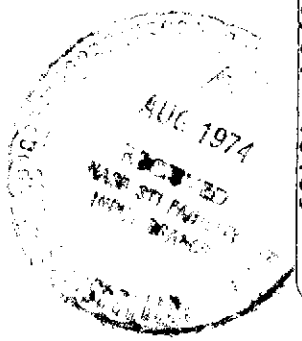
NASA SP-7037 (43)

AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY WITH INDEXES

Supplement 43

APRIL 1974



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ACCESSION NUMBER RANGES

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

IAA (A-10000 Series)	A74-16356	A74-19205
STAR (N-10000 Series)	N74-13700	N74-15699

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7037 (43)		

4. Title and Subtitle	5. Report Date
AERONAUTICAL ENGINEERING A Special Bibliography (Supplement 43)	April 1974
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D.C. 20546	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This special bibliography lists 421 reports, articles, and other documents introduced into the NASA scientific and technical information system in March 1974.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Aerodynamics Aeronautical Engineering Aeronautics Bibliographies	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	123 ~~120~~	

*For sale by the National Technical Information Service, Springfield, Virginia 22151

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974—739-162/150

NASA SP-7037 (43)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 43

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 March 1974 in

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

Scientific and Technical Information Office
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APRIL 1974
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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INTRODUCTION

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

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 421 reports, journal articles, and other documents originally announced in March 1973 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

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

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

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

An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc., (AIAA), as follows. Paper copies are available at $5.00 per document up to a maximum of 20 pages. The charge for each additional page is 25 cents. Microfiche [1] are available at the rate of $1.00 per microfiche for documents identified by the # symbol following the accession number. A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library. Minimum airmail postage to foreign countries is $1.00. Please refer to the accession number, e.g., A74-11072, when requesting publications.

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All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections. It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA. A listing of public collections of NASA documents is included on the inside back cover.

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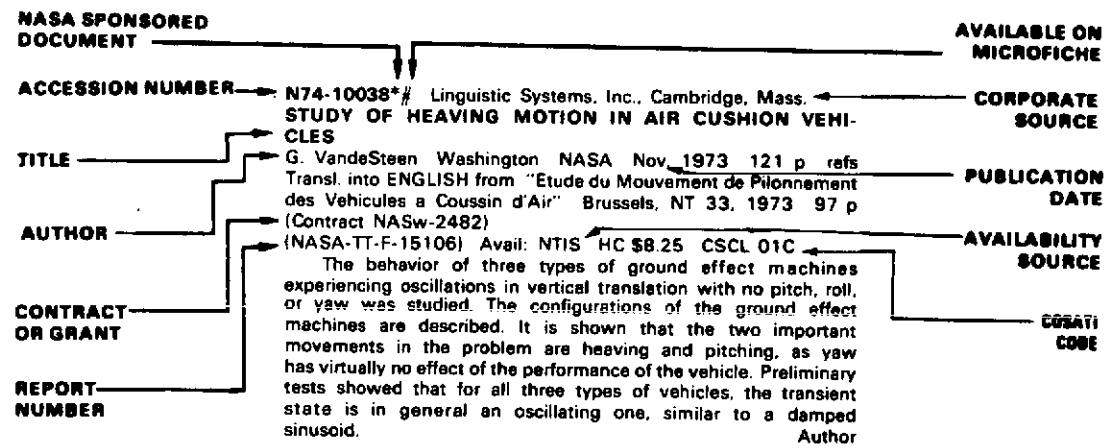

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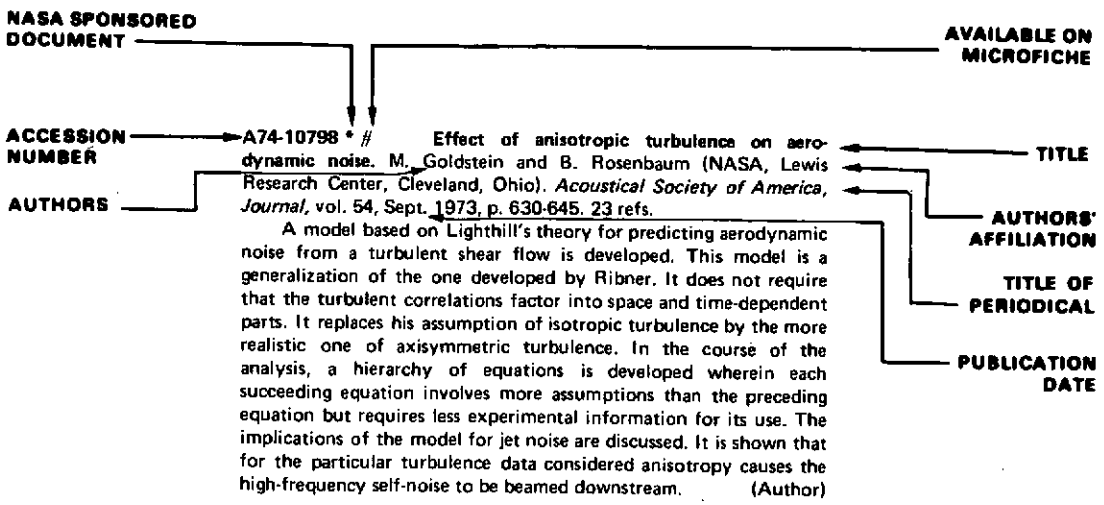

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 43) APRIL 1974

IAA ENTRIES

A74-16384 **Recent developments in sonic-boom simulation using shock tubes.** J. J. Gottlieb and I. I. Glass (Toronto, University, Toronto, Canada). In: Recent developments in shock tube research; Proceedings of the Ninth International Symposium, Stanford, Calif., July 16-19, 1973. Stanford, Calif., Stanford University Press, 1973, p. 113-129. 19 refs. Research supported by the Canadian Transport Development Agency and National Research Council of Canada; Grant No. AF-AFOSR-72-2274.

Gasdynamic and acoustic analyses were performed in order to provide greater insight into the operation of sonic-boom simulators utilizing shock-tube drivers. Three basic shock tubes were considered; each had a pyramidal driver joined at the diaphragm station to a pyramidal channel of the same divergence angle (pyramidal shock tube), or of a different angle, or joined to a constant-area channel. Classical acoustic theory was applied to obtain new analytical solutions to describe the wave motion in such facilities, in agreement with experimental data. In addition, a detailed study of the nonlinear generation and propagation features of the N-wave was made for the important and practical case of the pyramidal shock tube. (Author)

A74-16385 **Experimental investigation of sonic boom propagation through variable flow fields.** W. L. Harris, Sr. (MIT, Cambridge, Mass.). In: Recent developments in shock tube research; Proceedings of the Ninth International Symposium, Stanford, Calif., July 16-19, 1973. Stanford, Calif., Stanford University Press, 1973, p. 130-143. 15 refs. Research supported by the Massachusetts Institute of Technology; NSF Grant No. GK-5772.

The effects of thermodynamic gradients and flow curvature on the propagation of sonic boom signatures have been investigated experimentally. The gradients and flow curvature have been generated by inserting a series of movable deflection steps in the test section of a supersonic wind tunnel. The centered expansion which is produced as the supersonic flow expands over the deflection steps agrees to within 2% of theory. Sonic boom pressure signatures are generated by a series of bodies of revolution with varying degrees of nose bluntness placed within and ahead of the centered expansion fan. Depending upon the intensity of the gradients and position of the sonic boom source, the sonic boom may or may not decrease in width as it propagates through the nonuniform flow region. Trends in peak-to-peak overpressure and maximum overpressure have been noted with the gradients tending to enhance or at least to maintain the level of these quantities as the sonic boom propagates through the nonuniform flow region. (Author)

A74-16445 **Manufacturing exercise involved in the redesign of the Hawker Siddeley Trident /tri-jet/ fuselage.** J. Fielding (Hawker Siddeley Aviation, Ltd., Woodford, Ches., England). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 45-52.

Three particular areas were chosen for evaluation, viz., the sheet/stringer/frame structure in the keel area, the upper fuselage, and a window panel area. The usual attention was given to fatigue strength, critical crack length, and residual strength. Fusion welding was used whenever practicable, i.e., for skin to stringer joints and panel butt welds, with a little electrical resistance spot welding for the frame to fuselage skin attachment. The weight savings possible with titanium design as compared with an aluminum structure amounted to 23.6% overall on the complete fuselage section. Chemical milling, through welding under tension, welding on the tension draw welding machine, and vacuum hot sizing are discussed. F.R.L.

A74-16446 **The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier.** H. J. Sayer (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, England). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 53-56. Research sponsored by the Ministry of Defence.

A74-16447 **B-1 cost/weight trade methodology.** R. E. Edmonson and W. A. Reinsch (North American Rockwell Corp., Los Angeles, Calif.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 57-68.

A development is described which provides the capability for detailed subsystem selections based on cost/weight to a degree of credibility not previously obtainable. The process is based on the comparison of the weight differentials of competitive subsystem elements, converting these differentials to dollar value, and then evaluating these dollar values along with the detail acquisition cost estimate of the candidate design. This cost/weight trade study methodology has provided early visibility for potential cost and risk problems, and is considered a strong management tool for design decisions. In general, the structural components using titanium are required to be cost/weight effective, and to exhibit high fatigue life, good fracture toughness, and be relatively damage-tolerant. Annealed 6Al-4V was selected for these applications. F.R.L.

A74-16448 **Design and development support for critical helicopter applications in Ti-6Al-4V alloy.** P. R. Wedden (Westland Helicopters, Ltd., Yeovil, Somerset, England) and F. Liard (Société Nationale Industrielle Aérospatiale, Marignane, France). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 69-80. 5 refs.

The Lynx multiservice helicopter embodies a semirigid rotor-head and an electron beam welded transmission drive shaft in Ti-6Al-4V alloy. This alloy was chosen on the basis of some degree of previous design experience, weldability, a large background of semifinished product know-how, multinational alloy production, and a general lack of manufacturing problems. An attempt is made to

show the role and activity of a binational, interdisciplinary approach culminating in the utilization of 570 kg of titanium alloy forging and bar stock, which represent 5 percent all-up weight of the developemnt aircraft. Basic design requirements, basic material and process evaluation, electron beam welding, surface processing, grinding, pin fretting, and section size and microstructure are discussed. F.R.L.

A74-16449 Flat rolled beta titanium alloys for airframe application. G. A. Lenning and W. H. Heil (Titanium Metals Corporation of America, Toronto, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.
New York, Plenum Press, p. 81-89.

The beta alloy Ti-8Mo-Ti-8V-2Fe-3Al was selected for full-scale evaluation as continuous strip after examination of many compositions at the laboratory and development stages, and confirming that it could be melted by the conventional consumable electrode vacuum arc process. Processing details and mechanical properties of a production size heat processed by continuous strip methods are given. The alloy shows producibility and property characteristics that make it ideally suited for airframe applications such as honeycomb core and face sheets, welded tube and ducting, firewalls, bulkheads, stringers, skins, and miscellaneous formed parts. On a strength to density basis it will match or exceed the more popular Ti-6Al-4V alloy and at a lower unit cost. F.R.L.

A74-16450 Applications of the high strength alloy Ti-4Al-4Mo-2Sn-0.5Si in European aircraft projects. R. M. Duncan and R. T. J. Hubbard (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 91-103.

A74-16451 Titanium - The bridge to composites. L. R. Sanders, R. S. Baxter, and R. J. Juergens (McDonnell Aircraft Co., St. Louis, Mo.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 105-117.

The continuing demand for higher performance and lighter weight aircraft structure has led to the development of new lightweight composite materials possessing great strength. Sufficient confidence has been developed in high strength resin matrix composites such as boron/epoxy to permit their use in primary aircraft load carrying structure. Weight studies have shown that a very significant 20% weight reduction can be achieved through the use of composites in empennage control surfaces. This is an application that has been made possible primarily because of the compatibility of these composites with titanium, which is unique in its ability to be efficiently coupled with composite materials. It is titanium that permits the composite to be effectively joined to the conventional metal airframe. Full-scale composite empennage hardware is currently in production, and this advancement has been achieved by employing titanium as an integral part of the composite design. F.R.L.

A74-16476 Failure experience with and failure anticipation in titanium components. B. Cohen, H. M. Burte, and D. M. Forney, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 679-692.

A variety of service failures in titanium components is described, and some of the factors involved in these failures are discussed. The reviewed case varieties include fretting-, titanium-ignition, and fatigue-induced failures, as well as a case of silver-induced cracking. The possibilities of failure anticipation in titanium components are also considered. M.V.E.

A74-16477 Effects of Ti-6Al-4V alloy metallurgical structures on ultrasonic response characteristics. F. R. Billman and F. F. Rudolph (Alcoa Technical Center, Pittsburgh, Pa.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.
New York, Plenum Press, 1973, p. 693-705.

A74-16479 Ultrasonic inspection of titanium airframe components. K. L. Kremer, R. J. Lord, and R. J. Roehrs (McDonnell Aircraft Co., St. Louis, Mo.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 717-731.

Review of ultrasonic defect-detection techniques used for ensuring the internal integrity of titanium aircraft components. Following a discussion of defect origins and varieties, and consideration of the prerequisites to ultrasonic inspection effectiveness, the establishment of acceptance criteria and the implementation of ultrasonic inspection procedures are treated. General ultrasonic considerations include sound transmission characteristics, surface curvature compensation, and near-surface resolution. Special attention is given to the particular inspection requirements of forging stock, die forgings and preforms, plates, and bars. Ultrasonic inspection changes caused by fracture mechanics are also examined. M.V.E.

A74-16480 Non-destructive inspection of titanium jet engine disks. F. J. Vicki (United Aircraft Materials Engineering and Research Laboratory, Middletown, Conn.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.
New York, Plenum Press, 1973, p. 733-741.

Discussion of the material defects encountered and the nondestructive inspection techniques employed with the Ti-6Al-4V alloy used in the production of jet engine compressor disks. The defect categories considered include: (1) interstitial segregation, (2) chemical segregation, (3) high-density inclusions, and (4) clean porosity. Reviewed inspection methods include radiography, surface inspection, ultrasonic techniques, and the blue etch anodize method. M.V.E.

A74-16482 Nondestructive detection of hydrides and alpha-case in titanium alloys. D. J. Hagemaier (Douglas Aircraft Co., Long Beach, Calif.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 755-765.

Search for practical nondestructive tests to reliably measure rejectable levels of hydrogen and alpha-case in titanium alloys before parts or materials are manufactured or placed in service. A performed experimental evaluation of ultrasonic-attenuation, eddy-current, and thermoelectric tests is reviewed, and the results are discussed in terms of the capabilities and limitations of each test variety. M.V.E.

A74-16513 High cycle fatigue properties of titanium in aircraft application. W. J. Crichlow (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and T. Lunde (Lockheed-California Co., Burbank, Calif.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 2. New York, Plenum Press, 1973, p. 1257-1270. 13 refs.

The high-cycle spectrum fatigue properties of a number of alloys and product forms of titanium are discussed primarily from the viewpoint of aircraft usage. Constant load amplitude S-N type data

and the more realistic variable load amplitude spectra type data are reviewed. It is shown that titanium responds to variable load amplitude fatigue spectra in a manner similar to aluminum and steel, requiring very careful consideration of realistic spectrum type fatigue tests and special care in modifications of real spectra for laboratory test economics. If titanium is to remain competitive in the future, major improvement in high-cycle fatigue properties and reduction of scatter must be achieved by more stringent control of all steps of production, processing, and finishing, including tighter controls on heat-treatments, on grain size, oxygen, and other interstitial trace elements to which fatigue crackling is sensitive. T.M.

A74-16554 Development of cold headable titanium alloys for the 'Concorde' supersonic jet. E. Alhéritière, C. Drapier (Trèfimétaux GP, Argenteuil, Val-d'Oise, France), R. Molinier, and R. Syre (Trèfimétaux GP; Titanium GP, S.A., Argenteuil, Val-d'Oise, France). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 3. New York, Plenum Press, 1973, p. 1929-1943.

Three of seven titanium alloys studied meet the requirements for fabrication of cold headable rivets for the supersonic Concorde Jet. The three alloys include Ti-2.5 Cu X (low oxygen grade), Ti-1 Al-1.5 V (low oxygen grade), and Ti-X (Ti with controlled oxygen content around 0.13 percent). Careful analysis of the results has shown that in the range of compositions studied the strengthening effect of oxygen of forty times that of vanadium and aluminum and sixty times that of copper and iron. However, the decrease in strength resulting from an increase of temperature (20 to 120 C) is somewhat more important with the oxygen strengthened grade. Due to this slight disadvantage and, above all, to the need for precise control of oxygen content, the Ti-X grade has been finally adopted. T.M.

A74-16559 Deep hardenable titanium alloys for large airframe elements. E. Bohanek (Titanium Metals Corporation of America, Toronto, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 3. New York, Plenum Press, 1973, p. 1993-2008.

The development of improved titanium-base alloys for heavy sections is reviewed from the earliest commercial metastable beta alloy Ti-13V-11Cr-3Al to the latest innovations. The latest commercial metastable alloy Ti-8Mo-8V-2Fe-3Al exhibits improved fracture toughness, more abbreviated and predictable aging cycles, but also poorer transverse tensile ductility. Practical means are suggested for improving transverse ductility. The near beta alloy Ti-10V-2Fe-3Al is shown to exhibit good heat response in heavy sections with improved tensile ductility even without achieving the desired microstructural grain refinement. Noted improvements over earlier developments are the markedly improved machinability, the decrease in density, and increase in density, and increase in tensile modulus for Ti-10V-2Fe-3Al. M.V.E.

A74-16579 Dynamic creep of titanium alloy with 1.5 wt % Mn and 3% Al in high-velocity air streams. I. N. Bogachov, U. G. Veksler, and V. G. Sorokin (Ural'skii Politekhnicheskii Institut, Sverdlovsk, USSR). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 4. New York, Plenum Press, 1973, p. 2269-2278. 7 refs.

The transient creep of the Ti-3Al-1.5Mn alloy in a high-velocity air stream differs greatly from that in static air. The time before failure is 10 to 30 times shorter in the stream, plasticity being 2-3 times lower. Creep resistance in a rapid air stream will decrease considerably with increasing test temperature, angle of attack, and flow velocity. This is connected with changes in properties, composition, and structure of the material surface layers due to corrosion and erosion effects of the air stream. The nucleation of pittings, particularly at grain boundaries, contributes to accelerated weakening and failure of the alloy. T.M.

A74-16592 Fretting resistant coatings for titanium alloys. D. J. Padberg (McDonnell Aircraft Co., St. Louis, Mo.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 4. New York, Plenum Press, 1973, p. 2475-2486. Contract No. F33615-70-C-1538.

Investigation of the safe use of fretting-resistant coatings for the prevention of fretting-induced fatigue failures in aircraft components made of titanium alloys. The specific study goals explored and results presented pertain to: (1) the determination of fretting conditions prerequisite to fatigue life shortening in a titanium airframe joint; (2) evaluation and selection of potential fretting-resistant coatings that would not impair the properties of the basis metal; and (3) test of promising fretting-resistant coatings on experimental test elements using the critical fretting conditions determined under (1). M.V.E.

A74-16600 * Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation. H. R. Gray (NASA, Lewis Research Center, Cleveland, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 4. New York, Plenum Press, 1973, p. 2627-2638. 15 refs.

A74-16696 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap joints. J. P. Sandifer (Lockheed-California Co., Burbank, Calif.). *Wear*, vol. 26, Dec. 1973, p. 405-412. 7 refs.

Fatigue strength of aluminum lap joints subjected to fretting can vary widely, depending on the type of treatments applied to the faying surfaces. Many materials normally selected for their lubricity or good wear properties cannot be used in a bolted joint because of their interference with the load transfer requirements of the joint. Thus the best methods found in this evaluation in order of their effectiveness were bonded and shot-peened, bonded alone, shot-peened alone, and bonded steel wear pads. These techniques increased the fatigue strength at 10,000,000 cycles of an untreated joint from 12 ksi to a maximum of 23 ksi. (Author)

A74-16727 On the problem of rain erosion on a moving body flying at supersonic speed (Über das Problem der Regenerosion bei einem mit Überschallgeschwindigkeit bewegten Flugkörper). W. Körner (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Mathematik und Mechanik, Freiburg im Breisgau, West Germany). *Acta Mechanica*, vol. 18, no. 1-2, 1973, p. 103-115. 6 refs. In German.

When a body flying at supersonic speed approaches a liquid droplet, before impinging at the stagnation point the latter is exposed to the flow field in front of the body. The aerodynamic forces acting on the droplet reduce its impact velocity and also change its shape. Based on a suitable model, formulas for the rate of erosion at the stagnation point during the impact are derived in terms of dimensionless quantities describing the flight conditions. (Author)

A74-16755 # A 300 B static and fatigue tests. F. W. Vann (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). *Aircraft Engineering*, vol. 45, Dec. 1973, p. 6-8, 10.

The required testing is broken down into the three main categories of static strength testing, fatigue testing, and fail safe and residual strength testing. The loads to be applied to the specimen to simulate an actual flight case consist of fuselage inertia and aerodynamic, wing aerodynamic and inertia, tailplane aerodynamic and inertia, and fuselage pressurization loads, and miscellaneous

loads including inertia loads on the engines, and aerodynamic loads on the engines and their supporting pylons, etc. The sequence of testing of the static speciment is described in detail. F.R.L.

A74-16756 # **Lasers - Ranger and marked target seeker.** S. D. Lazenby (Ferranti, Ltd., Hollinwood, Lancs., England). *Aircraft Engineering*, vol. 45, Dec. 1973, p. 11.

The laser ranger and marked target seeker is essentially an air to ground device designed to augment the current generation of aircraft inertial navigation and attack systems. The laser provides instantaneous and extremely accurate range, which is one of the most important parameters to be established prior to a successful weapon strike. The laser ranger and marked target seeker normally comprises two units: the stabilized main unit, contained in a pressurized canister, and an electronics unit which is made up of power supplies and circuit cards. F.R.L.

A74-16758 # **Models in the design of fuel systems.** W. J. Rix (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). *Aircraft Engineering*, vol. 45, Dec. 1973, p. 14-17.

The use of scale fuel system models is discussed, a procedure used by Hawker Siddeley coupled with a small amount of rig testing. The construction of the models is described and some of the techniques evolved for solving specific fuel system problems are outlined. The problems of designing an aircraft fuel system break down into two basic categories. One is the problem of predicting and controlling the behavior of the fuel in the system pipework; the other is the problem of predicting and controlling the behavior of the fuel within the tanks. Tank venting, the positioning of refuel cut-off sensors, contents gauging, and the determination of unusable fuel conditions are discussed. Particulars of the Trident 3 and A300B Airbus fuel systems are given. F.R.L.

A74-16760 # **Titanium flamecutting reduces airframe costs.** H. M. Gallagher (British Oxygen Co., Ltd., London, England). *Aircraft Engineering*, vol. 45, Dec. 1973, p. 20, 21.

Oxy-gas flamecutting is based on the fact that when mild steel and titanium is raised to a temperature of about 800 C, it burns readily in the presence of oxygen. Oxy-fuel gas heating flames from the cutting nozzle maintain the combustion temperature while oxygen fed from the same nozzle maintains combustion and blows away the combustion products. Rate of cutting depends on the type and thickness of the material being cut, on fuel gas and pressure used. The height of the burner above the plate and other factors are also important, but given correct setting, perfectly smooth cuts can be produced in material up to 10 in. thick as routine, and more than 30 in. thick by skilled operators. F.R.L.

A74-16793 **YF-16 stresses advanced technology.** E. J. Bulban. *Aviation Week and Space Technology*, vol. 100, Jan. 7, 1974, p. 40-44, 47, 48.

The philosophy underlying the design and development of General Dynamics' YF-16 highly maneuverable light-weight 'dog-fighter' airplane that could complement the USAF/McDonnell Douglas F-15 Eagle and provide USAF with the numbers and tactical flexibility needed to counter large fighter forces. The approach adopted was that goals of low cost and high degree of combat maneuverability would be achieved by building the smallest lightest airplane possible, and integrating advanced technology that promised low risk. Aerodynamic technologies include a variable-camber wing, vortex lift, relaxed static stability component of a control-configured vehicle with fly-by-wire control system, wing-body blending, and underbelly engine inlet system. V.P.

A74-16822 # **Buckling loads and minimum weight of compressed curved ribbed aluminum alloy panels (Carichi di cedimento e peso minimo di pannelli curvi nervati compressi in leghe di alluminio).** G. Gabrielli and A. Ravetti. *Torino, Accademia delle Scienze, Classe di Scienze Fisiche, Matematiche e Naturali, Atti*, vol. 107, July-Oct. 1973, p. 499-513. 37 refs. In Italian. Research supported by the Consiglio Nazionale delle Ricerche.

Results of a study concerning the determination of the compressive strength of curved aluminum alloy panels stiffened with riveted ribs. These results, together with others obtained from the specialized literature, were processed and are represented in a unified form in order to facilitate a comparative study and to derive an envelope curve of the maximum buckling stress as a function of the structural load index, thus making it possible to choose, during the design stage the solution most suited to the weight effects. It is shown that the ratio between the weights of two panels which are made of the same material, have the same dimensions, and yield under the same load is given by the reciprocal of the respective buckling stresses for each value of the structural load index. Thus it is possible in the preliminary design of an aircraft to evaluate the minimum weight of the structures with a good approximation. A.B.K.

A74-16898 **Noise burden factor - New way of rating airport noise.** E. J. Richards and J. B. Ollerhead (Loughborough University of Technology, Loughborough, Leics., England). *Sound and Vibration*, vol. 7, Dec. 1973, p. 31-33, 5 refs.

It is shown that the relative benefits and disadvantages which an airport offers to its neighboring community can be evaluated with the aid of a criterion termed the noise burden factor. This measure represents the days of serious noise nuisance to one house dweller for each passenger or freight unit arriving at or leaving the airport. The noise burden factor is shown to provide a convenient means for comparing noise problems at different airports and for monitoring the effectiveness of noise control measures over a period of time. T.M.

A74-16951 * **Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings.** F. R. Bailey (NASA, Ames Research Center, Moffett Field, Calif.) and W. F. Ballhaus (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2. Berlin and New York, Springer-Verlag, 1973, p. 2-9. 6 refs.

The mixed elliptic-hyperbolic relaxation method for obtaining steady-state solutions to two-dimensional transonic potential equations is extended to the transonic small disturbance equation in three dimensions. In particular, transonic flow is considered both about nonlifting wing-cylinder combinations and over thin lifting wings with sweep and taper. The treatment is restricted to freestream Mach numbers less than one and to wings with subsonic trailing edges. M.V.E.

A74-16963 **A direct method for computing the steady flow at Mach number one past a given wing airfoil.** D. Euvrard and G. Tournemine (Rennes, Université, Rennes, France). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2.
Berlin and New York, Springer-Verlag, 1973, p. 146-152. 8 refs. Research supported by the Direction des Recherches et Moyens d'Essais.

The structure of a steady inviscid fluid flow past a convex airfoil at M 1 is described as one containing a purely subsonic region that extends from infinity upstream down to the sonic lines, a region containing two narrow supersonic strips bounded upstream by the sonic lines, a region consisting of two supersonic flow fields whose downstream boundaries are formed by shock waves at the trailing edge, and a region with a complex structure behind the shock waves. A procedure is proposed for calculating the velocity distribution in this flow. V.Z.

A74-16965 * **Calculation of separated flows at subsonic and transonic speeds.** J. M. Klineberg and J. L. Steger (NASA, Ames Research Center, Moffett Field, Calif.). In: International Conference

on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2. Berlin and New York, Springer-Verlag, 1973, p. 161-168. 7 refs.

A boundary-layer integral approach is combined with a finite-difference relaxation method to calculate viscous interactions between separated flows at subsonic and transonic velocities. Results are obtained for separated laminar flows on circular-arc airfoils at zero angle of attack and are compared with data of Collins (1972). Inviscid and viscous flows are covered. V.Z.

A74-16968 Development of a method of discretized-distribution singularities for the study of compressible and incompressible flows (Developement de la méthode des singularites à répartition discrétisée pour l'étude des écoulements incompressibles et compressibles). T.-S. Luu and G. Coulmy (CNRS, Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2. Berlin and New York, Springer-Verlag, 1973, p. 184-190. 13 refs. In French.

A74-16970 * A relaxation method for calculating transonic flows with detached bow shocks. E. M. Murman (NASA, Ames Research Center, Moffett Field, Calif.). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2. Berlin and New York, Springer-Verlag, 1973, p. 201-205. 9 refs.

The use of Murman and Krupp's (1971) method for calculating steady, inviscid, transonic flows with imbedded shock waves is discussed in application to two-dimensional problems for transonic flows past sharp and moderately blunt nosed geometries. A relaxation algorithm is used to solve the equations. M.V.E.

A74-16979 # Reduction of vibration and noise generated by planetary ring gears in helicopter aircraft transmissions. T. Chiang and R. H. Badgley (Mechanical Technology, Inc., Latham, N.Y.). *(American Society of Mechanical Engineers, Mechanisms Conference and International Symposium on Gearing Transmissions, San Francisco, Calif., Oct. 8-12, 1972, Paper 73-PTG-11.) ASME, Transactions, Series B - Journal of Engineering for Industry*, vol. 95, Nov. 1973, p. 1149-1158. 8 refs. Army-supported research.

Narrow-band studies of the noise generated by rotor-drive gear boxes indicate the presence of a number of very high narrow noise peaks located at gearbox mesh frequencies or their multiples. Exceptions are sideband noise components, located so near the main signal component as to be indistinguishable except for very narrow band reduction. An approach to the treatment of this type of noise is described which is based on systematic studies of the flow of high-frequency vibration energy in the drive train, aimed at determining the mechanism by which gear meshes generate vibrations, and examining the vibration response of the gearbox components supporting the gears. Calculations for two representative rotor-drive gearboxes are performed, and the possibility of noise reduction by modification of ring-gear casing design is studied. V.P.

A74-17007 Refrigerated containerized transport for 'Jumbo' jets. L. Tyree, Jr. (Liquid Carbonic Corp., Chicago, Ill.). In: Progress in refrigeration science and technology. Volume 4. Westport, Conn., AVI Publishing Co., Inc., 1973, p. 515-525; Discussion, p. 525. 6 refs.

The technology and economics of refrigerated containerized airfreight transportation by wide-bodied, double-decked 'Jumbo' jets are reviewed. In addition to the all-freight versions, the so-called passenger versions of these jets are true combination passenger-cargo aircraft, each with lower hold cargo capacities up to 40,000 lbs, ideally suited for shipments of perishables in self-contained refrigerated containers. Once these containers are loaded with freight and charged with dry-ice refrigerant, they require no further service or special handling throughout the in-transit time. It is expected that these new transportation techniques will have a substantial effect upon current freight traffic practices by creating new traffic patterns and new markets. M.V.E.

A74-17012 # Lifting-surface theory for an oscillating T-tail. K. Isogai (National Aerospace Laboratory, Tokyo, Japan). *AIAA Journal*, vol. 12, Jan. 1974, p. 28-37. 17 refs.

A lifting-surface theory for predicting aerodynamic forces on an oscillating T-tail is presented with special reference to the effects of tailplane dihedral and tailplane incidence. The analysis is confined to the incompressible flow case. By introducing a new coordinate system oscillating coincidentally with the in-plane motion of the tailplane and by employing a perturbation technique, the boundary-value problems are derived. The integral equations for the prediction of the antisymmetric load distributions on the tailplane, which are induced by the in-plane motion of the tailplane, are derived from the second-order boundary-value problem, while the first-order problems are those of conventional lifting-surface theories. A method for solving the integral equations is proposed, and the working forms of these equations are given. Some numerical examples for simplified T-tails are given and are compared with the experimental results. The theory is found to be useful for predicting the effects of tailplane dihedral and tailplane incidence on the flutter speed of a T-tail. (Author)

A74-17029 * # A vortex entrainment model applied to slender delta wings. P. L. Coe, Jr. (NASA, Langley Research Center, Joint Institut for Acoustics and Flight Sciences, Hampton, Va.; George Washington University, Washington, D.C.). *AIAA Journal*, vol. 12, Jan. 1974, p. 110-112. 10 refs.

A mathematical model of the vortex flow over a slender sharp-edged delta wing is proposed, and is shown to provide good agreement with the experiment. Although the technique requires experimental data in the form of the vortex core locations, it does account for the previously ignored mass entrainment of the vortex core. V.P.

A74-17048 * # Transonic transport wings - Oblique or swept. R. T. Jones (NASA, Ames Research Center, Moffett Field, Calif.) and J. W. Nisbet (Boeing Commercial Airplane Co., Renton, Wash.). *Astronautics and Aeronautics*, vol. 12, Jan. 1974, p. 40-47. 6 refs.

A comparative evaluation of fixed-geometry and variable-sweep wing designs, a fixed delta wing, and oblique wings with a single body or two bodies suggests that an oblique wing is preferable in a transonic transport aircraft in terms of gross weight, fuel consumption, and aircraft noise, and also shows an acceptable aeroelastic stability. Further studies are, however, needed to develop the full potential of the oblique-wing concept, including its economic implications. V.Z.

A74-17049 * # Putting all our noise technology to work. R. P. Jackson (NASA, Office of Aeronautics and Space Technology, Washington, D.C.). *Astronautics and Aeronautics*, vol. 12, Jan. 1974, p. 48-51.

An assessment of the present state of the art in noise reduction technology indicates that this technology has the potential for effectively attaining this goal - a conclusion that is in apparent conflict with the frequently voiced complaints on intolerable noise levels near airports. Measures are suggested for a more vigorous implementation of available technology in practice to combat the aircraft noise problem. V.Z.

A74-17103 Ablation. H. Hurwicz and J. E. Rogan (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: Handbook of heat transfer. New York, McGraw-Hill Book Co., 1973, p. 16-1 to 16-64. 124 refs.

Heat and mass transfer phenomena occurring in the ablation process are described, with emphasis placed on hypersonic flight. Various regimes involved in ablation are explained in terms of mass removal caused by thermochemical and mechanical processes, the response of the material to the environment, the mechanisms by which the material absorbs heat, boundary layer phenomena, and mass and energy balance at the surface. A comprehensive review is given of currently employed mathematical treatments of the thermochemical response of ablators which are surface coupled to a hypersonic, compressible, reacting, viscous flow field with a possibility of mass injection. T.M.

A74-17175 # **Noise and emission outlook for military engines.** D. W. Bahr, R. Lee, R. P. Taylor, and J. E. Worsham (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Aeronautical Meeting, Montreal, Canada, Oct. 29, 30, 1973; AIAA Paper 73-1156.* 8 p. 9 refs. Members, $1.50; nonmembers, $2.00.

Progress of technology in noise and exhaust gas and smoke discharge reduction in military engines is reviewed and further efforts needed in this field are considered with the emphasis on the reduction of NO(x), CO, and hydrocarbon emissions. Recommendations are given as to how R&D should be continued to meet the required standards. V.Z.

A74-17177 # **Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example (Vergleichende Untersuchung verschiedener Flugkörper-Antriebe am Beispiel einer Schiff-Schiff-Lenkwaffe).** G. Heise. *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt. Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-068.* 32 p. 5 refs. In German.

Design study illustrating the process of selection of the most suitable propulsion system for use in a hypothetical air-to-air missile under various circumstances. The propulsion systems considered include a low-cost turbojet engine with and without an afterburner, an improved ramjet engine, a second-generation pulse jet, solid-fuel engines, and solid-fuel ramjet rockets. The efficiencies and the costs of each type of propulsion system are taken into account, as well as fuel data. On the basis of curves for the initial mass and engine costs, an unequivocal relation can be obtained between engine type and missile range. A.B.K.

A74-17178 # **Some results of an experimental study of the Aerodyne concept by Dornier System GmbH (Einige Ergebnisse der Experimentalstudie der Dornier System GmbH zum Aerodyne-Konzept).** W. Melzer (Dornier-System GmbH, Friedrichshafen, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-069.* 12 p. In German.

Results of an experimental study concerned with laying the groundwork for the development of an unmanned flight vehicle which combines a hover capability with the high-speed performance of jet aircraft. The results of thrust and efficiency measurements on the experimental Aerodyne EI flight vehicle are presented, as well as the results of wind-tunnel tests on an electrically driven simplified model of the vehicle, and the results of hover-flight tests of the vehicle with respect to attitude stabilization, behavior during landing, and maneuverability. A.B.K.

A74-17179 # **Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle (Auslegung und Erprobung im Schwebeflug eines Lenkregelsystems für den flügellosen, ferngelenkten Experimentalflugkörper Aerodyne).** U. Schulz (Dornier-System GmbH, Friedrichshafen, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-070.* 30 p. In German.

Description of the design and testing of a hover flight controller for a vehicle which combines VTOL properties with a high flight speed capability. This flight controller is designed in such a way that the hover flight state can be maintained by an attitude control along the pitch and roll axis and a coarse course maintenance along the yaw axis. In order to improve the hover capability, translational damping in the x- and y-direction is employed. The transfer functions of the controller and the controlled plant are determined on the basis of simulation studies, and the dynamic behavior of the uncontrolled and controlled Aerodyne is assessed on the basis of a root locus analysis. A.B.K.

A74-17185 **An analytic approximate calculation of the nonlinear landing impact motions and loads on aircraft with both rigid and elastic wing structure (Eine analytische Näherungsrechnung zu den nichtlinearen Landestossbewegungen und -belastungen am Flugzeug bei starrer sowie bei elastischer Flügelstruktur).** W. Hagemann (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-078.* 89 p. 14 refs. In German.

A74-17186 # **Supersonic flow past sharp- and blunt-nosed conical bodies at angles of attack from 0 to 45 deg (Überschall-Umströmung von spitzen und stumpfen Kegelkörpern im Anstellwinkelbereich von 0 bis 45 deg).** W. Langefeld (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-080.* 69 p. 9 refs. In German.

Results of experimental studies of supersonic flow in the nose region of a truncated cone and a cone with a spherical nose. The studies performed concern the shock contour and the location of the shock front in the angle-of-attack plane, the behavior of the boundary line between the subsonic and supersonic regions in the neighborhood of the body in the angle-of-attack plane, and the pressure distribution on the body surface, as measured in the angle-of-attack plane and in the plane of the body symmetry axis. Existing methods of calculating the flowfields for sharp- and blunt-nosed cones at zero angle of attack are reviewed. In addition, approximate methods for determining the pressure distribution or shock contour at angle of attack are discussed, and their usefulness for application to the investigated family of conical bodies is ascertained. A.B.K.

A74-17187 **A method of designing supercritical lift profiles (Entwurfsmethode für auftriebsbehaftete überkritische Tragflügelprofile).** J. Scheerer and B. Kiekebusch (Messerschmitt-Bölkow-Blohm GmbH, Hamburg, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-081.* 43 p. 22 refs. In German.

Description of a method of designing supercritical lift profiles in which the desired solutions are obtained by matching with so-called basic profiles. It is shown that by applying methods of subsonic theory to supercritical basic profiles determined by Nieuwland's method (1964) supercritical solutions can be obtained for which the flow properties on the upper side of the profile are largely similar to those of the chosen basic profile. As a result, supercritical profiles of various thicknesses can be prepared for a given design Mach number by variation of the geometrical parameter influencing the profile thickness. By matching the pressure distribution on the upper side to a given 'target pressure distribution' while causing the minimum

possible change in the contour, a collisionless recompression is sought on the upper side of the profile, which has now become a lift profile. A.B.K.

A74-17192 Designing with plastic resin matrix composite materials (Entwerfen mit Kunstharzmatrix-Verbundwerkstoffen). C. Schulze (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-086.* 27 p. 7 refs. In German.

Consideration of the advantages and disadvantages of the use of plastic resin matrix bonded or mechanically joined composite materials. The possibilities and problems of designing large structural components out of such composite materials are indicated on the basis of existing design engineering experience. The potential advantages in using these composite materials are contrasted with the difficulties arising when laboratory results and materials theories are applied to the constructive shaping of large structural components. A practical procedure for the empirical development of design criteria to supplement the theory in different problem situations is illustrated by examples. Finally, examples of composite material structures used in fighter aircraft are cited and discussed. A.B.K.

