteady boundary layer on an axisymmetric body moving in the direction of its axis is studied. A general analysis is made following Froessling (1940) and Sarma (1964) and two particular problems, one the flow past a cone and the other flow past a sphere, are studied in detail. The skin friction coefficient and the dimensionless displacement thickness are calculated and their variations with angle parameter and time are analysed. The ranges of the validity of solutions for small and large times are determined graphically. The analysis is done in terms of the universal functions and the functions are integrated numerically. In the case of sphere the analysis is made for two values of the main stream velocity, one for the theoretical value as done by Schlichting (1955) and the other for the experimental value as done by Tomotika and Imai (1938). (Author)

A71-20151 * # University of Virginia superconducting wind-tunnel balance. R. N. Zapata, H. M. Parker, F. E. Moss (Virginia, University, Charlottesville, Va.), I. L. Hamlet, and R. S. Kilgore (NASA, Langley Research Center, Hampton, Va.). (*National Bureau of Standards, U.S. Navy, American Physical Society, Institute of Electrical and Electronics Engineers, and University of Colorado, Applied Superconductivity Conference, Boulder, Colo., June 15-17, 1970.*) *Journal of Applied Physics*, vol. 42, Jan. 1971, p. 3-5. NSF-supported research; Grant No. NGR-47-005-029.

The design of an electromagnetic balance using superconducting coils is reported. Both dc and ac coils are used to support aerodynamic models in a supersonic (Mach 3) wind tunnel and to simultaneously measure the forces acting on them along 3 orthogonal axes. Major design characteristics include: adoption of symmetrical coil arrangement to provide maximum space for the wind tunnel; 3 gradient-coil pairs capable of being driven between 0 and 350 A at a frequency of 30 Hz by specially designed power supplies; a vertical wind tunnel with a 6-in. test section located in the axial room-temperature access of a 250-liter liquid-helium Dewar. Results on ac losses for prototype gradient coils wound of three different superconducting materials are reported. (Author)

A71-20198 # Thermal stress and fatigue analysis in turbine rotors. C. L. Chow (Hong Kong University, Hong Kong). (*American Society of Mechanical Engineers, Joint Power Generation Conference, Pittsburgh, Pa., Sept. 27-30, 1970, Paper 70-Pwr-1.*) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol. 93, Jan. 1971, p. 13-20. 13 refs.

A method of thermal stress and fatigue analysis under triaxial stress conditions is presented. A rotor of a marine steam turbine is taken as a typical example to illustrate the detailed method of analysis in assessing the cycle damage life of the rotor. A computer technique of iterative block relaxation is devised for the thermal stress calculation as the physical geometry of the problem under consideration is fairly complex. This technique is particularly advantageous for such a system as (a) damping the magnitude of the oscillation in the solution of the ill-conditioned stress equations and (b) keeping the number of nodal points required in a converging solution to a minimum. Three different operating procedures of starting and loading the marine turbine have been studied with full three-dimensional stress and fatigue considerations. One of the three procedures which is found to be more desirable is recommended with the descriptions of detailed steam history and main features of the cold start throughout its whole operation. (Author)

A71-20200 * # Design and performance evaluation of four transonic compressor rotors. J. P. Gostelow (Cambridge University, Cambridge, England). *ASME, Transactions, Series A - Journal of Engineering for Power*, vol. 93, Jan. 1971, p. 33-41. 12 refs. NASA-sponsored research.

A set of four compressor rotors was designed as a means of optimizing blade camberline shape in the high-transonic Mach number region. One blade row was designed for a tip diffusion factor of 0.35 with the supersonic camber minimized. The other three blade rows were designed for a tip diffusion factor of 0.45 with tip ratios of supersonic to total camber varying from zero to the value corresponding to a double-circular-arc blade section. Performance maps and blade element data were generated as a result of testing on the four rotors. All rotors exceeded design efficiency and flow at conditions corresponding to design point operation. Operating range, from peak efficiency to stall, is highest in rotors designed for a low tip diffusion factor and which have the minimum amount of supersonic camber. (Author)

A71-20298 # Instruments for studying fogs and clouds and measuring humidity (Pribory dlia issledovaniia tumanov i oblakov i izmereniia vlazhnosti). V. A. Zaitsev and A. A. Ledokhovich. Leningrad, Gidrometeorologicheskoe Izdatel'stvo, 1970. 256 p. 147 refs. In Russian.

A description is given of new devices which are being used in studies of fogs and clouds and in the solution of engineering and technical problems related to the formation of artificial fogs, the dispersion of natural fogs, and the measurement of humidity at positive and negative temperatures. The principles of operation of the measurement devices are outlined, and the designs of the instruments and the methods of calibrating them are described. A method of measuring fog and cloud parameters is presented, and certain results of experimental studies of clouds and fogs are cited. The effect of water content on the operation of jet aircraft engines during flight in clouds and precipitation is considered. Particular attention is given to a description of a new condensation thermohydrometer which measures the air temperature and humidity at high (50 to 70 C) and low (-50 to -60 C) temperatures under natural conditions and in various chambers. A.B.K.

A71-20299 # Supports and suspensions of gyroscopic devices (Opory i podvesy girokopiicheskikh ustroistv). M. P. Kovalev. Moscow, Izdatel'stvo Mashinostroenie, 1970. 287 p. 48 refs. In Russian.

The accuracy, reliability, and lifetime of aircraft gyro systems are examined as a function of bearing quality and conditions of operation. Initial material consists of dynamic equations of motion for a solid body around a fixed point. Factors affecting the accuracy of two- and three-degree-of-freedom gyros are defined, including the effects of external forces, elasticity of the suspension elements, and friction in the gimbal axes. The causes of dynamic reactions in the suspensions are analyzed, together with their effects on the system operation. Methods of calculating and eliminating vibrations and friction are outlined for typical gyro structures. Particular attention is given to a method of solving statistical equilibrium equations for the rotor of a gyro suspended in tension on two identical radial-thrust bearings under the action of radial, axial, or combined loads. Formulas are given for the contact angles, support reactions, forces acting on bearings, and rotor displacements. T.M.

A71-20301 # Aircraft elastic mode control. Robert L. Swaim (Purdue University, Lafayette, Ind.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 65-71. 58 refs.

Research and development work concerned with elastic mode control systems which can suppress the level of normal accelerations at selected locations on the structure of an aircraft is discussed. Aspects of aircraft comfort are examined, and problems regarding performance criteria suitable for handling riding quality specifications are considered. Power spectral density analysis is discussed, structural loads and fatigue are investigated, and approaches for elastic mode control are explored. A review of past programs is given, and problems of linear optimal control are examined. In conclusion

it is pointed out that control systems for alleviating an airplane's rigid-body and elastic mode responses to turbulence have been proved feasible by comprehensive analysis and extensive flight test. Substantial improvements in riding quality, structural fatigue life, and peak loads have been demonstrated. Such systems are extremely sensitive to parameter variations, however, and must be carefully designed to prevent degraded responses and instabilities under off-design conditions. G.R.

A71-20302 # Perspective of SST aircraft noise problem. II - Thrust losses and installation factors. G. S. Schairer, J. V. O'Keefe, and P. E. Johnson (Boeing Co., Seattle, Wash.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 72-76.

The current state of research concerning noise suppression for SST jet engines is presented. Results of an extensive research program of both model and large scale levels which has investigated many different noise suppressor concepts are described. Test results covered in Part I (previously published in the *Journal of Aircraft*) show several fundamental means to reduce jet noise at different frequency regions. In Part II, means to reduce thrust losses associated with installed suppressor devices are shown. Installed noise suppressor designs are based on these charts. The factors which control noise levels for takeoff are examined. Substantial improvements in SST noise footprints are indicated as suppression development continues. (Author)

A71-20303 # Theoretical and experimental aerodynamics of the sailwing. Robert A. Ormiston (U.S. Navy; U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 77-84. 17 refs.

The sailwing is a unique type of semiflexible foldable wing. A brief description of its construction, basic properties, and some past research, is used to introduce an analytical and experimental study of its aerodynamic characteristics. Emphasis is placed on an approximate structural analysis which treats the nonlinear behavior of the sail deflection. Two-dimensional flexible airfoil theory and Prandtl lifting-line theory are used to establish the aerodynamic loading. The results allow prediction of the induced tensions, the nonlinear life curve, induced drag, and aeroelastic divergence of the sail chordwise deflection mode. Selected experimental results are presented for comparison with the theory, along with a brief discussion of the implications of the study regarding flight vehicle applications of the sailwing. (Author)

A71-20304 # Transonic airfoil design. M. S. Cahn and J. R. Garcia (Northrop Corp., Hawthorne, Calif.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 84-88. 8 refs.

A method recently developed by Northrop consists of a computer program which will determine an airfoil shape from predetermined supercritical velocity distributions having extensive regions of supersonic flow. The velocity is given vs the distance around the airfoil. This allows a designer to design to a given lift by specifying the required circulation. Also, boundary-layer problems can be avoided by restricting adverse velocity gradients. Starting with a given compressible pressure or velocity distribution with mixed subsonic and supersonic regions, an airfoil shape can be determined. This is done by making a transformation that causes the streamline and potential line network to give an equivalent incompressible flow. This incompressible problem is then solved by complex function theory, and the solution is transformed back to the compressible plane. A computer program using this method has been applied to several shapes with known solutions. Agreement between calculated shapes and actual shapes was excellent. A 4.6% airfoil was designed from a prescribed velocity distribution and tested in the wind tunnel at transonic speeds. Good agreement was obtained between theoretical and experimental results. Transonic airfoils can be designed by this method. (Author)

A71-20305 # Approach guidance to circular flight paths. F. H. Kishi and I. Pfeffer (TRW Systems Group, Redondo Beach, Calif.). (*American Institute of Aeronautics and Astronautics, Aerospace Computer Systems Conference, Los Angeles, Calif., Sept. 8-10, 1969, Paper 69-986.*) *Journal of Aircraft*, vol. 8, Feb. 1971, p. 89-95. Members, \$1.00; nonmembers, \$1.50.

Description of a novel technique for guiding an aircraft from a distant point to a given circular orbit over a fixed ground area. The aircraft navigation system used consists of a sensor which tracks a ground reference point to give pointing data in aircraft coordinates, and vertical and directional gyros to give bank and heading information. The system requires a computer (which solves the guidance problem in real time) and a display (which presents bank-angle commands to the pilot). Primary attention is given to the guidance equations required for a smooth, rapid approach to the desired orbit in spite of system constraints such as sensor-gimbal limits and bank and bank-rate limits. A computer simulation is made of the system, and typical trajectories derived from the chosen guidance philosophy are shown. Comparisons are also made between the chosen guidance scheme and theoretical optima. (Author)

A71-20306 * # Optimum horizontal guidance techniques for aircraft. Heinz Erzberger and Homer Q. Lee (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 95-101. 5 refs.

Discussion of automatic flight control techniques for problems in horizontal guidance, which in current terminal area operations are solved jointly by the pilot and the air traffic controller. The horizontal guidance tasks, which such a flight control system should be capable of performing, have been identified as being of three types: (1) guiding the aircraft from any initial location and initial heading to any final location and heading; (2) intercept and fly along a line of specified direction; and (3) a final location with arbitrary final heading. Guidance problems, such as capturing an ILS beam at a specified point on the beam, intercepting a VOR radial, and point to point navigation, can be formulated in terms of these problems. The guidance laws given minimize the arc length of the trajectories to fly between initial and final conditions subject to a constraint on the turning radius of the aircraft. A simple geometric technique is outlined for constructing the optimum trajectories graphically. G.R.

A71-20307 # Boundary-layer discontinuity on a helicopter rotor blade in hovering. Henry R. Velkoff (Ohio State University, Columbus, Ohio), Kenneth M. Jones (Boeing Co., Supersonic Transport Div., Seattle, Wash.), and Dwight A. Blaser. (*American Institute of Aeronautics and Astronautics and American Helicopter Society, VTOL Research, Design, and Operations Meeting, Georgia Institute of Technology, Atlanta, Ga., Feb. 17-19, 1969, AIAA Paper 69-197.*) *Journal of Aircraft*, vol. 8, Feb. 1971, p. 101-107. 18 refs. Army-supported research.

An experimental study was conducted using flow-visualization techniques to investigate the nature of the boundary layer on a helicopter rotor in hovering. The study revealed that an unanticipated boundary layer behavior occurred. The primary flow-visualization technique involved the use of ammonia injected into the boundary layer at the leading edge. The blade surface was chemically coated, and as the ammonia moved with the local airflow it formed a trace on the surface indicative of the boundary-layer flow. The traces initially moved chordwise along the surface then abruptly turned outwards. A short distance later, the traces moved inwards and then continued aft along the blade in a somewhat diffuse pattern. Similar traces were found over wide ranges of pitch angles and rotor speeds. It is hypothesized that a standing laminar separation bubble exists on the blade surface aft of the peak pressure position. (Author)

A71-20308 # A study of fog clearing using a CO₂ laser. G. J. Mullaney, W. H. Christiansen, and D. A. Russell (Boeing Scientific Research Laboratories, Seattle, Wash.). (*American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-18, 1969, Paper 69-670.*) *Journal of Aircraft*, vol. 8, Feb. 1971, p. 108-113. 11 refs.

Investigation of the physics of fog removal by a CO₂ laser and evaluation of the possibility of clearing airport runways. While initial estimates of the power required to clear a runway, 10^6 to 10^7 W, are large for present-day laser devices, they may not be excessive requirements for future systems. (Author)

A71-20309 # Use of ground based simulators in aircraft design. P. G. Dillenschneider and A. W. Shaw (Vought Aeronautics Co., Dallas, Tex.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 113-119. Contracts No. N 00019-68-C-0075; No. AF 33(657)-7868.

The growth in flight simulation technology in the flight training context and the extension of this technology to engineering oriented flight simulation is discussed briefly. Basic differences between simulation used for training and engineering design are identified. The use of ground based flight simulation in support of aircraft design is demonstrated by presenting three diverse but typical examples. The specific engineering oriented simulations discussed are an air combat simulation used to evaluate the effect of changes in gross aircraft characteristics on air combat effectiveness, the approach and landing on board an aircraft carrier at night to evaluate aircraft handling qualities in this critical tracking task, and a V/STOL assault transport simulation used to tailor aircraft dynamics, control feel system characteristics and flying qualities over the complete aircraft flight envelope. (Author)

A71-20310 # Wind-tunnel tests of small decelerator stabilizers. William B. Pepper and Harold N. Post (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 120, 121. AEC-supported research.

Discussion of low-speed wind-tunnel tests of small guide surface, slotted solid, ring-slot, cross, and streamer decelerators. Parachute diameters from 1 to 2 ft were used. Decelerator drag force was measured by means of the wind-tunnel balance system, and stability was recorded by cameras. It was found that the guide surface canopy design was the most favorable, having a high-drag efficiency and excellent stability for all sizes tested. It was also seen that the new alternating pocket streamer design is a cheap, reliable method of providing a small drag increment for initial body stabilization. G.R.

A71-20311 # Measurements of particulated gas flow pressure on cascade nozzles. W. Tabakoff and M. F. Hussein (Cincinnati, University, Cincinnati, Ohio). (*American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 6th, San Diego, Calif., June 15-19, 1970, Paper 70-712.*) *Journal of Aircraft*, vol. 8, Feb. 1971, p. 121-123. Grant No. DA-HC-04-69-C-0016.

An approximate method for calculating the flow properties of gas-particle mixture flowing over blades in a cascade is developed. The momentum and heat transfer between the gas and particles as well as compressibility effects are taken into consideration. The effect of particle concentration, mean diameter, particle material density, particle inlet velocity and temperature on the gas particle flow properties are investigated. The flow pressure distribution on the blade surface and the particle velocities and trajectories in the nozzle are determined experimentally. The experiments are performed in a wind tunnel and in a water table. The solid particle sizes range from 5 to 1000 microns and the particle concentration range from 0.03 to 0.2. (Author)

A71-20312 # A correction for compressible subsonic planar flow. Helge Nørstrud (Lockheed-Georgia Co., Marietta, Ga.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 123-125. 13 refs.

Discussion of an improvement over the Prandtl-Glauert rule for high subsonic speeds. It is pointed out that the one-dimensionality of the Prandtl-Glauert correction formula precludes a correct prediction of the pressure distribution at these speeds. A compressibility correction formula is given which is essentially a relationship between local variables, but which can be understood as being able to include some global effects. The compressibility correction presented yields reduced corrections to the Prandtl-Glauert value at locations of large curvature - e.g., at the nose region. G.R.

A71-20313 # Rapid calculation of inviscid and viscous flow over arbitrary shaped bodies. H. A. Dwyer, E. D. Doss, and A. Goldman (California, University, Davis, Calif.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 125-127. 9 refs.

It is shown how the high Reynolds number viscous and inviscid flow over arbitrary shaped two-dimensional bodies, particularly airfoils, can be calculated very rapidly and exactly with a modern digital computer. A numerical solution of the potential flow equations by a general method developed by Theodorsen and Garrick (1933) and a finite difference solution of the boundary-layer equations near the body surface up to the point of flow separation are considered. These two methods are combined into one computer program which can calculate the potential and boundary-layer flow over the body in a matter of seconds on the digital computer. G.R.

A71-20314 # Ratio of turbulent flight miles to total flight miles in the altitude range 45,000-65,000 ft. Edward V. Ashburn and David E. Waco (Lockheed-California Co., Burbank, Calif.). *Journal of Aircraft*, vol. 8, Feb. 1971, p. 127, 128. Contract No. AF 33(615)-69-C-1552.

Evaluation of data obtained during the High Altitude Clear Air Turbulence (HICAT) program reported by Crooks et al. (1967) taking into consideration adjustments made to correct for the effects of repeated flights through the turbulent regions. The ratios of turbulent flight miles to total flight miles for the HICAT sample are listed, and a subjective estimate of representative values of percentage of flight miles expected to be turbulent is presented. Based on data from more than 200 flights the percentage of flight miles that were turbulent is found to increase with underlying terrain roughness, decrease with altitude, and display a maximum in the winter and spring. G.R.

A71-20340 A strapdown magnetic azimuth detector. W. A. Shapiro (Bendix Corp., Navigation and Control Div., Teterboro, N.J.) and C. E. Roemer. *Navigation*, vol. 17, Winter 1970-1971, p. 370-374.

A system is described in which a strapdown 3-sensor magnetometer is used in conjunction with an inertial reference (such as a vertical gyro), to provide an indication of magnetic heading independent of aircraft attitude. The system eliminates the need for stable or pendulous mountings such as were used with previous azimuth detectors. (Author)

A71-20343 Man's future role as an aircraft navigator. Carl S. Hoffman and John J. Czaja (North American Rockwell Corp., Autonetics Div., Anaheim, Calif.). (*Institute of Navigation, Annual Meeting, 25th, Colorado Springs, Colo., July 1, 2, 1970.*) *Navigation*, vol. 17, Winter 1970-1971, p. 404-411.

This paper explores the role of man as a navigator in commercial and military aircraft. Performance of the crew's functions is considered in terms of the increasing stringency of requirements and the growing availability of navigation aids. These aids include sensors, information processing methods, and displays. The navigation task

and some of the advanced means used in its performance are discussed for the environments of long-range flight, terminal areas, and specialized military missions. An evolutionary development has occurred during the past generation with respect to commercial and military requirements, technology, and the crew's navigation functions. This development can be expected to continue into the future. (Author)

A71-20344 Man-machine considerations in system design for all-weather, low-level navigation. G. V. S. Raju and D. L. Horowitz (Ohio University, Athens, Ohio). (*Institute of Navigation, Annual Meeting, 25th, Colorado Springs, Colo., July 1, 2, 1970.*) *Navigation*, vol. 17, Winter 1970-1971, p. 412-418. 5 refs. DOD-supported research.

This paper is concerned with man-machine considerations in system design for low-level navigation. In particular, computer generation of command information and visual display presentation are described. Simulated results are presented which indicate that the pilot's ability to fly on a given route is improved with the roll command display. (Author)

A71-20346 The role of man in Aerospace Defense Command navigation. Richard M. Shute (USAF, Aerospace Defense Command, Ent AFB, Colo.). (*Institute of Navigation, Annual Meeting, 25th, Colorado Springs, Colo., July 1, 2, 1970.*) *Navigation*, vol. 17, Winter 1970-1971, p. 422-425.

Navigation and man play indispensable roles in the successful mission accomplishment of the Aerospace Defense Command. As new defensive systems are acquired to counter the threat, man's identity will be greatly changed. Regardless of this change, man will not be replaced by the machine and will continue to make viable contributions in the modernized aerospace defense force. (Author)

A71-20347 Inertial systems and area navigation in the U.S. domestic airspace. Joseph M. Del Balzo (FAA, Systems Research and Development Service, Washington, D.C.). (*Institute of Navigation, Annual Meeting, 25th, Colorado Springs, Colo., July 1, 2, 1970.*) *Navigation*, vol. 17, Winter 1970-1971, p. 426-431. 6 refs.

Inertial navigation systems are being adopted by air carriers for application on long-range oceanic routes and their existence in cockpits in increasing numbers warrants attention to their possible application during enroute and terminal, domestic operations. This paper discusses performance requirements for airborne area navigation systems as proposed in FAA Advisory Circular 90-45 and projects these performance requirements through 1995. The application of an INS with position updating from conventional ground referenced navigation aids to meet these present and forecasted performance requirements are assessed and the effects on pilot workload are discussed. Also included in this paper is a brief description of a planned flight evaluation to assess the effects of an integrated Inertial/DME-DME/Map Display area navigation system on aircraft navigation performance and pilot workload. (Author)

A71-20355 The latest airport lighting facilities. Osamu Sato, Kaiji Ishiguro, and Masami Kishimoto (Tokyo Shibaura Electric Co., Ltd., Tokyo, Japan). *Toshiba Review*, Jan. 1971, p. 36-41.

Discussion of the present status of airport lighting facilities, with particular emphasis on the situation in Japan, and on the various lighting fixtures lately developed or expected to be developed to be employed for airport lighting. Several types of marker lights and obstruction lights, and an apron floodlight are described. Examples of some recent major deliveries of airport lighting facilities to Japanese airports are reviewed. Notable future trends in the development of airport lighting facilities are outlined. O.H.

A71-20364 On the transverse and torsional vibrations of a fuselage-wing combination with wing-tip fuel tanks. C. Y. Lee and L. C. Jean. *Astronautical Society of the Republic of China, Transactions*, Nov. 1, 1970, p. 1-23. 7 refs.

Calculation of the mass matrix and the stiffness matrix for the equivalent elastic beam which represents the half-span wing with half-fuselage mass attached at one end and the tip tank mass at the other. The natural frequencies and the corresponding mode shapes for the combined transverse and torsional vibrations are then found. The fuel in the wing-tip tank is replaced by an equivalent pendulum with its pivot moving at the dominant frequency. Stability of the pendulum swing is then analyzed using the Floquet theory for Mathieu equations. F.R.L.

A71-20369 Analysis of nonlinear control systems with transport lag. Y. K. Chen, K. W. Han, and G. J. Thaler (Chung Shan Institute of Science and Technology; Chiao Tung University, Nationalist China). *Astronautical Society of the Republic of China, Transactions*, Nov. 1, 1970, p. 81-93. 5 refs.

Formulation of the parameter plane equations for a nonlinear system with transport lag, followed by demonstration that the imaginary axis of the s-plane can be mapped onto the parameter plane through these equations. The method is applied to a system with transport lag and one nonlinearity and also to a system with transport lag and hysteretic nonlinearity. In both cases the existence and characteristics of limit cycles are studied. The method is applied to an aircraft pitch control system, with both transport lag and hysteretic nonlinearity. F.R.L.

A71-20373 * # Problem areas for lift fan propulsion for civil VTOL transports. S. Lieblein (NASA, Lewis Research Center, Cleveland, Ohio). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on VTOL Propulsion, Munich, West Germany, Oct. 22, 23, 1970, Paper*. 35 p. 45 refs.

Problem areas and requirements involved in the lift fan propulsion system are examined, together with research considerations and approaches aimed at providing design and performance data necessary for a realistic evaluation of the potential applicability of the system for use in VTOL transport aircraft. Propulsion functions and concepts for lift, cruise, transition, attitude control, and their interactions are reviewed, and various methods for driving the lift fan are discussed. The principal features of these methods are examined. Major considerations concerning such installed fan characteristics as thrust, noise, weight and component and system design are presented. Factors in fan transition performance are noted. It is shown that the principle problems are encountered in the following areas: optimum integration of the lift, cruise, control, and transition functions; specific design of the fan stage and selection of its drive system; and fan performance and noise in cross flow. V.P.

A71-20401 National Electronics Conference, Chicago, Ill., December 7-9, 1970, Proceedings. Conference sponsored by the Illinois Institute of Technology, the Institute of Electrical and Electronics Engineers, the Northwestern University, and the University of Illinois. Oak Brook, Ill., National Electronics Conference, Inc. (NEC, Proceedings. Volume 26), 1970. 1050 p. \$10.00.

The topics include engineering in medicine and biology, digital systems and computers, adaptive systems, solid state devices and integrated circuits, and circuit theory. Investigations in electro-acoustics, electromagnetics, optimal control, aerospace electronics, information theory, and consumer electronics are also covered. Studies and developments in the fields of communications, general microwave theory and techniques, communications technology, wire communication, and educational television are reported. An author index and a technical papers index are included. G.R.

A71-20405 An adaptive landing system. W. D. T. Ruxton-Davies and F. D. Powell (Bell Aerospace Co., Buffalo, N.Y.). In: National Electronics Conference, Chicago, Ill., December 7-9, 1970, Proceedings.

Conference sponsored by the Illinois Institute of Technology, the Institute of Electrical and Electronics Engineers, the Northwestern University, and the University of Illinois. Oak Brook, Ill., National Electronics Conference, Inc. (NEC, Proceedings. Volume 26), 1970, p. 130-134.

An investigation was conducted to determine whether the performance of the mathematical model of the entire Automatic Carrier Landing System including nonlinear elements in the aircraft can be significantly improved by use of a linear adaptive Navigation Computer. The effectiveness of the adaptive computer in reducing system errors due to system nonlinearities and noise effects is demonstrated. The results obtained show that the adaptive loop is capable of improving overall system performance. The 'higher derivative' gain signal has proved extremely beneficial in reducing errors arising from system nonlinearities, even though the basic theory assumed a linear system. G.R.

A71-20546 Filament winding an aircraft wing structure David G. Whinery (North American Rockwell Corp., El Segundo, Calif.), C. E. Ady (Aerojet-General Corp., El Monte, Calif.), and C. Tanis (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). Society of Manufacturing Engineers, Technical Paper no. EM 70-406, 1970. 17 p. Members, \$1.50; nonmembers, \$2.00.

Manufacturing methods utilizing unidirectional glass reinforcements were applied to design and fabrication of a demonstration wing section representing the T-2B airplane wing station 115 to tip station 207.5. Basic tools for filament winding evolved from missile case winding practice. A rotating winder was developed for diagonal winding the truss spar tension diagonal members. The skin winding mandrel utilizing retractable steel box-sections and a water soluble sand contoured surface is discussed. Other tools consist of access door molds, honeycomb router guides, and trim fixtures. Achievement of 106 per cent of design ultimate loads during test of the demonstration wing substantiated these manufacturing processes. (Author)

A71-20556 Vortex devices in aircraft fluid systems. A. F. Taylor (Cranfield Institute of Technology, Cranfield, Beds., England). In: British Hydromechanics Research Association, Cranfield Fluidics Conference, 4th, University of Warwick, Coventry, England, March 17-20, 1970, Proceedings. Volume 1.

Edited by T. E. Brock and H. S. Stephens. Cranfield, British Hydromechanics Research Association, 1970, p. B2-21 to B2-32. 6 refs.

Consideration of vortex diodes and valves, which have the major advantage of low pressure drop in the preferred direction of flow, coupled with the ability to significantly reduce the flow or increase the pressure drop. Some possible applications in aircraft fuel and air conditioning systems are mentioned, and in particular the characteristics of various vortex valves are examined, using all possible combinations of flow patterns into and out of the vortex chamber. Experimental results show how, for a large range of both positive and negative control flows, the pressure drop of a vortex valve can be expressed in terms of a simple equation. F.R.L.

A71-20580 The design and construction of a pressure regulator including fluidic elements. C. Pavlin, E. Mace (Société Bertin et Cie., Paris, France), and G. Soviche (Société ERAP, France). In: British Hydromechanics Research Association, Cranfield Fluidics Conference, 4th, University of Warwick, Coventry, England, March 17-20, 1970, Proceedings. Volume 2.

Edited by T. E. Brock and H. S. Stephens. Cranfield, British Hydromechanics Research Association, 1970, p. J1-1 to J1-12.

Description of a pressure regulator which requires a high pressure fluidic proportional chain. Curved wall amplifiers were used. The pressure to be controlled is measured by a Bourdon tube controlling the first amplifier by means of a spoiler displacement. The regulator operates in a direct or inverse proportional way. Alternatively, a snap action may be obtained by switching a monostable into the chain. The gain, the set point, the proportional, or the snap action can be separately adjusted. Laboratory and field natural gas test results are given. F.R.L.

A71-20586 Fluidic sensors for measuring engine pressure ratio and turbine inlet temperature. M. P. Bland (McDonnell Aircraft Co., St. Louis, Mo.). In: British Hydromechanics Research Association, Cranfield Fluidics Conference, 4th, University of Warwick, Coventry, England, March 17-20, 1970, Proceedings. Volume 2. Edited by T. E. Brock and H. S. Stephens.

Cranfield, British Hydromechanics Research Association, 1970, p. L4-49 to L4-64. 10 refs.

A comparative study was conducted to determine the feasibility of using fluidic sensors for the measurement of engine pressure ratio and turbine inlet temperature on a new, high performance, fighter aircraft design. The performance of many recognized fluidic sensor concepts are compared, based on previous and current laboratory tests performed on many types of fluidic components. The most promising fluidic concepts are compared with conventional force balance type, engine pressure ratio sensors and thermocouples for measurement of turbine inlet temperature. The results of this study indicate that there are fluidic techniques for sensing engine pressure ratio and turbine inlet temperature which may offer some advantages over conventional methods. However, considerable development is still necessary before these sensors become production flightworthy hardware. (Author)

A71-20587 Development of a fluidic pressure ratio control unit for a vertical take-off aircraft lift engine. D. C. Cheffy (Plessey Co., Ltd., Ilford Essex, England). In: British Hydromechanics Research Association, Cranfield Fluidics Conference, 4th, University of Warwick, Coventry, England, March 17-20, 1970, Proceedings. Volume 2. Edited by T. E. Brock and H. S. Stephens. Cranfield, British Hydromechanics Research Association, 1970, p. L5-65 to L5-75.

Description of the pneumatic pressure ratio control unit, which limits the fuel flow of the Rolls Royce RB162-81 lift engine to prevent engine operation above a specified pressure ratio. The unit was designed to replace an existing mechanical device within the fuel system. The background and history of the project are outlined. The stages of testing and developing the breadboard circuit, the initial test bed unit, and the final flight standard are reported in some detail. F.R.L.

A71-20624 # Performances of cascade of blades with small aspect ratio. I - Performances at the center of blade span. Shintaro Otsuka and Showgo Hayashi (Nagoya University, Nagoya, Japan). (*Japan Society for Aeronautical and Space Sciences, Journal*, vol. 18, May 1970, p. 178-184.) *Nagoya University, Faculty of Engineering*.

Experimental study, at the center of blade span, of the performance of low aspect ratio (AR) compressor blades in cascade. All blades had the same span (50 mm), and their AR's were 2.08, 1.39, 1.04, and 0.83. Stagger angle (alpha) was varied from 0 to 60 deg, and the angle of attack (alpha sub i) from 0 to 15 deg. Results show that the total pressure loss coefficient has a minimum value at an AR about equal to 1, irrespective of alpha and alpha sub i. At alpha sub i over about 5 deg the turning angle increases, and at alpha sub i = 0 it decreases gradually with increasing AR. In the case where alpha = 30 deg, it keeps an almost constant value, irrespective of AR, at alpha sub i = a constant. In cases of alpha = 50 and 60 deg, it increases when alpha sub i equals or exceeds 5 to 10 deg with increasing AR. F.R.L.

A71-20674 # Fundamentals of aircraft engine design (Osnovy konstruktivii aviatsionnykh dvigatelei). E. L. Fel'dman, G. I. Danileiko, and L. N. Kapustin. Moscow, Izdatel'stvo Transport, 1970. 272 p. 6 refs. In Russian.

General problems of gas-turbine engine design are discussed. Structural schemes for the design of such engines are analyzed, and the functioning, construction, and conditions of operation of units, assemblies, and systems are described, as well as the loads to which these components are subjected and the materials of which they are composed. The requirements which structural components and systems must satisfy are outlined, and some very simple strength calculations are performed. A detailed analysis is made of the functioning and design of inlet devices, compressors, combustion chambers, turbines, outlet and reversing devices, rotors and their bearings, reducers, lubrication systems, fuel systems, automatic control systems, and starting systems. The design of piston-driven engines is considered. A.B.K.

A71-20683 VFR at bad weather - What is to be taken into consideration. II - Radio navigation and radio-telephone communication (VFR bei Schlechtwetter - Was gibt es zu beachten. II - Funknavigation und Funksprechverkehr). Max Körte. *Deutscher Aerokurier*, vol. 15, Jan. 1971, p. 10, 11. In German.

The need for a stricter separation of IFR and VFR traffic in connection with the introduction of commercial aircraft of greater velocity is considered. Aspects of orientation during a hypothetical flight between two locations in times of bad weather are discussed. It is assumed that the aircraft is equipped with a radio compass and VOR. Some concrete examples are given how this equipment can be used as a navigational aid during the hypothetical flight taking into consideration the VOR stations located in the area covered by the flight. The utilization of VOLMETS during bad weather is recommended, and the advantages of taking into account warnings transmitted by some stations regarding the occurrence of thunderstorms, hail, high wind velocity, and fronts are discussed. G.R.

A71-20684 Aeronautical electronics for pilots of gliders and touring aircraft. I (Luftfahrt-Elektronik für Segel- und Reiseflieger. I). Hans Helmut Mögling. *Deutscher Aerokurier*, vol. 15, Jan. 1971, p. 12, 14-16. In German.

The importance of aviation electronic equipment for questions of safety in aeronautical operations is examined. Equipment for radio-telephone communication for gliders is considered. Vhf radio equipment requirements for aircraft are examined and vhf equipment manufactured by a number of U.S., German, and French companies is described. Other equipment discussed includes NAV/COM installations and VOR-navigation receivers. G.R.

A71-20685 The art of centering (Über die Kunst des Zentrierens). Max Haubenhofer. *Deutscher Aerokurier*, vol. 15, Jan. 1971, p. 26-28. In German.

It is pointed out that the angle of attack and the force exerted by the air on the aircraft become larger when an aircraft enters an ascending current. The opposite effects are observed when the aircraft enters a descending current. Motions in an ascending current are analyzed taking into consideration effects on an aircraft which enters it. Variometer designs are described, and the correct use of a variometer as an aid for the pilot of a glider is discussed. A number of flight situations are examined giving attention to impressions as perceived by the pilot, his reactions, and possible operational mistakes. G.R.

A71-20686 Günter Cichon... conducts a test with Diamant 18 (Günter Cichon... testet den Diamant 18). Günter Cichon. *Deutscher Aerokurier*, vol. 15, Jan. 1971, p. 29-31. In German.

Test conditions are examined, and takeoff operations are described. The behavior of the glider during the flight at a low velocity, during stalling and spinning is reported. The effect of velocities up to 240 km/hr is investigated. The effectiveness of the control surfaces is considered, and questions of stability are explored. Details of glider design are presented taking into consideration the cockpit and its equipment. The materials used in the construction of the glider are described. G.R.

A71-20747 # **Damage to structures due to floor shocks.** Nelson M. Isada (New York, State University, Buffalo, N.Y.). *American Society of Civil Engineers, Structural Division, Journal*, vol. 97, Feb. 1971, p. 561-572. PHS Grant No. EC-00287.

Study of the factors affecting impending damage and structural failure in bent-type structures due to pulse-type floor acceleration shocks, such as damage to aircraft seats during crash landing. The governing equations are formulated, time-history solutions are determined and critical structural isodamage curves developed. Some of the conclusions reached relate the dynamic responses of structures to such factors as the quasi-static ultimate strength characteristic of the structure, the natural frequency of the structure, and duration of the floor acceleration. Recommendations are made for further research. M.V.E.

A71-20750 # **Practical aerodynamics of the Iak-40 aircraft (Prakticheskaja aerodinamika samoleta Iak-40).** L. E. Bogoslavskii. Moscow, Izdatel'stvo Transport, 1970. 176 p. In Russian.

The design and aerodynamic features of the Iak-40 passenger aircraft are discussed, as well as its flight-engineering characteristics. Problems concerning piloting techniques are considered, and specific recommendations are made on how to carry out flights under various conditions. Information is presented concerning the centering of the aircraft; its equilibrium, stability, and controllability; flights in special cases; and piloting the aircraft during engine failure and in turbulent air. Certain theorems of flight theory are reviewed which make it easier to study problems of practical aerodynamics and flight operation. A.B.K.

A71-20776 # **Lifting properties of some configurations according to the slender body theory (Nesushchie svoistva nekotorykh konfiguratsii po teorii tonkogo tela).** A. G. Sakhno and V. I. Kholiavko. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 3-10. 5 refs. In Russian.

The aerodynamic characteristics of conical and pyramidal configurations of various planforms are analyzed within the framework of slender body theory in which the three-dimensional flow at incidence past a slender body is replaced by the two-dimensional flow in a plane perpendicular either to the velocity vector of the oncoming flow or to the longitudinal axis of the body. The influence of the cross sectional shape and of such geometrical parameters as relative thickness and camber on the lifting characteristics of these bodies is assessed. The formulas derived are applicable also to non-slender bodies. V.P.

A71-20777 # **Approximate theoretical model of a wing with suction and blowing (Priblizhennaja teoreticheskaja model' struinogo i ezhektornogo kryla).** V. M. Suprun. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 11-17. In Russian.

The potential flow past a cylinder with singularities in the form of sources and sinks is analyzed. The results of the analysis are used to construct an approximate theoretical model for a wing with suction of the upper surface and blowing at the lower surface near the trailing edge. Formulas are derived for calculating the aerodynamic characteristics of wings of infinite span with boundary layer control and formulas for determining steady horizontal flight parameters as a function of the thrust-weight ratio and wing loading. V.P.

A71-20778 # **Nonstationary aperiodic motion of a lifting surface in an incompressible fluid (Zadacha o nestatsionarnom aperiodicheskom dvizhenii nesushchei poverkhnosti v neszhimaemoj zhidkosti).** A. N. Panchenkov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 18-26. 10 refs. In Russian.

An asymptotic method for solving problems of the nonstationary aperiodic motion of a lifting surface is developed. The method is based on the idea of Panchenkov's (1965) method of function parameters and its version - the 'small-time space method' (Panchenkov, 1969) for solving problems associated with nonstationary processes. The ideal of the method of functional parameters is based on mapping a parametric space into a new space enclosed within a certain interval. The asymptotic method proposed makes use of an algorithm for the direct solution of the uniformly-correct Cauchy problem for a linear differential equation in small-time space. V.P.

A71-20779 # **Method of determining the optimum minimum-noise take-off profile of an aircraft (Metod opredelenia optimal'nogo profilja vzleta samoleta s minimal'nym shumom na mestnosti).** K. G. Valeev, B. N. Mel'nikov, V. I. Tokarev, and I. P. Shmakov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 27-31. In Russian.

The various aspects of selecting the optimum minimum noise take-off profile are considered on the basis of a rigorous formulation of the problem. The amount of acoustic energy imparted to a point on the earth's surface during a certain time is taken as the noise criterion. The problem is reduced to obtaining a solution of the system of equations of motion of a jet aircraft, which would minimize the noise criterion. It is shown that such a solution can be obtained with the aid of methods in the theory of optimal processes. V.P.

A71-20780 # **Mathematical model of nonstationary gas motion in internal combustion engines (Matematicheskaja model' nestatsionarnogo gazoobmena v dvigateliakh vnutrennego sgoraniia).** D. A. Munshukov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 32-40. 5 refs. In Russian.

A model describing the motion of the intake and exhaust gas in the cylinders of a two-cycle internal combustion engine. The characteristic parameters of the processes occurring in a cylinder are determined. Systems of equations describing the correlated motions of the medium in the cylinders and in the intake and exhaust manifolds are derived. V.P.

A71-20781 # **Methodology of the experimental investigation of the influence of water supplied to the inlet of a centrifugal compressor on the compressor parameters (K metodike eksperimental'nogo issledovaniia vliianiia vody, podavaemoi na vkhode v tsentrobezhnyi kompressor, na ego parametry).** A. S. Moskalenko and N. L. Zel'des. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 41-48. 6 refs. In Russian.

Existing methods of cooling the precompressed inlet air of a diesel engine are analyzed. The advantages of evaporation cooling, involving the injection of water into the suction duct are pointed out. The influence of water injection on the operation of the compression system of a turbocharged diesel engine is studied theoretically and experimentally. The facility, procedure, and data processing techniques employed in the experiments are described. V.P.

A71-20782 # **Influence of air temperature on the intake process of internal combustion engines (Vliianie temperatury vozdukh na protsess vpuska dvigatelei vnutrennego sgoraniia).** B. Kh. Draganov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 49-55. In Russian.

An experimental investigation of the degree to which the air temperature influences the generalized characteristics of the intake

process of internal combustion engines is described. The SMD-14N and the YaMZ-236 engines were tested. The experimental data were processed in dimensionless coordinates with the aid of methods in similarity theory. The results are used to derive generalized relations for calculating the principal parameters of the intake process. V.P.

A71-20787 # Analysis of aircraft radio-compass error (Analiz oshibki samoletnogo radiokompasa). E. O. Brudnyi, L. Ia. Il'nitskii, and V. I. Baklaikin. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 71-77. In Russian.

Problems associated with increasing the precision of aircraft radio compass operation at moderate wavelengths are examined. Radio compass errors owing to inclinations of the loop antenna axis during such maneuvers as banking, diving, or pitch-up are studied theoretically and experimentally. The influence of radio compass error on the accuracy of air navigation is analyzed. V.P.

A71-20792 # Evaluation of the precision of executing the outside contours of units with allowance for the elastic characteristics of the elements assembled and equipment (K otsenke tochnosti vypolneniia naruzhnykh obvodov agregatov s uchedom uprugikh kharakteristik sobiraemykh detalei i osnastki). Iu. A. Boborykin, A. N. Bereziuk, V. V. Knigin, and N. M. Parkhomenko. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 109-112. In Russian.

The selection of the method of assembling aircraft systems is discussed with allowance for the rigidity of the components and its influence on the redistribution of errors in the application of external and internal force fields during the assembly process. It is shown that by taking into account the rigidity of the elements assembled in the relations describing the assembly process, it is possible to evaluate the limits of applicability of the various assembly methods. V.P.

A71-20793 # Service life of bearing elements of aircraft gear pumps (O sroke sluzhby podshpnikovyykh uzlov aviatsionnykh shesterenchatykh nasosov). N. P. Artemenko, I. L. Vinokurov, Iu. I. Voloshin, and L. M. Fel'dman. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 113-116. In Russian.

Design and technological means of increasing the service life of gear-pump bearing elements. Approximate quantitative estimates on the influence of errors in the principal circular pitch/spacing ratio on the service life of aircraft gear pumps are obtained. It is shown that the service life of the bearing elements and the pump itself can be increased by limiting the circular pitch/spacing error to 8 to 10 microns, by diminishing the spacing to 18 to 35 microns, and by strictly holding to the geometrical, dimensional, and hardness specifications. V.P.

A71-20797 # Investigation of the influence of operating conditions on the mean flight time between overhauls (Issledovanie vlianiia uslovii ekspluatatsii samoletov na velichinu ikh srednego mezhremontnogo naleta). L. E. Talianker. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 21, 1970, p. 148-156. In Russian.

Overhaul schedules of civil aviation aircraft are established along prescribed standards but also with consideration to the operational state of the aircraft. It is proposed to evaluate the influence of these conditions on the magnitude of the mean time between overhauls on the basis of statistical hypotheses concerning the agreement between estimated times between overhauls and estimated values of the characteristic parameter of the operational state of the aircraft. A procedure of testing the statistical hypotheses on the basis of the Kolmogorov-Smirnov criterion is proposed. V.P.

A71-20802 Towards a unified system of noise assessment.

D. W. Robinson (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). (*British Acoustical Society, Meeting on Community Noise Criteria, Loughborough University of Technology, Loughborough, Leics., England, July 23, 1970.*) *Journal of Sound and Vibration*, vol. 14, Feb. 8, 1971, p. 279-298. 15 refs.

Different indices are in current use for expressing the nuisance value of successions of noises, according to the type of noise. It is shown that a single index, termed noise pollution level, accommodates the experimental results of surveys of aircraft and of motor vehicle noise. The same formula satisfactorily explains the results of laboratory tests in which noise intensity is traded against duration to maintain equal impressions of objectionableness. The index is based on two terms, one representing the equivalent continuous noise level on the energy basis, and the other representing the augmentation of annoyance when fluctuations of noise level occur. Practical and theoretical implications of the index are discussed. (Author)

A71-20828 # Eddy flow of an ideal incompressible fluid past a flat partition (Obtekanie ploskogo zabora vikhrevym potokom ideal'noi neszhimaemoi zhidkosti). V. I. Kholiavko. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 22, 1970, p. 9-13. In Russian.

Investigation of a continuous flow past a plate located perpendicular to a wall along which an inviscid incompressible fluid with a linear variation of velocity with height is moving. The problem consists in solving the Poisson equation for the stream function for the case where this function is equal to zero on the wall and on the plate. A solution is obtained in finite form. The critical points in the flow are determined, and the behavior of the streamlines at these points is investigated. The results of a calculation of the pressure distribution on the wall for various values of the vorticity parameter are presented. A.B.K.

A71-20831 # Study of a 2500-HP turboprop engine as a plant for controlling the gas temperature in front of the turbine (Issledovanie turbovintovogo dvigatel'ia moshchnost'iu 2500 l. s. kak ob'ekta regulirovaniia temperatury gazov pered turbinoi). A. K. Ipatov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 22, 1970, p. 24-32. In Russian.

Derivation of an equation describing the operation of a turboprop engine with a high-pressure compressor as a plant for controlling the gas temperature in front of the turbine. Formulas for calculating the dynamic coefficients of the equation are obtained. Methods of determining each coefficient are briefly outlined, and the results of the calculations are presented in the form of graphs of the dependences of the dynamic coefficients on the operating mode of the engine at various flight altitudes and speeds. A.B.K.

