NASA SP-7037 (69)

NASA SP-7037(69) Aeronautical Engineering Pages 91–130 APRIL 1976

# AERONAUTICAL ENGINEERING

## A SPECIAL BIBLIOGRAPHY WITH INDEXES

## Supplement 69

APRIL 1976

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

## ACCESSION NUMBER RANGES

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

| | | |
|---|---|---|
| STAR (N-10000 Series) | N76-14018 | N76-16013 |
| IAA (A-10000 Series) | A76-15979 | A76-18885 |

This bibliography was prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Informatics Information Systems Company

NASA SP-7037 (69)

# AERONAUTICAL ENGINEERING

## A Special Bibliography

## Supplement 69

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 1976 in

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

*Scientific and Technical Information Office*
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
APRIL 1976
*Washington, D.C*

This Supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, for $4 00 For copies mailed to addresses outside the United States, add $2 50 per copy for handling and postage

# 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 305 reports, journal articles, and other documents originally announced in March 1976 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*

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

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

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

An annual cumulative index will be published.

# AVAILABILITY OF CITED PUBLICATIONS

## IAA ENTRIES (A76-10000 Series)

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 50 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 (A76-10091), when requesting publications

## STAR ENTRIES (N76-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation The most commonly indicated sources and their acronyms or abbreviations are listed below If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line

Avail NTIS Sold by the National Technical Information Service to U S customers at the price shown in the citation following the letters HC (hard, paper, or facsimile copy) Customers outside the U S should add $2 50 per copy for handling and postage charges to the price shown (Prices shown in earlier *STAR* volumes, 1962-1975, have been superseded but may be calculated from the number of pages shown in the citation The price schedule by page count was published in *STAR* numbers 2 and 3 of 1976, or it may be obtained from NTIS )

Microfiche[1] are available at a standard price of $2 25 (plus $1 50 for non-U S customers) regardless of source or quality of the fiche, for those accessions followed by a # symbol Accession numbers followed by a + sign are not available as microfiche because of size or reproducibility

Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Unit

NOTE ON ORDERING DOCUMENTS When ordering NASA publications (those followed by the * symbol), use the N accession number NASA patent applications (only the specifications are offered) should be ordered by the US-Patent-Appl-SN number Non-NASA publications (no asterisk) should be ordered by the AD, PB, or other *report* number shown on the last line of the citation, not by the N accession number It is also advisable to cite the title and other bibliographic identification

Avail SOD (or GPO) Sold by the Superintendent of Documents, U S Government Printing Office, in hard copy The current price and order number are given following the availability line (NTIS will fill microfiche requests, at the standard $2 25 price, for those documents identified by a # symbol )

(1) A microfiche is a transparent sheet of film, 105mm by 148mm in size containing as many as 60 to 98 pages of information reduced to micro images (not to exceed 26 1 reduction)

Avail NASA Public Document Rooms Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration, Public Documents Room (Room 126), 600 Independence Ave , S W , Washington, D C 20546, or public document rooms located at each of the NASA research centers, the NASA Space Technology Laboratories, and the NASA Pasadena Office at the Jet Propulsion Laboratory

Avail ERDA Depository Libraries Organizations in U S cities and abroad that maintain collections of Energy Research and Development Administration reports, usually in microfiche form, are listed in *Nuclear Science Abstracts* Services available from the ERDA and its depositories are described in a booklet, *Science Information Available from the Energy Research and Development Administration* (TID-4550), which may be obtained without charge from the ERDA Technical Information Center

Avail Univ Microfilms Documents so indicated are dissertations selected from *Dissertation Abstracts* and are sold by University Microfilms as xerographic copy (HC) at $10 00 each and microfilm at $4 00 each regardless of the length of the manuscript Handling and shipping charges are additional All requests should cite the author and the Order Number as they appear in the citation

Avail USGS Originals of many reports from the U S Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed in this Introduction The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction

Avail HMSO Publications of Her Majesty's Stationery Office are sold in the U S by Pendragon House, Inc (PHI), Redwood City, California The U S price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI

Avail BLL (formerly NLL) British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England Photocopies available from this organization at the price shown (If none is given, inquiry should be addressed to the BLL)

Avail ZLDI Sold by the Zentralstelle fur Luftfahrtdokumentation und -Information, Munich, Federal Republic of Germany, at the price shown in deutschmarks (DM)

Avail Issuing Activity, or Corporate Author, or no indication of availability Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document

Avail U S Patent Office Sold by Commissioner of Patents, U S Patent Office, at the standard price of 50 cents each, postage free

Other availabilities If the publication is available from a source other than the above the publisher and his address will be displayed entirely on the availability line or in combination with the corporate author line