A74-17205 # Problems in data management for earth monitoring missions (Probleme beim Data Management für erdbeobachtende Missionen). E. Velten (Dornier-System GmbH, Friedrichshafen, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-109.* 37 p. 6 refs. In German. Bundesministerium für Forschung und Technologie Contract No. RVII1-V17/72-KA-15.

Consideration of the problems connected with the handling of large quantities of data (generally in the form of images) obtained by aircraft and spacecraft during earth-monitoring missions. A parametric study is made of the problems connected with data acquisition, onboard data processing, data transmission, ground station data processing, and data evaluation by the user. Considering various sensor platfoms such as buoy- and ground-based measurement networks, aircraft, satellites, and unmanned spacecraft, the various measurement procedures which could theoretically be used for earth monitoring are discussed with reference to the possibilities of onboard data processing and the preparation of the data for transmission to the ground station. In connection with data processing at the ground station, the basic problems of processing large quantities of data, especially image data, are indicated, and methods of solution are suggested. The possibilities of user-oriented data evaluation are indicated on the basis of characteristic examples such as texture analysis and change detection. A.B.K.

A74-17216 Automatic control aspects of a control-configured aircraft with allowance for maneuver load control (Regelungstechnische Aspekte eines Flugzeuges künstlicher Stabilität /CCV/ unter besonderer Berücksichtigung der Manöverlaststeuerung). W. Kubbat (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-121.* 28 p. In German.

Review of automatic control problems arising in the design of a type of advanced aircraft called control-configured vehicles. Among the problems discussed are the control of unstable aircraft, maneuver load control, gust alleviation, flutter suppression, and new controlled variables. Examples are presented which give insights into the possibilities of the control-configured vehicle. It is shown that the problem of gust alleviation/maneuver load control cannot be treated as an isolated problem, and the concept of an integrated total control of the elastic aircraft is derived. This task includes both the control of rigid body forms and the addition of elastic forms of motion. It is shown that by the use of the elastic description of the surface in the treatment of the aircraft control stresses can be reduced and lifetime increased at the price of increasing expenditure on sensors, more complex signal processing, and the amalgamation of safety-determining and nonsafety-determining signal paths. A.B.K.

A74-17221 # The jet-flapped wing in ground proximity with special allowance for large angle of attack and large jet flap angle (Der Strahlklappenflügel in Bodennähe unter besonderer Berücksichtigung grosser Anstell- und Strahlklappenwinkel). R. Löhr. *Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, Paper.* 19 p. In German.

Investigation of the effect of the ground on an aircraft wing with jet blowing at the trailing edge. The method of singularities is used to calculate the inviscid plane flow past such a jet-flapped wing, with the ground being represented by mirror imaging. The problem leads to a system of nonlinear integral equations for the singularity distributions which also contains the initially unknown jet behavior. The system is solved numerically by an iterative method. The theory yields the pressure distribution, the jet behavior, the lift, and the moment as a function of the angle of attack, the jet flap angle, the blowing momentum, and the distance from the ground. The general (i.e., nonlinear) theory developed is found to show significant improvements over the linear theory, which is valid only for small angles of attack and small jet flap angles. A.B.K.

A74-17252 New concepts in AMTI radar - Nulling effects of Doppler filter/multi-element horn array. W. B. Goggins, C. J. Sletten, and F. S. Holt (USAF, Cambridge Research Laboratories, Bedford, Mass.). *Microwave Journal*, vol. 17, Jan. 1974, p. 29-33, 35. 8 refs.

New concepts for Airborne Moving Target Indicator Radar are described which exploit recent advances in optimum null forming-beam forming antennas and in real-time electronic digital processing of radar signals. This scheme makes use of contiguous fixed antenna beams covering a wide azimuthal sector from an aircraft and a complementary Doppler-filter processor which together with antenna nulls reject ground clutter. A coherent post detection beam forming scheme operates simultaneously with each Doppler channel and intergrates many target pulses to provide high signal to clutter ratios. Because the system does not require periodic pulsing, range ambiguity problems are reduced. A comparison with the displaced phase center and other AMTI methods is made. Some experimental efforts are described. The objective is to design airborne radar for detecting other aircraft against ground-clutter background with a modern, simple radar having an antenna composed of fixed radiating elements that can be flush mounted. (Author)

A74-17270 Nonlinear airfoil theory with allowance for ground effects (Nichtlineare Tragflügeltheorie in Bodennähe). D. Hummel (Braunschweig, Technische Universität, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 21, Dec. 1973, p. 425-442. 38 refs. In German.

As the basis for the solution of aerodynamic interference problems the complete field of induced velocities is calculated according to lifting line theory as well as to lifting surface theory for wings with a plane vortex sheet and with given load distribution. Lifting surface theory turns out to be in good agreement with experimental data, particularly in the vicinity of the wing. Using these results for the wing in ground proximity, the extended lifting line theory and the lifting surface theory are applied by means of the image technique. Plane vortex models parallel to the ground as well as inclined to the ground are used and calculations are performed with and without taking into account the longitudinal components of the induced velocities, produced by the image wing. This leads to lift and pitching moment coefficients which depend nonlinearly on

the angle of incidence. If the inclination of the wing against the ground and the longitudinal components of the induced velocities are considered simultaneously, the corresponding nonlinear lifting surface theory is in excellent agreement with experimental data. (Author)

A74-17272 Problem of adapting an intake to a turbojet engine for extremely high flight Mach numbers (Zum Problem der Anpassung eines Einlaufs an ein Turbotriebwerk für extrem hohe Flug-Machzahlen). H. Künkler (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 21, Dec. 1973, p. 445-453. 5 refs. In German.

After brief presentation of the possible types of a supersonic intake and its operational behaviour, the fundamental difficulties occurring during operation of a turbojet engine with a fixed geometry intake are shown and possibilities of elimination are studied. Design criteria and the influence of central body displacement are discussed using as example the design of a two-shock diffuser for a turbojet engine (ATAR-9). Finally, an intake with fully variable geometry for extremely high flight Mach numbers is planned for a turbojet engine which seems to be suitable for the propulsion of an aerodynamic spacecraft launcher. The possibility and/or necessity of adaptation by varying geometry, by air addition in the thrust nozzle and by speed control of the engine is investigated. (Author)

A74-17276 # The Type 3B altitude measurement system. A. N. Du Feu. *Aviation Review*, Oct. 1973, p. 8-11.

The Type 3B system is a modern comprehensive altitude measurement system which combines high accuracy with an ambiguous counter/pointer presentation, together with facilities for altitude reporting and alerting, and correction of static pressure error. A unique design feature of the altimeter enables very simple transducers to be employed. The components are described briefly, and comments are made of the system operation, in order that the maximum efficiency may be obtained. F.R.L.

A74-17277 # The impact of area navigation on flight control systems and displays. D. J. Mayes. *Aviation Review*, Oct. 1973, p. 14-16.

More stringent navigational requirements in terms of accuracy must have accompanying requirements for integrity to guard against gross errors. The duplicated area navigational systems available today can provide both the navigational accuracy and integrity of information but the integration of automatic flight control and instrumentation with these systems needs careful consideration to ensure that the total system, including the crew, is capable of utilizing this increased accuracy and integrity to provide a safe transport system with decreased pilot work load. F.R.L.

A74-17305 # Emission of gaseous pollutants by turbojet engines - The Olympus case (Emission des polluants gazeux par les turboréacteurs - Application à l'Olympus). A. Quillevere and J. Decouflet (SNECMA, Paris, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings. Paris, COVOS, 1973, p. II-1 1 to II-1 26. 5 refs. In French.

Discussion of the pollution problems associated with the use of afterburners with turbojet engines on commercial aircraft particularly in the case of the Olympus engine under such flight conditions as during takeoff, acceleration in transonic flight, and climb in supersonic flight. The topics reviewed include optimum combustion prerequisites and design requirements, mechanisms of pollutant formation, pollution-characterizing parameters, pollution emission by the turbojet engine and the afterburner, pollution characteristics of the Olympus engine, high-altitude pollution during afterburning, and pollution-reducing devices. M.V.E.

A74-17306 # Particle sampling and size analysis in the ejection zone of the Olympus jet engine at ground level (Prélèvements et analyses granulométriques dans la zone d'ejection du réacteur Olympus au niveau du sol). G. Madelaine and D. Vigla (Commissariat à l'Energie Atomique, Service Technique d'Etudes de Protection et de Pollution Atmosphérique, Fontenay-aux-Roses, Hauts-de-Seine, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings. Paris, COVOS, 1973, p. II-3 1 to II-3 9. In French.

Description of the techniques employed in obtaining particle samples in the jet stream of a jet engine, and review of the analytical procedures used in determining the collected particle concentration, size, and composition. Some preliminary experimental results are presented. M.V.E.

A74-17311 # Temperature, winds, and turbulence at SST flight levels (Température, vent et turbulence aux niveaux de vol des SST). P. Le Berre (Météorologie Nationale, Paris, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings. Paris, COVOS, 1973, p. VI-3 1 to VI-3 11. In French.

Review of the results of stratospheric wind and temperature studies by balloon-borne experiments performed up to 40-km altitudes in recent years. These results indicate the existence of two stratosphere layers: the upper one, where the 'east wind phenomena' (i.e., abrupt temperature rises and the stratospheric monsoon) take place, that is governed by the overlying levels; and the lower one, where SSTs are to operate, and which is governed by the underlying tropopause. The boundary between these two layers lies at an altitude of 20-22 km. The lower stratosphere exhibits a very thin-layered structure and is characterized by 'accidents' or discontinuities in its wind and temperature profiles that may last for more than 12 hrs and extend over several hundred kilometers. Some of the problems entailed by these discontinuities are discussed. M.V.E.

A74-17312 # Stratosphere contamination by aircraft and mathematical models (Injections stratosphériques par avionset modèles mathématiques). R. Joatton and J. Bensimon (Société Nationale Industrielle Aérospatiale, Direction Technique Avions, Paris, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings. Paris, COVOS, 1973, p. VII-4 1 to VII-4 12. In French.

Mathematical models pertaining to turbulence and pollutant diffusion, as well as to calculations of the relations with the environment of aircraft crews and passengers, and aircraft emissions, are discussed. Some of the preliminary results obtained from applications of these mathematical models to hypothesized Concorde-type aircraft traffic are presented and discussed. These order-of-magnitude results have been obtained without making any allowance for the undoubtedly important effects of dissociation and disappearance of the various emission products concerned and must be viewed with appropriate reservations. M.V.E.

A74-17374 Materials for the new generation of aircraft. M. A. Steinberg. In: The science of materials used in advanced technology. New York, Wiley-Interscience, 1973, p. 461-508. 20 refs.

Discussion of materials applications in aircraft, and examination of aircraft design requirements as related to strength and fatigue resistance to afford an insight into the problems of selecting materials for structural applications. The modern materials available for long-life, high-performance applications in aircraft are noted. The tradeoffs between material properties such as strength, fracture toughness, resistance to stress corrosion cracking, yield of minimum-weight structures, and ensurance of fail-safe design without premature failure are described. New developments in high-strength aluminum alloys to accomplish these tradeoffs are discussed. The effects of minor amounts of alloying elements in aluminum alloys,

the control of certain impurities, the thermomechanical processing treatments, and the newer overaging treatments to improve stress corrosion resistance, while maintaining adequate strength, fracture toughness, and tear resistance, are cited. The status of titanium technology as it applies to subsonic aircraft is discussed. Advantages and shortcomings, not only for aircraft structures, but also for engine applications, are illustrated. Finally, the development of new advanced high-strength steels and improvements in melting and processing practices are touched upon. A.B.K.

A74-17495 Characteristics of the wake behind a cascade of airfoils. R. Raj and B. Lakshminarayana (Pennsylvania State University, University Park, Pa.). *Journal of Fluid Mechanics*, vol. 61, Dec. 18, 1973, p. 707-730. 16 refs. Navy-sponsored research.

An analytical and experimental investigation of the near and far wake characteristics of a cascade of airfoils is reported in this paper. The measurement of mean velocity, turbulence intensity, and Reynolds stress across the wake at several distances downstream of the cascade indicates that the wake is asymmetrical and that this asymmetry is maintained even up to 3/4 of chord length. Experiments carried out at three incidences reveal that the decay of the wake defect is strongly dependent on the downstream variation of the wake edge velocity. For a cascade, the decay rate of the wake defect is found to be slower than that of a flat plate, cylinder, or symmetrical airfoil (at zero incidence). The level of turbulence and Reynolds stresses are found to be high, and some comments are made regarding self-preservation and structure of the flow. (Author)

A74-17531 Avionics design for maintainability - Are we gaining or losing. T. A. Ellison (United Air Lines, Inc., Chicago, Ill.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730882.* 9 p. Members, $1.25; nonmembers, $2.00.

An overview of avionics maintainability, as indicated from airline operating statistics, shows improvement in some elements and degradation in others, but a slowly degrading overall trend. Maintainability elements and trends are identified and discussed. Principal problems are the shop labor expended for the high proportion of removed equipment found to be in satisfactory condition, and the increasing line maintenance effort required by wide-body aircraft. Built-in test equipment (BITE) or monitoring within the system, if properly designed, appears to be a good approach to improve this situation. Design guidance for effective BITE or monitoring objectives is provided. (Author)

A74-17532 L-1011 upkeep. W. H. Spannuth (Trans World Airlines, Inc., Kansas City, Mo.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730883.* 8 p. Members, $1.25; nonmembers, $2.00.

The question has been asked whether the airline industry is gaining or losing in the design of new aircraft for maintainability. The Lockheed L-1011 aircraft is examined by an operator resulting in two answers: yes for routine maintenance and no for nonroutine maintenance. Areas for investigation for further improvement, particularly in the wide-body aircraft, include the care of passenger cabin and associated appliances and amenities. The airlines have increased interior maintenance by brightening up the interiors - trading dark colors, which do not show abuse, for the lighter, more attractive colors. The same principles and criteria need to be applied to cabin interior design as have been used to develop the reliable structures, systems, and powerplants now in operation. T.M.

A74-17533 Wing fuselage structural/concept study for a subsonic transport aircraft. G. V. Deneff (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730886.* 16 p. 5 refs. Members, $1.25; nonmembers, $2.00. Contract No. F33615-72-C-1450.

Results of a brief study program to devise and evaluate new structural materials and concepts for a subsonic, transport-type aircraft are presented. Comparisons of several wing concepts to the state-of-the-art baseline concept indicate a weight saving of 10%, but with corresponding total cost increases of 50-75%. One fuselage concept indicates a 7% weight saving with a 5% total cost saving. Corresponding aircraft performance payoffs with and without resizing are also established. Both baseline and new concept analyses are based on a common set of requirements for ultimate strength, fatigue life, damage tolerance, and flutter rigidity. The study is directed to metallic concepts. (Author)

A74-17534 Application of advances in structures and materials to the design of the YF-17 airplane. R. D. Hayes (Northrop Corp., Los Angeles, Calif.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730891.* 8 p. Members, $1.25; nonmembers, $2.00.

A review of the structural design and material selection in the YF-17 airplane is presented. Emphasis is placed on the choice of those design concepts and materials that are unique, and the effect on these choices of the prototyping philosophy is described. Special emphasis is placed on the use of graphite materials, but the use of other nonmetallic materials and the considerations involved in the selection of metallic alloys and heat treatments are also discussed. (Author)

A74-17535 An approach toward optimizing material cost and part function in advanced powerplants. R. W. Stusrud, E. S. Nichols, B. A. Zolezzi, and D. K. Hanink (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730909.* 8 p. Members, $1.25; nonmembers, $2.00.

This paper describes the recent and successful features of an intensive program to control the costs of advanced military aircraft gas turbine engines in line with the costs of current production engines and of those produced during the past several years. We have been attempting to incorporate highly advanced technology into our new products, while at the same time holding the costs in line with older technology products. In many instances, we have been able to use the advanced technology to lower costs at the same time that weight and performance are improved. There are examples of this in aerodynamics, mechanical design, and materials and processes. In other instances, the experience is more conventional, in that lower costs involve increases in weight; in these cases, lists of weight increases versus cost decreases are maintained, and the most attractive concepts are incorporated up to the acceptable weight limits of the engine specification. (Author)

A74-17536 The T700-GE-700 turboshaft engine program. W. J. Crawford, III (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730917.* 14 p. Members, $1.25; nonmembers, $2.00.

The 1500 SHP T700 engine is being developed for the U.S. Army UTTAS and AAH helicopters. Prototype engines have been running well since testing began early in 1973. Qualification is expected in early 1976. Engine history and current details, design features, program milestones and possible future developments are reviewed. The unique T700 design will achieve unusually high levels of reliability and maintainability. T.M.

A74-17537 Heavy Lift Helicopter main engines. D. R. Woodley (Boeing Vertol Co., Philadelphia, Pa.) and W. S. Castle (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *Society of Automotive Engineers, National Aerospace Engineering*

and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730920. 19 p. Members, $1.25; nonmembers, $2.00.

The Heavy Lift Helicopter (HLH) is the airborne component of a container ship and helicopter logistics system. This paper describes powerplant aspects of the HLH program, including engine sizing, selection, and development of the Detroit Diesel Allison 501-M62B engine for the test rig. The current development program for XT701-AD-700 flight engines for use in the HLH prototype is discussed. T.M.

A74-17541 **Development of requirements for, and evaluation of, manufacturer advanced design aircraft.** J. D. Graef (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730948.* 15 p. Members, $1.25; nonmembers, $2.00.

A74-17542 **Data acquisition, processing, and control for advanced aircraft.** H. E. Sutherland. *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730957.* 8 p. Members, $1.25; nonmembers, $2.00.

The advanced system monitor (ASM) is an integrated display device using digital data acquisition and processing techniques, and is intended for a new generation of transport aircraft. It provides the flight crew with the critical airplane condition data in one centralized location. The equipment described constitutes the data acquisition, processing, and control portion which works in conjunction with the ASMs electronic display. The mechanization is a dual redundant system having operational modes which allow for the safe flight of aircraft even if there are two failures. The heart of the system is a general-purpose computer which monitors and, on command, provides the crew with aircraft condition status and automatically notifies of deteriorating conditions so that an appropriate action can be taken. (Author)

A74-17736 **Dynamic test of air data computers with simulated flight profiles (Dynamische Prüfung von Luftwerterechnern mit simulierten Flugprofilen).** W. Schöfer (Telefunken AG, Konstanz, West Germany). *Internationale Elektronische Rundschau,* vol. 27, Dec. 1973, p. 270-272. In German.

An air data computer is used for the determination of important data which are required to provide the necessary flight safety to the aircraft. Atmospheric parameters are measured with the aid of sensing devices. The parameter values are supplied to the air data computer. The determination of the atmospheric conditions is discussed together with details regarding the measurement of the parameters and the functions of the air data computer. The objectives of the testing system are examined along with its principles of operation. G.R.

A74-17739 # **The use of fully stressed iteration and structural index in automated structural optimization.** L. Spunt (California State University, Northridge, Calif.). *SAWE Journal,* vol. 33, Dec. 1973-Jan. 1974, p. 11, 12, 21. 10 refs.

Consideration of a generalized iteration scheme applicable to a large number of variables in automated optimization of structural components. The scheme is similar to that given by Gellatry (1966) but incorporates structural index data without the necessity of determining internal loads. The steps of the iteration scheme are described. V.Z.

A74-17740 # **Utility analysis in weight control.** P. F. Halfpenny (Lockheed-California Co., Burbank, Calif.). *SAWE Journal,* vol. 33, Dec. 1973-Jan. 1974, p. 15-18.

Consideration of a method for combining weight, reliability, control stability and cost criteria into a single compatible value which represents the utility criterion for the selection of an optimal system design from system weight analysis and evaluation program. Effective temperature and weight are discussed as utility criteria in application to the L-1011 Environmental Control System. Different types of sample juries participated in experiments conducted in different cities across the nation in the evaluation of these criteria. V.Z.

A74-17776 **Vehicle crashworthiness.** S. P. Desjardins (Ultrasystems, Inc., Phoenix, Ariz.). In: Numerical and computer methods in structural mechanics. New York, Academic Press, Inc., 1973, p. 557-584. 6 refs.

Aircraft crashworthiness is discussed, with special attention to survivable crash environments for rotary-wing aircraft, light fixed-wing aircraft, and fixed-wing transport aircraft. It is shown that vehicles can be designed to provide crash protection to occupants at relatively little penalty to vehicle weight and cost, and that seating and restraint systems should have the strength required to remain in place until the surrounding structure collapses. M.V.E.

A74-17801 **Improvement of the downflow conditions behind an integrated shrouded propeller (Verbesserung der Abströmverhältnisse hinter einer integrierten Mantelschraube).** C. Kramer, H.-J. Gerhardt (Aachen, Fachhochschule, Aachen, West Germany), and H. Fischer (Rheinflugzeugbau GmbH, Mönchengladbach, West Germany). *Flug Revue/Flugwelt International,* Jan. 1974, p. 23-25. In German.

A74-17804 # **Automatic balancing of an aircraft (Automatyczne wywazanie samolotu).** A. Groszek. *Technika Lotnicza i Astronautyczna,* vol. 28, Dec. 1973, p. 4-9. In Polish.

The longitudinal balancing of an aircraft in flight is explained by reviewing the operation of a trimming tab on the elevator. Automatic trimming systems are described where the trimmer is operated either by an input signal proportional to the load on the elevator mechanism or by input signals generated with mechanical position sensors. The Concorde system of fuel allocation in balancing tanks is briefly outlined. T.M.

A74-17806 # **A color schlieren system.** T. J. Kessler and W. G. Hill. *Photographic Applications in Science, Technology and Medicine,* vol. 9, Jan. 1974, p. 22-24, 34. 5 refs.

Description of a color schlieren system to be used in studies of separated compressible fluid flows in supersonic wind tunnels. To achieve a color schlieren system, the conventional knife edge is replaced by a tri-color filter. The details of operation of the proposed color schlieren system, using a red-blue-yellow filter, are indicated. Excellent results have been obtained using the color schlieren system with both 35-mm still photographs and 16-mm high-speed motion pictures. Both photographic applications employ an auxiliary lens placed after the knife edge to refocus the test section image in the plane of the film. A.B.K.

A74-17810 * # **Airborne profiling of ice thickness using a short pulse radar.** R. S. Vickers (Colorado State University, Fort Collins, Colo.), J. E. Heighway, and R. T. Gedney (NASA, Lewis Research Center, Cleveland, Ohio). *Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., Dec. 2-6, 1973, Paper.* 10 p. 6 refs.

This paper describes helicopter-borne measurements of ice thickness in Lake Superior, Lake St. Clair, and the St. Clair river as part of NASA's program to develop an ice information system. The profiler described is a high resolution, nonimaging, short pulse radar, operating at a carrier frequency of 2.7 GHz. The system can resolve reflective surfaces separated by as little as 10 cm and permits measurement of the distance between resolvable surfaces with an accuracy of about 1 cm. Data samples are given for measurements both in a static (helicopter hovering), and a traverse mode. Ground

truth measurements taken by an ice auger team traveling with the helicopter are compared with the remotely sensed data and the accuracy of the profiler is discussed based on these measurements. (Author)

A74-17851 # **Nonstationary vibrations of a rigidly supported flexible rotor of variable mass (Nestatsionarnye kolebaniia gibkogo rotora s peremennoi massoi na zhestkikh oporakh).** E. Rakhimov. *Mekhanika Mashin*, no. 39-40, 1973, p. 80-91. 6 refs. In Russian.

Transient processes generated in a rotor system by simultaneous changes in the rotor mass and spin rate are analyzed with and without allowance for gyroscopic effects. The equations of the flexural vibrations of a rotor of variable mass are derived and are solved by an asymptotic method due to Bogoliubov and Mitropolskii (1964). V.P.

A74-17856 # **New jumbo jets must speak in whispers - Certifying the Lockheed 1011.** N. Shapiro and J. W. Vogel (Lockheed-California Co., Burbank, Calif.). *Noise Control Engineering*, vol. 1, Summer 1973, p. 16-23. 7 refs.

The L-1011-1 noise certification program is described, covering instrumentation, test site, data reduction and analysis, FAR Part 36 demonstration for the Federal Aviation Administration (FAA) and results. FAR Part 36 establishes effective perceived noise levels to be met at three reference locations. The central recording systems used includes a 14-channel FM tape recorder with low-level, differential inputs, oscilloscope monitoring, and Lockheed-built attenuators. Although FAR Part 36 only specified actual takeoffs and landings for demonstrating noise, for L-1011 certification a series of level flyovers was also conducted at heights above the runway of approximately 400 and 800 feet. The results of these level flyovers were used to confirm the noise vs engine parameter relationship developed in the course of the flight test program. F.R.L.

A74-17862 An aircraft exterior coating system and surface pretreatment. S. Tsukada, S. Sagata, K. Saito, and T. Kitagawa. *Mitsubishi Juko Giho*, vol. 10, no. 3, 1973, p. 430-440. 7 refs. In Japanese, with abstract in English.

Polyurethane paints were tested for evaluation of their properties in comparison with those of lacquer and alkyd enamel paints which have been generally used for aircraft exterior coating, in an attempt to plan a manufacturing program of polyurethane paints having excellent properties as aircraft exterior coating materials. Polyurethane paints were found to be superior to lacquer and alkyd enamel paints expecially with respect to resistance to weather, to contamination, and to synthetic lubricating oil. A flight test of the polyurethane coating on a supersonic aircraft over one year demonstrated its sufficient capabilities under operational conditions. The pretreatment of aircraft surfaces, which has significant effects on the adhesion and corrosion resistance of coatings, was also evaluated, and the relationship between the coating adhesion and the condition of the pretreatment film, such as heat deterioration, aging, and surface retreatment, was clarified. (Author)

A74-17887 **Aircraft components from remelted steels - Design and development (Pièces aéronautiques en aciers refondus - Réalisations et développement).** M. Rabbe (Creusot-Loire, Unieux, Loire, France) and M. Rambaud (Creusot-Loire, Pamiers, Ariège, France). *(Journée d'Etudes sur l'Amélioration des Performances des Aciers à Température Ambiante et à Haute Température, 5th, Le Bourget, Seine-St.-Denis, France, June 1, 1973.) Matériaux et Techniques*, vol. 61, Apr.-May 1973, p. 101-110. In French.

The serial production of high-quality landing gear and airframe steel components processed through remelting in consumable-electrode furnaces, under vacuum, or electroslag is reviewed. It is shown that the quality and variety range of products obtainable by these processes affords the designer choices adjustable to any set of safety requirements at the optimum cost efficiency compromise. M.V.E.

A74-17890 **Status of the latest turbine disk alloys in the U.S. (Point des alliages avancés pour disque de turbine aux U.S.A).** J. E. Coyne and W. H. Couts (SNECMA, Gennevilliers, Hauts-de-Seine, France). *(Journée d'Etudes sur l'Amélioration des Performances des Aciers à Température Ambiante et à Haute Température, 5th, Le Bourget, Seine-St.-Denis, France, June 1, 1973.) Matériaux et Techniques*, vol. 61, Apr.-May 1973, p. 147-155. 9 refs. In French.

Review of recent advances in the production technology of aircraft turbine disks made of conventional and hot-die forgings from powder-metallurgy processed René 95 and In 100 billets. The thermomechanical treatment techniques used are shown to offer the designer the possibility to meet the stringent requirements of turbine components. M.V.E.

A74-17891 **Heat-resistant titanium alloys - Introduction of the 651 A alloy (Les alliages de titane résistant à chaud - Présentation de l'alliage 651 A).** L. Séraphin, R. Tricot, and R. Castro (Ugine Aciers, France). *Matériaux et Techniques*, vol. 61, Apr.-May 1973, p. 156-171. 35 refs. In French. Research supported by the Services Techniques de l'Aéronautique.

Review of the principal thermomechanical characteristics of the new 651 A alloy that has been derived from the older 685 titanium alloy and possesses comparatively improved quenching properties. These improvements are shown to make possible its use in jet engine compressor disks. M.V.E.

A74-17892 **Evolution of applications of precision casting in turbojets (Evolution des applications de la fonderie de précision dans les turboréacteurs).** R. Brunetaud (SNECMA, Bois-Colombes, Hauts-de-Seine, France). *(Journée d'Etudes sur l'Amélioration des Performances des Aciers à Température Ambiante et à Haute Température, 5th, Le Bourget, Seine-St.-Denis, France, June 1, 1973.) Matériaux et Techniques*, vol. 61, Apr.-May 1973, p. 172-177. In French.

A74-17898 * **Recent studies of tire braking performance.** J. L. McCarty and T. J. W. Leland (NASA, Langley Research Center, Hampton, Va.). *(American Society for Testing and Materials, Symposium on Tire Traction, Lanham, Md., May 10, 1972.) Tire Science and Technology*, vol. 1, no. 2, 1973, p. 121-137.

The results from recent studies of some factors affecting tire braking and cornering performance are presented together with a discussion of the possible application of these results to the design of aircraft braking systems. The first part of the paper is concerned with steady-state braking, that is, results from tests conducted at a constant slip ratio or steering angle or both. The second part deals with cyclic braking tests, both single cycle, where brakes are applied at a constant rate until wheel lockup is achieved, and rapid cycling of the brakes under control of a currently operational antiskid system. (Author)

A74-17905 # **The hydrogen fuel economy and aircraft propulsion.** A. L. Austin (California, University, Livermore, Calif.) and R. F. Sawyer (California, University, Berkeley, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 9th, Las Vegas, Nev., Nov. 5-7, 1973, AIAA Paper 73-1319.* 6 p. 20 refs. Members, $1.50; nonmembers, $2.00. Grant No. AF-AFOSR-72-2299.

Considerable interest has been directed toward the use of hydrogen as an ultimate replacement for fossil fuels. It is clean burning at comparable thermal efficiencies in piston and turbine engines, exists as a huge resource, and since the primary combustion product is water, the cycle from ecosphere to use and back to ecosphere is probably measured in years rather than millions of years as is the case with fossil fuels via the carbon cycle. The other

fundamental advantage is that energy storage per unit weight is less than fossil fuels, and therefore hydrogen is an attractive fuel for aircraft. Large new sources of hydrogen at a low price are required before hydrogen can play an important role as an aircraft fuel. F.R.L.

A74-17969 **Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Annual Report 1972 (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Jahresbericht 1972).** Porz-Wahn, Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, 1973. 452 p. In German.

Activities in the field of fluid dynamics are reported together with investigations in the areas of the mechanics of flight, mechanical strength, materials, and design methods. Propulsion systems are considered, giving attention to aerial jet propulsion, chemical rocket propulsion, electrical propulsion, plasma dynamics, reaction kinetics, fuels, and lubricants. Other activities discussed are in the fields of electronics, space physics, space medicine, computers, aeronautics, and astronautics. G.R.

A74-17984 **Innovations in ATC communication systems.** R. Wainwright (FAA, Washington, D.C.). In: National Telecommunications Conference, Atlanta, Ga., November 26-28, 1973, Conference Record. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 7C-1 to 7C-3.

Advances and innovations in air traffic communications since the early 1920s are reviewed and shown to have been evolutionary in the sense of successive generations identifiable in relative time frames. The present status of development is defined, and current trends and goals for the future are discussed. M.V.E.

A74-18050 **Military and aerospace.** D. Mennie. *IEEE Spectrum*, vol. 11, Jan. 1974, p. 71-77.

Space age know-how is being used to solve immediate problems that the general public is facing, such as safe landing at congested airports. As a complement to airport radar the Air Traffic Control Radar Beacon System (ATCRBS), currently in widespread operation, provides the ground controller with aircraft position, identity, and altitude data. But the growing number of beacon-equipped aircraft and ground interrogators and the inherent self-interference limitations of the ATCRBS have motivated the development of hardware called the Discrete Address Beacon System (DABS). Coupled with a reshuffling of national priorities, space exploration has shifted to the task of providing an efficient means of performing routine missions. The technology which permitted a NASA scientist in Houston to control a TV system on the moon could make practical a defense concept that saves both men and money. F.R.L.

A74-18083 # **The problem of optimal design of gas-turbine engines (K voprosu ob optimal'nom konstruirovanii gazoturbinnykh dvigatelei).** N. D. Kuznetsov. *Problemy Prochnosti*, vol. 5, Nov. 1973, p. 55-60. In Russian.

Consideration of the stages of development of a new gas-turbine engine, and analysis of examples of optimization of various structural strength components. After briefly defining the concept of optimal design of an engineering structure, an attempt is made to determine the principles and methods which should underly an optimal design and the criteria which are to serve as the basis for evaluating optimality, and an optimal design scheme, constructed on the basis of the main stages of design of a gas-turbine engine, is proposed. Some examples of the design of engine subassemblies which are optimal from the strength standpoint are then presented, stressing the use of the theory of limiting equilibrium in achieving optimal design of heavily loaded subassemblies and components of gas-turbine engines, the use of the principle of maximum damping, and the use of methods of strengthening components. A.B.K.

A74-18085 # **A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in (Issledovanie povrezhdaemosti turbinnykh lopatok aviatsionnykh GTD posle ekspluatatsionnoi narabotki).** B. A. Griaznov, S. S. Gorodetskii, and A. S. Tugarinov (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR). *Problemy Prochnosti*, vol. 5, Nov. 1973, p. 65-67. 5 refs. In Russian.

Experimental evaluation of the fatigue characteristics of gas-turbine blades after 4000 hours of running-in operation. The regression equations of the fatigue curves are calculated, and the load-bearing surface of the blades after running in is plotted. It is established that under standard conditions of operation the blade lifetime after 10,000,000 cycles decreases by an average of 13 to 15%. A.B.K.

A74-18088 # **A study of the combined vibrations of the disk-blade system of a turboprop engine turbine wheel (Issledovanie sovmestnykh kolebanii sistemy disk-lopatki rabochego kolesa turbiny TVD).** A. K. Panteleev, L. N. Rzhavin, N. I. Glushchenko, V. I. Konovalov, and S. S. Tripol'skii. *Problemy Prochnosti*, vol. 5, Nov. 1973, p. 78-81. In Russian.

Study of the nature and mode of the blade and disk vibrations in the wheel of the third stage of a turboprop engine turbine. It is shown that the high stresses in the blades are caused by critical rotations of the wheel in the presence of mode vibrations with five nodal diameters. It is further shown that these vibrations can be eliminated by making appropriate changes in the elements of the system. A correlation is established between the critical rpm and the mean frequency in the case of a set of blades vibrating in the axial mode; on the basis of this correlation a control over the mean frequency of this set of blades during production is introduced. A.B.K.

A74-18090 # **Suitability of using titanium pipelines in the hydraulic systems of turbine engines (O tselesoobraznosti primeneniia titanovykh truboprovodov v gidravlicheskikh sistemakh gazoturbinnykh dvigatelei).** L. A. Vanetsov and A. F. Zhirnov. *Problemy Prochnosti*, vol. 5, Nov. 1973, p. 85, 86. In Russian.

A74-18097 **Vortex cases - At a turbulent crossroads.** P. Silverman (Speiser, Krause and Madole, Washington, D.C.). *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 325-342. 74 refs.

Discussion of some of the legal aspects of the problem of wake turbulence, a phenomenon to which a substantial number of air crashes has been attributed in recent years. The duty of air traffic controllers to warn of possible wake turbulence and the nature of this warning are examined. A number of court cases is reviewed to show how the courts look at wake turbulence, and some controversial cases are analyzed. During 1968-1970, more than $3,000,000 have been paid by the United States Government in indemnities where air traffic controllers were judged to have been negligent in helping prevent air crashes that had been caused by wake turbulence. It is felt that wake turbulence accidents cannot be expected to cease to happen, but the trend against the Government may ease sufficiently to permit a greater sharing of responsibility by pilots, the flying schools, and air taxi operators that employ them. M.V.E.

A74-18098 **Government responsibility for damages in airplane crash cases when weather is a factor.** J. D. Jamail. *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 343-351. 23 refs.

The legal problems are considered that arise when an airplane crashes because of inadequate weather information. The analysis includes a discussion of the waiver of sovereign immunity in the Federal Torts Claim Act and the exceptions to that waiver, as well as the duties of government employees and the preparation for trial of weather-related cases. M.V.E.

A74-18099 **An innovative approach to airport planning.** H. L. Newman (FAA, Fort Worth, Tex.). *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 353-359.

The spirit of foresight and cooperation is described that made the realization of the mammoth Dallas-Fort Worth Airport Project possible. The airport was officially dedicated in September 1973. The main considerations that went into the planning of this airport and the experiences of the people who worked on this project are reviewed. M.V.E.

A74-18100 **Skyjacking and airport security.** R. S. Maurer (Delta Air Lines, Inc., Atlanta, Ga.). *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 361-380. 26 refs.

The various factors are examined that are believed to have brought about the noticeable decline of airplane hijackings in recent years. The methods developed by airlines and the federal government for meeting the hijacking problem are reviewed, and the constitutional and practical consequences of these methods are discussed. M.V.E.

A74-18101 **The aftermath of a hijacking - Passenger claims and insurance.** G. N. Tompkins, Jr. (Notre Dame, University, Notre Dame, Ind.). *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 381-398. 69 refs.

A74-18139 # **Decoupling of a class of nonlinear systems and its application to an aircraft control problem.** S. J. Asseo (Calspan Corp., Buffalo, N.Y.). *Journal of Aircraft*, vol. 10, Dec. 1973, p. 739-747. 11 refs. Contract No. F33615-70-C-1647.

The necessary and sufficient condition for decoupling a nonlinear system with state feedback is obtained. It is shown that when this condition is satisfied there exists a control law which makes each output variable of the dynamical system independently controllable with a separate input. The theory is then applied to an aircraft control problem where the implication of the theoretical results is discussed. The objective of the aircraft control problem is to decouple the vertical and the horizontal path angles of the flight trajectory relative to earth-fixed axes. The aircraft equations are simplified by postulating a rudder control law which maintains zero sideslip velocity in flight. The control laws for the elevator and aileron which decouple the simplified aircraft model are obtained. The control system is then evaluated in a simulation study to show that it indeed decouples the flight path angles. (Author)

A74-18140 * # **An unsteady wake model for a hingeless rotor.** S. T. Crews, K. H. Hohenemser (Washington University, St. Louis, Mo.), and R. A. Ormiston (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *Journal of Aircraft*, vol. 10, Dec. 1973, p. 758-760. 7 refs. Contract No. NAS2-4151.

A simple nonsteady wake model derived from the unsteady moment of the momentum equation for zero advance ratio is correlated with cyclic pitch frequency response tests conducted with a small hingeless rotor model. Two and three or more bladed rotor analyses are presented. M.V.E.

A74-18141 # **Dynamics of slung bodies utilizing a rotating wheel for stability.** E. C. Micale and C. Poli (Massachusetts, University, Amherst, Mass.). *Journal of Aircraft*, vol. 10, Dec. 1973, p. 760-763. 8 refs. Army-supported research.

Investigation of the use of a reaction wheel to aid in the stabilization of slung bodies during airborne load towing. Both the longitudinal and lateral degrees of freedom are considered. While not completely satisfactory, the addition of a reaction wheel is found to have a very favorable effect on lateral stability. M.V.E.

A74-18142 # **On the fuel optimality of cruise.** J. L. Speyer. *Journal of Aircraft*, vol. 10, Dec. 1973, p. 763-765. 8 refs.

For the minimum fuel-fixed range with time either free or specified, the cruise condition based upon Schultz and Zagalsky's (1972) model of aircraft dynamics is shown not to be a minimizing singular arc by application of the generalized Legendre-Clebsch condition for vector control. This is seen to be consistent with the results for the energy-state approximation for which intermediate values of thrust are not minimizing. M.V.E.

A74-18143 # **Inviscid wake-airfoil interaction on multielement high lift systems.** A. Moser and C. A. Shollenberger (McDonnell Douglas Research Laboratories, St. Louis, Mo.). *Journal of Aircraft*, vol. 10, Dec. 1973, p. 765-767. 5 refs.

A linearized method is presented for estimating the inviscid wake effect on the flap surface pressure or lift when, in a multielement airfoil system, a wake shed by the main airfoil flows over the flap elements. An explanation of the effect is attempted, and the method application results are compared with 'exact' numerical calculations using a recently developed singularity method. M.V.E.

A74-18176 **Fixed wing aircraft (Starrflügelflugzeuge).** R. Riccius (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1441-1445. 31 refs. In German.