A71-20832 # An experimental arrangement for studying the delay time in the components of the propeller/rpm controller system of a turboprop engine (Eksperimental'naia ustanovlia dlia issledovaniia vremeni zapazyvaniia v elementakh sistemy vint-regulator chisla oborotov turbovintovogo dvigatel'ia). P. P. Minin and A. K. Ipatov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 22, 1970, p. 33-38. In Russian.

Description of an experimental arrangement which makes it possible to study the absolute values of the delay times in the propeller/rpm controller system as a whole and to ascertain the effect of various factors on the delay time. In the arrangement described an rpm controller head of original design is employed, as well as special sensors for measuring displacements of the sensing element slide valve and the angle of rotation of the blades. A.B.K.

A71-20836 # Determination of the optimal parameters of agents for protecting the compartments of a flight vehicle from aerodynamic heating during long flights at high flight speeds

(Opredelenie optimal'nykh parametrov sredstv zashchity ot aerodinamicheskogo nagreva otketov letatel'nogo apparata pri bol'shoi skorosti i prodolzhitel'nosti poleta). F. G. Iasinskii and A. A. Kobyl'skii. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 22, 1970, p. 61-69. In Russian.

Description of a method of determining the optimal weight of the outer and inner heat-protection layers of a stressed skin and the optimal efficiency of a cooling system for a compartment of a flight vehicle traveling at a high speed (at Mach numbers greater than 5) during a flight lasting several hours. The temperature of the stressed skin is assumed to be given. The density of the outer and inner layers of the thermal insulator is assumed to be temperature-dependent, while a linear temperature dependence is assumed for the thermal conductivity. Radiation from the outer surface of the high-temperature thermal insulator is taken into account. The problem is reduced to a determination of the relative extremum of a function of three variables with the aid of Lagrange multipliers. When a ready-made solution is used for the heat balance equation on the outer surface of the heat insulator, solutions for the optimal thicknesses of the heat-protection layers and the optimal efficiency of the cooling system are obtained in closed form. A.B.K.

A71-20839 # A gasdynamic stand for testing materials and structural elements for their resistance to cyclic thermal loading (Gazodinamicheskii stand dlia ispytaniia materialov i konstruktivnykh elementov na soprotivliaemost' tsiklicheskomu teplovomu vozdeistviu). L. P. Lozitskii, V. A. Konev, B. Ia. Kudsiashov, V. F. Lapshov, and N. A. Snegirev. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 22, 1970, p. 81-87. In Russian.

Description of a gasdynamic stand which makes it possible to test various structural elements of the hot part of a gas-turbine engine, as well as materials specimens, for their resistance to cyclic thermal loading at various heating and cooling rates in a wide range of thermal cycling with and without the application of mechanical loads. The proposed stand, constructed on the basis of a turboprop engine, uses a series-produced turbojet engine as the compressed-air generator. It is distinguished from other such devices in that the maintenance of real gas-air flow parameters is ensured, the lower limit of temperature thermal cycling is reduced to 0 to 10 C, and the number of turbine nozzle and working blades or materials specimens that can be tested simultaneously is increased to 50 to 60 units. A.B.K.

A71-20843 # Restoration of the working blades of compressors by vibrational tumbling (Vosstanovlenie rabochikh lopatok kompressorov vibrogaltovkoi). E. Ia. Korenevskii and V. K. Iatsenko. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 22, 1970, p. 121-125. In Russian.

Consideration of the problem of improving the surface finish and restoring the fatigue strength of axial compressor blades during regular overhauls of engines by means of vibrational tumbling. It is shown that the fatigue strength of blades made of 1Kh17N2 steel is increased by vibrational tumbling. Positive results were also obtained in restoring compressor blades made of 13Kh14NVFRA steel. It is concluded that the restoration of compressor blades by vibrational tumbling is much more effective and economically more feasible than mechanical manual polishing. A.B.K.

A71-20867 * Smoke emission from jet engines. Lawrence H. Linden and John B. Heywood (MIT, Cambridge, Mass.). *Combustion Science and Technology*, vol. 2, Jan. 1971, p. 401-411. 42 refs. Grant No. NGR-22-009-378.

The fundamental processes determining the amount of smoke in the exhaust of a gas turbine engine are examined. First, the configuration of modern combustors and the state of knowledge of the processes occurring within the combustor are reviewed. Data from laboratory flame studies of carbon formation are then discussed

and correlated with engine and combustor exhaust studies. It is seen that solid carbon is the nonequilibrium product of fuel vapor-air combustion in locally fuel rich zones. Calculations of carbon oxidation rates are then used to show that significant fractions of the carbon formed in the rich regions of the primary zone may be consumed in the leaner regions of the primary zone and in the secondary zone. Finally, combustor design features desirable for minimal exhaust smoke are summarized, and areas where further research would be most beneficial are identified. (Author)

A71-20917 Mechanical properties of high-performance plastics composites. J. D. Ray (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *Plastics Institute, International Conference on Carbon Fibres, their Composites and Applications, London, England, Feb. 2-4, 1971, Paper 29*. 14 p. 7 refs. \$24. per set of 49.

The high-performance composites are characterized as to the strength and moduli in tension, compression, flexure, and shear. Two processes used for boron-epoxy resin system composites are described, and the properties of these composites are summarized. The mechanical properties of composites reinforced by surface-treated and untreated silicon carbide fibers are presented. It is shown that certain filament treatments have a marked effect on the resulting mechanical properties. Three types of beryllium composites were fabricated and mechanically tested. The properties obtained are discussed in comparison to those of other composites. The average longitudinal properties of unidirectional graphite/epoxy composites are tabulated for different types of fibers. The future of these composites as high-performance aerospace materials is briefly discussed. Z.W.

A71-20929 Carbon-fibre aircraft structures - Some cost aspects. J. Fray (Hawker Siddeley Aviation, Ltd., Stockport, Ches., England). *Plastics Institute, International Conference on Carbon Fibres, their Composites and Applications, London, England, Feb. 2-4, 1971, Paper 46*. 5 p. \$24. per set of 49.

Study of the likely influence of material cost on the future utilization of carbon-fiber reinforced composites in aircraft structures. It is shown that an aircraft structure manufactured from conventional metals can, in general, be made lighter by redesigning it in carbon-fiber reinforced composites. While weight saving is very important, it is always necessary to limit expenditure on weight saving to what can be justified economically for the particular aircraft. The actual figure usually falls within the range of 10 pounds sterling per one pound of weight for the smaller conventional aircraft to 100 pounds per one pound for sophisticated high-speed aircraft. At the present time it costs between 60 to 330 pounds to save one pound of structure weight by using carbon-fiber composites, but if the price of fiber falls as is expected, the corresponding figures in 1975 will be 15 and 80 pounds. Thus, if the material is satisfactory technically the market for carbon fiber in aviation should become quite large. Z.W.

A71-21022 # Arrangement of manometric equipment on an oriented satellite (Ob ustanovke manometricheskoi apparatury na orientirovannom sputnike). V. A. Shabokhin, V. F. Kameko, V. M. Kovtunenka, E. P. Iaskevich, and N. V. Dzhordzhio. *Kosmicheskie Issledovaniia*, vol. 9, Jan.-Feb. 1971, p. 151, 152. In Russian.

Manometric measurements taken by equipment set up in the nose section of Cosmos 149 and Cosmos 320 spacecraft which were stabilized with respect to the velocity vector by an aerodynamic system. Results for the number of particles passing in unit time through a unit area of the sensor's inlet opening show that a plus or minus 15 deg variation in angle of attack causes only 3.5% error, which is covered by the instrumental errors. T.M.

A71-21049 **Flight operations to minimize noise.** Dennis R. Halwes (Bell Helicopter Co., Fort Worth, Tex.). (American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings.) *VertiFlite*, vol. 17, Feb. 1971, p. 4-9. 5 refs.

Certain helicopter operating conditions are known to produce higher noise levels than others. Flight test evaluations of various size helicopters are being made to determine which flight conditions cause the higher noise levels. The initial results of these tests have been used to define flight techniques which permit the pilot to avoid generating excessive noise while operating in and out of heliports. With these techniques an operator would be able to use heliports in many areas without violating city noise codes. Test results show that when the helicopter operates without blade slap, the altitude necessary to avoid exceeding noise code limits is one half the altitude necessary with blade slap. If the helicopter flies at the same altitude, the use of quieter operating techniques can reduce the ground area exposed to the same noise level by as much as 75%, and can reduce the required distance between a heliport and a noise-sensitive area boundary line by 50%. These reductions in noise exposure result in greater use of the helicopter's unique capabilities without exposing noise sensitive areas to high noise levels. (Author)

A71-21097 **Cell and battery case materials, cell sealing techniques for sealed silver-zinc batteries.** A. M. Chreitzberg (ESB, Inc., Raleigh, N.C.). In: Zinc-silver oxide batteries; Electrochemical Society, Fall Meeting, Symposium, Montreal, Canada, October 6-11, 1968, Proceedings. Symposium co-sponsored by the U.S. Air Force Aero Propulsion Laboratory. Edited by Arthur Fleischer and J. J. Lander. New York, John Wiley and Sons, Inc., 1971, p. 313-319.

Review of the case-cover materials for sealed Zn/KOH/AgO cells and batteries, as well as the cell sealing techniques, developed in the period 1960 to 1968 for Ranger, Mariner, and Surveyor space missions. Typical material characteristics are given, and cell jar material, capacity size, and burst pressures typical of different flight cells are summarized. Examples illustrating several sealing techniques are presented. O.H.

A71-21102 **Applications of zinc-silver oxide batteries.** Paul L. Howard. In: Zinc-silver oxide batteries; Electrochemical Society, Fall Meeting, Symposium, Montreal, Canada, October 6-11, 1968, Proceedings. Symposium co-sponsored by the U.S. Air Force Aero Propulsion Laboratory. Edited by Arthur Fleischer and J. J. Lander. New York, John Wiley and Sons, Inc., 1971, p. 371-373.

General discussion of the applications made possible by the development of the zinc-silver oxide battery since 1940. The original application of this battery was in the underwater area for use in torpedoes, mines, protective devices, and buoys. Aerial application consists of helicopters, aircraft, target drones, pilotless aircraft, and manned and unmanned stratosphere balloons. For helicopter and aircraft uses, a specially designed medium high-rate long-life cell is used which is comparable in useful life and service to the lead-acid cell. M.M.

A71-21103 **Aircraft zinc-silver oxide batteries.** G. H. Miller (USAF Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and S. F. Schiffer (Yardney Electric Corp., Pawcatuck, Conn.). In: Zinc-silver oxide batteries; Electrochemical Society, Fall Meeting, Symposium, Montreal, Canada, October 6-11, 1968, Proceedings. Symposium co-sponsored by the U.S. Air Force Aero Propulsion Laboratory. Edited by Arthur Fleischer and J. J. Lander. New York, John Wiley and Sons, Inc., 1971, p. 375-391.

Discussion of the service requirements, performance, and merits of zinc-silver oxide batteries used on U.S. military aircraft. An

outline of the characteristics of Air Force and Navy aircraft and of their electrical power systems is followed by a review of aircraft battery requirements and of specific battery design peculiarities. Information is presented on aircraft battery manufacturing and processing, operation and maintenance, as well as on field performance. Special attention is given to factors affecting battery performance, such as operating practices, battery conditions aboard aircraft, and battery limitations. The future prospects of zinc-silver oxide aircraft batteries are assessed. M.V.E.

A71-21115 **Equivalent tests of aircraft engines.** I. N. Shkanov, L. I. Burlakov, A. A. Kovalev, and V. P. Iurikov (Kazanski Aviatsonnyi Institut, Kazan, USSR). (*Problemy Prochnosti*, vol. 1, Dec. 1969, p. 30-34.) *Strength of Materials*, Dec. 1969, p. 596-599. Translation.

Examination of the principal damaging factors affecting the particular elements of an aircraft engine. A testing program is established for entire engine which is equivalent to 3000 hr of a regular stand test. The evaluation obtained by this program is compared with results obtained by regular tests. Z.W.

A71-21162* # **Statistics of the sound field of a source above a rough, imperfectly reflecting surface.** Jay C. Hardin and Thomas J. Brown (NASA, Langley Research Center, Hampton, Va.). *Acoustical Society of America, Annual Meeting, 80th, Houston, Tex., Nov. 3-6, 1970, Paper*. 28 p. 25 refs.

A theoretical analysis of the sound field due to a sinusoidal source located above a rough reflecting surface with variable admittance is developed. Both the elevation and the admittance of the surface are represented by isotropic random processes. The Helmholtz solution is employed with the boundary conditions approximated by the field which would be present on the local tangent plane. This yields a formulation in which contributions to the solution from variations in surface elevation, slopes, and admittance are clearly evident. Moment properties of the field are then obtained in terms of the first order and joint characteristic functions of the surface and the autocorrelation of the admittance. In certain instances, asymptotic expansions of the integrals representing the mean field yield simple formulas involving tabulated functions. The results are of interest in connection with ground effects on aircraft noise measurement. (Author)

A71-21163 **Jet aircraft noise over residential areas.** W. C. Meecham, S. R. Lane, and P. Hurdle (California, University, Los Angeles, Calif.). *Acoustical Society of America, Annual Meeting, 80th, Houston, Tex., Nov. 3-6, 1970, Paper*. 15 p.

Discussion of excessive noise intrusion caused by the flyover of jet aircraft in the densely populated Los Angeles area. Results of several previous noise measurement studies in this area are presented and analyzed. The measurements show that in ten residential communities (at distances of 15 to 30 miles from the airport) the noise levels caused by jet aircraft exceed one hundred times ordinary noise. There are four major approach and departure corridors to the airport with a total number of 500 commercial jet flights every day. Many communities are thus subjected to about 100 excessively noisy flights during the peak traffic hours (about three hours of the day). As a result, thousands of individuals are subjected to excessive noise every two minutes for several hours each day. Almost every flight exceeds the noise levels allowed by the municipal codes on residential noise disturbances. These noise ordinances, however, are not enforced against airlines. Several suggestions are presented to reduce the jet aircraft intrusion. O.H.

A71-21166 # **A station-oriented area navigation system.** J. C. Lumsden and C. A. Muller (Bendix Corp., Avionics Div., Fort Lauderdale, Fla.). *Bendix Technical Journal*, vol. 3, Winter 1970, p.

1-10.

A basic type of VOR/DME-station-oriented area navigation system is described in which horizontal guidance is provided by a special-purpose digital computer solution of the triangle that is defined by ground station, waypoint, and present aircraft position. The objectives of area navigation and its potential advantages are discussed, and attention is given to such system considerations as input/output circuitry, control, storage, signal processing, and guidance equations. (Author)

A71-21167 # The airline collision avoidance program. W. G. Shear (Bendix Corp., Avionics Div., Fort Lauderdale, Fla.). *Bendix Technical Journal*, vol. 3, Winter 1970, p. 11-23. 6 refs.

The history of the evolution of a collision avoidance system is briefly considered, and the basic principles of the Tau concept are examined. Salient aspects of time/frequency technology utilization are investigated. The practical collision avoidance system for aircraft defined by the Air Transport Association is discussed, and details are given regarding a test program for evaluating the compatibility and effectiveness of the equipment considered for the collision avoidance system. The results of the investigations are evaluated giving attention to range-rate accuracy, altitude accuracy, communications reliability, and synchronization. The path to implementation, questions of system integration with air traffic control, and the current design status are discussed. G.R.

A71-21169 # Position-determination systems for urban transit and air traffic control. T. T. Trexler (Bendix Corp., Aerospace Systems Div., Ann Arbor, Mich.). *Bendix Technical Journal*, vol. 3, Winter 1970, p. 35-44.

It is pointed out that the objectives of an automatic vehicle-monitoring system would be to supply independent surveillance information (vehicle identification and location) to a traffic control system, to provide airborne users with area-navigation approach and landing data, and to provide the pilot, vehicle operator, and traffic controller with the real-time information he requires to operate his vehicle. Position-determination requirements for a number of potential system users are investigated. Three potential position-determination system configurations are described including a navigation-satellite-based time difference system, a ground-based time difference system, and a differential time difference system. G.R.

A71-21170 # Digital-filter alignment of strapdown navigators. D. A. Zomick (Bendix Corp., Navigation and Control Div., Teterboro, N.J.). *Bendix Technical Journal*, vol. 3, Winter 1970, p. 45-53. 28 refs.

In vibrating and swaying vehicles, conventional strapdown alignment techniques, such as gravity sensing and gyrocompassing, have limited accuracy and require lengthy alignment times. In this paper, the initial alignment problem is defined and the difficulties are examined. System dynamics are couched in mathematics appropriate to digital filtering, and a number of methods for estimating and correcting the misalignment errors - including Kalman and least-squares filtering - are described and contrasted with respect to accuracy and computational complexity. The analysis and evaluation are kept as general as possible and are supplemented by digital simulation results showing the performance of particular filtering schemes in specific applications. (Author)

A71-21224 Airtruk. J. A. Winterbotham (Transfield Pty., Ltd., Sydney, Australia). *Shell Aviation News*, no. 391, 1971, p. 14-17.

Description of the Transavia Airtruk, which is an attempt to achieve a level of operational efficiency required to make aerial

application an economic proposition. The central feature of the Airtruk's design is the hopper. It has two 23 x 9-in. openings for spreading superphosphate, the openings being separated by an inverted V. A unique safety feature during jettison is derived from dual tails which are clear of the slipstream. The characteristics of the aircraft make possible a very uniform spread. From the viewpoint of both operator and farmer, the effectiveness of this aircraft lies in its work capacity measured in acres per working hour. F.R.L.

A71-21225 Tetra-Core - A three-dimensional space structure. Irving E. Figge, Sr. (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). *Shell Aviation News*, no. 391, 1971, p. 18-24.

Discussion of a new structural material (Tetra-Core), based on the design potential of composite materials and the need for improved structures. Tetra-Core uses unidirectional filamentary composites in a specially oriented space frame structure. This configuration means that the concept has excellent potential for structural applications because it uses the material in its optimum form (unidirectional fibers). Due to the inherent redundancy of the structure, it also offers potential application in areas where fail-safe requirements are high. The basic Tetra-Core elements consist of a series of tetrahedrons which are alternately inverted and placed so that they form continuous planes. F.R.L.

A71-21254 Maintenance of aeronautical charts on a world-wide basis. John B. Moran (USAF, Aeronautical Chart and Information Center, St. Louis, Mo.). In: American Society of Photogrammetry and American Congress on Surveying and Mapping, Technical Conference, Denver, Colo., October 7-10, 1970, Proceedings. Falls Church, Va., American Society of Photogrammetry, 1970, p. 313-323.

The problem of updating and keeping current, a multitude of series of charts of various scales supporting many weapon systems, is explained. The objective of maintaining up-to-date aeronautical charts is expounded and the various phases of effort to accomplish the task are discussed. These phases start with the review of the requirement and its translation into cartographic terms and extend to the printing and distribution of the new chart. The levels of chart evaluation and how these are derived is explained. The author explains the maintenance cycle procedures and demonstrates how a product moves thru the various phases in accord with the continuous review concept. (Author)

A71-21266 # Calculation of losses in the vaneless diffuser of a centrifugal compressor (K raschetu poter' v bezlopatochnom diffuzore tsentrobezhnogo kompressora). N. A. Alemasova. *Kazanskii Aviatsionnyi Institut, Trudy, Seriya Aviatsionnye Dvigateli*, no. 115, 1969, p. 32-40. In Russian.

Discussion of a hydrodynamic model of a flow in a diffuser designed as the basis for theoretical estimation of energy losses in vaneless diffusers of centrifugal compressors. The model was developed by experimental studies of the three-dimensional structure of airflows in such diffusers which indicated the existence of reverse flows at diffuser walls, having a substantial effect on the diffuser performance. Sets of equations are given for the energy balance at the diffuser inlet and outlet for various airflow structures. Expressions for energy losses as functions of the active flow width and of an exponential variable are also derived. V.Z.

A71-21267 # Improvement of multistage turbines in gas turbine engine designs (O ratsionalizatsii rascheta mnogo-stupenchatykh turbin GTD). V. A. Strunkin. *Kazanskii Aviatsionnyi Institut, Trudy, Seriya Aviatsionnye Dvigateli*, no. 115, 1969, p. 41-46. In Russian.

Extension of the author's single stage gas turbine improved designing technique (1969) to the calculation of parameters in multistage gas turbine designs. Expressions and nomograms are given for the translation of the previous results to multistage turbine parameter and component analysis and selection. Optimized turbine-stage, geometrical characteristics, blade and wheel parameters and multistage gas turbine efficiencies can be determined by using these expressions in computer calculations. V.Z.

A71-21300 # Optimization methods for jet-propulsion with respect to exergy. L. Narjes (Indian Institute of Technology, Madras, India). *Aeronautical Society of India, Journal*, vol. 22, Nov. 1970, p. 209-217. 6 refs.

The paper deals with two optimization procedures by introducing the thermodynamic concepts of exergy and anergy. From purely thermodynamic considerations, the first part of the analysis leads to minimum specific fuel consumption or minimum specific exergy loss which corresponds to maximum thermodynamic efficiency. The second takes into account both capital investment and expenses due to exergy need (or fuel consumption) of the unit. This leads to minimum total cost flux or an economically optimum unit. The optimum conditions are achieved by varying the compressor pressure ratio of the unit in both cases. The results calculated on the basis of adiabatic, incomplete combustion from experimental observations on a furnace burning heavy oil used for steam generation are compared with the results of adiabatic and complete combustion in jet engine combustion chambers. (Author)

A71-21301 # Hypersonic airbreathing engines for launching space vehicles. K. A. Damodaran (Indian Institute of Technology, Madras, India). *Aeronautical Society of India, Journal*, vol. 22, Nov. 1970, p. 218-224. 11 refs.

The cost of the present day space transportation is extremely high due to high operational and vehicle costs. Reduction in the overall cost of space exploration programmes appears feasible with a launching system which uses a composite rocket cum airbreathing propulsion unit. By adapting such a system a reduction in operating cost by half to one third of that of the conventional rockets is expected. A further cost reduction can be achieved by making the system fully or partially recoverable. (Author)

A71-21302 # Flutter of simply supported skew panels with mid-plane forces in supersonic flow. Somayajulu Durvasula (Indian Institute of Science, Bangalore, India). *Aeronautical Society of India, Journal*, vol. 22, Nov. 1970, p. 225-234. 28 refs.

Panel flutter of stressed, flat, simply supported skew panels is investigated using the classical small deflection thin plate theory. The two-dimensional 'static approximation' is used to represent the aerodynamic loading. An approximate solution is obtained by using Lagrange's equations representing the deflection surface in terms of double Fourier sine series in oblique coordinates. Results of numerical calculation for the critical dynamic pressure of stressed rhombic panels are presented. The influence of each of the components of orthogonal stress resultants is studied. It is found that the critical dynamic pressure is lowered by the compressive and shear forces. In particular the shear stress is found to significantly lower the critical dynamic pressure as in the case of rectangular panels. (Author)

A71-21305 # Design features and characteristics of the 9 x 6 ft wind tunnel at H.A.L., Bangalore. T. N. Krishnaswamy (Indian Institute of Science, Bangalore, India), Raj Mahindra, S. R. Telang, and K. S. Sudheendra (Hindustan Aeronautics, Ltd., Bangalore,

India). *Aeronautical Society of India, Journal*, vol. 22, Nov. 1970, p. 251-256.

The details of design, construction, instrumentation and calibration of the wind tunnel at H.A.L., commissioned recently, are briefly dealt with, in this report. The wind tunnel is 'Return Circuit' type and has a 9 x 6 ft rectangular test section with chamfered corners. The wind tunnel is driven by a 750 hp electric motor to achieve a speed of 200 mph at the test section. A sting type of model support is provided. A six component strain gauge balance in conjunction with a data logging system is used for force measurements. The flow in the test section is generally satisfactory and the deviations are within tolerable limits. (Author)

A71-21322 * On barriers in a problem of collision avoidance. W. J. Grantham, E. M. Cliff, and T. L. Vincent (Arizona, University, Tucson, Ariz.). In: *Hawaii International Conference on System Sciences*, 4th, University of Hawaii, Honolulu, Hawaii, January 12-14, 1971, Proceedings. Conference sponsored by the University of Hawaii and the U.S. Army. Edited by Shu Lin. North Hollywood, Calif., Western Periodicals Co., 1971, p. 136-138. Grant No. NGR-03-002-011.

A simple dynamical system is used to study the problem of collision avoidance between two aircraft. The barriers separating the regions where capture is possible, for various flight conditions, are determined by solving an optimal control problem for abnormal arcs and similarly for a differential game. (Author)

A71-21335 * System aspects of air traffic control. Michael Athans (MIT, Cambridge, Mass.). In: *Hawaii International Conference on System Sciences*, 4th, University of Hawaii, Honolulu, Hawaii, January 12-14, 1971, Proceedings. Conference sponsored by the University of Hawaii and the U.S. Army. Edited by Shu Lin. North Hollywood, Calif., Western Periodicals Co., 1971, p. 335-337. 6 refs. Grants No. NGL-22-009-124; No. AF AFOSR 69-1724A.

This paper considers the problem of coordinating the traffic flow and holding patterns of N aircraft which desire to land in a single runway. A distance separation is to be enforced over the outer marker. It is shown that this problem can be attacked as a variation of a linear-quadratic optimal control problem. The solution of this optimization problem can be used to indicate which aircraft can accomplish headway corrections by velocity control, and which require to undergo path stretching or holding maneuvers. (Author)

A71-21343 * Minimum variance estimates of signal derivatives - A problem in instrument landing systems. J. Campbell Martin, Bobby J. Prochaska, and Dan C. Stanzione (Clemson University, Clemson, S.C.). In: *Hawaii International Conference on System Sciences*, 4th, University of Hawaii, Honolulu, Hawaii, January 12-14, 1971, Proceedings. Conference sponsored by the University of Hawaii and the U.S. Army. Edited by Shu Lin. North Hollywood, Calif., Western Periodicals Co., 1971, p. 477-479. Grant No. NGR-41-001-024.

This approach uses the form of the Kalman filter as an observer for the derivatives of observable signals or states. The gain matrix for the filter is derived to minimize the variance of the estimate of the derivative of the state, instead of the state itself. The results are shown superior to other methods, under prevalent conditions. (Author)

A71-21369 Are microelectronic circuits reliable enough for aircraft engine control applications. R. S. Smith (Texas Instruments, Inc., Dallas, Tex.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing*

Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700822. 8 p. Members, \$1.00; nonmembers, \$1.50.

Review of jet engine environmental conditions, along with documented microcircuit performance under similar environmental conditions. Data are provided to enable a design engineer to further seek out devices or equipment to meet his particular requirements. It is pointed out that reliability testing programs are now proving that microcircuits can be tested and selected for severe temperature and vibration environments. M.M.

A71-21425 # Experimental atmospheric absorption values from aircraft flyover noise signals. Dwight E. Bishop and Myles A. Simpson (Bolt Beranek and Newman, Inc., Los Angeles, Calif.). *Acoustical Society of America, Meeting, 80th, Houston, Tex., Nov. 3-6, 1970, Paper.* 16 p.

Discussion of the results of a study performed to obtain experimental values of atmospheric absorption coefficients from recorded noise samples of aircraft flyovers. An attempt is made to develop and test new methods for analyzing flyover noise signals received at different ground positions to obtain experimental values of air absorption, and to compare these values with those predicted by the SAE Aerospace Recommended Practice, referred to as ARP-866. Atmospheric absorption values over the frequency range up to 8000 Hz are obtained and presented graphically. It is shown that the values are in a good agreement with calculated values over the frequency range from 1250 to 6300 Hz. At 1000 Hz and lower frequencies, the experimental values are significantly greater than the calculated ones. It is suggested that this increase in absorption at lower frequencies may reflect losses due to scattering in the lower atmosphere not accounted for in the current calculation procedures. There is also poor agreement with calculated values at 8000 Hz, which may, in part, reflect the lessened accuracy in field measurements due to sharp reduction in data sample sizes at 8000 Hz. O.H.

A71-21426 Flight test measurement of exterior turbulent boundary layer pressure fluctuations on Boeing model 737 airplane. W. V. Bhat (Boeing Co., Seattle, Wash.). *Journal of Sound and Vibration*, vol. 14, Feb. 22, 1971, p. 439-457. 19 refs.

Investigation of the turbulent boundary layer pressure fluctuations on the exterior of high-speed aircraft, based on two separate in-flight measurements on Boeing model 737 airplane. In these flight tests, a seven-microphone array was used at two different locations along the fuselage. The measurements were carried out for Mach numbers of 0.78, 0.6, and 0.45 for the forward location, and for Mach numbers of 0.78 and 0.45 for the aft location. The pressure power spectral densities (PSD) and root mean square pressure fluctuations were calculated at all five flight conditions. PSD measurements and the subsequent analysis indicated that exterior turbulent boundary layer pressure fluctuation measurements are contaminated by the jet engine noise at Mach 0.45 forward location, and Mach 0.78 and 0.45 aft location. Therefore, other statistical properties, such as wideband convection velocity, wideband spatial correlation, narrow band convection velocity, and the amplitude of cross PSD, are presented only for Mach 0.78 and 0.6 forward location. The measurements at these two flight conditions are compared with laboratory measurements of the turbulent boundary layer pressure fluctuations on a flat plate. A physical description of the turbulent boundary layer pressure fluctuations is presented. O.H.

A71-21431 Effect of structural damping on the airborne sound transmission loss of ribbed panels. John M. Zalas (Lord Manufacturing Co., Erie, Pa.). *Journal of Environmental Sciences*, vol. 14, Jan.-Feb. 1971, p. 16-20. 8 refs.

Discussion of a series of laboratory measurements of the airborne sound transmission loss (TL) on ribbed aluminum panels with and without structural damping treatments. The purpose was to empirically determine the controlling parameters in the transmission

of sound through ribbed panels and to quantitatively evaluate the effect of structural damping in altering these parameters. Specifically, the program sought to evaluate the significant characteristics of the TL curve in terms of the dynamic characteristics of the panels. The applicability of the results obtained to aircraft structures is examined. O.H.

A71-21441 # Q-Star experimental quiet aircraft. E. D. Griffith (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *Acoustical Society of America, Meeting, 80th, Houston, Tex., Nov. 3-6, 1970, Paper.* 14 p.

Discussion of the design and acoustical characteristics of the Q-Star or Quiet-Star Aircraft built by Lockheed as a research vehicle to study Quiet Aircraft Technology. The research aircraft is designed to have minimum acoustic noise signature so that it can perform its mission while being undetected aurally by observers on the ground. Its basic airframe is that of a Schweizer 2-32 sailplane with a 'Wankel'-type rotary combustion, water-cooled engine mounted just aft of the cockpit, and an efficient muffler system which minimizes engine exhaust noise. Acoustic data taken from aircraft flyovers at altitudes of 125 ft are given graphically showing the aircraft overall sound pressure level as a function of indicated air speed. Acoustic characteristics for a three-blade and a six-blade propeller are examined. To provide some judgment in the degree of noise reduction achieved on the Q-Star, a comparison to similar conventional aircraft is made. It is shown that at an altitude of about 2000 ft, the Q-Star noise approaches a level that will be masked by background noise. O.H.

A71-21450 # Conditions inside cumulus clouds preceding the onset of precipitation. Martin R. Schock and A. S. Dennis (South Dakota School of Mines and Technology, Rapid City, S. Dak.). *Journal of Applied Meteorology*, vol. 10, Feb. 1971, p. 70-72. 8 refs. U.S. Department of the Interior Contract No. 14-06-D-5979.

Conditions within 16 cumulus congestus clouds were measured on aircraft penetrations near the -5C level and precipitation development during the subsequent 45 min were noted. Significant correlations exist between the in-cloud conditions and the time of onset and intensity of precipitation. The degree of spatial correlation among the fields of temperature, vertical motion and water content within a given cloud proved more important to subsequent developments than did the mean values of these variables. (Author)

A71-21625 Aircraft gas turbine engine technology. I. E. Treager (Purdue University, Lafayette, Ind.). New York, McGraw-Hill Book Co., 1970. 470 p. \$14.95.

Consolidated information treating the gas turbine engine at the technical level is offered to supplement what has been written elsewhere from an engineering viewpoint. Although the text is designed primarily to provide a source of information for aircraft technicians, it may be used by others interested in this type of power plant. An attempt is made to follow a logical presentation, and to use the type of approach that does not assume a great deal of technical knowledge on the part of the reader. Beginning with the background and development of the gas turbine engine, the book concludes with a discussion of the Pratt and Whitney JT3D, the General Electric J79, the Lycoming T-53, the Allison 501-D13, and the Continental J69-T-25. Sections of the text are devoted to construction and design, systems and accessories, and testing and maintenance. Fuel control is considered in detail, because fuel metering is a critical factor in correct engine operation, and because the fuel control is probably the most complicated and difficult to understand unit on the entire engine. F.R.L.

A71-21659 # Use of computers in air traffic control. Gustav E. Lundquist (FAA, Washington, D.C.). *University of Tennessee*

Space Institute, Computer Developments and Applications Short Course, Tullahoma, Tenn., Dec. 8-12, 1969, Paper. 36 p.

Description of the air traffic control (ATC) automation program for en route and terminal facilities which has evolved in response to the continuing growth of air traffic and is intended to provide increased capacity and safety to the existing ATC system. A brief review is given of the characteristics of today's manual ATC system, followed by a detailed discussion of the implementation and operation of the en route portion of the automation program, termed NAS En Route Stage A. Finally, the features of the terminal automation program, termed ARTS III, are presented. When completed, the combined system will provide automation at each of the 20 air route traffic control centers and those terminals where automation is warranted. All of these facilities will be interconnected with data transmission links, and the entire system will function as a nationwide, realtime automated system. O.H.

A71-21660 # A small computer in range instrumentation. Lewis C. Corey (Mitre Corp., Bedford, Mass.). *University of Tennessee Space Institute, Computer Developments and Applications Short Course, Tullahoma, Tenn., Dec. 8-12, 1969, Paper. 31 p.*

Review of some aspects of the methods and equipment used at the Test Center of the Patuxent Naval Air Station for testing the overall performance of aircraft avionics and weapons systems as whole mission-implementing entities. In particular, the integration of a computer with a radar and phototheodolite range instrumentation system is evaluated in terms of its contribution to reduced time requirements for obtaining useful test results (such as early diagnosis and correction of malfunctions) as against computer investment and operation costs. The importance is assessed of computer-provided instant replay capability of every radar report in slow motion. Some of the merits of off-line operations concurrently with on-line computing are pointed out. The radar-complementing contribution of the phototheodolite ranging system is also reviewed. M.V.E.

A71-21661 * # The calculation of optimal linings for jet engine inlet ducts. J. P. D. Wilkinson (GE Research and Development Center, Schenectady, N.Y.). *Acoustical Society of America, Meeting, 80th, Houston, Tex., Nov. 3-6, 1970, Paper. 31 p. 5 refs. Contract No. NASw-1992.*

A numerical method is presented for calculating the optimal lining impedance for the inlet duct of a jet engine. The calculation is based on the condition that the total radiated power from the duct shall be a minimum. Several situations are considered: first, the case of an axially symmetric duct in a stationary acoustic medium; second, that of a body of arbitrary geometry in a stationary medium; and finally, the case of an axially symmetric duct in the presence of spinning modes and axial air flow. In each case, the method may yield the optimal lining impedances for a given discrete frequency, flow velocity, and duct geometry. To demonstrate the application of the method, a number of cases are investigated. First, a cylindrical duct closed at one end with a vibrating piston is used to make comparisons with predictions obtained analytically by Rice. Then a more complex problem of a bell-mouth compressor is investigated. A discussion of the results obtained is presented, together with a critique of the potential difficulties of the method as applied to complex duct configurations. (Author)

A71-21666 # The history, evolution, and use of wind tunnels. Kenneth L. Goin (Sandia Laboratories, Albuquerque, N. Mex.). *AIAA Student Journal*, vol. 9, Feb. 1971, p. 3-13. 12 refs. AEC-supported research.

General discussion of wind tunnels, commencing with a historical review, followed by descriptions of major developments. The initial achievements of manned flight and the rapid advance of both manned and unmanned flight have followed the development of wind tunnels and techniques for testing. The wind tunnel is the single

tool that has been most important to the rapid advances of flight technology. Fundamental concepts are outlined, and some early low speed wind tunnels are briefly described. The work carried out by the National Advisory Committee for Aeronautics (NACA) in the fields of variable density wind tunnels and large wind tunnels is reviewed. Attention is given to high speed, transonic, supersonic, hypersonic, and hypervelocity wind tunnels. Some recent special purpose tunnel developments are described. F.R.L.

A71-21679 # Technical failures in civil aircraft accidents in Canada. T. W. Heaslip (Ministry of Transport, Accident Investigation Engineering Laboratory, Canada). *Canadian Aeronautics and Space Journal*, vol. 17, Feb. 1971, p. 43-50.

Material failures continue to play a major role in aircraft accidents. Such failures tend to disclose some of the most serious technical problems encountered by the aircraft industry. In an endeavour to preclude similar recurrences, all material failures in Canada which contribute to accidents are investigated in depth. This paper initially describes the Canadian organization to ensure effective aircraft accident investigation. Next the accident picture over the past ten years is covered, followed by a survey of technical failure investigations which reveals the significant problem areas. Typical examples of material failures are also included. Finally, the manner in which information will flow in future to the aviation community is discussed. (Author)

A71-21680 # A V/STOL microwave approach and landing system. A. J. Stein (FAA, Washington, D.C.). *(Canadian Aeronautics and Space Institute, Aerospace Electronics Symposium, Ottawa, Canada, Mar. 19, 1970.) Canadian Aeronautics and Space Journal*, vol. 17, Feb. 1971, p. 51-55.

Flight characteristics of V/STOL aircraft, restricted size of V/STOL runways and the unique locations of V/STOL ports require an approach and landing system which differs in many ways from those now in use for conventional fixed wing aircraft. The microwave scanning beam technique offers the best potential for satisfactory performance of a V/STOL ILS. An engineering model of a V/STOL approach and landing system being procured by the FAA is described. (Author)

A71-21681 Ball forming solves contouring problems. Wynand W. Brandel and Lawrence S. Klass (Avco Corp., Aerostructures Div., Nashville, Tenn.). *Metal Progress*, vol. 99, Mar. 1971, p. 56, 57.

Description of the ball forming technique and its application to the contouring of structural parts of aluminum alloys. In this technique, steel balls of uniform size and shape are used as forming media. To avoid surface roughness, the balls are delivered at low velocities. As an example, a procedure of wing panel forming is described, and the advantage of prestress tooling is discussed. Z.W.

A71-21684 Plasma-arc welding of jet engine components. J. R. Kelley and W. P. Hughes (General Electric Co., Evendale, Ohio). *Metal Progress*, vol. 99, Mar. 1971, p. 66-68.

The plasma-arc welding of jet engine components of titanium- and nickel-base alloys is described and compared with gas tungsten-arc and electron beam processes. It is concluded that the effectiveness of plasma arc welding stems from the fact that the ionized gas stream is forced to pass through a constricting chamber. In comparison with the gas tungsten-arc method, there is a substantial increase in arc energy generated per unit area, and the efficiency of energy transferred to the workpiece is improved. Z.W.

A71-21685 **Improving structural efficiency through materials selection.** Donald Webster (Boeing Co., Seattle, Wash.). *Metal Progress*, vol. 99, Mar. 1971, p. 81, 84-87.

Basic equations are presented for obtaining the lightest components of airframe structures made in the form of solid panels, sandwich panels, columns, and floor panels. The structural efficiency of wide panels made of 7075-T6 aluminum, mill-annealed Ti-6Al-4V, and 4340M steel is compared. The effect of high temperature on the strength and the Young's modulus of these materials is briefly examined. Z.W.

A71-21710 **Some questions related to the vibration strength of aviation gas-turbine motors with long operating times.** V. I. Omel'chenko. (*Problemy Prochnosti*, vol. 2, Jan. 1970, p. 95-98.) *Strength of Materials*, Jan. 1970, p. 95-99. Translation.

Description of the improvements in the strength and gas dynamic characteristics of gas turbine engines AI-20 by decreasing their vibrations. Topics discussed include: (1) vibration decrease of this engine by means of elastic elements, (2) effect of the elastic supports at the bearing nodal points of the rotor on the vibration level, and (3) effect of the interaction between the engine body and the propeller on the vibrations of the engine. Z.W.

A71-21713 **A review of the status of the technology of the air cushion vehicle.** P. A. Sullivan (Toronto, University, Toronto, Canada). *Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710183*. 22 p. 28 refs. Members, \$1.00; nonmembers, \$1.50. Research supported by the National Research Council of Canada.

This paper reviews the current status of the technology of the air cushion vehicle (ACV). ACV economics are examined to suggest priorities for research and development, and to illustrate the effects of various design decisions. The basic features of and problems associated with flexible skirt systems are discussed. Problems in propulsion, structures, control and other areas are reviewed, and topics for research are indicated. The paper concludes by suggesting that much more development work is required to bring the vehicle to a reasonable state of maturity. Operating costs and controllability are singled out as requiring special attention. However, solutions to many of the problems seem possible so that there are grounds for optimism about the future of this vehicle. (Author)

A71-21722 # **Some basic characteristics of observational data.** John C. Bellamy (Wyoming, University, Laramie, Wyo.). In: *Meteorological observations and instrumentation*; American Meteorological Society, Symposium, Washington, D.C., February 10-14, 1969, Proceedings. Edited by Sidney Teweles and James Giraytys. Boston, American Meteorological Society (Meteorological Monographs. Volume 11, No. 33), 1970, p. 71-78. 6 refs. ESSA Contract No. E-291-68(6).

The characteristics of observational data are analyzed here from an overall point of view with respect to how it can best contribute to more complete knowledge and utilization of all scales of physical occurrences throughout the atmosphere. Several novel concepts are formulated, among which the explicit recognition of the more ordinal than cardinal number characteristic of observational data is of basic importance. Formal definitions of the relationships between these two quite different kinds of numbers lead to definitions of 'continuous (ordinal number) data' and 'coordinal' relationships among importantly related kinds of quantities, with respect to which highly informative 'residual data' can well be concisely portrayed. A clearer understanding is thereby also obtained concerning the basic theoretical and practical role that variables such as barometric 'altitude' could well play in meteorological as well as aeronautical operations. (Author)

A71-21724 # **Developments in stratospheric and mesospheric analyses which dictate the need for additional upper air data.** Richard Scherhag, Karin Labitzke (Berlin, Freie Universität, Berlin, West Germany), and Frederick G. Finger (U.S. Weather Bureau, Suitland, Md.). In: *Meteorological observations and instrumentation*; American Meteorological Society, Symposium, Washington, D.C., February 10-14, 1969, Proceedings. Edited by Sidney Teweles and James Giraytys. Boston, American Meteorological Society (Meteorological Monographs. Volume 11, No. 33), 1970, p. 85-90. 13 refs.

Meteorologists are still faced with the problem of explaining stratospheric phenomena such as 'explosive warmings.' The most recent event which took place in late 1967 is briefly discussed with the aid of both rawinsonde and rocketsonde data. A continual need for more stratospheric data to the highest possible levels is stressed, especially for studies of possible tropospheric-stratospheric relationships. Future supersonic transport operations will require this information, as well as space vehicles reentering the atmosphere. Several proposed programs, which should supply a relatively large amount of stratospheric data, are discussed. However, improvements in the present-day data-gathering systems are vitally necessary before these programs can proceed. (Author)

A71-21732 # **The need, meaning and usefulness of meteorological observations for aviation.** Peter E. Kraght, W. B. Beckwith, S. G. Bigler, Eugene Bollay, R. D. Fletcher, and N. E. Rider (American Airlines, Inc., New York, N.Y.). In: *Meteorological observations and instrumentation*; American Meteorological Society, Symposium, Washington, D.C., February 10-14, 1969, Proceedings.

Edited by Sidney Teweles and James Giraytys. Boston, American Meteorological Society (Meteorological Monographs. Volume 11, No. 33), 1970, p. 173-177.

Summarization of a panel discussion on the importance of meteorological observations and some approaches to overcome weather problems in aviation. The various aspects of the problem of modifying the terminal weather, particularly that of airport fog dispersal, are examined. Recent developments in long distance remoting of radar data are reviewed. The question of what meteorological information is needed and how it can be used to ensure the safe and efficient utilization of airspace is discussed and analyzed. The subject of instrumentation by which aircraft reports of wind and temperature over data-sparse areas might be fed into ground-based data processing systems, and the possibility of designing completely automated reporting systems, are dealt with. Finally, several remarks of a general character about meteorological observations in the terminal area are presented. O.H.

A71-21739 # **Problems and status of worldwide development of upper air sounding systems.** M. F. E. Hinzpeter (Bundesministerium für Verkehr, Deutscher Wetterdienst, Munich, West Germany). In: *Meteorological observations and instrumentation*; American Meteorological Society, Symposium, Washington, D.C., February 10-14, 1969, Proceedings. Edited by Sidney Teweles and James Giraytys. Boston, American Meteorological Society (Meteorological Monographs. Volume 11, No. 33), 1970, p. 361-377. 25 refs.

About ten different sounding systems are used by the aerological networks of the Northern Hemisphere. The main characteristics of these systems with regard to sensors and telemetry are described. The method of reducing the daytime readings of radiosondes to nighttime readings is used in order to illustrate that worldwide compatibility in synoptic analyses of higher atmospheric levels is still unsatisfactory. Some features in the field of aerodynamics are demonstrated. The results show that a freely rising balloon is not an ideal sensor for measuring wind velocity aloft, and that the radiation error of temperature sensors is not only a function of the solar elevation angle, the air density and the rate of ascent, but is also influenced by the microstructure of the air. It is shown that

the wind speed aloft may be used as a measure of the microstructure. Some aspects of improved sensors are discussed which may serve as a reference for the present sounding systems. (Author)

A71-21742 # Constant-level balloons for sounding systems.

Vincent E. Lally (National Center for Atmospheric Research, Boulder, Colo.). In: Meteorological observations and instrumentation; American Meteorological Society, Symposium, Washington, D.C., February 10-14, 1969, Proceedings. Edited by Sidney Téweles and James Giraytys. Boston, American Meteorological Society (Meteorological Monographs, Volume 11, No. 33), 1970, p. 392-396. 5 refs.