## GENERAL AVAILABILITY

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

## ADDRESSES OF ORGANIZATIONS

American Institute of Aeronautics
and Astronautics
Technical Information Service
750 Third Ave
New York, N Y 10017

British Library Lending Division,
Boston Spa, Wetherby, Yorkshire,
England

Commissioner of Patents
U S Patent Office
Washington, D C 20231

Energy Research and Development
Administration
Technical Information Center
P O Box 62
Oak Ridge, Tennessee 37830

ESA - Space Documentation Service
ESRIN
Via Galileo Galilei
00044 Frascati (Rome), Italy

Her Majesty's Stationery Office
P O Box 569, S E 1
London, England

NASA Scientific and Technical Information
Facility
P O Box 8757
B W I Airport, Maryland 21240

National Aeronautics and Space
Administration
Scientific and Technical Information
Office (KSI)
Washington, D C 20546

National Technical Information Service
Springfield, Virginia 22161

Pendragon House, Inc
899 Broadway Avenue
Redwood City, California 94063

Superintendent of Documents
U S Government Printing Office
Washington, D C 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, Michigan 48106

University Microfilms, Ltd
Tylers Green
London, England

U S Geological Survey
1033 General Services Administration Bldg
Washington, D C 20242

U S Geological Survey
601 E Cedar Avenue
Flagstaff, Arizona 86002

U S Geological Survey
345 Middlefield Road
Menlo Park, California 94025

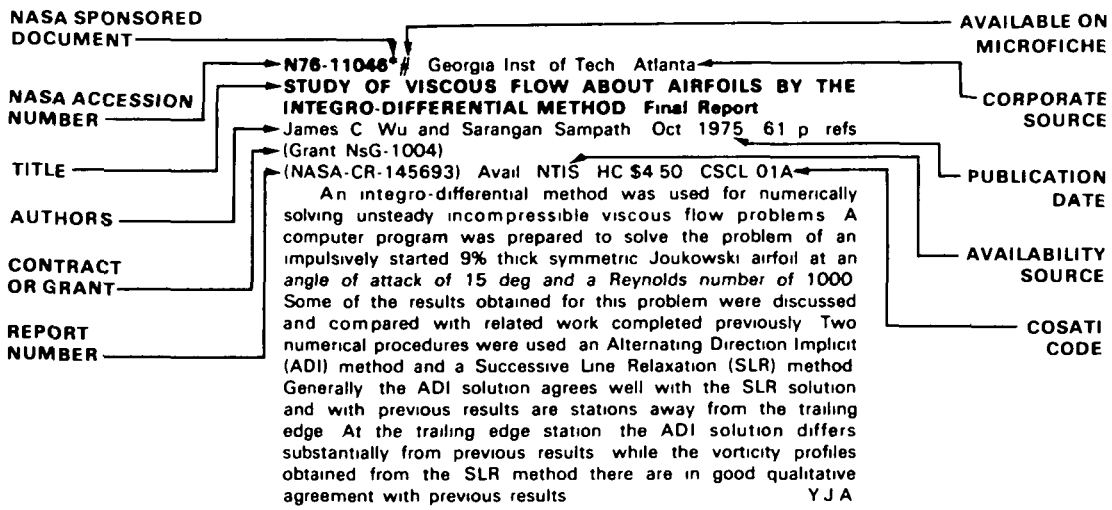
U S Geological Survey
Bldg 25, Denver Federal Center
Denver, Colorado 80225

Zentralstelle fur Luftfahrtdoku-
mentation und -Information
8 Munchen 86
Postfach 880
Federal Republic of Germany