New developments in the field of subsonic aircraft are considered, giving attention to the VFW614, the airbus A300B, the B747SP, the B747SR, and STOL aircraft. Changes in the design of the supersonic TU144 are briefly reported along with questions concerning the operational status of the Concorde. It is pointed out that in the area of general aviation aircraft for business trips become more and more similar to the large airliners as far as performance and the convenience of traveling is concerned. Advances in the field of military aircraft are also reviewed. G.R.

A74-18177 **Rotary-wing aircraft (Drehflügel-Flugzeuge).** G. Reichert (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn; Darmstadt, Technische Hochschule, Darmstadt, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1446-1448. 48 refs. In German.

A heavy lift helicopter which is capable to carry a payload of about 25 metric tons is being developed. New technologies of rotor design are discussed together with advances in bearing construction, the military utility tactical transport aircraft system program, the advanced attack helicopter, and the light observation helicopter. A number of research programs are concerned with the development of novel rotor systems. G.R.

A74-18178 **Vertical take-off and landing aircraft (Vertikal startende und landende Flugzeuge).** S. Harmsen (Berlin, Technische Universität, Berlin, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1449-1451. 20 refs. In German.

Studies were conducted concerning the suitability of an employment of VTOL aircraft for solving transportation problems in West Germany, giving attention to the operation of helicopters which utilize different types of propulsion systems. Questions of the experimental testing of helicopter designs are considered together with problems of flight simulation, the noise produced by the propulsion system, operational aspects, aerodynamics, and recirculation effects. G.R.

A74-18179 **Propulsion system installations (Triebwerksanlagen).** O. Lutz (Braunschweig, Technische Universität, Braunschweig, West Germany) and W. Alvermann (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Antriebssysteme, Braunschweig, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1451-1456. 41 refs. In German.

The state of development of propulsion systems is examined, giving attention to the number of units needed, studies conducted to improve subsonic aircraft characteristics, advances concerning STOL aircraft, supersonic aircraft, and engines for the propulsion of large aircraft carrying 700 passengers. Possibilities for reducing the noise in the case of jet engines are considered together with approaches for noise attenuation in the area of the piston engines of general aviation, and ways to increase the thrust during take-off. New methods for increasing the performance of jet turbines are also discussed, taking into account subsonic and supersonic aircraft. G.R.

A74-18180 Aviation fuels and lubricants (Flugkraftstoffe und Flugschmierstoffe). G. Spengler (München, Technische Universität; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe; Landesgewerbeanstalt, Bayern, Prüfamt für Brenn-, Kraft- und Schmierstoffe, Munich, West Germany), E. Jantzen, and J. Kern (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe, Munich, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1457-1459. 52 refs. In German.

It is pointed out that in the case of the fuel required for supersonic aircraft the lubricating properties of the fuel itself are insufficient. The needed lubricating characteristics of the fuel have, therefore, to be provided by suitable additives. Approaches for reducing the air pollution produced by aircraft are discussed together with developments regarding fuels for missiles operating at conventional and hypersonic velocities. The use of dry lubricating agents, such as molybdenum disulfide, is considered in connection with a discussion of aviation lubricants. G.R.

A74-18181 Flight control (Flugregelung). F. Leiss, G. Schweizer, and H. Seefmann (Dornier-System GmbH, Friedrichshafen, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1459-1461. 37 refs. In German.

The employment of computers for the guidance and control of aerospace vehicles is considered. It is pointed out that the design of efficient programming languages is a crucial factor for an economic control system. Stabilization and flight control systems are discussed together with questions regarding the instrumentation needed and details concerning the navigation systems required. G.R.

A74-18182 Air traffic control (Flugsicherung). O. Heer (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1462-1465. 18 refs. In German.

For the last two years studies concerned with the air traffic control system of the future have been conducted in West Germany, giving attention to the time after 1980. Questions of long-term planning are discussed together with new developments in the sector of air traffic control and the improvement of existing procedures and installations. Problems of frequency distribution are considered along with traffic flow questions, navigational systems, instrumental landing systems, radio equipment, and radar installations. G.R.

A74-18190 Structural materials of aeronautics and astronautics (Strukturwerkstoffe der Luft- und Raumfahrt). E. Loechelt (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *VDI-Z*, vol. 115, no. 18, Dec. 1973, p. 1495-1498. 46 refs. In German.

Components made of steel are used in an aircraft whenever the material is subjected to high stress concentrations. Under certain conditions savings in weight can be obtained by replacing the steel alloys with titanium alloys. Suitable steel and titanium alloys are discussed, giving attention also to new developments in the areas of powder metallurgy, titanium precision forgings, and titanium castings. New advances in the fields of aluminum alloys are considered together with magnesium alloys, fiber-reinforced composite materials, and the state of development of beryllium technology. G.R.

A74-18261 The German law for protection against the noise of aircraft (La loi allemande pour la protection contre le bruit des aéronefs). R. Goy (Rouen, Université, Rouen, France). *Revue Générale de l'Air et de l'Espace*, vol. 36, no. 3, 1973, p. 267-282. In French.

The law for protection against aircraft noise was one of the first dealing with the subject, and is exemplary for the conditions of its adoption and for its content, because it attacked the problems and defined solutions in a way very rich in information for other countries. The law originated in various discussions, and was further developed in parliamentary debates. The debates dealt with passive and active protection against noise. The text of the law is given in an appendix. F.R.L.

A74-18271 # Control of an elastic aircraft (Ob upravlenii uprugim samoletom). T. P. Grigor'eva. *Avtomatika i Telemekhanika*, Nov. 1973, p. 5-10. 5 refs. In Russian.

Study of large-dimension systems, and development of a method for synthesizing a control law based on the combined measurement of the coordinates of both aircraft motion and elastic airframe oscillations. A numerical example is presented for illustrating the method. M.V.E.

A74-18288 # Experimental study of the internal noise in injector driven wind tunnels (Etude expérimentale du bruit interne dans les souffleries a induction). V. Schmitt (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Supersonic Tunnel Association, Meeting, 40th, Bedford, England, Sept. 24-26, 1973.) La Recherche Aérospatiale*, Nov.-Dec. 1973, p. 321-324. In French. (Translation).

The strong emission of acoustic perturbations by the supersonic injector, as the driving element of an injector-driven wind tunnel, required basic studies concerning its positioning in the circuit, its design and its mode of operation, so as not to jeopardize the quality of the flow and, consequently, the validity of the tests. The solutions put forward at the present stage of studies are presented, based on the experience acquired in a pilot wind tunnel which offers the possibility of a detailed study of the injector as regards its performance and the flow quality. A number of particulars emerge from the initial results concerning the internal noise of this wind tunnel. (Author)

A74-18289 # Numerical investigation of vortex sheets issuing from a separation line near the leading edge (Etude numérique de nappes tourbillonnaires issue d'une ligne de décollement près du bord d'attaque). C. Rehbach (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(EUROMECH, Colloque sur les Tourbillons Concentrés, 41st, Norwich, England, Sept. 18-21, 1973.) La Recherche Aérospatiale*, Nov.-Dec. 1973, p. 325-330. 15 refs. In French. (Translation).

Observation shows that, even for small incidences, the flow around slender delta wings separates along a line near the leading edge, forming a vortex sheet which rolls up into a pair of spiral vortices. A theoretical treatment of this problem is possible for this simple form of wing and has been carried out within the limits of such approximations as slender-body theory and/or conical flow. However, the phenomenon of building up of vortex sheets on the leading edge of lifting surfaces is encountered for more general geometric configurations for which an analytic treatment is out of the question. For these configurations, an iterative calculation method is proposed which is based on the substitution of the vortex sheet representing the wing and its trailing sheet by a network of concentrated line vortices. All though the proposed method might be used for wings of arbitrary shape, the results presented are limited to

those of plane delta wings. They are compared with results obtained by purely analytic methods, and with experiments performed in a water tunnel. (Author)

A74-18291 # Calculation of the dynamic characteristics of a helicopter structure by the method of branch modes (Calcul des caractéristiques dynamiques d'une structure d'hélicoptère par la méthode des modes partiels). C. T. Tran, R. Dat (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), and W. Twomey. *La Recherche Aérospatiale,* Nov.-Dec. 1973, p. 337-354. 5 refs. In French. Research supported by the Société Nationale Industrielle Aérospatiale.

A74-18296 Automatic flight controls in fixed wing aircraft - The first 100 years. R. W. Howard (Marconi-Elliott Avionic Systems, Ltd., Rochester, Kent, England). *Aeronautical Journal,* vol. 77, Nov. 1973, p. 533-562. 58 refs.

The evolution of the systems involved in automatic flight controls is reviewed, concentrating mainly on the period from the beginning up to the end of World War II. Early history is first reviewed, followed by discussion of developments after Kitty Hawk. The concept of design for high stability with limited controllability had been shown to be undesirable. The work carried out during the first world war, the 1920s, and the 1930s is examined. British, American, and German studies carried out in World War II are treated. The first post-war civil and military aircraft were fitted with equipments which were limited developments of wartime devices, and particulars of developments are given. The post-war autopilot is described, and attention is given to analog simulation, the solid state era, high pressure hydraulic systems, automatic landing, redundancy, microcircuits, and digital computing. Brief particulars of the Concorde automatic flight control system are given. F.R.L.

A74-18297 Random vibration with non-linear damping. C. L. Kirk (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal,* vol. 77, Nov. 1973, p. 563-569. 6 refs.

The random vibration of linearly elastic, lumped-mass systems containing nonlinear damping to ideal stationary Gaussian white noise excitation is studied. It is shown experimentally that the hysteretic restoring force in a built-up beam reduces the rms acceleration by a maximum of about 13% for q = 12.5 lbf/in. For lower or higher values of q the response is essentially the same as that of the solid beam. The effect of nonlinearity is to produce a non-Gaussian response similar to that obtained with (velocity)2 damping. The experiments confirm qualitatively the rms response characteristics predicted theoretically by Caughey (1960). F.R.L.

A74-18299 Helicopter modelling /18th Henson and Stringfellow Lecture/. R. A. Ormiston (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *Aeronautical Journal,* vol. 77, Nov. 1973, p. 579-591. 23 refs.

Helicopter models provide a comparatively simple, inexpensive, and safe alternative to full scale flight testing. They are also invaluable for studying problems that are too complex for mathematical analysis and for exploring flight conditions that may be especially hazardous. The inherent versatility of small-scale helicopter models stems mainly from the capability for testing special configurations and making trial and error modifications that would be impossible or impractical with large scale models or flight test aircraft. Three general categories of helicopter modeling are discussed. These are exploratory models, which are used for investigating radically new concepts or ideas; development models, which are used in direct support of the design and development of new helicopters; and research models, which are necessary to advance the fundamental knowledge on which helicopter technology is based. F.R.L.

A74-18596 The Eole balloons and air safety (Les ballons Eole et la sécurité aérienne). J. Muller (Centre National d'Etudes Spatiales, Brétigny-sur-Orge, Essonne, France). *L'Aéronautique et l'Astronautique,* no. 42, 1973, p. 3-14. In French.

The 500 balloons of the Eole space program have fulfilled their meteorological mission. They flew at a constant altitude of 36,000 feet in the Southern Hemisphere during several months. This flight altitude is also that of long distance jetliners and an eventual collision was possible. During four years, the CNES undertook a technical program, in order to study and fabricate balloon payloads, non-hazardous to air traffic. The tests were conducted on the two very sensitive areas of a plane; the windshield of the cockpit and the jet engines. By simulating collisions in the ground facilities, guide lines were clearly defined for manufacturing components and complete tests were performed on the flight models to be certain that the payload was not dangerous for the aircrafts. (Author)

A74-18597 Theory and practice of avionics reliability (Théorie et pratique de la fiabilité des équipements). M. M. Ravier (Compagnie Nationale Air France, Paris, France). *L'Aéronautique et l'Astronautique,* no. 42, 1973, p. 18-24. In French.

Some of the theoretical and practical aspects of the maintenance and reliability of avionics systems are reviewed. Discussed topics include the actuarial approach to failure expectancy as a function of age, acceptable reliability criteria, service life extension and reliability, maintenance routines, and manufacturer-airline liaison. M.V.E.

A74-18598 Importance of the means of engine condition surveillance (Importance des moyens de surveillance d'état des moteurs). M. F. Fry (Compagnie Nationale Air France, Paris, France). *L'Aéronautique et l'Astronautique,* no. 42, 1973, p. 25-32. In French.

Review of the nature and efficiency of the various techniques used for keeping the condition of aircraft engines under proper surveillance, and assessment of the relative costs of these techniques. The techniques considered include performance monitoring, inspection by boroscope, detection by Foucault currents, gamma-ray inspection, and spectroscopic and physico-chemical analyses of the oil used in the lubrication of the engines. M.V.E.

A74-18599 Aircraft and systems reliability (Fiabilité avion et systèmes). M. R. Cypkin (Compagnie Nationale Air France, Paris, France). *L'Aéronautique et l'Astronautique,* no. 42, 1973, p. 33-37. In French.

The application of individual systems reliability analysis and enhancement techniques to the very elaborate overall systems complex that modern aircraft represent is discussed. Special attention is given to aircraft overhaul and maintenance routines and the interrelation of various reliability criteria. M.V.E.

A74-18603 Supersonic compressor test facility (Banc d'essai de compresseur supersonique). F. Charron, G. Janssens, and J. Paulon. *L'Aéronautique et l'Astronautique,* no. 42, 1973, p. 79-88. 11 refs. In French.

Description of a 1500-kW supersonic compressor test facility. This bench of closed-circuit type, uses freon 114 as the active gas, and operates at subatmospheric pressure. The related control and monitoring circuits of this facility are thus rather complex. The aerodynamic study of the compressor includes, as well as overall measurements, detailed explorations of the flow in various locations, as shown in a few examples. (Author)

A74-18632 # A method of calculating the flow around a wing of arbitrary planform, positioned on a cylindrical body (Metod rascheta obtekaniia kryla proizvol'noi formy v plane, raspolozhennogo na tsilindricheskom tele). V. A. Graivoronskii and M. A. Koval'. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 31, 1973, p. 3-10. In Russian.

Analysis of the nonseparated steady flow of a perfect fluid around a low-aspect-ratio wing on a relatively long cylindrical body. The wing is modeled by a previously proposed vortex system that can be used in flow calculations for a wide range of angles of attack. The cylinder is modeled with a system obtained by mapping segments of free wing vortices. T.M.

A74-18635 # **Evaluation of the influence of errors in specifying boundary conditions on the accuracy of the determination of temperature fields in infinite cylinders (Otsenka vliianiia pogreshnostei pri zadanii granichnykh uslovii na tochnost' opredeleniia temperaturnykh polei beskonechnykh tsilindrov).** E. E. Prokhach. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 31, 1973, p. 19-25. In Russian.

A74-18638 # **Evaluation of the operations contained in algorithms carried out by digital controller computers (Otsenka sostava operatsii algoritmov realizuemykh na tsifrovykh upravliaiushchikh mashinakh).** V. A. Popov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 31, 1973, p. 34-39. In Russian.

A74-18641 # **Some current problems and prospects for development of rotary-wing aircraft (Nekotorye voprosy sostoianiia i perspektiv razvitiia legkikh vintokrylykh letatel'nykh apparatov).** B. I. Mysov and V. N. Revinov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 31, 1973, p. 47-52. In Russian.

A74-18642 # **Analytical design of optimal monolithic panels (Analiticheskoe proektirovanie optimal'nykh monolitnykh panelei).** F. G. Iasinskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 31, 1973, p. 52-61. 7 refs. In Russian.

Description of an approximate analytical method of calculating the geometrical parameters of optimal monolithic panels subject to compressive loads at normal and elevated temperatures. Geometrical dimensions are expressed analytically in terms of load levels, mechanical properties of the panel material, and size ratios. The fact that no auxiliary graphs are required permits the use of the method as a computer aided design procedure. T.M.

A74-18645 # **An algorithm for rational selection of the parameters of nonlinearly deforming thin-walled framework elements (Ob odnom algoritme ratsional'nogo vybora parametrov nelineino deformiruemukh tonkostennykh karkasirovannykh sterzhnei).** V. M. Riabchenko, V. G. Toporov, and V. E. Lukhanin. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 31, 1973, p. 77-85. 8 refs. In Russian.

A74-18648 # **Experimental study of metal-plastic couplings in tension (Eksperimental'noe issledovanie metalloplastikovykh sochlenenii pri rastiazhenii).** V. E. Gaidachuk, A. F. Pil'nik, and I. N. Tsybul'nik. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 31, 1973, p. 100-105. In Russian.

A74-18654 # **The new Advanced Airborne Command Post.** D. E. Graves (Boeing Aerospace Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-240.* 7 p. Members, $1.50; nonmembers, $2.00.

The need, functional and physical descriptions, and equipment configuration for the new Advanced Airborne Command Post (AABNCP) are presented. Based on the commercial Boeing 747 airplane and equipped with modern command, control, and communications equipment that will assure real-time, survivable, strategic force management, the AABNCP can provide the Commander-in-Chief with real-time information regarding the availability of strategic force assets during battle to assure full utilization of surviving retaliatory weapons. M.V.E.

A74-18655 # **Airborne warning and control system /AWACS/.** R. G. Cross, Jr. (USAF, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-241.* 5 p. Members, $1.50; nonmembers, $2.00.

The E-3A AWACS, Airborne Warning and Control System, is being developed by the United States Air Force to furnish an improved capability for management of air operations during future potential crises. The most distinguishing feature of AWACS is its advanced surveillance radar, which is integrated with suitable control and computational equipment on a rapidly deployable jet platform. Operating from a general purpose aircraft pool, AWACS will constitute a national resource to furnish necessary support for world-wide tactical or strategic defensive contingencies, enhancing deterrence and increasing effectiveness of our military forces. (Author)

A74-18664 # **Structural analysis of light aircraft using NASTRAN.** C. Eaton and A. Dobbins (Louisiana Tech University, Ruston, La.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-257.* 3 p. Members, $1.50; nonmembers, $2.00.

A three-dimensional structural analysis was performed on the Baby Ace aircraft using the general structural program called NASTRAN. The model consisted of 195 grid points and 352 beam members. The load distribution arising from aerodynamic forces was applied consistent with Federal Aviation Administration Utility Category guidelines of 4.4 g loading. Two loading cases of a high and low angle of attack were investigated. An inertial relief method was used which consistently distributed inertial loads throughout the aircraft in proportion to the mass distribution. The masses of both structural and nonstructural components were included. It is concluded that the cost of the analysis is prohibitive for most homebuilt designs. (Author)

A74-18665 # **A sailplane wing constructed of foam core and polyester fiberglass skin.** R. D. Kriz. *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-258.* 6 p. 5 refs. Members, $1.50; nonmembers, $2.00.

The results from a stress analysis of a thin skin, foam core, high aspect ratio wing indicate a possible method of constructing sailplane wings. The analysis includes an approximation of the maximum core and skin shear stress, a computer program to evaluate the stress distribution and displacements of a thin-walled unsymmetrical tapered cylinder and the accountability of creep. (Author)

A74-18666 # **Wind tunnel dynamic analysis of an oscillating airfoil.** R. J. Silcox and W. J. Szwarc (Notre Dame, University, Notre Dame, Ind.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-259.* 10 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Flow visualization of the stream field of an oscillating airfoil in linear flow is presented. The sequence of events leading up to and through dynamic stall of NACA airfoil 0012 is demonstrated. Emphasis is placed on the laminar separation and subsequent reattachment of the flow over the leading edge bubble and the resulting vortex shed from the leading edge. The delay of stall in the dynamic model is shown and discussed. Possible physical models are presented and compared with experimental results. (Author)

A74-18669 # **Future air traffic control - Ground, cockpit, or space.** D. R. Israel (FAA, Office of Systems Engineering Management, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-262.* 5 p. Members, $1.50; nonmembers, $2.00.

The possibilities for transferring existing functions of our largely ground-based air traffic control system to aircraft cockpits or to space platforms are considered against an anticipated doubling of traffic activity every 10-15 years and major growth in the general aviation category of flying. The transfer of functions to the cockpit does not promise to produce economy or efficiency, and hence will be limited. Early use of aeronautical satellite relays for voice communications and surveillance is planned for oceanic air traffic control. The cost of avionics is the major deterrent to the use of satellites for any traffic control purposes over the United States. (Author)

A74-18674 # **Influence of boundary layer blowing on the low-speed aerodynamic performance of a 45 degree swept-wing airplane.** J. D. Sorenson (USAF, Hill AFB, Utah). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-269.* 13 p. 18 refs. Members, $1.50; nonmembers, $2.00.

This paper presents the results of a research and flight test evaluation of a 45 degree swept-wing jet airplane with and without blowing boundary layer control (BLC) being applied to the upper surface of the wing airfoil. The test vehicle used during this study was an F-4 jet airplane which employs a leading and trailing edge blowing-type BLC system. Data presented in this paper demonstrate that a significant improvement in the landing performance characteristics of a high speed swept-wing airplane can be obtained by injecting a high velocity air mass (blowing) into the primary layer airstream. Results obtained during this study show that the approach speed, sink rate, landing speed, and landing roll distance of a particular airplane are significantly improved when a blowing-type boundary layer control system is designed into the airplane. (Author)

A74-18675 * # **A direct method for calculating flutter speeds.** D. P. Beres (Ohio State University, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-27.* 8 p. Members, $1.50; nonmembers, $2.00. Grant No. NGL-36-008-109.

The basic objective of this work is to provide a direct and simple means for calculating classical flutter. The analysis makes no use of free vibration modes, although the method is readily adaptable to a modal type approach. Only subsonic aerodynamics are considered; however, the method applies to any speed regime. The problems of following modes and modal coupling are completely avoided. The simplicity and accuracy of the direct solution is stressed. The analysis is applicable to both straight and swept wings although only straight wings, uniform as well as nonuniform, are presented. (Author)

A74-18681 # **Calculation of the aerodynamic characteristics of a wing system moving at subsonic speed near land or smooth water surface (Raschet aerodinamicheskikh kharakteristik sistemy kryl'ev, dvizhushcheisia s dozvukovoi skorost'iu vblizi zemli ili gladkoi vodnoi poverkhnosti).** S. D. Ermolenko and V. G. Khrapovitskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 32, 1973, p. 3-15. 6 refs. In Russian.

A74-18682 # **Some specific characteristics of small gas turbines and the modeling problems of their wind tunnel testing (Nekotovye osobennosti malogabaritnykh gazovykh turbin i voprosy modelirovaniia pri produvkakh ikh vozdukhom).** V. V. Il'inskii and E. A. Skvorchevskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 32, 1973, p. 16-19. In Russian.

A74-18684 # **Heat transfer investigation in a high-temperature gas flow spreading over a plane surface (K issledovaniiu teploobmena pri natekanii vysokotemperaturnogo gazovogo potoka na ploskuiu poverkhnost).** I. P. Goldaev, V. Iu. Latka, A. P. Pershin, and V. P. Sabadash. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 32, 1973, p. 23-25. In Russian.

A74-18686 # **A film thermocouple with a platinum electrode for thermometry of gas turbine engine blades (Plenochnaia termopara s platinovym termoelektrodom dlia termometrii rabochikh lopatok gazoturbinnykh dvigatelei).** A. Ia. Anikin, L. S. Grigor'ev, and D. F. Simbirskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 32, 1973, p. 31-36. 7 refs. In Russian.

A74-18694 # **Determination of the basic parameters of light helicopters on the basis of the treatment and analysis of statistical data (Opredelenie osnovnykh parametrov legkikh vertoletov na osnovanii obrabotki i analiza statisticheskikh materialov).** V. N. Revinov and B. I. Mysov. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 32, 1973, p. 80-86. In Russian.

Development of a method of carrying out a preliminary choice of parameters pertaining to very light helicopters with flight weights up to 900 kg. A method of determining the basic flight-engineering characteristics of a light helicopter is proposed which is based on a scheme of mutual correlation of parameters involving the use of functional dependences of the various parameters on the flight weight and the power plant capacity. The mutual correlation scheme is constructed in such a way that a given parameter depends on several variables, thus eliminating any randomness in determining the final result, which is expressed as the arithmetic mean of several determination variants. A.B.K.

A74-18697 # **Experimental investigation of glass-plastic and metal-plastic joints under shear (Eksperimental'noe issledovanie stekloplastikovykh i metalloplastikovykh soedinenii pri sdvige).** V. E. Gaidachuk, A. F. Pil'nik, and I. N. Tsybul'nik. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 32, 1973, p. 102-107. In Russian.

A74-18722 # **Noise from nonuniform turbulent flows.** C. H. Berman (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-2.* 11 p. 26 refs. Members, $1.50; nonmembers, $2.00.

The effects of a nonuniform mean flow on turbulence noise generation and propagation are treated analytically. A special form of an equation studied by Lilley is applied to a parallel flow model possessing arbitrary mean velocity and temperature profiles. Solutions of the resultant ordinary differential equation show that inviscid attenuation of sound occurs at very high frequencies, while a boost in sound level is present at very low frequencies. A new interpretation of shear and self noise generation terms is presented. The applicability of these results to jet noise prediction is discussed. (Author)

A74-18723 # **Jet noise modeling - Experimental study and models for the noise and turbulence fields.** L. F. Moon and S. W. Zelazny (Bell Aerospace Co., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-3.* 11 p. 33 refs. Members, $1.50; nonmembers, $2.00. Research sponsored by the Bell Aerospace Co.; Contract No. F44620-70-C-0116.

Detailed turbulence profiles were measured at 28 axial locations extending from the nozzle exit to twelve nozzle diameters downstream for a circular jet exhausting into an ambient environment. Measurements include mean velocity, turbulence intensity, shear stress as well as sound intensity, spectral distribution and directivity. A noise model was developed which accurately predict sound amplitude, spectral distribution and directivity pattern in terms of

self and shear noise components. A turbulence model was also developed which accurately predicted mean velocity, turbulence intensity, and shear stress in subsonic and supersonic axisymmetric jets with predictions starting in the potential core. Turbulence and noise models were computationally coupled and the sensitivity of noise predictions to inaccuracies in the predicted turbulence field studied. It is shown that errors of only 20% in predicted peak turbulence intensity level in the core region results in up to a 5-db difference in the predicted overall sound pressure level. (Author)

A74-18732 # **Erosion prediction in turbomachinery due to environmental solid particles.** G. Grant (Northrop Corp., Beverly Hills, Calif.) and W. Tabakoff (Cincinnati, University, Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-16.* 17 p. 14 refs. Members, $1.50; nonmembers, $2.00. Grant No. DA-ARO(D)-124-G154.

The erosion resulting from solid particles injested into rotating machinery is predicted using a Monte Carlo simulation of the physical process. This simulation takes into account the aerodynamic drag on the contaminant particles, the rebound dynamics of the particles impacting the solid blades or channel walls and the material removal process. The computerized model is used to predict the quantity of material removed from the stationary and rotating blades of a turbomachine as well as the location of the erosion of the blades. This model is verified by testing a specially designed one and one-half stage compressor and measuring the erosion. (Author)

A74-18736 # **Two numerical methods to solve realistic air-to-air combat differential games.** A. L. Leatham (U.S. Air Force Academy, Colorado Springs, Colo.) and U. H. D. Linch (USAF, Space and Missile Systems Organization, Los Angeles Air Force Station, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-22.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A first-order gradient algorithm and a neighboring optimal algorithm are developed to solve the two-point boundary value problem associated with air-to-air combat differential games. Aerodynamic, structural, and engine constraints are properly incorporated into the mathematical description of the systems. To incorporate the constraints, angle of attack is used as the lift control below the corner speed and load factor is used above the corner speed. This artifice allows the use of constant-constraint boundaries which greatly simplify the problem formulation. Two numerical examples are solved to demonstrate the algorithms - a missile vs aircraft and an aircraft vs aircraft problem. Both algorithms are shown to be effective; however, the neighboring optimal method is limited to problems with no singular surfaces. (Author)

A74-18737 # **Differential-turning optimality criteria.** H. J. Kelley (Analytical Mechanics Associates, Inc., Jericho, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-23.* 6 p. 8 refs. Members, $1.50; nonmembers, $2.00. Contract No. N00014-73-C-0328.

Circling encounters between aircraft modelled in energy approximation are studied in a differential game setting. Capture is defined in terms of turn-angle and a derived altitude-match requirement. Two optimality criteria are obtained; one a necessary condition for capture of an optimally evading opponent in a prolonged turning chase, the second a sufficient condition guaranteeing capture. Since there is not an unduly large gap between these conditions, they appear of interest as design criteria providing measures of overall turn-performance superiority of one aircraft design over another. (Author)

A74-18738 # **Application of damage tolerance technology to advanced metallic fighter wing structure.** L. L. Jeans and R. L. La Rose (Northrop Corp., Aircraft Div., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-29.* 10 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-72-C-1891. AF Project 486U.

Current Air Force damage tolerant criteria requirements were developed to ensure that proper emphasis is given in new aircraft structural systems to flaw initiated failure analysis. In this study damage tolerant criteria were analytically investigated in an indepth preliminary design environment on wing components representative of metallic materials and design concepts applicable to future fighter aircraft. Direct comparisons with static and fatigue strength considerations were made. Crack growth analysis was completed for the most critical structure using the Willenborg retardation model and appropriate material crack growth rate and toughness data. (Author)

A74-18745 * # **Vortex age as a wake turbulence scaling parameter.** J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.) and J. R. Marshall (U.S. Naval Weapons Laboratory, China Lake, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-36.* 8 p. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-10646-15.

Tests were conducted in the Virginia Tech Stability Wind Tunnel to determine the significance of vortex age as a scaling parameter in wake turbulence development and dissipation. Vortex structure was measured over a range of three angles of attack, three free-stream speeds, and seven downstream positions from 2 to 30 chordlengths using an NACA 0012 wing and a five hole yawhead probe. The resulting data indicates that vortex age is not a self-sufficient scaling parameter but a free-stream velocity influence also exists at higher angles of attack which cannot be explained in terms of Re or M. (Author)

A74-18747 # **A method of calculating aircraft wake velocity profiles and comparison with full-scale experimental measurements.** C. Donaldson, R. D. Sullivan (Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.), and R. S. Snedeker. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-39.* 12 p. 14 refs. Members, $1.50; nonmembers, $2.00. Research sponsored by the U.S. Department of Transportation, U.S. Air Force, and FAA.

A method is developed for the calculation of the initial inviscid form of rolled-up wake vortices behind a wing having arbitrary lift distribution. The method makes use of the Betz assumptions of conservation of wake vorticity and moments of vorticity. It is found that a simple relationship exists between the radial distribution of vorticity in the rolled-up wake and the spanwise lift distribution. Computed tangential velocity profiles for DC-7, DC-9, and C-141 aircraft are shown to compare favorably with profiles measured by the FAA during tower flyby tests of these aircraft in both flapped and unflapped configurations. (Author)

A74-18749 * # **Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions.** J. D. Holdeman (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-41.* 7 p. 5 refs. Members, $1.50; nonmembers, $2.00.

A method is presented for estimating the dispersion and dilution of jet aircraft exhaust from aircraft passage through times on the order of weeks thereafter. In the near wake of the aircraft, the solution is that for round turbulent jets in a parallel flow. More rapid dispersion due to atmospheric effects begins when the scale-dependent eddy viscosity becomes larger than the turbulent jet eddy viscosity. In the far wake region, the solution approaches that for scale-dependent dispersion from a point source moving with the aircraft. Calculations are presented for supersonic aircraft at high-altitude flight conditions. (Author)

A74-18764 # **Integral equation method for calculation of subsonic flow past airfoils in a ventilated wind tunnel - Comparison with NAE high Reynolds number measurements.** M. Mokry (National Aeronautical Establishment, Ottawa, Canada). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-83.* 16 p. 29 refs. Members, $1.50; nonmembers, $2.00.

A74-18765 * # **Nonlinear aerodynamics of aircraft in high-angle-of-attack maneuvers.** M. Tobak and L. B. Schiff (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-85.* 11 p. 12 refs. Members, $1.50; nonmembers, $2.00.

A nonlinear aerodynamic moment system is formulated for arbitary motions of aircraft at high angles of attack. The total moment is shown to be compounded of the contributions from three simple motions. The basic motion is coning, where the nose of the aircraft describes a circle around the velocity vector, while the remaining motions are oscillatory perturbations carried out in the presence of coning. A re-examination of the assumptions underlying the formulation enables a characterization of aerodynamic phenomena whose effects can and cannot be treated within the scope of the formulation. Recommendations are made as to the most appropriate types of wind-tunnel tests that could be undertaken in fulfillment of the formulation's requirements. (Author)

A74-18768 * # **Sonic inlet noise attenuation and performance with a J-85 turbojet engine as a noise source.** H. W. Groth (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-91.* 10 p. Members, $1.50; nonmembers, $2.00.

A74-18776 # **Aerodynamic forces and moments on a slender body with a jet plume for angles of attack up to 180 degrees.** E. L. Fleeman and R. C. Nelson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-110.* 16 p. 25 refs. Members, $1.50; nonmembers, $2.00.

A74-18789 * # **On repetitive flutter calculations in structural design.** R. T. Haftka and E. C. Yates, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-141.* 12 p. 25 refs. Members, $1.50; nonmembers, $2.00.

The use of continually updated natural modes, called changing modes, is discussed together with the employment of fixed modes in the design process. 'No-derivatives' methods are considered. The flutter solution process is separated into parts which are mode dependent and parts which are mode independent. On the basis of this separation an attempt is made to identify the type of design problems which are suitable for the use of changing modes, and the type of problems which are more suitable for fixed modes. The use of derivative methods is also examined. G.R.

A74-18797 * # **The jet engine design that can drastically reduce oxides of nitrogen.** A. Ferri and A. Agnone (New York University, Bronx, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-160.* 10 p. Members, $1.50; nonmembers, $2.00. Grant No. NGR-33-016-131.

The problem is analyzed for the case of hydrogen fuel, taking into account supersonic and hypersonic vehicles using scramjet engines. The combustion in scramjets occurs at very high velocity and in a short time. In scramjet combustor designs, two different criteria can be used to design the engine. The amount of NO formed in the diffusion flame depends substantially on the maximum temperature reached. Effects of changing the mode of combustion from a diffusion flame to a heat conduction flame are considered, giving attention to the amount of NO produced in an engine of a given design. G.R.

A74-18798 # **The refining of turbine fuels by modern hydrotreating.** R. L. Richardson and B. Peralta (Union Oil Company of California, Brea, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-162.* 5 p. Members, $1.50; nonmembers, $2.00.

This paper reviews the present status of technology for removing sulfur compounds and hydrogenating aromatics in jet fuels, often designated as turbine fuels. The newer technique of catalytic hydrotreating will be emphasized because of its effectiveness in removing sulfur as well as nitrogen compounds, its flexibility in refinery applications, and its ability to upgrade other fuel characteristics, such as smoke point, aromatics content and thermal stability. (Author)

A74-18807 * # **Unsteady lift forces on highly cambered airfoils moving through a gust.** H. Atassi (Notre Dame, University, Notre Dame, Ind.) and M. Goldstein (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-88.* 10 p. 11 refs. Members, $1.50; nonmembers, $2.00.

An unsteady airfoil theory in which the flow is linearized about the steady potential flow of the airfoil is presented. The theory is applied to an airfoil entering a gust. After transformation to the W-plane, the problem is formulated in terms of a Poisson's equation. The solutions are expanded in a Fourier-Bessel series. The theory is applied to a circular arc with arbitrary camber. Closed form expressions for the velocity and pressure on the surface of the airfoil are obtained. The unsteady aerodynamic forces are then calculated and shown to contain two terms. One in an explicit closed analytical form represents the contribution of the oncoming vortical disturbance, the other depends on a single quadrature and accounts for the effect of the wake. (Author)

A74-18808 * # **A self-reorganizing digital flight control system for aircraft.** R. C. Montgomery (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.) and A. K. Caglayan (NASA, Langley Research Center, Hampton; Virginia Polytechnic Institute and State University, Blacksburg, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-21.* 15 p. 7 refs. Members, $1.50; nonmembers, $2.00.

This paper presents a design method for digital self-reorganizing control systems which is optimally tolerant of failures in aircraft sensors. The functions of this system are accomplished with software instead of the popular and costly technique of hardware duplication. The theoretical development, based on M-ary hypothesis testing, results in a bank of M Kalman filters operating in parallel in the failure detection logic. A moving window of the innovations of each Kalman filter drives the detection logic to decide the failure state of the system. The detection logic also selects the optimal state estimate (for control logic) from the bank of Kalman filters. The design process is applied to the design of a self-reorganizing control system for a current configuration of the space shuttle orbiter at Mach 5 and 120,000 feet. The failure detection capabilities of the system are demonstrated using a real-time simulation of the system with noisy sensors. (Author)

A74-18812 * = **Transonic flow about lifting wing-body combinations.** R. W. Barnwell (NASA, Langley Research Center, Hampton,

Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-185.* 16 p. 16 refs. Members, $1.50; nonmembers, $2.00.

Calculations for transonic flow about wing-body combinations at angles of attack of the order of the body thickness-to-length ratio are presented. These calculations show that lift can alter the flow drastically at near-sonic speeds in this angle-of-attack range so that the area rule must be modified. This effect of lift is explained from simple physical considerations. The computational procedure is based on slender-wing theory and a two-variable method of relaxation solution. A small perturbation analysis is used to show that this simple procedure is adequate for these transonic wing-body flow fields. (Author)

A74-18813 # Trimmed drag and maximum flight efficiency of aft tail and canard configurations. S. E. Goldstein and C. P. Combs (Rockwell International Corp., Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-69.* 13 p. 5 refs. Members, $1.50; nonmembers, $2.00.

An analytical method for estimating total trimmed drag polars of airplanes with two lifting surfaces is presented. Drag due to lift is developed as a function of the load carried by each surface, its aerodynamic characteristics, and the inclination of the aft surface lift due to downwash. Tail surfaces are sized consistent with stability and control constraints. Expressions for maximum trimmed cruise efficiency are also developed. Aft tails and canards are compared showing effects of changes in configurations, center of gravity, and stability requirements on trimmed drag in cruise and maneuvering flight. Regions of inherent advantage for each are indicated. A clear advantage is shown for canard configurations with wing tip-mounted vertical fins. (Author)

A74-18815 * # Ingestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere. J. N. Nielsen, S. S. Stahara, and J. P. Woolley (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-42.* 18 p. 15 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-7337.

Detailed analysis has been made of the ingestion and dispersion of engine exhaust products into the trailing-vortex system of a supersonic aircraft flying in the stratosphere. The rate of mixing between the supersonic jet and the coflowing supersonic stream was found to be an order of magnitude less than would be expected on the basis of subsonic eddy-viscosity results. Ingestion started at the end of the potential core, and all hot gas from the engine was ingested into the trailing vortex within two core lengths. The temperature rise in the wake of the supersonic aircraft was found to be much greater than that for a subsonic transport, since temperature rise varies directly as speed squared and inversely as aspect ratio. As a result, the final buoyancy phase started only ten seconds after leaving the trailing edge. Comparison between the buoyancy calculations for the supersonic case with nondimensionalized subsonic aircraft contrail data on wake spreading showed good agreement. (Author)

A74-18831 # Isolated airfoil - TIP vortex interaction noise. R. W. Paterson, R. K. Amiet (United Aircraft Research Laboratories, East Hartford, Conn.), and C. L. Munch (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-194.* 10 p. 8 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAHC04-72-C-0040.

An experimental investigation was conducted in a controlled turbulence-level, open-jet wind tunnel to define the noise characteristics associated with the interaction of a stationary tip vortex and a downstream stationary airfoil. This model test geometry simulated, in its simplest form, the tip vortex-blade interaction which occurs on single-rotor helicopters during hover. For moderate to high lift test conditions, the vortex-airfoil interaction was found to cause local blade stall and an attendant increase in the blade far-field noise. These results indicate that this interaction may be an important source of helicopter broadband noise during hover. Cross-correlation measurements conducted amongst surface-mounted and far-field microphones demonstrated that the operative noise mechanism was 'trailing edge noise' arising from the interaction of stall generated eddies with the airfoil trailing edge. (Author)

A74-18832 # Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap. R. B. Oetting (Missouri, University, Rolla, Mo.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-191.* 8 p. 13 refs. Members, $1.50; nonmembers, $2.00. Research supported by the Minna-James-Heineman-Stiftung.