The superpressure balloon floats at a constant-density altitude, the maximum deviation from design altitude rarely exceeding 40 m. Balloons flying in the stratosphere will remain aloft for years, the longest flight duration to date being 15 months. Satellite location of these superpressure (GHOST) balloons is planned to provide global data on the atmospheric circulation. Icing remains the major problem in achieving long durations for flights above the freezing level and below 10 km. The superpressure balloon can be used in conjunction with satellites to provide a global description of the atmospheric circulation at all levels and at all latitudes. (Author)

A71-21767 VFR at bad weather - Flights over closed cloud cover, radar support from the ground. III (VFR bei Schlechtwetter - Flüge über geschlossenen Wolkendecken, Radarunterstützung vom Boden. III). Max Körte. *Deutscher Aerokurier*, vol. 15, Feb. 1971, p. 68, 69. In German.

It is pointed out that blind flying even for very short periods in order to fly through the cloud layer when the destination is reached should not be undertaken without a suitably equipped aircraft and without the required license. Conditions are analyzed which permit flying above clouds. A flight altitude of at least 1000 ft above ground or water is required. It must be possible to stay on the intended flight course, and radiotelephone communication must be possible. Weather conditions which make it highly inadvisable to fly above the clouds are pointed out. Questions of radar support are discussed giving attention to difficulties in landing aircraft not equipped with a transponder. G.R.

A71-21768 Aeronautical electronics for pilots of gliders and touring aircraft - Equipment for the 1971 season. II (Luftfahrt-Elektronik für Segel- und Reiseflieger - Das Angebot für die Saison 1971. II). Hans Helmut Mögling. *Deutscher Aerokurier*, vol. 15, Feb. 1971, p. 72-74. In German.

Advantages and disadvantages of ADF are examined, and a number of devices available in this field are described taking into consideration equipment at prices from about \$800 up to about \$3000. Radio equipment not absolutely necessary for visual flight but nevertheless providing valuable navigational aid is considered. The merits of transponders are evaluated, and a number of transponder models with their prices are listed. Distance measuring equipment available is reviewed, and computers for general aviation are discussed. G.R.

A71-21769 Motor glider with Wankel engine - K8B/KM 914, SF-24/KM 29 (Motorsegler mit Wankel-Motor - K8B/KM 914, SF-24/KM 29). *Deutscher Aerokurier*, vol. 15, Feb. 1971, p. 88, 89. In German.

The present state of development of the project K8B/KM 914 is reviewed. The objective of tests presently conducted is to demonstrate that the Wankel engine is suitable for the propulsion of motor gliders which can take off under their own power. Design data and flight characteristics of the present model are presented. Another

motor glider with a Wankel engine discussed is the model SF-24/KM 29. The advantages of the Wankel engine are described and data regarding the flight characteristics of the glider are presented. The motor glider rises from a grass grown surface after about 120 m.

G.R.

A71-21770 Mechanics of curvilinear flight for glider pilots (Kurvenflugmechanik der Segelflieger). Max Haubenhofer. *Deutscher Aerokurier*, vol. 15, Feb. 1971, p. 90, 91. In German.

The transformation of the polar for gliding into the polar for curvilinear flight is discussed taking into account relations involving rate of sink in the curve, flight velocity in the curve, and curvature. A graph for determining optimal climbing conditions in an ascending current is presented, and relations of dynamic pressure and sloping position for constant angles of attack are investigated. G.R.

A71-21811 Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971. 309 p. \$19.50.

The subjects considered include the training of acoustical engineers, the airport and community interface, and air-pollution problems produced by aircraft. Attention is given to airport and aircraft noise, community response to aircraft noise, and state, Federal, and international regulations concerning aircraft noise. Alleged dangers in connection with the SST, and the compatibility of city and airport, are examined. G.R.

A71-21812 U.K. research in sonic boom. J. B. Large and D. N. May (Southampton, University, Southampton, England). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 5-8. 17 refs.

Research regarding the effect of the sonic boom on humans is discussed taking into account physiological and behavioral effects. Work concerned with calculating and measuring the loudness of pressure transients is considered. Investigations regarding the effects of the sonic boom on structures are reported giving attention to theoretical studies and the use of simulators. It is pointed out that the Concorde's present overflights are accompanied by an extensive research program to assess the effects of the boom on cathedrals, greenhouses, museum specimens, apartment buildings, homes, cliffs, and humans and animals. G.R.

A71-21813 Noise reduction operational procedures. John O. Powers (FAA, Washington, D.C.) and T. P. Ball (Air Transport Association of America, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 9-14.

Takeoff procedures are examined. It is found that in general a two segment climbout by transport airplanes can best serve noise abatement requirements consistent with acceptable safety margins. Modifications in approach procedures for the purposes of noise abatement are investigated. An increase in the glide slope by approximately one-half a degree is recommended. The use of preferential runway systems is discussed. It is pointed out that the implementation of a 3,000-foot glide slope intercept within the terminal control area could improve the acoustic impact during final approach. G.R.

A71-21814 Aircraft noise, its source and reduction. R. E. Russell (Boeing Co., Seattle, Wash.) and J. D. Kester (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 15-31.

The evolution of subsonic jet engine noise-reduction efforts is traced taking into account early turbojets and turbofan engines. Problems encountered with jet suppressors are examined, and noise characteristics of turbojet aircraft at three locations are investigated. Aspects of fan-noise-suppression technology are explored giving attention to obtainable community benefits. Design questions for high-bypass-ratio engines in connection with noise minimization are discussed. Aspects involved in coping with the noise problem of existing aircraft are considered taking into account a nacelle retrofit schedule and noise reduction through flight procedures. G.R.

A71-21815 Aircraft and the environment - Airlines/community. William B. Becker (Air Transport Association of America, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 35-41.

Three approaches to jet noise abatement are considered involving the reduction of noise at the source, adjustments in method of flight, and compatible land use around airports. Alterations of takeoff profiles undertaken for the sole purpose of reducing noise on the ground are described, and the use of preferential runways and the establishment of aircraft tracks over the ground are discussed. The advances made by the airlines in reducing the total amount of pollution created per aircraft engine are examined. Some details are presented concerning the origin and the characteristics of the pollution produced by aircraft. G.R.

A71-21818 Land use strategies for aircraft noise alleviation. Richard H. Broun and James F. Miller (U.S. Department of Housing and Urban Development, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 64-74.

Legislative action resulting from an increased concern with environmental quality is considered. A number of basic questions in connection with a series of metropolitan aircraft noise abatement policy studies are discussed. These studies indicate that land use strategies must take into account the necessity of solving the very serious noise problem in communities that already exist around many airports, and the necessity of preventing the same situation from developing around other airports. Major findings and conclusions from the Boston International Airport study are examined. G.R.

A71-21819 Appraisal of community response to aircraft noise - At the grass roots level. Martin Gach (FAA, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 75-83.

The study provides an appraisal of some of the problems that have developed as the result of the effect of aircraft overflight on neighboring communities, and from the resultant noise emissions. Specific emphasis is placed on the short-term problem and the reaction of individuals or community leaders to the noise experience

occasioned by daily operations. Emphasis is also made with respect to the hours of duration of such noise experience and the times of the day. Officials concerned with airport operations and runway usage will have to cope with the problem of community reaction until such time when technical results reduce public reaction. Interim alleviation of the problem is discussed with respect to reduced long time runway usage. (Author)

A71-21820 Gas turbine engine emission characteristics and future outlook. C. W. Bristol, Jr. (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 84-92.

Some of the characteristics of both the visible and invisible exhaust emissions from aircraft gas turbines are discussed. Data is presented for some of the currently used commercial engines. Possible means for reducing levels of some of the pollutants are indicated. Gas turbine emission characteristics are compared with those of automotive reciprocating engines. (Author)

A71-21821 The United States SST and air quality. John M. Swihart (Boeing Co., Seattle, Wash.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 93-102. 19 refs.

The contribution of all turbine-powered aircraft to world pollution is shown to be something less than one percent of the total tonnage of pollution generated in the energy conversion processes of the world. The natural forces which may affect the global climate are briefly examined, and a brief description of the ambient conditions in which the SST fleet will operate is given. An overview of calculations made regarding the principal exhaust products of the SST fleet is presented. Alleged climatic modification affects of these substances are investigated. It is found that there is no basis to predict that the operation of a fleet of SST's will significantly affect the weather or climate. G.R.

A71-21822 Water vapor pollution of the upper atmosphere by aircraft. Lester Machta (National Oceanic and Atmospheric Administration, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 107-120. 12 refs.

Residence times of atmospheric carbon dioxide and water vapor are examined, and present and future emissions of these two substances from aviation activities are considered. The question whether the water vapor from future enlarged subsonic aircraft could produce a cirrus veil over large areas of the earth is discussed. Observed changes in high tropospheric cloudiness are examined. The distribution of water vapor emitted by the SST in the stratosphere is investigated, and the observed variability of water vapor is examined. Relations between water vapor and ozone concentration and between water vapor and stratospheric cloudiness are explored. The role of water vapor in the stratosphere regarding the radiation balance is discussed giving attention to the possible significance of SST emissions. G.R.

A71-21823 Air pollution at Heathrow Airport, London - April-September, 1970. J. Parker (Board of Trade, Warren Spring

Laboratory, Stevenage, Herts., England). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 121-146. 8 refs.

Calculations have been made of total pollution emissions at Heathrow Airport, London, from aircraft operations, heating installations and road traffic. Comparisons were made of concentrations of pollution levels from the airport and from nearby residential areas. Measurements of smoke sulphur dioxide, oxides of nitrogen, carbon monoxide, total hydrocarbons and deposited matter were also carried out in different parts of the airport. The results showed that the airport was not contributing unduly to local pollution. At no time did pollution concentrations at the airport ever exceed values which have been found in central London. The highest values obtained came from road traffic in the Central Area. (Author)

A71-21824 Dispersion modeling of airport pollution. N. Milford, G. C. McCoyd, L. Aronowitz, and J. H. Scanlon (Grumman Aerospace Corp., Bethpage, N.Y.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 147-162. 19 refs.

This paper describes the procedures followed in developing and validating computer models of air pollution caused by airports. Such dispersion models are used to calculate how the pollution emitted from the many contributing sources spreads to affect surrounding areas. This simulation permits a realistic evaluation of possible alternative strategies for air pollution abatement. The basic elements of a modeling problem are seen to be the emission sources, the meteorology, and the dispersion parameters; current methods for handling each of these are explained. The treatment of a sample airport is described and typical results are presented. Finally, the paper indicates some of the areas in which limited knowledge affects the implementation or accuracy of airport dispersion modeling. (Author)

A71-21825 The role of state government in aircraft noise abatement regulation. Joseph R. Crotti (California Department of Aeronautics, Business and Transportation Agency, Calif.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 163-169. 9 refs.

It is pointed out that California is the first state in the nation to undertake the development of noise regulations for airports. The reason for this development is the lack of federal regulations in this area. The necessity of noise regulations in a competitive economy for the reduction of aircraft noise is shown. Legislative aspects are examined, and the more important elements of the airport noise problem are analyzed. Questions of definitions of noise, noise exposure level, community noise equivalent level, maximum acceptable noise level, the determination of noise impact area, and compatible land use and quieter aircraft are among the subjects discussed. Approaches for solving the noise problem, the requirement for noise monitoring systems, and the time required to achieve noise reduction are considered. G.R.

A71-21826 International regulation of aircraft noise. B. W. Meynell (British Embassy, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 170-175.

The London conference at the end of 1966 concluded that there were sound reasons to expect that civil transport aircraft of the

future could be made very much quieter than those then in service. In order to take full advantage of acoustic technological capability compulsory standards of quietness are called for. It is pointed out that unless such standards for aircraft are developed on an international basis serious commercial discrimination between different manufacturers and airlines could result. Approaches taken to tackle the noise-at-source problem internationally are discussed giving attention to future work required. G.R.

A71-21827 The federal regulation of aircraft noise. Ronald W. Pulling (FAA, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 176-182. 11 refs.

Review of federal regulatory activities in the area of aircraft noise. The evolution of more and bigger aircraft, increased operation, and urbanization of airport environs have attracted attention to the social and physical annoyance of aircraft noise. The elements and participants in the noise problem are identified, and the historical background leading to the enactment of federal legislation supporting FAA regulatory activities is presented. The scope and status of FAA regulations, and the constraints and alternatives affecting an ultimate solution of the problem are discussed. F.R.L.

A71-21828 The legal role of states, local governments and airport proprietors in regulating aircraft noise. Warren Christopher (O'Melveny and Myers). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 183-188.

Discussion of the power of state and local governments to control aircraft noise at airports not owned or operated by the governmental entity making the regulation. It is considered that, because of the pervasive federal control over the navigable airspace, local attempts to establish minimum altitudes of flight, maximum noise levels, or night curfews have generally been held to be unenforceable. Attention is given to the unsettled question of the power of the proprietor of an airport to make and enforce regulations with respect to the control of aircraft noise. Various legal actions brought by interested parties are cited and evaluated. F.R.L.

A71-21829 Federal regulation of aircraft noise, the legal rights of airport neighbors, and legal aspects of compatible land use. Lyman M. Tondel, Jr. (Cleary, Gottlieb, Steen, and Hamilton). In: Society of Automotive Engineers and U. S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 189-204. 117 refs.

Discussion of various aspects of the aircraft noise problem, which has increased in magnitude over the past few years, owing to the increased public need for air transport. Extensive efforts to control noise by design, flight pattern arrangement, and modified operational procedures have only been partially successful. The most significant developments in the realm of Federal legislation and regulation since 1965 are summarized, and the most significant court cases in the last five years are reviewed. Attention is given to the largely unsuccessful efforts to obtain injunctions in airport noise cases. Some of the reasons why land use planning has not been effective in most places are discussed, and some possible means of improving the legal framework for such planning are suggested. F.R.L.

A71-21830 Legal aspects of military sonic booms. William F. McCormack (USAF, Office of the Judge Advocate General,

Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 205-217. 100 refs.

Attempt to show some of the legal developments which have resulted from military supersonic flight. The law has developed to meet the new challenges, and old rules of liability have been modified to meet the changed conditions. The sonic boom and the effects of high overpressure sonic booms are described. Administrative remedies, remedies under the Federal Tort Claims Act (FTCA), discretionary function defense under FTCA, absolute liability under FTCA, liability under FTCA based on negligent or wrongful conduct, and liability for trespass and nuisance are discussed. Attention is given to Tucker Act cases and remedies in state courts. A large number of cases and their dispositions are reviewed. F.R.L.

A71-21831 Role of NAPCA in controlling aircraft pollutant emissions. George D. Kittredge and Barry D. McNutt (National Air Pollution Control Administration, Div. of Motor Vehicle Research and Development, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 218-227. 9 refs.

Discussion of some general results of a program initiated in 1967 by the National Air Pollution Control Administration (NAPCA) on the characterization and control of emissions from aircraft operations. The program, which is being carried out through contract research and cooperative government/industry studies, covers the measurement of emissions, development of testing instrumentation and procedures, and basic research in emission control technology. Based on the results of this program obtained so far, characteristics of emissions from aircraft are presented and it is shown how they can be identified in a quantitative fashion suitable for predicting their contribution to total community air quality. A brief description of NAPCA's plans for future research is also included. Finally, a discussion of possible emission control techniques and regulatory considerations which will affect future standard setting, is presented. O.H.

A71-21832 The current and future basis for aircraft air pollution control. William T. Westfield (FAA, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 228-233. 8 refs.

Description of efforts to develop an efficient regulatory tool for assessment of aircraft smoke emissions. The present basis, the Ringelmann Smoke Chart, is described and some of the shortcomings associated with its use for aircraft are discussed. Research and development approaches devised so far in an attempt to improve this system are characterized. The gaseous pollutants, their relative importance in an airport area, and the research underway or needed are discussed. O.H.

A71-21834 An environmental approach to air transportation needs - Guidelines for federal assistance. Martin Convisser (U.S. Department of Transportation, Office of Environment and Urban Systems, Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 240-244.

Discussion of the various environmental aspects which must be

taken into account in the construction or further development of airport facilities to prevent unnecessary conflicts between airports and their neighbors. A thorough consideration of environmental factors is now required by three Federal statutes - i.e., the Airport and Airway Development Act of 1970, the Department of Transportation Act of 1966, and the National Environmental Policy Act of 1969. The role of the Assistant Secretary for Environment and Urban Systems in the Department of Transportation, who has the ultimate responsibility for ensuring that these legislative requirements are fully understood and incorporated into the approval process, is discussed. O.H.

A71-21835 Environmental aspects of airport systems planning. H. C. Lamberton, Jr. (Howard, Needles, Tammen and Bergendoff, New York, N.Y.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 245-260.

Discussion of airport system planning for environmental compatibility. The requirements of and constraints upon airport system planning are reviewed in terms of the planning time frame, forecasting base, location and use of airports, meteorological effects, number of airports and runways, size of aircraft, and measures to increase airport capacity. The impact of airport system planning on the preservation of natural and urban environment is examined in detail. Several methods of both technical and institutional nature for effecting airport environmental compatibility are proposed and discussed. O.H.

A71-21836 Strategies of noise abatement through land use. Richard B. Ross (Market Facts, Inc.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 261-266.

Discussion of land development control as an effective approach to aircraft noise abatement. It is shown that because it is very unlikely that aircraft noise will be eliminated or reduced to a manageable level by technological improvements, land use strategies which substitute nonnoise sensitive uses for very sensitive uses in high noise exposure zones are necessary. The land development problem is significantly different at existing and at new airports so that different noise abatement strategies must be applied. Some of these strategies are proposed and discussed. It is emphasized, however, that all strategies have limitations and potential adverse effects on community goals other than noise reduction. Implementation of any of the strategies is complex, requiring compromises among competing groups and community goals. O.H.

A71-21837 Comprehensive planning and aircraft noise at Kansas City International Airport. John L. Taylor and Robert A. Kipp. In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings, Part 1. New York, Society of Automotive Engineers, Inc., 1971, p. 287-293.

Description of a new planning program for guidance of private land development and for the provision of transportation undertaken by the city of Kansas City, Mo., in the vicinity of Kansas City International Airport. The airport is an entirely new public transportation facility now in the final construction stages and expected to be operational by 1972. The development guidance system is designed to take account of environmental noise utilizing FAA noise exposure forecasts in conjunction with land use control zones. O.H.

A71-21863 # Use of unsteady analogy in constructing hypersonic flows past blunt bodies (O primenenií nestatsionarnoi analogii pri postroenii giperzvukovykh techenii okolo zatuplennykh tel). M. N. Kogan and V. V. Mikhailov. *Prikladnaia Matematika i Mekhanika*, vol. 34, Nov.-Dec. 1970, p. 1053-1057. 10 refs. In Russian.

Construction of a class of unsteady flows to which direct application of unsteady analogy can be made when calculating hypersonic flow past a blunt body in a region far from the blunt part of the body. The basic idea of the method employed for this purpose is that the entropy corrections are not introduced into the flowfield or the body configuration, but into the head wave configuration as determined by unsteady analogy. The shape of this shock wave is determined from the condition that the fields of the steady and unsteady solutions must totally coincide, while the body configuration corresponds to the trajectory of a particle of an unsteady flow with an entropy equal to the entropy behind a normal shock wave.

A.B.K.

A71-21864 # Singular current surfaces in conical gas flows (Osobyie poverkhnosti toka v konicheskikh techeniakh gaza). A. I. Golubinskii. *Prikladnaia Matematika i Mekhanika*, vol. 34, Nov.-Dec. 1970, p. 1058-1066. 8 refs. In Russian.

Consideration of the field of a conical perfect gas flow in the vicinity of conical current surfaces. It is shown that, in addition to ordinary (regular) current surfaces, which are constant-entropy surfaces (isentropes), singular current surfaces with a distributed variable entropy may exist on the ordinary surfaces. These singular surfaces are the envelopes of the flowfield isentropes and may be continuously joined with regular surfaces provided that the flowfield remains continuous both in the vicinity of the singular current surface and in the vicinity of the junction. The results obtained lead to the assumption that the flow pattern of an asymmetrical flow past conical bodies has a continuous and single-valued distribution of the gasdynamic parameters in the flowfield without any singular points.

A.B.K.

A71-21865 # Designing a supersonic nozzle contour with allowance for changes in the flight conditions of a flight vehicle (O postroenii kontura sverkhzvukovogo sopla s uchetom izmeneniia uslovii poleta letatel'nogo apparata). A. N. Kraiko and A. A. Osipov. *Prikladnaia Matematika i Mekhanika*, vol. 34, Nov.-Dec. 1970, p. 1067-1075. 11 refs. In Russian.

Consideration of the problem of designing a rigid (unadjustable) contour for the supersonic part of a nozzle which is optimal in the sense of solving a certain trajectory problem with allowance for changes in the flight conditions and the operating mode of the engine. The flight vehicle in this case is assumed to be a material point of variable mass, while its drag at a given moment is regarded as equal to the corresponding steady value. In addition to obtaining general results, a detailed study is made of two cases where the solution of the problem using the optimality conditions obtained turns out to be comparatively simple. The first case occurs if the Mach number distribution at the nozzle inlet does not vary during the flight time. It is established that in this case the optimal contour belongs to a family of contours corresponding to the solution of a variational problem with fixed conditions. The second case occurs if the flow at the nozzle inlet remains uniform and supersonic during the entire flight time, while the nozzle is plane and 'short.' In this case the generatrix of the optimal nozzle is rectilinear.

A.B.K.

A71-21872 # Formation of a hanging shock wave during flow past a profile with a broken generatrix (Obrazovanie 'visiachego' skachka uplotneniia pri obtekanii profil'ia s izlomom obrazuiushchei). E. G. Shifrin. *Prikladnaia Matematika i Mekhanika*, vol. 34, Nov.-Dec. 1970, p. 1159-1167. 7 refs. In Russian.

Analytical demonstration that a hanging shock wave arises during uniform supersonic flow past a profile with a broken

generatrix. The properties of this shock wave in a plane ideal gas flow are ascertained. The case of a small supersonic incident flow velocity is investigated, when variations in entropy behind the shock wave may be neglected. In this case it is found possible to employ a transonic approximation of the shock polar and of the characteristics intersecting it. The study is carried out with the aid of a mapping of the region behind the shock wave with a Cartesian coordinate system into the plane of the velocity hodograph.

A.B.K.

A71-21922 # Heat exchange and frictional drag during turbulent flow of air with equilibrium ionization and dissociation around a plate (Teplootdacha i soprotivlenie pri turbulentnom obtekanii plastiny ravnovesno dissoitsirovannym i ionizirovannym vozdukhom). V. N. Popov (Moskovskii Energeticheskii Institut, Moscow, USSR). *Teplofizika Vysokikh Temperatur*, vol. 8, Nov.-Dec. 1970, p. 1209-1217. 17 refs. In Russian.

Calculation of the heat exchange and frictional drag during stationary longitudinal turbulent flow of dissociated and ionized air around a plate. It is assumed that the plate surface temperature and the temperature of the incident flow are constant. Equilibrium dissociation and ionization are also assumed - i.e., the mixture composition at each point in the boundary layer is the same as that under conditions of thermodynamic equilibrium. The effects of mass forces, dissipation, and radiation are negligibly small. Calculations are made for pressures of 1 and 10 atm and plate surface temperatures of 500, 2000, and 3000 deg K. The incident flow temperature is varied between 2000 and 30,000 deg K, and the Reynolds number is varied from 2400 to 2.4 billion.

T.M.

A71-21925 # Position of the closing shock in a supersonic underexpanded two-phase jet (Polozhenie zamykaiushchego skachka v sverkhzvukovoi nedorasshirennoi dvukhfaznoi strue). L. Napolitano, R. Monti (Napoli, Università, Naples, Italy), and G. V. Tsiklauri (Moskovskii Energeticheskii Institut, Moscow, USSR). *Teplofizika Vysokikh Temperatur*, vol. 8, Nov.-Dec. 1970, p. 1235-1243. 9 refs. In Russian.

An experimental investigation is described in which the position of the closing shock in single-phase and two-phase jets was studied in a wind tunnel, using air and water vapor as the working medium. The influence of the concentration of the liquid phase on the Mach number and the pressure at the nozzle exit section is determined. It is shown that two-phase jets are characterized by a nonuniform velocity and concentration profile. In two-phase jets, the Mach number at the nozzle exit section in the gas phase decreases, owing to the mechanical work performed by the gas to accelerate the droplets and also to the friction losses at the particles. The ratio of active to passive pressure increases due to phase slipping.

V.P.

A71-21982 # The NOL Hypervelocity Wind Tunnel. W. J. Glowacki, E. L. Harris, R. K. Lobb, and M. I. Schlesinger (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-253*. 14 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

The NOL Hypervelocity Wind Tunnel will provide a high Reynolds number turbulent flow simulation in the Mach number range 10 to 20. This facility, much needed for large-scale testing of hypersonic vehicles, will be operational in late 1972. The tunnel is a blowdown type, utilizing high-pressure nitrogen as the test gas. Supply pressures up to 40,000 psi will be maintained constant for 1 to 4 seconds during which stable, condensation-free flow conditions will prevail. This paper will highlight the gasdynamic and mechanical design of the major components of the facility. In addition, a comparison will be given between the tunnel operating conditions and those required for simulating free flight.

(Author)

A71-21986* # Methane-air combustion gases as an aerodynamic test medium. R. R. Howell and L. R. Hunt (NASA, Langley

Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-258.* 11 p. 31 refs. Members, \$1.50; nonmembers, \$2.00.

The present paper gives a review of the major problems associated with the use of hydrocarbon-air combustion gases as an aerodynamic test medium. Condensation of water vapor is identified as the major problem, and actual experience is offered as evidence of its effects on aerodynamic flow parameters. Aerodynamic data obtained from tests in methane-air combustion gases are compared with theory and with data obtained on the same shapes in other test facilities using other test media. The comparisons indicate that data obtained in combustion gas compare well with data obtained in other test media. (Author)

A71-21990 * # **Supersonic aerodynamic and wake characteristics of large-angle cones at low Reynolds numbers including effects of model support.** Melvin M. Carmel and Clarence A. Brown, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-264.* 12 p. Members, \$1.50; nonmembers, \$2.00.

Experimental demonstration of the effects of sting diameter and Reynolds number variation in the low range on the aerodynamic characteristics of a 140 deg cone at $M = 1.5$ and 2.0 . The effects of support interference on the wake of a 120 deg cone at $M = 1.6$ is also presented. The results indicate no appreciable effect of sting diameter or Reynolds number on the cone aerodynamic characteristics other than an increase in the apical-force coefficient with sting diameters greater than about 0.3 of the ratio of sting diameter to cone diameter. Also, asymmetry of the support system for blunt cones may lead to significant error in wake results. (Author)

A71-21991 * # **Comparisons between sting-supported and free-flight tests in the JPL Hypersonic Wind Tunnel on a modified Saturn-Apollo launch configuration.** Bain Dayman, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-265.* 12 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

Trajectories predicted from sting-supported internal-balance model tests conducted in the Jet Propulsion Laboratory (JPL) 21-inch Hypersonic Wind Tunnel (HWT) were compared with trajectories of free-flight model tests on a modified Saturn-Apollo launch configuration run in the JPL HWT. They were also compared with tests run in the U.S. Naval Ordnance Laboratory (NOL) Pressurized Ballistics Range No. 3 (PBR3). The purpose of this test program was to determine, under controlled and ideal conditions, just how closely 'static' data can compare with 'flight' data. In spite of the extremely complex flow field over the model (the characteristics, attached vs separated flow, were a strong function of Mach and Reynolds numbers, ratio of model wall temperature to flow temperature, and angle of attack) the comparisons with the sting-supported model tests were generally within 5% in drag and 2% of model diameter in center-of-pressure location for the wind tunnel free-flight trajectories and were within 5% and 7%, respectively, for the ballistics range trajectories. Pitch damping determined from the wind tunnel and ballistics range free-flight trajectories also compared quite favorably. (Author)

A71-21992 # **The aerodynamics of a fixed ground plane for a powered STOL wind-tunnel model.** J. E. Hackett and J. L. Justice (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-266.* 11 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

Theoretical and experimental tests on a 0.10 scale C-130 STOL model, over a fixed ground plane, allowed a close examination both of ground-boundary-layer effects and other aspects of such high-lift testing. Excellent experimental/theoretical agreement is demonstrated for both ground pressures (vortex-lattice techniques) and boundary layer characteristics. Detailed prediction of ground boundary layers is shown to be feasible, and retrospective allowances for displacement effects may even be possible for the milder cases. Other aspects discussed include flow-breakdown criteria, contraction-lag effects, strut-fairing interference and circulation around 'flow-over-both-sides' ground planes. (Author)

A71-21993 # **An evaluation of single and multiple sting support methods to obtain unmodified interference-free wind tunnel data.** D. G. Hammond and C. Wilkerson, Jr. (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-267.* 10 p. Members, \$1.50; nonmembers, \$2.00.

Wind tunnel tests of a conventional force model were conducted in which the 'Image Sting' method of support was used in an attempt to obtain corrections that could be applied to data to eliminate aerodynamic interference effects caused by the model single-sting support system. The tests were conducted over a Mach number range of 0.85 to 2.20 in the General Dynamics High-Speed Wind Tunnel. The test results for several single-support and multiple-support sting arrangements are compared with the Image Sting results as a means of evaluating this method of support. The Image Sting demonstrated its acceptability as a means of determining interference free wind tunnel model data. A single sting method that provides test data in close agreement with the Image Sting data levels was also determined. (Author)

A71-21994 # **A new wind tunnel technique for providing simulation of flight base flow.** J. C. Y. Koh (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-268.* 6 p. Members, \$1.50; nonmembers, \$2.00.

The dimensionless base pressure of a body in subsonic and supersonic flows is shown to be governed by the Mach number and the dimensionless boundary layer thickness. An experimental technique is described whereby in wind tunnel tests a base pressure model is attached to a long cylindrical body extended and supported far upstream so that there is no interference in the neighborhood of the base. The boundary layer thickness is controlled by suction upstream of the base. Results of experiments with bluff cylinder bases have successfully demonstrated the validity of this technique. (Author)

A71-21995 # **A wind tunnel simulation of rocket/launcher interference effects.** Raymond R. Maestri and Chris A. Kalivretos (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-269.* 12 p. Members, \$1.50; nonmembers, \$2.00.

Investigation of the effect of the aerodynamic interaction between the rocket, the rocket exhaust, the launch pod, and the free stream on the ballistic dispersion of an unguided, air-launched rocket. The aerodynamic interaction phenomenon was simulated in the Naval Ordnance Laboratory Supersonic Wind Tunnel No. 1. Conditions simulated were a launch aircraft Mach number of 0.6 and rocket exhaust jet pressure to ambient pressure ratios from zero to six. High-pressure air was used to simulate the rocket exhaust gas in most tests; however, in some tests high-pressure helium was used in order to measure the effect of exhaust gas density and speed of sound. Rocket forces and moments were measured at rocket

positions starting within the launch tube until the aft end of the rocket was eight calibers in front of the launcher. The force and moment data were reduced to interference coefficients which were then used to calculate rocket dispersion. Approximately eight mils of dispersion were found to result from this aerodynamic interaction effect. The greatest part of the dispersion was found to occur before the rocket was completely out of the launch tube. O.H.

A71-21996 # Static pressure port errors in hypersonic turbulent flow. D. E. Nestler (General Electric Co., Re-Entry and Environmental Systems Div., Philadelphia, Pa.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-270.* 9 p. 26 refs. Members, \$1.50; nonmembers, \$2.00.

The use of a static pressure port is known to cause local flow disturbances which may affect the pressure being measured. In this paper, several hypersonic pressure measurements for cones are compared with theory. A consistent positive error is noted, as in previous subsonic and supersonic studies. An approximate shear layer momentum balance is used to derive a simple relation for this static pressure increase. Due to inconsistencies in correlation of the experimental static pressure error with theoretical steady flow parameters, it is concluded that unsteady effects such as turbulent fluctuations may also be present. (Author)

A71-22000 * A nonlinear aerodynamic moment formulation and its implications for dynamic stability testing. Murray Tobak and Lewis B. Schiff (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-275.* 8 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

A nonlinear aerodynamic moment system, formulated in a previous study to apply to arbitrary motions of bodies of revolution in free flight, is generalized to include nonaxisymmetric bodies (e.g., aircraft) within a uniform treatment. The total moment is shown to be compounded of the contributions from four simple motions and a clear physical meaning is attached to each contribution. Applied to aircraft motions, the formulation includes the nonlinear interactions between motions that normally are excluded in the classical treatment. The results may be useful in the design of experiments and the interpretation of results obtained therefrom. (Author)

A71-22001 # On dynamic stability testing of unconventional configurations. K. J. Orlik-Rückemann, P. A. Adams, and J. G. LaBerge (National Aeronautical Establishment, Ottawa, Canada). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-276.* 11 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

Situations frequently occur when standard wind-tunnel test equipment, based on the concept of an all-containing rear-sting support is impractical or even impossible to use. In this paper some possible alternative test arrangements are indicated and descriptions are given of the actual experimental equipment and procedures. Full- and half-model techniques are discussed and the experimental procedures include free- and forced-oscillation methods. Examples contain cases such as cones at incidence and combinations of two models in close proximity (space shuttle), at supersonic and hypersonic speeds. Comparisons of results obtained with different methods and techniques are included. (Author)

A71-22002 * # Dynamic support interference - Fact or fiction. J. Peter Reding and Lars E. Ericsson (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque,*

N. Mex., Mar. 10-12, 1971, Paper 71-277. 12 p. 23 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS 1-6450.

Available experimental results are reviewed and organized to provide a logical explanation of aerodynamic support interference for dynamic wind tunnel testing. Configurations involving bulbous bases, mass addition, boundary layer transition near the base, and hypersonic low density flows are shown to be particularly sensitive to sting interference effects. Transverse rod support interference occurs at all Mach numbers depending on oscillation amplitude and/or trim angle of attack. The postulated flow model predicts that cylindrical and flared stings will have opposite interference effects in agreement with experimental observations. An analytical method of correcting the wind tunnel results for dynamic support interference is proposed. (Author)

A71-22003 # Wind-tunnel free-flight testing of configurations with high-fineness ratio bodies. John E. Holmes and Frederick A. Woehr (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-278.* 12 p. Members, \$1.50; nonmembers, \$2.00.

The launch and data-reduction techniques used in supersonic wind-tunnel free-flight testing are described. Included are descriptions of the launcher and launch head designs used with fin-stabilized, high-fineness ratio (up to 40) bodies. At the lower initial angles of attack, up to approximately 15 degrees, the models were spun prior to launch. The high angle-of-attack launches, up to 90 degrees, were made with models having no initial spin. The method of differential corrections was used to fit the observed data to the nonlinear second-order differential equations of motion for both three and six degrees of freedom. Results containing nonlinear forces and moments have been obtained for three-degree-of-freedom flights with initial angles of attack of 40 degrees. Both the progress and problems encountered in using the method of differential corrections in the development of free-flight testing are discussed. (Author)

A71-22004 # Three-degree-of-freedom gas bearing for wind-tunnel dynamic measurements. Frank J. Regan and Eugene V. Horanoff (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-279.* 5 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

Supports used in the measurement of dynamic forces and moments in a wind tunnel often limit model motion to a single degree of freedom. NOL has relaxed this single-degree-of-freedom restriction with the development of a three-degree-of-freedom gas bearing which allows the model to spin, pitch and yaw simultaneously. In the NOL design, the model is attached to the ball in a ball and socket bearing. Lubricating gas (at present air) is admitted through adjustable pads into the region between the ball and socket. Each pad is allowed to align itself to the center of the ball. Since each pad has its own gas supply, the gas pressure to each pad can be adjusted independently to accommodate heavy models or models having high axial loads. A variety of digital and analog transducers for determining angular position and rate are under consideration. However, in the present discussion only photographic records are used. The pitch damping of a blunted, slender cone has been measured using this gas bearing in an NOL wind tunnel at a Mach number of 5. The measurements have been reduced using the NOL free-flight data-reduction program and are presented in the form of the pitch-damping derivative. (Author)

A71-22006 * # Sonic-boom wind-tunnel testing techniques at high Mach numbers. Odell A. Morris and David S. Miller (NASA,

A71-22010

Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-280.* 7 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

Sonic-boom wind-tunnel tests are known to present severe problems associated not only with accurate construction of very small models but also with the presence of tunnel flow angularities, interference from model mounting apparatus, and boundary-layer effects. Recent experience has shown that some of these problems become critical at high supersonic speeds. The problems are reviewed and techniques for avoiding them or minimizing their effect are discussed. Sample of pressure signatures obtained at Mach numbers up to 4.63 through use of improved techniques are shown. (Author)

A71-22010 # The use of a laser Doppler velocimeter in supersonic flow. W. J. Yanta, D. F. Gates, and F. W. Brown (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-287.* 9 p. 16 refs. Members, \$1.50; nonmembers, \$2.00.

Results are presented for an experimental program which investigated the application of an LDV technique in supersonic flows. This paper presents an analysis of the behavior of light-scattering particles in rapidly accelerating or shock decelerated flows, an evaluation of particle production techniques and the results of several velocity measurements. Measurements include the velocity distribution along the nozzle centerline and flow over a diamond airfoil in a Mach 3 tunnel and velocity profiles for a turbulent boundary layer in a Mach 4.8 facility. It is demonstrated that LDV measurements can be made consistently with errors of less than five percent if the particle lag is considered. (Author)

A71-22012 # Scale effect studies of airfoil profile drag at high subsonic speed. Dezsó George-Falvy (Boeing Co., Commercial Airplane Group, Renton, Wash.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-289.* 13 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

Experimental techniques and data correlations from a series of tests involving airfoil profile drag measurements are presented. Full-scale flight measurements of wing section profile drag and boundary layer characteristics were made on a Boeing 727 jet transport using a newly developed traversing probe. The flight test results were correlated with corresponding wind tunnel data obtained from a scale model of the test airplane and from two-dimensional tests of the airfoil. The two-dimensional tests were conducted in two different facilities: a conventional transonic wind tunnel and a blow-down-type high Reynolds number tunnel. It was concluded that: (1) the drag increment due to roughness and excrescences on the wing section tested is about 15%; (2) the data correlate well with respect to minimum profile drag using the conventional scaling rules; (3) the correlations are less satisfactory with respect to the polar shape and drag rise; (4) the main problems affecting drag prediction from wind tunnel data are uncertainties regarding the extent of laminar flow on the model (even with trip) and scale effects on shock/boundary layer interaction; and (5) flight testing is preferable to high Reynolds number wind tunnel testing for verifying the performance of advanced airfoils. (Author)

A71-22013 # Experimental wall interference studies in a transonic wind tunnel. D. P. Cumming and W. H. Lowe (General Dynamics Corp., Convair Aerospace Div., San Diego, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-292.* 9 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

Interference study utilizing a 4- by 4-foot high-speed wind tunnel equipped with either porous or slotted walls. The porous walls

behaved like an open jet based on measurements of downwash and streamline curvature correction factors; the slotted wall reduced the downwash corrections to less than delta times alpha = 0.007 C sub L degrees and reduced the streamline curvature to less than delta times C sub m = 0.006 C sub L. The correction factors in both walls were unaffected by wing span-to-tunnel width ratios of 0.71 to 0.88. Wing boundary layer transition was affected by the wall geometry. (Author)

A71-22014 # Store separation from high speed aircraft with emphasis on comparisons of predictions and flight test results. Donald L. Brooks (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-294.* 10 p. Members, \$1.50; nonmembers, \$2.00.

Three methods for predicting store separation characteristics from high-speed aircraft are presented and comparisons are made between flight test results and predictions for each method. Results of the comparisons show good agreement for (1) stores released at subsonic and supersonic speeds and (2) stores released from the weapon bay and from the wing pylon. This finding demonstrates that acceptable methods have been developed to predict full-scale store separation characteristics and that these methods can be used to reduce the flight testing required to clear store release envelopes. (Author)

A71-22015 # External store pressure distributions during captive flight aboard an F-4B aircraft. C. F. Markarian (U.S. Naval Weapons Center, China Lake, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-295.* 12 p. Members, \$1.50; nonmembers, \$2.00.

A captive flight store, instrumented to measure detailed surface pressure distributions, was constructed and tested as part of an experimental investigation of the effects of the carrying aircraft on the flow field about airborne ordnance. Surface pressure distributions were obtained at Mach numbers from 0.6 to 2.0 and altitudes ranging from nearly ground level to over 40,000 feet. Wind tunnel tests of a scale model of the captive flight store alone were conducted in order to provide interference-free, reference pressure distributions. Comparison between the captive flight and wind tunnel data aided the identification and evaluation of the full scale flow disturbances. Significant interference effects, in particular flow redirection and shock wave impingement, are evident in the captive flight data. Instrumentation and test techniques are described, and representative captive flight and wind tunnel test results are presented. (Author)

A71-22016 # A comparison of flight test data for two subsonic spin stabilized projectiles with trajectory predictions based on aerodynamic data obtained in a water tunnel. N. Seiden (Susquehanna Corp., Alexandria, Va.) and T. M. Ward (California Institute of Technology, Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 6th, Albuquerque, N. Mex., Mar. 10-12, 1971, Paper 71-296.* 5 p. Members, \$1.50; nonmembers, \$2.00.

Experimental determination of accurate aerodynamic data necessary for predicting the trajectories of two subsonic spin-stabilized projectiles. The two configurations tested were basically right circular cylinders; the first had a blunt nose and tail whereas the second differed only in having an unusually shaped rounded nose. The aerodynamic data were obtained in a free surface water tunnel test series. Based on the data, trajectories for the two projectiles are calculated. O.H.

A71-22025 * # **Fatigue and fracture mechanics.** Herbert F. Hardrath (NASA, Langley Research Center, Materials Div., Hampton, Va.). (*American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics, and Materials Conference, 11th, Denver, Colo., Apr. 22-24, 1970, AIAA Paper 70-512.*) *Journal of Aircraft*, vol. 8, Mar. 1971, p. 129-142. 203 refs.

Review of the complex design problems involved in the development of an efficient airframe capable of operating economically and safely for a long life. Existing design procedures for fatigue are based primarily on empirical rules and results taken from systematic test series. Large numbers of tests are being performed to evaluate the adequacy of designs and much judgment is employed to produce flightworthy structures. A purely analytical fatigue design method is not yet available. If it were, tremendous numbers of calculations would be required. The scatter inherent in fatigue behavior and in service conditions would require that results of such analyses be interpreted statistically. Consequently, effective designs will continue to be produced through a judicious combination of experience, intuition, fatigue analysis, and evaluation testing. The use of high-strength materials has increased the chances of major failures caused by moderate damage or flaws. Fracture mechanics analysis procedures appear capable of treating simple problems of this sort, but are not yet adequate for complex structural and loading conditions. However, simple applications of these procedures provide a useful rationale for defining inspection techniques and schedules. M.V.E.

A71-22026 # **Dynamics of circular periodic structures.** Thomas J. McDaniel (Dayton, University, Dayton, Ohio). *Journal of Aircraft*, vol. 8, Mar. 1971, p. 143-149. 15 refs. Contract No. AF 33(615)-67-C-1187.

The frequency response matrix is determined for a periodically supported, periodically damped, closed circular beam structure which is an approximate model of a skin-stringer aircraft fuselage structure. The analytical technique which is developed depends on the periodic nature of the structure to simplify the analysis. The analysis is a complementary approach to the transfer matrix method for determining frequency response. One purpose of the analysis is to circumvent the numerical and/or computer storage difficulties commonly found in computing the frequency response for typical aircraft fuselage structure from a transfer matrix analysis. Numerical difficulty is avoided by using the properties of the transfer matrix for one periodic unit and a consequence of the Cayley-Hamilton theorem to obtain an analytical solution for the frequency response matrix. The second purpose of the analysis is to investigate the spatial decay of response from a point or region of the structure which is being excited. This spatial decay isolates the response to a region of structure near the excitation and reduces the overall dynamic stress level of the structure for a general excitation. Three damping devices that utilize a viscoelastic link to produce spatial decay are evaluated. Several numerical examples are shown. (Author)

A71-22028 * # **Vortex breakdown on slender sharp-edged wings.** W. H. Wentz, Jr. (Wichita State University, Wichita, Kan.) and D. L. Kohlman (Kansas, University, Lawrence, Kan.). (*American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, Los Angeles, Calif., July 14-16, 1969, Paper 69-778.*) *Journal of Aircraft*, vol. 8, Mar. 1971, p. 156-161. 14 refs. NSF-supported research; Grant No. NGR-17-002-043.

Systematic wind-tunnel investigations of vortex breakdown have been conducted on sharp-edged delta and modified delta wings with sweep angles from 45 to 85 degrees at Reynolds numbers of about 1,000,000, utilizing a schlieren system for flow visualization. Vortex breakdown positions are presented as a function of angle of attack and sweep. Lift measurements generally compare favorably with Polhamus' leading-edge suction analogy. Drag due to lift is predicted quite satisfactorily as the streamwise component of normal force for all models tested. Effects of vortex breakdown on pitching moments

are presented and discussed. Tests of the modified delta wings show that vortex breakdown is influenced much more strongly by planform changes near the apex than changes near the trailing edge. (Author)

A71-22029 # **Wind-tunnel boundary interference on a V/STOL model.** Ching-Fang Lo (ARO, Inc., Arnold Air Force Station, Tenn.). (*American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 5th, Tullahoma, Tenn., May 18-20, 1970, Paper 70-575.*) *Journal of Aircraft*, vol. 8, Mar. 1971, p. 162-167. 13 refs.

Boundary-layer transition experiments were conducted in the AEDC-VKF 12- and 40-in. supersonic wind tunnels at Mach numbers 3 and 4 on an adiabatic wall, 10-deg total-angle sharp cone. The effects of spherical roughness elements and free-stream disturbances (radiated aerodynamic noise) on transition were investigated. The large variation in smooth wall transition locations which exists on models in supersonic wind tunnels of different sizes is shown to influence trip performance. These studies have also indicated that the 'effective point' location proposed by van Driest, et al. is relatively independent of the smooth wall transition location (or free-stream disturbance and tunnel size) at supersonic speeds. The correlation parameters developed by van Driest-Blummer and Potter-Whitfield are examined, and their ability to predict the tripped transition location is discussed. (Author)

A71-22030 # **An efficient, steady, subsonic collocation method for solving lifting-surface problems.** Atlee M. Cunningham, Jr. (General Dynamics Corp., Fort Worth, Tex.). (*American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 8th, New York, N.Y., Jan. 19-21, 1970, Paper 70-191.*) *Journal of Aircraft*, vol. 8, Mar. 1971, p. 168-176. 18 refs.