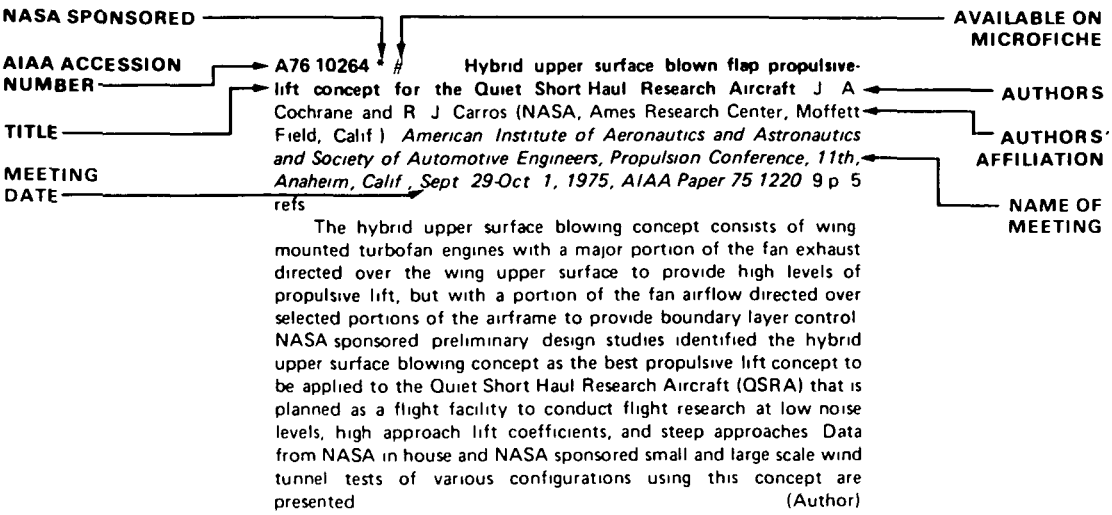
# TABLE OF CONTENTS



## TYPICAL CITATION AND ABSTRACT FROM *STAR*




## TYPICAL CITATION AND ABSTRACT FROM *IAA*



# AERONAUTICAL ENGINEERING

*A Special Bibliography (Suppl. 69)*

APRIL 1976

## IAA ENTRIES

**A76-16390** # **Experimental vibration-damping study for flat aircraft-skin panels (Eksperimental'noe issledovanie dempfirovaniia kolebanii panelei ploskikh samoletnykh obshivok)** A I Kashchuk and V V Matveev *Problemy Prochnosti,* Oct 1975, p 95-100 6 refs In Russian

The structural damping capacity of six D16AT duralumin panels of different design was studied as a function of their structural and technological characteristics. It is shown that by using appropriate flexible viscoelastic adhesives (of the type of VK-3), the acoustic resonance vibrations of two-layer panels can be drastically reduced V P

**A76-16491** **Testing Europe's Panavia MRCA** C Gilson and S Broadbent *Flight International,* vol 108, Dec 18, 1975, p 883-886

It is expected that by the end of February 1976 the Governments of Britain, West Germany, and Italy will have most of the information required for a decision concerning Panavia's Multi-Role Combat Aircraft (MRCA) Details regarding the flight-test program are discussed, taking into account studies conducted by British, German, and Italian aerospace companies Approaches used for low-speed drag measurements are reported The development of a spin-prevention system for the normal operational aircraft is considered in connection with possible roll and yaw stability problems Attention is also given to plans for the conduction of supersonic tests G R

**A76-16492** **Nav attack trials - Successful first stage** *Flight International,* vol 108, Dec 18, 1975, p 887-889

The first flight of P 04 in September represents a significant advance in the development of the MRCA avionics The fourth prototype of the MRCA is fully equipped with the inertial nav/attack and radar systems specified for the combat aircraft which is being developed jointly by the aerospace industries in Britain, West Germany, and Italy Much of the avionics equipment, with the exception of the airborne radar, is of European design and manufacture The radar is built by a U S company Attention is given to the inertial navigation system, the laser rangefinder and marked-target receiver, and the head-up display G R

**A76-16543** **The use of titanium castings to produce a complex shaped intermediate casing of MRCA engine RB 199 (Die Anwendung von Titangussteilen im MRCA Triebwerk RB 199 zur Herstellung eines komplexen Zwischengehäuses)** W G Hansen (Motoren- und Turbinen-Union Munchen GmbH, Munich, West Germany) *Zeitschrift fur Werkstofftechnik,* vol 6, Nov 1975, p 361-367 In German

This paper describes the present position on a highly stressed casing and its functions in the RB 199-34 R engine When the parts of the casing are made from solid forged titanium billets, up to 93% of the material used is machined away For this reason, the most complicated parts of the casing were procured as castings and welded together by TIG welding The paper describes the present quality standard of the titanium castings The tests on the materials and their mechanical properties show that the castings are inferior to the forgings only with respect to their HCF behavior and their elongation at rupture Macroscopic flaws are not entirely inevitable but can be detected by X-ray tests The future prospects for titanium castings are considered favorable (Author)

**A76-16579** **Impact damage effects on boron-aluminum composites** J C Carlisle, R L Crane, L T Montulli (USAF, Institute of Technology, Dayton, Ohio), and W J Jaques In Composite reliability, Proceedings of the Symposium, Las Vegas, Nev., April 15, 16, 1974 Philadelphia, Pa , American Society for Testing and Materials, 1975, p. 458-470. 16 refs