A small model wind tunnel experiment was performed on a semispan wing with an upper-surface blown flap in order to determine the aerodynamic performance and acoustic characteristics at various wing-flap positions. The constant chord wing had an aspect ratio of 4.5 (2.25 for the semispan). Configurations with the upper-surface blown flap are compared with the corresponding nonblown flap configurations. Aerodynamic results indicate that upper-surface blowing increases the lift coefficient 33% at maximum lift for a flap deflection of 60 deg. In all cases tested, noise shielding by the wing was obtained. The noise level in the wake of the wing increases with flap deflection. (Author)

A74-18833 # Methods for the design and analysis of jet-flapped airfoils. N. D. Halsey (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-188.* 12 p. 19 refs. Members, $1.50; nonmembers, $2.00. Research supported by the McDonnell Douglas Independent Research and Development Program.

Some recent developments in jet-flap airfoil theory are presented, including a nonlinear potential flow method for analyzing the flow about airfoils of given shape and a simple design method for determining the airfoil shapes required to produce specified velocity distributions. The nonlinear analysis method is believed to be superior to other similar methods in the suitability of its singularity distributions, the reliability of its iterative procedures, and its applicability to complex flow conditions. The design method, based on certain approximations which have been verified by the nonlinear analysis method, has been used to design airfoils having certain desirable characteristics. (Author)

A74-18834 # Thin-airfoil theory of an ejector-flapped wing section. H. W. Woolard (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-187.* 12 p. 9 refs. Members, $1.50; nonmembers, $2.00.

A theoretical analysis of the aerodynamics of a thin ejector-flapped wing section (augmentor wing) is presented. The idealized external and internal (ejector) flow field and their approximate interfacing are treated. The linearized external flow-field analysis is an extension of Spence's method for jet-flapped airfoils. Summary curves of the section lift- and pitching-moment characteristics and their relation to the ejector characteristics are presented. Fourier coefficients are tabulated for use in calculating airfoil surface pressure distributions and other flow-field details. Comparisons are made with a related work by Y. Y. Chan. (Author)

A74-18835 * # Analysis of flow-reversal delay for a pitching airfoil. R. M. Scruggs, J. F. Nash, and R. E. Singleton (Scientific and Business Consultants, Inc., Atlanta, Ga.). *American Institute of*

Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-183. 12 p. 24 refs. Members, $1.50; nonmembers, $2.00.

The coupled unsteady turbulent boundary layer and potential flow about a pitching airfoil are analyzed using numerical methods to determine the effect of pitch rate on the delay in forward movement of the rear flow reversal point. An explicit finite difference scheme is used to integrate the unsteady boundary layer equations, which are coupled at each instant of time to a fully unsteady and nonlinear potential flow analysis. A substantial delay in forward movement of the reversal point is demonstrated with increasing pitch rate, and it is shown that the delay results partly from the alleviation of the gradients in the potential flow, and partly from the effects of unsteadiness in the boundary layer itself. (Author)

A74-18838 * # **Analysis of three-dimensional unsteady flow around oscillating wings.** T. Bratanow and A. Ecer (Wisconsin, University, Milwaukee, Wis.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-184.* 14 p. 19 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-50-007-001.

A method based on the Navier-Stokes equations was developed for determining analytically the three-dimensional unsteady flow patterns around oscillating wings. The Helmholz vorticity transport equations were discretized in three-dimensional finite element form from a variational formulation and integrated numerically. At each time step of the numerical integration the velocity field was calculated from the representation of the three-dimensional wing by a system of optimized distribution of vortices in space. During the numerical integration of the vorticity transport equations the time-dependent boundary conditions on the wing were specified as external constraint conditions. Examples of obtained results describing the three-dimensional unsteady flow around a wing were presented. (Author)

A74-18841 * # **Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations.** C. H. Fox, Jr. (NASA, Langley Research Center, Hampton, Va.) and W. J. Breedlove, Jr. (Old Dominion University, Norfolk, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-186.* 5 p. Members, $1.50; nonmembers, $2.00.

F. A. Woodward, under contract to the NASA Langley Research Center, has recently formulated a distributed vortex aerodynamic singularity and developed an improved unified subsonic-supersonic potential flow computer program employing this singularity. This improved program is applicable to the prediction of the local surface pressure distribution for a large class of essentially arbitrarily shaped aircraft configurations. Results are presented for two classes of aircraft configurations of current interest: a maneuvering fighter type and a supersonic transport type. Comparison of these results with experiment indicate the program has good prediction capability. (Author)

A74-18843 # **Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus.** C. W. Brix, Jr. and M. F. Platzer (U.S. Naval Postgraduate School, Monterey, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-14.* 7 p. 12 refs. Members, $1.50; nonmembers, $2.00. Navy-supported research.

Supersonic flow past finite oscillating flat-plate cascades with subsonic leading-edge locus is analyzed using a linearized characteristics method. Blade pressure distributions are computed for arbitrarily specified free-stream Mach number, solidity, stagger angle, frequency of oscillation and interblade phase angle. Comparisons with an alternate solution for a two-blade cascade using the method of singularities and a combined analytical/finite difference solution by J. M. Verdon show good agreement. (Author)

A74-18851 # **Multi-surface system for the CCV B-52.** R. D. Poyneer (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-126.* 6 p. 8 refs. Members, $1.50; nonmembers, $2.00.

This paper summarizes an analytical study conducted by the Control Configured Vehicles (CCV) technical staff to synthesize a CCV Multi-Surface System (MSS) for the CCV B-52 airplane. Quadratic optimal control theory was used to design a multiple-input, multiple-output controller for the lateral-directional axis. The controller used five sensors and four aerodynamic control surfaces to reduce accelerations, and stresses on the B-52. This paper covers the design requirements, and constraints, design procedure, and the study results. The results show that the MSS performs better than the individually designed concepts of Ride Control and Lateral Augmented Stability (RCS/LAS). (Author)

A74-18852 * # **Lift-induced wing-tip vortex attenuation.** J. C. Patterson, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-38.* 7 p. Members, $1.50; nonmembers, $2.00.

It has been shown by a new static airflow visualization method that a drogue device properly positioned downstream of the wing tip causes vortex breakdown. This same result has been obtained by mounting a jet engine simulator at the wing tip and directing the high-energy jet blast downstream into the vortex. These configurations, among others, are now under intensive investigation in the new Langley Vortex Research Facility. In this facility a balance mounted vortex generating model is propelled along the 1800-foot track while a second model trailed at 160 feet (scale distance of 1 mile) measures the far-field rolling moment induced by the vortex of the generating model. (Author)

A74-18855 # **The effect of inlet distortion on the performance and stability of the low-speed spool of a turbofan engine.** J. A. Korn (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-234.* 12 p. Members, $1.50; nonmembers, $2.00.

A74-18858 * # **Fracture mechanics /Dryden Lecture/.** H. F. Hardrath (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-230.* 11 p. 33 refs. Members, $1.50; nonmembers, $2.00.

A historical outline of the engineering discipline of fracture mechanics is presented, and current analytical procedures are summarized. The current status of the discipline is assessed, and engineering applications are discussed, along with recommended directions for future study. M.V.E.

A74-18865 # **Automatic Flight Control System development for U.S. Army heavy lift helicopter.** J. W. Gaul, E. D. Diamond, and J. M. Davis (Boeing Vertol Co., Philadelphia, Pa.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-25.* 8 p. Members, $1.50; nonmembers, $2.00.

A fail-operational Automatic Flight Control System (AFCS) is being developed for the Army Heavy Lift Helicopter. The heart of the system consists of triplex digital computers which process

identical sensor and navigation/guidance inputs to generate both differential and parallel command outputs. A developmental system has been built for initial testing in a modified CH-47. This system utilizes incremental serial digital computers with cross-channel, bit-by-bit processing synchronization; median signal select for sensor inputs; failure monitoring with auto shutdown at the system, axis, and control mode levels; and off-line BITE. Initial flight testing will begin in February, 1974. (Author)

A74-18877 # **Three dimensional supersonic flow field analysis of the B-1 airplane by a finite difference technique and comparison with experimental data.** L. D'Attorre, M. A. Bilyk, and R. J. Sergeant (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-189.* 23 p. 10 refs. Members, $1.50; nonmembers, $2.00. Contracts No. F33657-71-C-1055; No. F33657-73-C-0058.

A finite difference, artificial viscosity computer code has been successfully utilized to calculate numerically the 3-dimensional flow field over the B-1 bomber. For the Mach numbers considered (1.6 and 2.2), an excellent correlation has been obtained between the theory and experimental wind tunnel data. Vehicle local surface pressure, surface flow field (oil flow) and shock wave locations are all predicted quite accurately. The near and far flow field cross flow, vortex flow, shock interactions and exhaust jet interference were also determined. The airplane shape was represented numerically by the exact cross-section coordinates which define the actual shape of the vehicle. (Author)

A74-18881 * # **Electronic displays and digital automatic control in advanced terminal area operations.** S. Salmirs (NASA, Langley Research Center, Hampton, Va.) and H. N. Tobie (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-27.* 8 p. Members, $1.50; nonmembers, $2.00.

A74-18882 # **Evaluation of aircraft departure divergence criteria with a six-degree-of-freedom digital simulation program.** R. J. Pelikan (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-68.* 8 p. Members, $1.50; nonmembers, $2.00.

A74-18897 Investigations concerning wing-fuselage interference in the case of subsonic velocity (Untersuchungen zur Flügel-Rumpf-Interferenz bei Unterschallgeschwindigkeit). H. Körner, S. R. Ahmed, and R. Müller (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *DFVLR-Nachrichten,* Dec. 1973, p. 509-511. In German.

It is pointed out that in modern subsonic commercial aircraft the fuselage has a considerable effect on the distribution of the pressure to which the wing area is subjected. Theoretical studies conducted to investigate this effect are discussed, giving attention to the development of a computational approach for a wing-fuselage combination with a circular fuselage. The further development of a procedure for computations in the case of complete aircraft configurations of arbitrary geometry is also considered. The theoretical studies have been supplemented with experimental investigations in three different wind tunnels. G.R.

A74-18901 A new ILS localizer for regional airports (Neuer ILS-Landekurssender für Regionalflugplätze). W. Fogy, M. Raab, M. Mozer, and R. Stoiber (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugfunk und Mikrowellen and Institut für Satellitenelektronik, Oberpfaffenhofen, West Germany). *DFVLR-Nachrichten,* Dec. 1973, p. 517, 518. In German.

The new installation described employs two horizontal dipoles. The antennas provide the basis of an interferometer. The third antenna of the conventional localizer is not required by the new system. Tests show that difficulties occurring in connection with certain weather conditions and ground characteristics can be overcome by relatively simple means. Technical problems regarding the phase and amplitude constancy have been solved. Electronic details concerning the new localizer are examined. G.R.

A74-18902 # **The Alpha Jet programme.** P. Kania. *Dornier-Post* (English Edition), no. 4, 1973, p. 3-10.

The Alpha Jet aircraft is being developed by Dassault-Breguet and Dornier as a joint German-French venture. The Alpha Jet is to be built in two almost identical versions including close air support aircraft for the German Air Force and a trainer for the French Air Force. The early program phases are discussed together with the development phase and aspects of flight testing. The first production aircraft are scheduled for delivery toward the end of 1976. It is pointed out that an aircraft of the Alpha Jet class would have good export prospects. Only conventional methods and familiar materials are to be used in producing the aircraft. G.R.

A74-18925 Supersonic fuels from medium oils produced by the thermal cracking of crude oil residues (Überschallkraftstoffe aus Mittelölen der thermischen Krackung von Rohölrückständen). R. Erlmeier (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe, Munich, West Germany) and E. Meisenburg (Union Rheinische Braunkohlen Kraftstoff AG, Wesseling, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie,* vol. 26, June 1973, p. 334-338. 10 refs. In German. (DFVLR-SONDDR-301)

The processing steps involved in obtaining the fuels are discussed, taking into account distillation, hydrogenation, and refining procedures. Attention is given to the effect of n-paraffins and aromatic compounds on the fuel characteristics. The composition of the fuels was determined by analytical procedures which included thermodiffusion and NMR measurements. The properties of the fuels are compared with the requirements for fuels on a hydrocarbon basis which are to be used for velocities at Mach number 3. The investigation shows that the considered approach can provide suitable fuels for supersonic flight applications. G.R.

A74-18987 On the modes of icing of symmetrical lifting surfaces. A. M. Mkhitarian, V. A. Kas'ianov, L. P. Goliakov, and Iu. G. Koval' (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *(Gidromekhanika,* vol. 21, 1972, p. 60-65.) *Fluid Mechanics - Soviet Research,* vol. 2, Nov.-Dec. 1973, p. 151-156. Translation.

A method is presented which allows one to investigate the form of ice forming on the tip of simple aerodynamic shapes placed in a monodisperse aerosol flow under conditions of instantaneous glaciation of the captured particles. This method is used for obtaining diagrams of zones of types of icing for theoretical shapes formed by a 'source-sink' system of identical strength and by a 'source-uniformly distributed sink array' system. (Author)

A74-18998 T700 aims at low combat maintenance. M. L. Yaffee. *Aviation Week and Space Technology,* vol. 100, Jan. 28, 1974, p. 45, 47-49.

The described T700-Ge-700 engine under development is a small compact turboshaft engine. The 15-sph engine has been selected by the Army to power its utility tactical transport aircraft and advanced attack helicopter. A distinctive feature of the engine is an integral inlet particle separator which will operate all the time with the engine on and which is expected to reduce significantly engine maintenance on helicopters operating in severe combat environments. V.P.

A74-19051 # **Computer prediction of aircraft noise.** P. J. Dickinson (Southampton, University, Southampton, England). *Tech Air*, vol. 30, Jan. 1974, p. 9-11.

A mathematical computer model was designed to predict the economic impact of achieving reduced noise levels from aircraft. The program suite designed is shown in block form. Ten main programs are supplied with input data from three storage files. The first of these contains all the data relating to each aircraft type. The second file contains all the flight data at the airports under investigation. The third file includes a delimitation of each airport environ into five land usage categories. G.R.

A74-19205 # **The S-3A - A new dimension in airborne sea control.** R. R. Heppe, L. E. Channel, and C. W. Cook (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-239.* 12 p. Members, $1.50; nonmembers, $2.00.

The new S-3A patrol aircraft fills the requirement to replace the obsolescent and operationally inadequate S-2. The S-3A has been shown to offer major performance gains in all systems areas having significant impact on mission effectiveness. The gains in S-3A effectiveness are primarily attributable to the advanced data processing, sensors, and new integration features which, in combination, comprise the central most important system capability in the S-3A. These additional capabilities, in turn, make it possible to utilize increased numbers of sonobuoys and additional weapons capabilities to further enhance effectiveness. F.R.L.

STAR ENTRIES

N74-13701 Maryland Univ., College Park.
ARTIFICIAL DEVELOPMENT OF AN ATMOSPHERIC BOUNDARY LAYER FLOW MODEL IN A WIND TUNNEL Ph.D. Thesis
Fredric Allen Godshall 1973 117 p
Avail: Univ. Microfilms Order No. 73-23725

A wind flow model of the atmospheric boundary layer may be produced in a wind tunnel. With the use of wind flow modulating devices placed in the tunnel entrance, a thick flow model may be produced at the entrance to the tunnel. Thus a long wind fetch in the tunnel is not needed to produce the thick boundary layer model. In this experiment a thermally stable boundary layer wind flow model was produced for the purpose of studying atmospheric diffusion. Hot wire anemometry and cold wire temperature measuring equipment are used to measure vertical heat and momentum flux in the model. These fluxes are used to compute a flux value for L which is found to be equal to the gradient determined value of L. The suitability of the model for study of atmospheric diffusion is demonstrated by this test of eddy flux in the model. Dissert. Abstr.

N74-13702 Notre Dame Univ., Ind.
THE DETERMINATION OF NON-SYMMETRIC VEHICLE STABILITY PARAMETERS FROM RESPONSE DATA Ph.D. Thesis
Robert John Lusardi 1973 145 p
Avail: Univ. Microfilms Order No. 73-24322

Methods are presented for the determination of the parameters of ordinary differential equations from response data. Application is made to the angular motion of a non-symmetric flight vehicle. In particular, the supposedly symmetric spinning body of revolution is investigated to show that those parameters which depend on the dynamic flow field are not governed by the symmetry assumption. Dissert. Abstr.

N74-13706*# Scientific Translation Service, Santa Barbara, Calif.
THE INSTITUTE FOR FLIGHT MECHANICS, BRAUNSCHWEIG (081) AND STUTTGART (027)
Washington NASA Dec. 1973 69 p refs Transl. into ENGLISH from the German report
(Contract NASw-2483)
(NASA-TT-F-15197) Avail: NTIS HC $5.50 CSCL 01A

The Institute of Flight Mechanics of the DFVLR is engaged in theoretical and experimental works on the solution of flight dynamic problems predominantly in the field of aeronautics. In the field of flight dynamics of aircraft, emphasis is on the project of a variable stability aircraft using the HFB 320-S1 research aircraft. Thus important flight test data may be obtained for current research activities supporting the improvement of methods to predict aircraft performance and handling qualities. Further, emphasis is laid on investigations of rescue and recovery systems. Drop tests, model tests and theoretical investigations, run side by side, to approach the solutions of the numerous problems (such as function, dynamic behavior, strength). Finally, system analyses and system evaluations are performed with probabilistic and operations research methods in cooperation with other institutes. Author

N74-13707*# Kanner (Leo) Associates, Redwood City, Calif.
CALCULATION OF POTENTIAL FLOW ABOUT AXIALLY SYMMETRIC FUSELAGES, ANNULAR PROFILES AND ENGINE INLETS
W. Geissler Washington NASA Dec. 1973 16 p refs Transl. into ENGLISH from Z. Flugwissenschaften (West Germany), v. 20, no. 12, Dec. 1972 p 457-462
(Contract NASw-2481)
(NASA-TT-F-15213) Avail: NTIS HC $3.00 CSCL 01A

The calculation of the potential flow about bodies of revolution (closed bodies, inlets, cowls) is done by a method using surface distributions of sources, sinks, and vortices. This method deals with the case of an arbitrary flow about the body. Besides axisymmetric flows and flows at incidence to the body axis, it is possible to take care of the flow field induced by another bod (interference problem). A panel method is used for the numerical solution of the problem. In the case of an axisymmetric body, the surface elements are frustums of cones of small axial length. For different types of bodies the results of this method are compared with measurements. Author

N74-13708*# Avco Corp., Wilmington, Mass. Systems Div.
ANALYSIS OF STALL FLUTTER OF A HELICOPTER RADAR BLADE Final Report
Peter Crimi Washington NASA Nov. 1973 134 p refs Sponsored in part by USAAMRDL
(Contract NAS1-11378)
(NASA-CR-2322) Avail: NTIS HC $4.50 CSCL 01C

A study of rotor blade aeroelastic stability was carried out, using an analytic model of a two-dimensional airfoil undergoing dynamic stall and an elastomechanical representation including flapping, flapwise bending and torsional degrees of freedom. Results for a hovering rotor demonstrated that the models used are capable of reproducing both classical and stall flutter. The minimum rotor speed for the occurrence of stall flutter in hover, was found to be determined from coupling between torsion and flapping. Instabilities analogous to both classical and stall flutter were found to occur in forward flight. However, the large stall-related torsional oscillations which commonly limit aircraft forward speed appear to be the response to rapid changes in aerodynamic moment which accompany stall and unstall, rather than the result of an aeroelastic instability. The severity of stall-related instabilities and response was found to depend to some extent on linear stability. Increasing linear stability lessens the susceptibility to stall flutter and reduced the magnitude of the torsional response to stall and unstall. Author

N74-13709*# Advisory Group for Aerospace Research and Development, Paris (France).
DYNAMIC STALL
P. Crimi (Avco Corp., Wilmington, Mass.) and P. F. Yaggy, ed. (Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.) Nov. 1973 41 p refs Sponsored by NASA
(NASA-CR-136473; AGARD-AG-172) Avail: NTIS HC $4.25 CSCL 01A

Problems associated with unsteady stall are summarized and past experimental and theoretical studies, relating primarily to dynamic stall of helicopter rotor blades, are reviewed. The problems attendant to analytic treatment of dynamic stall, including identification of relevant flow elements and definition of unsteady separation, are then discussed, and the basis for a theory which accounts for viscous effects and viscous-inviscid interactions analytically is presented. Results of computations are compared with measured loading on an airfoil undergoing sinusoidal pitching motion. The amounts of lift overshoot and their variation with frequency are in good agreement. Analyses of wake-induced stall and stall flutter of a helicopter rotor blade are then presented. The results indicate that the large stall-related torsional oscillations which commonly limit helicopter forward speed are the response to rapid changes in aerodynamic moment which accompany stall and unstall, rather than the consequence of an aeroelastic instability. Author

N74-13710# Advisory Group for Aerospace Research and Development, Paris (France).
MAGNUS CHARACTERISTICS OF ARBITRARY ROTATING

BODIES
I. D. Jacobson (Va. Univ.) and P. F. Yaggy, ed. (Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.) Nov. 1973 62 p refs
(AGARD-AG-171) Avail: NTIS HC $5.25

Theoretical and experimental investigations of the Magnus effect on arbitrary bodies of revolution are reviewed. The main emphasis is on spinning projectiles at angle of attack, both with and without fins. Flow visualization measurements are used to assess the accuracy of the existing theories. Laminar, turbulent, and mixed boundary layers are considered. Author

N74-13713 West Virginia Univ., Morgantown.
THE STABILITY OF HELICAL VORTEX FILAMENTS IN THE WAKE OF A HOVERING ROTOR Ph.D. Thesis
Ojars Skujins 1973 130 p
Avail: Univ. Microfilms Order No. 73-23891

The geometry and stability of the wake of a hovering rotor out of ground effect was investigated. A schlieren system in conjunction with a high speed drum camera was developed for this purpose, so that real time sequence photographs could be taken of the vortex filaments as they were convected downstream, with rotor azimuth angle increments as small as 15 degrees being possible between exposures. Two, three and four bladed 16 inch diameter rotors were used operating at rotor speeds of up to 9000 RPM. The effects of the various rotor parameters, such as rotor speed, number of blades, and collective pitch, were correlated with the stability of the vortex wake system. Factors including vortex instability growth rate and modes of instabilities are discussed. Dissert. Abstr.

N74-13714 Georgia Inst. of Tech., Atlanta.
EFFECT OF COMPRESSIBILITY ON THREE-DIMENSIONAL HELICOPTER ROTOR BLADE FLUTTER Ph.D. Thesis
William Felton White 1973 94 p
Avail: Univ. Microfilms Order No. 73-22947

An analytical study is presented to determine a flutter criterion applicable to helicopter rotor blades. To accomplish this, it is necessary to establish the relative accuracy and computational efficiency of compressible unsteady aerodynamic theories applicable to rotor blades. Considerations are restricted to the classical flutter of an equivalent single rotor in hover at low inflow. Strip theory is used to compute aerodynamic loads. Comparison is made with experimental data. Dissert. Abstr.

N74-13715*# Stanford Univ., Calif. Guidance and Control Lab.
AUTOMATIC CONTROL OF A HELICOPTER WITH A HANGING LOAD
Narendra K. Gupta and Arthur E. Bryson, Jr. Jun. 1973 88 p refs
(Contract NAS2-5143)
(NASA-CR-136504; SUDAAR-459) Avail: NTIS HC$6.50 CSCL 01C

An autopilot logic is designed here for controlling a helicopter with a hanging load. A 16th order model for the system is decoupled into four subsystems: (1) a second order system for yawing motion, (2) a second order system for vertical motion, (3) a sixth order system for longitudinal motion, and (4) a sixth order system for lateral motion. A measuring scheme, which could be used in remote areas, is developed and filters are designed to estimate the state variables from these measurements. The autopilot can be used to move the load over short distances without retracting the cables. This is done by automatically shifting the autopilot modes from position-hold (hover) to acceleration-hold to velocity-hold (cruise) to deceleration-hold to velocity-hold (near hover) to position-hold (hover). Use of such an autopilot might save considerable turnaround time. The Sikorsky S-61 helicopter is chosen as an example vehicle. The performance of the controlled system is studied in the presence of longitudinal and lateral winds. Author

N74-13716# Cranfield Inst. of Technology (England). Coll. of Aeronautics.
PERFORMANCE CHARACTERISTICS OF SHORT HAUL TRANSPORT AIRCRAFT INTENDED TO OPERATE FROM REDUCED LENGTH RUNWAYS
D. Howe Apr. 1973 32 p refs
(CRANFIELD-AERO-18) Avail: NTIS HC $3.75

The design characteristics of future short haul transport aircraft intended to operate from runways of reduced length are compared to those used at the present time. The results show that it should be possible to design reduced take off and landing (RTOL) aircraft to operate safely from runways of 4000 ft length without the need for power augmented lift. Such an aircraft would operate at speeds very similar to those used by current short haul transports, the main difference being in the need to provide a static thrust/weight ratio of the order of 0.4. On the other hand short take off and landing (STOL) aircraft intended to operate from runways of about 2000 ft length require a substantial degree of powered lift both for take off and landing. Author

N74-13717*# Scientific Translation Service, Santa Barbara, Calif.
NEW TECHNOLOGIES AND PROFITABILITY OF HELICOPTERS
J. Andres Washington NASA Dec. 1973 54 p ref Transl. into ENGLISH of the paper presented at the AGARD Flight Mech. Panel Symp. Aircraft Design Integration and Optimization (Maignane, France), Oct. 1973 22 p
(Contract NASw-2483)
(NASA-TT-F-15195) Avail: NTIS HC $4.75 CSCL 01C

A study was conducted to determine the economic aspects of helicopter operation for commercial purposes. Concepts of specific cost and cost per kilogram provide the basis for the analysis. The fundamental characteristics of helicopters which determine its mission and profitability are discussed. Specific areas investigated are: (1) fatigue life of components, (2) noise reduction, (3) vibration reduction, (4) optimization of rotary wings, and (5) application of composite materials for helicopter construction. Author

N74-13718*# Boeing Co., Wichita, Kans.
THE INFLUENCE OF WING LOADING ON TURBOFAN POWERED STOL TRANSPORTS WITH AND WITHOUT EXTERNALLY BLOWN FLAPS Final Report
R. L. Morris, C. R. Hanke, L. H. Pasley, and W. J. Rohling Washington NASA Nov. 1973 165 p refs
(Contract NAS1-11370)
(NASA-CR-2320; D3-8514-7) Avail: NTIS HC $4.75 CSCL 01C

The effects of wing loading on the design of short takeoff and landing (STOL) transports using (1) mechanical flap systems, and (2) externally blown flap systems are determined. Aircraft incorporating each high-lift method are sized for field lengths of 2,000 feet, 2,500 feet, and 3,500 feet, and for payloads of 40, 150, and 300 passengers, for a total of 18 point-design aircraft. An assumed 1975 level of technology is applied to both concepts in terms of propulsion, weights, active controls, supercritical wing methodology, and acoustics. Low-wing-loading STOL configurations with mechanical flaps are found to be competitive with externally blown flap STOL configurations over wide ranges of payload and field length for the airworthiness rules and technology improvements assumed. Because the results of design studies like this one are sensitive to the ground rules assumed, careful attention is paid to describing the assumptions. These assumptions must be understood before the results are compared with other STOL airplane studies. Author

N74-13719*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC AND NOISE MEASUREMENTS ON A QUASI-TWO DIMENSIONAL AUGMENTOR WING MODEL WITH LOBE-TYPE NOZZLES

Thomas N. Aiken Sep. 1973 77 p refs
(NASA-TM-X-62237) Avail: NTIS HC $6.00 CSCL 01C

An investigation was made of the static, wind-on aerodynamic and static noise characteristics of an augmentor wing having lobe type nozzles. The study was made in the Ames 7-by 10-Foot No. 1 Wind Tunnel using a small-scale, quasi-two-dimensional model. Several configurations of lobe nozzles as well as a normal slot nozzle were tested. Results indicate that lobe nozzles offer improved static and wind-on aerodynamics and reduced static noise relative to slot nozzles. Best wind-on performance was obtained when the tertiary gap was closed even though the static thrust augmentation was maximum with the gap open. Static thrust augmentation, wind-on lift and drag, and static noise directivity are presented as well as typical static and wind-on exit velocity profiles, surface pressure distributions and noise spectrums. The data are presented with limited discussion. Author

N74-13720*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

TAKEOFF AND LANDING PERFORMANCE AND NOISE MEASUREMENTS OF A DEFLECTED SLIPSTREAM STOL AIRPLANE WITH INTERCONNECTED PROPELLERS AND ROTATING CYLINDER FLAPS

James A. Weiberg, Demo Giulianetti, Bruno Gambucci, and Robert C. Innis Dec. 1973 58 p refs
(NASA-TM-X-62320) Avail: NTIS HC $5.00 CSCL 01C

A YOV-10A aircraft was modified to incorporate rotating cylinder flaps and interconnected propellers with Lycoming T-53-L11 engines. Flight tests were made to evaluate the low speed handling qualities and performance characteristics. The flight test results indicated that landings could be made with approach speeds of 55 to 65 knots (CL = 4.5) and descent angles of 6 deg to 8 deg for total flap angles of 60 deg to 75 deg. At higher flap angles, deterioration of stability and control characteristics precluded attempts at landing. The noise level on the ground under an 8 deg landing approach path was below 86 PNdB at distances beyond 1 nautical mile from touchdown. Takeoffs were made with 30 deg to 45 deg flaps at lift off speeds of 75 to 80 knots and climb angles of 4 deg to 8 deg. Noise levels were below 83 PNdB at 3.5 nautical miles from the start of ground roll. Author

N74-13721*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

WIND TUNNEL INVESTIGATION OF A LARGE-SCALE 25 DEG SWEPT-WING JET TRANSPORT MODEL WITH AN EXTERNAL BLOWING TRIPLE-SLOTTED FLAP

Kiyoshi Aoyagi, Michael D. Falarski, and David G. Koenig Nov. 1973 59 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Moffett Field, Calif.
(NASA-TM-X-62197) Avail: NTIS HC $5.00 CSCL 01C

An investigation has been conducted to determine the aerodynamic characteristics of a large-scale subsonic jet transport model with an externally blown triple-slotted flap. The lift of the model was augmented by the turbofan engine exhaust impingement on the flap surface. The model had a 25 deg swept wing of aspect ratio 7.28 and four turbofan engines. The model was tested with two flap extents. One extended from 0.11 to 1.00 of the wing semispan, and the other extended from 0.11 to 0.75 of the wing semispan with a single-slotted aileron from 0.75 to 1.00 of the wing semispan. The results were obtained for several flap deflections with and without the horizontal tail at gross thrust coefficients from 0 to 4.0. Longitudinal and lateral data are presented with three and four engines operating. Author

N74-13722*# Giravions Dorand Co., Suresnes (France).

MARCH 1971 WIND TUNNEL TESTS OF THE DORAND DH 2011 JET FLAP ROTOR, VOLUME 1 Final Report

Marcel Kretz, Jean-Noel Aubrun, and Marc Larche Jun. 1973 55 p refs 2 Vol.
(Contract NAS2-3673)
(NASA-CR-114693; DH-2011-D-E5-Vol-1) Avail: NTIS HC $4.75

The results of wind tunnel tests, second series of tests performed in the NASA Ames 40 x 80 foot wind tunnel, of the DH 2011 jet-flap rotor are presented and analyzed. The tests have been focused on multicyclic effects and the capability of this rotor to reduce the vibratory loads and stresses in the blades. The reductions of the vibrations and stresses at tip speed ratio of 0.4 have attained 50%. The theory shows further reductions possible, reaching 80%. The results show that the performance characteristics after the modifications introduced since 1965 remained unchanged. The domain of investigation has been enlarged to include the tip speed ratios of 0.6 and 0.7. To analyze the complex aeroelastic phenomena a new analytical technique has been utilized to represent the mathematical model of the rotor. This technique, based on transfer matrices and transfer functions, appears very simple and it is believed that this analysis is applicable to many kinds of investigations involving large numbers of variables. Author

N74-13723*# Giravions Dorand Co., Suresnes (France).

MARCH 1971 WIND TUNNEL TESTS OF THE DORAND DH 2011 JET FLAP MOTOR, VOLUME 2 Final Report

Marcel Kretz, Jean-Noel Aubrun, and Marc Larche Jun. 1973 151 p Sponsored in part by Army Air Mobility Lab. 2 Vol.
(Contract NAS2-3673)
(NASA-CR-114694; DH-2011-D-E5-Vol-2) Avail: NTIS HC $9.75 CSCL 01C

Wind tunnel tests were conducted of the Dorand DH 2011D jet flap rotor. The data recorded during the tests consist of: (1) multicyclic cam coefficients, (2) stress analysis, (3) vibratory loads, (4) Fourier analysis of flap deflection, and (5) blade bending stress. Data are presented in the form of tables and graphs. Author

N74-13724*# Boeing Co., Wichita, Kans.

DEVELOPMENTAL DESIGN, FABRICATION, AND TEST OF ACOUSTIC SUPPRESSORS FOR FANS OF HIGH BYPASS TURBOFAN ENGINES

R. H. Tucker, M. D. Nelsen, G. E. Gregg, and F. I. Palmer Washington NASA Jan. 1974 63 p refs
(Contract NAS3-14321)
(NASA-CR-2338; D3-8952) Avail: NTIS HC $3.50 CSCL 01C

An analysis procedure was developed for design of acoustically treated nacelles for high bypass turbofan engines. The plan was applied to the conceptual design of a nacelle for the quiet engine typical of a 707/DC-8 airplane installation. The resultant design was modified to a test nacelle design for the NASA Lewis quiet fan. The acoustic design goal was a 10 db reduction in effective perceived fan noise levels during takoff and approach. Detailed nacelle designs were subsequently developed for both the quiet engine and the quiet fan. The acoustic design goal for each nacelle was 15 db reductions in perceived fan noise levels from the inlet and fan duct. Acoustically treated nacelles were fabricated for the quiet engine and quiet fan for testing. Performance of selected inlet and fan duct lining configurations was experimentally evaluated in a flow duct. Results of the tests show that the linings perform as designed. Author

N74-13725*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT STUDY OF A VEHICLE OPERATIONAL STATUS AND MONITORING SYSTEM

James E. Love, William J. Fox (Lockheed-Calif. Co.), and Edward J. Wicklund (Honeywell, Inc.) Washington Jan. 1964 12 p
(NASA-TN-D-7546; H-789) Avail: NTIS HC $2.75 CSCL 01C

An analog onboard monitoring system was installed on a YF-12 airplane as the first phase of a program to monitor the engine inlet and portions of the airplane's electrical and fuel management subsystems in flight. The system provided data which were considered to form a suitable base for diagnostic test logic and decision criteria for the rest of the program. The data were

also adequate for the purpose of maintaining the engine inlet and identifying malfunctions within it. The investigation showed that the requirements of an onboard monitoring system should be considered during the original design of the system to be monitored. Author

N74-13726*# Hamilton Standard, Windsor Locks, Conn.
Q-FANSTM FOR GENERAL AVIATION AIRCRAFT
Rose Worobel and Millard G. Mayo Dec. 1973 267 p refs
(Contract NAS2-6834)
(NASA-CR-114665) Avail: NTIS HC $15.50 CSCL 01C

Continued growth of general aviation over the next 10 to 15 years is dependent on continuing improvement in aircraft safety, utility, performance and cost. Moreover, these advanced aircraft will need to conform to expected government regulations controlling propulsion system emissions and noise levels. An attractive compact low noise propulsor concept, the Q-FANTM when matched to piston, rotary combustion, or gas turbine engines opens up the exciting prospect of new, cleaner airframe designs for the next generation of general aviation aircraft which will provide these improvements and meet the expected noise and pollution restriction of the 1980 time period. New Q-FAN methodology which was derived to predict Q-FAN noise, weight and cost is presented. Based on this methodology Q-FAN propulsion system performance, weight, noise, and cost trends are discussed. Then the impact of this propulsion system type on the complete aircraft is investigated for several representative aircraft size categories. Finally, example conceptual designs for Q-FAN/engine integration and aircraft installations are presented. Author

N74-13727*# Boeing Vertol Co., Philadelphia, Pa.
V/STOL TILT ROTOR AIRCRAFT STUDY. VOLUME 10: PERFORMANCE AND STABILITY TEST OF A 1-14.622 FROUDE SCALED BOEING VERTOL MODEL 222 TILT ROTOR AIRCRAFT (PHASE 1)
F. J. McHugh, W. Eason, H. R. Alexander, and H. Mutter Oct. 1973 521 p refs 10 Vol.
(Contract NAS2-6598)
(NASA-CR-114603; D222-10053-1-Vol-10) Avail: NTIS HC $28.25 CSCL 01C

Wind tunnel test data obtained from a 1/4.622 Froude scale Boeing Model 222 with a full span, two prop, tilt rotor, powered model in the Boeing V/STOL wind tunnel are reported. Data were taken in transition and cruise flight conditions and include performance, stability and control and blade loads information. The effects of the rotors, tail surfaces and airframe on the performance and stability are isolated as are the effects of the airframe on the rotors. Author

N74-13728# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
CONTROL CONFIGURED VEHICLE RIDE CONTROL (CCV RCS). B-52 CONTROL SYSTEM ANALYSIS, SYNTHESIS, AND DESIGN Technical Report, Dec. 1971 - Jan. 1973
C. R. Stockdale and R. D. Poyneer Jul. 1973 223 p refs
(AF Proj. 487T)
(AD-767590; AFFDL-TR-73-83) Avail: NTIS CSCL 01/2

The Control Configured Vehicle Ride Control System Program was conducted to demonstrate the capability of significantly improving the ride quality of a large flexible airplane and lengthening its structural life. The ride control system employs both horizontal and vertical canards to be installed and flight tested on the B-52 LAMS vehicle. The analysis, design, and flight demonstration of the ride control system was directed toward one discrete flight condition, low level, high speed. The ride control system was designed to reduce pilot station acceleration while flying through atmospheric turbulence.
Author (GRA)

N74-13729# Little (Arthur D.), Inc., Cambridge, Mass.
FAILURE ANALYSIS OF HELICOPTER EXTERNAL CARGO-HANDLING SYSTEMS Final Report
Robert E. Hunt Jun. 1973 168 p refs
(Contract DAAJ02-72-C-0063; DA Proj. 1F1-62203-AA-33)
(AD-767254; ADL-C-74645; USAAMRDL-TR-73-44) Avail: NTIS CSCL 01/3

A study of the failure of helicopter cargo-handling systems was conducted. A data search and compilation were completed from which the external cargo-handling system was defined and the system operation explained. Operational parameters were also defined and explained. Also criteria for assessing failures were established, data sources were cited, a search plan outlined, and failure data and consensus data were retrieved and categorized. The data were taken primarily from cargo helicopters deployed in Vietnam. Their overall utilization, load categories, and rigging materials were determined, and a consensus summary of the cause of specific failures was compiled and documented. A data analysis was conducted with the relationship of failure occurrences and rates determined for specific types of accidents and failures. Predominant causes of failures were analyzed, a cost/value of relationship of cargo dropped established, and projections of the heavy-lift helicopter as a cargo carrier were made. Candidate corrective actions were recommended, with the development of specific corrective actions made, encompassing a collapsible cargo net-pallet concept and an investigation of cargo hook design principles. Author (GRA)

N74-13730# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
NOISE GENERATION BY CYLINDRICAL SPOILERS IMMERSED IN AN AIR DUCT Interim Technical Report
T. M. Tower, Edelbert G. Plett, H. H. Chiu, and Martin Summerfield Mar. 1973 255 p refs
(Contract N00014-67-A-0151-0029)
(AD-767336; AMS-1092) Avail: NTIS CSCL 01/3