In the collocation approach for solving the integral equation of steady subsonic lifting-surface theory, accurate integration of the product of the kernel and pressure functions over the wing surface is required before a stable solution can be achieved. A Gaussian quadrature integration technique is developed which includes correction terms that account for the error incurred while integrating through the singularity and discontinuity of the kernel function. It is shown how inconsistent treatment of the chordwise discontinuity will cause the spanwise integration to diverge with increasing integration chords. An optimum relationship is given between chordwise downwash points and excess chordwise integration points. Also given is an empirically determined optimum ratio of spanwise to chordwise control points based on planform geometry. By comparison with experiment and other theories, the method is shown to be both stable and accurate as well as more efficient than methods based on finite aerodynamic element representations of lifting surfaces. (Author)

A71-22032 # **Minimum time turns for a supersonic airplane at constant altitude.** J. Karl Hedrick and Arthur E. Bryson, Jr. (Stanford University, Stanford, Calif.). *Journal of Aircraft*, vol. 8, Mar. 1971, p. 182-187. 9 refs.

Optimal control theory is used to determine thrust, bank angle, and angle-of-attack programs for minimum time turns of a supersonic airplane at constant altitude for three different terminal conditions: (1) both heading angle and velocity specified, (2) only heading angle specified, (3) only velocity specified. The angle-of-attack is constrained to be less than the stall angle of the aircraft and the thrust is constrained to be less than the maximum attainable thrust, which at constant altitude is a function of velocity. Numerical results are given for a typical supersonic airplane at two different altitudes. These results show that in general a variable velocity, variable bank angle turn at full throttle is minimizing. (Author)

A71-22033 # **Crossflow profiles for compressible, turbulent boundary layers.** J. Richard Shanebrook (Union College,

Schenectady, N.Y.) and William J. Sumner. *Journal of Aircraft*, vol. 8, Mar. 1971, p. 188, 189. 7 refs. NSF Grant No. GK-12697.

Demonstration that a family of hodograph models, previously applied to the crossflow velocity component of three-dimensional, turbulent, incompressible boundary layers, provides an adequate representation for compressible crossflow profiles with (S-shaped profiles) and without (D-shaped profiles) flow reversal. It is recommended that this family of crossflow models can be considered in future developments of practical momentum integral methods for predicting the behavior of three-dimensional, compressible, turbulent boundary layers. M.M.

A71-22035 # Determination of the aerodynamic characteristics of an elastic swept wing in subsonic flow (Opredelenie aerodinamicheskikh kharakteristik uprugogo strelovidnogo kryla v dozvukovom potoke). A. Kh. Karimov. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 5-13. In Russian.

An approximate method of calculating the aerodynamic loads acting on an elastic swept wing with given lift characteristics. In the calculation of the elastic strains, the wing is schematically represented by a beam subjected to combined bending and torsion, and the redistribution of the aerodynamic loads caused by the deformations is taken into account. The aerodynamic forces acting on a swept wing in subsonic flow are calculated by Belotserkovskii's (1965) method. The procedure of calculating the aerodynamic loads is outlined for various laws of deformation of the middle surface. The method proposed is well suited for engineering calculations of external loads acting on an aircraft in the solution of static aeroelasticity problems. V.P.

A71-22039 # Shape of the leading edge of a minimum-drag slender wing for hypersonic velocities (Forma perednei kromki tonkogo kryla minimal'nogo soprotivleniia pri giperzvukovykh skorostiakh). E. I. Filatov. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 39-43. 6 refs. In Russian.

The problem of the shape of the leading edge of a minimum-drag hypersonic wing is analyzed within the framework of Newtonian theory, under the assumption that the bluntness curve of the wing profile is known. The cases where the bluntness curve is constant over the wing span, and where the bluntness curves are similar at each cross section of the wing, are examined. In the first case, a rectilinear leading edge is found to be the optimum configuration. In the second case, a series expansion in powers of the derivative of the radius of bluntness for the functional defining the characteristic drag of the leading edge is obtained under the assumption that the radius of bluntness varies gradually along the leading edge. The shape of the leading edge is diagrammed for examples corresponding to each case. V.P.

A71-22041 # Flow for a sudden widening of the channel (Techenie pri vnezapnom rasshirenii kanala). G. M. Gorelov and A. E. Trianov. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 54-62. 11 refs. In Russian.

The flow in a channel abruptly widening at one side is studied theoretically and experimentally. A new formula for calculating the flow boundary in the circulation is proposed. A formula for calculating the dimensionless velocity profile in the expanding region of the flow is derived within the framework of Prandtl's semi-empirical turbulence theory, under the assumption of a linear shearing stress distribution across the flow. The experimental data employed were obtained in a wind tunnel blown with air. V.P.

A71-22042 # Selection of the design point on the characteristic curve of the fan of a turbofan engine with a large bypass ratio (K voprosu o vybore raschetnoi tochki na kharakteristike ventilatora DTRD s vysokoi stepen'iu dvukhkoturnosti). N. V. Pervyshin and

T. P. Kuchinskaiia. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 63-69. In Russian.

The characteristics of bypass engines with a bypass ratio between 1 and 8, a takeoff gas temperature in front of the turbine between 1300 and 1500 K, a compression ratio in the inner contour between 20 and 25, and an optimal energy distribution between the contours are analyzed. It is shown that an increase in bypass ratio leads to a pronounced decrease in specific impulse, and thereby in the flight velocity. The influence of the decrease in specific impulse on the temperature level in front of the turbine in cruising flight is examined. Guidelines for selecting a design point on the characteristic curve of the fan at takeoff, which provides the required vertical thrust, are proposed. V.P.

A71-22044 # Experimental investigation of radial-flow energy losses in the rotating circular cylindrical-profile cascade of an inward-flow-turbine wheel (Eksperimental'noe issledovanie poter' energii radial'nogo potoka vo vrashchaiushcheisia krugovoi reshetke tsilindricheskikh profilei rabocheho koleasa tsentrostremitel'noi turbiny). V. B. Avdeev. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 75-85. 6 refs. In Russian.

An experimental procedure for determining the rotation energy loss for an inward-flow-turbine wheel at low subsonic velocities of the radial flow is proposed. The procedure is applied to the determination of the energy loss balance of the cascade. The profile losses and the exit blade angle are determined as a function of the angle of incidence. V.P.

A71-22045 # Probabilistic estimate of the aerodynamic imbalance of aircraft gas-turbine rotors (Veroiatnostnaia otsenka aerodinamicheskoi neuravnovesennosti rotorov aviatsionnykh GTD). A. I. Gleizer and G. P. Fedorchenko. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 86-93. In Russian.

A method of determining the aerodynamic imbalance of gas-turbine rotors, caused by production errors of turbine and compressor rotor blades, is proposed. The analysis is limited to errors in the flow passage cross-sectional area of turbines and to errors in the blade angle of compressors. The method proposed is useful for determining the excitation forces acting on a rotor, which are required, for example, in damper design. V.P.

A71-22048 # Investigation of the flow parameters in a centrifugal-pump wheel (Issledovanie parametrov potoka v rabochem kolese tsentrobezhnogo nasosa). D. V. Stetsiuk. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 108-114. 11 refs. In Russian.

An optical method of measuring local flow velocities in centrifugal-pump channels is developed and is applied to the measurements of the relative flow velocity of water in the channels. It is shown that under normal operating conditions, the flow in a radial channel separates from the blades near the outlet. As a result, the fluid lags behind in the rotation of the channel, and its angular velocity becomes smaller than that of the channel and of the fluid particles at the blades. Because of this, an excess energy is imparted to the particles at the blades. These results may explain the discrepancy observed between experimental and theoretical flow parameters in centrifugal-pump channels. V.P.

A71-22049 # Some results of investigations of centripetal and radial-flow stages (Nekotorye rezul'taty ispytaniia radial'no-osevykh i radial'nykh stupeniei). G. A. Filippov, M. F. Zatsepin, K. K. Aleksandrov, and I. E. Rozenshtein. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 115-123. In Russian.

The influence of the exit blade angle on the economic viability and thrust ratio of a centripetal stage is analyzed, and the optimum exit blade angle is determined. It is shown that flow rate control by means of variable-pitch nozzle guide vanes is the most advantageous

of such techniques. Relations for the efficiency of centripetal, radial-flow, and axial-flow stages are obtained. It is shown that radial-flow and axial-flow stages have the same flow coefficients. A formula for calculating the pressure in the nozzle throat from the pressure behind a radial-flow cascade is proposed. V.P.

A71-22050 # Analytical methods of determining the characteristics of certain spatial maneuvers of an aircraft (Analiticheskie metody opredeleniia kharakteristik nekotorykh prostranstvennykh manevrov samoleta). L. B. Goroshchenko. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 124-131. In Russian.

Approximate methods of determining the time, path, and fuel consumption required for climb at a constant-radius turn and a constant or variable velocity and constant engine power rating are examined. It is shown that simple formulas can be obtained by taking into account that the engine thrust and the aircraft drag component which is independent of the lifting force vary in direct proportion to the air pressure at heights above 11 km and constant aircraft speed. V.P.

A71-22052 # Construction of lines of flow in a complex region of two-dimensional supersonic flow (K postroeniiu linii toka v slozhnoi oblasti ploskogo sverkhzvukovogo techeniia). lu. 1. Tsybizov. *Aviatsionnaia Tekhnika*, vol. 13, no. 3, 1970, p. 135-140. 6 refs. In Russian.

A method of calculating the lines of flow in a two-dimensional supersonic flow region characterized by the interaction of rarefaction waves from several disturbance sources. The flow lines are obtained in two variables which are analogs of generalized polar coordinates. By using a moving system of coordinates, flow lines can be constructed in the plane of the flow from a known solution of the hodograph equations. A numerical example is included. V.P.

STAR ENTRIES

N71-16901# Lockheed Missiles and Space Co., Palo Alto, Calif.
ANALYTICAL SOLUTIONS FOR THE CASE OF FLYING VEHICLE MOTION AT LOW ANGLES OF ATTACK, CHAPTER 8. THREE DIMENSIONAL MOTION

G. E. Kuzmak [1970] 10 p refs Transl. into ENGLISH from the book "Dinamika Nepravliaemogo Dvizheniia Letatelnykh Apparatov pri Ukhode v Atmosferu" Moscow, Nauka Press, 1970 p 307-321

Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

The three-dimensional motion of a flying vehicle at low angles of attack is examined. Emphasis is given to the EE' section of the trajectory, which abuts directly on the boundary of the atmosphere. A linear theory of three-dimensional motion is discussed.

Author

N71-16902# Lockheed Missiles and Space Co., Palo Alto, Calif.
VISCOUS GAS FLOW IN A SHOCK LAYER IN THE PRESENCE OF EQUILIBRIUM CHEMICAL REACTIONS

I. M. Breev [1970] 4 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 4, 1970 p 150-153

Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

Stationary supersonic air flow around a sphere is considered taking into account viscosity, heat conduction, and real physicochemical processes. Under the assumption of local thermodynamic equilibrium, the flow in the shock layer is investigated at flight velocities of 3 to 10 km/s. Simplified Navier-Stokes equations, whose solution is found by finite differences, are used to describe the flow. The case of a cooled body surface is examined. A distribution of the gasdynamic parameters is obtained in different flow modes. The heat flux and friction coefficient distribution as a function of the free stream parameters and the sphere radius is investigated. The shape and location of the shock wave are determined, and streamlines and sonic lines are constructed.

Author

N71-16903# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE QUESTION OF THE VALUE OF ENTROPY ON THE SURFACE OF A BODY OF REVOLUTION AT A NONZERO ANGLE OF ATTACK

M. D. Ladyzhenskii [1970] 2 p Transl. into ENGLISH from the book "Prostranstvennye Giperzvukovye Tsecheniia Gaza" Moscow, Mashinostroenie, 1968 p 28-29

Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

The entropy takes on its maximum value on the surface of a body of revolution at a zero angle of attack. Computations and experiments show that the entropy retains its maximum value even at nonzero angles of attack, to the accuracy obtained in these computations and experiments.

Author

N71-16904# TRW Systems Group, Redondo Beach, Calif.
HIGH-SPEED GROUND TRANSPORTATION SYSTEMS ENGINEERING STUDY: TRACKED AIR CUSHION VEHICLE

SYSTEMS Final Report

May 1970 623 p refs

(Contract DOT-C-353-66)

(PB-195030: TRW-06818-6039-R0-00: FRA-RT-71-59) Avail: NTIS HC\$10.00/MF\$0.65 CSCL 13F

The tracked air cushion vehicle is one of several advanced ground transportation systems being studied as a possible means of providing safe, high-speed, high-capacity transportation along densely populated areas. Based on requirements and constraints chosen for an operational system, subsystem alternatives are evaluated and the selected subsystems are synthesized into a TACV system. Cost and performance are estimated over a range of parameters, such as design cruise speed (150 to 350 mph) and vehicle capacity (50 to 150 passengers per vehicle). The configuration defined consists of trainable, electrically powered TACV's which collect power from trackside power rails mounted on the side of a channel guideway. Propulsion is by linear induction motors with variable frequency speed control. Control of the vehicles, singly or in trains, is automated and centralized. The vehicles are supported on and guided by peripheral jet air cushions with high pressure air provided by electrically driven axial flow compressors.

Author (GRA)

N71-16951# Lockheed Missiles and Space Co., Palo Alto, Calif.
VISCOUS HYPERSONIC FLOW AROUND A NONAXISYMMETRIC SLENDER BODY

M. D. Ladyzhenskii [1970] 9 p refs Transl. into ENGLISH of the book "Prostranstvennye Giperzvukovye Tsecheniia Gaza" Moscow, Mashinostroenie, 1968 p 47-58

Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

Results are presented of a numerical computation of viscous hypersonic flow around a nonaxisymmetric, slender, elongated body whose generator in each meridian plane is the parabola y is approximately $x(3/4)$. It is assumed that the streamlined body differs slightly from a body of revolution. As the computational results show, the lift on the body for the case of a heat insulated wall exceeds the lift in an inviscid flow.

Author

N71-16983# Lockheed Missiles and Space Co., Palo Alto, Calif.
ANALYTICAL SOLUTIONS FOR THE CASE OF FLYING VEHICLE MOTION AT LOW ANGLES OF ATTACK, CHAPTER 8. 32: PLANE MOTION, DETERMINATION OF THE TIME OF TRANSITION OF ROTATIONAL INTO VIBRATIONAL MOTION

G. E. Kuzmak [1970] 8 p refs Transl. into ENGLISH from the book "Dinamika Nepravliaemogo Dvizheniia Letatelnykh Apparatov pri Vkhode v Atmosferu" Moscow, Nauka Press, 1970 p 297-307

Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

Considered are cases of motion when the equation for the angle of attack on the EE' section of the trajectory directly abutting on the boundary of the atmosphere has an exact solution expressed in terms of Bessel functions. The motion must occur at low angles of attack. This assumes compliance with definite demands on the approach of a flying vehicle to the boundary of the atmosphere. Solutions expressed in terms of Bessel functions allow clarification of a number of motion details when the angular velocity of the flying vehicle outside the atmosphere is quite low.

Author

N71-16987# Oklahoma Univ. Research Inst., Norman.
STATE OF OKLAHOMA AIRPORT PLAN

May 1970 150 p refs Sponsored in part by Okla. Aeron. Comm. and HUD Prepared for Okla. Ind. Develop. and Park Dept. and Okla. Aeron. Comm.

(PB-194937) Avail: NTIS CSCL 01E

A systematic plan for airport development over the time

N71-16988

period to 1980 was considered. To accomplish this task, the project was separated into five work elements: (1) verification and classification of airports; (2) determinants of airport facilities; (3) aviation development model; (4) test of the model; (5) schedule of projected investments for Oklahoma airports. Author (GRA)

N71-16988# Regional Planning Commission, Cleveland, Ohio. **DATA FILE EDITING AND PRELIMINARY ANALYSIS, CLEVELAND-HOPKINS AIRPORT ACCESS STUDY Final Report**

May 1970 174 p
(Contract DOT-OS-A9-023)
(PB-195047; DOT-OS-A9-023-3) Avail: NTIS CSCL 13B

An analysis of the impact of the rapid rail extensions on airport users was conducted before the opening of the rail transit service to the airport and another survey was conducted one year later after the rail rapid service was opened. The data from these surveys were compared to determine the effect of the new rail transit service on the choice of travel mode by the different groups of airport users. The report documents the procedures used in the preparation of files for analysis of the surveys. Author (GRA)

N71-16989# Regional Planning Commission, Cleveland, Ohio. **DATA FILE FORMATS AND CODE DESCRIPTIONS, CLEVELAND-HOPKINS AIRPORT ACCESS STUDY Final Report**

Jun. 1970 90 p
(Contract DOT-OS-A9-023)
(PB-195048; DOT-OS-A9-023-4) Avail: NTIS CSCL 13B

The impact of rapid rail extension was analyzed. A survey of airport users was conducted before the opening of the rail transit service to the airport and another survey was conducted one year later after the rail rapid service was opened. The data from these surveys were compared to determine the effect of the new rail transit service on the choice of travel mode by the different groups of airport users. The report documents the file formats and code descriptions for the survey data tape. Author (GRA)

N71-16990# Regional Planning Commission, Cleveland, Ohio. **CLEVELAND-HOPKINS AIRPORT ACCESS STUDY: SURVEY RESULTS Final Report**

Jun. 1970 163 p
(Contract DOT-OS-A9-023)
(PB-195045; DOT-OS-A9-023-1) Avail: NTIS CSCL 13B

A survey of airport users was conducted before the opening of the rail transit service to the airport and another survey was conducted one year later after the rail rapid service was opened. The data from these surveys were compared to determine the effect of the new rail transit service on the choice of travel mode by the different groups of airport users. The report compares the results of the surveys. Author (GRA)

N71-16991# Regional Planning Commission, Cleveland, Ohio. **CLEVELAND-HOPKINS AIRPORT ACCESS STUDY: AIR PASSENGER SURVEY SELECTED TABULATIONS Final Report**

Jun. 1970 275 p
(Contract DOT-OS-A9-023)
(PB-195049; DOT-OS-A9-023-5) Avail: NTIS CSCL 13B

An analysis of the impact of the rapid rail extension to Hopkins Airport was performed. A survey of airport users at Hopkins Airport was conducted before the opening of the rail transit service to the airport and another survey was conducted one year

later after the rail rapid service was opened. The data from these surveys were compared to determine the effect of the new rail transit service on the choice of travel mode by the different groups of airport users. The report presents selected tabulations. Author (GRA)

N71-16992# Regional Planning Commission, Cleveland, Ohio. **CLEVELAND-HOPKINS AIRPORT ACCESS STUDY: SURVEY PROCEDURES Final Report**

May 1970 126 p
(Contract DOT-OS-A9-023)
(PB-195046; DOT-OS-A9-023-2) Avail: NTIS CSCL 13B

Analyzed is the impact of rapid rail extension to Hopkins Airport. A survey of airport users at Hopkins Airport was conducted before the opening of the Cleveland Transit System rail transit service to the airport and another survey was conducted one year later after the rail rapid service was opened. The data from these surveys were compared to determine the effect of the new rail transit service on the choice of travel mode by the different groups of airport users. This report documents the procedures used in the surveys. Author (GRA)

N71-16993# Lockheed Missiles and Space Co., Palo Alto, Calif. **NEW ON-BOARD INSTRUMENTS**

F. Gerchikov [1970] 4 p Transl. into ENGLISH from Aviat. i Kosmonavt. (Moscow), no. 9, 1970 p 20-21
Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

The design of a sensitive altimeter for high speed aircraft and space vehicles is described. The instrument uses radioactive radiation from the aircraft, together with energy level measurements of photons reflected from earth, for control. Reflected photons proceed to a detector, through an amplifier and to an altitude pulse selection circuit whereupon the signal Poisson distribution is converted into a Gaussian distribution and then into normal signals. Altimeter accuracy at the 2.5 to 3m critical preset-down flight altitude is about 2.5 cm, which is satisfactory for jet aviation demands. G.G.

N71-17044# Royal Aircraft Establishment, Farnborough (England). Engineering Physics Dept. **TEMPERATURE AND FLUID PROPERTY EFFECTS ON CAVITATION IN AIRCRAFT FUEL PUMPS**

W. G. S. Lester London Aeron. Res. Council 1970 27 p refs
Supersedes RAE-TR-69165; ARC-31725
(ARC-CP-1128; RAE-TR-69165; ARC-31725) Copyright. Avail: NTIS; HMSO: 40p; BIS: \$1.60

Problems of measuring net positive suction head (NPSH) are considered and a test technique for examining cavitation performance using a closed loop system is described. Results from a small booster pump operating in water and kerosene fuel confirmed that less NPSH is required to pump the fluids at elevated temperatures than when cold. The pump performance with kerosene was inferior to that with cold water as NPSH is reduced due to the difference in air solubility between the two fluids. Prediction of pump cavitation performance in aircraft fuels will be difficult because of the influence of dissolved air content and the dependence of the vapor pressure of multi-component fluids on vapor/liquid ratios. Author (ESRO)

N71-17046# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany). Inst. fuer Angewandte Gasdynamik.

DATA ACQUISITION ON HYPERSONIC WIND TUNNELS [MESSWERTERFASSUNG AN HYPERSCHALLWINDKANALEN]

Josef Thelen Sep. 1970 47 p refs In GERMAN; ENGLISH

summary

(DLR-FB-70-44) Avail: NTIS; ZLDI Munich: 14.10 DM

A digital data acquisition system for hypersonic wind tunnels is described. The hardware controlled system scans up to 50 channels at high speed (10,000 measurements/sec), digitizes the input signals, and records them on magnetic tape. The data are punched on paper tape for further processing in a computing center.

Author (ESRO)

N71-17063# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: COMPANIA DOMINICANA DE AVIACION DOUGLAS DC-4, CARVAIR ATL 98, HI-168 NEAR MIAMI INTERNATIONAL AIRPORT, MIAMI, FLORIDA, 23 JUNE 1969

12 Aug. 1970 34 p

(NTSB-AAR-70-17; SA-415) Avail: NTIS

Dominicana Airlines, Flight 401, a DC-4, operating as a cargo flight from Miami, Florida, to Santo Domingo, Dominican Republic, crashed shortly after takeoff from Miami International Airport on June 23, 1969. The aircraft was destroyed by impact and the ensuing ground fire. Several buildings in the area of the accident site were also damaged. The four occupants of the aircraft, as well as six persons on the ground, were fatally injured. The Safety Board determined that the probable cause of the accident was the confused action on the part of the crew while attempting to cope with the catastrophic failure of an engine during takeoff.

Author

N71-17081# National Physical Lab., Teddington (England), Aerodynamics Div.

AN ANALYSIS OF SOURCES OF ERROR IN TYPICAL PRESSURE MEASUREMENTS IN A BLOWDOWN SUPERSONIC TUNNEL

P. G. Pugh and J. Peto Nov. 1969 24 p refs

(NPL-AERO-1306; ARC-31585) Avail: NTIS

Pressure measurement errors at supersonic speeds due to transducer calibration, electrical noise, transducer nonlinearity, test section flow non-uniformity, model manufacturing tolerances, as well as static hole diameter, depth, position, and quality were separately identified. The accuracy of pressure measurements in blowdown supersonic wind tunnels is also discussed.

Author (ESRO)

N71-17082# Royal Aircraft Establishment, Bedford (England), Aerodynamics Dept.

LOW SPEED FLIGHT TESTS ON A TAILLESS DELTA WING AIRCRAFT (AVRO 707B). PART 4: WING FLOW

D. H. Perry, W. G. A. Port, and J. C. Morrall London Aeron. Res. Council 1970 52 p refs Supersedes RAE-AERO-2639; ARC-22256

(ARC-CP-1107-Pt-4; RAE-AERO-2639-Pt-4; ARC-22256-Pt-4) Copyright. Avail: NTIS; HMSO: 50p; Bis: \$2.00

Flow visualization tests showed that the growth of the separated area occurred by progressive inboard movement of a separation boundary which lay roughly chordwise across the wing so accounting for most of the changes in the aerodynamic characteristics of the aircraft at high incidence. Attempts to reduce the longitudinal instability caused by the flow separation with wing fences and a notch were unsuccessful.

Author (ESRO)

N71-17083# Royal Aircraft Establishment, Bedford (England), Aerodynamics Dept.

LOW SPEED FLIGHT TESTS ON A TAILLESS DELTA WING AIRCRAFT (AVRO 707B). PART 3: LATERAL STABILITY

AND CONTROL

D. H. Perry, J. C. Morrall, and W. G. A. Port London Aeron. Res. Council 1970 80 p refs Supersedes RAE-AERO-2638; ARC-22242

(ARC-CP-1106-Pt-3; RAE-AERO-2638-Pt-3; ARC-22242-Pt-3)

Copyright. Avail: NTIS; HMSO: 85p; Bis: \$3.40

Measurements of the aileron and rudder powers enabled the sideslip and damping derivatives to be determined. The control powers and sideslip derivative measurements agreed with wind tunnel measurements, and high lift coefficient changes were consistent with smoke and tuft wing flow studies. The derivatives were used to estimate the period, damping and roll-yaw ratio of the lateral oscillation which agreed with the flight measurements.

Author (ESRO)

N71-17084# National Gas Turbine Establishment, Pyestock (England).

INGESTION OF DEBRIS INTO INTAKES BY VORTEX ACTION

D. E. Glenny London Aeron. Res. Council 1970 47 p refs Supersedes NGTE-R-307; ARC-31474

(ARC-CP-1114; NGTE-R-307; ARC-31474) Copyright. Avail: NTIS; HMSO: 48p; Bis: \$2.40

The impulsive lifting of particles by the ground-to-intake vortex core is considered both theoretically and experimentally. For a given inlet velocity the strength of the vortex and the maximum size of particle that can be lifted depends on ambient vorticity and the strength of the wind blowing on to the intake. Various methods of reducing ingestion were examined but none provided an absolute safeguard. However, a progressive opening of the throttle as the aircraft initially accelerates, may reduce the ingestion problem.

Author (ESRO)

N71-17085# National Physical Lab., Teddington (England), Aerodynamics Div.

AN EXPERIMENTAL INVESTIGATION OF WIND-TUNNEL WALL CONDITIONS FOR INTERFERENCE-FREE DYNAMIC MEASUREMENTS

A. W. Moore and K. C. Wight Dec. 1969 50 p refs

(NPL-AERO-1307; ARC-31704) Copyright. Avail: NTIS

Results of dynamic tests on two model half-wings performing pitching oscillations in a tunnel with a slotted roof and floor and perforations of variable size behind the slots are presented. A porosity which gives small interference for all speeds in the range from 0.40 to 1.05 M is discussed and a method is suggested for selecting a wall porosity to give interference-free damping derivatives; interference-free stiffness derivatives are not simultaneously obtained and small corrections to measured values are required.

Author (ESRO)

N71-17089# National Physical Lab., Teddington (England), Aerodynamics Div.

SOME OBSERVATIONS ON VORTEX SHEDDING AND ACOUSTIC RESONANCES

M. Gaster Jan. 1970 17 p refs

(NPL-AERO-1311; ARC-31829) Copyright. Avail: NTIS

Acoustic resonances excited by vortex shedding from cylinders and plates are discussed. It is shown that very powerful resonances can be produced, but that these are determined by the dimensions of the wind tunnel and not solely by the model as previously proposed.

Author (ESRO)

N71-17099# Association Internationale des Constructeurs de Materiel Aerospatial, Paris (France).

INVENTORY OF THE PRINCIPAL EUROPEAN WIND

TUNNELS CAPABLE OF BEING USED FOR AERODYNAMIC TESTS IN THE POST APOLLO PROGRAM

J. Brocard 1970 9 p Presented at the 4th EUROSPACE US-European Conf., Venice, 22 - 25 Sep. 1970

Avail: NTIS

Size, stagnation pressure, Reynolds number and Mach number ranges of European wind tunnels operating in the subsonic, transonic, supersonic, and hypersonic ranges, and at low density, are tabulated. ESRO

N71-17100# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

AN INVESTIGATION OF THE STRESSES IN A WIND TUNNEL CORNER SECTION

D. E. W. Stone and P. S. A. Baxter London Aeron. Res. Council 1970 62 p refs Supersedes RAE-TR-69021; ARC-31468 (ARC-CP-1117; RAE-TR-69021; ARC-31468) Copyright. Avail: NTIS; HMSO: 75p; BIS: \$3.00

The stresses were studied with a 1/6 scale model and both the brittle coating technique and elevated temperature strain gages were employed. The thermal and pressure stresses were simulated separately. Author (ESRO)

N71-17102# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

THE CONTROL CHARACTERISTICS OF AIRCRAFT EMPLOYING DIRECT-LIFT CONTROL

W. J. G. Pinsker London Aeron. Res. Council 1970 61 p refs Supersedes RAE-TR-68140; ARC-30835L (ARC-R/M-3629; RAE-TR-68140; ARC-30835) Copyright. Avail: NTIS; HMSO: £ 1.50; BIS: \$5.40

The theory is developed for the control characteristics of aircraft in which direct lift is commanded directly by the pilots' stick. Basic requirements are established for acceptable response characteristics; of particular importance is the location at which direct lift acts relative to the center of gravity, the aerodynamic center, and maneuver point. The line of action of the control lift can be controlled by mechanical interconnections between the conventional pitch control and direct lift systems. Potential benefits of direct lift control include improved precision in landing large aircraft, more effective control of gust effects, and reduced possibility of stalling. Author (ESRO)

N71-17103# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

RECTANGULAR AND CARET SAILS IN SUPERSONIC FLOW

L. H. Townsend London Aeron. Res. Council 1970 56 p refs Supersedes RAE-TR-67006; ARC-29541 (ARC-R/M-3624; RAE-TR-67006; ARC-29541) Copyright. Avail: NTIS; HMSO: £ 1.40; BIS: \$5.40

For free stream Mach numbers between 10 and 4, a study is made of the profiles assumed and isentropic waves produced in nonviscous flows by two-dimensional sails, under pure tension and of finite weight. At the higher free stream Mach numbers, large parts of the compression flow are virtually centered, and even for long sails (e.g. 100 ft chord) at a high Mach number (e.g. 10) and low stress (e.g. 5 tons/sq in), the weight of such a membrane need not exceed 1 lb/sq ft. The analysis is modified to include the effects of skin friction and is then extended to singly-curved caret sails, which allow leading edges to be swept but can still produce two-dimensional waves; while their curvature imparts to such sails a stiffness-due-to-shape, it is shown that equilibrium can alternatively be maintained by appropriately applied tensile forces. Rectangular and/or caret sails may find applications as wings, intakes, cowls, and nozzles for hypersonic vehicles. Author (ESRO)

N71-17108# Liverpool Univ. (England). Dept. of Mechanical Engineering.

A WIND-TUNNEL INVESTIGATION OF THE STALLING PERFORMANCE OF TWO COMPRESSOR CASCADES OF DIFFERENT ASPECT RATIOS AT LOW SPEED

M. R. A. Shaalan London Aeron. Res. Council 1970 41 p refs Sponsored jointly by Min. of Aviation and United Arab Rep. Govt. Supersedes ARC-30083 (ARC-CP-1103; ARC-30083) Copyright. Avail: NTIS; HMSO: 50p; BIS: \$2.00

The blade section profile was staggered at 36 deg with a space-chord ratio of 0.88, and there was no tip clearance. Changes in aspect ratio were obtained by changing the blade chord only. The high aspect ratio blade (4.83) gave more deflection at mid-span near stall, but it stalled earlier and suddenly and the high pressure rise coefficient increased slightly with incidence up to the stall point. The low aspect ratio blade (2.10) stalled more progressively. The increase in axial velocity for both cascades was high, a greater spanwise contraction being evident for the low aspect ratio. The wall stall for the high aspect ratio blade was nearly equally distributed between the blade surface and the end wall, whilst it was shifted towards the blade surface for the other one. Author (ESRO)

N71-17109# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

ON LIFTING SURFACES SUPPORTING ONE OR MORE PLANE SHOCK WAVES

J. Pike London Aeron. Res. Council 1970 41 p refs Supersedes RAE-TR-66127; ARC-28452 (ARC-R/M-3623; RAE-TR-66127; ARC-28452) Copyright. Avail: NTIS; HMSO: £ 1.05; BIS: \$3.78

Stream surfaces from the flow through a plane shock wave are used as compression surfaces to obtain higher lift to drag ratios than the two dimensional wedge ones. Two such compression surfaces can be combined into a W-Nonweiler shape, which gives in effect a central body below a swept wing. The viscous drag tends to be high, because the shapes have a large ratio of wetted area to plan area. For hypersonic speeds where the inviscid improvement over a two dimensional wedge is small, the high viscous drag puts the W-wings at a disadvantage compared with flat-bottomed configurations. At high supersonic speeds the inviscid improvement is more marked and a gain in performance, including viscosity, over that of the two dimensional wedge, and flat-bottomed shapes can be shown. For best performance the trailing edge of the W-wing is swept and its pressure drag and viscous drag are approximately equal. Author (ESRO)

N71-17112# Queen Mary Coll., London (England). Dept. of Aeronautical Engineering.

DELTA WINGS WITH LONGITUDINAL CAMBER AT LOW SPEED

R. K. Nangia and G. J. Hancock London Aeron. Res. Council 1970 29 p refs Supersedes ARC-31588 (ARC-CP-1129; ARC-31588) Copyright. Avail: NTIS; HMSO: 37.5p; BIS: \$1.50

Comparison of experimental results for the streamwise lift distribution on a delta wing of aspect ratio 1 having various streamwise cambers with simplified slender linear theory was good even for large cambers, although linear theory is totally inadequate for total lift prediction. Author (ESRO)

N71-17113# Aircraft Research Association, Ltd., Bedford (England).

TESTS WITH A WING-MOUNTED FAN NACELLE WITH THE FAN JET SIMULATED BY COLD AIR BLOWING

AND ALTERNATIVELY BY A GAS GENERATOR SHROUD
Interim Report

G. Pauley London Aeron. Res. Council 1970 47 p refs
Supersedes ARA-M-28/1; ARC-30158
(ARC-CP-1111; ARA-M-28/1; ARC-30158) Copyright. Avail:
NTIS; HMSO: 70p; BIS: \$2.80

Wind tunnel tests were made on a simulated high by-pass ratio fan engine mounted close to a wing to determine the interference effects in the Mach number range from 0.6 to 0.81. The nacelle and adjacent wing surfaces were fully pressure plotted and overall force measurements were obtained. Comparisons with test data from a free flow nacelle supported by a pylon suggests that the nacelle has a major influence on the local wing flow, whereas a pylon could be designed to have relatively little effect on this flow. Free flow nacelle effects were amplified by a cold fan jet. Attempts at reproducing the jet effects with a simple gas generator shroud were a complete failure. Author (ESRO)

N71-17114# Royal Aircraft Establishment, Farnborough (England), Aerodynamics Dept.

THE ESTIMATION OF THE LOADING ON SWEEPED WINGS WITH EXTENDING CHORD FLAPS AT SUBSONIC SPEEDS

J. McKie London Aeron. Res. Council 1970 45 p refs
Supersedes RAE-TR-69034; ARC-31285
(ARC-CP-1110; RAE-TR-69034; ARC-31285) Copyright. Avail:
NTIS; HMSO: 60p; BIS: \$2.40

A method is given for estimating lift and vortex drag increments due to part span, extending chord flaps on thin, sweptback, tapered wings of large aspect ratio in inviscid, incompressible flow. This linear theory accounts for sweepback, tip, and center effects. Spanwise loadings are obtained by quadrature methods, extended to include discontinuities in wing chord, and examples are given for some typical wing and flap layouts. Author (ESRO)

N71-17117# Royal Aircraft Establishment, Farnborough (England), Aerodynamics Dept.

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF TRAILING-EDGE SWEEPBACK ON THE SUBSONIC LONGITUDINAL CHARACTERISTICS OF SLENDER WINGS

D. L. I. Kirkpatrick and A. G. Hepworth London Aeron. Res. Council 1970 33 p refs
Supersedes RAE-TR-70039; ARC-32237
(ARC-CP-1130; RAE-TR-70039; ARC-32237) Copyright. Avail:
NTIS; HMSO: 42.5p; BIS: \$1.70

Measurements of the lift, drag, and pitching moment characteristics on three slender ogee wings with different trailing-edge sweepback angles are presented. The characteristics of these wings are correlated with those of wings with unswept trailing edges. Author (ESRO)

N71-17118# Royal Aircraft Establishment, Bedford (England), Aerodynamics Dept.

SUPER VC 10 CRUISE DRAG: A WIND TUNNEL INVESTIGATION. PART 1: EXPERIMENTAL TECHNIQUES

C. R. Taylor, J. R. Hall, and R. W. Hayward London Aeron. Res. Council 1970 44 p refs
Supersedes RAE-TR-69180; ARC-31771
(ARC-CP-1125; RAE-TR-69180; ARC-31771) Copyright. Avail:
NTIS; HMSO: 60p; BIS: \$2.40

Measurements were made of the longitudinal forces and moments on a 1/27 scale model of the Super VC 10 at Mach numbers between 0.60 and 0.86. The model design, test techniques and corrections, and the measuring techniques are discussed. Author (ESRO)

N71-17119# Laboratorium für Betriebsfestigkeit, Darmstadt (West Germany).

FREQUENCY DISTRIBUTIONS AND EXTREME VALUES OF THE CENTER OF GRAVITY ACCELERATION AND OF THE STRESS ON LOWER WING SURFACE OF A BOEING 720-B [HAEUFIGKEITSVERTeilUNGEN UND EXTREMWERTE DER SCHWERPUNKTSBESCHLEUNIGUNG UND DER SPANNUNG AN DER FLUEGELUNTERSEITE EINER BOEING 720-B]

O. Buxbaum Fraunhofer Ges. Mar. 1970 44 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verkehr
(TB-87-1970) Avail: NTIS

In order to evaluate the effects of gust load seasonal variations on airframes the following parameters were recorded continuously during 571 flights of a Boeing 720-B airplane during normal service and analyzed statistically: vertical acceleration near center of gravity, lower wing in-spar skin stress, pressure altitude and air-speed, airplane takeoff and landing weights, and flight duration. Author (ESRO)

N71-17130*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

INVESTIGATION OF FLOW CHARACTERISTICS OF SOME WIRE-FORM AND LAMINATE-FORM POROUS MATERIALS

Albert Kaufman and Hadley T. Richards Washington Oct. 1970 23 p refs
(NASA-TM-X-2111; E-5748) Avail: NTIS CSCL 01A

Experimentally determined flow characteristics were correlated with standard flow rates and absolute filtration ratings of wire-form materials and with functions of hydraulic diameters and external hole spacings of laminate-form materials. Effects on flow characteristics of specimen curvature and use of high temperature air up to 840 degrees F were investigated. The conclusion was drawn that flow rates both for elevated temperature conditions and for specimen curvatures simulating leading edge radii of turbine blades can be predicted with good accuracy from correlations developed and the basic flow equation for porous materials. Author

N71-17131*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

CONVECTIVE HEAT TRANSFER TO THE AMES M2 AND M2-F2 LIFTING ENTRY VEHICLES

H. Lee Seegmiller Washington Dec. 1968 83 p refs
(NASA-TM-X-1691) Avail: NTIS CSCL 01C

The convective heat transfer to the M2 and M2-F2 lifting entry vehicles has been measured at angles of attack from minus 7 degrees to plus 77 degrees during tests at hypersonic Mach numbers. Heating of the configuration is generally concentrated at the nose, pitch control, and fin leading edges at low angles of attack and at the lower surface, pitch control, and extended rudders at high angles of attack. Three dimensional separated flow occurred in the region of the lower pitch controls and extended rudders in all tests at the lower angles of attack. Author

N71-17132*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

BASE PRESSURE MEASUREMENTS ON THE XB-70 AIRPLANE AT MACH NUMBERS FROM 0.4 TO 3.0

Edwin J. Saltzman, Sheryll A. Goecke, and Chris Pembo Washington Sep. 1968 36 p refs
(NASA-TM-X-1612) Avail: NTIS CSCL 01C

Full-scale flight base pressure coefficients obtained from the XB-70 propulsion package are compared with predicted values based on a combination of cold jet flow wind-tunnel models and data from a two-engine side-by-side jet, full scale aircraft. At cruise Mach numbers the base pressures on the full-scale aircraft were higher than predicted, resulting in a favorable increment of about two percent in terms of lift-drag ratio. At low supersonic speeds

near a Mach number of 1.2, the negative base pressure coefficients were about three times larger than predicted, resulting in a significant lift-drag ratio decrement. Author

N71-17144# National Physical Lab., Teddington (England). Hovercraft Unit.

THE CORRECTION OF HOVERCRAFT PERFORMANCE TO STANDARD CONDITIONS

J. C. Shipway Sep. 1970 54 p refs
(NPL-Hovercraft-16) Copyright. Avail: NTIS

Coefficients, derived from trials with four different hovercraft types, for correcting hovercraft performance to assumed standard conditions are discussed. The results suggest that craft performance is best compared on the basis of achieved Froude number versus (observed wave height/overall craft length). Author (ESRO)

N71-17145# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Physik der Atmosphaere.

SYNOPTIC AEROLOGICAL CONDITIONS FOR THE OCCURRENCE OF CLEAR AIR TURBULENCE [DIE SYNOPTISCHAEROLOGISCHEN BEDINGUNGEN FUER DAS AUFTRETEN VON CLEAR-AIR-TURBULENZ]

Friedhold Weber Aug. 1970 113 p refs In GERMAN; ENGLISH summary
(DLR-FB-70-29) Avail: NTIS; ZLDI Munich: 34.50 DM

After a literature review the results of Lufthansa North Atlantic jet stream clear air turbulence (CAT) observations are given. Vertical acceleration was related to certain meteorological situations and different atmospheric parameters. Special synoptic aerological conditions during which moderate or severe CAT can be expected are discussed. Author (ESRO)

N71-17160# National Physical Lab., Teddington (England). Hovercraft Unit.

MOVEMENT OF HIGH DENSITY LOADS

A. T. A. Wride Jul. 1970 34 p
(NPL-Hovercraft-TM-31) Copyright. Avail: NTIS

High density loads can be moved over 1 in. obstacles using fingered skirts giving a hoverheight of 2 in. and cushion pressures up to 5 p.s.i. Author (ESRO)

N71-17161# National Physical Lab., Teddington (England). Hovercraft Unit.

A COMPARISON OF THE CRUISE EFFICIENCY AND RANGE OF MARINE VEHICLES AND AIRCRAFT

J. R. Bishop Jun. 1970 36 p refs
(NPL-Hovercraft-12) Copyright. Avail: NTIS

The discussion also includes jet aircraft which are often excluded from comparisons with marine vehicles because their shaft power is not known. Data are also presented for ships, aircraft, hovercraft, hydrofoils, and helicopters. High speed marine vehicles have cruise efficiencies considerably lower than those of aircraft due to inferior lift-drag ratio and propulsive efficiency. Author (ESRO)

N71-17179# National Physical Lab., Teddington (England). Aerodynamics Div.

THE RESPONSE OF A TURBULENT BOUNDARY LAYER ON AN INFINITE SWEEPED WING TO THE SUDDEN REMOVAL OF PRESSURE GRADIENT

P. Bradshaw (Imperial Coll.) and M. G. Terrell (Rolls-Royce, Ltd., Derby) Oct. 1969 31 p refs

(NPL-AERO-1305; ARC-31514) Copyright. Avail: NTIS

A limited series of measurements showed no appreciable dependence of turbulence structure on moderate three-dimensionality, although large differences between the direction of the shear stress vector and the direction of the velocity gradient vector appeared in the outer layer. Author (ESRO)

N71-17181# Oerlikon Machine Tool Works, Zurich (Switzerland). **PROSPECTUS FOR A EUROPEAN COMPANY WITH REGARD TO THE OPERATION OF REGIONAL APPLICATION SATELLITE SYSTEMS**

P. L. Burckhardt 1970 9 p Presented at the 4th EUROSPACE US-European Conf., Venice, 22 - 25 Sep. 1970
Avail: NTIS

Major ESRO projects proposed to European government, e.g. telecommunication, air traffic, and meteorological satellites, are outlined. The importance of creating regional application satellite systems and a European company (EUROSAT) are emphasized. Problems are analyzed and solutions suggested. ESRO

N71-17190# Idaho Nuclear Corp., Idaho Falls. **SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT TEST REPORT: TESTS 822 AND 823**

D. J. Olson and J. F. Whitbeck Oct. 1970 58 p refs
(Contract AT(10-1)-1230)
(IN-1393) Avail: NTIS

The preliminary test results of two decompression experiments (Tests 822 and 823) performed in the Semiscale Blowdown Emergency Core Cooling Project are presented. The purpose of the Semiscale Blowdown and Emergency Core Cooling Project is to provide the experimental data base required for the development and assessment of analytical models for the prediction of the thermal-hydraulic behavior occurring in a large PWR during a loss-of-coolant accident. Tests 822 and 823 were initiated by hot leg breaks of a system configuration that includes both an operating loop and a simulated core with internals. The break size in Test 822 was 30% of the pipe area (0.027 sq ft), and the break size in Test 823 was 100% (0.09 sq ft). The measurements obtained provided information on fluid conditions as a function of time including quality, velocity, and mass flow rate as well as subcooled pressure loads throughout the loop and thrust measurements on the vessel. Author (NSA)

N71-17247# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STATIC-PRESSURE CONTOURS IN THE BLADE PASSAGE AT THE TIP OF SEVERAL HIGH MACH NUMBER ROTORS

Genevieve R. Miller and Everett E. Bailey Washington Feb. 1971 16 p refs
(NASA-TM-X-2170; E-5875) Avail: NTIS CSCL 01A

Static pressure contours across the blade passage at the tip of three high Mach number rotors are presented. Inlet relative Mach numbers vary from 1.23 to 1.59. Flow rates vary from near choke values to those near blade stall. Blade shapes include both double circular arc and multiple circular arc. The static pressure contour plots indicate the location of the passage shock waves over a range of Mach numbers and operating conditions. Qualitative comparisons of flow conditions through blade passages for the two blade shapes can be made. However, a quantitative analysis of the data is not attempted. Author

N71-17253# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF THE VIKING LANDER CAPSULE AT MACH 6

Theodore J. Goldberg and James C. Emery Washington Feb. 1971 18 p refs

(NASA-TM-X-2205; L-7516) Avail: NTIS CSCL 20D

An investigation of the longitudinal aerodynamic characteristics of a 0.0348-scale Viking lander capsule has been conducted at a Mach number of 6 and free-stream Reynolds numbers from 0.98×10 to the 7th power to 2.35×10 to the 7th power per meter. Data obtained at angles of attack from -3 deg to 20 deg were compared with analytical values obtained by the sine squared deficiency method and modified Newtonian theory. Author

N71-17254*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ACOUSTIC AND AERODYNAMIC PERFORMANCE OF A 6-FOOT DIAMETER FAN FOR TURBOFAN ENGINES. 3: PERFORMANCE WITH NOISE SUPPRESSORS

Edward J. Rice, Charles E. Feiler, and Loren W. Acker Washington Feb. 1971 61 p refs

(NASA-TN-D-6178; E-5878) Avail: NTIS CSCL 21E

Inlet and exhaust noise suppressors for a 6-ft. (1.83-m-) diameter fan for a high-bypass-ratio turbofan engine were tested. The perforated-plate-on-honeycomb suppressors provided a much broader band noise attenuation than was predicted. Perceived noise level attenuations obtained due to the suppressors were 13 and 12 PNdB for simulated approach and takeoff conditions, respectively. The theory used for the design of the suppressors is discussed. In general, the theory predicts the frequency for peak attenuation but underpredicts the peak attenuation amplitude. For frequencies above and below peak, the observed attenuations are more than predicted. Degradations of aerodynamic performance caused by the noise suppressors were smaller than the experimental errors, which were estimated to be 2 percent. Author

N71-17330# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

AN INVESTIGATION OF THE SCATTER IN VARIABLE-AMPLITUDE FATIGUE-TEST RESULTS OF 2024 AND 7075 MATERIALS

A. M. Stagg London Aeron. Res. Council 1970 119 p refs

Supersedes RAE-TR-69110; ARC-32032 (ARC-CP-1123; RAE-TR-69110; ARC-32032) Copyright. Avail: NTIS; HMSO: £ 1.50p; BIS: \$5.40

The fatigue life scatter of identical specimens was estimated, using a log-normal distribution, from several experimenters' results. These estimates were analyzed for the effect of various test loading parameters on the magnitude of the scatter produced and the results are discussed in terms of a simple fatigue failure model.

Author (ESRO)

N71-17334# National Physical Lab., Teddington (England). Aerodynamics Div.

THE USE OF AERODYNAMIC-STABILIZING STRAKES ON CHIMNEY STACKS SUPPORTING PIPES

D. E. Walshe and C. F. Cowdrey Feb. 1970 29 p refs

(NPL-AERO-1310) Copyright. Avail: NTIS

Aerodynamic stability tests were carried out on linear mode models to compare the excitation of a model stack of circular cross section with that for a stack supporting a small diameter pipe. The presence of the pipe increased the excitation and it was reduced, but not eliminated, by strakes. Author (ESRO)

N71-17345*# Connecticut Univ., Storrs. Dept. of Electrical Engineering.

CONTROL OF DISTRIBUTED PARAMETER SYSTEMS AS APPLIED TO A LUNAR LANDING VEHICLE SIMULATOR

George W. Starkweather Jan. 1971 59 p refs Revised (Grant NGL-07-002-002)

(NASA-CR-116482) Avail: NTIS CSCL 14B

A study was undertaken for the purpose of obtaining an improved feedback control for a lunar landing vehicle simulator. The simulator, used to train astronauts for lunar landing, consists of a cable supported, rocket propelled vehicle. The lunar gravity is simulated by maintaining tension on the cable equal to $5/6$ of the vehicle weight. A drum, onto which the cable is wound, is controlled to keep the proper tension on the cable, and to allow the cable length to be changed. The scope of the investigation is restricted to a study of vehicular motion along a horizontal coordinate axis. Since for small perturbations the responses of the system along the three axes are decoupled, the study can to a first approximation be readily generalized to include the three dimensional case.

Author

N71-17354*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECTS OF SPECIFIC SPEED ON THE EXPERIMENTAL PERFORMANCE OF A RADIAL-INFLOW TURBINE

Milton G. Kofskey and William J. Nusbaum Washington Feb. 1971 29 p refs

(NASA-TN-D-6182; E-5928) Avail: NTIS CSCL 21E

A 4.97-inch (12.62-cm) tip diameter radial-inflow turbine was investigated over a range of specific speeds from 36 to 76 (rpm) at equivalent design speed and pressure ratio. This specific speed range was obtained by using stators with different throat areas. Each stator was tested with the unmodified or design rotor and with a rotor extension that reduced the rotor throat area to 53 percent of design. Results are presented to show the effect of the change in specific speed on turbine performance. Comparison is made between results obtained with the design rotor and with the rotor extension. Author

N71-17372# Advisory Group for Aerospace Research and Development, Paris (France).

HIGH TEMPERATURE TURBINES

Jan. 1971 587 p refs Presented at the 36th Meeting of the AGARD Propulsion and Energetics Panel, Florence, 21-25 Sep. 1970

(AGARD-CP-73-71) Avail: NTIS HC\$6.00/MF\$0.95

Cooling techniques for turbine blades of high temperature aeronautical gas turbine engines. Advanced cooling methods and the application of improved heat resistant materials are discussed.

N71-17373# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).

HIGH ENTRY TEMPERATURE TURBINE ON TURBOREACTORS AND GAS TURBINES [DES HAUTES TEMPERATURES DEVANT TURBINE SUR TURBOREACTEURS ET TURBINES A GAZ]

P. Alesi In AGARD High Temp. Turbines Jan. 1971 14 p In FRENCH

Avail: NTIS HC\$6.00/MF\$0.95

High entry temperatures for gas turbine engines decrease specific wear and always augment reduced pressures so that gas turbines can compete with Diesel engines in operational performance. Studies on turbocompressors with increased inlet temperatures showed that specific power in simple and double fluxes of moderate expansion increased and that all compressor double flux expansion rates were augmented threefold. Increased temperatures at turbine inlets augment compression and improve the efficiency of compression diluting elements. Transl. by G.G.

N71-17374# National Gas Turbine Establishment, Pyestock (England).

HEAT TRANSFER CALCULATIONS FOR TURBINE BLADE DESIGN

J. Dunham and J. P. Edwards /in AGARD High Temp. Turbines Jan. 1971 18 p refs

Avail: NTIS HC\$6.00/MF\$0.95

The operating temperature of a cooled turbine blade depends on the heat transfer rate from the hot gas stream, the heat conduction within the metal, and the heat convection to the cooling air. Discussed are methods of calculating these factors, and their application to blade design. The effect of cooling on turbine performance is also considered. Author

N71-17375# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).

TEMPERATURE DETERMINATIONS IN THE BLADES OF CONVECTION COOLED TURBINES [DETERMINATION DES TEMPERATURES DANS LES AUBES DES TURBINES REFROIDIES PAR CONVECTION]

G. Chiron /in AGARD High Temp. Turbines Jan. 1971 13 p refs In FRENCH

Avail: NTIS HC\$6.00/MF\$0.95

A mathematical method is presented for calculating the temperature distribution in a convectively cooled turbine blade by considering the temperature constraints imposed on blade life in the estimation. Comparison between experimental and theoretical results verify the validity of this method for short and median length operations. Transl. by G.G.

N71-17376# Rolls-Royce, Ltd., Bristol (England): Bristol Engine Div.

OLYMPUS 593 TURBINE COOLING

M. J. Holland /in AGARD High Temp. Turbines Jan. 1971 21 p refs

Avail: NTIS HC\$6.00/MF\$0.95

Turbine cooling effectiveness and efficiency are defined for subsequent use in descriptions of cooling performance. The factors affecting the choice of cooling design point and the sources of cooling air are discussed. In particular, the use of 5th stage H.P. compressor air in place of compressor delivery air is shown to result in lower rotor blade temperatures for the H.P. turbine. The differing environments and requirements for turbine stator and rotor blades are discussed, together with the importance of combustion chamber outlet gas temperature profiles. The turbine rotor and stator blades are convection-cooled and are fairly conventional. The evolution of the various blade cooling designs is described together with summaries of their cooling performance. Author

N71-17377# Sussex Univ., Brighton (England). School of Applied Sciences.

HEAT TRANSFER INSTRUMENTATION

A. B. Turner /in AGARD High Temp. Turbines Jan. 1971 18 p refs

Avail: NTIS HC\$6.00/MF\$0.95

A brief review of heat transfer instrumentation with particular attention to the requirements of the gas turbine engineer is presented. The work is focused primarily on heat fluxmeters, recent developments in methods of temperature measurement and thermocouple installation errors. In this latter section a numerical procedure for the problem of sensors embedded in insulation channels is presented together with some correlations and predictions for typical examples in solid and porous surfaces. Author

N71-17378# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

HEAT FLUX MEASUREMENTS ON FIXED TURBINE BLADES [MESURES DE FLUX DE CHALEUR SUR AUBES FIXES DE TURBINES]

Jacques Michard /in AGARD High Temp. Turbines Jan. 1971 9 p refs In FRENCH; ENGLISH Summary

Avail: NTIS HC\$6.00/MF\$0.95

Experimental results obtained on a set-up including a moderately high temperature combustion chamber (1300 K) and two stages of fixed blades are presented. The first stage is used as a distributor, the other one turning the flow parallel to its upstream direction at the outlet. Heat transfer and local exchange coefficients obtained with an upstream Mach number of 0.2 and a Reynolds number of 25,000 per cm are analyzed. Author

N71-17379# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Luftsaugende Antriebe.

TEMPERATURE MEASUREMENTS WITH THERMOCOUPLES INCLUDING ERRORS CAUSED BY CATALYTIC EFFECTS

P. Stottmann /in AGARD High Temp. Turbines Jan. 1971 10 p refs

Avail: NTIS HC\$6.00/MF\$0.95

Several methods for the temperature measurement in combustion gas are discussed, especially the measurement with thermocouples. Corrections for compensation of the influences due to flow velocity, radiation, and heat conduction are described. In case of using noble metal thermocouples the possible errors by catalytic effects are studied. Experimental results are presented, which show the ignition of a fuel-air-mixture outside the boundary layer of the probe, initiated by the catalytic influence of the platinum surface. The reproducible catalytic effects, which initiate or force reactions in a gaseous fuel-air-mixture are dependent on the external flow conditions, gas temperature, gas velocity, fuel-air-ratio, and the distribution and evaporation of the fuel. Coating the noble metal surfaces with Al₂O₃ avoids the catalytic effects. Author

N71-17380# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).

DESIGN OF SMALL DIMENSION TURBINE BLADE BY THEORETICAL ANALYSIS [DESSIN D'UNE AUBE DE TURBINE DE PETITE DIMENSION AU MOYEN DE PROCEDURES THEORIQUES]

C. Loudet /in AGARD High Temp. Turbines Jan. 1971 28 p refs In FRENCH; ENGLISH Summary

Avail: NTIS HC\$6.00/MF\$0.95

The method of blade boundary layer optimization due to Le Foil is used for the calculation of a small turbine blade, in incompressible flow, with Goldstein's method for the resolution of the inverse potential flow problem. A blade with a cusped trailing edge has been calculated for the following flow conditions: inlet angle 32 deg, outlet angle 54.8 deg and Reynolds number based on the chord and outlet velocity. This blade gives a theoretical loss coefficient, based on the dynamic outlet pressure, of 4.45%. The calculated losses are in good agreement with the experimental results taking into account the fact that a truly two dimensional flow could not be obtained during the tests. Author

N71-17381# United Aircraft of Canada, Ltd., Longueuil (Quebec). AN EXPERIMENTAL COOLED RADIAL TURBINE

U. Okapuu and G. S. Calvert (Pratt and Whitney Aircraft, West Palm Beach, Fla.) /in AGARD High Temp. Turbines Jan. 1971 12 p

Avail: NTIS HC\$6.00/MF\$0.95

A cooled radial turbine, suitable for compressor drive in a twin spool engine, was designed and is at present undergoing experimental evaluation. Assumed turbine design point conditions were 2300 degrees F inlet temperature, 17-1/2 atmospheres inlet

pressure, 4.9 lbs/sec. mass flow rate, 5.1:1 turbine pressure ratio, 220 BTU/lb. enthalpy drop, and a rotational speed of 67,000 rpm. Turbine components are nickel alloy castings in which cooling air passages are incorporated. The design features of the turbine and the results of thermal and stress analyses of its components are described. Author

N71-17382# Motoren-und Turbinen-Union Muenchen G.m.b.H. (West Germany).

EFFUSION COOLING OF TURBINE BLADES

H. Prechter, A. Schoenbeck, and N. Scholz *In* AGARD High Temp. Turbines Jan. 1971 14 p refs

Avail: NTIS HC \$6.00/MF \$0.95

Theoretical and experimental investigations into the aerodynamic and thermodynamic performance of effusion cooled turbine blades are presented. To estimate the aerodynamic and cooling performance an extensive computer programme has been worked out, the physical background of which is described in this report. Few available experimental test results are drawn on to back up the theoretical procedure. Some parametric studies are presented showing the chord- and spanwise temperature distributions for an effusion cooled blade with different coolant flow distribution. The cooling effectiveness is investigated for various parametric changes and compared with that of an internally cooled blade. The aerodynamic behaviour reveals a considerable increase in profile loss coefficient of a porous turbine blade both with and without coolant effusion. The effect on overall engine performance by using an effusion cooled high pressure turbine in a modern turbo-jet engine is briefly discussed. Author

N71-17383# Sussex Univ., Brighton (England). School of Applied Sciences.

TRANSPIRATION-COOLED TURBINES

F. J. Bayley and A. B. Turner *In* AGARD High Temp. Turbines Jan. 1971 16 p refs

Avail: NTIS HC \$6.00/MF \$0.95

The steps in the development chain of air cooling for gas turbine components and transpiration cooling are described. The three modes of heat transfer involved in transpiration cooling (gas side heat transfer, coolant side heat transfer, and interstitial heat transfer) are discussed separately. Finally, consideration is given to the practical problems of transpiration cooling in advanced gas turbines. Author

N71-17384# Curtiss-Wright Corp., Wood-Ridge, N.J.

EXPERIENCE WITH TRANSPIRATION COOLED BLADES

S. Lombardo and S. L. Moskowitz (Sucola di Guerra Aerea) *In* AGARD High Temp. Turbines Jan. 1971 20 p refs

Avail: NTIS HC \$6.00/MF \$0.95

The propulsion system requirements of advanced aircraft necessitate incorporation of significant technological advances in the state-of-the-art of major components in the engine. These advances evolve from the use of advanced design concepts coupled with adequate testing to substantiate the performance and durability through component and full scale engine testing. Achievement of high turbine inlet temperatures in turbine engines through the use of transpiration air-cooled turbine blades is considered. Briefly reviewed are the various transpiration air-cooled turbine blades evaluated. This evaluation includes blade design aspects, modes of fabrication, and materials of construction. The results of component and full scale engine testing, up to 3000 F (1650 C), are also presented. Author

N71-17386# General Electric Co., Cincinnati, Ohio.

HIGH TEMPERATURE TURBINE DESIGN

CONSIDERATIONS

S. N. Suci *In* AGARD High Temp. Turbines Jan. 1971 29 p refs

Avail: NTIS HC \$6.00/MF \$0.95

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

N71-17387# Technische Hochschule Aachen (West Germany). Inst. fuer Strahlantriebe.

EXPERIMENTAL INVESTIGATION ON A SINGLE-STAGE AIR-COOLED GAS TURBINE

W. Kuehl *In* AGARD High Temp. Turbines Jan. 1971 14 p refs

Avail: NTIS HC \$6.00/MF \$0.95

Temperature measurements made within the convection air-cooled rotor blade of a gas turbine during operation cannot deliver complete information of the temperature field; for the number of measuring points is limited by technical considerations. But by using the analogy between the heat flux and the electric current within a three-dimensional model it is possible to determine the heat flow in a complete blade, i.e. the full temperature field within the blade and also the local gas side and coolant side heat transfer coefficients. This paper describes the way from temperature measurements at the turbine rotor to the complete temperature field within the rotor blade. Author

N71-17388*# Minnesota Univ., Minneapolis. School of Mechanical Aerospace Engineering.

FILM COOLING WITH INJECTION THROUGH HOLES

E. R. G. Eckert *In* AGARD High Temp. Turbines Jan. 1971 19 p refs Sponsored by NASA and the Navy

(NASA-CR-116376) Avail: NTIS CSCL 21E

Film cooling with ejection through a row or rows of holes is under consideration for gas turbine blades. Discussed is an analytical approach to the prediction of the effectiveness of this cooling method developed in analogy to a method which proves successful for ejection through a slot and some experimental results which are compared with prediction obtained by this analysis. Author

N71-17389# Centre National de Recherches Metallurgiques, Liege (Belgium).

MEETING REQUIREMENTS FOR HIGH TEMPERATURE GAS TURBINES A CHALLENGE TO METALLURGISTS

D. Coutouradis *In* AGARD High Temp. Turbines Jan. 1971 17 p refs

Avail: NTIS HC \$6.00/MF \$0.95

Metallurgists involved in the development of materials for high temperature gas turbines are challenged by problems of increasing difficulty leading them to explore continually new areas. Some of the current approaches used for the improvement of cobalt and nickel base alloys are reviewed and illustrated. The scope is not limited to an increase in strength but also to insuring structural stability, hot corrosion resistance, coatability. Processing

variables such as hot deformation of normally cast alloys, controlled and directional solidification of conventional or eutectic type alloys, powder metallurgy techniques, are evaluated. Author

N71-17390# National Gas Turbine Establishment, Pyestock (England).

FIBRE STRENGTHENED NICKEL-BASE ALLOY

A. W. H. Morris and A. Burwood-Smith *In* AGARD High Temp. Turbines Jan. 1971 15 p refs
Avail: NTIS HC \$6.00/MF \$0.95

The development and application of high temperature composites for gas turbine blading is discussed. Of the currently available reinforcements examined, only tungsten-5% rhenium wire affords acceptable stability in nickel-base alloys and a satisfactory increase in stress-rupture strength, but only by incurring a weight penalty. The maximum volume fraction reinforcement is controlled by composite density and blade geometry; at the low levels imposed the advantage of reinforcement is controlled by composite density and cooled blade. If adopted, fibre reinforcement is likely to be used in solid blades in engine stages where cooling is prohibitive and then only as a selected area reinforcement. Indeed the whole question of application may rest on the thermal fatigue behavior. Laboratory tests on cylindrical specimens indicate very poor thermal fatigue crack resistance. Application of the newer low density single crystal alumina fibre is also discussed. Author

N71-17391# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

THERMO-CHEMICAL PROTECTION OF REFRACTORY SUPERALLOYS FOR AIRCRAFT GAS TURBINES [PROTECTION DES SUPERALLIAGES REFRACTAIRES POUR TURBINES A GAZ AERONAUTIQUES PAR VOIE THERMO-CHEMIQUE]

Philippe Galmiche *In* AGARD High Temp. Turbines Jan. 1971 12 p refs *In* FRENCH; ENGLISH summary

Avail: NTIS HC \$6.00/MF \$0.95

A first part of the paper is devoted to a survey of the corrosion problems of refractory materials for gas turbines, as they appear at present in the case of the most advanced superalloys. After recalling briefly the main protection methods of refractory superalloys now in use or under study, the second part of the paper describes the chromaluminumization method that has been developed. Author

N71-17392# Societe Nationale d'Etude et de Construction des Moteurs d'Aviation, Corbeil (France).

MATERIALS DEVELOPMENT FOR HIGH TEMPERATURE TURBINES [EVOLUTION DES MATERIAUX POUR TURBINES A HAUTE TEMPERATURE]

Robert Brunetaud *In* AGARD High Temp. Turbines Jan. 1971 8 p *In* FRENCH; ENGLISH summary
Avail: NTIS HC \$6.00/MF \$0.95

Turbine blades and vanes work in complex conditions with creep, thermal fatigue, corrosion, erosion, etc. Base cobalt and base nickel alloys are developed for these turbine parts in new processes (vacuum melting, vacuum precision casting, unidirectional solidification). Spectacular advantages are possible with niobium alloys but the problems of niobium coatings are not resolved. Low cycle fatigue has to be considered more than creep aspects in disk fabrication. New techniques of isothermal forging or the use of wrought sintered products are indicated for the manufacturing of modified alloys from materials used for blades. Author

N71-17393*# Solar, San Diego, Calif.

THE COMPOSITION, MICROSTRUCTURE AND

PROTECTION AFFORDED BY SEVERAL COMMERCIAL COATINGS ON TWO NICKEL-BASE ALLOYS

A. R. Stetson and V. S. Moore *In* AGARD High Temp. Turbines Jan. 1971 56 p refs
(Contract NAS3-9401)
(NASA-CR-116374) Avail: NTIS CSCL 11F

Six commercially available aluminide coatings were evaluated by simulated turbine environmental testing. The environment was the combustion products of JP-5 fuel and air at 0.85 Mach. Coating performance was assessed by weight change and metallographic methods. Electron microprobe X-ray analyses and, to a limited extent, X-ray diffraction were carried out to identify phases and define compositional differences which could be related to performance. Types of aluminide coatings included in this evaluation program were those containing significant quantities of: (1) silicon; (2) chromium applied either before or after the aluminum; and (3) ceramic material. Coatings were also represented that were hyper- and hypo-stoichiometric in the betaNiAl system. In general, the coatings with the greatest initial aluminum reservoir (thickness) provided the greatest protection. Hyper- rather than hypo-stoichiometric coatings appeared to provide longer protection at the maximum test temperature. The substrate also influenced coating performance with the coatings on B1900 showing consistently better performance than coatings on IN-100. Author

N71-17394# von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).

APPLICATION OF FILM COOLING TO GAS-TURBINE BLADES

C. Liess and J. Carnel *In* AGARD High Temp. Turbines Jan. 1971 11 p refs
Avail: NTIS HC \$6.00/MF \$0.95

The injection of a secondary flow into a high velocity main stream was investigated. The secondary flow was heated and injected by a row of inclined holes into a main flow of ambient temperature. The geometry of the injection holes and the main flow velocity corresponded to conditions encountered on real turbine blades. After a brief review of the application of film cooling to gas turbine blades the results of the measurements are presented. The tests concerned the adiabatic wall effectiveness and the flow field downstream of the injection holes. The test results show that approximate two-dimensional flow conditions can be obtained not far downstream of the holes, provided that the spacing to diameter ratio of the holes is small. Author

N71-17395# Arizona State Univ., Tempe.

EVALUATION OF FILM COOLING PERFORMANCE ON GAS TURBINE SURFACES

D. E. Metzger, J. R. Biddle, and J. M. Warren *In* AGARD High Temp. Turbines Jan. 1971 10 p refs
Avail: NTIS HC \$6.00/MF \$0.95

Film cooling of gas turbine components is often characterized by relatively short cooled lengths and injection geometries which are dictated primarily by fabrication and stress considerations. For many of the resulting configurations, film cooling information based on adiabatic wall temperatures alone is inadequate for design purposes. In addition, the complexity of the film cooling process makes extrapolation of results from one injection configuration to another uncertain. A transient method is described that has been used to rapidly assess the relative performance of various film cooling configurations. Advantages as well as some inherent disadvantages of the method are discussed. The experimental facilities are described, and typical results are presented for a variety of flush, angled injection ports. Emphasis is placed on recent results obtained for high injection rates with variable injection angle, where the heat transfer is dominated by the film flow and effective heat transfer coefficients are much larger than those associated with the primary flow alone. Author

N71-17396# Rolls-Royce, Ltd., Derby (England). Aero Engine Div.

NOZZLE GUIDE VAN COOLING: THE STATE OF THE ART

G. A. Halls *In* AGARD High Temp. Turbines Jan. 1971 19 p ref

Avail: NTIS HC\$6.00/MF\$0.95

Reviewed is the present state of the art on air cooling of nozzle guide vanes for aircraft gas turbines. It shows how the design of the cooling system, and manufacturing techniques have changed over the years to keep pace with increased turbine entry temperatures. The compromise has gradually shifted towards tailoring the design of the vane to operate within the limitations of available materials. Author

N71-17397# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).

COOLING OF TURBINE DISTRIBUTION BLADES THROUGH IMPACT EFFECT [REFROIDISSEMENT DES AUBES DE DISTRIBUTEUR DE TURBINE PAR EFFET D'IMPACT]

E. Bassinot *In* AGARD High Temp. Turbines Jan. 1971 19 p refs *In* FRENCH

Avail: NTIS HC\$6.00/MF\$0.95

One of the improved methods for turbine cooling is the utilization of the impact effect in generating a discharge flow that

allows very sensitive temperature corrections. Discussed are experimental studies that use slotted blades surfaces for distributing cooling air through impacting pressure and theoretical calculations of the effects of certain parameters on the impact. The experimental blade consisted of a heat resistant exterior shell and an inner lining that served as distributor of the cooling air and guided it into the convective cooling regions. The functional motor pressure provided the impact effect. It is concluded that this improved impact cooling method is suitable for distributing blades of advanced turbomachinery. Transl. by G.G.

N71-17398# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

COOLING OF TURBINE BLADES BY LIQUID METALS [REFROIDISSEMENT DES AUBES DE TURBINES PAR LES METAUX LIQUIDES]

E. Le Grives and J. Genot *In* AGARD High Temp. Turbines Jan. 1971 20 p refs *In* FRENCH; ENGLISH summary

Avail: NTIS HC\$6.00/MF\$0.95

Mass transfer conditions in thermosyphon or evaporative cycles under high centrifugal acceleration are first briefly analyzed. Sodium potassium alloys are shown to be best suited on account of their heat transfer ability with air cooled exchangers at the blade roots. A high rotation speed test set-up on which the heat flux on the blades is comparable to that of a real turbine has been extensively used for an experimental study of these processes. Both cycles lead to a temperature drop as high as 650 C at the blade tips, with a mass flow rate of cooling air of 10 g. per sec. kW. However, several advantages are shown to be expectable for the evaporative cycle in view of its application to high temperature gas turbine cooling. Author

N71-17400# Rolls-Royce, Ltd., Derby (England). Aero Engine Div.

THERMAL FATIGUE (FILM)

In AGARD High Temp. Turbines Jan. 1971 9 p

Avail: NTIS HC\$6.00/MF\$0.95

The incidence of thermal fatigue in cooled turbine blades is

illustrated. Problems of this nature have recently been encountered and it is demonstrated how a means of overcoming such problems without resorting to expensive and time consuming rig testing can be provided. Author

N71-17401# National Gas Turbine Establishment, Pyestock (England).

SOME MECHANICAL DESIGN PROBLEMS OF TURBINE BLADES AND DISCS

J. B. Bullard and B. B. Baxendale *In* AGARD High Temp. Turbines Jan. 1971 19 p refs

Avail: NTIS HC\$6.00/MF\$0.95

Internally air-cooled turbine rotor blades usually have a non-uniform temperature distribution. The non-uniform stress pattern thus created is redistributed by creep occurring at different rates within the blade depending on the local value of stress and temperature. The effect of this process on the blade life is discussed and experiments to check the validity of some of the assumptions are described. The stress patterns in rotating discs are modified when plastic strain occurs dependent on the strain-hardening characteristics of the disc material. This places limitations on the use of conventional material properties as design data. These limitations and the effect of the material stress-strain curve on stress redistribution are discussed. Author

N71-17402# Air Force Systems Command, Wright-Patterson AFB, Ohio.

AIR FORCE AERO PROPULSION LAB. AIR-COOLED TURBINE DESIGN CRITERIA

Jack Richens *In* AGARD High Temp. Turbines Jan. 1971 6 p

Avail: NTIS HC\$6.00/MF\$0.95

A new technology for gas turbine engines is developed and applied in new engines. In order to accomplish this, a phased development cycle has been established that permits high levels of risk in the early stages of development reducing to low levels of risk prior to commitment of the substantial resources necessary for development for production. The development cycle with particular attention to the design or selection criteria that have been or are being successfully applied to air-cooled turbines, is described. Author

N71-17404# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).

TECHNOLOGICAL ASPECTS OF TURBINE BLADE COOLING BY AIR FILM [LES ASPECTS TECHNOLOGIQUES DU REFROIDISSEMENT DES AUBES DE TURBINE PAR FILM D'AIR]

Jacques M. Bertrand *In* AGARD High Temp. Turbines Jan. 1971 18 p

Avail: NTIS HC\$6.00/MF\$0.95

Technological aspects of placing cooling air emission holes in turbine blade tip portions are considered by evaluating mechanical blade resistance, internal duct organization resulting in an air film, and fabrication methods suitable for multiple cooling. Theoretical and experimental studies of the operational problems connected with the multiple hole cooling method for turbine blades prove the validity of the concept for application in technically advanced turbo machinery. Transl. by G.G.

N71-17414*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF A SHORT MODULAR TURBOJET COMBUSTOR SEGMENT USING ASTM-A1 FUEL

Richard W. Niedzwiecki and Harry M. Moyer Washington Feb. 1971 33 p refs
(NASA-TN-D-6167; E-5726) Avail: NTIS CSCL 21E

A 27-inch long rectangular combustor segment consisting of an array of 48 combustor modules was tested to determine its performance. Each module mixed and swirled fuel with air and stabilized combustion. Test conditions were inlet temperatures of 600 and 1150 F, a pressure of 3 atmospheres, and reference velocities to 160 ft/sec. Results were combustion efficiencies of 100 percent, a pressure loss of 5.4 percent for an inlet Mach number of 0.25, a heat release rate of 11,860,000 Btu per (hr)(ft³)(atm) for a temperature ratio of 2.5, and pattern factor spans of 0.30 to 0.37 and 0.22 to 0.28 with 600 and 1150 F inlet air temperatures, respectively. Altitude blowout and relight data, as well as a comparison of results with a longer combustor, are also included. Author

N71-17415*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

AERODYNAMIC DAMPING AND OSCILLATORY STABILITY IN PITCH AND YAW OF A VARIABLE-SWEEP SUPERSONIC TRANSPORT CONFIGURATION AT MACH NUMBERS FROM 0.40 TO 1.80

Robert A. Kilgore Washington Feb. 1971 30 p refs
(NASA-TM-X-2164; L-7429) Avail: NTIS CSCL 01C

Wind-tunnel measurements have been made with wing leading-edge sweep angles of 25 deg at Mach numbers of 0.40 and 0.80, 50 deg at Mach numbers of 0.80, 0.90, 1.00, and 1.20, and 75 deg at a Mach number of 1.80. The investigation was made at an oscillation amplitude of about 1 deg by using a forced-oscillation technique. The effects of horizontal and vertical tails, as well as the effect of horizontal-tail height, were investigated. The engine inlets were blocked since internal flow through the engines could not be simulated. In order to determine qualitatively the effect of blocking the engine inlets, tests were also made with a configuration having an ogive nose. Author

N71-17423*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

FLIGHT INVESTIGATION OF A V/STOL TRANSPORT MODEL WITH FOUR POD-MOUNTED LIFT FANS

William J. Newsom, Jr. and Sue B. Grafton Washington Feb. 1971 32 p refs
(NASA-TN-D-6129) Avail: NTIS CSCL 01C

The investigation consisted of free-flight model tests in hovering and forward flight through the transition speed range up to the point where conversion would be wingborne flight. Dynamic stability characteristics of the model were also calculated for correlation with flight results. Because of a small static margin and speed instability, artificial damping in pitch was needed to obtain satisfactory pitch characteristics. No problem was experienced with roll or yaw through the transition speed range. Author

N71-17424*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

VORTEX-LATTICE FORTRAN PROGRAM FOR ESTIMATING SUBSONIC AERODYNAMIC CHARACTERISTICS COMPLEX PLANFORMS

Richard J. Margason and John E. Lamar Washington Feb. 1971 141 p refs
(NASA-TN-D-6142; L-7262) Avail: NTIS CSCL 01A

A computer program was developed for estimating the subsonic aerodynamic characteristics of complex planforms. The program represents the lifting planform with a vortex lattice. The material presented is intended as a user's guide and includes a study of the effect of vortex lattice arrangement on computed results,

several sample cases, and a listing of the FORTRAN computer program. Author

N71-17425*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
SOME TRANSONIC AND SUPERSONIC DYNAMIC STABILITY CHARACTERISTICS OF A VARIABLE-SWEEP-WING TACTICAL FIGHTER MODEL

Robert A. Kilgore Washington Feb. 1971 45 p refs
(NASA-TM-X-2163; L-7428) Avail: NTIS CSCL 01C

Wind-tunnel tests were made by using a small-amplitude forced-oscillation mechanism to determine the damping and oscillatory stability in pitch and in yaw and the effective-dihedral parameter at angles of attack from about -5 deg to 17 deg at Mach numbers from 0.40 to 2.50. The effect of individual model components, tail incidence, and wing-sweep angle was investigated. The data are presented without analysis. Author

N71-17426*# Boeing Co., Seattle, Wash.
STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION VOLUME 5: SONIC INLET DEVELOPMENT Contractor Report, 1 May 1967 - 1 Nov. 1969

Washington NASA Jan. 1971 121 p
(Contract NAS1-7129)

(NASA-CR-1715) Avail: NTIS CSCL 01C

Several sonic throat inlet concepts were investigated as a means of reducing the forward-radiated fan noise of turbofan JT3D-powered 707-320B/C airplanes. The acoustic, internal aerodynamic, and operational characteristics of a selected contracting cowl inlet were evaluated in model and full-scale ground rig tests. Static and in-flight inlet operation was simulated for both the noise-suppressed and unsuppressed modes of operation. Tests were conducted for a range of engine speeds, inlet Mach numbers, throat areas, and boundary-layer control configurations with both fixed and variable geometry inlets. Results are presented for fan noise attenuation, Mach number distributions, total and static pressure recovery, and effects on engine operation. Results are shown also for the dynamic response characteristics of the inlet and engine while operating with the inlet under automatic control. At simulated landing approach conditions, the results indicate that a 14- to 16-PNdB reduction of fan noise from the inlet was achieved with inlet center line Mach numbers of 0.7 to 0.8. Principal airplane performance penalties appear to be associated with the increased weight and drag of the acoustic nacelles. Author

N71-17432*# Advisory Group for Aerospace Research and Development, Paris (France).

MANUAL ON AEROELASTICITY: SUBJECT AND AUTHOR INDEX

E. C. Pike, ed. Jan. 1971 28 p refs
(AGARD-R-578-71) Avail: NTIS

The Subject Index and Author Index cover all the chapters in the six loose-leaf volumes of the Manual on Aeroelasticity and were up to date in April 1970. Since that date new chapters of the manual have been published in the AGARD Report series. The indexes are published in two forms: in the AGARD Report series as AGARD Report 578 and in loose-leaf form for insertion in Volume VI of the Manual. Entries are given by volume, chapter and page number. For example, II/9/56 denotes Volume II, Chapter 9, page 56. The letter S after a chapter number denotes a supplement to that chapter. The letters TG denote the section of tables and graphs in Volume VI. The abbreviation INTRO denotes the introductory survey in Volume I. Author

N71-17433*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

SIMULATOR STUDY OF FLIGHT CHARACTERISTICS OF A JET-FLAP STOL TRANSPORT AIRPLANE DURING APPROACH AND LANDING

William D. Grantham, Robert W. Sommer, and Perry L. Deal
Washington Feb. 1971 42 p refs

(NASA-TN-D-6225; L-7582) Avail: NTIS CSCL 01C

A fixed-base simulator study was conducted to provide a preliminary determination of the low-speed handling qualities of a STOL transport configuration equipped with an external-flow jet flap and high-bypass-ratio turbofan engines. Real-time digital simulation techniques were used. The computer was programmed with equations of motion for six degrees of freedom and the aerodynamic inputs were based on measured wind-tunnel data. A visual display of a STOL airport was provided for simulation of the flare and touchdown characteristics. The primary piloting task was an instrument approach to a breakout at a 200-foot ceiling, with a visual landing. Author

N71-17441*# Scientific Translation Service, Santa Barbara, Calif. ESTABLISHMENT OF TAKE-OFF AND LANDING SAFETY MARGINS FOR THE BREGUET 941 [ESTABLISSEMENT DES MARGES DE SECURITE AU DECOLLAGE ET A L'ATTERRISSAGE POUR LE BREGUET 941]

J. Bastidon Washington NASA Feb. 1971 15 p Transl. into ENGLISH from Proc. of the 37th Meeting of the AGARD Flight Mech. Panel, (Baden Baden), 20-23 Oct. 1970 6 p (Contract NASw-2035)

(NASA-TT-F-13453) Avail: NTIS CSCL 01C

Two types of safety margins are considered: (1) speed margins (take-off speed and approach speed), and (2) field length margins. These two types of margins are examined and discussed from the point of view of one individual aircraft, the BR 941. The establishment of these margins depends on theoretical consideration, results of in-flight measurements, and operational tests. Discussions with the F.A.A. are also taken into consideration with respect to establishing special considerations for civil certification of this aircraft. Author

N71-17443*# Techtran Corp., Glen Burnie, Md. FLOW WITH A SEPARATED SHOCK WAVE PAST A WEDGE-SHAPED PROFILE [OBTEKANIYE KLINOVIDNOGO PROFILYA S OTSOEDINENNOY UDARNOY VOLNOY]

V. G. Bukovshin Washington NASA Feb. 1971 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza (USSR), no. 2, Mar.-Apr. 1969 p 83-85

(Contract NASw-2037)

(NASA-TT-F-13469) Avail: NTIS CSCL 20D

A supersonic gas flow past a wedge at zero degree angle of attack and with a separated shock wave is analyzed by the integral relations method. Numerical values are given for the velocity gradient at the stagnation point and for distribution of pressure and drag at the wedge at Mach numbers from 3-20 and semiapex angles from 60-85 deg. These values are compared with values obtained by the Newtonian theory and by a modified formula of Newton. The values obtained by the integral relations method for pressure distribution and drag coefficient differ significantly from the values obtained by the Newtonian formulas. The velocity gradient increases with an increase of Mach number and a decrease of the semiapex angle. Author

N71-17444*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala. OPTICAL PROBING OF SUPERSONIC AERODYNAMIC TURBULENCE WITH STATISTICAL CORRELATION. PHASE 1: FEASIBILITY

B. H. Funk, Jr. and H. A. Cikanek, Jr. Washington Feb. 1971 143 p refs

(NASA-TN-D-6077; M-165) Avail: NTIS CSCL 20D

The feasibility of measuring statistical properties of supersonic aerodynamic turbulence by statistical correlation of signals remotely retrieved by optical probing without the use of tracers was investigated. Theoretical analyses and qualitative experimental results are presented concerning the application of laser schlieren and laser shadow-correlation remote sensing systems. Cross-correlation measurements made on-line with parallel and crossed beams are shown and discussed. A one-shot statistical correlation concept is introduced and experimentally verified that allows the time-history of the decay of turbulent structures to be computed from a single composite signal and displayed on an oscilloscope while data are being retrieved. Author

N71-17468*# Scientific Translation Service, Santa Barbara, Calif. THE AIRFOIL THEORY

Claus Jacob Washington NASA Feb. 1971 16 p refs Transl. into ENGLISH from Proceedings of the 8th Symp. on Advanced Probl. and Methods in Fluid Dyn., (Tarda), 18-25 Sep. 1967 p 35-43

(Contract NASw-2035)

(NASA-TT-F-13471) Avail: NTIS CSCL 20D

The thin airfoil theory is discussed by taking into account the solution of a harmonic Dirichlet problem for the complex plane. The function representing the solution of this problem is investigated. The results obtained make it possible to resolve directly the Dirichlet problem for the harmonic function considered. The explicit solution of the problem of the thin airfoil is discussed, and an example for the determination of the complex velocity is presented. Author

N71-17475# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT: US CIVIL AVIATION, ISSUE NO. 5: 1969 ACCIDENTS

Nov. 1970 450 p

(NTSB-BA-70-6) Avail: NTIS; HC \$6.00/MF \$0.95

Statistical tables and accident briefs are presented on general aviation and supplemental air carrier accidents. N.E.N.

N71-17476# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: TEXAS INTERNATIONAL AIRLINES, INCORPORATED, DOUGLAS DC-9, N1308T, HARLINGEN, TEXAS, 11 JANUARY 1970

2 Dec. 1970 25 p refs

(NTSB-AAR-70-28) Avail: NTIS

The investigation report is presented for the accident in which the aircraft struck a tree and two power poles 12,000 feet short of the runway threshold during a predawn instrument approach in fog. It was concluded that the probable cause was the continuation of descent through the minimum descent altitude as a result of inadequate crew monitoring of altimeters. Contributing factors were a lack of awareness of the actual meteorological conditions, caused by crew fatigue, and company workload priorities which prevented normal communications and deferred the dissemination of essential meteorological information. Author

N71-17483# National Aviation Facilities Experimental Center, Atlantic City, N.J.

INVESTIGATION OF JET ENGINE COMBUSTION CHAMBER BURN-THROUGH FIRE Final Report, 1963-1969

Thomas Rust, Jr. Mar. 1971 49 p refs
(FAA-RD-70-68; FAA-NA-70-40) Avail: NTIS

Test conditions for testing materials which are intended for use as fire barriers for protection against a jet engine combustion chamber burn-through type of failure are presented. The development of such a failure was accomplished on a General Electric J-47 jet engine. The resulting flame was quite severe, penetrating the present standard firewall material in 2 seconds. Studies were made of the flame impingement characteristics, including impingement temperatures and pressures; and various potential firewall materials were tested for effectiveness as fire barriers for protection against such a failure. Most materials tested in this manner failed to provide adequate protection against such an engine failure. An investigation was conducted toward development of a means of simulating a combustion chamber burn-through failure with the ultimate goal of developing a suitable laboratory test flame for evaluating potential firewall materials. A combustion chamber simulator, which will produce a flame of similar severity to the flame produced in the J-47 engine, was developed.

Author

N71-17506*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

ANALYTICAL HEAT TRANSFER INVESTIGATION OF INSULATED LIQUID METHANE FUSELAGE TANKS FOR SUPERSONIC CRUISE AIRCRAFT

Eugene J. Pleban Washington Feb. 1971 15 p refs
(NASA-TN-D-6157; E-5910) Avail: NTIS NTIS CSCL 20M

Liquid methane boiloff from fuselage tanks was computed for typical SST missions for cruise Mach numbers of 2.7 and 3.5, insulation thicknesses of 0.5, 1.0, and 2.0 in., various vent pressure settings, and saturated and subcooled fuel. Boiloff rates during fuel fill and ground hold are discussed. Boiloff losses less than 2.5 percent are possible for a cruise Mach number of 2.7 and an insulation thickness of 1.0 in.

Author

N71-17511# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: EXECUTIVE JET AVIATION INCORPORATED LEARJET L23A, N434EJ NEAR THE EMMET COUNTY AIRPORT PELLSTON, MICHIGAN, 9 MAY 1970

22 Dec. 1970 31 p ref
(NTSB-AAR-71-3) Avail: NTIS

On May 9, 1970, Lear Jet N434EJ, operated by Executive Jet Aviation, Inc., was on a nonscheduled air taxi flight from Detroit, Michigan to Pellston, Michigan. The aircraft crashed at approximately 2128 during an instrument approach to the Emmet County Airport at Pellston. Both crewmembers and the four passengers aboard received fatal injuries. The aircraft made initial contact with trees on a hill located approximately 2-1/4 miles southwest of the approach end of Runway 5. A swath approximately 45 feet wide and 254 feet long, on a true heading of 107 deg, had been cut through the trees by the aircraft. The highest mean sea level (m.s.l.) elevation of the trees at the break points was 886 feet. The Board determines the probable cause of this accident to be illusions produced by the lack of visual cues during a circling approach over unlighted terrain at night to a runway not equipped with approach lights or other visual approach aids. These illusions, which made the pilot think that he was higher than his true position, were made more acceptable to him because of a strong possibility of an erroneously high indication on his altimeter.

Author

N71-17512# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: NORTH CENTRAL

AIRLINES, INCORPORATED, CONVAIR 580, N2045, O'HARE INTERNATIONAL AIRPORT, CHICAGO, ILLINOIS, 27 DECEMBER 1968

12 Nov. 1970 52 p
(NTSB-AAR-70-27) Avail: NTIS

North Central Airlines, Flight 458, a Convair 580, crashed while it was on an instrument approach at O'Hare International Airport, Chicago, Illinois, at approximately 2022 c.s.t., on December 27, 1968. The aircraft struck the side of a hangar, located adjacent to the approach end of the runway, in a near-inverted attitude, and was destroyed by impact and resultant ground fire. Twenty-seven of the 45 persons on board the aircraft, including the pilot, copilot, and an additional crewmember who was occupying the observer's seat, were fatally injured. One person in the hangar also received fatal injuries as a result of the accident. The National Transportation Safety Board determines that the probable cause of this accident was spatial disorientation of the captain precipitated by atmospheric refraction of either the approach lights or landing lights at a critical point in the approach wherein the crew was transitioning between flying by reference to flight instruments and by visual reference to the ground.

Author

N71-17524# Laboratorium fur Betriebsfestigkeit, Darmstadt (West Germany).

STRENGTH OF LIGHT METAL ALLOY RODS WITH IRREGULAR NOTCHES UNDER CYCLIC TENSILE LOADS AND PERIODICALLY INTERSPERSED COMPRESSION LOADS [ZUR FRAGE DES FESTIGKEITSVERHALTENS REGELLOS IM ZUG-SCHWELL-BEREICH BEANSPRUCHTER GEKERBTER LEICHTMETALLSTAEBE BEI PERIODISCH EINGESTREUTEN DRUCKBELASTUNGEN]

E. Haibach, D. Schuetz, and O. Svenson Fraunhofer Ges. Mar. 1970 25 p refs In GERMAN; ENGLISH summary Sponsored by Deut. Forsch. Gemeinschaft
(FB-78-1969) Avail: NTIS

The cyclic plastic strains and stresses occurring at the notch root during a typical flight-by-flight load sequence were used to study the effect of the ground-to-air cycle on the fatigue life. Local stress histories were determined by recording local strain histories during cycling and reproducing these histories in simple unnotched 2024 material specimens.

Author (ESRO)

N71-17527# National Aviation Facilities Experimental Center, Atlantic City, N.J.

FIELD TEST AND EVALUATION OF THE NAS EN ROUTE STAGE A MODEL 1b WEATHER SUBSYSTEM Final Report, Feb. -Nov. 1969

Howard L. McFann Mar. 1971 122 p
(FAA-NA-70-62) Avail: NTIS

Four weather outline generators produced contours around radar weather clutter at two different intensity levels. The contours were processed by the radar video digitizers for transmission to air route traffic control centers as weather map messages. A series of technical and operational tests were run in the field to obtain performance data pertinent to the preparation of specifications for future systems. Calibration methods and trouble shooting aids were established. It was concluded that the generators were capable of producing reliable contours around the periphery of clutter without interference from aircraft signal returns. The dynamic range of the systems, when using logarithmic video inputs, was sufficient to permit contouring of weather cells from 42 to 50 db above the radar receiver minimum discernible signal levels. Effective control of weather map data rates was achieved by a sampling and interleaving technique that transmitted outer contour data every 8.4 deg and inner contour data every 2.1 deg.