The report describes a study concerned with the effect of thin cylindrical flow spoilers upstream of the exit plane of a constant-area duct on the acoustic power output and directivity patterns of the noise field external to the duct. Spoilers of diameter 1/16, 5/32, and 3/16 in. were placed at 1/8 in. and 11 in. from the exit plane of a 1 in. diameter duct. Far-field sound pressure levels were measured in an anechoic chamber over a mean velocity range of 250 to 900 ft/s. The frequency range of the investigation was 200 Hz to 50 kHz, while the Reynolds number range, based on mean velocity upstream of the spoiler and on spoiler diameter, was 8000 to 80,000. (Modified author abstract) GRA

N74-13731# Systems Associates, Inc., Long Beach, Calif.
US ARMY HELICOPTER HYDRAULIC SERVOCYLINDER RELIABILITY AND MAINTAINABILITY INVESTIGATION Final Report
James L. Huffman and Sheldon Dockswell May 1973 148 p refs
(Contract DAAJ02-71-D-0003; DA Proj. 1F1-62205-A-119)
(AD-767243; SAI-R73-009; USAAMRDL-TR-73-29) Avail: NTIS CSCL 13/7

The report describes an investigation carried out to identify, isolate, and verify the causes of problems with hydraulic servocylinder actuators used on U.S. Army helicopters, and to trace the resulting effects on helicopter availability. Design requirements, quality assurance provisions, maintenance procedures and practices were analyzed to assess their impact upon the current problems. The analysis of the pertinent failure data and documentation revealed that five failure modes were responsible for over 90% of the total hydraulic servocylinder removals in a 6 1/2-year period. Subsequent analysis of the various policies, practices and procedures showed that these documents contain anomalies that contribute to the occurrence of the five predominant failure modes. The lack of stringent basic design requirements, quality control, and adequate maintenance manuals was shown to be a major contributor to the leaking failure mode. This mode accounts for approximately half of the servocylinder removals from U.S. Army helicopters.
Author (GRA)

N74-13732# Boeing Vertol Co., Philadelphia, Pa.
TRANSMISSION THERMAL MAPPING (CH-47C FORWARD ROTOR TRANSMISSION) Final Report
Rocco C. Tocci, A. J. Lemanski, and Nelson J. Ayoub May 1973 170 p refs
(Contract DAAJ02-72-C-0075; DA Proj. 1G1-62207-AA-72) (AD-767875; D210-10545-1; USAAMRDL-TR-73-24) Avail: NTIS CSCL 01/3

The report presents the results of tests conducted to obtain the thermal maps of a CH-47C helicopter forward rotor transmission. The tests were conducted at several torque levels and to several controlled oil-out target temperatures. Thermal growth between selected points on the transmission case was measured and analyzed. Author (GRA)

N74-13733# General Dynamics/Convair, San Diego, Calif.
STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 2: DESIGN COMPENDIUM Final Report, 7 Jun. 1971 - 31 Jan. 1973
J. Herbert, Jr., E. S. Levinsky, J. C. Ramsey, E. C. Laudeman, and H. G. Altman May 1973 273 p refs
(Contract F33615-71-C-1754; AF Proj. 643A) (AD-767561; GDCA-DHG73-001-Vol-2; AFFDL-TR-73-21-Vol-2) Avail: NTIS CSCL 01/1

The design compendium presents methods for estimating the aerodynamic and stability and control characteristics of mechanical flaps and the three lift/propulsion systems: mechanical flaps plus vectored thrust, externally blown flaps, and internally blown flaps. A review of various theoretical approaches is presented to form a basis for the generalized methods that are developed to estimate lift, drag, pitching moment, downwash, and the lateral-directional stability derivatives. Sample problems are presented to allow the most advantageous utilization of the methodology. The data correlations shown at the end of the major sections verify and substantiate the selected approaches. A general methodology has been developed for predicting the low speed aerodynamic and stability characteristics of STOL transport aircraft. The methodology is applicable to the EBF, IBF, and MF/VT STOL concepts. The basic procedures, which predict the lift curve versus angle of attack, maximum lift coefficient, induced drag, thrust recovery, pitching moment, and downwash angle are easily hand-calculated for a single case or programmed on a small computer to calculate a large number of configurations. Author (GRA)

N74-13734# General Dynamics/Convair, San Diego, Calif.
STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 4: WIND TUNNEL DATA ANALYSIS Final Report, 7 Jun. 1971 - 31 Jan. 1973
J. Herbert, Jr., J. C. Ramsey, E. C. Laudeman, C. A. Whitney, and N. A. Pondmareff May 1973 406 p refs
(Contract F33615-71-C-1754; AF Proj. 643A) (AD-767363; GDCA-DHG73-001-Vol-4; AFFDL-TR-73-21-Vol-4) Avail: NTIS CSCL 01/3

Force and rake information measured during 1087 hours of low speed wind tunnel testing conducted by Convair Aerospace are summarized. Over 2730 data runs were generated on 242 major configuration variables that covered the following lift/propulsion concepts: mechanical flaps plus vectored thrust, externally blown flaps, and internally blown flaps. Lift data was reduced into three basic terms: power-on to power-off lift curve slope ratio, trailing edge flap lift increment at alpha = zero degrees, and maximum lift coefficient increment due to the application of power. These relationships were evaluated as a function of blowing momentum coefficient and correlated for the effects of configurational variations (wing planform, leading and trailing edges, and nacelle location). Drag data was reduced into the form of induced drag factor, minimum profile drag, thrust recovery and then analyzed as a function of blowing momentum coefficient. The pitching moment data analysis compares the flap pitching moment increment among the various configurations. (Modified author abstract) GRA

N74-13735# General Dynamics/Convair, San Diego, Calif.
STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 5: FLIGHT CONTROL TECHNOLOGY Final Report, 7 Jun. 1971 - 31 Jan. 1973
J. Hebert, Jr., G. Campbell, E. Price, L. B. White, and R. Aalstenberg May 1973 347 p refs
(Contract F33615-71-C-1754; AF Proj. 643A) (AD-767364; GDCA-DHG73-001-Vol-5; AFFDL-TR-73-21-Vol-5) Avail: NTIS CSCL 01/3

Flight control studies conducted during the STOL Tactical Aircraft Investigation by Convair Aerospace were directed toward development of flight control systems for three versions of the medium STOL transport. Baseline vehicles used for flight control studies were: externally blown flap, internally blown flap, and mechanical flap/vectored thrust configurations. Requirements of MIL-F-8785B and MIL-F-833000 for aircraft handling qualities were the guiding criteria for the control system study. The mechanization trade study concluded that fly-by-wire mechanization is preferred over the more mechanical version which requires significant fly-by-wire features to achieve the required augmentation and decoupling. (Modified author abstract) GRA

N74-13736# General Dynamics/Convair, San Diego, Calif.
STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 6: AIR CUSHION AND GROUND MOBILITY STUDY Final Report, 7 Jun. 1971 - 31 Jan. 1973
J. Herbert, Jr., H. Weber, G. T. Draper, C. Kerr, Jr., and T. F. Reid May 1973 43 p refs
(Contract F33615-71-C-1754; AF Proj. 643A) (AD-767300; GDCA-DHG73-001-Vol-6; AFFDL-TR-73-21-Vol-6) Avail: NTIS CSCL 01/3

The air cushion landing system for the STOL transport aircraft is discussed. The configuration includes a rubber-nylon, torus-shaped trunk attached to the lower portion of the fuselage. Air is supplied to the trunk by turboshaft-driven fans. It is then exhausted through rows of holes along the trunk ground tangent. Aircraft weight is distributed over the cushion area providing the desired low ground pressure. After liftoff, the trunk is deflated and retracts into the fuselage by elastic action. Author

N74-13737# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPTIMAL CAPABILITIES OF HYPERSONIC PASSENGER AIRCRAFT ON KEROSENE FUEL
Ya. N. Gaukham 12 Sep. 1973 25 p Transl. into ENGLISH from Sb. Aerodin. Sverkhzvukovykh Samoletov (USSR), v. 2, no. 182, 1971 p 14-30
(AD-767887; FTD-HT-23-801-73) Avail: NTIS CSCL 01/3

The report evaluates the optimum flight characteristics of a hypersonic aircraft using kerosene fuel. GRA

N74-13738# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FLIGHT CONTROL OF AIRPLANES AND HELICOPTERS
V. T. Borodin and G. I. Rylskii 27 Sep. 1973 342 p refs Transl. into ENGLISH of the publ. "Upravlenie Poletom Samoletov i Vertoletov" Moscow, 1972 p 1-238
(AD-767943; FTD-MT-24-318-73) Avail: NTIS CSCL 01/3

In the report an analysis is given and fundamental results systematized from foreign investigations on the development of promising means of automation of flight control of aircraft and helicopters. Structural diagrams and descriptions of the control systems of contemporary aircraft and helicopters, flexible aircraft, and also adaptive (self-adjusting, with variable structure, self-organizing) aviation systems are given. Bionic principles of adaptation and the possibility of their use in control systems of aircraft, and also the problems of automation of landing, flight on low and maximally low altitudes, and the arrangement of installed equipment are examined. Methods of reflecting flight information to the pilot, the systems of semiautomatic control, systems for the prevention of collisions of aircraft in the air, landing systems, profile flight and the contemporary complexes of installed equipment are described. GRA

N74-13739# Naval Postgraduate School, Monterey, Calif.
A MODIFIED DESIGN CONCEPT, UTILIZING DECK MOTION PREDICTION, FOR THE A-7E AUTOMATIC CARRIER LANDING SYSTEM M.S. Thesis
Thomas Maxwell Judd Jun. 1973 75 p refs
(AD-767691) Avail: NTIS CSCL 01/2

The present concept of automatic carrier landings, Mode I operational capability, as employed in Navy carrier-based aircraft, was investigated. The aircraft chosen for study was the A-7E. The A-7E All Weather Carrier Landing System (AWCLS) and the carrier landing environment including burble effects and deck motion were simulated. Height of hook above ramp, touchdown point, and velocity of impact dispersions were determined. The current system was then modified, utilizing the concept of a SPN-42 Deck Motion Compensation Lead Computer which operates on the basis of known aircraft characteristics and predicted carrier heave motion. Simulation showed that automatic carrier landing performance as measured by number of ramp strikes, hard landings, and bolters could be improved. The modifications suggested require only a minimum of component additions to the AWCLS currently in use in the Navy. Author (GRA)

N74-13740# Army Material Command, Texarkana, Tex. Intern Training Center.
MINIMUM LIFE CYCLE COSTING FOR A V/STOL TRANSPORT
Thomas W. Smith 1973 120 p refs
(AD-768133; USAMC-ITC-1-73-21) Avail: NTIS CSCL 01/3

The report proposes a new methodology for life cycle costing. In particular, a Vertical/Short Take-off and Landing (V/STOL) transport aircraft is considered. The costs included are those of research and development, production, maintenance, and operation. The minimum cost is found by the minimization of a function of three variables; maximum speed at best altitude, gross take-off weight, and maximum thrust per engine. Several methods of minimization were investigated, including geometric programming, Sequential Unconstrained Minimization Technique (SUMT), and the pattern search technique. The latter method was used with success and numerous computer runs were executed. The impact of the variation of many input parameters is shown in the results. Author (GRA)

N74-13741# Sanders Nuclear Corp., Nashua, N.H.
TACTILE DISPLAY FOR AIRCRAFT CONTROL Final Technical Report, 1 Jul. 1972 - 31 Aug. 1973
Don H. Ross, Richard A. Sanneman, William H. Levison, Robert B. Tanner, and Thomas J. Triggs 31 Aug. 1973 97 p refs
Prepared in cooperation with Bolt, Beranek and Newman, Inc., Cambridge, Mass.
(Contract N00014-73-C-0031; ARPA Order 2108; NR Proj. 196-123)
(AD-767763) Avail: NTIS CSCL 01/4

The final report presents a set of manual tracking experiments that have been conducted to determine the suitability of tactual displays for presenting flight-control information in multi-task situations. Although tracking error scores are considerably greater than scores obtained with a continuous visual display, preliminary results indicate the inter-task interference effects are substantially less with the tactual display in situations that impose high visual scanning workloads. The single-task performance degradation found with the tactual display appears to be a result of the coding scheme rather than the use of the tactual sensory mode per se. Analysis with the state-variable pilot/vehicle model shows that reliable predictions of tracking errors can be obtained for a limited set of system configurations once the pilot-related model parameters have been adjusted to reflect the pilot-display interaction. Author (GRA)

N74-13742# Naval Aerospace Medical Research Lab., Pensacola, Fla.
ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1970: RELATIVE INCIDENCE AND COST
Jorma I. Niven, W. Carroll Hixson, and Emil Spezia 14 Sep. 1973 36 p refs
(MF51524005)
(AD-768307; NAMRL-1192; USAARL-74-5) Avail: NTIS CSCL 01/2

The report is the fourth in a series of reports dealing with pilot disorientation/vertigo accident problem is Regular Army UH-1 helicopter operations. Incidence and cost data presented for fiscal year 1970 include a total of 43 major and minor orientation-error, accidents (17 of which were fatal), resulting in 66 fatalities, 67 nonfatal injuries, and a total UH-1 aircraft damage cost of $7,706,191. Author (GRA)

N74-13743# Army Natick Labs., Mass. Clothing and Personal Life Support Equipment Lab.
ENGINEERING EVALUATION OF AGE LIFE EXTENSION, T-10 HARNESSES, RISERS AND T-10 TROOP CHEST RESERVE PARACHUTE CANOPIES. SUPPLEMENT 1: 1964 - 1965 YEAR CLASSES
Michael E. Mahar, Vasant K. Devarakonda, and Richard D. Wells Oct. 1973 23 p
(AD-767711; C/PLSEL-112-Suppl-1
USA-NLABS-TR-74-9-CE-Suppl-1) Avail: NTIS CSCL 01/3

An engineering evaluation of T-10 troop-type harnesses, risers, and chest reserve parachute assemblies of year classes (dates of manufacture) 1964 and 1965 was conducted by laboratory testing of component materials. The data obtained from limited samplings from Fort Bragg, No. Carolina, Alaska and the Panama Canal Zone indicated a generally serviceable condition for this equipment at nine and eight years of total age. Taken with more extensive data and with the technical background and criteria developed in the earlier basic report 72-59-CE, (DDC AD 742-668) of the same title, dated March 1972, it was concluded that the recently extended 13 year (risers and harnesses) and 12 year (canopy assemblies) limits are fully substantiated for these 1964-65 classes. Subject to later check testing, further extension of the age life limit may be found appropriate. Author (GRA)

N74-13744# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A PRELIMINARY DESIGN OF A REMOTELY-CONTROLLED GLIDER FOR A LONG-LINE OPERATION M.S. Thesis
Elbridge Lee Snapp, III Jun. 1973 106 p refs
(AD-767879; GA/AE/71-1) Avail: NTIS CSCL 01/3

Low-level, covert observation of a small area of ground may be obtained by an unmanned glider towed from a large aircraft and suspended in Long-Line-Loiter. This glider is equipped with a Visually-Coupled Control System operated through a Low-Light-Level Television camera. The glider has a gross weight of 442.5 lb of which 282.3 lb is payload. The vehicle features a high wing and a constant-chord airfoil with 30 ft span. Overall vehicle length is 17.7 ft. Wings-level stall speed is 35.8 knots. The glider exhibits static longitudinal, lateral, and directional stability. Attaching the tow cable to the top of the fuselage above the vehicle center of gravity allows the glider to be flown in high-speed trail or suspended in Long-Line-Loiter.
Author (GRA)

N74-13745# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.
PRODUCTION DATA PACKAGE 267 GALLON EXTERNAL FUEL TANK
Albert E. Simkins 23 Aug. 1973 28 p refs
(AD-767937; NADC-73147-30) Avail: NTIS CSCL 01/3

A production data package was developed for a 267 gallon external fuel tank suitable for use on the F-14 aircraft.
Author (GRA)

N74-13746# Illinois Univ., Savoy. Aviation Research Lab.
THE DESIGN AND FLIGHT EVALUATION OF A PERFORMANCE CONTROL SYSTEM M.S. Thesis
Craig Alan Bergman Aug. 1973 68 p refs
(Contract F44620-70-C-0105; AF Proj. 9778)

(AD-767786; ARL-73-16/AFOSR-73-10; AFOSR-73-1696TR) Avail: NTIS CSCL 01/3

A performance control system, which provides direct pilot control of vertical speed and bank angle, has been designed and flight tested in a twin-engine, general aviation aircraft. Automatic coordination and lift compensation in turns are provided. The system is FAA-certified for normal category operations under VFR conditions, above 400 feet AGL, with a qualified safety pilot. The operating ranges are plus or minus 1500 fpm vertical speed and plus or minus 60 degrees of bank angle. The system is insensitive to airspeed and altitude changes. Vertical speed accuracy is within 100 fpm for changes of power setting and landing gear extension/retraction. During flap changes and turning maneuvers the vertical speed changes by as much as 550 fpm, but recovery to within 100 fpm is accomplished within 20 seconds. Bank angle holding accuracy is approximately three degrees for turns of standard rate or less. Author (GRA)

N74-13747# Naval Postgraduate School, Monterey, Calif.
THE SIMULATION AND ANALYSIS OF CARRIER LANDINGS USING A NONLINEAR PILOT MODEL M.S. Thesis
Clark Albert Wilson Jun. 1973 62 p refs
(AD-767679) Avail: NTIS CSCL 01/2

The report investigated the interaction of the pilot and the Fresnel lens optical landing system (FLOLS) with the aircraft system dynamics of a carrier landing and attempted to determine whether or not the dynamics of the FLOLS contributed to a nosedown command by the pilot when approaching touchdown. With the assumption of a nonlinear pilot model, the entire system's equations of motion were programmed on an analog computer and time histories of approaches for various pilot gains were recorded and analyzed. Results obtained showed that the stability of the entire system near touchdown was very sensitive to gains which the pilot adopted. Also, because of the lag in the FLOLS dynamics, the pilot would, for some pilot gains, input a definite nosedown command to counteract a rising meatball on the FLOLS display. The typical result of such a command is a hard landing or ramp strike. Author (GRA)

N74-13748# Naval Postgraduate School, Monterey, Calif.
THE DESIGN, FABRICATION AND EVALUATION OF THE AURAL ANGLE OF ATTACK/STALL WARNING SYSTEM
Penn Evans Mullowney, Jr. Jun. 1973 90 p refs
(AD-767663) Avail: NTIS CSCL 01/2

Maximum performance and stall avoidance can be realized in high-performance aircraft only if the pilot is fully aware of angle of attack. Because present methods of providing this information have proven to be inadequate, an alternative method has been proposed. The paper describes an electronic device providing angle of attack. GRA

N74-13749# Air Force Academy, Colo. Dept. of Aeronautics.
A PYLON TO DECREASE THE EFFECTS OF EXTERNAL STORES ON THE STABILITY OF AIRCRAFT Final Report
Edgar W. Lorson and Lawrence E. Day Jul. 1973 51 p refs
(AD-767913; DFAN-TR-73-5) Avail: NTIS CSCL 01/3

A series of wind tunnel studies were accomplished at the USAFA to determine the effect of a new low side area pylon on the static longitudinal stability of aircraft carrying external stores. Several configurations of MK 82 and M 117 bombs on triple ejection racks and multiple ejection racks were run at Mach numbers of .2, .82 and .91. The static margins for similar bomb configurations on inventory type pylons and new low side area pylons are compared. For the tests at M .2 the loss in static margin for a given configuration on the new low side area pylon was an average of 19% less than that on an inventory type pylon. The average loss in static margin for the transonic runs with the inventory pylon was 8.9% mean aerodynamic chord (MAC) while the same configurations with the new pylon gained an average of 2.2% mean aerodynamic chord (MAC). Author (GRA)

N74-13750# Air Force Academy, Colo. Dept. of Aeronautics.
A COMPUTER PROGRAM FOR AIRCRAFT OPTIMAL CONTROL PROBLEMS
Jerry D. Hines and Juane M. Davis Jul. 1973 117 p refs
(AD-767919; DFAN-TR-73-4) Avail: NTIS CSCL 01/3

The report described uses a gradient technique having a rapid convergence rate to investigate problems of aircraft optimal control. The FORTRAN program for the Burroughs 6700 computer and sample output are included for a minimum time turn (3 dimensional) for an aircraft with thrust vectoring capability. The operation of the program is explained and the program variables are identified. Author (GRA)

N74-13751# Center for Naval Analyses, Arlington, Va.
AIRCRAFT FORCE PROTECTION MODEL. VOLUME 1: USERS GUIDE TO AFPM
Steven W. Klein and Thomas H. Thoureen Mar. 1973 151 p refs
(Contract N00014-68-A-0091)
(AD-767946; CNA-Res-Contrib-225) Avail: NTIS CSCL 15/5

The Aircraft Force Projection Model (AFPM) is a FORTRAN model which projects the Navy's aircraft inventory over a ten-year period and attempts to satisfy the operating requirements of a given set of forces with the projected operating inventory. This comparison of operating inventory and force requirements is the characteristic which sets the AFPM apart from most inventory projection models. The AFPM generates useful characteristics of the aircraft inventory such as projections of the age distribution, attrition quantities, pipeline requirements and rework requirements. Author (GRA)

N74-13752# Environmental Protection Agency, Washington, D.C. Office of Noise Ablatement and Control.
MILITARY AIRCRAFT AND AIRPORT NOISE AND OPPORTUNITIES FOR REDUCTION WITHOUT INHIBITION OF MILITARY MISSIONS Final Report
Sidney Nethery 27 Jul. 1973 187 p refs
(PB-223637/0GA) Avail: NTIS HC $5.25 CSCL 01C

The report is a result of an extensive task force effort to gather all available data pertinent to military aircraft and airport noise and opportunities for reduction without inhibition of military missions. It represents the interpretation of such data by the task group chairman responsible for this specific report. GRA

N74-13753# Naval Postgraduate School, Monterey, Calif. Dept. of Electrical Engineering.
TURNING CHARACTERISTICS OF THE BELL 100 TON SURFACE EFFECT SHIP M.S. Thesis
Kenneth Randall Myers Jun. 1973 145 p refs
(AD-767680) Avail: NTIS CSCL 13/10

The turning characteristics of the Bell 100 ton captured Air Bubble Surface Effect Ship (CAB/SES) are studied with the aid of the Oceanic Incorporated computer simulation. The crafts motions for straight runs, straight runs with waves and turning runs under calm water conditions, are compared with the final set of computer simulation turning maneuvers with waves involving changing speeds, wavelengths, wave amplitudes, and final rudder angles. Author (GRA)

N74-13754# Rockwell International Corp., Los Angeles Calif. Aircraft Div.
STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP. VOLUME 1: CONFIGURATION DEFINITION. SUPPLEMENT 1: AERODYNAMIC TRADES OF FLAP AND ROLL CONTROL SYSTEM Final Report, 10 Jun. 1971 - 10 Dec. 1972
Dirk J. Renselaer Wright-Patterson AFB, Ohio AFFDL Apr. 1973 122 p refs 6 Vol.
(Contract F33615-71-C-1760; AF Proj. 643A)
(AD-767179; AFFDL-TR-73-20-Vol-1-Suppl-1) Avail: NTIS CSCL 01/3

Contents: Comparison of climb speeds; Comparison of roll acceleration with all engines operating; Comparison of roll acceleration with one engine inoperative; Comparison of lift loss due to maximum roll control. GRA

N74-13755# Rockwell International Corp., Los Angeles Calif. Aircraft Div.
STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP. VOLUME 3: PERFORMANCE METHODS AND LANDING RULES Final Report, 10 Jun. 1971 - 10 Dec. 1972
Dirk J. Renselaer Wright-Patterson AFB, Ohio AFFDL Apr. 1973 161 p refs 6 Vol.
(Contract F33615-71-C-1760; AF Proj. 643A)
(AD-767180; AFFDL-TR-73-20-Vol-3) Avail: NTIS CSCL 01/3

Contents: Identification of critical STOL safety aspects; Recommended ground rules; STOL takeoff performance; STOL landing performance. GRA

N74-13756# Rockwell International Corp., Los Angeles Calif. Aircraft Div.
STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP. VOLUME 5, PART 1: CONTROL SYSTEM MECHANIZATION TRADE STUDIES Final Report, 10 Jun. 1971 - 10 Dec. 1972
Robert W. Phillips Wright-Patterson AFB, Ohio AFFDL Apr. 1973 70 p refs 6 Vol.
(Contract F33615-71-C-1760; AF Proj. 643A)
(AD-767181; AFFDL-TR-73-20-Vol-5-Pt-1) Avail: NTIS CSCL 01/3

Contents: System analyses; System characteristics comparison; Control component requirements; Handling qualities. GRA

N74-13757# Rockwell International Corp., Los Angeles Calif. Aircraft Div.
STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP, VOLUME 5, PART 3: STABILITY AND CONTROL DERIVATIVE ACCURACY REQUIREMENTS AND EFFECTS OF AUGMENTATION SYSTEM DESIGN Final Report, 10 Jun. 1971 - 10 Dec. 1972
Victor H. Kumoto and William K. Elsanker Wright-Patterson AFB, Ohio AFFDL Apr. 1973 201 p refs 6 Vol.
(Contract F33615-71-C-1760; AF Proj. 643A)
(AD-767182; AFFDL-TR-73-20-Vol-5-Pt-3) Avail: NTIS CSCL 01/3

Contents: Flying qualities requirements; Selection of baseline flight condition; Selection of coefficient variation ranges; Technical approach; Coefficient prediction accuracy requirements; Lateral-directional parameter variation data; Longitudinal parameter variation data; Coefficient accuracy requirements -- unaugmented aircraft; Coefficient accuracy requirements -- baseline augmented aircraft. GRA

N74-13882*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A REAL-TIME DIGITAL PROGRAM FOR ESTIMATING AIRCRAFT STABILITY AND CONTROL PARAMETERS FROM FLIGHT TEST DATA BY USING THE MAXIMUM LIKELIHOOD METHOD
Randall D. Grove and Stanley C. Mayhew (Electronic Assoc., Inc.) Washington Dec. 1973 132 p refs
(NASA-TM-X-2788; L-8796) Avail: NTIS HC $4.50 CSCL 09B

A computer program (Langley program C1123) has been developed for estimating aircraft stability and control parameters from flight test data. These parameters are estimated by the maximum likelihood estimation procedure implemented on a real-time digital simulation system, which uses the Control Data 6600 computer. This system allows the investigator to interact with the program in order to obtain satisfactory results. Part of this system, the control and display capabilities, is described for this program. This report also describes the computer program by presenting the program variables, subroutines, flow charts, listings, and operational features. Program usage is demonstrated with a test case using pseudo or simulated flight data. Author

N74-13903# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
THE ac POWER CONTROLLERS FOR SOLID STATE DISTRIBUTION SYSTEM. VOLUME 1: DESIGN, DEVELOPMENT, FABRICATION, AND TEST OF HYBRID DEVICES Final Report, Jun. 1971 - May 1973
James T. Mitchell, W. W. Billings, K. C. Shuey, and C. M. Gauthier Sep. 1973 162 p
(Contract F33615-71-C-1900; AF Proj. 3145)
(AD-768199; WAED-73-12-Vol-1; AFAPL-TR-73-75-Vol-1) Avail: NTIS CSCL 09/3

The report describes the work done in a program in which solid state power controllers were designed, developed, fabricated, and tested. Units rated 1.0 through 5.0 amperes, 230 volts, and 1.0 through 75 amperes, 115 volts, 400 Hz, were built using hybrid thick-film bare chip and wire techniques. Details of the test results, circuit designs, and recommendations are included as part of this report. Author (GRA)

N74-13954# Army Transportation Engineering Agency, Newport News, Va.
RESTRAINT PROCEDURES FOR CARGO LOADED IN VEHICLES TO BE AIR TRANSPORTED
Louis Zabohonski, Jr. Aug. 1973 46 p
(AD-768172; USATEA-73-23) Avail: NTIS CSCL 13/6

The report covers an analysis of the strength of the side racks of Army tactical cargo vehicles to determine their suitability to restrain cargo during air transport. The shear strength of the attachment of the cargo bed to the frame is defined based on information furnished from the US Army Tank-Automotive Command (USATACOM). Outlined are procedures for properly loading and restraining cargo in vehicles, using commonly available material. Results of the report indicate that the cargo bed shear from the frame and that these loads can be adequately restrained to the vehicle. The report also reveals potential problems in analyzing aircraft floor loads when the cargo is a loaded vehicle. Author (GRA)

N74-13957# Braun (C. F.) and Co., Alhambra, Calif.
TURBOJET AIRCRAFT ENGINE TEST CELL POLLUTION ABATEMENT STUDY Final Report, Jul. - Dec. 1972
George F. Davies and Richard H. Crow 29 Jun. 1973 96 p refs
(Contract N62399-72-C-0020)
(AD-768287; NCEL-CR-74.001) Avail: NTIS CSCL 21/5

The report summarizes the results of a survey and analysis of the application of conventional air pollutant abatement systems to the exhaust gas from jet engine test cells. The following methods for gas treatment were investigated: wet scrubbers, incinerators, electrostatic precipitators, filters, dry inertial collectors. The least costly methods for meeting present emission standards are water scrubbing systems. One of the most attractive of wet scrubbers using Koch Flexitrays is developed in detail. The report covers the associated problem of water supply and disposal. The report also includes research and development suggestions for test cell emission control. Author (GRA)

N74-13960 New York Univ., N.Y.
THREE-DIMENSIONAL COMPRESSIBLE BOUNDARY LAYER FLOW OVER A YAWED CONE WITH MASS INJECTION Ph.D. Thesis
Ohyun Rho 1973 191 p
Avail: Univ. Microfilms Order No. 73-19402

. An analytical scheme called the method of multi-interval expansions was introduced to solve the equations of the three-dimensional boundary layer flow. In multi-interval expansions, the solutions of the boundary layer equations in the interval are expressed in terms of those of the previous interval in such a way that all the physical properties and the relevant differential equations are continuous at the boundary between intervals. Consequently, the solutions for the whole flow field are obtained if the solutions of the first interval have been obtained. The first interval can be chosen, in general, as any region of the flow field. However, it may be preferably chosen as a domain, if possible, of the flow field where the governing differential equations are simplified in view of the nature of the flow field at that particular domain, for example, the plane of symmetry of a yawed cone. Dissert. Abstr.

N74-13992# ARO, Inc., Arnold Air Force Station, Tenn.
CALCULATION OF THE BOUNDARY-LAYER FLOW IN THE WINDWARD SYMMETRY PLANE OF A SPHERICALLY BLUNTED AXISYMMETRIC BODY AT ANGLE OF ATTACK, INCLUDING STREAM LINE-SWALLOWING EFFECTS Final Report, Sep. 1971 - Dec. 1972
Arloe W. Mayne, Jr. AEDC Oct. 1973 57 p refs
(ARO Proj. VW5206; ARO Proj. VF203)
(AD-768340; ARO-VKF-TR-73-102; AEDC-TR-73-166) Avail: NTIS CSCL 20/4

Three-dimensional compressible boundary-layer equations are particularized to the windward symmetry plane of a spherically blunted axisymmetric body at incidence under hypersonic conditions. Through the use eddy transport and streamwise intermittency both transitional and fully turbulent boundary layers may be treated. A scheme is presented for determining the outer-edge boundary conditions based on a mass flow balance treatment of the boundary-layer entrainment of the inviscid flow. A finite-difference technique is described for solving the set of partial differential equation governing the boundary-layer flow, and for treating the streamline-swallowing phenomenon. GRA

N74-14119# Sandia Labs., Albuquerque, N.Mex. Signal Analysis Div.
AIRCRAFT VELOCITY MEASUREMENT THROUGH RADAR-ALTIMETER ECHO: A THEORETICAL INVESTIGATION
Charles S. Williams Jul. 1973 36 p refs Sponsored by AEC
(SLA-73-669) Avail: NTIS HC $4.00

An examination of the character of the fading of the echo of a radar altimeter indicates that it might be used to obtain aircraft velocity with considerable accuracy. This preliminary examination considers neither the hardware problems nor the problems that an extremely rough terrain might cause. Author (NSA)

N74-14126# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN INVESTIGATION OF PATTERN RECOGNITION OF AIRCRAFT ATTITUDES INDICATOR DISPLAYS M.S. Thesis
Robert Parker Bateman Jun. 1973 54 p refs
(AD-768345; GA/EE/73-3) Avail: NTIS CSCL 01/4

Spatial disorientation accident statistics are reviewed, along with unsuccessful attempts to prevent these aircraft accidents. The lack of a theoretical basis for flight instrument design is noted. A systems approach to the problem is proposed, which requires a knowledge of the human visual system. It is suggested that attitude indicator displays, the interface between man and machine, should be designed to be compatible with an internal model of spatial position. Orientation in space by the use of flight instruments is identified as a pattern recognition problem. A Fourier transform model of the human visual system is used to evaluate and classify attitude indicator displays. An algorithm is proposed for separating patterns. (Modified author abstract) GRA

N74-14138*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IMPROVED CIRCUMFERENTIAL SHAFT SEAL FOR AIRCRAFT GEAR TRANSMISSIONS
Lawrence P. Ludwig and Thomas N. Strom Washington Dec. 1973 14 p
(NASA-TN-D-7130; E-7133) Avail: NTIS HC $2.75 CSCL 11A

Operation under simulated aircraft transmission conditions of speeds to 2850 m/min (9350 ft/min), lubricant temperatures to 394 K (250 F), shaft radial runouts to 0.254 mm (0.010 in.) F.I.R. (full indicator reading), and pressure differentials to 1.03 N/cm2 (1.5 psi) revealed that conventional circumferential seals leaked excessively. Modifying the conventional seal by adding helical grooves to the seal bore reduced leakage rates to within the acceptable level of 10 cm3/hr. The leakage rate of this modified seal was not significantly affected by lubricant flooding or by shaft radial runout. Author

N74-14238# General Dynamics/Fort Worth, Tex. Convair Aerospace Div.
STUDY OF STRUCTURAL CRITERIA FOR COMPOSITE AIRFRAMES, VOLUME 1: EVALUATION Final Technical Report
Sherrill D. Manning and Glen H. Lemon Wright-Patterson AFB, Ohio AFFDL Apr. 1973 248 p refs 3 Vol.
(Contract F33615-72-C-1066)
(AD-767706; AFFDL-TR-73-4-Vol-1) Avail: NTIS CSCL 11/4

Criteria and design practices currently used for aircraft structures are examined and evaluated for applicability to composite structures. Selected probabilistic or statistical rationales are also reviewed and evaluated for possible applications. From these studies a plan was developed for acquiring understanding and data from which structural criteria and design practices applicable to composite airframes may be written. The basic characteristics of filamentary composites that are unique in comparison to those of metals are defined and explored. Special areas investigated include laminates, joints, and cutouts. (Modified author abstract) GRA

N74-14239# General Dynamics/Fort Worth, Tex. Convair Aerospace Div.
STUDY OF STRUCTURAL CRITERIA FOR COMPOSITE AIRFRAMES. VOLUME 2: CURRENT/CRITERIA/ SELECTED RATIONALE REVIEW AND EVALUATION Final Techinical Report
Sherrill D. Manning, Glen H. Lemon, and Innes Bouton Wright Patterson AFB, Ohio AFFDL Apr. 1973 227 p refs 3 Vol.
(Contract F33615-72-C-1066)
(AD-767707; AFFDL-TR-73-4-Vol-2) Avail: NTIS CSCL 11/4

Criteria and design practices currently used for aircraft structures are examined and evaluated for applicability to composite structures. Selected probabilistic or statistical rationales are also reviewed and evaluated for possible applications. From these studies a plan was developed for acquiring understanding and data from which structural criteria and design practices applicable to composite airframes may be written. The basic characteristics of filamentary composites that are unique in comparison to those of metals are defined and explored. Special areas investigated include laminates, joints, and cutouts. The structural criteria derived from metallic structure experiences are not applicable to composite structure because the critical interaction of a low strain to failure material with structural complexity is not recognized; universal requirements and rigid design practices irrespective of material, design concept or manufacturing methods, or size effects are imposed, and an assumption of translation of residual strength and lifetime allowables from the material level to the component level, which is incompatible with observed composite behavior is imposed. Accelerated test procedures have not been developed successfully; therefore, near-term composite designs should be developed using a realistic random load and environment simulation. In order to achieve the necessary confidence in structural integrity, the composite design should acknowledge fleet size, reliability goals, structural complexity, scaling from test specimen-to-component level. (Modified author abstract) GRA

N74-14246# Air Force Materials Lab., Wright-Patterson AFB, Ohio.
IMPROVED SILICONE FLUIDS AS CANDIDATE GAS TURBINE ENGINE OILS FOR MINUS 40 F TO 465 F TEMPERATURE RANGE Technical Report, Nov. 1971 - Jul. 1972
George J. Morris Jul. 1973 29 p refs
(AF Proj. 7345)
(AD-767898; AFML-TR-73-72) Avail: NTIS CSCL 11/8

A physical and chemical laboratory study of several silicone fluids that represent some of the latest technology in the area has been conducted. These fluids were an alkyl methyl silicone, a trifluoropropyl methyl silicone and a methyl silicone improved by the use of additive formulation. These fluids were investigated for possible use as candidate gas turbine engine oils in the temperature range of -40F to -465F. The viscosity-temperature characteristics, volatility, oxidation stability, corrosion reactivity towards selected metals and lubrication capabilities were assessed for conformance with the recently established specification, MIL-L-27502, covering the aforementioned temperature range. The alkyl methyl silicone, although having favorable rheological and lubrication behavior, was so oxidatively unstable and corrosion prone that further study is not recommended. Both trifluoropropyl methyl silicone and improved methyl silicone have demonstrated sufficient oxidation and corrosion stability to warrant further study.
GRA

N74-14271# Advisory Group for Aerospace Research and Development, Paris (France).
ATMOSPHERIC POLLUTION BY AIRCRAFT ENGINES
Sep. 1973 405 p refs Mostly in ENGLISH; partly in FRENCH Conf. held at London, 9-13 Apr. 1973
(AGARD-CP-125) Avail: NTIS HC $22.25

The proceedings of a conference on the effects of aircraft engines on atmospheric pollution are presented. The impact of military and civilian aircraft operations on pollution levels are compared with the pollution from other sources. The subjects stressed are: (1) effects of pollution at very high altitudes, (2) effects of pollution near airports, and (3) methods for reduction of pollutant production in combustion processes and in engines. A review of the physiological effects of air pollution is included.