Author

N71-17545# Department of Transportation, Washington, D.C. Office of Supersonic Transport Development.

SUPERSONIC TRANSPORT DEVELOPMENT

ENVIRONMENTAL IMPACT STATEMENT

7 Dec. 1970 34 p

Avail: NTIS

A discussion is presented concerning the knowledge that is now possessed and that which will be required in order to determine the environmental impact of supersonic transports. Current research directed at the major environmental concerns is briefly summarized and covers the following areas: (1) airport and community noise, (2) weather and climate modification, (3) cosmic radiation, and (4) sonic booms. The present status of U.S. plans for development of the SST is reviewed and alternatives for future direction of efforts are discussed. D.L.G.

N71-17546# Federal Aviation Administration, Washington, D.C. Airports Service.

PLANNING THE METROPOLITAN AIRPORT SYSTEM

May 1970 111 p refs Original Contains Color Illustrations (FAA-AC-150/5070-5) Avail: SOD \$1.25

A systematic approach to planning for the nation's airport needs is presented. The metropolitan airport system planning process involves the preparation of both broad and specific policies, plans, and programs needed to establish a viable, integrated network of airports at the metropolitan level. The planning process is described in detail under the following chapter headings: (1) organization for the planning process, (2) funding the planning process, (3) general criteria and policy objectives, (4) study design, (5) inventories, (6) forecasting, (7) consideration of new technology, (8) general facility requirements, (9) development of alternative system plans, (10) plan implementation, and (11) the continuing planning process. D.L.G.

N71-17553# Federal Aviation Administration, Washington, D.C. Flight Standards Service.

TENTATIVE AIRWORTHINESS STANDARDS FOR POWERED LIFT TRANSPORT CATEGORY AIRCRAFT

Aug. 1970 144 p

Avail: NTIS

Tentative airworthiness standards are presented which are intended for study, trial application, and comment during the design and development of verticraft and other powered lift aircraft. Because of the wide variety of novel features of these emerging aircraft and lack of experience in their certification and operation, the proposed standards are not expected to be appropriate for all designs. However, the tentative standards are aimed at providing useful guidelines for designers and the FAA in arriving at the acceptable level of airworthiness. Author

N71-17554*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF AN AUXILIARY INLET EJECTOR NOZZLE WITH FLOATING INLET DOORS AND FLOATING SINGLE-HINGE TRAILING-EDGE FLAPS

Albert L. Johns Washington Feb. 1971 45 p refs

(NASA-TM-X-2173-E-5883) Avail: NTIS CSCL 21A

A nozzle designed for a supersonic-cruise aircraft was tested at off-design Mach numbers from 0 to 1.0. Two primary throat areas were tested: one to simulate both dry acceleration and subsonic cruise, and the other to simulate reheat acceleration. The auxiliary inlet doors included single- and double-hinge types which were free-floating either with or without synchronization. Results from this cold-flow model are compared with a similar nozzle which was optimized using fixed inlet doors and flaps. The inlet doors and trailing edge flaps did not float to the maximum thrust condition at subsonic-cruise Mach numbers. In addition, the single-hinge flaps were unstable at many of the assumed flight conditions. Author

N71-17585* National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

ANGULAR POSITION AND VELOCITY SENSING APPARATUS Patent

Leo J. Veillette, inventor (to NASA) Issued 17 Mar. 1970 (Filed 28 Jul. 1967) 13 p Cl. 318-138; Int. Cl. H02p7/28

(NASA-Case-XGS-05680; US-Patent-3,501,664;

US-Patent-Appl-SN-656953) Avail: US Patent Office CSCL 14B

A system is described for regulating brushless DC motors of the type where an internal stator field is rotated in space 90 deg ahead of the rotor field. To maintain the correct spatial relation between the stator and rotor fields, the angular position of the rotor is continually sensed and the position indication is used to continually change the stator field orientation as the rotor rotates. The rate of rotation of the rotor is also determined to provide controlled-damping and rate-limiting of the motor.

Official Gazette of the U.S. Patent Office

N71-17589*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

TWO-DIMENSIONAL CASCADE TEST OF A JET-FLAP TURBINE ROTOR BLADE

Stanley M. Nosek and John F. Kline Washington Feb. 1971 18 p refs

(NASA-TM-X-2183; E-5989) Avail: NTIS CSCL 21E

A jet-flap turbine blade was tested in a two-dimensional cascade of six blades to study the effectiveness of the concept as a boundary-layer control device and as a variable-area device. Principal measurements were surveys of blade surface static pressure and blade exit total pressure, static pressure, and flow angle at midspan. Data were taken at constant pressure ratio for jet flows from 0 to 4 percent of primary flow. Results are presented in terms of primary flow, blade surface pressure distribution, blade specific force, kinetic energy loss coefficient, total pressure loss, and exit flow angle. Author

N71-17590*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

COLD-AIR INVESTIGATION OF A TURBINE WITH TRANSPIRATION-COOLED STATOR BLADES. 2: PERFORMANCE OF STATOR WITH WIRE-MESH SHELL BLADING

Frank P. Behning, Herman W. Prust, Jr., and Thomas P. Moffitt Washington Feb. 1971 28 p refs

(NASA-TM-X-2166; E-5939) Avail: NTIS CSCL 21E

The effects on stator performance of transpiration coolant discharge from wire-mesh shell blading were experimentally determined for ratios of coolant flow to primary flow of 0 to 0.07. The results showed that transpiration coolant discharge from this type of blading caused an efficiency loss relative to comparable noncooled blading. The results for transpiration discharge from wire-mesh shell blading are similar to results previously obtained for transpiration discharge from discrete hole blading. A comparison of the effects on stator efficiency of transpiration discharge and trailing-edge discharge shows a significantly larger loss for transpiration discharge. Author

N71-17591*# Boeing Co., Seattle, Wash.

STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION. VOLUME 2: ACOUSTIC LINING DEVELOPMENT, 1 MAY 1967 - 1 NOVEMBER 1969

Washington NASA Jan. 1971 184 p refs

(Contract NAS1-7129)

(NASA-CR-1712) Avail: NTIS CSCL 01B

An acoustic lining development program is described, which covers selection of facing materials and lining concepts suitable for

attenuating turbofan engine noise generated by a fan compressor and development of acoustic lining design technology. A theoretical method for predicting lining attenuation in a duct without airflow is presented and is combined with an empirical prediction method developed from parametric results of the flow-duct tests to establish a lining design procedure. Concurrent and interrelated investigations, which comprised the acoustic lining development program, are described as is the facilities equipment used. Evaluation of more than 40 types of acoustic facing materials resulted in the selection of woven metallic fiber, metallic felt, reinforced metallic felt, and resin impregnated fiberglass laminate facing materials as most suitable for acoustic linings in a turbofan nacelle environment. A study of lining concepts resulted in selecting a broadband resistive-resonator type lining as best suiting engine-fan-duct and inlet-installation requirements. Results are presented of analytical and experimental investigations undertaken to develop an acoustic lining design procedure and to select suitable lining concepts and materials for reducing fan-compressor-generated noise in turbofan engines. A comprehensive acoustic-lining flow-duct test program established the parameters controlling the amount and peak frequency of attenuation provided by a lining. Test results also showed metallic and nonmetallic linings, having the same flow resistance and geometry, provide similar attenuation characteristics. Author

N71-17610* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

THERMAL PUMP-COMPRESSOR FOR SPACE USE Patent

Franklin W. Booth and Hubert K. Clark, inventors (to NASA) Issued 14 Mar. 1967 (Filed 2 Apr. 1963) 4 p Cl. 230-162 (NASA-Case-XLA-00377; US-Patent-3,309,012; US-Patent-Appl-SN-270118) Avail: US Patent Office CSCL 20M

A thermal pump-compressor for converting solar energy is described. The energy is converted into air pressure to operate pneumatic equipment. The pump comprises a solar reflector, a thermal bulb containing a volatile liquid for creating gas pressure, and a numping means. E.C.

N71-17641*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

COMPUTER PROGRAM FOR PRELIMINARY DESIGN AND ANALYSIS OF V/STOL TIP-TURBINE FANS

Henry C. Haller, Seymour Lieblein, and Bruce M. Auer Washington Feb. 1971 143 p refs (NASA-TN-D-6161; E-5660) Avail: NTIS CSCL 21E

An analysis of a tip-turbine driven lift fan was developed for use in preliminary design or parametric investigation of tip-turbine lift fan systems applicable to V/STOL aircraft. The analysis was programmed for an electronic digital computer with provisions for treating a fan rotor with either one- or two-stage tip turbines mounted on the fan periphery. Both turbine types have impulse rotors with single-stage designs employing impulse, diffusing, or no exit stators. The program includes tip-turbine velocity diagram determination, blade row loss analysis, partial admission, and turbine-to-fan leakage. A sample calculation is given. Author

N71-17668*# Boeing Co., Seattle, Wash.
STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION. VOLUME 4: FLIGHTWORTHY NACELLE DEVELOPMENT. 1 MAY 1967 1 NOVEMBER 1969

Washington NASA Jan. 1971 192 p refs (Contract NAS1-7129) (NASA-CR-1714) Avail: NTIS CSCL 01B

A flightworthy configuration of the treated inlet and fan exhaust duct resulted from further development of acoustic, aerodynamic, and structural design of the nacelle concept developed and tested. Both the design and manufacturing processes that developed

placed performance goal achievement above minimum weight considerations. The estimated airplane empty weight increase of a weight-oriented production design is 3140 lb. Four nacelles were fabricated and each was subjected to ground calibration testing. Compared to baseline ground test results of an existing 707 airplane nacelle, static takeoff thrust of the flightworthy nacelle was shown to be essentially unchanged, with 2 percent less fuel consumption at cruise. Attainment of the 15-PNdB reduction in perceived noise level set as a program goal for flight operations was indicated. Author

N71-17686* Technidyne, Inc., West Chester, Pa.

METHODS AND APPARATUS EMPLOYING VIBRATORY ENERGY FOR WRENCHING Patent

Nicholas Maropis, William A. Wilson, and Herman T. Blaise, inventors (to NASA) Issued 1 Sep. 1970 (Filed 7 Dec. 1967) 10 p Cl. 29-428; Int. Cl. B23p11/00, 19/00, 19/04 Continuation-in-part of US-Patent-Appl-SN-674999, Filed 12 Oct. 1967 Sponsored by NASA (NASA-Case-MFS-20586; US-Patent-3,526,030; US-Patent-Appl-SN-688868) Avail: US Patent Office CSCL 13I

A wrench is described for applying vibratory energy primarily to mechanical fasteners which are elastically compliant along the radius vector so as to effect improved tightening or loosening of fasteners. The direction of the particle motion constituting the introduced vibration is essentially along the radius vector of the fastener to which the vibration is introduced. Provision is made for tightening the fastener to a predetermined specified torque level and for applying the requisite vibratory energy while simultaneously rotating the fastener an additional amount without extending the said torque level. Official Gazette of the U.S. Patent Office

N71-17697# Committee on the District of Columbia (U.S. Senate).

UTILIZATION AND FUTURE OF MAJOR AIRPORTS IN THE NATIONAL CAPITAL REGION. PART 2: STRETCH JETS AT NATIONAL AIRPORT

Washington GPO 1970 175 p refs Hearings before Comm. on the District of Columbia, 91st Congr., 2d Sess., 19 May 1970 Avail: Subcomm. on Business and Commerce

Discussions in support of and against permitting Boeing 727 jets to land at Washington National Airport are presented. Specific problems associated with the jet use of the airport, overall impact on affected and other airlines, phasing controls, premium fees, and community relations are covered. A study of the Baltimore/Washington biregional air facilities plan and program, and a staff information report on the current and future prospects, problems, and needs of the National Airport are included. N.E.N.

N71-17702 Stanford Univ., Calif.

AN EXPERIMENTAL STUDY OF THE EFFECTS OF LEADING-EDGE BLOWING UPON THE CHARACTERISTICS OF A JET-FLAPPED AIRFOIL

Timothy Wang (Ph.D. Thesis) 1969 166 p Avail: Univ. Microfilms: HC \$7.80/Microfilm \$3.00 Order No. 70-1624

The extent to which maximum lift and stalling angle can be increased by diverting a portion of the jet flap momentum efflux through a leading-edge blowing slot is discussed. The basic wing model tested has a 1 ft. chord, a 2 ft. span, a truncated NACA 0015 profile (thickness of 18 percent chord) and an 8.3 percent chord trailing-edge flap incorporating shroud blowing. Two nose configurations, one having a blowing slot at the leading edge and the other having a blowing slot at 1/2 percent chord, were tested with the model. A full span slide valve within the model enabled diversion of up to approximately 1/3 of the total jet momentum efflux through the nose slot. Substantial increases in stalling angle and maximum lift were achieved with the incorporation of

leading-edge blowing. For the same total jet momentum coefficient, flap deflection, and angle of attack, the addition of leading-edge blowing was found to increase the nose-down quarter chord pitching moment, the fraction of jet momentum recovered as thrust, and the lift of a jet-flapped airfoil. Dissert. Abstr.

N71-17725 Alabama Univ., University.

THE EFFECT OF TAILPIPE LENGTH ON COMBUSTOR STABILITY

John Amos Belding, Jr. (Ph.D. Thesis) 1969 184 p
 Avail: Univ. Microfilms: HC \$8.40/Microfilm \$3.00 Order No. 70-1365

A theoretical analysis of an adiabatic homogeneous reactor was carried out for a ramjet type combustor in order to describe the effect of an increase in tailpipe length on stability limits. Correlation of combustion loading, with known homogeneous reactor data was made in order to verify results of the theoretical analysis. General theoretical computer programs are included. A ramjet type combustor using premixed air-fuel was constructed. The combustor consisted of a two inch diameter tube which housed a disk bluff body flameholder. Various tailpipe lengths were also constructed. Experimental data pertinent to the combustor loading parameter were obtained. These data included total and static pressure measurements outside the flame front, flame front radii and recirculation zone radii, all measured at various locations down the duct. In addition, the lengths of the recirculation zone were measured. Dissert. Abstr.

N71-17728# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DETERMINATION OF THE EFFECT OF ATMOSPHERIC HUMIDITY ON THE CHARACTERISTICS OF A TURBOFAN ENGINE

B. D. Fishbeyn et al [1970] 13 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Aviat. Tekn. (Kazan), no. 2, 1967 p 112-118

(AD-715232; FTD-HT-23-290-68) Avail: NTIS CSCL 21/5

A mathematical method is presented for the study of the humidity effect on parameters of any gas-turbine engine.

Author (GRA)

N71-17733# Naval Weapons Lab., Dahlgren, Va.
ON RESONANCE INSTABILITY FOR FINNED CONFIGURATIONS HAVING NON-LINEAR AERODYNAMIC PROPERTIES

Thomas A. Clare Oct. 1970 51 p refs
 (AD-715110; NWL-TR-2473) Avail: NTIS CSCL 20/4

An approximate solution is presented for the angular motion, at and near resonance, of finned configurations (with small aerodynamic asymmetries) having non-linear aerodynamic properties. An extension of the Method of Slowly Varying Parameters (or Averaging Method) is used to solve the simultaneous pitch and yaw equations of motion, in terms of amplitude-rate equations, at the resonance point. Included in this analysis are the non-linear variations of the restoring, damping, and Magnus moments with angle of attack. Both transient and steady state solutions are obtained. A detuning of the rolling velocity from its resonant value is performed to yield a solution in the critical near-resonant region. This result is shown to give rise to the well-known resonance jump in the steady state case. Finally, allowing the detuning parameter to vary with time enables an examination of the non-linear catastrophic yaw problem in which both the rolling velocity and the roll orientation angle may vary with time. In this regard, the effects of a non-linear variation of the induced side moment with angle of attack are determined. The accuracy of these solutions is evaluated by comparison with exact numerical integrations of the equations of motion. Author (GRA)

N71-17747# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN PROBLEMS OF STRUCTURAL SYNTHESIS OF SPATIAL MOTION CONTROL SYSTEMS FOR AN ORBITAL AIRCRAFT IN THE EARTH'S ATMOSPHERE

B. N. Petrov et al 13 Aug. 1970 23 p refs Transl. into ENGLISH from 4th Congr. Guidance and Control in Space, Intern. Federation of Autom. Control (Warsaw), 1969 p 3-18
 (AD-714796; FTD-HT-23-392-70) Avail: NTIS CSCL 22/1

A theoretical analysis is given of linear multichannel control systems for vehicles orbiting in the atmosphere of the earth at supersonic velocities. A procedure is developed for obtaining a set of control system structures providing a selection invariance which can be used as a basis for the optimization of such control systems in terms of both quality and simplicity of realization. Equations describing the spatial motion of such vehicles and a graphic mathematical model of these equations are derived in the process. The methods of graph theory are applied in developing the algorithms for constructing such control systems. GRA

N71-17752 California Inst. of Tech., Pasadena.

THE HYPERSONIC LAMINAR BOUNDARY LAYER NEAR A SHARP EXPANSION CORNER

Keith Jordis Victoria (Ph.D. Thesis) 1969 142 p
 Avail: Univ. Microfilms: HC \$6.80/Microfilm \$3.00 Order No. 70-1426

The integral moment method for treating interactions between a laminar boundary layer and an external supersonic flow is applied to the problem of the hypersonic laminar boundary layer near sharp and slightly rounded convex (expansion) corners. The general features of this type of interacting flow are established by an analytical solution of the integral equations using the method of matched asymptotic expansions for the case of small interaction parameter. Numerical solutions are obtained for flows for which the interaction parameter can no longer be considered small. An experimental study is carried out in the GALCIT Mach 8 hypersonic wind tunnel in order to study the two-dimensional laminar boundary layer expansion. Major emphasis is placed on the acquisition of detailed data near the corner region. The basic measurements consist of the model surface pressure distribution and pitot pressure surveys of the boundary layer and inviscid flow field between the boundary layer and the leading edge shock wave both upstream and downstream of the corner region. The surface pressure measurements illustrate the striking departure of the flow field at hypersonic speeds from the classical Prandtl-Meyer description. Dissert. Abstr.

N71-17753# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.

AN INVESTIGATION OF THE TRAILING VORTEX SYSTEM GENERATED BY A JET-FLAPPED WING OPERATING AT HIGH WING LIFT COEFFICIENTS Final Report

Barnes W. McCormick and William J. Schumacher Wright-Patterson AFB, Ohio AFFDL 5 Jun. 1970 48 p refs
 (Contract F33615-69-C-1165)

(AD-715315; AFFDL-TR-70-90) Avail: NTIS CSCL 1/3

The purpose of the investigation was to measure the geometry of the trailing vortex generated behind a jet-flapped wing. Such vortices can pose a serious hazard to aircraft that penetrate them. Previous investigations performed on conventional wings indicate that these vortices persist for some time and have maximum tangential velocities which increase linearly with the lift coefficient. As future aircraft may employ high lift devices such as jet-flapped wings, the vortices generated could be even stronger. Two semispan models of a jet-flapped wing were tested in a subsonic wing tunnel. Parameters varied during testing included the jet flap angle, angle of attack, aspect ratio, and jet momentum coefficient. Vortex measurements were obtained using a vortex meter which measured the rotational speed of the fluid within the vortex. Values obtained were numerically integrated to yield the tangential

N71-17766

velocity and circulation distributed through the vortex. Experimental results indicate that the maximum tangential velocity increases to a maximum and then decreases with continually increasing jet blowing. At high values of jet blowing, the vortex was found to decay rapidly downstream. Author (GRA)

N71-17766# Naval Research Lab., Washington, D.C. Security Systems Branch.

AN EXTENSION OF NONSYNCHRONOUS INTERROGATION REPETITION FREQUENCY SELECTION METHODS

W. K. Gardner Nov. 1970 38 p refs
(AD-715335; NRL-MR-2175) Avail: NTIS CSCL 17/7

Consideration of the timewise occupancy within the overall period band due to initial choices of nonsynchronous Interrogation Repetition Frequencies (IRFs) for application to radar beacon systems results in the ability to determine as well the open time slots remaining for succeeding choices. Thus all possible succeeding choices that could become members of a particular nonsynchronous IRF set can be located. A simple method has been found for progressively locating by computer all open slots (integer period values) for each next choice of a given nonsynchronous IRF set. The blocked/open slot concept further results in a detailed understanding of the effects upon the selection process of changes in the parameter n , the number of interrogations, and the parameter δ , the dead time of a transponder, and explains the great dependency upon n and δ of the total number of available nonsynchronous IRFs. Author (GRA)

N71-17779# Civil Aeronautics Board, Washington, D.C.

REMARKS PREPARED FOR DELIVERY BEFORE THE 1970 ATA ENGINEERING AND MAINTENANCE CONFERENCE

Secor D. Browne 7 Oct. 1970 8 p Conf. held at Atlanta, Georgia, 7 Oct. 1970
Avail: Issuing Activity

The status of certain operational and administrative issues in civil aeronautics is summarized. Topics cited include: route systems, scheduling, air traffic control, air space and terminal congestion, noise control, SST development, and air fare rates. E.C.

N71-17792# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

AN IN-FLIGHT INVESTIGATION OF LATERAL-DIRECTIONAL DYNAMICS FOR THE LANDING APPROACH Final Technical Report

G. Warren Hall and Edward M. Boothe Wright-Patterson AFB, Ohio AFFDL Oct. 1970 288 p refs
(Contract F33615-69-C-1664)
(AD-715317; CAL-BM-2821-F-5; AFFDL-TR-70-145) Avail: NTIS CSCL 1/3

Lateral-directional handling qualities and roll control power requirements for executive jet and military Class II Airplanes in the landing approach flight phase were investigated in the variable stability T-33 airplane. Particular emphasis was placed on the effects of crosswinds and turbulence. Simulated IFR ILS approaches and VFR offset and crosswind approaches were made. Specifically, two Dutch roll frequencies, three Dutch roll damping ratios, three roll-to-sideslip ratios and three roll mode time constants were investigated. It was found that lateral-directional dynamics do not establish a limiting crosswind value; however, they do determine the ease or difficulty with which a crosswind approach can be accomplished. Roll control power requirements were determined from actual control usage data obtained throughout the evaluation program. In addition, a number of configurations were reevaluated with limited roll control power to determine minimum acceptable levels. Available roll control power can establish a limiting crosswind component. A number of configurations were evaluated with a

stick controller in place of the normally used wheel controller to determine if the type of controller affected the lateral-directional dynamics for acceptable handling qualities. No difference was found to exist. A detailed comparison with MIL-F-8785B(ASG) requirements is included and generally shows the present requirements to be too conservative in the landing approach flight phase. Author (GRA)

N71-17798# Civil Aeronautics Board, Washington, D.C.
CIVIL AERONAUTICS BOARD CAREERS FOR ECONOMISTS AND TRANSPORTATION INDUSTRY ANALYSTS

[1970] 12 p
Avail: Issuing Activity

Economist and air transportation analyst employment opportunities and qualification specifications are outlined. Employee benefits provided by the Civil Aeronautics Board are summarized. E.C.

N71-17799# Civil Aeronautics Board, Washington, D.C.
REMARKS TO THE EXECUTIVE PROGRAM ON TRANSPORTATION AND LOGISTICS

Secor D. Browne 6 Aug. 1970 12 p Conf. held at Boston, 6 Aug. 1970
Avail: Issuing Activity

The following topics are considered: air piracy prevention, effects of reductions in air passenger capacity, controlling labor costs, smoke and noise control, air traffic control procedure revisions, and airways congestion. An edited transcript of the question and answer session is also presented. E.C.

N71-17832# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

AUTOMATION OF TECHNOLOGICAL PROCESSES IN AIRCRAFT-ENGINE CONSTRUCTION

M. I. Evstigneev 10 Sep. 1970 275 p refs Transl. into ENGLISH of the book 'Avtomatizatsiya Tekhnologicheskikh Protsesov v Avia-Dvigatelaystryeni' Moscow, Izd-Vo Mashinostroyeniye, 1969 p 1 267
(AD-714858; FTD-MT-24-102-70) Avail: NTIS CSCL 13/8

The book expounds on questions of planning the technological processes of automated production. The systems and mechanisms of the automatic control of technological units and machine-tool lines are described. The methods and means of automating the machining and quality control of components and subassemblies of aircraft engines and the principles of setting up automatic machine-tool lines are examined, the technical and economic bases of the selection of rational methods of automating the technological processes in aircraft engine construction are presented. Author (GRA)

N71-17843*+ Georgia Inst. of Tech., Atlanta.
INTERURBAN AIR TRANSPORTATION SYSTEM: A GRADUATE PROJECT IN COMPLEX SYSTEMS DESIGN, PRESENTED BY THE STUDENTS OF AE-EE-ME 655-656 (WINTER-SPRING QUARTERS, 1969)

Cassius Mullen, ed. Dec. 1969 409 p refs
(Grants NGT-11-002-064; NGR-11-002-081; NSF GU-2161)
(NASA-CR-116431) Avail: NTIS HC \$6.00 CSCL 01E

A systems approach was used to study the interurban public air transportation problem for the 1975 to 1985 period. The nature of this problem was determined, alternate solutions were posed and measures of effectiveness and cost were applied. Basic areas of demand and route structure, air vehicles, terminals and ground facilities, and air traffic control were used to formulate a mathematical model for common carrier air transportation in the United States of America. Author

N71-17854# Naval Aerospace Medical Inst., Pensacola, Fla.
ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY HU-1 AIRCRAFT DURING FISCAL YEAR 1967: RELATIVE INCIDENCE AND COST
 W. Carroll Hixson, Jorma I. Niven, and Emil Spezia 25 Aug. 1970
 38 p refs
 (AD-715107; NAMRL-1108; USAARL-71-1) Avail: NTIS CSCL 1/2

The report dealing with the magnitude of the pilot disorientation/vertigo accident problem in Regular Army UH-1 helicopter operations. Incidence and cost data presented for fiscal year 1967 include a total of 50 major and minor orientation-error accidents (15 of which were fatal), resulting in 38 fatalities, 88 nonfatal injuries, and a total UH-1 aircraft damage cost of \$7,542,177. Author (GRA)

N71-17876# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DRILLED-CORE STORAGE HEATER FOR A HYPERSONIC TUNNEL

Erwin A. Lezberg Washington Mar. 1971 23 p refs
 (NASA-TM-X-2202; E-5850) Avail: NTIS CSCL 14B

A design for a graphite drilled-core storage heater for supplying heated nitrogen gas to a hypersonic propulsion facility was developed using results from a transient-heat-transfer program. Hole size and spacing were determined from the results of the computer program and from consideration of thermal stress and cost factors. A model of the proposed matrix design was fabricated and tested in a pilot storage heater facility to evaluate thermal stress limitations and to compare performance of the heater with predictions based on the heat-transfer calculations. No cracking or deterioration of the matrix had occurred during the test program. Measured matrix temperatures were only in fair agreement with the results of a two-dimensional transient-heat-transfer program, but the discrepancies are believed to be due to thermocouple installation errors. Author

N71-17877# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN EXPERIMENTAL INVESTIGATION OF THE AIRFLOW OVER A CAVITY WITH ANTIRESONANCE DEVICES

Donald A. Buell Washington Mar. 1971 72 p refs
 (NASA-TN-D-6205; A-3691) Avail: NTIS CSCL 20D

Airflow over deep cavities was investigated in a wind tunnel and in flight at high subsonic speeds at equivalent or actual altitudes of 7 to 12 km. The cavities were large, with opening dimensions on the order of 1 m. Pressures were measured in and near the cavities with and without externally mounted devices intended to suppress resonances in the cavities. Some of the devices reduced the pressure fluctuations from as much as 50 to 2 or 3 times the amplitude occurring in a normal attached boundary layer. The pressure data were analyzed for spectral content, coherence, phase, shear-layer thickness, and shear-layer location. Author

N71-17882# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OVERALL PERFORMANCE IN ARGON OF A 3.7-INCH SIX-STAGE AXIAL-FLOW COMPRESSOR

Edward R. Tysl, Laurence J. Heidelberg, and Carl Weigel Washington Mar. 1971 23 p refs
 (NASA-TM-X-2194; E-5522) Avail: NTIS CSCL 21E

Overall performance from the compressor inlet to the collector exit and overall performance from the compressor inlet to the exit of the sixth-stage stator are presented as a function of equivalent weight flow. Peak efficiency (compressor inlet to collector exit) was 0.755 at the design equivalent rotative speed of 49,213 rpm and occurred at an equivalent weight flow of 1.55 lb/sec (0.70 kg/sec). The pressure ratio at peak efficiency was 2.72. Author

N71-17897* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HEAT PROTECTION APPARATUS Patent

Paul R. Hill and Otto F. Trout, Jr., inventors (to NASA) Issued 20 Sep. 1966 (Filed 19 Dec. 1962) 9 p Cl. 62-467
 (NASA-Case-XLA-00892; US-Patent-3,273,355; US-Patent-App'l-SN-245941) Avail: US Patent Office CSCL 20M

A thermal protection system for application to the wing, control, and other surfaces of hypersonic aircraft and reentry vehicles is described. A fiber oriented pile is applied as a covering element to the vehicle surfaces exposed to the greatest amount of aerodynamic heating. Orientation of the fibers in the direction of airflow insures radiation away from the surfaces and eliminates penetration of the heated air below the outer face of the fibers. NASA

N71-17906# Office of Naval Research, London (England).

THIRD INTERNATIONAL CONFERENCE ON RAIN EROSION AND ASSOCIATED PHENOMENA

E. I. Salkovit 20 Oct. 1970 31 p Conf. held at Hartley Wintney, Engl., 11-13 Aug. 1970

(AD-715100; C-25-70) Avail: NTIS CSCL 1/3

Equipment was described to test rain, hail and sand erosion damage to aircraft components flying at sub- and supersonic velocities. Materials were evaluated in terms of such meteorological exposure, and appropriate modeling techniques were described. Analyses were given of various factors influencing rain erosion resistance and investigations were conducted on the nature and consequences of raindrop disintegration on impact. Author (GRA)

N71-17907# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.

HELICOPTER APPLICATION STUDIES OF THE VARIABLE DEFLECTION THRUSTERJET FLAP Final Report

Ronald G. Bailey and Jeffrey M. Hammer Nov. 1970 117 p refs

(Contract N00014-69-C-0267)

(AD-715071; Doc-12153-FRI(R)) Avail: NTIS CSCL 1/3

The results of an analytical study to determine the application of a blown flap device called the Variable Deflection Thruster (VDT) to a helicopter rotor are presented and analyzed. The study is part of a longer-range program to investigate and develop control techniques for stabilization of the higher harmonic modes of helicopter rotor blades. A high-speed digital computer program was used to calculate the aerodynamic characteristics and performance of a Sikorsky CH-34 rotor system as though equipped with a blown two-dimensional section. The study was made over a range of rotor flight profiles and operating parameters including advance ratio, shaft angle of attack, blade pitch, tip Mach number, jet deflection angle and blowing rate. Performance of the blown rotor is compared to the conventional CH-34 rotor to illustrate VDT application effectiveness. Results show that the operating lift capability and propulsive force of the CH-34 rotor are increased when the rotor is equipped with a blown device. A preliminary analysis of the attenuation of rotor hub-shear variation by programmed blowing is also shown. In all cases, improved performance through application of blown control requires additional power. Author (GRA)

N71-17908# Army Foreign Science and Technology Center, Washington, D.C.

PRACTICAL AERODYNAMICS OF THE Mi-6 HELICOPTER

M. S. Yatsunovich 2 Nov. 1970 212 p Transl. into ENGLISH from THE PUBL. 'Prakticheskaya Aerodinamika Vertoleta Mi-6' Moscow, Moscow Transport, 1969

(AD-714915; FSTC-HT-23-1172-70) Avail: NTIS CSCL 1/1

The book presents a brief description of the helicopter, the aerodynamics of its lifting system and fuselage, characteristics

of the D-25V gas turbine engine and the pitch-gas system. The basic flying modes of the helicopter, methods for performing them and flying limitations for the Mi-6 helicopter with trapezoidal and rectangular lifting rotor blades, as well as problems of balancing, control centering and stability of the helicopter and special cases in flight are analyzed. The diagrams of forces in flying modes with forward speed are presented for simplicity without considering banking or slipping with which the helicopter should be balanced. These problems are discussed in the analysis of balancing of the helicopter. Author (GRA)

N71-17951*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

ACOUSTIC ATTENUATION DETERMINED EXPERIMENTALLY DURING ENGINE GROUND TESTS ON THE XB-70 AIRPLANE AND COMPARISON WITH PREDICTIONS

Norman J. McLeod Washington Mar. 1971 15 p refs
(NASA-TM-X-2223; H-633) Avail: NTIS CSCL 01C

Acoustic data obtained during ground runs of the XB-70 airplane enabled the attenuation of sound to be determined for ground-to-ground propagation over distances of 500 feet (152 meters) and 1000 feet (305 meters) for one set of atmospheric conditions. The considerable scatter in the experimentally determined attenuations seemed to be associated with variations in the wind parameters. For downwind propagation, reducing the predicted acoustic-attenuation values ARP 866 by 50 percent for octave bands above 1000 hertz resulted in good agreement between the present experimentally determined and predicted values. Author

N71-17958*# Pratt and Whitney Aircraft, East Hartford, Conn.
AERODYNAMIC BROADBAND NOISE MECHANISMS APPLICABLE TO AXIAL COMPRESSORS

Robert A. Arnoldi Washington NASA Mar. 1971 46 p refs
(Contract NASw-1908)
(NASA-CR-1743; PWA-3930) Avail: NTIS CSCL 21E

A study of broadband noise produced by the interactions of turbulence with the shock system upstream of a supersonic compressor and with the surface of the rotor blade has been made. The dynamic response of the rotor blade in the latter interaction was constructed empirically, based on the results of a complementary experimental program. This program obtained the lift response of an instrumented airfoil subjected to periodic upwash fluctuations. Both source mechanisms are found to produce noise levels of significant magnitude; either might be a prime source of broadband engine noise, and further study of both is recommended. The effect of incidence past stall on the unsteady response is shown to be a small reduction in magnitude and a slowly increasing delay in phase, neither of which make any substantial modifications in predicted noise output. This result was measured at a reduced frequency of 3.9; further investigations over a wider range is recommended. Author

N71-17963# American Airlines, Inc., New York. ATC Research Dept.

ATC STOL TASK FORCE
May 1970 21 p
Avail: NTIS

The feasibility of STOL operations in the Northeast Corridor is reviewed, including the viability of a proposed intercity STOL operation in areas heavily congested with air traffic. Area navigation routes and the corresponding en route and terminal area operational procedures are proposed for a STOL operation between Boston Logan Airport, a Manhattan STOLport and Anacostia Naval Air Station. Author

N71-18015*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

REAL-GAS EFFECTS ON THE DRAG AND TRAJECTORIES OF A NONLIFTING 140 DEG CONICAL AEROSHELL DURING MARS ENTRY

Dennis O. Allison and Percy J. Bobbitt Washington Feb. 1971 28 p refs
(NASA-TN-D-6240; L-7522) Avail: NTIS CSCL 22A

The influence of real-gas effects on the drag and trajectories of a 140 deg conical aeroshell during entry into five model Mars atmospheres is discussed. Drag coefficients are obtained by using an approximate technique which enables their determination at every point along a trajectory with reasonable computer time. The standard point mass trajectory equations are used and a spectrum of entry conditions are considered that consist of velocities of 4.27, 4.57 and 4.88 km/sec (14 000, 15 000, and 16 000 ft/sec) and entry-flight-path angles of 13.5 deg, 15 deg, and 17.5 deg. All calculations were made for an entry spacecraft with a ratio of mass to maximum cross-sectional area of 76.5 kg/square meter (0.487 slug/square foot). It is shown that a single curve may be chosen to represent the drag coefficient variations within 2 percent accuracy for all five model atmospheres and all the entry conditions considered. Author

N71-18018# Human Resources Research Organization. Alexandria, Va.

FUNCTIONAL REQUIREMENTS FOR GROUND-BASED TRAINERS: HELICOPTER RESPONSE CHARACTERISTICS

W. G. Matheny and L. E. Wilkerson Oct. 1970 121 p refs
(Contract DAHC19-70-C-0012)

(AD-714954; HUMRO-TR-70-17) Avail: NTIS CSCL 5/9

The overall research purpose was to develop methods for analyzing the helicopter pilots control tasks, as a basis for deciding characteristics needed in a ground-based trainer for use in pilot training. The report covers one phase, the response characteristics of the helicopter as it reacts to control inputs and external forces. Analyses were made of (a) characteristics of each dimension of control, (b) interaction among the dimensions, (c) effect of external forcing functions such as wind, (d) information the pilot receives by kinesthetic feedback from the controls. A measure of man-machine system characteristics was postulated--the effective-time constant, the time it takes for the displayed output of the system to rise above the pilots threshold of perception. Dealing with the effects of interaction among the controls proved to be one of the most difficult pilot tasks; of the single dimensions, pitch control is the most difficult. The characteristics of the system were identified in such a way that they can be varied quantitatively in research on task difficulty and transfer of training. Author (GRA)

N71-18022 Rennselaer Polytechnic Inst., Troy, N.J.

OPTIMIZATION OF COMPOSITE STRUCTURES: OPTIMUM COST AND WEIGHT DESIGN FOR A CYLINDRICAL SHELL SUBJECTED TO RE-ENTRY LOADS AND HEATING

Edgar Gebrath Menkes (Ph.D. Thesis) 1969 171 p
Avail: Univ. Microfilms: HC \$8.00/Microfilm \$3.00 Order No. 70-2631

An improved method of structural optimization is presented which encompasses recent advances in nonlinear mathematical programming methods and methods of analysis for fibrous composite materials. The methodology is based on a transformation of an inequality constrained minimization problem into a sequency of unconstrained minimizations, by applying a penalty function formulation. Advances include the formulation and solution of a composite shell design problem including constraints on joint-discontinuity stresses, and the development of a methodology for assessing the effects of uncertainties in system parameters on the optimum design. The optimization method is first developed by

considering a classic structural design application, the redundant three bar truss. Next an application to a composite shell structure is demonstrated. Dissert. Abstr.

N71-18025*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

AN ANALYTIC STUDY OF RADIATIVELY COOLED DELTA-WING STRUCTURES FOR HYPERSONIC AIRCRAFT

James C. Robinson, Robert W. Mc Withey, and George F. Klich
Washington Feb. 1971 65 p refs
(NASA-TN-D-6138; L-6666) Avail: NTIS CSCL 01A

A thermal analysis and a stress and deflection analysis of five structural configurations for a radiatively cooled discrete delta wing were carried out by using design conditions characteristic of a Mach 8 research vehicle. The configurations included wing cover panels possessing either biaxial or uniaxial stiffness, support systems along the root chord or at two points on the root chord, and airfoil sections having either positive or negative camber. Results indicate that for configurations supported along the full root chord, no excessive thermal or airload deformations occur. However, high thermal stresses occur in the wing cover panels that possess axial stiffness in the chordwise direction. Configurations in which the cover panels possess only spanwise axial stiffness exhibit significantly lower thermal stress in the panels but require that the rib caps carry larger thermal loads. Author

The article presents the results of investigation of the gas dynamics of fan jets at various injection angles from 60 degrees to 135 degrees. To increase the effectiveness of GTE afterburners, the flame is converted to jet or gas dynamic stabilization which produces a zone of backflows by injecting the gas jet (air, gaseous fuel, or a mixture) into the flow of combustible mixture. The limits of stable combustion in jets depend essentially on the parameters determined by the gas dynamics of the stream in the zone of interaction of jets with a flow. Author (GRA)

N71-18036# Cincinnati Univ., Ohio. Dept. of Aerospace Engineering.

ESTIMATION OF SUPERSONIC COMPRESSOR EFFICIENCY

W. Wells and R. E. Pavri Oct. 1970 16 p refs
(Contract DAHCO4-69-C-0016; Proj. Themis)
(AD-715005; THEMIS-AE-70-15; AROD-T-4-21-E) Avail: NTIS CSCL 13/7

A semi-empirical determination of the adiabatic efficiency of a supersonic compressor stage is obtained. The method utilizes the normal shock relations, a recently developed efficiency expression for subsonic cascade flow and experimental pressure loss data from supersonic cascades of various geometrical shapes. A correction factor is determined which makes it possible to convert the subsonic stage efficiency to the case of supersonic flow involving shock losses. Author (GRA)

N71-18029*# New York Univ., N.Y.

DIFFRACTION OF A PULSE BY A THREE-DIMENSIONAL CORNER

Lu Ting and Fanny Kung Washington NASA Mar. 1971 92 p refs
(Grant NGL-33-016-119)
(NASA-CR-1728; NYU-AA-70-06) Avail: NTIS CSCL 20D

For the diffraction of a pulse by a three-dimensional corner, the solution is conical in three variables $\zeta = r/(Ct)$, θ and α . The three-dimensional effect is confined inside the unit sphere $\zeta = 1$, with the vertex of the corner as the center. The boundary data on the unit sphere is provided by the appropriate solutions for the diffraction of a pulse by a two-dimensional wedge. The solution exterior to the corner and inside the unit sphere is constructed by the separation of the variable ζ from θ and α . The associated eigenvalue problem is subjected to the differential equation in potential theory with an irregular boundary in $\theta - \alpha$ plane. A systematic procedure is presented such that the eigenvalue problem is reduced to that of a system of linear algebraic equations. Numerical results for the eigenvalues and functions are obtained and applied to construct the conical solution for the diffraction of a plane pulse. For the diffraction of a general incident wave by corners or edges, two theorems are presented so that the value at the vertex of the corner or along the edges can be determined without the construction of the three-dimensional nonconical diffraction solutions. Relevant numerical programs for the analysis are presented in the appendix. Author

N71-18040# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.

EXECUTIVE SUMMARY OF ANALYTICAL STUDY OF AIR TRAFFIC CAPACITY IN THE NEW YORK METROPOLITAN AREA AND NEW YORK AIR TRAFFIC CAPACITY STUDY (REAL TIME SIMULATION) Final Reports

Feb. 1970 15 p
(FAA-RD-70-7; FAA-RD-70-4; FAA-NA-70-15) Avail: NTIS

The air traffic system capacity in the New York Metropolitan Area was examined. The effects of adding runways at Kennedy International and Newark Airports and the use of standardized instrument arrival and departure procedures, a revised route structure based on area navigation capability, and automated control aids and regulating traffic are estimated. Estimates were derived from a dynamic real-time simulation study and an analytical study covering system aspects not amenable to dynamic simulation. Estimates include: practical annual capacity, severe congestion annual capacity, and airspace system capacity in terms of controller workload and airspace physical capacity. Author

N71-18034# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE EFFECT OF THE INJECTION ANGLE ON GAS DYNAMICS OF FAN JETS IN THE DEFLECTED FLOW

V. A. Kosterin et al 4 Sep. 1970 11 p refs Transl. into ENGLISH from Aviat.-Inst., Kazan, Tr. (USSR), no. 101, 1968 p 32-38
(AD-714790; FTD-HT-23-443-70) Avail: NTIS CSCL 21/5

N71-18072# Department of Transportation, Washington, D.C. **NATIONAL TRANSPORTATION PLANNING MANUAL (1970 - 1990). MANUAL A: GENERAL INSTRUCTIONS**
Jul. 1970 187 p
(PB-194964; BOB-004-S700028) Avail: NTIS

General instructions are given on how to present and summarize cooperative comprehensive and continuing planning for the economic development of a national transportation system. The overall process covers all modes of domestic transportation and includes both private and public sectors of the economy. G.G.

N71-18078# Civil Aeronautics Board, Washington, D.C.
REMARKS PREPARED FOR DELIVERY BEFORE THE ASSOCIATION OF LOCAL TRANSPORT AIRLINES FALL QUARTERLY REGIONAL MEETING

Secor D. Browne 28 Sep. 1970 8 p Conf. held at Anchorage, Alaska, 28 Sep. 1970

Avail: Issuing Activity

The present state of local air transport and the main aspects to be considered in deciding future transport service are briefly discussed. The topics mentioned include the following: current economic plight of local airlines; the new Class Rate 5 formula being developed; the need for cooperation between local representatives, Systems Analysis Research Corporation, and the Civil Aeronautics Board; Mutual Aid Pact; encouragement of industries to locate away from urban areas; suitability of serving all existing points on routes where there is competition; fares; and marketing departments. N.E.N.

N71-18079# Civil Aeronautics Board, Washington, D.C.
REMARKS PREPARED FOR DELIVERY BEFORE THE 1970 NATIONAL AIRPORTS CONFERENCE

Secor D. Browne 6 Oct. 1970 6 p Conf. held at Norman, Okla., 6 Oct. 1970

Avail: Issuing Activity

The airport community noise problem and ways of noise reduction are discussed. The retrofit programs were examined and found to be high in cost and dubious in outcome. Suggestions were made to the FAA, which could be implemented immediately and cut noise exposure up to 90%: raise the approach floor of the ILS system 3000 feet and change the departure noise abatement procedures to allow pilots to take full advantage of the jet transport climb capability. It is also felt that effort should be spent on producing new, quiet, clean engines in the 20,000 to 30,000 pound thrust class. N.E.N.

N71-18087# Commerce Dept., Washington, D.C.
NATIONAL EXPORT EXPANSION COUNCIL: REPORT OF THE INDUSTRY COMMITTEE ON COMMERCIAL AIRCRAFT

Robert J. Murphy, Jr. May 1970 38 p

Avail: Issuing Activity

Civil aircraft export strategy and recommendations for increased exports during the 1970's are discussed. It is pointed out that significant competition comes not only from the United Kingdom but also from Japan and the USSR. It is felt that to meet the increased competition, industry and Government must work closely together and adequate long term financing will be crucial. Financing from the Export-Import Bank, commercial banks, and Government is recommended. It is also considered that overseas procurement and production, and politico/military policies should be reviewed. N.E.N.

N71-18099# Regional Science Research Inst., Philadelphia, Pa.
ECONOMIC IMPACT OF THE DALLAS-FORT WORTH REGIONAL AIRPORT ON THE NORTH CENTRAL TEXAS REGION IN 1976

Robert E. Coughlin, Robert C. Douglas, Thomas W. Langford, Jr., and Benjamin H. Stevens Jan. 1970 78 p refs Sponsored in part by Dept. of Housing and Urban Develop.