N74-14272* New York Univ., N.Y. Dept. of Aeronautics and Astronautics.
REDUCTION OF NO FORMATIONS BY PREMIXING
Antonio Ferri *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 10 p ref

(Grant NGR-33-016-131)

The effects of exhaust gases from supersonic transport aircraft on the equilibrium of the stratosphere are discussed. A method for reducing the amount of nitrogen oxides generated by the engines of supersonic transports is describes. The engine requirements for the turbojet engines of the supersonic transport aircraft are defined. The design of combustion chambers to provide premixed flames and the thermodynamic properties of premixed flames are analyzed. Charts are developed to show the isotherms of the ignited mixtures for various conditions and the mass fraction of nitrogen oxide along selected streamlines.
Author

N74-14273 Department of Transportation, Washington, D.C.
UNITED STATES DEPARTMENT OF TRANSPORTATION RESEARCH PROGRAM FOR HIGH ALTITUDE POLLUTION
Alan J. Grobecker *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p refs

A review of a United States program to provide an assessment by 1974 of the impact on man, plants and animals of climatic changes due to perturbations of the upper atmosphere by the propulsion effluents of a world high-altitude aircraft fleet as projected to 1990 is presented. Some physical considerations which must be taken into account in this program are described, including representations: of the stratosphere in its unperturbed state, of the effluents of vehicles expected in 1990, of the perturbed stratosphere of 1990, of the perturbed troposphere of 1990 and 2020, of the effects of climatic changes on the biosphere and of social and economic measures of these biological effects.
Author

N74-14277 Bonn Univ. (West Germany). Inst. fuer Physikalische Chemie
PHOTO-OXIDATION OF AIRCRAFT ENGINE EMISSIONS AT LOW AND HIGH ALTITUDES
K. H. Becker and U. Schurath *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 9 p refs

The mechanism of photochemical smog formation is examined. The applicability of photochemical smog formation to aircraft emissions is described. It is concluded that photo-oxidation mechanisms of pollutants from aircraft and other sources in the troposphere undergo fundamental changes with altitude, radical and atom reactions, and probably reactions of metastable oxygen molecules, becoming more important in the colder regions of the troposphere. Serious contamination of the troposphere by aircraft is not expected, because the residence time of pollutants is short compared with emissions rates.
Author

N74-14278 Oslo Univ. (Norway). Inst. of Geophysics.
EFFECT OF SUPERSONIC TRANSPORT UPON THE OZONE LAYER, STUDIED IN A TWO-DIMENSIONAL PHOTOCHEMICAL MODEL WITH TRANSPORT
Eigil Hesstvedt *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 8 p refs

A steady state two-dimensional model of the stratospheric ozone layer is presented. Photochemical reactions involving oxygen, hydrogen, and nitrogen are considered along with the effect of a parameterized, two-dimensional transport, by mean motion and by eddies. A parameterized meridional distribution of NOx is applied, computed from one-dimensional models. The model is in fair agreement with observed ozone data. The reduction of ozone from emission of NOx from supersonic aircraft is studied, assuming a fleet of 200 aircraft, flying at given altitudes and uniformly distributed over the globe. The effect is found to depend critically upon the flight level. For mid-latitude, summer, the ozone column density is reduced by 0.4% for a flight level of 18 km. For flight levels 23 km and 28 km the reduction is 1.6% and 2.3%, respectively. Accordingly, the increase in UV-radiation amounts to approximately 0.8%, 3.2%, and 4.6% for the same flight levels.
Author

N74-14281 Bristol Univ. (England). Dept. of Aeronautical Engineering.
PROBLEMS OF CHEMICAL POLLUTION BY AIRCRAFT. THE AIRPORT AND ITS IMMEDIATE ENVIRONMENT
T. V. Lawson *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 3 p

The chemical pollution of the airport and its environment is discussed. It calls for a careful study of all surveys so that the inbuilt implications of the model are obvious, and it concludes that the problems of chemical pollution by the aircraft themselves are small. It suggests that much more progress will be made in attempts to reduce pollution around airports by concentrating upon organizations other than the engine manufacturers. It closes by suggesting that authors of technical papers be encouraged to supply an epilogue in which they summarize the findings of their work for the benefit of the lay public.
Author

N74-14282 Warren Spring Lab., Stevenage (England). Air Pollution Div.
RELATIVE AIR POLLUTION EMISSIONS FROM AN AIRPORT IN THE UK AND NEIGHBOURING URBAN AREAS
A. W. C. Keddie, J. Parker, and G. H. Roberts *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 9 p refs

Air pollution levels at Stansted Airport in relation to emissions from four nearby towns are discussed. Calculations have been made of pollution emissions from these four sources and also from the airport and the expected contributions from these sources at three local sites have been examined. These values are compared with actual measurements at the three sites. Author

N74-14283 Chemical Defence Experimental Establishment, Porton (England).
GROUND CONTAMINATION BY FUEL JETTISONED FROM AIRCRAFT
N. L. Cross and R. G. Picknett IN AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 9 p refs

A study of the problem of ground pollution produced by fuel jettisoned from aircraft under emergency conditions was conducted. The likely size distribution of drops produced when fuel is jettisoned is examined. The proportions of jettisoned fuel which survive evaporation to reach the ground are determined. It is stated that the contamination density on the ground depends on atmospheric stability, wind speed, and direction of flight relative to wind direction. Data obtained from flight tests of jettisoned fuel are presented in tables and graphs. Author

N74-14284 Air Corporations Joint Medical Service (BEA/BOAC), London (England).
POLLUTION LEVELS AT LONDON (HEATHROW) AIRPORT AND METHODS FOR REDUCING THEM
D. M. Bruton *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 6 p ref

Exhaust pollution levels at Heathrow Airport, London, England were conducted. Medical surveys of the interior of buildings were conducted to determine pollution levels. It was determined that pollution levels are below those of many urban areas and do not appear to represent either a short or long range hazard to health. Local pollution problems constitute a source of annoyance to ground personnel employed at the airport. Methods for reducing the exhaust fume emission by vehicle selection, engine tuning, and maintenance practices are recommended. Author

N74-14285 Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.
POLLUTION CONTROL OF AIRPORT ENGINE TEST FACILITIES
D. L. Baily, P. W. Tower, and A. E. Fuhs *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 32 p refs

Engine test facilities are required to meet the same environmental standards as any other industrial facility. To meet the standards for smoke, noise, gaseous pollutants, etc. control equipment must be installed. Due to large mass flow rates the control equipment is expensive, careful attention to design is necessary to control costs. Pollution control forces new constraints on exhaust stack temperature, flow uniformity and pressure. Conversely, installation of pollution abatement apparatus may cause adverse operating conditions such as distorted flow into the engine and wrong augmentation ratio. The internal aerodynamics of engine test cells must be mastered to a level not possible previously. Scale models of test cells were fabricated in modules so that some 750 different combinations could be tested. Distortion at the engine face was measured and correlated in terms of component factors. Augmentation ratio and cell depression were measured. An analytical model correctly predicted the measured quantities except for distance from engine nozzle to augmenter inlet. With the data accumulated it should be possible to match pollution control requirements to test cell parameters. Author

N74-14291* Massachusetts Inst. of Tech., Cambridge Dept. of Mechanical Engineering.
PARAMETERS CONTROLLING NITRIC OXIDE EMISSIONS FROM GAS TURBINE COMBUSTORS
John B. Heywood and Thomas Mikus *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 16 p refs
(Grant NGR-22-009-378)

Nitric oxide forms in the primary zone of gas turbine combustors where the burnt gas composition is close to stoichiometric and gas temperatures are highest. It was found that combustor air inlet conditions, mean primary zone fuel-air ratio, residence time, and the uniformity of the primary zone are the most important variables affecting nitric oxide emissions. Relatively simple models of the flow in a gas turbine combustor, coupled with a rate equation for nitric oxide formation via the Zeldovich mechanism are shown to correlate the variation in measured NOx emissions. Data from a number of different combustor concepts are analyzed and shown to be in reasonable agreement with predictions. The NOx formation model is used to assess the extent to which an advanced combustor concept, the NASA swirl can, has produced a lean well-mixed primary zone generally believed to be the best low NOx emissions burner type. Author

N74-14292 California Univ., Berkeley. Dept. of Mechanical Engineering.
FACTORS CONTROLLING POLLUTANT EMISSIONS FROM GAS TURBINE ENGINES
R. F. Sawyer, N. P. Cernansky, and A. K. Oppenheim *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p refs
(Grants AF-AFOSR-2299-72; AF-AFOSR-2200-72)

Primary pollutants emitted by aircraft gas turbine engines are carbon monoxide, hydrocarbons, aldehydes, smoke, particulates, and nitric oxide. Factors controlling emissions of these pollutants are analyzed on the basis of aircraft engine exhaust composition and laboratory studies of gas turbine combustion processes. Moreover, an analytical prediction of the effect of aircraft operating parameters on the emission of nitric oxide is also given. The formation and destruction of these pollutants were investigated in a laboratory gas turbine combustor. The oxidation of carbon monoxide, hydrocarbons, and aldehydes was measured in the dilution zone where thermal quench phenomena were observed. The apparent oxidation of particulates in the dilution zone was also observed. The formation of nitric oxide was observed in the primary zone and in the first part of the dilution section of the combustor. Operational conditions and engine parameters were studied analytically, yielding rational criteria for the prediction of their effect on the emmission of nitric oxide. Author

N74-14293 Norwegian Inst. for Air Research, Kjeller.
A SYSTEMATIC APPROACH TO THE STUDY OF THE CONNECTION BETWEEN EMISSION AND AMBIENT AIR CONCENTRATIONS
Knut Erik Groenskei *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 10 p refs

A systematic approach to study the effect of a complex source distribution on the ambient air quality is described. Measurements of emission, meteorological parameters, and ambient air concentrations are used to develop a quantitative model describing the important physical and chemical processes. The model is mathematically formulated in a modified form of the continuity equation for the pollution component. To improve the model, regression analysis can be used. An example of this approach is given in the study of air pollution in Oslo where it has been shown that a systematic vertical motion is the most important process to clean the air in Oslo during inversion situations. Some comments are made on the model approach to the air pollution problem around an airfield. Author

N74-14300 General Electric Co., Cincinnati, Ohio. Advanced Combustion and Emissions Control Technology.
TECHNOLOGY FOR THE REDUCTION OF AIRCRAFT TURBINE ENGINE EXHAUST EMISSIONS
Donald W. Bahr *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p refs

Tests of both production and advanced engines were conducted to determine the emission characteristics of aircraft

turbine engines. The results of these engine evaluations are presented. Also presented are the results of exploratory investigations to define and develop design approaches for reducing the carbon monoxide, unburned hydrocarbons, and nitrogen oxides emission levels of high performance, annular combustors - with already developed low smoke emission characteristics. In these latter investigations, the emissions level reductions obtainable through the use of advanced primary combustion zone stoichiometry control methods and advanced fuel injection techniques were evaluated. In addition, results are presented on the use of water injection techniques to suppress the formation of nitrogen oxides in combustors. It is concluded that future engines can be developed with significantly lower levels of these gaseous emissions than those of current engines.
Author

N74-14301 Cranfield Inst. of Technology (England). School of Mechanical Engineering.
A PRELIMINARY STUDY ON THE INFLUENCE OF FUEL STAGING ON NITRIC OXIDE EMISSIONS FROM GAS TURBINE COMBUSTORS
A. H. Lefebvre and R. S. Fletcher *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 7 p refs

The results are presented from a preliminary investigation carried out on a tubular aircraft combustor chamber which was perfectly standard apart from an additional fuel injector located just downstream of the primary zone. Measurements of nitric oxide exhaust emissions were carried out over a range of fuel to both primary and secondary zones and the results compared with predictions based on a previously derived mathematical model.
Author

N74-14302* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND EVALUATION OF COMBUSTORS FOR REDUCING AIRCRAFT ENGINE POLLUTION
Robert E. Jones and Jack Grobman *In* AGARD Atmospheric Pollution by Aircraft Engine Sep. 1973 8 p refs

Various techniques and test results are briefly described and referenced for detail. The effort arises from the increasing concern for the measurement and control of emissions from gas turbine engines. The greater part of this research is focused on reducing the oxides of nitrogen formed during takeoff and cruise in both advanced CTOL, high pressure ratio engines, and advanced supersonic aircraft engines. The experimental approaches taken to reduce oxides of nitrogen emissions include the use of: multizone combustors incorporating reduced dwell time, fuel-air premixing, air atomization, fuel prevaporization, water injection, and gaseous fuels. In the experiments conducted to date, some of these techniques were more successful than others in reducing oxides of nitrogen emissions. Tests are being conducted on full-annular combustors at pressures up to 6 atmospheres and on combustor segments at pressures up to 30 atmospheres.
Author

N74-14304 Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
AIRCRAFT GAS TURBINE POLLUTANT LIMITATIONS ORIENTED TOWARD MINIMUM EFFECT ON ENGINE PERFORMANCE
Robert E. Henderson and William S. Blazowski *In* AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p refs

The proposed Environmental Protection Agency (EPA) regulations for aircraft engine emissions are examined in terms of their impact on the application to military aircraft gas turbine engines. A quantitative assessment of current engine emission levels, design trends, and potential emission control techniques is presented. It is concluded that special considerations must be afforded to military aircraft relative to direct application of EPA regulations; however, many future emission--reducing advances will be applicable to military gas turbines. U. S. Air Force goals were established to insure that new engines take advantage of this technology, and are in accordance, to the greatest degree possible, with what EPA requires of commercial aircraft. These goals are in terms of minimum idle combustion inefficiency, maximum allowable oxides of nitrogen (lb/1000 lb-fuel), and maximum allowable smoke number. The rationale behind using these parameters, and the means by which the numerical limitations were derived, are described.
Author

N74-14340# Airborne Instruments Lab., Deer Park, N.Y.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 1.0, VOLUME 1.1: TECHNIQUE ANALYSIS PROGRAM
Washington FAA 27 Sep. 1972 347 p refs
(Contract DOT-FA72WA-2800)
(FAA-RD-73-166-Vol-1.1) Avail: NTIS HC $19.50

The development plan for a microwave landing system is analyzed. The subjects investigated are: (1) system functional requirements, (2) signal format and hardware characteristics, (3) compatibility of proposed system with existing landing systems and aircraft equipment, (4) critical technical areas, and (5) special component development requirements. The objective of the study is to prove feasibility of the concept and to show that the system will be practical and cost effective.
Author

N74-14341# Airborne Instruments Lab., Deer Park, N.Y.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 1.0, VOLUME 1.2, BOOK 1: POST TACD DEVELOPMENT PLAN
Washington FAA 27 Sep. 1972 433 p refs
(Contract DOT-FA72WA-2800)
(FAA-RD-73-166-Vol-1.2,1-Bk-1) Avail: NTIS HC $23.75

The test program for evaluation of a microwave landing system is presented. The purpose of the plan is to confirm that the system has the capability of meeting specified functional and operational requirements. The tests which are considered necessary to evalute the performance of the system are defined. The test methods, including flight test phases, are explained. The phases, equipment tested, test objectives, and test facilities are tabulated.
Author

N74-14342# Airborne Instruments Lab., Deer Park, N.Y.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 1.0, VOLUME 1.2, BOOK 2: POST TACD DEVELOPMENT PLAN
Washington FAA 27 Sep. 1972 372 p refs
(Contract DOT-FA72WA-2800)
(FAA-RD-73-166-Vol-1.2,2-Bk-2) Avail: NTIS HC $20.75

The various configurations of the microwave landing system are discussed. The variations are developed from the requirements of the organizations using the system. Each variation of the microwave landing system is described in terms of: (1) functional characteristics, (2) azimuth guidance equipment, (3) elevation guidance equipment, (4) distance measuring equipment, and (5) airborne equipment. Circuit diagrams of the electronic components of the system are provided.
Author

N74-14343# Airborne Instruments Lab., Deer Park, N.Y.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 3.0, VOLUME 3.1, BOOK 1: COMPILATION OF CRITICAL TECHNICAL AREA REPORTS
Washington FAA 27 Sep. 1972 346 p refs
(Contract DOT-FA72WA-2800)
(FAA-RD-73-166-Vol-3.1,1-Bk-1) Avail: NTIS HC $19.50

The critical technical areas (CTA) involved in the development of a microwave landing system are presented. The CTA's discussed are: (1) curved path utilization, (2) air traffic control interface, (3) auxiliary data utilization, (4) back course utilization, (5) missed approach transition, (6) airborne antennas, and (7) azimuth side lobe suppression. Author

N74-14344# Airborne Instruments Lab., Deer Park, N.Y.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 3.0, VOLUME 3:1, BOOK 2: COMPILATION OF CRITICAL TECHNICAL AREA REPORTS
Washington FAA 27 Sep. 1972 351 p refs
(Contract DOT-FA72WA-2800)
(FAA-RD-73-166-Vol-3.1.2-Bk-2) Avail: NTIS HC $19.75

The critical technical areas (CTA) involved in the development of a microwave landing system are presented. The CTA's discussed are: (1) auxiliary data recovery, (2) auxiliary data interpretation, (3) channel pairing, (4) receiver spurious response analysis, (5) decoder class compatibility, (6) distance measuring equipment, and (7) signal attenuation. Author

N74-14352 Royal Aircraft Establishment, Farnborough (England).
AIRCRAFT INERTIAL SYSTEM TESTING AND EVALUATION IN THE UNITED KINGDOM
R. F. Stokes and S. G. Smith *In* AGARD Testing Philosophy and Methods of Guidance and Control Systems and Subsystems Oct. 1973 49 p

Internal system testing by Government Departments in the United Kingdom is undertaken by two Establishments - RAE Farnborough and A and AEE Boscombe Down. For historical reasons most flying is done at A and AEE, where a fully instrumented aircraft has been provided for precise navigation trials, but the methods used are largely derived at RAE. Details of the reference equipment available, its advantages and drawbacks, are given, together with a description of the methods used to obtain a high quality, world-wide position and velocity reference. Various methods of obtaining statistical performance parameters are discussed and their consistency is demonstrated. The problems of performance diagnosis are illustrated with a worked example, which also shows the use of a digital mathematical model of an IN system. Some ideas on a possible new approach to inertial system testing are also given. Author

N74-14360# National Aviation Facilities Experimental Center, Atlantic City, N.J.
FIELD EVALUATION OF ARTS 2 B (TRACAB) Interim Report, Feb. - Apr. 1973
Robert A. Clark and James F. Akers Oct. 1973 50 p refs
(AD-768203; FAA-NA-73-54; FAA-RD-73-119) Avail: NTIS CSCL 17/7

A programmable ARTS (Automated Radar Terminal System) II B, non-tracking, beacon alphanumeric system was installed in a TRACAB (Terminal Radar Approach Control Cab) configuration in a live air traffic control tower environment. Operational suitability and techniques to be used in the automation program for low-density terminal/towers were evaluated. The system was evaluated over a six-week period through collection of subjective data obtained from controller questionnaires. It was concluded that while suitable for application in a TRACAB (Terminal Radar Approach Control Cab) environment and compatible with the controller, extensive modification to both display subsystem and software were required to improve its usefulness. Author (GRA)

N74-14361# Transportation Systems Center, Cambridge, Mass.
USER'S MANUAL FOR ILSLOC: SIMULATION FOR DEROGATION EFFECTS ON THE LOCALIZER PORTION OF THE INSTRUMENT LANDING SYSTEM
G. Chin, L. Jordan, D. Kahn, S. Morin, D. Newsom, and A. Watson Aug. 1973 91 p
(AD-768049; DOT-TSC-FAA-73-13; FAA-RD-73-76) Avail: NTIS CSCL 17/7

The manual presents the complete ILSLOC computer program package. In addition to including a thorough description of the program itself and a commented listing, the manual contains a brief description of the ILS system and antenna patterns. To illustrate the program a test case was created and the figures of the case are incorporated in the report. Program DYNM and program ILSPLT are included as Appendices. The ILSPLT, complete with sample graphs, is a plotting routine for ILSLOC. For a technical mathematical analysis of the system, the FAA report Instrument Landing System Scattering No. FAA-RD-72-137 should be consulted. Author (GRA)

N74-14362# Tactical Air Warfare Center, Eglin AFB, Fla.
SIMPLIFIED VISUAL APPROACH SLOPE INDICATOR (VASI) Final Report, 16 Apr. - 31 Jul. 1973
James F. Yealy Sep. 1973 28 p
(AD-767901) Avail: NTIS CSCL 17/7

The purpose of this operational test and evaluation was to determine the value of a simplified visual approach slope indicator (VASI) system to the USAF Special Operations Force by accomplishing three test objectives; formulate and document construction criteria, establish user acceptance/rejection, and incorporate an air-transportable capability. Two types of systems were designed and constructed for user evaluation. Both were identical except for the support arrangement. One system was embedded in the ground, and the other was anchored to the ground by using sandbags. Both systems could be transported by air. Two hundred and eighty approaches were flown against the systems by 61 different pilots. The majority of pilots indicated that the systems were effective beginning at distances ranging from 1/2 to 1 mile and ending at 25- to 50-foot altitude (approximately 450 to 950 feet in front of the boards) during night or daytime operation. The best color combination was determined to be black stripe on white background. It was recommended that USAF Special Operations Force retain the two systems for potential future use during deployments to austere bases, temporary airfields, and landing zones not equipped with standard VASI. Author (GRA)

N74-14379 Connecticut Univ., Storrs.
THE SPECTRUM OF TURBOMACHINE ROTOR NOISE CAUSED BY INLET GUIDE VANE WAKES AND ATMOSPHERIC TURBULENCE Ph.D. Thesis
Donald Burnett Hanson 1973 142 p
Avail: Univ. Microfilms Order No. 73-24404

A theoretical methodology is developed to calculate the partially coherent acoustic radiation of propellers, helicopter rotors, and axial flow fans due to inflow turbulence which is not plots of experimental data. The methodology is applied to two important cases: in the first case the rotor inflow contains non-homogeneous turbulence in the wakes of inlet guide vanes (IGV's) and in the second case it contains the turbulence ingested from the atmosphere which is highly anisotropic at low or zero forward flight speed. Dissert. Abstr.

N74-14383*# Scientific Translation Service, Santa Barbara, Calif.
REPRESENTATION OF HOT JET TURBULENCE BY MEANS OF ITS INFRARED EMISSION
J.-F. DeBelleval and M. Perulli Washington NASA Dec. 1973 24 p refs Transl. into ENGLISH from Office Natl. d'Etudes et de Rech. Aerospatiales (France), report tp-1277, 17-21 Sep. 1973 10 p
(Contract NASw-2483)
(NASA-TT-F-15233; TP-1277) Avail: NTIS HC $3.25 CSCL 20A

The theoretical description of a jet acoustic radiation is characterized by turbulence data, defined at the scale of the total emissive volume. These data have average values in time, i.e. representing the whole spectrum. A representation of a hot jet turbulence by means of crossed spectral densities is presented. It is possible to define at any point of the source volume the characteristics turbulence data by frequency bands. Author

N74-14384*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SONIC INLET NOISE ATTENUATION AND PERFORMANCE WITH A J-85 TURBOJET ENGINE AS A NOISE SOURCE
Harold W. Groth 1974 14 p refs Proposed for presentation at 12th Aerospace Sci. Meeting, Washington, D. C., 30 Jan. - 1 Feb. 1974
(NASA-TM-X-71488; E-7823) Avail: NTIS HC $3.00 CSCL 20A

A static test program was conducted to investigate aerodynamic and acoustic performance of a sonic inlet used as a noise suppressor. A translating centerbody type inlet with radial vanes was tested ahead of a J85-GE-13 turbojet engine. The inlet when fully choked, maintained high recovery with low distortions while dramatically reducing noise emanating from the compressor. Recoveries of 98.1% at simulated takeoff and 95% at approach were attained with associated sound attenuation of 40 db and 38 db respectively. Inlet lip shape was found to have significant effects on noise attenuation at these static conditions. Author

N74-14437 South Dakota State Univ., Brookings.
THE UNSTEADY CIRCULATION DISTRIBUTION IN ROTORS AND ITS APPLICATION TO NOISE STUDIES Ph.D. Thesis
Assem Fathy Aly Fathy 1973 103 p
Avail: Univ. Microfilms Order No. 73-22970

A new method for the calculation of the unsteady circulation distribution in axial flow compressors was developed. The classical assumption of representing the rotor by a two dimensional infinite cascade was eliminated. Instead the more realistic case of a radial cascade with blades of finite length was studied. The value of the circulation calculated using the present analysis was used in the classical theory of compressor noise prediction to study the effects of the different compressor design parameters on the noise generated under different types of inlet disturbances. The results suggest that in reaching an optimum design based on minimum noise both steady and unsteady loading effects must be taken into consideration. Dissert. Abstr.

N74-14439# Cranfield Inst. of Technology (England). School of Mechanical Engineering.
ESTIMATION AND OPTIMIZATION OF THE FILM COOLING REQUIREMENTS IN A GAS TURBINE COMBUSTION CHAMBER
D. R. Ballal Oct. 1973 35 p refs
(Cranfield-SME-5) Avail: NTIS HC $3.75

The film cooling requirements of a gas turbine combustion chamber over a typical aircraft flight path were investigated. A computational procedure is used to estimate and optimize the coolant flow for a given value of the metal temperature along the whole length of the liner wall. Results are presented for a variety of mainstream and slot flow conditions. The effects of different film cooling, geometries, mainstream turbulence, and hot gas acceleration were analyzed. Author

N74-14440# Cranfield Inst. of Technology (England).
A PROPOSED METHOD FOR CALCULATING FILM-COOLED WALL TEMPERATURES IN GAS TURBINE COMBUSTION CHAMBERS
D. R. Ballal and A. H. Lefebvre Jun. 1973 20 p refs
(Cranfield-SME-4) Avail: NTIS HC $3.00

A method for calculating the film cooled wall temperatures in gas turbine combustion chambers was developed. Thermal paint tests were conducted at pressures up to 30 atmospheres to confirm the theoretical procedures. The data are applied to minimizing the amount of air used for film cooling of the jet engine combustion chambers as a method for reducing the amount of air pollutants generated by the engine. Author

N74-14444# Creare, Inc., Hanover, N.H.
MODELING A HIGH PRESSURE RATIO CENTRIFUGAL COMPRESSOR USING A LOW SPEED OF SOUND GAS Final Report
James A. Block and Peter W. Runstadler, Jr. May 1973 245 p refs
(Contract DAAJ02-70-C-0022; DA Proj. 1G1-62207-AA-71) (AD-767241; USAAMRDL-TR-73-18) Avail: NTIS CSCL 21/5

The results of a program are presented which demonstrate that low-speed-of-sound modeling is a practical tool for the research and development of high-pressure-ratio, high-speed centrifugal compressors. The compressor air performance and the details of its internal fluid dynamics were replicated at reduced rotational speed when a low-speed-of-sound gas was used, providing inlet Mach number, Reynolds number, and gas specific heat ratio were duplicated. Duplication of inlet specific heat ratio was essential to accurate modeling of the air-equivalent flow rate. Stage pressure ratio and stage efficiency were found to be less sensitive to the accurate replication of air-equivalent inlet specific heat ratio. (Modified author abstract) GRA

N74-14445# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
RESEARCH ON NOISE GENERATED BY DUCTED AIR-FUEL COMBUSTION SYSTEMS Annual Report, 1 Mar. 1972 - 28 Feb. 1973
Edelbert G. Plett, H. H. Chiu, and Martin Summerfield Mar. 1973 33 p refs
(Contract N00014-67-A-0151-0029; NR Proj. 094-366) (AD-767337; AR-2) Avail: NTIS CSCL 21/5

A two-pronged approach to the study of noise generation by combustion in a confined flow system, similar to a jet engine configuration, is described. One aspect deals with the mechanisms of noise generation by combustion; the other aspect deals with the effect of confinement on the noise generation and radiating properties of an unsteady solid-body-flow interaction. The mechanisms of noise generation by combustion are being studied analytically. It is noted that the steady flame structure determine the basic thermodynamic properties such as the sound speed and distribution of heat release, which affect amplification, dispersion and propagation of sound. The non-steady flame characteristics are responsible for noise generation; the turbulent scale, period and intensity affect the burning rate and heat release rate. The overall noise generation character is a superposition of the steady and non-steady acoustic characteristics. In studies with ducted and non-ducted sources, it is found that the interaction between the duct and the noise source can enhance the noise generation potential of the source region. The noise due to unsteady flow over small struts inside a duct is found to overwhelm the free jet noise up to speeds in excess of 1000 ft/sec. Author (GRA)

N74-14447# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LIFE OF FATIGUE CRACKS ON ROTOR BLADES OF TURBINES IN GAS TURBINE ENGINES
V. A. Pivovarov 21 Sep. 1973 14 p refs Transl. into ENGLISH from Vop. Dinam. i Prochnosti (USSR), no. 214, 1971 p 46-55
(AD-767947; FTD-HT-23-817-73) Avail: NTIS CSCL 21/5

The report presents experimental data derived from tests performed on gas turbine blades to ascertain the relationship between cracks and blade fatigue life. GRA

N74-14569 Lehigh Univ., Bethlehem, Pa.
AN IMPROVED EXCEEDANCE THEORY FOR COMBINED RANDOM STRESSES WITH APPLICATION TO AIRCRAFT GUST RESPONSE Ph.D. Thesis
Harold C. Lester 1973 210 p
Avail: Univ. Microfilms Order No. 73-23809

The general n-dimensional theory for calculating the average number of times per second that a random stress vector crosses an interaction boundary is developed. This represents an extension of Rice's classic solution for the exceedances of a constant level by a single random process to its counterpart for an n-dimensional random vector process. In the extension n jointly-stationary random processes forming the components of an n-dimensional stress

vector are considered. A stress interaction boundary is assumed in the form of a closed surface imbedded in this n-dimensional stress space. The theory for the number of exceedances of an arbitrary stress interaction boundary is presented using a joint-statistical approach which fully accounts for all cross-correlation effects and leads to a closed-form expression for the exceedance density function. Dissert. Abstr.

N74-14594* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STRUCTURAL ANALYSIS OF LIGHT AIRCRAFT USING NASTRAN
Michael T. Wilkinson (Louisiana Tech. Univ.) and Arthur C. Bruce (Louisiana Tech. Univ.) *In its* NASTRAN: Users' Experiences Sep. 1973 p 123-124
CSCL 20K

An application of NASTRAN to the structural analysis of light aircraft was conducted to determine the cost effectiveness. A model of the Baby Ace D model homebuilt aircraft was used. The NASTRAN model of the aircraft consists of 193 grid points connected by 352 structural members. All members are either rod or beam elements, including bending of unsymmetrical cross sections and torsion of noncircular cross sections. The aerodynamic loads applied to the aircraft were in accordance with FAA regulations governing the utility category aircraft. Author

N74-14599* Avco Lycoming Div., Stratford, Conn.
BLADE DYNAMICS ANALYSIS USING NASTRAN
Peter S. Kuo *In* NASA. Langley Res. Center NASTRAN: Users' Experiences Sep. 1973 p 251-267 refs

CSCL 20K

The complexities of turbine engine blade vibration are compounded by blade geometry, temperature gradients, and rotational speeds. Experience indicates that dynamics analysis using the finite element approach provides an effective means for predicting vibration characteristics of compressor and turbine blades whose geometry may be irregular, have curved boundaries, and be subjected to high temperatures and speeds. The NASTRAN program was chosen to help analyze the dynamics of normal modes, rotational stiffening and thermal effects on the normal modes, and forced responses. The program has produced reasonable success. This paper presents the analytical procedures and the NASTRAN results, in comparison with a conventional beam element program and laboratory data. Author

N74-14616* Bell Helicopter Co., Fort Worth, Tex.
STATIC AND DYNAMIC HELICOPTER AIRFRAME ANALYSIS WITH NASTRAN
H. E. Wilson and J. D. Cronkhite *In* NASA. Langley Res. Center NASTRAN: Users' Experiences Sep. 1973 p 611-619 refs
CSCL 20K

The use of NASTRAN at Bell Helicopter Company for structural static and dynamic analysis of a helicopter airframe is described. Analysis of airframe internal loads, main rotor isolation systems, and airframe vibration is discussed. The use of each rigid format for these types of analysis is summarized. Suggested improvements to NASTRAN to increase its effectiveness in performing helicopter airframe analysis are given. Author

N74-14621* United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft.
NASTRAN DATA GENERATION OF HELICOPTER FUSELAGES USING INTERACTIVE GRAPHICS
J. B. Sainsbury-Carter and John H. Conaway *In* NASA. Langley Res. Center NASTRAN: Users' Experiences Sep. 1973 p 661-678 refs
CSCL 09B

The development and implementation of a preprocessor system for the finite element analysis of helicopter fuselages is described. The system utilizes interactive graphics for the generation, display, and editing of NASTRAN data for fuselage models. It is operated from an IBM 2250 cathode ray tube (CRT) console driven by an IBM 370/145 computer. Real time interaction plus automatic data generation reduces the nominal 6 to 10 week time for manual generation and checking of data to a few days. The interactive graphics system consists of a series of satellite programs operated from a central NASTRAN Systems Monitor. Fuselage structural models including the outer shell and internal structure may be rapidly generated. All numbering systems are automatically assigned. Hard copy plots of the model labeled with GRID or elements ID's are also available. General purpose programs for displaying and editing NASTRAN data are included in the system. Utilization of the NASTRAN interactive graphics system has made possible the multiple finite element analysis of complex helicopter fuselage structures within design schedules. Author

N74-14625*# Boeing Commercial Airplane Co., Seattle, Wash.
ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF AIRCRAFT METAL STRUCTURES REINFORCED WITH FILAMENTARY COMPOSITES. PHASE 3: MAJOR COMPONENT DEVELOPMENT Final Report
L. L. Bryson and J. E. McCarty Washington NASA Nov. 1973 112 p refs
(Contract NAS1-8858)
(NASA-CR-2122; D6-60136-3) Avail: NTIS HC $4.25 CSCL 20K

Analytical and experimental investigations, performed to establish the feasibility of reinforcing metal aircraft structures with advanced filamentary composites, are reported. Aluminum-boron-epoxy and titanium-boron-epoxy were used in the design and manufacture of three major structural components. The components were representative of subsonic aircraft fuselage and window belt panels and supersonic aircraft compression panels. Both unidirectional and multidirectional reinforcement concepts were employed. Blade penetration, axial compression, and inplane shear tests were conducted. Composite reinforced structural components designed to realistic airframe structural criteria demonstrated the potential for significant weight savings while maintaining strength, stability, and damage containment properties of all metal components designed to meet the same criteria. Author

N74-14631*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC SINGLE-MODE FLUTTER AND BUFFET OF A LOW ASPECT RATIO WING HAVING A SUBSONIC AIRFOIL SHAPE
Larry L. Erickson Washington Jan. 1974 24 p refs
(NASA-TN-D-7346; A-4966) Avail: NTIS HC $2.75 CSCL 01A

Transonic flutter and buffet results obtained from wind-tunnel tests of a low aspect ratio semispan wing model are presented. The tests were conducted to investigate potential transonic aeroelastic problems of vehicles having subsonic airfoil sections. The model employed NACA 00XX-64 airfoil sections in the streamwise direction and had a 14 deg leading edge sweep angle. Aspect ratio, and average thickness were 4.0, 0.35, and 8 percent, respectively. The model was tested at Mach numbers from 0.6 to 0.95 at angles of attack from 0 deg to 15 deg. Two zero lift flutter conditions were found that involved essentially single normal mode vibrations. With boundary layer trips on the model, flutter occurred in a narrow Mach number range centered at about Mach 0.90. The frequency and motion of this flutter were like that of the first normal mode vibration. With the trips removed flutter occurred at a slightly high Mach number but in a mode strongly resembling that of the second normal mode. Author

N74-14650*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE EFFECT OF WATER INJECTION ON NITRIC OXIDE EMISSIONS OF A GAS TURBINE COMBUSTOR BURNING ASTM JET-A FUEL
Nicholas R. Marchionna, Larry A. Diehl, and Arthur M. Trout

Washington Dec. 1973 24 p refs
(NASA-TM-X-2958; E-7531) Avail: NTIS HC $2.75 CSCL 20M

Tests were conducted to determine the effect of water injection on oxides of nitrogen (NOx) emissions of a full annular, ram induction gas turbine combustor burning ASTM Jet-A fuel. The combustor was operated at conditions simulating sea-level takeoff and cruise conditions. Water at ambient temperature was injected into the combustor primary zone at water-fuel ratios up to 2. At an inlet-air temperature of 589 K (600 F) water injection decreased the NOx emission index at a constant exponential rate: NOx = NOx (o) e to the -15 W/F power (where W/F is the water-fuel ratio and NOx(o) indicates the value with no injection). The effect of increasing combustor inlet-air temperature was to decrease the effect of the water injection. Other operating variables such as pressure and reference Mach number did not appear to significantly affect the percent reduction in NOx. Smoke emissions were found to decrease with increasing water injection. Author

N74-14651*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF WATER INJECTION ON NITRIC OXIDE EMISSIONS OF A GAS TURBINE COMBUSTOR BURNING NATURAL GAS FUEL
Nicholas R. Marchionna, Larry A. Diehl, and Arthur M. Trout Washington Dec. 1973 26 p refs
(NASA-TM-X-2959; E-7565) Avail: NTIS HC $3.00 CSCL 20M

The effect of direct water injection on the exhaust gas emissions of a turbojet combustor burning natural gas fuel was investigated. The results are compared with the results from similar tests using ASTM Jet-A fuel. Increasing water injection decreased the emissions of oxides of nitrogen (NOX) and increased the emissions of carbon monoxide and unburned hydrocarbons. The greatest percentage decrease in NOX with increasing water injection was at the lowest inlet-air temperature tested. The effect of increasing inlet-air temperature was to decrease the effect of the water injection. The reduction in NOX due to water injection was almost identical to the results obtained with Jet-A fuel. However, the emission indices of unburned hydrocarbons, carbon monoxide, and percentage nitric oxide in NOX were not. Author

N74-14669 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany).
SECTION 2: FLIGHT MECHANICS, FLIGHT CONTROL [FACHGEBIET 2: FLUGMECHANIK, FLUGFUEHRUNG]

In its DFVLR Annual Review, 1972 1972 p 95-149 refs In GERMAN; ENGLISH summary

Aviation oriented problems studied pertain to operational procedures to increase aircraft handling qualities and flight safety. Development of redundant control systems for satellite, missile, and aircraft guidance is discussed. Special flight systems consider rescue and recovery methods for military applications. Transl. by G.G.

N74-14670 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany).
SECTION 3: STABILITY, CONSTRUCTION MATERIALS, CONSTRUCTION METHODS [FACHGEBIET 3: FESTIGKEIT, WERKSTOFFE, BAUWEISEN]
In its DFVLR Annual Review, 1972 1972 p 151-197 refs In GERMAN; ENGLISH summary

Research in relation to aerospace industrial application stresses problems of structure, materials, and design. Strength and stability of structures subjected to temperature and other stress fields are considered in the framework of aeroelastic and aeromechanical problems of aircraft and spacecraft. Weight optimal utilization of fiber reinforced composite materials is emphasized. Transl. by G.G.

N74-14675 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany).
AEROTECHNOLOGY IN AVIATION PROBLEMS [LUFTFAHRTTECHNISCHER BEREICH]
In its DFVLR Annual Review, 1972 1972 p 383-401 refs In GERMAN; ENGLISH summary

Scientific-engineering coordination with Federal ministries and industries is provided in planning, accomplishing, and evaluating aviation problems of safety and traffic regulations. This includes supplying of pilots and aircraft for scientific tasks of research and testing. Transl. by G.G.

N74-14682*# Techtran Corp., Glen Burnie, Md.
ECONOMICS OF AIR TRANSPORT
M. C. Alvarez Washington NASA Jan. 1974 20 p Transl. into ENGLISH from Rev. Aeron. Astron. (Spain), no. 388, Mar. 1973 p 173-183
(Contract NASw-2485)
(NASA-TT-F-15249) Avail: NTIS HC $3.00 CSCL 05C

The costs of air transportation are analyzed, giving attention to direct and indirect costs. Systems of cost analysis are considered together with the effect of individual parameters on the costs of operation. Attention is given to cruising speed, flight time, total operational time, aircraft design, and aircraft manufacture. A first estimation of operational costs has to take into account the weight of the aircraft, the weight of the fuel needed during the flight, the fuel reserve, and questions of the selection of one of three operational approaches in conducting the flight. Direct costs of the flight operation are discussed in detail together with expenses for maintenance, inspection, depreciation, and fuel costs. Indirect expenses include costs of administration, publicity, and airport charges. Author

N74-14701 Engineering Sciences Data Unit, London (England).
PROFILE DRAG AT THE DRAGE-RISE CONDITION OF AEROFOILS HAVING A SPECIFIED FORM OF UPPER-SURFACE PRESSURE DISTRIBUTION AT THIS CONDITION
Oct. 1973 5 p refs
(ESDU-67011) Copyright. Avail: Issuing Activity

The development of airfoils based on an inviscid flow theory incorporating a description of compressibility effects is discussed. An inversion of the method has led to the derivation of a new family of airfoils in which boundary layer displacement effects and the use of compressibility factors are significant. A method for obtaining the profile drag of the airfoils is reported. The drag coefficient increments for the redesigned airfoils are plotted in graph form. The drag coefficient increments for the upper surface, lower surface, and total, for fully attached flow are presented. Author

N74-14704 Ohio State Univ., Columbus.
THE EFFECTS OF HYPERSONIC VISCOUS INTERACTION ON STATIC STABILITY OF SLENDER BODIES IN SIMULATED NON-EQUILIBRIUM FLOWS Ph.D. Thesis
Robert William Betts 1973 103 p
Avail: Univ. Microfilms Order No. 73-26772

One phase of a similitude study of slender bodies in low density nonequilibrium flow is reported. Force and moment coefficients were obtained for a 10 degree half-angle cone at hypersonic, low density conditions for which viscous interaction is important. Measurements were made over an angle of attack from 0 to 10 degrees. By the introduction of selected amounts of argon to air it was possible to simulate the range of specific heat ratio variation from 0 to 100 percent oxygen dissociation in air. Both Newtonian theory and a modified version of tanget cone theory (MTC) were used to define the similitude parameters applicable to both free flight and wind tunnel data. Dissert. Abstr.

N74-14705 Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.

FORCE MEASUREMENTS ON CARET AND DELTA WINGS OVER THE INCIDENCE RANGE 27 DEG LESS THAN OR EQUAL TO ALPHA LESS THAN OR EQUAL TO 55 DEG AT M 12.2

C. J. Carr Oct. 1971 11 p refs
(IC-Aero-71-22)

A series of tests measuring and comparing the forces on a flat bottom delta wing and a caret wing performed at M 12.2 over the incidence range 27 deg to 55 deg. The wings were of identical planform and thickness. The caret wing exhibited higher values of normal force, lift, and drag coefficients than the flat delta for any given incidence within the range tested. ESRO

N74-14706 Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
THE FLOW FIELD AND PRESSURE DISTRIBUTION OF AN ISOLATED ROAD WHEEL

J. E. Fackrell and J. K. Harvey 1972 11 p refs Sponsored partly by Sci. Res. Council and Dunlop Tyre Co.
(IC-Aero-72-14)

The air flow around two wheel profiles typical of those used on racing cars was studied. The flow around a stationary wheel is compared with that around the same wheel when rotating in order to highlight the specific effects of rotation. Lift and drag are calculated from pressure distributions over the wheels. The distributions themselves reveal useful information on the flow field. Total head measurements of the flow around the wheel and some special features are discussed. Author (ESRO)

N74-14707*# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
[FLUTTER COMPUTER PROGRAM AND LIFTING SURFACE THEORY WITH BOUNDARY LAYER] Semiannual Progress Report, 1 Apr. - 1 Oct. 1973

Earl H. Dowell and C. Samuel Ventres 1 Oct. 1973 7 p refs (Grant NGR-31-001-197)
(NASA-CR-136559) Avail: NTIS CSCL 01A

A flutter program has been developed for a rectangular, orthotropic panel on point supports of finite stiffness as well as edge, line supports of finite stiffness. To check the flutter program, per se, simple piston theory aerodynamics were used. Lifting surface theory with boundary layer was used to solve the incompressible, steady, two dimensional flow problem. Author

N74-14708# National Research Council of Canada, Ottawa (Ontario).
AN EXPERIMENTAL ANALYSIS AND BUFFET INVESTIGATION OF THE SHOCKLESS LIFTING AIRFOIL NO. 1

J. J. Kacprzynski Aug. 1973 52 p refs
(NRC-13673; LR-569) Avail: NTIS HC $4.75

Wind tunnel tests to determine the aerodynamic characteristics of a shockless lifting airfoil were conducted. The improvements to the wind tunnel which led to conducting the tests are described. The experiments were performed with 20.5 percent porosity of the top and bottom walls of the test section. The aerodynamic coefficients obtained from integration of the pressure distribution and from the balance and wake drag measurements are listed. Buffet characteristics were investigated at Mach numbers of 0.51, 0.621, 0.7, and 0.768. The buffet boundaries determined from oscillations of the normal force component correspond well with the pressure divergence observed. Author

N74-14709# Advisory Group for Aerospace Research and Development, Paris (France).
AERODYNAMIC DRAG

Oct. 1973 469 p refs Partly in ENGLISH and partly in FRENCH Proc. of the Fluid Dyn. Panel Specialists Meeting, Izmir, Turkey, 10-13 Apr. 1973
(AGARD-CP-124) Avail: NTIS HC $25.50

The proceedings of a conference on aerodynamic drag are presented. Current research and future prospects in the field of aerodynamic drag are considered. Main emphasis was placed on subjects of practical value to the aerospace industry in relation to the need for accurate prediction, measurement, and alleviation of drag. Some of the subjects considered are: (1) aircraft drag, (2) wing drag, (3) base drag and separation, (4) interaction effects, (5) hypersonic drag, and (6) testing techniques and correlation of flight test and wind tunnel test data.

N74-14710 Ministry of Defence, London (England).
TECHNICAL EVALUATION REPORT

S. F. J. Butler *In* AGARD Aerodyn. Drag Oct. 1973 11 p

A primary objective of research on aerodynamic drag is the development and proving of prediction methods in a form suitable for direct use by aircraft development teams and by those who have to assess the relative merits of alternative designs. Aircraft drag estimation methods are needed at various levels of sophistication and reliability. Basic statistical analyses can form the basis of an acceptable forecasting procedure at the feasibility stage, although such an approach is essentially conservative and can lead to the perpetuation of low design standards, as well as being of little use when novel aircraft design concepts are under consideration. Of some significance is the ability to predict reliably the drag of a datum streamlined aircraft with fully-turbulent flow, against which achieved drag levels can be compared in a figure-of-merit approach. During the design development and refinement stage, the research aims include the achievement of drag design objectives and the limitation of drag growth. In this phase, drag predictions in practice must be prepared by a process of synthesis (rather than simple summation), within a format which can readily accommodate the changing sources of data. Author

N74-14711 Lockheed-Georgia Co., Marietta.
A SURVEY OF DRAG PREDICTION TECHNIQUES APPLICABLE TO SUBSONIC AND TRANSONIC AIRCRAFT DESIGN

J. H. Patterson, D. G. MacWilkinson, and W. T. Blackerby *In* AGARD Aerodyn. Drag Oct. 1973 38 p refs

The following aspects of aircraft drag prediction in the subsonic to transonic range are discussed: (1) preliminary estimation procedures, (2) estimation using wind tunnel test data, and (3) wind tunnel data and flight test data correlation. Inaccuracies in the approach to the use of flat plate skin friction, with appropriate shape factors, to predict profile drag are identified. Attempts to use low Reynolds number wind tunnel drag levels to predict full scale drag are shown to be reasonably successful. The prediction of C-5A aircraft drag characteristics from wind tunnel tests is discussed. Author

N74-14713 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Aerodynamik.
ON SOME BASIC AND NEW ASPECTS ABOUT THE DRAG PROBLEM OF WINGS AND BODIES IN SUPERSONIC FLOWS

Arabindo Das *In* AGARD Aerodyn. Drag Oct. 1973 26 p refs

With the objective to determine optimum shapes of slender wings and bodies for minimum total drag in supersonic flows a comprehensive theoretical and experimental analysis of the problem has been carried out. The theoretical formulas for the various drag components which are necessary for a variational problem of drag minimization have been reviewed, summarized, partly modified or extended, and finally compared with experimental values. Based on the linearized mass flux concept already known in the literature a modified boundary condition leads to a certain improvement in the results of the linear theory. A simplified treatment of the modified linear theory is presented. A unified approach to the problem of minimization of wave drag due to volume and wave drag due to lift yields very simple analytical results. The optimum body shapes show a certain dependence on Mach number. For minimization of vortex drag the necessary wing twist yields a remarkable improvement, which could also be verified by experiment. While the known friction drag formulas from the literature have been checked with

experimental values, the problem of base drag of axial symmetrical bodies has not been completely solved as yet; theoretical work on this topic is being continued. Author

N74-14714 Royal Aircraft Establishment, Bedford (England).
MEASUREMENTS OF THE DRAG OF SOME CHARACTERISTIC AIRCRAFT EXCRESCENCES IMMERSED IN TURBULENT BOUNDARY LAYERS
L. Gaudet and K. G. Winter *In* AGARD Aerodyn. Drag Oct. 1973 12 p refs

Measurements are described of the drag of various forms of excrescence mounted on balances installed in the walls of the working section of the RAE 8ft x 8ft wind tunnel. The tests cover a range of Mach numbers between 0.2 and 2.8 (but not transonic) and a range of Reynolds number. The excrescences tested include two-dimensional steps and ridges, circular cylinders and wings mounted normal to the surface, and holes and fairings. It is shown, for excrescences which are of height small compared with the boundary-layer thickness, that the scale effects on drag are well correlated in terms of the wall variables of the turbulent boundary layer, but that there is a dependence of drag on Mach number. For steps and ridges the effect of chamfering or rounding the upper corners was found to be beneficial at subsonic speeds but far less so at supersonic speeds. For circular holes the drag depends strongly upon the depth to diameter ratio. The fairings tested were either half-bodies of revolution with pointed or rounded ends or of square or rectangular section with pointed ends. The effects of different amounts of immersion of the bodies into the boundary layer was found in some cases by testing geometrically similar bodies of different sizes. Author

N74-14715 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
PROBLEMS OF ESTIMATING THE DRAG OF A HELICOPTER
S. N. Wagner *In* AGARD Aerodyn. Drag Oct. 1973 12 p refs

The components which contribute to the drag of a helicopter are identified as: (1) the drag of the main and tail rotors, (2) fuselage drag, (3) pylon drag, (4) landing gear drag, (5) fairing drag, and (6) drag caused by interference between the helicopter components. The difficulties and advantages of methods for defining the drag of a helicopter are analyzed. Procedures for testing small scale models of helicopters are discussed. The correlation of model data with flight test data is examined. Author

N74-14716 Royal Aircraft Establishment, Farnborough (England).
AIRCRAFT DRAG PREDICTION FOR PROJECT APPRAISAL AND PERFORMANCE ESTIMATION
S. F. J. Butler *In* AGARD Aerodyn. Drag Oct. 1973 50 p

The principal stages in aircraft feasibility study and design development are considered, leading to the specification of desirable characteristics of aircraft drag prediction models. The contributions to drag modelling to be expected from research are reviewed, together with the impact of computerized design selection and mission analysis methods. An assessment of the relative importance of different components and sources of drag introduces surveys, which examine the present state of the art of prediction for specific classes of aircraft and for particular aspects of drag. The main problems involved in executing and analysing model and aircraft tests are also discussed in the drag context. The collection, analysis and dissemination of data suitable for direct use in practical design methods are discussed. Author

N74-14717 Engineering Sciences Data Unit, London (England).
APPENDIX: A DATA ITEM SERVICE FOR AIRCRAFT DRAG ESTIMATION
In AGARD Aerodyn. Drag Oct. 1973 9 p refs

Avail: NTIS

The terms of reference for an engineering unit concerned with determining aerodynamic drag are discussed. The functions of the organization are defined: (1) to collect and disseminate information on drag prediction for sweptwing aircraft, (2) to arrange for the correlation and analysis of relevant data, (3) to formulate a comprehensive framework for the analysis and synthesis of aircraft drag, and (4) to encourage the introduction and adoption of improved drag prediction methods. Author

N74-14718 Douglas Aircraft Co., Inc., Long Beach, Calif.
REMARKS ON METHODS FOR PREDICTING VISCOUS DRAG
A. M. O. Smith and Tuncer Cebeci *In* AGARD Aerodyn. Drag Oct. 1973 12 p refs

While predictions of low speed profile drag are accurate for monoelement airfoils at low angle of attack, the methods are not very accurate at higher angles of attack, or for multielement airfoils or for fatter bodies of revolution. Two courses that might lead to possible improvement in accuracy have been investigated. One was an attempt to perform direct shear and pressure stress calculations on an airfoil or body. The other was an attempt to improve the Squire-Young momentum defect method by actually solving the wake for a short distance. The first method was not successful but the second method shows promise. Hence, it is tentatively concluded that refinement of the momentum defect method is the most promising path towards improved accuracy. Author

N74-14719 National Aeronautical Establishment, Ottawa (Ontario).
DRAG OF SUPERCRITICAL AIRFOILS IN TRANSONIC FLOW
J. J. Kacprzynski *In* AGARD Aerodyn. Drag Oct. 1973 20 p refs

Analytical methods of evaluation of drag coefficients of contemporary supercritical airfoils are discussed. Some results of experimental values of drag coefficient for supercritical airfoils are compared against results of theoretical evaluations. Some results of drag coefficients of conventional airfoils are included for comparison. Difficulties of accurate experimental recording of drag coefficients are indicated. Author

N74-14720 General Dynamics/Convair, San Diego, Calif. Aerospace Div.
TRANSONIC DRAG DUE TO LIFT OF PLANAR JET-FLAPPED AIRFOILS
H. Yoshihara, R. Magnus, and D. Zonars (AFFDL) *In* AGARD Aerodyn. Drag Oct. 1973 8 p refs

In contrast to the low speed case test results indicate that lift augmentation by the jet flap in the transonic regime is accompanied, not by a large thrust recovery, but by a significant increase in drag. However to achieve moderate to high lifts the use of jet flaps rather than incidence has led to a significant reduction in the drag due to lift. To calculate the transonic jet flap flow a modified Spence jet flap condition is postulated and incorporated into the (unsteady) finite difference procedure. An example is then calculated and compared with experimental results. Author

N74-14721 National Aerospace Lab., Amsterdam (Netherlands).
COMPARISON OF VARIOUS METHODS FOR CALCULATING PROFILE DRAG FROM PRESSURE MEASUREMENTS IN THE NEAR WAKE AT SUBCRITICAL SPEEDS
J. Zwaaneveld *In* AGARD Aerodyn. Drag Oct. 1973 12 p refs

Methods for calculating the profile drag from total and static pressure measurements in aircraft wake have been compared. An analytical model of a compressible two-dimensional wake is used to obtain numerical results. Both the oldest method of Betz and the widely used method of Jones allow the static pressure variation across the wake to be taken into account. These methods are therefore suitable to treat the flow in the very near wake. The third method developed by Squire and

Young is in principle only valid when the static pressure variation across the wake is negligible. To extend this method to the more general case, two modifications are considered, the first as proposed by Squire and Young, the second as presented by the author. The latter modification makes use of the momentum integral equation with modified parameters. The numerical results show this new approach to be in far better agreement with the method of Jones than the first mentioned modified version.
Author

N74-14722 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
DRAG AND SEPARATION
Maurice Sirieix *In* AGARD Aerodyn. Drag Oct. 1973 23 p refs In FRENCH; ENGLISH summary

The unsteady character of some separated flows and their resulting effects are discussed. The different types of turbulent separated flows of a limited extent and quasi-steady character are defined. The expected effects of these separated flows on the aerodynamic drag were studied. Theoretical methods of prediction are explained. Examples in which separated flows appear are analyzed.
Author

N74-14723 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
NEW INVESTIGATIONS FOR REDUCING THE BASE DRAG OF WINGS WITH A BLUNT TRAILING EDGE
Mauri Tanner *In* AGARD Aerodyn. Drag Oct. 1973 9 p refs

Investigations were conducted to determine methods for reducing the base drag of wings with blunt trailing edges. Measurements were performed on a rectangular wing in a low speed wind tunnel. The wing was fitted with broken trailing edges, splitter plates, and splitter wedges. The tests showed that the base drag could be substantially reduced by fitting a splitter wedge on the trailing edge. For the most advantageous splitter wedge, the base drag was nearly zero. In this case the maximum lift to drag ratio for the wing with a blunt trailing edge was as great as that for the corresponding wing with a conventional sharp trailing edge.
Author

N74-14726 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
ASSESSMENT OF THE INFLUENCE OF INLET AND AFTBODY/NOZZLE PERFORMANCE ON TOTAL AIRCRAFT DRAG
Philip P. Antonatos, Lewis E. Surber, James A. Laughrey, and Donald J. Stava *In* AGARD Aerodyn. Drag Oct. 1973 28 p refs

The influence of propulsion system installation on aircraft drag is discussed. Using information from several investigations, different aspects of airframe propulsion integration are explored, each of which affects the assessment of aircraft drag. A great deal of apparently conflicting data has been generated on airframe-propulsion integration simply because the investigators concerned with different aspects of a system development have not properly integrated their own efforts to assure that theoretical analysis methods are consistent with wind tunnel test methods, that the test models are consistent with each other, and that adequate corrections for the effect of model mounting systems can be made. Even rather small inconsistencies in just a few of these considerations may result in errors of sufficient magnitude to affect aircraft design decisions adversely. A major part of the difficulty of making an accurate assessment of inlet/aftbody nozzle effect on aircraft drag is the prediction of flight performance from wind tunnel test data. Early system development should be studied carefully to assure that the program of airframe-propulsion integration and the demands on propulsion related drag assessment are consistent with drag estimate accuracy for the airframe.
Author

N74-14727 Boeing Commerical Airplane Co., Renton, Wash.
THE PROBLEM OF INSTALLING A MODERN HIGH BYPASS ENGINE ON A TWIN JET TRANSPORT AIRCRAFT
Walter C. Swan and Armand Sigalla *In* AGARD Aerodyn. Drag Oct. 1973 12 p

An examination of the engine placement on a modern jet transport presents new drag and stability problems. Large high bypass ratio engines create large annular and wetted area drag and blockage surfaces which can cause difficult configuration problems as well as large interference drag and stability effects. The option is open to conventional underwing and aftbody mounted installations as well as renewed opportunity for over-the-wing installations. In this paper the drag and stability consequences for each class of configuration is examined for a typical intermediate range transport. The results are equally valid for short haul and certain STOL missions. In some instances, it is shown, proper pod shape and positioning may result in favorable drag increments, especially on modern swept wings with supercritical airfoil sections. Side effects such as pod influences on wing flutter, deep stall, and general sizing of the empennage are discussed.
Author

N74-14729 Royal Aircraft Establishment, Bedford (England).
THE DRAG OF EXTERNALLY CARRIED STORES: ITS PREDICTION AND ALLEVIATION
P. G. Pugh and P. G. Hutton *In* AGARD Aerodyn. Drag Oct. 1973 11 p refs

The installed drag of stores makes a major contribution to the total drag of combat aircraft. It can be several times the sum of the free-air drags of the individual stores and its prediction and reduction are essential to the design of high-performance aircraft. Interference effects involved range from simple buoyancy to complex interactions involving viscous and wave drag phenomena. For the simpler cases there are good prospects that the installed drag can be accurately predicted either by current methods or by relatively straightforward extensions of these. However, empirical methods will continue to be needed for the prediction of the drag of complicated cases eg. multiple store arrays at transonic speeds. Some examples are given to show the opportunities for reducing the installed drag either by redesigns to take advantage of improved mechanical systems or through the development of radically new installations.
Author

N74-14730 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
DRAG IN HYPERSONIC RAREFIED FLOW
Walter Wuest *In* AGARD Aerodyn. Drag Oct. 1973 12 p refs

The drag force in hypersonic flow may be divided into cold pressure drag (incident molecules), temperature depending pressure drag (diffusively reflected molecules) and friction drag. The pressure drag dominates on blunt bodies which show a slighter drag variation with rarefaction whereas on slender bodies friction drag dominates and the total drag is strongly influenced by rarefaction. Relaxation and radiation do not appreciably alter the pressure drag but influence the flow field, stand-off distance of shock wave, and heat transfer.
Author

N74-14731 Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique.
DRAG OF LIFTING BODIES FOR PILOTS AT HIGH ALTITUDE [TRAINEE DE CORPS PORTANTS PILOTES A HAUTE ALTITUDE]
J. Allegre, C. Matrand, and M. F. Scibilia *In* AGARD Aerodyn. Drag Oct. 1973 10 p refs In FRENCH; ENGLISH summary

Lifting bodies with 60 deg swept delta wings fitted out with control devices, located near the trailing edge of the wings are analyzed. The present experimental study of the aerodynamic behaviour of the wing is realized in a rarefied flow simulating a flight altitude of about 70 km. Experiments are performed in an open jet and continuously operating wind tunnel. The air flow is characterized by a Mach number of 8.1 and a free stream Reynolds number of 2200 per cm. Results show how much aerodynamic devices associated with the delta wing, like spoilers, remain

efficient and can be used in order to control the trajectory at high altitude. Drag coefficient data are given in the range of incidences between minus 20 deg and 20 deg. A comparison between efficiencies of trailing edge solid spoilers and trailing edge fluid spoilers allows to point out some advantages of the fluid spoilers. In particular, this jet control mechanism can create a sufficient side thrust without entailing a large increase of the drag. Author

N74-14734 Naval Air Systems Command, Washington, D.C.
DEVELOPMENT OF TECHNIQUES TO MEASURE IN-FLIGHT DRAG OF A US NAVY FIGHTER AIRPLANE AND CORRELATION OF FLIGHT MEASURED DRAG WITH WIND TUNNEL DATA
E. C. Rooney *In* AGARD Aerodyn. Drag Oct. 1973 18 p

Wind tunnel and flight drag measurement techniques and correlation of wind tunnel and flight drag data for a U. S. Navy fighter airplane are discussed. Wind tunnel drag data were obtained with aerodynamic, induction system and powered nozzle/afterbody models. A common reference afterbody configuration between aerodynamic and propulsion models was utilized to assure compatibility of thrust and drag measurements. Flight drag data were obtained from steady-state, quasi steady-state and dynamic (wind-up/down turn) maneuvers utilizing sensitive three-axis accelerometers to determine excess thrust and the internal pressure method for measuring engine thrust. Compressor airflow, afterburner pressure drop and nozzle coefficients used for computing engine net thrust were obtained from isolated engine tests at simulated flight conditions throughout the flight envelope. Wind tunnel data were used to account for propulsion system drag caused by subcritical inlet spillage and nozzle interference drag. Author

N74-14735* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
REVIEW OF DRAG MEASUREMENTS FROM FLIGHT TESTS OF MANNED AIRCRAFT WITH COMPARISONS TO WIND-TUNNEL PREDICTIONS
Jon S. Pyle and Edwin J. Saltzman *In* AGARD Aerodyn. Drag Oct. 1973 12 p refs

In-flight studies of the overall and local components of drag of many types of aircraft were conducted. The primary goal of these studies was to evaluate wind-tunnel and semiempirical prediction methods. Some evaluations are presented in this paper which may be summarized by the following observations: Wind-tunnel predictions of overall vehicle drag can be accurately extrapolated to flight Reynolds numbers, provided that the base drag is removed and the boattail areas on the vehicle are small. The addition of ablated roughness to lifting body configurations causes larger losses in performance and stability than would be expected from the added friction drag due to the roughness. Successful measurements of skin friction have been made in flight to Mach numbers above 4. A reliable inflatable deceleration device was demonstrated in flight which effectively stabilizes and decelerates a lifting aircraft at supersonic speeds. Author

N74-14739*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PLOTTING PROGRAM FOR AERODYNAMIC LIFTING SURFACE THEORY
Richard T. Medan and K. Susan Ray (Computer Sci. Corp., Mountain View, Calif.) Nov. 1973 31 p refs
(NASA-TM-X-62321) Avail: NTIS HC $3.75 CSCL 01A

A description of and users manual for a USA FORTRAN IV computer program which plots the planform and control points of a wing are presented. The program also plots some of the configuration data such as the aspect ratio. The planform data is stored on a disc file which is created by a geometry program. This program, the geometry program, and several other programs are used together in the analysis of lifting, thin wings in steady, subsonic flow according to a kernel function lifting surface theory. Author

N74-14740# Aeronautical Research Inst. of Sweden, Stockholm.
A QUICK LOOK AT THE STATE-OF-THE-ART IN FLIGHT TESTING OF CERTAIN AERODYNAMIC PARAMETERS RELATED TO WIND TUNNEL TESTING Final Report
A. Bertelrud 1973 78 p refs
(FFA-AU-966) Avail: NTIS HC $6.00 CSCL 01A

Flight test techniques and the accuracy that can be obtained with the instrumentation and data reduction procedures are discussed. An analysis of the extent to which wind tunnel tests can reproduce the actual characteristics of real aircraft was conducted. The subjects considered are: (1) buffeting, (2) skin friction, and (3) maximum lift/stall characteristics. The types of instrumentation required to obtain data on various aerodynamic characteristics are reported. Author

N74-14741*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A STUDY OF THE NONLINEAR AERODYNAMICS OF BODIES IN NONPLANAR MOTION Ph.D. Thesis - Stanford Univ., Calif.
Lewis Barry Schiff Washington Jan. 1974 94 p refs
(NASA-TR-R-421; A-5057) Avail: NTIS HC $3.75 CSCL 01A

Concepts from the theory of functionals are used to develop nonlinear formulations of the aerodynamic force and moment systems acting on bodies in large-amplitude, arbitrary motions. The analysis, which proceeds formally once the functional dependence of the aerodynamic reactions upon the motion variables is established, ensures the inclusion, within the resulting formulation, of pertinent aerodynamic terms that normally are excluded in the classical treatment. Applied to the large-amplitude, slowly varying, nonplanar motion of a body, the formulation suggests that the aerodynamic moment can be compounded of the moments acting on the body in four basic motions: steady angle of attack, pitch oscillations, either roll or yaw oscillations, and coning motion. Coning, where the nose of the body describes a circle around the velocity vector, characterizes the nonplanar nature of the general motion. Author

N74-14744# National Aerospace Lab., Tokyo (Japan).
MEASUREMENTS OF ROLLING MOMENTS ACTING ON THE STABILIZER OF T-TAILS OSCILLATING IN YAW
Teruo Ichikawa, Koji Isogai, Yasukatsu Ando, and Hiroshi Ejiri 1973 10 p refs In JAPANESE; ENGLISH summary
(NAL-TR-324) Avail: NTIS HC $3.00

Low speed wind tunnel tests to determine aerodynamic rolling moments are discussed. Measurements were made of the forces acting on an isolated wing, with and without dihedral, at incidence and oscillating in yaw about the axis at the midchord point of the midspan. Tests were also conducted on the horizontal stabilizer of a T-tail configuration, with zero and finite angle of attack of the stabilizer, and oscillating in yaw about the axis through the fin midchord. Author

N74-14745*# Calspan Corp., Buffalo, N.Y.
ANALYSIS OF THE FLOW ABOUT DELTA WINGS WITH LEADING EDGE SEPARATION AT SUPERSONIC SPEEDS
Joseph P. Nenni and Chee Tung [1973] 43 p refs
(Contract NAS1-11577)
(NASA-CR-132358) Avail: NTIS HC $4.25 CSCL 01A

A research program was conducted to develop an improved theoretical flow model for the flow about sharp edge delta wings with leading-edge separation at supersonic speeds. The flow model incorporates a representation of the secondary separation region which occurs just inboard of the leading edge on such wings and is based on a slender-wing theory whereby the full three-dimensional problem is reduced to a quasi two-dimensional problem in the cross-flow plane. The secondary separation region was modeled by a surface distribution of singularities or a linearized type of cavity representation. The primary vortex and separation were modeled by a concentrated vortex and cut in the cross-flow potential which represents its feeding sheet. The cross-flow solutions for the cavity model were obtained, but these solutions have physical significance only in a very restricted range of angle

of attack. The reasons for the failure of the flow model are discussed. The analysis is presented so that other interested researchers may critically review the work. Author

N74-14746# Advanced Technology Labs., Inc., Westbury, N.Y.
SIMILARITY PARAMETERS AND THEIR SENSITIVITY FOR TRANSONIC AIRFRAME EXHAUST NOZZLE INTERACTIONS Technical Report, 24 Jan. - 25 Sep. 1972
Gerald Roffe and Gabriel Miller Jan. 1973 75 p refs
(Contract F33615-72-C-1362; AF Proj. 1476)
(AD-768988; ATL-TR-175; AFFDL-TR-73-9) Avail: NTIS CSCL 01/1

A qualitative description of the fluid mechanics of transonic airframe interaction with engine exhaust flows is formulated and used to derive the pertinent similarity parameters of the problem. The sensitivity of the flow field to these parameters is explored by computations and analysis of available data and leads to the conclusion that viscous parameters such as boundary layer momentum thickness, engine exit flow profiles and mass flux ratio have a pronounced effect on simulation capability. Based on the findings of the similarity and sensitivity studies, experiments are outlined for both continuous and blowdown facilities to investigate the role of viscous parameters more fully.
Author (GRA)

N74-14747# Boeing Aerospace Co., Seattle, Wash. Research and Engineering Div.
EXHAUST SYSTEM INTERACTION PROGRAM Final Technical Report
John E. Postlewaite and Victor Salemann Jun. 1973 178 p refs
(Contract F33615-70-C-1450; AF Proj. 3066)
(AD-769086; D162-10467-13; AFAPL-TR-73-59) Avail: NTIS CSCL 01/3

The program consisted of two phases. The purpose of Phase 1 was to define what needs to be known, and when, and with what accuracy to define the engine cycle and thrust required by a proposed airplane, and to develop methods to obtain the required information -- particularly in the engine-exhaust system area. The second phase simulated the preliminary design and engine airframe matching portions of an airplane system development, stressing the evaluation of exhaust system installation losses at several levels of validity. This final report presents a summary of the work. The individual tasks are documented in seven volumes from Phase 1 (Vols. 1 - 7), ten volumes from Phase 1 (Vols. 8 - 17) of Ancilliary Reports (including D162-10467-12). Author (GRA)

N74-14748# National Aeronautical Lab., Bangalore (India).
AERODYNAMIC ASPECTS OF THE PROBLEMS OF AIR-INTAKES AND EXHAUST FOR A SUPERSONIC TRANSPORT AIRCRAFT
J. Leynaert Nov. 1973 21 p refs Transl. into ENGLISH of "Aspects Aerodynamiques des Problemes de Prises d'Air et de Sorties de Reacteurs pour un Avion de Transport Supersoniques", French report ONERA-TP-124 Presented at Assoc. for Maritime and Aeronaut. Tech., Paris, 11-15 May 1964
(NAL-TR-194; NEAR-TP-124) Avail: NTIS HC $3.25

An overall view of the aerodynamic problem of air intakes and exhaust for a supersonic transport aircraft flying at 2.2 Mach no. is given from the point of view of the design of the air-intake and the after body of the jet engine for supersonic cruise speeds with adaptation to intermediate flight speeds. Particular attention is given to the principle of boundary layer bleed at air-intake. Author

N74-14749# Institute of Transport Aviation, Paris (France).
AVIATION NEEDS AND PUBLIC CONCERNS
Emile VanLenner 29 Oct. 1973 22 p Presented at 7th Dr. Albert Plesman Mem. Lecture, Delft, Netherlands, 29 Oct. 1973
Avail: NTIS HC $3.25

Economic profits in the continuous growth of civil aviation are weighed against the social impact on human life in the building of Europe's transportation network. Problems of aircraft noise, demands on energy resources, airport congestion, and consequently of environmental control are considered. G.G.

N74-14750# Edizioni Museo Aeronautico Caproni di Taliedo, Rome (Italy).
FORTY YEARS OF CIVIL AVIATION, 1931 - 1971 [QUARANTANNI DI AVIAZIONE CIVILE, 1931 - 1971]
Maria Quilici 1973 77 p refs In ITALIAN
Avail: NTIS HC $6.00

A brief history of Italian civil aviation is presented. Articles published during this period are included. Transl. by F.O.S.

N74-14751*# Techtran Corp., Silver Spring, Md.
CALCULATION AND ANALYSIS OF AIRCRAFT MOTION
S. A. Gorbatenko, E. M. Makashov, Yu. F. Polushkin, and L. V. Sheftel Washington NASA Dec. 1973 379 p refs Transl. into ENGLISH of the book "Raschet i Analiz Dvizheniya Letatelnykh Apparatov" Moscow, Mashinostr., 1971 p 1-351
(Contract NASw-2485)
(NASA-TT-F-757) Avail: NTIS HC $8.00 CSCL 01B

Methods of calculating and analyzing motion, trajectories, transient processes, control and stability of aircraft are described. Calculation and properties of various guidance methods are discussed. Control based on linear automatic control theory, nonlinear mechanics and theory of stability of nonlinear systems are described. Problems of optimal control theory and methods of solution are explained. Numerical methods of calculating trajectories, transient processes, steady state flight and control optimization problems are presented. Author

N74-14752*# Kansas Univ. Center for Research, Inc., Lawrence.
FLIGHT TEST DATA FOR A CESSNA CARDINAL
David L. Kohlman Washington NASA Jan. 1974 35 p refs
(Grant NGR-17-002-072)
(NASA-CR-2337; FRL-72-001) Avail: NTIS HC $3.00 CSCL 01C

The results of a flight test analysis of the performance of a standard Cessna 177B Cardinal airplane are presented. The airplane was fully instrumented to obtain steady state performance, stick-fixed dynamic stability characteristics, and roll response data. Results obtained include graphs of C sub L versus alpha, C sub D versus C sub L, and speed-power relationships. Dynamic data include Phugoid and Dutch characteristics, and roll response characteristics. Author

N74-14753*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
HFL-10 LIFTING BODY FLIGHT CONTROL SYSTEM CHARACTERISTICS AND OPERATIONAL EXPERIENCE
Weneth D. Painter and George J. Sitterle Washington Jan. 1974 35 p refs
(NASA-TM-X-2956; H-704) Avail: NTIS HC $3.00 CSCL 01C

A flight evaluation was made of the mechanical hydraulic flight control system and the electrohydraulic stability augmentation system installed in the HL-10 lifting body research vehicle. Flight tests performed in the speed range from landing to a Mach number of 1.86 and the altitude range from 697 meters (2300 feet) to 27,550 meters (90,300 feet) were supplemented by ground tests to identify and correct structural resonance and limit-cycle problems. Severe limit-cycle and control sensitivity problems were encountered during the first flight. Stability augmentation system structural resonance electronic filters were modified to correct the limit-cycle problem. Several changes were made to control stick gearing to solve the control sensitivity problem. Satisfactory controllability was achieved by using a nonlinear system. A limit-cycle problem due to hydraulic fluid contamination was encountered during the first powered flight, but the problem did not recur after preflight operations were improved. Author

N74-14754*# General Electric Co., Pittsfield, Mass.
ANALYSIS AND CALCULATION OF LIGHTNING-INDUCED VOLTAGES IN AIRCRAFT ELECTRICAL CIRCUITS Final Report
J. A. Plumer Washington NASA Jan. 1974 65 p refs
(Contract NAS3-14836)
(NASA-CR-2349; SRD-72-066) Avail: NTIS HC $3.50 CSCL 01C

Techniques to calculate the transfer functions relating lightning-induced voltages in aircraft electrical circuits to aircraft physical characteristics and lightning current parameters are discussed. The analytical work was carried out concurrently with an experimental program of measurements of lightning-induced voltages in the electrical circuits of an F89-J aircraft. A computer program, ETCAL, developed earlier to calculate resistive and inductive transfer functions is refined to account for skin effect, providing results more valid over a wider range of lightning waveshapes than formerly possible. A computer program, WING, is derived to calculate the resistive and inductive transfer functions between a basic aircraft wing and a circuit conductor inside it. Good agreement is obtained between transfer inductances calculated by WING and those reduced from measured data by ETCAL. This computer program shows promise of expansion to permit eventual calculation of potential lightning-induced voltages in electrical circuits of complete aircraft in the design stage.
Author

N74-14755*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.
CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS, PHASE 1
Kurt H. Hohenemser and Gopal H. Gaonkar Sep. 1967 74 p refs
(Contract NAS2-4151)
(NASA-CR-114707) Avail: NTIS HC $5.75 CSCL 01C

A number of lifting rotor conditions with random inputs are discussed. The present state of random process theory, applicable to lifting rotor problems is sketched. Possible theories of random blade flapping and random blade flap-bending are outlined and their limitations discussed. A plan for preliminary experiments to study random flapping motions of a see-saw rotor is developed.
Author

N74-14756*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.
CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS, PHASE 2
Kurt H. Hohenemser and Gopal H. Gaonkar Aug. 1968 56 p refs
(Contract NAS2-4151)
(NASA-CR-114708) Avail: NTIS HC $5.00 CSCL 01C

A comparison with NASA conducted simulator studies has shown that the approximate digital method for computing rotor blade flapping responses to random inputs, tentatively suggested in Phase I Report, gives with increasing rotor advance ratio the wrong trend. Consequently, three alternative methods of solution have been considered and are described: (1) an approximate method based on the functional relation between input and output double frequency spectra, (2) a numerical method based on the system responses to deterministic inputs and (3) a perturbation approach. Among these the perturbation method requires the least amount of computation and has been developed in two forms - the first form to obtain the response correlation function and the second for the time averaged spectra of flapping oscillations.
Author

N74-14757*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.
CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS (THE EFFECTS OF SOME ROTOR FEEDBACK SYSTEMS ON ROTOR-BODY DYNAMICS), PHASE 7-A
Kurt H. Hohenemser and S. K. Yin Jun. 1973 92 p refs
(Contract NAS2-4151)
(NASA-CR-114709) Avail: NTIS HC $6.75 CSCL 01C

The effects of three gyroless rotor feedback systems: (1) coning feedback, (2) proportional tilting feedback, and (3) a combination of these on the rotor-body dynamics of hingeless rotorcraft are studied with a simplified analytical model in the advance ratio range from 0 to .8. Combinations of feedback phase angles and control phase angles are selected to minimize control cross coupling and control sensitivity changes between low and high speed flight. For the feedback systems thus selected the effects of feedback gain and control actuator time lag on the stability both with fixed hub and in free flight is studied, whereby the rotorcraft is free in pitch, roll and vertical motion but otherwise restrained. For the free flight is studied, whereby the rotorcraft is free in pitch, roll and vertical motion but otherwise restrained. For the free flight conditions the effects of a horizontal tail are also determined in itself and in combination with the rotor feedback systems.
Author

N74-14758*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.
CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS (IDENTIFICATION OF LIFTING ROTOR SYSTEM PARAMETERS FROM TRANSIENT RESPONSE DATA), PHASE 7-B
Kurt H. Hohenemser and D. A. Prelewicz Jun. 1973 39 p refs
(Contract NAS2-4151)
(NASA-CR-114710) Avail: NTIS HC $4.00 CSCL 01C

System identification methods have been applied to rotorcraft to estimate stability derivatives from transient flight control response data. While these applications assumed a linear constant coefficient representation of the rotorcraft, the computer experiments used transient responses in flap-bending and torsion of a rotor blade at high advance ratio which is a rapidly time varying periodic system. It was found that a simple system identification method applying a linear sequential estimator also called least square estimator or equation of motion estimator, is suitable for this periodic system and can be used directly if only the acceleration data are noise polluted. In the case of noise being present also in the state variable data the direct application of the estimator gave poor results.
Author

N74-14759*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.
CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS (FURTHER EXPERIMENTS WITH PROGRESSING/REGRESSING ROTOR FLAPPING MODES), PHASE 7-C
Kurt H. Hohenemser and S. T. Crews Jun. 1973 76 p refs
(Contract NAS2-4151)
(NASA-CR-114711) Avail: NTIS HC $6.00 CSCL 01C

The experiments with progressing/regressing forced rotor flapping modes have been extended in several directions and the data processing method has been considerably refined. The 16 inch hingeless 2-bladed rotor model was equipped with a new set of high precision blades which removed previously encountered tracking difficulties at high advance ratio, so that tests up to .8 rotor advance ratio could be conducted. In addition to data with 1.20 blade natural flapping frequency data at 1.10 flapping frequency were obtained. Outside the wind tunnel, tests with a ground plate located at different distances below the rotor were conducted while recording the dynamic downflow at a station .2R below the rotor plane with a hot wire anemometer.
Author.

N74-14760*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
PERFORMANCE OF A BALLUTE DECELERATOR TOWED BEHIND A JET AIRPLANE
Jon S. Pyle, James R. Phelps, and Robert S. Baron Dec. 1973 26 p. refs

(NASA-TM-X-56019; H-815) Avail: NTIS HC $3.50 CSCL 01C

An F-104B airplane was modified to investigate the drag and stability characteristics of a ballute decelerator in the wake of an asymmetrical airplane. Decelerator deployments were initiated at a Mach number of 1.3 and an altitude of 15,240 meters (50,000 feet) and terminated when the airplane had decelerated to a Mach number of 0.5. The flight tests indicated that the decelerator had a short inflation time with relatively small opening forces. The drag levels attained with the subject decelerator were less than those obtained with other high-speed decelerators behind a symmetrical tow vehicle. The ballute demonstrated good stability characteristics behind the testbed airplane. Author

N74-14762*# General Dynamics/Convair, San Diego, Calif. Convair Aerospace Div.