Avail: NTIS

Air transportation activities are projected for the Dallas-Fort Worth area. Proposed dollar value of purchases and employment

resulting from airport construction are discussed, emphasizing cost per unit, output determination from operating levels, adjustment for increased productivity, and total output and employment. Gross and net economic impact of purchases by airport activities of north central Texas region are reviewed, along with air transportation and regional growth. J.A.M.

N71-18100# Institute of Transport Aviation, Paris (France).
ATTITUDES TAKEN WITH REGARD TO AMENDMENTS TO THE WARSAW CONVENTION [LES PRISES DE POSITION AU REGARD DES AMENDEMENTS A LA CONVENTION DE VARSOVIE]

H. Beaubois 1970 58 p refs (Rept-1970/8-E) Avail: NTIS

An investigation is presented on the attitudes of members towards the revised limits of liability to international air transport passengers, as fixed by the Warsaw Convention and amended by The Hague Protocol. The positions adopted, in light of proposed amendments, since the first meeting of the ICAO Legal Committee in 1968, and how the different viewpoints evolved before crystallizing in the conclusions finally formulated by the Legal Committee itself are studied. The proposed amendments primarily concern the following six points: laws governing liability in passenger transport and means of defence open to the carrier; financial limitations on liability, and possible exceptions; the limit sum or sums; revising the limit sum; legal costs; and jurisdictional competence. The discussions pursued during 1968, 1969, and 1970 stemmed from the initial stands adopted and made known to the Subcommittee by IATA and the US Government. Their arguments are set out in detail after the more pertinent comments formulated by the Subcommittee's panel of experts are mentioned. The stands adopted by certain delegations throughout the legal Committee's labors on the six points are explained. Author

N71-18101# Federal Aviation Administration, Washington, D.C.
ALPA: A SURVEY OF AIRPORT FIRE AND RESCUE FACILITIES

B. V. Hewes 1970 84 p

Avail: NTIS

The annual survey of crash fire and rescue equipment at airports being served on at least a daily basis by the 11 trunks, 9 local service and 7 Alaskan and Hawaiian airlines is presented. Airports served exclusively by third level or airline operators are not included due to the problems encountered when collecting the necessary data. The purpose of the survey is to: (a) inform the airline pilot of the crash fire and rescue equipment available at the airports and (b) inform government agencies, airline authorities and other responsible groups and individuals of the facts concerning the status of crash fire and rescue equipment at North American and Canadian airports. Author

N71-18103# National Aviation Trades Association, Inc., Washington, D.C.

TESTIMONY OF MIDAIR COLLISION HAZARD BEFORE THE NATIONAL TRANSPORTATION SAFETY BOARD

Frank Kingston Smith Nov. 1969 182 p refs

Avail: NTIS

An analysis of midair collisions between commercial aircraft and general aviation aircraft is presented. The causes of midair collisions occurring during 1969 are discussed. Recommendations are made for measures to be employed for reducing the midair collision hazards. P.N.F.

N71-18104# American Airlines, Inc., New York.
INTER-METROPOLITAN STOL EVALUATION (PHASE 10)
Final Report
 Jan. 1970 146 p
 (Rept-50) Avail: NTIS

An integrated inter-metropolitan transport system was investigated to serve the expanding short-haul market. The McDonnell Douglas Model 188 STOL aircraft (Breguet 941S) was selected for the evaluation of the navigation systems, ATC procedures, and operational procedures. It was concluded that effective airline use of STOL aircraft is now operationally and technically feasible. It is recommended that the air carriers develop a STOL transport system, starting with existing aircraft and simple interim facilities, to demonstrate the market and economics of a continuing passenger carrying service.
 F.O.S.

N71-18105 California Univ., Los Angeles. Div. of Vocational Education.
AIR TRAFFIC CONTROL: A FEASIBILITY STUDY
 David Allen, William K. Bowers, Richard L. Lano, and John M. Meyer 1970 177 p
 Copyright. Avail: NTIS

A Task inventory of the air traffic controller occupation was conducted and development of performance objectives was analyzed. A preliminary listing of curriculum content is identified. A task inventory questionnaire was developed, data were collected and tabulated, and the data were analyzed with recommendations for curriculum content including the depth of required learning for each topic.
 Author

N71-18109# Radio Technical Commission for Aeronautics, Washington, D.C.
MINIMUM OPERATIONAL CHARACTERISTICS FOR AIRBORNE ATC TRANSPONDER SYSTEMS
 12 Mar. 1970 56 p refs
 (DO-144) Avail: NTIS

The requirements of basic characteristics for navigation and communication systems used in air traffic control are discussed. Equipment specifications, and environmental and international standards are presented.
 R.B.

N71-18112# Institute of Transport Aviation, Paris (France).
THE FREQUENCY OF SCHEDULED SERVICES: AN ANALYSIS OF AIR TRANSPORT SUPPLY
 G. Desmas and R. Mathieu 1970 92 p
 (Rept-1970/1-E) Avail: NTIS

A detailed analysis of air transport supply on scheduled services in one month of 1967 is presented for the Europe-Mediterranean region and Southeast Asia. Supply was measured by a set of four variables: the number of stages, flights, available seats, and available seat-km. The distribution of these variables was examined according to three parameters: frequency, the level of supply (in available seats), and stage length. A double classification was carried out and the stages sorted by frequency and distance, and then by frequency and supply level. The study was continued with mean values and, after determining the area in which the mean frequency/mean capacity combinations varied at the different supply levels, the relations existing between the mean frequency and mean supply level calculated for homogeneous groups of stages, and between the mean frequency and mean distance were investigated. An analysis was also made of aircraft type use and share in overall activity. It was found that the utilization of different aircraft was dispersed over a wide frequency range. The analysis was applied to Italy and Japan.
 Author

N71-18114# Stanford Research Inst., Menlo Park, Calif.
TESTS OF ORTHO-DECOUPLED AIRCRAFT STATIC DISCHARGERS
 R. L. Tanner and J. E. Nanevicz [1970] 18 p refs
 Contracts AF 33(616)-6561; AF 19(604)-3458
 Avail: NTIS

Flight tests were conducted to evaluate devices for discharging static electricity from aircraft without the production of radio interference. The devices employed a principle, known as ortho-decoupling, by which the radio interference generated from corona discharges taking place at the devices is decoupled from the radio antennas. Two different installations of dischargers were tested. In one installation the ortho-decoupling principle was incorporated in flush-mounted dischargers installed along the trailing edges at the tips of wing and tail surfaces. The flush-mounted dischargers were supplemented by small external blade dischargers, also incorporating the ortho-decoupling principle, which were installed in the region of vortex formation at the tips of the airfoil surfaces. In the second installation a number of simple externally mounted rod dischargers replaced the flush-mounted dischargers on the trailing edges.
 Author

N71-18115# Institute of Transport Aviation, Paris (France).
REGIONAL STATISTICS ON SAFETY IN AIR TRANSPORT [STATISTIQUES REGIONALES SUR LA SECURITE DU TRANSPORT HERIEN]
 R. Mathieu 1970 69 p refs
 (Rept-1970/10-E) Avail: NTIS

Accidents incurred by scheduled airlines are examined by country or region of the operator. A comparison between the share of each region in scheduled traffic and its share in accidents shows differences in the safety levels of the operators of each region. All accidents occurring in air transport to aircraft of over 5700 kg are considered. Because of lack of data on the corresponding traffic, the accident rates between the operators in the various regions are not made. The proportion of fatal accidents is shown to be higher in air transport accidents as a whole than in scheduled service accidents as a whole. Accidents are also studied by region and type of accident, and differences are noted in the proportion of the same type of accident in total accidents for each region.
 Author

N71-18116# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.
SURVEY OF AIR TRAFFIC CONTROL RADAR BEACON SYSTEM OPERATIONAL PROBLEMS (30 DAY ATC CONTROLLER SURVEY)
 Kenneth Wise Jan. 1970 50 p
 Avail: NTIS

The survey results presented include the significant findings of over 12,000 individual trouble reports received from air traffic controllers at beacon sites. The reports were collected from civil and military towers and centers and include problems connected with ground equipment as well as those of the aircraft.
 D.L.G.

N71-18117# Federal Aviation Administration, Washington, D.C. Aviation Weather Systems Branch.
METEOROLOGICAL EFFECTS ON AIR TRANSPORTATION
 Arthur Hilsenrod Jan. 1971 26 p refs Presented at the 51st Ann. Meeting of the Am. Meteorol. Soc., San Francisco, 21 Jan. 1971
 Avail: NTIS

Data are presented on the frequency of and costs resulting from environmental restrictions on air transportation. An operational system that overcomes the restrictive conditions is described, along with specific programs of FAA and the Department of Transportation.
 Author

N71-18118 Michigan Univ., Ann Arbor. Bureau of Business Research.

ALTERNATIVE LOGISTICS SYSTEMS FOR EXPENSIVE PARTS: AN AIRLINE STUDY

William G. Browne 1969 242 p refs
Copyright. Avail: NTIS

The overhaul and inventory procedures of commercial airlines for major aircraft parts are analyzed, along with the policy alternatives for providing the services with increased efficiency. A computer simulation was developed to examine the impact on cost and service levels of different inventory and overhaul configurations for the GE-4 engine, which will be used to propel the SST. Experimentation with the different locations of overhaul facilities and inventory was conducted. The simulation included provisions for changes in ownership, engine status, number of overhaul facilities in the system, engine failure rates, overhaul times, and rates of fleet growth and system expansion. A survey of management attitudes toward increased consolidation indicates that overhaul facility location is the most critical factor inhibiting consolidation efforts. The major conclusions were: (1) considerable cost savings can be achieved through policy changes providing for intercompany consolidation of engine overhaul and storage facilities, and (2) the attainment of an overhaul and inventory consortium with more than three or four members is likely to be most difficult, considering present industry attitudes. Author

N71-18138*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

UNSTART AND STALL INTERACTIONS BETWEEN A TURBOJET ENGINE AND AN AXISYMMETRIC INLET WITH 60-PERCENT INTERNAL-AREA CONTRACTION

David A. Choby, Paul L. Burstadt, and James E. Chalogeras
Washington Mar. 1971 38 p refs
(NASA-TM-X-2192; E-5923) Avail: NTIS CSCL 21E

The effects of inlet unstart on engine operation and the characteristics of stall propagation through the compressor and inlet system are discussed. With inlet unstarts at Mach 1.98, the instantaneous compressor pressure ratio which stalled the engine correlated with the steady-state value of the stall compressor pressure ratio. The unstart transient was so large at Mach 2.50 that it caused abrupt compressor stall at all engine operating conditions. Compressor stalls obtained by back-pressuring the engine at Mach 2.50 initiated hammer shocks through the inlet which caused surface static pressures to exceed freestream total pressure. Author

N71-18161# Atomic Energy of Canada Ltd., Chalk River (Ontario).
RESULTS OF TWO-PHASE BLOW-DOWN EXPERIMENTS. PART 1: STRAIGHT TUBE TEST SECTION

R. F. White Aug. 1970 73 p refs
(AECL-3664) Avail: AEC Depository Libraries; Atomic Energy of Can., Ltd., Chalk River: \$2.00

Experiments on the blowdown rig have yielded detailed information of the behavior of flowing two-phase steam-water mixtures during the first 100 ms after rupture of a diaphragm at the end of a pipe 15 feet long and 0.621 in. ID. Blowdown tests were made from initial pressures of 485 psia and 1002 psia and steam qualities from 8% to 31%. Pressure transients measured at three positions about 7 feet apart in the test section showed that the transition from the pre-blowdown pressure gradient to that corresponding to critical discharge occurred in about 100 ms after rupture. Measured rarefaction wave velocities were in the range 1520 to 1570 ft/sec and all were within 6% of corresponding theoretical values. Measured masses of water discharged during the first 100 ms after diaphragm rupture agreed with values predicted by the homogeneous model for steady state two-phase critical flow, contrary to critical discharge rates measured under steady state conditions which agree with an annular two-phase critical flow model. Author (NSA)

N71-18187*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

A SUMMARY OF AVAILABILITY AND ACCURACY OF LANDING AIDS FOR SHUTTLE APPLICATIONS

Richard J. Labrecque 14 Aug. 1970 6 p refs
(NASA-TM-X-66720; MSC-70-FM22-137) Avail: NTIS CSCL 17G

Observations on landing the shuttlecraft and navigational aid capabilities are summarized. Findings show that if emergency landings at almost any airport are attempted some of the current navigational aids should be included in the shuttle equipment. There are a variety of navigational aids available accurate enough to vector the shuttle to the landing area and perform a guided approach. There is no system however that has demonstrated guided landings at the large glide angles in unpowered shuttle landings. A transponder type RR set right at the landing site could help vector the shuttle in an emergency or serve to update the inertial system. Author

N71-18269# School of Aerospace Medicine, Brooks AFB, Tex.
NOISE ASSOCIATED WITH OPERATION OF THE C-9A (AEROMEDICAL EVACUATION) AIRCRAFT

Donald C. Gasaway Oct. 1970 37 p refs
(AD-715222; SAM-TR-70-63) Avail: NTIS CSCL 20/1

Noise within the Douglas C-9A during various phases of operation is described and illustrated. Near-field acoustic exposures are also discussed and illustrated. Degrees of speech interference and auditory risk are discussed and methods of controlling potentially undesirable effects are proposed. Author (GRA)

N71-18367*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PRELIMINARY STUDY OF ADVANCED HYPERSONIC RESEARCH AIRCRAFT

Le Land H. Jorgensen, Walter P. Nelms, Jr., and Lionel L. Levy, Jr. Washington Mar. 1971 18 p refs
(NASA-TM-X-2222; A-3567) Avail: NTIS CSCL 01C

Important flight constraints for hypersonic research aircraft are reviewed. Maximum lift-drag ratios for state-of-the-art hypersonic aircraft in trimmed flight have been derived from wind-tunnel tests. Weights, cruise times, and ranges for rocket-boosted research airplanes with air-breathing cruise engines are estimated and compared. Both horizontal take-off from the ground and air launch from a subsonic airplane are considered. Author

N71-18397*# Techtran Corp., Glen Burnie, Md.
MEASUREMENTS OF INTERFERING UNSTEADY FORCES BETWEEN LIFTING SURFACES IN TANDEM [MESURES DES FORCES INSTATIONNAIRES D'INTERACTION ENTRE SURFACES PORTANTES EN TANDEM]

R. Destuynder Washington NASA Feb. 1971 18 p refs Transl. into ENGLISH from French Report ONERA-TP-890 (Contract NASw-2037)
(NASA-TT-F-13482; ONERA-TP-890) Avail: NTIS CSCL 01A

Wind tunnel tests were conducted in order to determine the effect of interference between two lifting surfaces in tandem. Models of rectangular and swept wings were used with variable horizontal and vertical separations. The tests were limited to pure pitch and translation of the wings. Author

N71-18401*# Scientific Translation Service, Santa Barbara, Calif.
CONTRIBUTION TO THE STUDY OF SONIC FLOWS PAST AN OBSTACLE

D. Euvrard Washington NASA Feb. 1971 17 p refs Transl. into ENGLISH from Proceedings of the 8th Symp. on Advanced Probl. and Methods in Fluid Dyn. (Tarda), 18-25 Sep. 1967

p 369-377

(Contract NASw-2035)

(NASA-TT-F-13472) Avail: NTIS CSCL 20D

The main findings of a series of investigators dealing with sonic flow past an obstacle of finite dimensions are summarized. A detailed study is made of the regions upstream and downstream from the shock waves in the case of an airfoil in a flow which is uniform and sonic at infinity. Cases of symmetrical and asymmetrical flow are also considered. A case involving a three-dimensional flow is also presented. F.S.

N71-18422* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

EXPERIENCE WITH THE X-15 ADAPTIVE FLIGHT CONTROL SYSTEM

Washington Mar. 1971 28 p refs

(NASA-TN-D-6208; H-618) Avail: NTIS CSCL 01C

The X-15 adaptive flight control system is briefly described, and system development and flight-test experiences in the X-15 research airplane are reviewed. Airplane handling qualities with the system and system reliability are also discussed. Author

N71-18423* Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique.

DELTA WING STUDY IN A LOW DENSITY HYPERSONIC FLOW [ETUDE D'UN ECOULEMENT HYPERSONIQUE A BASSE DENSITE AUTOUR D'AILES DELTA]

Jean Alligre and Jean-Claude restingier Sep. 1970 59 p refs In FRENCH; ENGLISH summary

(Rept-70-9) Avail: NTIS

Experiments are performed in a rarefied hypersonic flow characterized by a Mach number of 8 and a free stream Reynolds number of 2200 per cm. Present results include wall pressure and heat transfer distributions along 60 and 70 deg delta wings, considering both incidence and leading edge thickness effects. Wall pressure and heat transfer data on the wing axis are compared with previous theoretical laws valid in the strong interaction regime. Drag and lift coefficients are deduced from aerodynamic force measurements. In order to point out the skin friction effect, aerodynamic force components due only to the wall pressure are calculated and compared with total aerodynamic force values. Author (ESRO)

N71-18424* Cambridge Univ. (England). Dept. of Engineering. **IMPROVED ENTRAINMENT METHOD FOR CALCULATING TURBULENT BOUNDARY LAYER DEVELOPMENT**

M. R. Head and V. C. Patel London Aeron. Res. Council Mar. 1968 27 p refs Supersedes ARC-31043

(ARC-R/M-3643; ARC-31043) Copyright. Avail: NTIS; HMSO: 70p; BIS: \$2.80

(ARC-R/M-3643; ARC-31043)

A simple integral method is presented for the calculation of two dimensional incompressible turbulent boundary layers. Use is made of established relationships to determine values of the entrainment coefficient for equilibrium layers, and the entrainment coefficient for nonequilibrium conditions is obtained by multiplying the corresponding equilibrium value by a suitable empirical function. This increases the entrainment when the rate of growth of the layer is less than that of the corresponding equilibrium layer, and decreases it when the rate of growth is greater. This variation of entrainment is in accordance with observation, and a simple physical explanation is proposed to account for it. This explanation further suggests how the effects of flow convergence may be taken into account. Comparisons with measured boundary layer developments show the general accuracy of the method. Author (ESRO)

N71-18425* National Physical Lab., Teddington (England). Aerodynamics Div.

NUMERICAL APPRAISAL OF MUTHOPP'S

LOW-FREQUENCY SUBSONIC LIFTING-SURFACE THEORY

H. C. Garner London Aeron. Res. Council 1970 102 p refs Supersedes NPL-AERO-1278; ARC-30607; N69-38133

(ARC-R/M-3634; NPL-AERO-1278; ARC-30607) Copyright. Avail: NTIS; HMSO: £ 2.60; BIS: \$9.36

Extensive tabulated results are presented for 17 varied planforms at uniform incidence or in low-frequency pitching oscillation. Numerical accuracy and convergence are studied in relation to parameters representing chordwise and spanwise collocation, spanwise integration, and central rounding of sweptback wings; general criteria for selecting these are recommended. Collocation error is reduced by doubling the central rounding, but no improvement is obtained unless its aerodynamic influence is subtracted. Author (ESRO)

N71-18428* National Aeronautics and Space Administration Flight Research Center, Edwards, Calif.

LIFTING-BODY Progress Report

Milton O. Thompson 1970 4 p Presented at the ELDO/NASA Space Transportation Systems Briefing, Bonn, 7-8 Jul. 1970

(NASA-TM-X-66712) Avail: NTIS CSCL 22A

The lifting body flight test program, concerning mainly the HL-10 reentry vehicle, the M2-F2 lifting body, and the X-24A aircraft is described. The flight test results demonstrate that configurations designed for lifting entry can have acceptable low speed flight characteristics and adequate maneuverability for approach and landing and are suitable for the shuttle mission. ESRO

N71-18439* Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

WING LIFTING LINE REPRESENTATION: APPLICATION TO THE TWO WINGS IN TANDEM INTERACTION [REPRESENTATION D'UNE AILE PAR DES LIGNES PORTANTES: APPLICATION AU CALCUL DE L'INTERACTION DE DEUX AILES EN TANDEM]

Roland Dat and Yoshio Akamatsu 1970 18 p refs In FRENCH; ENGLISH summary Presented at the AGARD Symp. on Unsteady Aerodyn. for Aeroelastic Anal. of Interfering Surfaces, Toensberg, Norway, 3-4 Nov. 1970 Submitted for publication

(ONERA-TP-891; Rept-5) Avail: NTIS

The simulation of wings by a lattice of lifting lines appears to be suitable for the computation of unsteady aerodynamic forces on combinations including several lifting surfaces, such as wing-horizontal tail or fin-horizontal tail. It can be considered as a compromise between the doublet lattice method, which is advantageous for its flexibility, and the so-called lifting surface method, the results of which are more accurate for a given number of collocation points. A numerical program has been developed for the application to wings in two parallel planes. The particular features of the calculation method are presented, as well as some numerical results. Author (ESRO)

N71-18441* Aviatest GmbH, Duesseldorf (West Germany).

INVESTIGATIONS OF HYPERSONIC CHARACTERISTICS OF TWO PHASE FLOWS AND THEIR POSSIBLE USE FOR AERODYNAMIC MEASUREMENTS [UNTERSUCHUNGEN ZUM UEBERSCHALLVERHALTEN VON ZWEIFLASENSTROEMUNGEN UND IHRER MOEGELICHEN ANWENDUNG FUER AERODYNAMISCHE MESSUNGEN]

V. Denk, B. Feldmann, and H. Griesser Bonn Bundeswehramt 1970 147 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung

(BMVtdg-FBWT-70-1) Avail: NTIS; Bundeswehramt, Bonn: 25 DM

The pilot plant for generation of quasi-homogeneous water-air-mixture flows is described. Emphasis is made on the measurement of the two phase flow characteristics and various measurement methods are dealt with. The tests performed confirm the theoretically expected supersonic characteristics of the two phase flow at slight flow rates, and show the possibility to apply the test results to aerodynamics. Author (ESRO)

N71-18442*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
FLIGHT EVALUATION OF ANGLE OF ATTACK AS A CONTROL PARAMETER IN GENERAL-AVIATION AIRCRAFT
 Shu W. Gee, Harold G. Gaidick, and Einar K. Enevoldson
 Washington Mar. 1971 23 p refs
 (NASA-TN-D-6210; H-603) Avail: NTIS CSCL 01C

The use of angle-of-attack information for a pilot's display in a general-aviation airplane was investigated to determine whether this form of information would improve performance and flight safety. An angle-of-attack system consisting of a wing-mounted vane, an electronic computer unit, and a display instrument was installed and flight tested in a typical twin-engine, general-aviation airplane. The flight-test maneuvers were limited to the low-speed flight region where the benefits of angle-of-attack presentation were likely to be greatest. Some of the expected advantages of this parameter, such as visual indication of stall margin and its independence of gross weight and flap position, were realized; however, certain aerodynamic characteristics of the airplane, such as the phugoid and directional-control capability, were found to limit and tended to negate some of the expected advantages. As a result, this use of angle of attack did not show a significant improvement in performance and flight safety. Author

N71-18444# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany) Abteilung Ueberschallkanal.
EFFECT OF THE POSITION OF MAXIMUM THICKNESS AND OF THE LENGTH OF BODIES OF REVOLUTION ON AERODYNAMIC COEFFICIENTS IN SUPERSONIC FLOW [EINFLUSS DER DICKENRUECKLAGE UND DER RUMPLAENGE VON ACHSENSYMMETRISCHEN FLUGKOERPERN AUF DIE AERODYNAMISCHEN BEIWERTE IM UEBERSCHALL]

Hansgeorg Riedel, Hans Emunds, and Franz Joachim Niezgodka
 Nov. 1970 190 p refs In GERMAN; ENGLISH summary
 (DLR-FB-70-54) Avail: NTIS; ZLDI Munich; 66.60 DM

The aerodynamic coefficients of bodies of revolution consisting of ogive-cylinder combinations were determined in a 30 x 30 sq cm supersonic wind tunnel by force and pressure measurements for the Mach number range from 1.57 to 4.15. A comparison is made of the results with the slender body theory and a first and second order theory. Author (ESRO)

N71-18449# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

MEASUREMENT OF UNSTEADY AIR LOADS OF INTERACTING LIFTING SURFACES IN TANDEM [MESURES DES FORCES INSTATIONNAIRES D'INTERACTION ENTRE SURFACES PORTANTES EN TANDEM]

Roger Destuynder 1970 13 p refs In FRENCH; ENGLISH summary Presented at the AGARD Symp. on Unsteady Aerodyn. for Aeroelastic Anal. of Interfering Surfaces, Toensberg, Norway, 3-4 Nov. 1970. Submitted for publication
 (ONERA-TP-890) Avail: NTIS

Wind tunnel tests have been performed for analyzing the influence of several parameters on the aerodynamic interference between two lifting surfaces in tandem. The aim was to determine the magnitude of the coupling terms in order to provide a theoretical explanation of the flutter instabilities occurring on variable sweep

airplanes. The tests have been limited to two types of motion: pure translation and pure pitching oscillation of one wing. The model consisted of two rectangular or swept wings whose relative position could be adjusted continuously in the horizontal and in the vertical direction. Several conclusions can be drawn from the test results, and the phenomena of interaction are shown to be important for certain configurations. Some comparisons between theory and experiment have been undertaken. Author (ESRO)

N71-18452# Royal Aircraft Establishment, Farnborough (England).
A SURVEY OF SOME EUROPEAN HYPERSONIC RESEARCH
 D. Kuechemann 1970 13 p refs Presented at the 4th EUROSPACE US-European Conf., Venice, 22-25 Sep. 1970
 Avail: NTIS

The aim of the Eurohyp program relating to hypersonic boundary layer and flow fields is reviewed. The experimental facilities available in Europe for investigating compressible boundary layers, lifting bodies, propulsion aerodynamics, and fluid dynamics of real gases are listed and discussed. It is concluded that the Eurohyp activities may well provide the basis for a future official European research program, including the aerodynamic design of hypersonic transport aircraft, a space shuttle, and its launcher. ESRO

N71-18456# National Physical Lab., Teddington (England). Aerodynamics Div.

WAKE BLOCKAGE CORRECTIONS IN A CLOSED WIND TUNNEL FOR ONE OR TWO WALL-MOUNTED MODELS SUBJECT TO SEPARATED FLOW

R. W. F. Gould London Aeron. Res. Council Feb. 1969 23 p refs Supersedes NPL-AERO-1290; ARC-31007
 (ARC-R/M-3649; NPL-AERO-1290; ARC-31007) Copyright. Avail: NTIS; HMSO: 60p; BIS: \$2.40

Measurements described show that wake blockage corrections apply to rectangular plates normal to the flow, over the aspect ratio range from 1/3 to 3 tested, whether the plates are mounted on the tunnel axis or adjacent to a wall. Only small nonlinear effects were found even when the corrections approached 100%. Blockage correction formulas are developed for use when two models are present in the working section at the same time (but each outside the wake of the other). The method of determining the required blockage factors is described with examples from measurements on flat plates mounted normal to a wall and on lattice models. Author (ESRO)

N71-18461# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

WIND-TUNNEL INVESTIGATIONS OF INSTABILITY IN A CABLE-TOWED BODY SYSTEM

A. R. Mettam London Aeron. Res. Council Feb. 1969 23 p refs Supersedes RAE-TR-69022; ARC-31372
 (ARC-R/M-3644; RAE-TR-69022; ARC-31372) Copyright. Avail: NTIS; HMSO: 80p; BIS: \$3.20

A brief investigation was made into instability of a body towed by a helicopter. This was undertaken after an incident in which a divergent oscillation led to cable failure in flight. Stability boundaries in terms of cable length and forward speed were determined for the original cable/body system. The effects of various body and suspension modifications were then studied. Existing theory was compared with the experimental results and both were used in forecasting the behavior of a new cable/body system. Subsequent experimental work elsewhere confirmed the validity of these estimates. Enhanced stability of the system was observed at short cable lengths and a possible explanation is suggested. Author (ESRO)

N71-18462# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

COMPUTATION OF THE AERODYNAMIC INTERACTIONS BETWEEN AIRCRAFT LIFTING ELEMENTS IN SUPERSONIC STEADY OR UNSTEADY FLOW [CALCUL D'INTERACTIONS AERODYNAMIQUES ENTRE LES ELEMENTS PORTANTS D'UN AVION EN ECOULEMENT SUPERSONIQUE STATIONNAIRE OU INSTATIONNAIRE]

Michel Enselme, Jean-Paul Boisseau, and Andre Guillois 1970 8 p refs In FRENCH; ENGLISH summary Presented at the AGARD Meeting on Aerodyn. Interference, Silver Spring, MD., 28-30 Sep. 1970 Submitted for publication (ONERA-TP-850) Avail: NTIS

After recalling the principle of analog computation of a lifting assembly in supersonic steady or unsteady flow a numerical process copied on the analog process using an explicit method for computing the solutions of the wave equation is presented. Results obtained either by analog or by numerical computation are presented. They concern wing-body or wing-pod interactions, and the computation of a wing of arbitrary planform in unsteady flow.

Author (ESRO)

N71-18464# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

WIND TUNNEL INVESTIGATION INTO AERODYNAMIC INTERACTIONS INDUCED BY DROP LOADS [ETUDE EN SOUFFLERIE DES INTERACTIONS AERODYNAMIQUES DUES AUX CHARGES LARGABLES]

Jean Christophe and Jacques Coste 1970 13 p refs In FRENCH; ENGLISH summary Presented at the AGARD Meeting on Aerodyn. Interference, Silver Spring, MD., 28-30 Sep. 1970 Submitted for publication (ONERA-TP-849) Avail: NTIS

The wind tunnel techniques currently used for the investigation into aerodynamic interactions induced by drop loads are reviewed and some representative results shown. Special attention is paid to directly tracing the trajectories of dropped loads and microrocket-propelled missiles by high-speed filming in the tunnel. The results so obtained are compared with those of the newly developed alternative method of weighing the load in the aerodynamic field of the aircraft and reconstructing its trajectory by a computing routine.

Author (ESRO)

N71-18468# Cambridge Univ. (England). Dept. of Engineering.

CALCULATION OF THE TURBULENT BOUNDARY LAYER IN A VORTEX DIFFUSER

T.-S. Cham and M. R. Head London Aeron. Res. Council May 1969 32 p refs Supersedes ARC-31237 (ARC-R/M-3646; ARC-31237) Copyright. Avail: NTIS; HMSO: 80p; BIS: \$3.20

In two dimensional potential flow the combination of a source and free vortex produces an axisymmetric flow with streamlines in the form of equiangular spirals. Calculations have been made of the turbulent boundary layer developing beneath such a flow and the results have been compared with measurements made elsewhere. The integral equations of momentum and entrainment are satisfied in a streamline coordinate system in the calculation method used.

Author (ESRO)

N71-18469# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).

CALCULATION OF THE POTENTIAL FLOW AROUND ROTATIONALLY SYMMETRICAL RING PROFILES [BERECHNUNG DER POTENTIALSTROEMUNG UM ROTATIONSSYMMETRISCHE RINGPROFILE]

W. Geissler 1970 120 p refs In GERMAN *Its Mitt. aus dem Max-Planck-Inst. fuer Stroemungsforsch. und Aerodyn.*

Versuchsanstalt No. 47

Avail: NTIS

A procedure is shown for calculating the potential flow around rotationally symmetrical ring profiles using the singularity method. Contrary to linearized methods, utilizing singularity distributions on a cylindrical substitute body, this procedure uses vortex distributions on the curved profile surface. Main problems of profile theory for ring profile skeletons and thick ring profiles are solved.

ESRO

N71-18471# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin (West Germany). Abteilung Aeroakustik und Instabilitaet.

A NOTE ON THE SPATIAL JET-INSTABILITY OF THE COMPRESSIBLE CYLINDRICAL VORTEX SHEET

Alfons Michalke Oct. 1970 20 p refs (DLR-FB-70-51) Avail: NTIS; ZLDI Munich: 6.20 DM

The linearized inviscid disturbance equations were derived for a compressible circular jet with variable temperature and density profile. The eigenvalue changes of the instability problem for the cylindrical vortex sheet were computed and discussed for the variations with Strouhal and Mach numbers, and temperature ratios. It was found that contrary to temporal amplification the phase velocity of spatially growing disturbances can exceed the jet velocity. Furthermore, additional disturbance modes can exist in the spatial case.

Author (ESRO)

N71-18472# Max-Planck-Institut fur Stromungsforschung, Gottingen (West Germany).

PECULIARITIES OF TURBULENT WAKES [EIGENTUEMLICHKEITEN TURBULENTER NACHLAUFSTROEMUNGEN]

R. Ermshaus 1970 94 p refs In GERMAN *Its Mitt. aus dem Max-Planck-Inst. fuer Stroemungsforsch. und Aerodyn.* Versuchsanstalt No 46 Avail: NTIS

Mean and turbulent parameters of plane and rotationally symmetrical wakes were investigated in a wind tunnel. The results show distinct differences in the profiles of their wakes. For both types of wake a uniform exponent of width development was found.

ESRO

N71-18473# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

APPLICATION OF LIFTING SURFACE THEORY TO WINGS WITH CONTROL SURFACES [APPLICATION DE LA THEORIE DE LA SURFACE PORTANTE A DES AILES MUNIES DE GOUVERNES]

Bertrand Darras and Roland Dat 1970 15 p refs In FRENCH; ENGLISH summary Presented at the AGARD Symp. on Unsteady Aerodyn. for Aeroelastic Anal. of Interfering Surfaces, Toensberg, Norway, 3-4 Nov. 1970 Submitted for publication (ONERA-TP-889) Avail: NTIS

The problem of control surfaces in subsonic unsteady flow is considered. The method for solving it is based on the formulation of the logarithmic singularity of the pressure field and on an analysis of the usual matrix solution of the integral equation. This method is extended here to an arbitrary planform. The comparison of experimental and theoretical results obtained for the rectangular wing is also shown.

Author (ESRO)

N71-18480# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

EXPERIMENTAL WAKE SURVEY BEHIND A 120 DEG INCLUDED ANGLE CONE AT ANGLES OF ATTACK OF 0

DEG AND 5 DEG. MACH NUMBERS FROM 1.60 TO 3.95, AND LONGITUDINAL STATIONS VARYING FROM 1.0 TO 8.39 BODY DIAMETERS

Clarence A. Brown, Jr., James F. Campbell, and Dorothy H. Tudor
Washington Jan. 1971 344 p refs
(NASA-TM-X-2139; L-7517) Avail: NTIS CSCL 20D

An investigation was conducted to obtain flow properties in the wake of a 120 deg-included-angle cone at Mach numbers from 1.60 to 3.95 and at angles of attack of 0 deg and 5 deg. The wake flow properties were calculated from total and static pressures measured with a pressure probe at longitudinal stations varying from -0.42 to 3.0 body diameters. These measurements showed a consistent trend throughout the range of Mach numbers and longitudinal distances and an increase in dynamic pressure with increasing downstream position. Author

N71-18499*# Boeing Co., Seattle, Wash.

STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION VOLUME 7: SUBJECTIVE EVALUATION TESTS Contractor Report, 1 May 1967 - 1 Nov. 1969

Washington NASA Jan. 1971 104 p refs
(Contract NAS1-7129)
(NASA-CR-1717) Avail: NTIS CSCL 01C

Judgments of relative annoyance caused by flyover noises from a standard Boeing 707-320B and one with acoustically treated nacelles were made by 180 persons. The primary aim of the experiment was to determine whether the noise reductions measured during previous flight tests of the acoustically treated nacelles would be perceived by a sample of persons from the community. This aim was achieved by determining the relationship between the noise ratings of the 180 judges and each of 18 engineering calculation procedures that convert sound pressure spectra into subjective units. Author

N71-18509*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

VERIFICATION OF TAKEOFF PERFORMANCE PREDICTIONS FOR THE XB-70 AIRPLANE

Terry J. Larson and William G. Schweikhard Washington Mar. 1971 29 p refs
(NASA-TM-X-2215; H-574) Avail: NTIS CSCL 01C

XB-70 airplane standardized takeoff data are compared with simple predictions based on aerodynamic and engine estimates. Effects of atmospheric and aircraft variables on takeoff distance are evaluated. Although experimentation with various techniques for aircraft rotation to liftoff attitudes was limited, the effects of the pilot techniques used are discussed and compared. Predictions of distance from brake release to initiation of rotation as a function of velocity were found to be accurate to approximately 100 feet. Because of the significant drag at the high aircraft attitudes required for takeoff, the standardized ground roll distance for a given velocity was increased nominally by 400 feet over the distance which would occur with no increase in drag. Standardized performance during climb from liftoff to a height of 35 feet with all engines operating was marginal because of low longitudinal accelerations, resulting from high induced drag at liftoff attitude. Author

N71-18519*# Royal Aircraft Establishment, Farnborough (England).
THE DESIGN AND DEVELOPMENT OF AN AIRCRAFT MOUNTING PRINTED-CIRCUIT SPIRAL AERIAL COVERING THE RANGE 200-800 MHz

D. P. L. May, G. F. Milne, and F. O. Baker Apr. 1970 41 p refs
(RAE-TR-70062) Copyright. Avail: NTIS

The measured characteristics of a right-hand circularly polarized unidirectional aerial, covering from 200 to 800 MHz in two octave-wide ranges, are given. The beam width and circularity are remarkably constant throughout the band, half power beam width

being about 82 deg. Ellipticity is as low as 0.5 dB with a maximum of 3.0 dB at 800 MHz. The feed impedance is 50 ohms unbalanced and the gain is about 7 dB relative to a circular isotropic source. It is particularly suitable where projections beyond the aircraft hull are undesirable. Author (ESRO)

N71-18532*# Laboratorium für Betriebsfestigkeit, Darmstadt (West Germany).

SERVICE LOADS OCCURRING ON MAIN LANDING GEARS OF F-104G TYPE AIRPLANES [BETRIEBSKRAEFTE AN HAUPTFAHRWERKEN DES FLUGZEUGES F-104G]

O. Buxbaum Fraunhofer Ges. Jan. 1970 104 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung Prepared for Entwicklungsring-Sued (FB-82-1969) Avail: NTIS

At the main landing gears of two airplanes vertical, lateral, and drag loads have been recorded continuously during 50 flights and have been analyzed statistically. The loading conditions such as landing, springback, taxi, transition, braking, engine run-up, turning, and pivoting; the cumulative frequencies and extreme value distributions of the different loads in the three axes are presented. The correlations between simultaneously occurring load components are also discussed. Author (ESRO)

N71-18556*# Aerospace Corp., El Segundo, Calif. Lab. Operations.
NEAR-CONTINUUM AXISYMMETRIC HYPERSONIC FLOW PAST VERY SLENDER BODIES, OCTOBER 1969-JULY 1970

John W. Ellinwood 30 Oct. 1970 45 p refs
(Contract F04701-70-C-0059)
(AD-715901; TR-0059-6240-10-2; SAMSO-TR-70-409) Avail: NTIS CSCL 20/4

The hypersonic theory for boundary layers with large transverse curvature is relaxed to allow surface slip and jump. Slip and jump coefficients for use with this continuum theory are found to be essentially unaffected by transverse curvature of the Knudsen layer. This finding follows from a study of the linearized model equation including transverse curvature terms, with diffuse reflection and total accommodation assumed at the surface. When used to estimate skin friction on an insulated 5-deg half-angle cone in helium at Mach 29, the present theory proved to be both sufficient and useful over most of the transitional flow regime. The slip velocity ratio is two and a half times as large as Mach number over root Reynolds number, which measures other neglected near-continuum effects. Author (GRA)

N71-18558*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE V/STOL TRANSPORT MODEL WITH TANDEM LIFT FANS MOUNTED AT MID-SEMISPAN OF THE WING

Stanley O. Dickinson, Leo P. Hall, and Brent K. Hodder Washington Mar. 1971 64 p refs
(NASA-TN-D-6234; A-3189) Avail: NTIS CSCL 01C

The low-speed aerodynamic characteristics of a large-scale V/STOL transport model powered by tip-turbine-driven fans were investigated. The model has four fans, tandem mounted in pods, fore and aft of the wing at mid-semispan. The high mounted wing had an aspect ratio of 5.8, was swept back 35 deg at the quarter-chord line, and had a taper ratio of 0.3. The results showed a large increase in lift with forward speed in spite of the unloading of the wing induced by front fan operation. Longitudinal characteristics with four fans operating appear to be similar to the characteristics of conventional aircraft. A comparison of test results, past and present, indicates that a configuration with the front fans at wing mid-semispan and the aft fans inboard near the wing root may have good induced lift characteristics. Author

N71-18559*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

FURTHER STUDIES OF THE EXTRAPOLATION OF NEAR FIELD OVERPRESSURE DATA

Joel P. Mendoza and Raymond M. Hicks Washington Mar. 1971 34 p refs

(NASA-TM-X-2219; A-3716) Avail: NTIS CSCL 20D

The technique of extrapolating measured near-field overpressure data to any larger altitude has been applied to wind-tunnel overpressure data for a wide variety of wing-body combinations. A compilation of measured and extrapolated overpressure data is presented here in an effort to show the range of configurations for which the extrapolation technique is applicable. Included are simple shapes, such as cone-cylinder and unswept wing-alone models, as well as complete airplane configurations. The range of test Mach numbers was 1.41 to 3.0, while the altitude to model length ratio varied from 1 to 20. Except for the case of a high aspect ratio wing-alone model, the extrapolation procedure was shown to give almost perfect agreement with experimental measurement; even for the high aspect ratio wing alone, the agreement was adequate. A method for determining the validity of the extrapolation is discussed. Author

N71-18560*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

COMBUSTION STABILITY LIMITS FOR SWIRL JET COMBUSTOR MODULES COMBINING AIR SWIRL AND IMPINGING JET ATOMIZATION OF ASTM A-1 FUEL

Robert D. Ingebo Washington Mar. 1971 13 p refs

(NASA-TM-X-2218) Avail: NTIS CSCL 21E

Eight different designs of swirl-jet combustor modules were tested in a 3.25-inch-diameter duct with 600 F air at reference velocities of 200 to 500 feet per second and atmospheric pressure. The highest ratio of rich-to-lean combustion stability limits was obtained with a module consisting of a single air swirler, a single pair of 180 deg impinging fuel jets (0.076-cm diameter.), and a coiled-strip-type flame stabilizer. Results were considerably better than those obtained in recent investigations using swirl-can combustor modules. Author

N71-18561*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EFFECT OF VARIOUS DIFFUSER DESIGNS ON THE PERFORMANCE OF AN EXPERIMENTAL TURBOJET COMBUSTOR INSENSITIVE TO RADIAL DISTORTION OF INLET AIRFLOW

James A. Biaglow Washington Mar. 1971 19 p refs

(NASA-TM-X-2216; E-5975) Avail: NTIS CSCL 21E

Tests were performed on an experimental combustor insensitive to shifts in the radial velocity profile at the compressor outlet. The purpose was to investigate alternate diffuser designs for this type combustor. Test conditions were atmospheric pressure, 600 F inlet air temperature, and average exit temperatures up to 2200 F. The fuel used was ASTM A-1. The performance of a dump-type diffuser and a 53 deg wide-angle diffuser showed that these designs of simple construction may be interchanged with that of the previously developed combustor without penalty. Tests of three diffusers with different axial lengths but similar to the design used in the previously developed combustor were investigated only at isothermal conditions with 600 F inlet air. When the diffuser length to inlet height ratio was changed from 4.0 to 7.0, at an inlet Mach number of 0.30, the combustor total-pressure loss decreased from a nominal value of 7.1 to 5.4 percent. Author

N71-18566*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

AN ALGORITHM FOR DIGITAL RESOLUTION OF RANGE FOR V/STOL AIRCRAFT

Gilbert G. Robinson and Michael J. Bondi Washington Mar. 1971 22 p refs

(NASA-TN-D-6232; A-2842) Avail: NTIS CSCL 01C

The system described provides the necessary precise range measurements for the trilateration technique used in guiding V/STOL aircraft during all-weather and variable approach operation. In a trilateration scheme, two or three ranges are measured from the aircraft to transponders on the ground. Each range is measured by determining the phase delay of a continuous radio wave transmitted from the aircraft to a ground transponder and back. For precision, three radio waves of different frequencies are transmitted to each transponder to provide a coarse, a fine, and a very fine measurement of range. Thus to obtain the inherent accuracy of the very fine measurement unambiguously, this measurement must be combined properly with the fine and coarse range data. Furthermore, the effect of noise on the range words should be minimized. To achieve maximum accuracy, the system investigated presented the primary range data in digital form. A range resolution algorithm is described that allows three ambiguous digital range words derived from a phase measuring system to be combined into a single range word that is unambiguous up to 32 miles. The word retains the very fine resolution afforded by the most precise of the three range words and eliminates the effect of noise to a high degree. The algorithm is developed theoretically and is mechanized. Examples are given showing typical operation. Measurements of the range to an aircraft making an overhead pass indicate that range can be measured to a precision of at least 1.6 feet under actual flight conditions. Author

N71-18572# Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique.

EXTERNAL SOUND FIELD EFFECT ON A TURBULENT LAYER [INFLUENCE D'UN CHAMP ACOUSTIQUE EXTERIEUR SUR UNE COUCHE LIMITE TURBULENTE]

Pierre Gougat Sep. 1970 103 p refs In FRENCH

(Rept-70-8) Avail: NTIS

The response of a boundary layer to harmonic oscillations is analyzed. The study is restricted to the influence of an acoustic field on heat exchange in a turbulent boundary layer on a flat plate. Wind tunnel tests have been performed using a hot-wire anemometer linked to a Wheatstone bridge. It is shown that an ultrasonic field is not appropriate and that, with the wind tunnel used, measurements were not possible for low frequencies. ESRO

N71-18586# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.

DETERMINATION OF THE COEFFICIENTS IN MULTIVARIABLE SYSTEMS OF FLIGHT DYNAMICS BY A MODEL WITH AUTOMATIC PARAMETER ADJUSTMENT USING AN ANALOG COMPUTER [BESTIMMUNG DER KOEFFIZIENTEN IN MEHRGROESSENSYSTEMEN DER FLUGMECHANIK DURCH EIN MODELL MIT AUTOMATISCHER PARAMETEREINSTELLUNG AM ANALOGRECHNER]

Ruthard Koehler Jul. 1970 27 p refs In GERMAN; ENGLISH summary

(DLR-FB-70-30) Avail: NTIS ZLDI Munich; 9 DM

A multivariable system described by a system of linear differential equations with constant or slowly varying coefficients can be analyzed by a model with automatic parameter adjustment. For checking the method, the longitudinal motions of an aircraft and a helicopter were simulated and analyzed using an analog computer. The results are discussed. Author (ESRO)

N71-18593# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).