COMPUTER PROGRAM TO PERFORM COST AND WEIGHT ANALYSIS OF TRANSPORT AIRCRAFT. VOLUME 1: SUMMARY Final Report

Nov. 1973 92 p refs

(Contract NAS1-11343)

(NASA-CR-132361) Avail: NTIS HC $6.75 CSCL 01C

A digital computer program for evaluating the weight and costs of advanced transport designs was developed. The resultant program, intended for use at the preliminary design level, incorporates both batch mode and interactive graphics run capability. The basis of the weight and cost estimation method developed is a unique way of predicting the physical design of each detail part of a vehicle structure at a time when only configuration concept drawings are available. In addition, the technique relies on methods to predict the precise manufacturing processes and the associated material required to produce each detail part. Weight data are generated in four areas of the program. Overall vehicle system weights are derived on a statistical basis as part of the vehicle sizing process. Theoretical weights, actual weights, and the weight of the raw material to be purchased are derived as part of the structural synthesis and part definition processes based on the computed part geometry. Author

N74-14763*# General Dynamics/Convair, San Diego, Calif. Convair Aerospace Div.

COMPUTER PROGRAM TO PERFORM COST AND WEIGHT ANALYSIS OF TRANSPORT AIRCRAFT. VOLUME 2: TECHNICAL VOLUME Final Report

Nov. 1973 185 p refs

(Contract NAS1-11343)

(NASA-CR-132362) Avail: NTIS HC $11.25 CSCL 01C

An improved method for estimating aircraft weight and cost using a unique and fundamental approach was developed. The results of this study were integrated into a comprehensive digital computer program, which is intended for use at the preliminary design stage of aircraft development. The program provides a means of computing absolute values for weight and cost, and enables the user to perform trade studies with a sensitivity to detail design and overall structural arrangement. Both batch and interactive graphics modes of program operation are available. Author

N74-14764# National Aerospace Lab., Tokyo (Japan).

GROUND OPERATION TESTS OF FLYING TEST BED FOR VTOL AIRCRAFT AT NATIONAL AEROSPACE LABORATORY

Naoto Takizawa, Yoshikazu Tanabe, Akiyoshi Shibuya, Toshio Ogawa, Hirotoshi Fujieda, Tadao Kai, Yoshito Miyamoto, Koichi Ono, and Tadao Torisaki 1973 57 p refs In JAPANESE; ENGLISH summary

(NAL-TR-319) Avail: NTIS HC $5.00

The ground operation tests of a flying test bed designed to investigate problems of hovering, vertical takeoff, and landing of vertical takeoff aircraft are discussed. During the tests, the flying test bed was fixed on a force test stand at a height of about six feet and controlled remotely from a control room. Total engine running time was about five hours in forty four operations and approximately thirty items were measured in each operation by special wiring, telemetry, and other methods. Author

N74-14765*# Boeing Vertol Co., Philadelphia, Pa.

A STUDY OF THE EFFECT OF FLIGHT DENSITY AND BACKGROUND NOISE ON V/STOL ACCEPTABILITY Final Report

Harry Sternfeld, Jr., Ernest G. Hinterkeuser, Roy B. Hackman, and Jerry Davis Washington NASA Jan. 1974 84 p refs (Contract NAS1-11607)

(NASA-CR-2197; D210-10662-2) Avail: NTIS HC $3.75 CSCL 01C

A study was conducted in which test subjects evaluated the sounds of a helicopter, a turbofan STOL and a turbojet airplane while engaged in work and leisure activities. Exposure to a high repetitive density of the aircraft sounds did not make the individual sounds more annoying but did create an unacceptable environment. The application of a time duration term to db(A) resulted in a measure which compared favorably with EPNL as a predictor of annoyance. Temporal variations in background noise level had no significant effect on the rated annoyance. Author

N74-14766# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

CALCULATION OF THE INDUCED VELOCITY FIELD ON AND OFF THE WING PLANE FOR A SWEPT WING WITH GIVEN LOAD DISTRIBUTION

C. C. L. Sells London Aeron. Res. Council 1973 41 p refs Supersedes RAE-TR-69231; RAE-TR-70146; ARC-32144; ARC-32549

(ARC-R/M-3725; RAE-TR-69231; RAE-TR-70146; ARC-32144; ARC-32549) Avail: NTIS HC $4.25; HMSO £1.55; PHI $6.25

Computer programs have been written to evaluate the integrals of lifting-surface theory for the velocity field of a thin wing with given load distribution. Different programs are used for the downwash at points on the wing and for any or all three velocity components off the wing. The heart of the programs is an analytic evaluation of the spanwise integral over a short line following the local sweep; by combining a number of such integrals, the complete integral over the wing is built up. Both programs were tested by comparison with other results. The downwash program cannot compute the downwash at the apex of a swept wing with rounded isobars, nor exactly at a wing tip. Author (ESRO)

N74-14767# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

SIMILARITY REQUIREMENTS FOR AEROELASTIC MODELS OF HELICOPTER ROTORS

G. K. Hunt London Aeron. Res. Council 1973 35 p refs Supersedes RAE-TR-72005, ARC-33730

(ARC-CP-1245; RAE-TR-72005; ARC-33730) Avail: NTIS HC $3.75; HMSO 55p; PHI $2.35

The parameters determining the dynamic similarity of flexible lifting rotors, ignoring thermal effects, are identified. Their relative importance is discussed and practical design procedures are developed for aeroelastic helicopter rotor models. A model should satisfy six similarity requirements. The full-scale Mach number and Froude number cannot be represented at the same time, and the full-scale Reynolds number cannot be represented at all. Hence models will generally be designed to achieve either Mach number or Froude number similarity. The uses, limitations, and characteristics of each kind of model are examined, and the interpretation of measurements obtained from them is explained. Most models are likely to be structural replicas, and the problems of making such models are discussed. The quality of construction, necessary to ensure that the models yield reliable experimental data, is shown to be high. Author (ESRO)

N74-14768# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.

COMPARISON OF THE FLYING QUALITIES OF THE A-7D AIRCRAFT WITH THE REQUIREMENTS OF MIL-F-8785B ASG Technical Report, Mar. - Dec. 1972

Daryl J. Joseph Apr. 1973 232 p refs

(AD-768390; ASD-TR-73-15) Avail: NTIS CSCL 01/3

The report compares the flying qualities of the A-7D light attack airplane with the major flying qualities items of the Military Specification MIL-F-8785B(ASG). The comparison is based primarily on theoretical data supplemented as required by flight test data. The theoretical data is obtained from the contractor's report number 2-53320/8R-8089, dated 15 January 1968. The A-7D is aerodynamically the same as the A-7A; therefore, the A-7D estimated flying qualities are based on data obtained from flight tests of the A-7A airplane and A-7A model tests in the contractor's wind tunnel. Author (GRA)

N74-14769# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
APPLICATION OF THE AEROSPACE MULTIPROCESSOR TO THE A-7D FLIGHT CONTROL SYSTEM M.S. Thesis
Robert Russell Summers Jun. 1973 103 p refs
(AF Proj. 6090)
(AD-768382; GGC/EE/73-17) Avail: NTIS CSCL 01/4

The application of the Aerospace Multiprocessor as the flight control computer for a digital fly-by-wire control system for the A-7D aircraft is described. First a brief discussion of the evolution of flight control systems, ranging from mechanical to digital fly-by-wire, is presented. Next, the topic of digital computers for aircraft flight control is covered. First general computer characteristics are discussed. This is followed by an extensive discussion of Aerospace Multiprocessor characteristics and principles of operation. The present analog flight control system for the A-7D aircraft is described. Various methods of digitizing the A-7D flight control system are considered. The Tustin method of digitization is covered at length, and difference equation derivations are shown in detail. The flight control microprogram written for the Aerospace Multiprocessor is described at a flowchart level. A multiply subroutine, written during this study, is described in detail. Then a description is given of the laboratory tests that were made with the Aerospace Multiprocessor programmed for flight control. Test results are discussed. Finally, the Aerospace Multiprocessor is evaluated regarding its suitability for use in a flight control application.
Author (GRA)

N74-14770# Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.
LDF POWERED BALLOON PROGRAM Instrumentation Papers
Arthur O. Koran, Richard C. Leclaire, and Catherine B. Rice 18 Jul. 1973 48 p refs
(AD-768673; AFCRL-TR-73-0424; ACRL-IP-198) Avail: NTIS CSCL 01/3

The report describes POBAL, a test flight to demonstrate the feasibility of accomplishing station-keeping by powering a 711,000-cu. ft. free balloon against the wind in the minimum wind field near 60,000-ft altitude. The propulsion system, fabricated from off the shelf components, incorporated a 35-ft diameter helicopter rotor and an 8-hp electric motor powered by Ag-Zn batteries. Line of thrust was controlled by a 9-ft high rudder, steerable either by radio command or by autopilot. POBAL was flown from Holloman AFB, New Mexico in September 1972. System components, flight results, recommendations and feasibility studies for a long duration POBAL system are discussed. Author (GRA)

N74-14771# Army Missile Command, Redstone Arsenal, Ala.
METHODS FOR REDUCING VIBRATIONS OF EQUIPMENT MOUNTED ON HELICOPTER EXTERNAL STORES STATIONS
James M. Oliver 6 Aug. 1973 59 p refs
(DA Proj. 1M2-62303-A-214)
(AD-768774; RL-TR-73-6) Avail: NTIS CSCL 19/7

Three designs for reducing the vertical oscillations induced in equipment mounted on the wings of AH-1G helicopters are submitted. A design for a variable stiffness spring to accommodate a change in the mass of the system to be isolated is presented. By use of an analog simulation of a dynamic absorber it is shown that a dynamic absorber is not satisfactory for small ratios of damper mass to system mass. An experimental program is formulated to determine the dynamic properties of a test fixture to be used in determining isolator effectiveness.
Author (GRA)

N74-14772# Army Cold Regions Research and Engineering Lab., Hanover, N.H.
OPERATIONAL EVALUATION OF THE SK-5 AIR CUSHION VEHICLE IN ALASKA
Ronald A. Liston Sep. 1973 44 p refs
(AD-768781; CRREL-TR-243) Avail: NTIS CSCL 01/3

The report discusses the evaluation of the SK-5 air cushion vehicle, during operations on terrain typical of central Alaska. The intent of the evaluation was to consider the SK-5 as representative of the state of the art rather than as a candidate for a specific military role in Alaska. The study included tests to: determine slope-climbing ability, measure skirt drag, identify maneuverability as a function of surface conditions; determine air flow characteristics through the gap between the skirt and ground; and to identify the change in cushion pressure as a function of obstacle geometry. The test procedures and results are discussed. Conclusions for each test are drawn as is an overall conclusion concerning the potential value of air cushion vehicles in helping to solve Alaskan transportation problems.
Author (GRA)

N74-14773# LTV Aerospace Corp., Dallas, Tex. Vought Systems Div.
DEFINITION OF STUDY OBJECTIVES FOR INTEGRATED CREW MODULE DEVELOPMENT Final Report, 1 Jul. 1972 - 31 Aug. 1973
E. R. Atkins, J. C. Hodges, T. L. Harper, J. R. Hankine, and A. A. Hall Aug. 1973 264 p refs
(Contract N00014-72-C-0143; NR Proj. 213-106)
(AD-769065; Rept-2-57110/3R-3104; JANAIR-730705) Avail: NTIS CSCL 01/2

A study was conducted to identify and qualify objectives in the development of the integrated crew module crew station. The study efforts encompassed the man factor in addressing crew performance and the machine factor through analysis of critical design factors such as: (1) anthropometry, (2) geometry, (3) controls and displays, (4) vision, and (5) arrangement. A baseline configuration was developed from the studies. A significant portion of the study was devoted to the supine position of the crew member for acceleration tolerance improvement.
Author

N74-14774# Northrop Corp., Hawthorne, Calif. Electronics Div.
IN-FLIGHT STABILIZATION OF EXTERNALLY SLUNG HELICOPTER LOADS Final Report, 25 Jun. 1970 - 17 Jun. 1972
David T. Liu May 1973 237 p refs
(Contract DAAJ02-70-C-0067; DA Proj. 1F1-62203-A-435)
(AD-769063; NORT-72-39; USAAMRDL-TR-73-5) Avail: NTIS CSCL 01/3

The purpose of the study was to select the best technical approaches for stabilizing a wide spectrum of externally slung helicopter loads at forward speeds up to 150 knots equivalent air speed (KEAS). This effort was accomplished in a two-phase program. Phase I was designed to identify and characterize typical sling loads, to establish their aerodynamic and dynamic characteristics, to gain physical understanding of helicopter/sling-load coupling dynamics, and to develop design approaches for stabilizing devices together with criteria and methodology for cost-effectiveness analysis. Phase II was devoted to the performance of a trade-off study of load stabilization systems, the formulation of preliminary design concepts for the most effective load stabilization approaches, and an evaluation of candidate stabilization systems using a moving-base flight simulator. (Modified author abstract) GRA

N74-14775# Mechanical Technology, Inc., Latham, N.Y.
RECOMMENDED DESIGN MODIFICATIONS TO THE CH-47 FORWARD ROTOR DRIVE GEARBOX

Robert H. Badgley Jun. 1973 89 p refs
(Contract DAAJ02-72-C-0040; DA Proj. 1G1-62207-AA-72)
(AD-769062; MTI-73TR1; USAAMRDL-TR-73-33) Avail: NTIS CSCL 01/3

The report describes the results of a study of modifications to existing helicopter power-train hardware for the purpose of reducing acoustic-frequency vibrations and noise. Mechanical vibration analysis methods were put to further tests by applying them to the redesign of CH-47C gearbox components. This program was undertaken carefully and methodically to avoid the excessive costs which often accompany hit-or-miss approaches to gearbox noise reduction. The results include vibration reduction predictions for a number of carefully documented designs. The key products in this overall effort are reduced bearing radial dynamic forces: thus, the results of this program are expected to have major impact upon bearing and gear lifetimes, in addition to the obvious benefits in the area of gearbox noise. (Modified author abstract) GRA

N74-14777# Army Materiel Systems Analysis Agency, Aberdeen Proving Ground, Md.
SIMPLIFIED AIRCRAFT PERFORMANCE METHODS: POWER REQUIRED FOR SINGLE AND TANDEM ROTOR HELICOPTERS IN HOVER AND FORWARD FLIGHT
C. Raymond Dietz Aug. 1973 57 p refs
(AD-768769; AMSAA-TR-78) Avail: NTIS CSCL 01/3

The report presents a combination graphic and computing method for quick determination of shaft horsepower required for helicopters in hover and forward flight. Sets of equations were developed for computing power required. These equations are based upon theory and test data and show good agreement with published power required data on many currently operating helicopters. The equations have also been programmed for digital computation thereby making possible detailed studies of helicopter performance and the effects of parametric variations. Author (GRA)

N74-14778# Southwest Research Inst., San Antonio, Tex.
ENGINEERING APPRAISAL OF SOUTHWEST RESEARCH INSTITUTE MAGNETIC CRACK DEFINER APPLIED TO CH47 ROTOR BLADES
J. Robert Birchak, Robert R. King, C. Gerald Gardner, and John R. Barton Oct. 1973 57 p refs
(Contract DAAJ01-73-C-0533)
(AD-769068; SwRI-15-3653; USAAVSCOM-TR-73-20) Avail: NTIS CSCL 14/2

The Magnetic Crack Definer (MCD), a nondestructive evaluation device recently developed at Southwest Research Institute, was evaluated to determine the applicability for detecting fatigue cracks in CH-47 helicopter rotor blade spars (AISI 4340) in the fully assembled blade. For test purposes, fatigue cracks were produced by cyclically stressing several sheet specimens cut from a spar from a scrap blade. Several different probe configurations and other system parameters of the MCD were investigated, and after optimizing overall design, cracks as small as 0.3-inch long by 0.025-inch deep were reliably detected under the major adverse conditions associated with the blade, namely: varying lift-off up to 0.10-inch; and different types of overlaying materials, including stainless steel, fiberglass, mastic and adhesive. Additional investigations are recommended to determine the capability for detecting fatigue cracks under the ferromagnetic steel doubler plates, and to determine possible sources of false alarms. Author (GRA)

N74-14779# Hercules, Inc., Magna, Utah. Bacchus Works.
GRAPHITE COMPOSITE LANDING GEAR COMPONENTS - SIDE BRACE ASSEMBLY AND TORQUE LINK FOR A37-B AIRCRAFT Final Report, 15 May 1971 - 15 May 1973
R. E. Randolph, J. Witzel, J. N. Burns, H. L. T. Pritt, and J. C. Samisis 15 May 1973 150 p refs
(Contract F33615-71-C-1508; AF Proj. 1369)
(AD-769041; H400-12-1-17; FFDL-TR-73-6923) Avail: NTIS CSCL 01/3

The effort deals with the design, fabrication and testing of three separate components of the main landing gear for A37B aircraft. Specifically, the upperside brace, lower side brace, and torque arm are involved. Designs of point loaded graphite/epoxy composite landing gear components along with their fabrication, including the use of chopped graphite/epoxy curing molds, are presented. The program demonstrated that complex components can be fabricated using chopped and continuous graphite/epoxy to withstand the static and fatigue loads encountered by the production metal components in service. Component weight savings as great as 50 percent have been achieved. (Modified author abstract) GRA

N74-14780# Army Aviation Systems Command, St. Louis, Mo. Systems Performance Assessment Div.
MAJOR ITEM SPECIAL STUDY (MISS), AH-1G DRIVESHAFT ASSEMBLY, MAIN TRANSMISSION TO ENGINE Interim Report, 1 Jan. 1964 - 30 Jun. 1972
Oct. 1973 23 p
(AD-768763; USAAVSCOM-TR-73-26) Avail: NTIS CSCL 01/3

An analysis of the failures occurring with the H-1 helicopter and AH-1G helicopter drive shafts was conducted. The effects of the failures on logistics, spare parts, aircraft maintenance, and helicopter availity are described. The quality control and cost effective aspects of continuing to use the drive shafts are analyzed. P.N.F.

N74-14781# Radio Corp. of America, Burlington, Mass. Aerospace Systems Div.
HELICOPTER INSPECTION DESIGN REQUIREMENTS
Douglas O. Blake, Fred W. Hohn, and Frank E. Starses May 1973 215 p refs
(Contract DAAJ02-72-C-0052; DA Proj. 1F1-62201-A-119)
(AD-769061; USAAMRDL-TR-73-22) Avail: NTIS CSCL 01/3

Existing aircraft and presently used inspection techniques were analyzed to determine the impact of present design on the ease of inspection. Initial engineering analyses established failure modes and inspection techniques for helicopter components which contribute significantly to the inspection problem. Analysis results were supplemented by field interviews with inspectors experienced in inspection of six aircraft types (AH-1, UH-1, CH-47, CH-54, OH-58, and OH-6). The field survey helped definitize components in each aircraft which present inspection problems. Problem areas were then reviewed and classified into categories. These categories included candidates for component or installation redesign, and changes in inspection technique or interval. Engineering analyses then explored for worthwhile solutions. This report contains the resulting specific recommendations for design approaches which offer improvements in inspection efficiency in future designs and inspection aids which warrant consideration for application to present or future designs. The MAVIS (Model for Analysis of Vehicle Inspection Systems) computer model, described in USAAMRDL Technical Report 72-35, was used to assess quantitatively the improvements in inspection efficiency available through the adoption of the study's recommendations. The modeling indicated significant reduction in maintenance man-hour requirements and improvement in aircraft availability and mission reliability. Author (GRA)

N74-14782# Army Aviation Systems Command, St. Louis, Mo.
MAJOR ITEM SPECIAL STUDY (MISS), AH-1G MAST ASSEMBLY Interim Report, Jan. 1964 - Jun. 1972
Oct. 1973 32 p
(AD-768764; USAAVSCOM-TR-73-25) Avail: NTIS CSCL 01/3

The report describes a failure analysis performed on a helicopter antenna mast assembly. GRA

N74-14783# Douglas Aircraft Co., Inc., Long Beach, Calif.
DEVELOPMENT OF A GRAPHITE HORIZONTAL STABILIZER Interim Technical Report, 1 Jan. - 30 Jun. 1973
George M. Lehman, D. M. Purdy, A. Cominski, C. G. Dietz, and R. Teodosiadis Jul. 1973 82 p refs
(Contract N00156-70-C-1321)
(AD-768869; MDC-J6080) Avail: NTIS CSCL 01/3

The results of analyses and development component tests of the redesigned graphite horizontal stabilizer are presented. The upper and lower skin panels were redesigned with bonded internal stepped-lap titanium doublers at the main pivot and actuator fitting interfaces. The minimum predicted margin-of-safety for the redesigned pivot joint structure is 29% at the first fastener outboard of the titanium doubler. Three development components were fabricated and tested to verify the static and fatigue load capacities of the pivot joint and the static load capacity of the actuator joint. The pivot joint development component attained a static ultimate load of 170% Design Limit Load (DLL) and a residual static ultimate load of 195% DLL after 12,000 hours of simulated fatigue spectrum loading. The actuator joint development component attained a static ultimate load of 195% DLL. The calculated weight of the graphite structure is 183 pounds, an increase of approximately six pounds for the structural redesign, and a reduction of 26% in comparison with the conventional metal structure. Fabrication techniques for the upper and lower skin panels are discussed. Engineering drawings, quality control test results, and the test plan for the second stabilizer unit are included in appendices. Author (GRA)

N74-15115# Instrument Flight Center, Randolph AFB, Tex.
EVALUATION OF THE MODIFIED BENDIX AAU 19A/A AIMS ALTIMETER Final Report
Manuel H. Tapia Aug. 1973 20 p
(IFC Proj. TE-73-4)
(AD-768722; IFC-TR-73-8) Avail: NTIS CSCL 01/4

The USAF Instrument Flight Center, Research and Development Division (IFC/RD), evaluated the modified Bendix AAU 19A/A AIMS altimeter from a pilot factors point of view. The emphasis was placed on hang and lope deficiencies noted during the original IFC evaluation of the Bendix AAU 19A/A altimeter (IFC TR-73-2). Three different types of aircraft were used for the evaluation -- a T-38 was used to investigate high performance capabilities of the altimeter while another altimeter was installed in a T-39 and a third in a T-29 to evaluate the altimeters: performance in a slower airspeed regime. Experienced instructor pilots from IFC/RD and several Instrument Pilot Instructor School (IPIS) student pilots evaluated the altimeter during 45 missions totaling approximately 60 hours of flying time. (Modified author abstract) GRA

N74-15349# Advisory Group for Aerospace Research and Development, Paris (France).
TECHNICAL EVALUATION REPORT ON AGARD TECHNICAL MEETING ON ATMOSPHERIC POLLUTION BY AIRCRAFT ENGINES
Paul A. Libby (Calif. Univ., La Jolla) Nov. 1973 6 p Presented at the Proc. of the Propulsion and Energetics Panel 41st Meeting, Regent's Park, Engl., 9-13 Apr. 1973
(AGARD-AR-63; AGARD-CP-125) Avail: NTIS HC $3.00

The environmental problems associated with aircraft operations are discussed. Emphasis is placed on the general problem of air pollution in the neighborhood of airports due to aircraft engine exhaust products. The anticipated benefits from basic combustion research for reducing the pollutants in aircraft engine exhaust are examined. The necessity to determine the amount of pollution caused by aircraft engines as compared with vehicular traffic and adverse meteorological conditions as a basis for cost effective propulsion system modifications is stressed. Author

N74-15367# Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.
THERMAL AND CHEMICAL FOG DISSIPATION: RESULTS OF FIELD EXPERIMENTS AT VANDENBERG AFB, CALIFORNIA DURING JULY 1972 Environmental Research Papers
Bruce A. Kunkel, Bernard A. Silverman, and Alan I. Weinstein 8 Aug. 1973 51 p refs
(AF Proj. 7605)
(AD-768671; AFCRL-TR-73-0502; AFCRL-ERP-454) Avail. NTIS CSCL 04/2

Results of thermal and chemical fog dispersal tests, conducted by AFCRL during July 1972, are presented and discussed. Forty-three tests were conducted in fog, thirty-three of which were suitable for analysis. Ninety-six additional heat tests were conducted in clear air. Two wide-area urea seeding tests were also performed. An instrumented 200-ft tower, a lidar, and a ground network of visibility sensors and droplet sampler were used to monitor the effects of the tests on the foggy environment. The seeding tests were unsuccessful. Improper execution of the wide-area seeding pattern due to a lack of knowledge of the winds at the seeding location was responsible for the failure of the seeding tests. (Modified author abstract) GRA

N74-15378*# Stanford Univ., Calif. Guidance and Control Lab.
MULTI-INPUT, MULTI-OUTPUT REGULATOR DESIGN FOR CONSTANT DISTURBANCES AND NON-ZERO SET POINTS WITH APPLICATION TO AUTOMATIC LANDING IN A CROSSWIND
William E. Holley and Arthur E. Bryson, Jr Aug. 1973 61 p refs
(Grant NGL-05-020-007)
(NASA-CR-136618; SUDAAR-465) Avail: NTIS HC$5.25 CSCL 09C

Undesirable steady offsets result when a stationary, linear regulator using state feedback is subjected to constant disturbances and/or non-zero setspoints. To eliminate these offsets, the disturbances and non-zero setpoints can be fed forward to the control. Only when the number of outputs is less than or equal to the number of control inputs can the outputs be maintained at arbitrary non-zero setpoints. The state and the disturbance may be estimated using a constant gain Kalman filter or by modeling the constant disturbances as exponentially correlated processes with long correlation times. Author

N74-15379# Lincoln Lab., Mass. Inst. of Tech., Lexington.
EMPIRICAL ASSESSMENT OF ATCRBS Final Report
A. G. Cameron and D. H. Pruslin 31 Oct. 1973 227 p refs
(Contracts DOT-FA72WAI-242; F19628-73-C-0002)
(ATC-16; FAA-RD-73-139) Avail: NTIS HC $13.50

The operational performance of the FAA ATCRBS system, as determined from data extracted from the ARTS III digital processing system is discussed. Quantitative performance data, as well as discussion of the problem area and possible techniques and procedures for its solution, are provided in the areas of weak/broken targets, synchronous garble, interference, erroneous decoding, improper defruiter operation, and insufficient angular resolution. A discussion of improvements that can alleviate some of the deficiences of today's secondary radar (ATCRBS) system is included. Author

N74-15380# Texas Instruments, Inc., Austin.
FAILURE MODES, EFFECTS AND CRITICALITY ANALYSIS (FMECA) OF CATEGORY III INSTRUMENT LANDING SYSTEM WITH TRAVELING: WAVE LOCALIZER ANTENNA Final Report, Jan. - Oct. 1973
Cliff White Oct. 1973 207 p refs
(Contract DOT-FA71WA-2635)
(U1-840912-100; FAA-RD-73-111) Avail: NTIS HC $12.50

A Failure Modes, Effects and Criticality Analysis (FMECA) is used to optimize system performance by identification of all potentially hazardous failure modes affecting either personal safety of operational mission success. This in-depth systematic approach of such an analysis provides quantitative assurance of the system's reliability and integrity. The previous FMECA performed on the FAA Mark III ILS is updated in this analysis to determine the impact on localizer and system reliability of the additional equipment required by the substitution of the traveling wave

antenna array for the wide aperature parabolic antenna. All relevant hidden equipment failure modes are identified within the analysis and based upon allowable probabilities of occurrence, their respective preventive maintenance frequencies are specified.
Author

N74-15381# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. VOLUME 1: EXECUTIVE SUMMARY
27 Sep. 1972 40 p ref
(Contract DOT-FA72WA-2803)
(FAA-RD-73-150-1) Avail: NTIS HC $4.00

The design, development, and operation of a microwave landing system are presented. The technical features of the system are described to show the: (1) method of time reference measurement, (2) the scanning beam antenna using electronically-switched feed elements, and (3) the course deviation function. A multipath control technique is described which provides low angle microwave vertical guidance at angles close to the terrain. Diagrams of typical installations of the system are provided.
Author

N74-15382# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. VOLUME 3: 1.1.1 PERFORMANCE VALIDATION
27 Sep. 1972 379 p refs
(Contract DOT-FA72WA-2803)
(FAA-RD-73-150-3) Avail: NTIS HC $21.00

The multipath and propagation problems of a microwave landing system are discussed. The specific sources of multipath transmission are identified and their effects on the system are analyzed. The influences of refraction, polarization, and rain attenuation are investigated. Proposed solutions are made for: (1) obstacle multipath, (2) ground reflection, (3) blockage, and (4) diffraction.
Author

N74-15383# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNICAL ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM, VOLUME 3A
27 Sep. 1972 363 p refs
(Contract DOT-FA72WA-2803)
(FAA-RD-73-150-3A) Avail: NTIS HC $20.25

The parameters and processing methods that are critical to designing a precision distance measuring equipment system for use with a microwave landing system are discussed. The overall system accuracy, search times, and performance under high density environments are analyzed. Emphasis is placed on: (1) results of system capacity and interference analysis, (2) multipath summary, (3) DME power requirements and low angle coverage, and (4) DME dynamic range.
Author

N74-15384# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. VOLUME 4: SYSTEM CONSIDERATIONS 1.1.2 THROUGH 1.1.5
27 Sep. 1972 161 p refs
(Contract DOT-FA72WA-2803)
(FAA-RD-73-150-4) Avail: NTIS HC $10.25

The studies and analyses to support the development of a microwave landing system are presented. The subjects considered are: (1) the economic model and life cycle costs, (2) time reference angular measurement against coding on the beam, (3) integrity enchancement by dual angle mode encoding, (4) beam forming network, (5) electronic scan compared with mechanical scan, and (6) system configuration and deployment tradeoffs. The compatibility of the microwave system with airport installations and with aircraft types, missions, and aerodynamics is analyzed.
Author

N74-15385# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. VOLUME 5: POST TA/CD PLANS, MANAGEMENT PERFORMANCE
27 Sep. 1972 310 p refs
(Contract DOT-FA72WA-2803)
(FAA-RD-73-150-5) Avail: NTIS HC $17.50

The proposed methods for conducting a feasibility demonstration, prototype development, and limited production of a microwave landing system are discussed. The plans consist of: (1) test and evaluation, (2) analytical verification, (3) hardware design and fabrication, (4) prototype hardware design and fabrication, and (5) reliability and maintainability.
Author

N74-15386# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. VOLUME 6: SUPPORTING STUDIES, APPENDICES D THROUGH N
27 Sep. 1972 591 p refs
(Contract DOT-FA72WA-2803)
(FAA-RD-73-150-6-App-D-N) Avail: NTIS HC $31.75

Various studies which were conducted during the planning and development of a microwave landing system are presented. The subjects considered include the following: (1) obstacle multipath effects, (2) rough ground effects, (3) refraction, (4) convex runways, and (5) aircraft blockage. A summary of computer simulation results is developed. Circuit development practices and diagrams of subsystem circuits are provided.
Author

N74-15454 Wisconsin Univ., Madison.
THE DIVIDED COMBUSTION CHAMBER CONCEPT AND DESIGN FOR CONTROL OF SI ENGINE EXHAUST AIR POLLUTANT EMISSIONS Ph.D. Thesis
Ibrahim Ahmed El-Messiri 1973 308 p
Avail: Univ. Microfilms Order No. 73-19298

The divided combustion chamber engine was designed specifically for control of SI engine air pollutant emissions through basic modification of the combustion process within the engine. The basis for reduction of pollutant emissions is division of the combustion space into two regions, a primary chamber and a secondary chamber. These two chambers communicate via an orifice. Just prior to ignition the primary chamber contains a homogeneous combutible fuel-air mixture while the secondary chamber contains only air. Following ignition, burned combustion gases expand immediately and with high velocity into the secondary chamber, where rapid mixing with the relatively cool secondary chamber air suppresses further formation of nitric oxide. At the same time, further oxidation of carbon monoxide and unburned hydrocarbons, issuing from the primary chamber, occurs. The engine is operated with an overall fuel-air ratio that is leaner than chemically correct, thus affording control of unburned hydrocarbon carbon monoxide emissions as well as nitric oxide.
Dissert. Abstr.

N74-15465*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLIGHT VELOCITY EFFECTS ON JET NOISE OF SEVERAL VARIATIONS OF A 48-TUBE SUPPRESSOR INSTALLED ON A PLUG NOZZLE
Richard R. Burley and Verlon L. Head Washington Feb. 1974 38 p refs

(NASA-TM-X-2919; E-7513) Avail: NTIS HC $3.00 CSCL 21E

Because of the relatively high takeoff speeds of supersonic transport aircraft, it is important to know if the flight velocity affects the noise level of suppressor nozzles. To investigate this, a modified F-106B aircraft was used to conduct a series of flyover and static tests on a 48-tube suppressor installed on an uncooled plug nozzle. Comparison of flyover and static spectra indicated that flight velocity had little effect on the noise suppression of the 48-tube suppressor configuration. However, flight velocity adversely affected noise suppression of the 48-tube suppressor with an acoustic shroud and plug installed. Author

N74-15466*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FLIGHT VELOCITY EFFECTS ON JET NOISE OF SEVERAL VARIATIONS OF A TWELVE-CHUTE SUPPRESSOR INSTALLED ON A PLUG NOZZLE

Richard R. Burley and Albert L. Johns Washington Feb. 1974 38 p refs

(NASA-TM-X-2918; E-7449) Avail: NTIS HC $3.00 CSCL 21E

Because of the relatively high takeoff speeds of supersonic transport aircraft, it is important to know whether the flight velocity effects the noise level of suppressor nozzles. To investigate this, a modified F-106B aircraft was used to conduct a series of flyover and static tests on a 12-chute suppressor installed on an uncooled plug nozzle. Comparison of flyover and static spectra indicated that flight velocity adversely affected noise suppressions of the 12-chute configurations. Author

N74-15467# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE TESTING OF JET ENGINES, CHAPTERS 5 AND 6

L. S. Skubschevskii 6 Sep. 1973 69 p refs Transl. into ENGLISH from the publ. "Ispytaniya Vozdushno- Kakt ivnukh Dvigatele" USSR, 1972 115 p

(AF Proj. G101)

(AD-768492; FTD-MT-24-345-73) Avail: NTIS CSCL 21/5

The report describes the structural parts of jet engine test stands and explains the function of each part. GRA

N74-15468# Phillips Petroleum Co., Bartlesville, Okla. Research and Development Dept.

REDUCTION OF POLLUTANTS FROM AIRCRAFT TURBINE BY FUEL SELECTION AND PREVAPORIZATION Final Report, 14 Sep. 1972 - 14 Jun. 1973

H. T. Quigg Oct. 1973 184 p refs

(Contract N00140-72-C-6969)

(AD-769099; Rept-6607-73) Avail: NTIS CSCL 21/5

An investigation was conducted, using the Phillips 2-Inch combustor operating under conditions simulating those in modern aircraft turbine engines, to provide information on the effects of hydrocarbon type and fuel volatility on flame radiance and exhaust emissions. Fuels used in the investigation were a JP-5 for reference and ten pure hydrocarbons (normal, iso-, and cycloparaffins and aromatics) with various boiling points within each hydrocarbon type. Hydrogen content of the fuels ranged from 7.7 to 16.4 weight per cent. The effects of differences in physical properties of the fuels were minimized by prevaporization before introduction to the combustor and maximized by using pressure atomization for injection of fuel to the combustor. Inlet air humidity was included as an operating variable. Empirical equations, based on fuel and operating variables were developed for prediction of flame radiance, NO, NOx, CO, and smoke. (Modified author abstract) GRA

N74-15612 British Aircraft Corp., Preston (England) Military Aircraft Div.

OPTIMISATION OF AIRCRAFT STRUCTURES WITH MULTIPLE STIFFNESS REQUIREMENTS

I. C. Taig and R. I. Kerr *In* AGARD Second Symp. on Structural Optimization Nov. 1973 14 p refs

A general optimality theorem is presented for structures whose members have stiffnesses proportional to their masses and which are designed by generalized stiffness requirements. The theorem is used to derive an iterative procedure for optimum structure design. Modifications to the basic theorem enable practical constraints such as minimum material gauges and strength or stability requirements to be introduced. The method can be used where stiffness requirements are directly specified for given loading conditions or where vibration frequency or aeroelastic efficiency requirements are stipulated. A useful feature of the method, when used in conjunction with automated design procedures, is that the optimization can operate with real structure variables and constraints so that there is no subsequent design operation required to convert idealised structure dimensions to feasible detail sizes. Several examples are quoted to show that very favorable results and computing times are obtainable for demonstration problems. The ability to handle major structural optimization is also illustrated by applications to actual airframe structures. Author

N74-15614 Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany). Stress Dept.

OPTIMIZATION AND DESIGN OF THE REAR FUSELAGE OF THE A 300 B AIRCRAFT STRUCTURE

D. Schulz *In* AGARD Second Symp. on Structural Optimization Nov. 1973 15 p refs

A method is described for the automatically controlled calculation of a skin/stringer structure. The method was programmed and applied for the first time for the development of the Airbus A 300 B. The method can be considered as a link in a process chain, the target of which is the overall development of aircraft structures. It starts with the calculation of statically indeterminate forces and ends up with the statical strength analysis. Input and output data for the calculations of statically indeterminate forces are used as input data for structure dimensioning or strength analysis program. The structure dimensioning program iterativly modifies the originally defined wall thicknesses so that the reserve factors required to prevent failure under tensile, compression and shear loads are reached or only slightly exceeded in all critical load cases. The originally defined structural concept (stringer and frame spacing as well as stringer shapes) is not changed in this case. Final dimensioning is influenced by manufacturing considerations. On completion of the dimensioning work the dimensions are laid down and the strength analysis is carried out in a single computer run. The flow of the program is demonstrated in the example of the Airbus A 300 B rear fuselage. Author

N74-15659*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF INCREASED FUEL TEMPERATURE ON EMISSIONS OF OXIDES OF NITROGEN FROM A GAS TURBINE COMBUSTOR BURNING ASTM JET-A FUEL

Nicholas R. Marchionna Washington Jan. 1974 18 p refs

(NASA-TM-X-2931; E-7634) Avail: NTIS HC $2.75 CSCL 20M

An annular gas turbine combustor was tested with heated ASTM Jet-A fuel to determine the effect of increased fuel temperature on the formation of oxides of nitrogen. Fuel temperature ranged from ambient to 700 K. The NOx emission index increased at a rate of 6 percent per 100 K increase in fuel temperature. Author

N74-15666# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

COMBUSTION GENERATED NOISE IN TURBOPROPULSION SYSTEMS Interim Technical Report

B. N. Shivashankara, J. C. Handley, and W. C. Strahle 24 Jul. 1973 97 p refs

(Grant AF-AFOSR-2365-72; AF Proj. 9711)

(AD-768615; AFOSR-73-1899TR) Avail: NTIS CSCL 21/2

Experiments on noise radiation by open turbulent premixed flames are described. Detailed directionality distributions, scaling rules for acoustic power radiated, thermo-acoustic efficiency and spectral content are presented and discussed. Scaling rules for

reacting volume are generated by a direct flame photography technique. These experiments are shown to be quite useful in decomposing combustion noise scaling laws. The acoustic power is shown to scale as U(2.7) D(2.8) SL(1.4) F(0.4), and combustion noise spectra peak in the 250-700 Hz range. The directionality is quite weak for noise from open turbulent flames. The experimental results are critically examined in the light of the theoretical predictions from Strahle's theory of combustion noise. Author (GRA)

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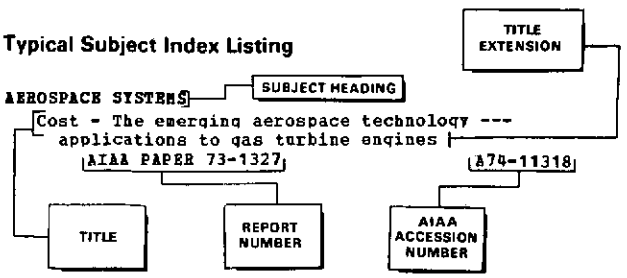

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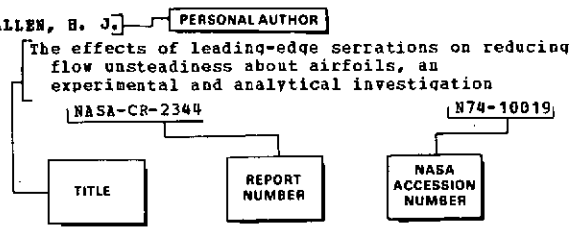

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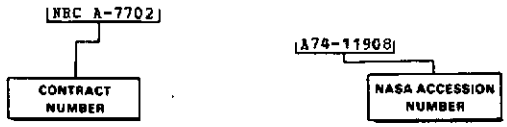
CONTRACT NUMBER INDEX

Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the *IAA* or *STAR* section.