HYPERSONIC LOW DENSITY WIND TUNNEL PLANT

[EINE HYPERSONISCHE WINDKANALANLAGE FUER KLEINE GASDICHTEN]

G. Hefer, G. Koppenwallner, H. Legge, and W. Wuest Bad Godesberg, West Ger. Bundesmin. fuer Bildung und Wiss Sep. 1970 93 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Bildung und Wiss. (BMBW-FB-W-70-51) Avail: NTIS; ZLDI Munich. 19.10 DM

A new plant consisting of a vacuum tunnel with two test sections of different sizes and Mach number ranges and a high vacuum tunnel with two separate pumping systems is described. The auxiliary equipment, serving mainly the electroforming and electroplating of the wind tunnel models and the cooling of models and nozzles by liquid nitrogen, is also described. A short survey on research work carried out in the hypersonic tunnel is given.

Author (ESRO)

N71-18628*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

NUCLEAR POWER FOR SURFACE EFFECT VEHICLE AND AIRCRAFT PROPULSION

Frank E. Rom [1970] 21 p refs Presented at the 7th Ann. Meeting of the AIAA, Houston, Tex., 19-22 Oct. 1970 (NASA-TM-X-52963) Avail: NTIS; CSCL 18L

Preliminary results of an economic study of large nuclear surface effect vehicles and aircraft indicate that these vehicles may have the potential for hauling transoceanic commerce at rates of 1 to 2 cents per ton mile. Transoceanic commerce forecast for 1980 indicates that it would take 1500 10,000 ton gross weight surface effect vehicles to handle all the cargo that is worth shipping at 1 to 2 cents per ton mile. Similarly, it would take 500 10,000 ton aircraft to handle this same volume. One of the most important technical problems is the problem of safety during high speed impacts. Tests of mobile reactor models indicate a potential for withstanding impacts up to 1000 feet per second with reinforced concrete without rupturing or producing leaks in the reactor containment vessel.

Author

N71-18651*# Air Force Systems Command, Wright-Patterson AFB, Ohio, Materials Lab.

DEVELOPMENT AND CALIBRATION OF A MACH 1.2 RAIN EROSION TEST APPARATUS Technical Report, Mar. 1966 Aug. 1969

Charles J. Hurley and George F. Schmitt, Jr. Oct. 1970 79 p refs

(AD-715909; AFML-TR-70-240) Avail: NTIS; CSCL 14/2

Development of a Mach 1.2 rain erosion test apparatus is described. This rotating arm apparatus is capable of evaluating the relative rain erosion resistance of materials and can be operated at speeds of 450 to 900 mph in a 1 or 2 inch/hour simulated rainfall. The report describes the design and development of the apparatus including the rotating arm, power train, test enclosure, rain simulation and control systems. Calibration and correlation experiments are also described.

Author (GRA)

N71-18714*# Dynasciences Corp., Blue Bell, Pa. Scientific Systems Div.

PRACTICAL ENGINEERING METHODS FOR PREDICTING HOT GAS REINGESTION CHARACTERISTICS OF V/STOL AIRCRAFT JET LIFT ENGINES

L. Gray and E. Kisielowski Feb. 1971 171 p refs (Contract NAS1-9465)

(NASA-CR-111845; DCR-323) Avail: NTIS; CSCL 21E

Engineering methods are presented for predicting the temperatures and velocities in the vicinity of vertical lift engines of jet V/STOL aircraft operating near the ground. The methods are based on existing theoretical analyses, available test data, and empirical and semiempirical approaches. Parametric variations in engine nozzle diameter, pressure, temperature, height, and ambient

crosswind velocity are considered for single-, two-, and four-nozzle (rectangular) arrangements.

Author

N71-18717*# Air Force Systems Command, Wright-Patterson AFB, Ohio, Aero Propulsion Lab.

OPERATING CHARACTERISTICS OF THE AFAPL HYPERSONIC SHOCK TUNNEL Technical Report, Jun. 1966 Feb. 1969

R. R. Craig Aug. 1970 41 p refs

(AD-715907; AFAPL-TR-70-2) Avail: NTIS; CSCL 14/2

A description is presented of the development efforts accomplished to make the AFAPL Hypersonic Shock Tunnel an operational aerodynamic facility. A semiconductor strain gage pressure transducer was developed to overcome calibration problems with the original pressure transducer design. Heat transfer measurements were initially made using standard shock tunnel thin film gage technology. Gage erosion problems were solved through use of a surface thermocouple which uses n-p germanium crystal elements. Improved data recording capability was achieved with the installation of a 64 channel digital data system. A contoured nozzle with interchangeable throats to provide parallel uniform flows at Mach 8, 9, 10, and 11 was installed and calibrated. The nozzle produced good flow profiles up to six feet from the nozzle exit.

Author (GRA)

N71-18729*# Air Force Systems Command, Wright-Patterson AFB, Ohio, Aero Propulsion Lab.

A KINETIC STUDY OF THE CATALYTIC DEHYDROGENATION OF METHYLCYCLOHEXANE AT 600, 650, AND 700 F AND A PRESSURE OF 5 ATMOSPHERES

Herbert R. Lander, Jr. Oct. 1970 137 p refs

(AD-715926; AFAPL-TR-70-46) Avail: NTIS; CSCL 21/4

Fuel enthalpy offers a readily available heat sink and can be used to dissipate the aerodynamic heating that results from sustained high speed flight in the earth's atmosphere, but is effective only up to certain levels of temperature. Catalytically enhanced heat-absorbing chemical reactions, however, can be used to increase the heat sink capacity from the fuel enthalpy. These reactions include dehydrogenation, dehydrocyclization, depolymerization, and hydrocracking. The dehydrogenation of methylcyclohexane over a commercially available platinum-alumina catalyst bed will approximately double the heat sink from fuel enthalpy. The dehydrogenation reaction was studied at temperatures of 600, 650, and 700 degrees F and a pressure of 5 atmospheres. Tabulations and plots of test data are presented on the effects of time, reaction rate, molar feed ratio, presence of toluene, presence of reactor inerts, reaction pressure, and temperature.

Author (GRA)

N71-18733*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PARAMETRIC ENGINE STUDY FOR A MACH 0.98 COMMERCIAL AIR TRANSPORT

John B. Whitlow, Jr., Gerald A. Kraft, and Kestutis C. Civinskas Feb. 1971 33 p refs

(NASA-TM-X-52961-E-6154) Avail: NTIS; CSCL 21E

Advanced engine weight technology, compatible with a mid-decade introduction into commercial service, was used in the study of the three-engine, 300-passenger airplane with the supercritical wing. A takeoff gross weight of 386,000 pounds was selected to provide a range of about 3000 nautical miles. Fan pressure ratios (FPR) from 1.50 to 2.25 and takeoff turbine-inlet temperatures from 2460 to 2860 R were considered. Significant improvements in range were obtained by raising the FPR over this spectrum when bypass ratio (BPR) and overall pressure ratio (OPR) were optimized. An increase in inlet temperature over the spectrum considered here had much less effect on range than an increase in FPR. Neither the approach nor the (lift-off) sideline noise requirements of F.A.R. could be met with any of these engines

without acoustic treatment of the nacelles. Even with acoustic treatment, only one-stage fan engines could meet the approach requirement for the maximum suppression of 15 PNdb assumed in this study. Unfortunately, FPR must therefore be limited to about 1.7. Author

N71-18734# Human Engineering Labs., Aberdeen Proving Ground, Md.

VISUAL DETECTION OF ILLUMINATING SURFACES

Richard T. Maruyama Oct. 1970 74 p refs

(AD-715851; HEL-TM-26-70) Avail: NTIS CSCL 1/3

Determining the requirements of helicopter lighting requires selecting the major factors that contribute to the lighting power of a surface light source. Since the light source must be functional, sky brightness, atmospheric attenuation and other characteristics of light sources such as size, shape and angular velocity must be studied. The report presents a model that looks at each of these variables separately. More investigation is needed in the field of search time to improve the reliability of the model for given background luminances. The necessary light output for an area light source can be determined by methods described; in addition the required boundary range for a surface light source can be computed for almost all conditions. Author (GRA)

N71-18739# Illinois Univ., Urbana. Aviation Research Lab.

THE FREQUENCY-SEPARATED DISPLAY PRINCIPLE, PHASE 2 Annual Summary Report, 1 Apr. 1969 - 31 Oct. 1970

David C. Denny, Steven L. Johnson, and Stanley N. Roscoe Oct. 1970 18 p refs

(Contract N00014-67-A-0305-0014)

(AD-715458; TR-ONR-70-3) Avail: NTIS CSCL 1/4

The report includes: (1) a brief review of the frequency-separated display problem, (2) a summary of the work accomplished during Phase I, (3) work accomplished during Phase II, (4) research plans for Phase III, and (5) personnel involved in the research. Author (GRA)

N71-18749*# General Motors Corp., Indianapolis, Ind. Detroit Diesel Allison Div.

SINGLE STAGE EXPERIMENTAL EVALUATION OF BOUNDARY LAYER BLOWING AND BLEED TECHNIQUES FOR HIGH LIFT STATOR BLADES, 5 Final Report

R. J. Loughery, R. A. Horn, Jr., and P. C. Tramm Mar. 1971 106 p refs

(Contracts NAS3-7619; NAS3-7900)

(NASA-CR-54573; EDR-6060) Avail: NTIS CSCL 01A

Tests were conducted on a single-stage compressor rig to determine the feasibility of increasing stator blade loading beyond current levels by bleeding or blowing the suction surface boundary layer. The compressor rig employed stator hub and tip end wall boundary layer bleeds. Six highly loaded stator configurations were tested. One of the configurations employed no suction surface boundary layer bleeding or blowing features and was used to establish a performance base line. Two stator configurations provided for suction surface boundary layer bleed and the other three stator configurations employed features to reenergize the suction surface boundary layer by blowing. A significant improvement in stator performance was achieved with suction surface boundary layer bleed compared to the baseline configuration. Performance with suction surface boundary layer blowing was generally inferior to that of the baseline configuration. Author

N71-18761*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

A TECHNIQUE FOR EVALUATING PARAMETER VARIATIONS FOR AUTOMATICALLY CONTROLLED

AIRCRAFT WITH AN APPLICATION TO THE LANDING APPROACH

Stuart C. Brown and Homer Q. Lee Washington Mar. 1971 46 p refs

(NASA-TN-D-6230; A-3244) Avail: NTIS CSCL 01C

A method involving the minimization of a performance criterion was used to analyze the ability of automatically controlled aircraft to maintain accurate flight-path control during the landing approach. The criterion was based primarily on the ability of the aircraft to follow a constant slope glide path in the presence of statistically described gust disturbances. Constraints on the adjustments of the linear control system parameters were included as part of the method. The method was implemented by means of a digital computer to perform the parameter search required for the minimization of the performance index. The utility of the method was evaluated by determining effects of variations in several aircraft parameters on the control of longitudinal motions of a subsonic and a supersonic jet transport aircraft. Author

N71-18801# Curtiss-Wright Corp., Wood-Ridge, N.J.

WTF-48 SINGLE ROTOR COMPRESSOR DEVELOPMENT Final Technical Report

Charles H. Muller 6 Nov. 1970 61 p refs

(Contract N00019-69-C-0533)

(AD-715626; CW-WR-69-098F) Avail: NTIS CSCL 21/5

Development of the reduced scale WTF-48 lift fan engine was continued under this program. The objective of the program was improvement of the pressure ratio, efficiency and diffusion of the compressor rotor. This program investigated the effects of debunting and sweep of the rotor trailing edge and modification of the passage area schedule and wall contours. The modifications investigated in this program did not produce increased rotor pressure ratio or efficiency. An increase of 11% in rotor static pressure, accompanied by a 20% reduction in diffuser losses, was accomplished. This improvement produced a 5 point increase in stage efficiency of the compressor. Author (GRA)

N71-18815# Federal Aviation Agency, Washington, D.C.

SYSTEM DESCRIPTION OF THE FIELD TEST MODEL OF THE MODULAR ALPHA NUMERIC NON-TRACKING ATC SYSTEM (ARTS2)

Nov. 1969 37 p

Avail: NTIS

The field test model of the automated radar terminal system (ARTS 2) is described. The system is suitable for application to radar terminal facilities that do not meet the requirements for the ARTS 3 system. Various aspects of the system are treated in separate sections and include: (1) a presentation on the system's background, environment, design objective, and expansion; (2) a description of the equipment and computer programs employed in the programmable ARTS 2 field evaluation model; (3) an operational description of the capability of the system when applied to existing facilities utilizing present radar and beacon subsystems; and (4) a section illustrating the system functions for typical arrival and departure control actions. D.L.G.

N71-18836*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

A QUADRATIC PERFORMANCE INDEX FOR A VTOL AIRCRAFT PREFILTER MODEL REFERENCE ATTITUDE CONTROL SYSTEM

Terrence D. Gossett and Lloyd D. Corliss (Army Mobility R and D Lab.) Washington Mar. 1971 46 p refs

(NASA-TN-D-6231; A-2897) Avail: NTIS CSCL 01C

Several performance criteria methods for optimizing a prefilter model reference control system are reviewed, and the quadratic

performance index is studied in detail. The prefilter model reference system consisted of a second-order model and a fourth-order follower. The form of this follower system was typical of that required for a VTOL aircraft in hover. For the VTOL problem, the quadratic performance index was found to be the most versatile and comprehensive criterion. Weighting matrices for various system states can be iterated until the desired system response is obtained; that is, if the response is too oscillatory, the elements of the weighting matrices can be changed to produce a less oscillatory response. A major advantage of the quadratic performance index is that it can be minimized through the use of readily available digital computer programs. The solution of these programs provides a set of optimal gains for a given system configuration and the chosen configuration. Constraints on the use of the quadratic performance index are that the index must be expressed in terms of states and the control vector, all states must be observable, and only linear system formulations are acceptable. Author

N71-18838 Royal Air Force, Farnborough (England). Inst. of Aviation Medicine.

AN EVALUATION OF THE USEFULNESS OF FOUR SECONDARY TASKS IN ASSESSING THE EFFECT OF A LAG IN SIMULATED AIRCRAFT DYNAMICS

H. F. Huddleston and R. V. Wilson Jul. 1969 18 p refs (IAM-R-479) Copyright. Avail: Issuing Activity

Eight male subjects were required to perform a tracking task using an electronic windshield display. The task had two levels of difficulty, an essentially unlagged condition and a condition, chosen to be perceptibly more difficult, having an exponential lag of 0.5 sec. Integrated tracking error scores alone were unable to distinguish between the two difficulty levels. Four secondary tasks were utilized involving a response to digits presented in the forward field of view. These four tasks were arranged to be of comparable difficulty level in pretests using the same subjects. Two secondary tasks indicated a difference between the primary task conditions. The addition of a secondary task also permitted tracking error scores themselves to indicate a difference. Author

N71-18863*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF EXIT AREA VARIATION ON THE PERFORMANCE OF AN AUXILIARY INLET EJECTOR NOZZLE AT MACH NUMBERS FROM 0 TO 1.27

Bernard J. Blaha and Albert L. Johns Washington Mar. 1971 38 p refs (NASA-TM-X-2182; E-5945) Avail: NTIS CSCL 21A

An auxiliary inlet ejector nozzle designed for a supersonic-cruise aircraft was tested in the Lewis 8 by 6 foot supersonic wind tunnel to determine the effect of internal expansion on the performance of the nozzle, especially at subsonic cruise. Internal area ratio was varied from 2.0 to 3.7 with a series of fixed exit areas simulating the movement of a triple-hinge, trailing-edge flap. A smaller primary area simulated subsonic cruise and dry acceleration and a larger primary area simulated reheat acceleration. The nozzles were tested over a range of nozzle pressure ratio from 1.9 to 8.0. At a subsonic-cruise Mach number of 0.9 and a nozzle pressure ratio of 3.2, an increase in internal expansion from 2.0 to 2.9 reduced the nozzle gross thrust coefficient about 1.0 percent. A further increase in expansion ratio to 3.74, however, resulted in an additional 10-percent loss in performance. Author

N71-18865*# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif. **VARIABILITY OF FLYOVER NOISE MEASURES FOR REPEATED FLIGHTS OF TURBOJET AND PISTON ENGINE TRANSPORT AIRCRAFT**

Dwight E. Bishop Washington NASA Mar. 1971 38 p refs (Contract NAS1-8168)

(NASA-CR-1752) Avail: NTIS CSCL01C

Various flyover noise measures are reported for noise data recorded at five ground positions located underneath and to the side of the flight path during 20 controlled level flight flyovers of two aircraft, (a four-engine piston airplane and a four-engine turbojet airplane) during one day of flight tests. Noise measures are compared to show the degree of variability among flyover measurements during repeat runs or among measurements made at different positions during the same flyover and to show the degree of correlation between different flyover noise measures. The reported flyover measures range from those derived from simple frequency weighting networks, such as the A- or N-weighted sound levels, to those computed from one-third octave band spectra such as the perceived noise level. Author

N71-18867*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

LIFT AND DRAG CHARACTERISTICS OF THE HL-10 LIFTING BODY DURING SUBSONIC GLIDING FLIGHT

Jon S. Pyle Washington Mar. 1971 26 p refs (NASA-TN-D-6263) Avail: NTIS CSCL01C

Subsonic lift and drag data obtained during the HL-10 lifting body glide flight program are presented for four configurations for angles of attack from 5 deg to 26 deg Mach numbers from 0.35 to 0.62. These flight data, where applicable, are compared with results from small-scale wind-tunnel tests of an HL-10 model, full-scale wind-tunnel results obtained with the flight vehicle, and flight results for the M2-F2 lifting body. The lift and drag characteristics obtained from the HL-10 flight results showed that a severe flow problem existed on the upper surface of the vehicle during the first flight test. This problem was corrected by modifying the leading edges of the tip fins. The vehicle attained lift-drag ratios as high as 4.0 during the landing flare (performed with the landing gear up), which is approximately 14 percent higher than demonstrated by the M2-F2 vehicle in similar maneuvers. Author

N71-18882*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL PERFORMANCE AND COMBUSTION STABILITY OF A FULL SCALE DUCT BURNER FOR A SUPERSONIC TURBOFAN ENGINE

J. Robert Branstetter, Albert J. Juhasz, and Peter W. Verbulecz Washington Mar. 1971 84 p refs (NASA-TN-D-6163; E-5679) Avail: NTIS CSCL 20M

A 67.7-in. (172-cm) diameter flight weight, annular diffuser and combustor assembly for the fan stream of a duct burning turbofan underwent numerous modifications to achieve a highly efficient geometry and stable combustion. The apparatus was tested in a connected pipe facility at conditions simulating those of a supersonic transport plane. Two zones of fuel injection provided overall fuel-air ratios of 0 to 0.050. Air entered the upstream combustion zone by means of ram-scoops. Effort was devoted to combating combustion instability (70 to 470 Hz) encountered at many test conditions. These efforts, only partially successful, are described along with other performance results. Author

N71-18920# Western Gear Corp., Lynwood, Calif. Research Dept.

PRECISION FORGING OF SPIRAL BEVEL GEARS FOR ARMY HELICOPTERS Final Report, Jan. 1968 - Apr. 1970

Millard R. Berger 15 Sep. 1970 81 p

(Contract DAAJ01-68-C-1446)

(AD-715419; Rept-7003-310) Avail: NTIS CSCL 13/8

The objective of the project was to develop an alternate manufacturing method for spiral bevel gears used in Army helicopters. The report covers the technical description of a program to develop high velocity forging techniques to produce spiral bevel

gears to pre-grind tolerances. Initial objectives were to obtain as-forged gears with .005 inches excess material on the side of each tooth for finish grinding after the heat treating. The report includes a discussion of die design parameters, the manufacturing techniques for dies, forging parameters, dimensional checks of the forged gears, machining techniques for determining as-forged geometry and macroscopic and microscopic metallurgical data showing grain flow and micro-structure. Also included is a discussion of difficulties experienced and recommendations for future investigations. Author (GRA)

N71-18929*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NOISE MEASUREMENT EVALUATION OF TAKEOFF AND APPROACH PROFILES OPTIMIZED FOR NOISE ABATEMENT

H. Rodney Peery and Heinz Erzberger Washington Mar. 1971 29 p refs

(NASA-TN-D-6246; A-3548) Avail: NTIS CSCL 01C

A flight investigation to determine the effective perceived noise level associated with certain takeoff and landing profiles has been conducted. The tests were designed to evaluate noise-optimum takeoff profiles, previously obtained in an analytical study, and to investigate the potential for noise abatement of nonstandard approach procedures. During the takeoff tests, the flaps were set at either 27 deg or 10 deg and the climb airspeeds varied from $V_{sub 2} + 15$ to $V_{sub 2} + 50$ knots ($V_{sub 2}$ refers to the takeoff safety speed of the aircraft). Power was reduced to yield either 500 or 750 ft/min rate of climb when the aircraft reached 1500 ft altitude. The assumed noise sensitive ground track extended along the runway centerline from 3.5 to 5.7 nautical miles from the start of the takeoff roll. The average of the noise measurements taken at points along the noise sensitive portion of the ground track was used to compare the various takeoff profiles. The takeoff that produced the least average noise, 90.5 EPNdB, used takeoff flaps of 10 deg and a climb airspeed of $V_{sub 2} + 50$ knots to 1500 ft altitude, at which point power was reduced to yield a 750 ft/min rate of climb. The landing profiles were flown along a 3 deg glide slope at constant flap settings of 50 deg, 27 deg, 10 deg, and 0 deg. The approach speed for each profile was 1.3 $V_{sub S1} + 10$ knots ($V_{sub S1}$ refers to stall speed of the aircraft at the flap setting and gross weight used in the approach). In addition, a decelerating profile with engines at flight idle and 0 deg flaps was flown over a single noise measuring station at an altitude of 1000 ft. Reducing the flap setting from 50 deg to 0 deg on the approach reduced the noise from 110.5 to 106.5 EPNdB along the ground track between 5 and 1 nautical miles from the touchdown. The decelerating overflight with engines at flight idle reduced the noise an additional 12.5 EPNdB compared to the 0 deg flap approach at the same altitude. Author

N71-18937*# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

THE FEASIBILITY AND USE OF ANTI-TORQUE SURFACES IMMERSSED IN HELICOPTER ROTOR DOWNWASH
Technical Report, Jan. 1968 - Dec. 1969

Chee Tung, John C. Erickson, Jr., and Frank A. DuWaldt Feb. 1970 59 p refs

(Contract N00014-68-C-0241)

(AD-715438; CAL-BB-2584-S-2) Avail: NTIS CSCL 1/3

An analytical investigation was made of the effectiveness of anti-torque aerodynamic surfaces immersed in helicopter rotor downwash. It is shown that additional vertical tail surface having areas equal to about two percent of the main rotor disk area could provide torque trim for speeds above about 75 ft/sec for representative current vehicles. Author (GRA)

N71-18951*# National Academy of Sciences National Research Council, Washington, D.C. Highway Research Board.

PUBLIC TRANSPORTATION TO AIRPORTS: 7 REPORTS

1970 42 p refs Presented at the 49th Ann. Meeting of the Highway Res. Board / *Its Highway Res. Record No. 330*
Avail: Issuing Activity

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N71-18952*# National Academy of Sciences National Research Council, Washington, D.C. Highway Research Board.

MASS TRANSIT TO AIRPORTS: AN OVERVIEW

Kenneth E. Cook *In its Public Transportation to Airports: 7 Rept. 1970 p 1-4 ref*

Avail: Issuing Activity

The current patterns in airport access systems are briefly discussed with the advantages, and disadvantages of mass transit systems. The potential applications of rail, and bus transit systems are also presented. F.O.S.

N71-18953*# Japan Airport Terminal Co., Ltd., Tokyo.

THE AIRPORT ACCESS PROBLEM IN TOKYO

Toru Akiyama *In NAS-NRC Public Transportation to Airports: 7 Rept. 1970 p 5-12*

Avail: Issuing Activity

The mass transit systems used for access to the Tokyo International Airport are studied. A statistical analysis of the traffic patterns shows that 70% of the passengers use automobiles for arrivals and departures. Conclusions reached in considering the access problems to the new Tokyo airport are: (1) City terminals that have passenger check-in facilities are desirable (2) The city terminals should be located in strategic points with easy access to downtown and the airport. (3) Limousine/bus service should be established with specially designed vehicles. F.O.S.

N71-18954*# British Airports Authority, London (England).

AIRPORT ACCESS TO HEATHROW AIRPORT, LONDON

George Hole *In NAS-NRC Public Transportation to Airports: 7 Rept. 1970 p 13-15*

Avail: Issuing Activity

The public transportation requirements for access to London's airports are discussed by considering the traffic position of Heathrow. The existing transportation systems of bus, subway, and rail services to Heathrow are described, and it is concluded that the British Rail duorail system can be adapted to meet the traffic requirements of 2000 passengers per hour in each direction. F.O.S.

N71-18955# Kansas City Area Transportation Authority, Mo.
PROVIDING GROUND ACCESS TO THE KANSAS CITY AIRPORT

William Icenogle /in NAS-NRC Public Transportation to Airports:
 7 Rept. 1970 p 16-20
 Avail: Issuing Activity

Based on the recommendations of an engineering survey of the traffic requirements for a freeway system to service the Kansas City International Airport, the design and location of a transitway is presented. One end of the recommended transitway is in the business district, near downtown hotels, and at the airport, buses operate on an elevated road separate from general vehicular traffic. The total cost of this access system is estimated at \$30 million. F.O.S.

N71-18956# Department of Transportation, Washington, D.C.
 Office of the Secretary.

CLEVELAND RAIL TRANSIT AIRPORT SERVICE

George F. Wiggers /in NAS-NRC Public Transportation to Airports:
 7 Rept. 1970 p 21-24
 Avail: Issuing Activity

The rail rapid transit system to Hopkins International Airport was studied to develop the means to make accurate forecasts of transit demands as a mode for airport access. Four types of tripmakers are included in the study. These are: inbound and outbound air passengers, persons meeting or seeing off air passengers, casual visitors to the airport such as sightseers, and employees at the airport. The transit system is a publicly owned, 19-mile, two-track rail rapid transit line with 17-stations on the line. The airport is the last stop on the west end. Travel time to downtown Cleveland is 25-minutes, with trains departing every 10-minutes. It is concluded that most of the air travelers are not residents of Cleveland, and do not have their private automobiles available to them. They require high frequency, dependable, and time saving transportation services. F.O.S.

N71-18957# Massachusetts Bay Transportation Authority, Boston.
AIRPORT ACCESS PLANS FOR BOSTON

Ronald Muehlberger /in NAS-NRC Public Transportation to Airports: 7 Rept. 1970 p 25-29 refs
 Avail: Issuing Activity

The existing access systems for Logan International Airport are presented with plans and recommendations for improvement. It is shown that almost 69% of the travelers use private automobiles as the access mode. The recommended improvements center around a proposed third harbor tunnel to alleviate the severe congestion during rush hours at the Callahan Tunnels, and the Mystic River Bridge. A survey of the airport populations showed that each passenger generated almost one nonflying visitor. The available parking spaces number 5800; by 1980 it is estimated that 17,700 parking spaces will be required. The greatest single improvement to existing systems is considered to be an extension of the rail routes to provide direct connection of the airport with the downtown sections of Boston. F.O.S.

N71-18958# Simpson and Curtin, Philadelphia, Pa.
THE PHILADELPHIA AIRPORT ORIGIN-DESTINATION SURVEY: A STATISTICAL ANALYSIS

Joseph C. Corradino /in NAS-NRC Public Transportation to Airports: 7 Rept. 1970 p 30-36 refs
 Avail: Issuing Activity

A statistical survey of ground and air traffic at the Philadelphia International Airport was taken to help in solving the ground-air interface problems confronting airport activities. An in-flight survey of arriving and departing flights was conducted. Results indicate that a one-directional survey accurately mirrors the reverse direction of travel, and that any analysis of airport ground travel based on data from home-interview surveys should be supplemented by an examination of nonresident air passenger travel. F.O.S.

N71-18962*# Aerojet-General Corp., Sacramento, Calif. Nuclear Systems.

WATER DROPLET SIZE DETERMINATION FOR BREAKUP OF LARGE DIAMETER JETS

May 1970 153 p refs
 (Contract SNP-1)
 (NASA-CR-116820; FAC-FTR01-W224-3; ANSC-1) Avail: NTIS CSCL 20D

The drops generated by the breakup of water jets from nozzles ranging in diameter from 0.25 to 1.5 in. were photographed in a series of wind tunnel tests. The volume mean drop size generated in these tests compared favorably with that calculated using the empirical equation generated by Ingebo for nozzles from 0.01 to 0.04-in. in diameter. An empirical expression is presented that characterizes the water-jet mass distribution in a cross flow of gas. A series of tests of flat spray nozzles indicates that the penetration is decreased to 50 to 60% of that attained with a penetration or fire-hose nozzle. Author (NSA)

N71-18987*# Translation Consultants, Ltd., Arlington, Va.

A NUMERICAL METHOD OF DETERMINING THE AERODYNAMIC COEFFICIENTS OF THIN SUPERSONIC WINGS WHICH ARE DEPENDENT ON THE ANGLE OF ATTACK [NUMERISCHES VERFAHREN ZUR BESTIMMUNG ANSTELLWINKELABHAENIGER AERODYNAMISCHER BEIWERTE DUENNER UEBERSCHALLFLUEGEL]

W. H. Diesinger Washington NASA Feb. 1971 62 p refs
 Transl. into ENGLISH from German report DLR-FB-71-01
 (Contract NASw-2038)
 (NASA-TT-F-13521) Avail: NTIS CSCL 01A

The numerical method makes use of the linearized potential flow theory and is limited to wings where Evvard's theorem can be applied. The method is especially suited for preliminary design calculations where the effects of warping and the wing thickness are not needed. The aerodynamic coefficients are determined by numerical integration of the velocity potential for which the numerical accuracy can be determined by simple addition. Because of the comparatively small number of calculations the method may be applied in order to reduce the running time of existing computer programs. For application to desk calculators, tables are given and simple computational examples included. Author

N71-18989 Syracuse Univ., N.Y.

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE STABILITY OF PIPE FLOW WITH RESPECT TO THREE-DIMENSIONAL DISTURBANCES

Thomas Michael Houlihan (Ph.D. Thesis) 1969 66 p
 Avail: Univ. Microfilms: HC \$3.80/Microfilm \$3.00 Order No. 70-1955

The stability of fully developed laminar flow in a circular pipe, perturbed by an infinitesimal three-dimensional helical disturbances is presented. A method analogous to the classical boundary layer study of Tollmien has been followed in the analysis. This yielded a neutral stability curve which, while unlike the classical hairpin result, nevertheless could conceivably describe pipe flow instability. Preliminary results of experiments in a carefully constructed wind-tunnel facility are presented for flow in a 1.25 in. diameter pipe at a Reynolds number of order 12,000. It was verified that the flow was quite stable to axisymmetric disturbances. But more significantly it was shown that a point source form of helical disturbance did seem to grow with a wavelength predicted by the theory for the given test Reynolds number. Author

N71-18996*# Johns Hopkins Univ., Baltimore, Md. Dept. of Physics.

A REPORT ON SOME RESULTS FROM THE NASA 1968 AIRBORNE AURORAL EXPEDITION

K. A. Dick and W. G. Fastie Aug. 1970 44 p refs
(Grant NGR-21-001-001)
(NASA-CR-116855: TR-24) Avail: NTIS CSCL 04A

The spectrometer scanned a region n lambda (12,400-14,000 A), with the capability of isolating second, third, and fourth orders by means of Corning color glass filters. The photometer sampled each feature two out of every ten seconds; the spectrometer scanned every 15 seconds. The results are reviewed for some 124 hours of flying of approximately a quarter million photometer readings and thirty thousand spectral scans (each with as many as 40Q resolution intervals). Author

N71-19040# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: MARTIN 404, N464M, 8 STATUTE MILES WEST OF SILVER PLUME, COLORADO, 2 OCTOBER 1970

24 Dec. 1970 56 p refs
(NTSB-AAR-71-4) Avail: NTIS

The circumstances leading to the crash of a transport aircraft which caused 30 fatalities are reported. The probable cause of the accident was the intentional operation of the aircraft over a mountain valley route in an altitude from which the aircraft could neither climb over the obstructing terrain ahead, nor execute a successful course reversal. Significant contributions to the accident were: (1) overloaded condition, (2) lack of flight planning, (3) lack of understanding of the aircraft capabilities and limitations, and (4) supervisory error. Author

N71-19041# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: JETCO AVIATION, INCORPORATED, SHORT BROTHERS AND HARLAND, LIMITED, SKYVAN SERIES 3 (SC-7), N21CK, WASHINGTON NATIONAL AIRPORT, WASHINGTON, D.C., 2 JULY 1970

13 Jan. 1971 20 p refs
(NTSB-AAR-71-6) Avail: NTIS

The circumstances preceding a fatal crash of a cargo aircraft are discussed. The aircraft assumed a steep descent and left turn while approaching the airport and crashed in a small body of water. The accident investigation determined that the cause of the accident was a forward shift of improperly secured cargo. Author

N71-19043# National Transportation Safety Board, Washington, D.C.

REPORT OF PROCEEDINGS OF THE NATIONAL TRANSPORTATION SAFETY BOARD INTO THE MIDAIR COLLISION PROBLEM

12 Nov. 1970 138 p refs Conf. held in Washington, D.C., 4-10 Nov. 1970
(NTSB-AAS-70-2) Avail: NTIS

The proceedings and recommendations of a conference concerning the subject of midair collisions are presented. Subjects discussed are: (1) traffic segregation in the terminal area, (2) collision avoidance systems, (3) pilot warning indicators, (4) standardized traffic patterns, (5) flightcrew training program, (6) area navigation, (7) visual detection of aircraft on collision course, and (8) primary radar target enhancement. Author

N71-19114# Advisory Group for Aerospace Research and Development, Paris (France).

AGARD BULLETIN: MEETINGS, MEMBERSHIP, PUBLICATIONS, JANUARY 1971

Jan. 1971 61 p refs
(AGARD-Bul-71/1) Avail: NTIS

The schedule of AGARD 1971 technical meetings is presented. The announcement includes these panel activities: aerospace medicine, avionics, electromagnetic propagation, fluid dynamics, guidance and control, propulsion and energetics, structures and materials, and technical information. The membership of the various panels is given, and summaries of the 1970 AGARD publications are included. F.O.S.

N71-19122*# General Electric Co., Pittsfield, Mass.

MEASUREMENTS AND ANALYSIS OF LIGHTNING-INDUCED VOLTAGES IN AIRCRAFT ELECTRICAL CIRCUITS

K. J. Lloyd, J. A. Plumer, and L. C. Walko Washington NASA
Feb. 1971 170 p refs
(Contract NAS3-12019)

(NASA-CR-1744: HVL-69-161) Avail: NTIS CSCL 09E

An experimental investigation of voltages induced by lightning in aircraft electrical circuits is described. An extensive series of measurements was made of voltages induced in circuits within a metallic aircraft wing by full-scale simulated lightning currents flowing through its skin and structure. The measured data were mathematically analyzed to enable determination of voltages across load impedances to which the circuits might be connected elsewhere in the aircraft. Relationships between induced voltages and lightning current, wing structure, and circuit parameters were determined. Induced voltages of magnitudes likely to cause damage or interference with avionics were measured. Author

N71-19139*# TRW Systems Group, Redondo Beach, Calif.

A STUDY OF THE USE OF LIQUID BASE FOAMS FOR JET NOISE REDUCTION

L. Manson, S. Lieberman, and H. L. Burge Washington NASA
Feb. 1971 142 p refs
(Contract NAS1-9426)

(NASA-CR-1695) Avail: NTIS CSCL 20A

An experimental investigation of the acoustical properties of liquid base foams and of jet noise reduction through foam injection is discussed. Results are given for an analytical effort to build a mathematical model of the sound propagation and absorption of foams. The experimental investigation showed attenuation constants on the order of 3 nepers/inch. Jet noise reduction values up to 10 PNdB were recorded. The analytical effort confirmed the hypothesis of a resonant response of foams to sound waves. The overall results indicate foam has a high potential as a sound attenuation medium. Author

N71-19170# Weapons Research Establishment, Salisbury (Australia).

FURTHER FLOW CALIBRATION IN THE BLOWDOWN WIND TUNNEL S3

M. L. Robinson Jun. 1970 29 p refs Supersedes WRE-TN-HSA-115
(WRE-TN-HSA-171) Avail: NTIS

The distribution of Mach number in the 7 in by 6 in working section of wind tunnel S3 was measured at Mach numbers 2.8, 3.5, 4.0 and 5.0. The results given supersede those of the previous calibration tests carried out in 1965 at which time no Mach number 3-5 nozzle was available. The present calibration results differ by about 0.02 in Mach number from the previous test results for the unmodified Mach number 2-8 and 4-0 nozzles. Remachining of the Mach number 5.0 nozzle blocks has not improved the uniformity of flow produced by the nozzle. The standard deviation of Mach number in the working section is 0.3% for the Mach number 2-8 and 3-5 nozzles, 0.4% for the Mach number 4-0 nozzle and 0.6% for the Mach number 5-0 nozzle. Design ordinates for the Mach number 3-5 nozzle are given, and Mach number distributions for all nozzles are presented in tabular and graphical form. Author

N71-19217# Joint Publications Research Service, Washington, D.C.

TRANSLATIONS ON EASTERN EUROPE: PROJECT OF DOLPHIN-LIKE DIRIGIBLE DISCUSSED

4 Feb. 1971 17 p Transl. into ENGLISH from Various E. European Publications *Its Scientific Affairs* No. 157 (JPRS-52330) Avail: NTIS

The design and characteristics of a double hulled dirigible are discussed. The airship consists of a symmetric airfoil body with end plates for accomodating the crew and passengers. The gas cells are located in the center section of the airship. Propellers are located fore and aft on the center structure and nuclear propulsion is proposed. The advantages of the dirigible lie in its large cargo capacity, aerodynamic stability, and vertical let down capability. P.N.F.

N71-19220# Lockheed Missiles and Space Co., Palo Alto, Calif.
SCANNING SYSTEMS FOR THERMAL VIEWERS

E. Ia. Karizhenskii et al 1970 6 p refs Transl. into ENGLISH from Opt.-Mekh. Prom. (USSR), no. 9, 1970 p 39-42
Avail: NTIS; National Translations Center, John Crerar Library, Chicago, Ill. 60616

Peculiarities of detector scanning systems intended for thermal viewers, producing a picture similar to television and operating from a fixed base, are analyzed. The engineering possibilities and advantages of utilizing an alternate-line sweep in these instruments are shown. Fundamental relationships are determined between the output parameters of the thermal viewer, the frequency band of the amplifier channel, and the size characteristics of the scanning system. The value of the coefficient of mirror facet utilization and the possibility of its application as a criterion to estimate the degrees of optimality of the scanning systems of such instruments are shown. Author

N71-19239*# Boeing Co., Wichita, Kans.
THE SIMULATION OF A LARGE JET TRANSPORT AIRCRAFT. VOLUME 1: MATHEMATICAL MODEL

C. Rodney Hanke Washington NASA Mar. 1971 59 p
(Contract NAS2-5524)
(NASA-CR-1756) Avail: NTIS CSCL 01C

The mathematical models used in the manned simulation of a jumbo jet transport aircraft are described. Included are the models of the basic airframe, the longitudinal lateral and directional control systems, the high lift system, the propulsion system, and the landing gear system. In addition, the low speed buffet characteristics and atmospheric model are described. Included is a list of necessary tests of the simulation to insure validity of the model, of the computer program, and of the quantitative values. Author

N71-19250*# Martin Marietta Corp., Denver, Colo.
AEROSPACE SYSTEMS PYROTECHNIC SHOCK DATA (GROUND TEST AND FLIGHT). VOLUME 7: INVESTIGATION OF MASS LOADING EFFECTS Final Report, 12 May 12 Nov. 1970

Ivar K. Engelskjerd and W. P. Rader 12 Nov. 1970 127 p
(Contract NAS5-21241)
(NASA-CR-116019) Avail: NTIS CSCL 20K

The results are presented of a test and analysis program to determine the effect of weight variation in mounted subassemblies on the pyrotechnic shock environment at the interface of the subassembly and the mounting structure. This effect, designated as mass loading, was studied for two types of aerospace mounting structures. (1) airframe, skin, and stringer structure; and (2) truss structure. An explosive device was used as a controlled source of shock to the loaded and unloaded structures. High frequency accelerometers and associated electronics were utilized to give a frequency capability of 20,000 Hz. The recorded shock transients

were digitized at a sample rate of 100,000 samples per second and digital shock spectrum analyses were performed with a damping ratio of 5%. For each accelerometer, comparison plots were made of the spectra obtained from the bare structure and three different weight configurations. The results are presented graphically and a discussion of the significant findings is given. D.L.G.

N71-19276*# Grumman Aerospace Corp., Bethpage, N.Y.
FINITE ELEMENT ANALYSIS OF STRUCTURES IN THE PLASTIC RANGE

H. Armen, Jr., A. Pifco, and H. S. Levine Washington NASA Feb. 1971 281 p refs
(Contract NAS1-7315)
(NASA-CR-1649) Avail: NTIS CSCL 20K

An extension of finite-element methods to provide analytical means for determining the nonlinear response of aircraft structures is presented. Consideration is given to material and geometric nonlinearity, acting separately or in combination. The methods developed are applicable to loading conditions that cause either membrane stresses or pure bending, or both in combination. The finite-element analysis methods for material nonlinearity can account for the Bauschinger effect for biaxial stress states by using the Prager-Ziegler kinematic hardening theory of plasticity. Application of the methods is made to several simple structures including notched bars and rectangular, circular, and annular plates, although it should be noted that these methods are fully capable of being applied to complex, built-up structures. Good correlation is obtained between results from the present analysis and existing experimental and/or analytical results. Author

N71-19281*# National Aeronautics and Space Administration, Washington, D.C.

NASA SPACE VEHICLE DESIGN CRITERIA (STRUCTURES); STRUCTURAL VIBRATION PREDICTION

J. S. Archer (TRW Systems Group) Jun. 1970 41 p refs
(NASA-SP-8050) Avail: NTIS CSCL 20K

Space vehicle structural vibration resulting from induced or natural environments and with methods of determining internal structural loads and stresses caused by such vibrations are considered. Structural vibration causes internal loads and stresses in structural components and localized loads at attachment points where equipment is supported by the structure. The degree or magnitude of structural response may be expressed as an acceleration or displacement of various critical points as a function of time, as a weighted average acceleration (root mean square), or as spectra of acceleration or stresses as functions of frequency at discrete times. Severe vibration of space vehicle structural elements usually results from rocket noise and from aerodynamic noise and buffet. Severe vibration can also result from other sources, such as thrust oscillation and rocket-engine resonances, wind gust and shear, transportation, tests, operation of internal equipment, and unstable dynamic coupling of the structure with the control system or with the propulsion system. Author

N71-19287*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

TRAFFIC CONTROL SYSTEM AND METHOD Patent
Charles R. Laughlin, Roger C. Hollenbaugh, and Walter K. Allen, inventors (to NASA) Issued 13 Oct. 1970 (Filed 30 Jan. 1968) 22 p Cl. 343-112; Int. Cl. G01s5/14
(NASA-Case-GSC-10087-1; US-Patent-3,534,367; US-Patent-Appl-SN-701679) Avail: US Patent Office CSCL 17G

A system is described in which the position of a vehicle, such as a transoceanic SST, is determined by a computer at a central ground station, supplied to a central air traffic controller, and transmitted to a number of adjacent vehicles in flight via a synchronous satellite. Side tone ranging patterns, as well as the

digital and voice signals, are modulated on a carrier transmitted from the central station and received on all of the supersonic transports. Each aircraft communicates with the ground stations via a different frequency multiplexed spectrum. Position is determined in response to variable phase information imposed on the side tones at the aircrafts, with a number of different side tone techniques being employed, and relayed back to the transports. Common to all of the side tone techniques is Doppler compensation for the supersonic transport velocity.

Official Gazette of the U.S. Patent Office

N71-19289*# AiResearch Mfg. Co., Los Angeles, Calif.
COMPARISON OF HYDROGEN AND METHANE AS COOLANTS IN REGENERATIVELY COOLED PANELS

C. E. Richard and F. M. Walters Washington NASA Mar. 1971
 43 p refs Revised

(Contract NAS1-5002)

(NASA-CR-1652; Rept-67-2490-Rev-1) Avail: NTIS CSCL 20M

Comparisons are made of the minimum weights, ranges of applicability, and coolant requirements of methane-cooled, and hydrogen-cooled, structural panels determined from analytical studies of flat panels designed for heat fluxes up to 500 Btu/sec-sq ft and pressure loads up to 250 psi.

Author

N71-19320# Detroit Edison Co., Mich. Great Lakes Area Trade Development.

TRANSPORTATION OF FREIGHT IN THE YEAR 2000 WITH PARTICULAR REFERENCE TO GREAT LAKES AREA

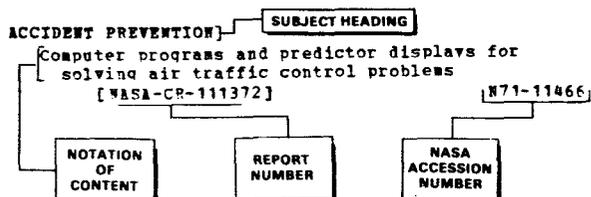
James Easton Sep. 1970 140 p refs

Avail: Issuing Activity

The main modes of transportation for the Great Lakes Area, in the year 2000 are examined to assess the freight movement by each mode. The intercity ton milage during the next 30 years is expected to triple the 1970 figure. Shipping on the St. Lawrence Seaway and Great Lakes, railroads, trucking, inland waterways, barges, pipeline system, and air transport are considered with emphasis on the influence of future government policies. F.O.S.

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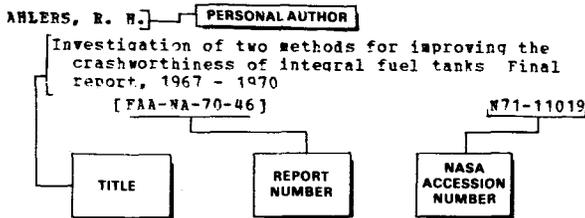
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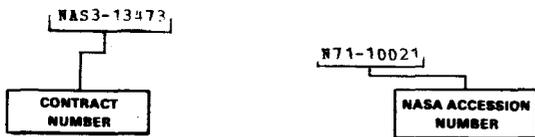
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