The foreign-object damage problem associated with jet engines was investigated by impacting both titanium (6Al-4V) and boron-aluminum specimens with either steel or room-temperature vulcanizing rubber spheres to simulate the two principal types of ingested foreign objects To simulate engine operating conditions, some specimens were impacted while under a tensile load Results indicate that a prestressed composite suffers much greater damage than simple cantilevered specimens Ti-6Al-4V exhibits excellent impact resistance, loosing only 10 percent of its ultimate tensile strength up to the highest prestresses and impact velocities Composite specimens react much differently depending on the type of impactor Steel spheres cause severe damage at very low impact velocities Room-temperature vulcanizing rubber, on the other hand, causes little damage up to a velocity threshhold Above this point, specimen failure was observed at some prestresses upon impact The residual tensile and low-cycle fatigue strength of both boron-aluminum and titanium was documented for various impacting velocities and prestresses A fracture-mechanics analysis is presented which successfully predicts the effects of room-temperature vulcanizing rubber impact on boron-aluminum composites (Author)

**A76-16635** # ***Resonance vibrations of a rotor on an elastic base with allowance for dry friction (Rezonansnye kolebaniia vinta na uprugom osnovanii s uchetom sukhogo treniia)*** R F Ganiev (Akademiia Nauk Ukrainskoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR) and A A Shcherbina (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) *Prikladnaia Mekhanika,* vol 11, Oct 1975, p 77-82 In Russian

The model of a rotor resting on an elastic base is used to study the ground resonance of a rotor-craft with allowance for dry friction arising in the sealing rings and journal boxes The ground resonance problem is formulated as the problem of the behavior of the system under conditions of combinational resonance and is studied in the first approximation by an asymptotic method The possible occurrence of self-excited vibrations is demonstrated, and the mechanisms of excitation are examined The influence of the self-excited vibrations on the ground resonance is assessed V P

**A76-16675** # ***Aeromechanics of supersonic flows past power-law bodies of revolution (Aeromekhanika sverkhzvukovogo obtekaniia tel vrashcheniia stepennoi formy)*** V I Blagosklonov, V I. Vasil'chenko, S S. Grigorian, G L Grodzovskii, R A Zhukova, N L Krasheninnikova, Iu A Lashkov, P D Mikhailov, M F Pritulo, and A A Rafaeliants Moscow, Izdatel'stvo Mashinostroenie,

1975 184 p 157 refs In Russian

The results of theoretical and experimental studies dealing with the supersonic aeromechanics of minimum-drag power-law bodies of revolution are reviewed and generalized It is shown that such bodies are characterized also by a low heat transfer coefficient, and that effects observed at hypersonic speeds will also manifest themselves at moderate supersonic speeds Exact methods for calculating the aerodynamic characteristics of power-law bodies of revolution at hypersonic and supersonic speeds are outlined V P

**A76-16698** # **Experimental investigation of some statistical vibration characteristics of an aircraft engine (Eksperimental'noe issledovanie nekotorykh statisticheskikh kharakteristik vibratsii aviatsionnogo dvigatelia)** S G Gershman and V D Svet (Akademiia Nauk SSSR, Akusticheskii Institut, Moscow, USSR) *Akusticheskii Zhurnal*, vol 21, Sept -Oct 1975, p 711-720 12 refs In Russian

Experiments were conducted to determine the two-dimensional laws governing the distribution of probabilities and their parameters along with conventional spectral-correlation characteristics as related to the vibrations of a turbojet aircraft engine A major conclusion is that the different vibration components in the various regions of the spectrum are nonlinearly correlated with each other This nonlinear correlation is dependent on the condition of the mechanism used S D

**A76-16719** **Some computational aspects of thin wire modeling** E K Miller and F J Deadrick (California, University, Livermore, Calif ) In Numerical and asymptotic techniques in electromagnetics New York, Springer-Verlag New York, Inc , 1975, p 89-127 36 refs Research supported by the U S Coast Guard and AEC

Computational problems in modeling of thin-wire structures are discussed, with results obtained from a subsectional collocation solution involving point matching of boundary conditions and a three-term current expansion of the thin-wire electric-field integral equation Structure segmentation, the thin-wire approximation, near-field numerical anomalies, matrix factorization roundoff error, multiple junction treatment, and required computer time are discussed Errors in solving the integral equation by the method of moments are distinguished, and various pitfalls and numerical anomalies are singled out for attention The wire-grid numerical method is shown to be applicable to the study of several other practical problems, such as radar cross section analysis, antenna analysis, and modeling of aircraft and helicopter airframes R D V

**A76-16740** **Acoustic excitation of high-velocity jets** Iu Ia Borisov and N M Gynkina (Akademiia Nauk SSSR, Akusticheskii Institut, Moscow, USSR) *(Akusticheskii Zhurnal*, vol 21, May-June 1975, p 364-371 ) *Soviet Physics - Acoustics*, vol 21, no 3, 1975, p 230-233 10 refs Translation

Experimental study of the effect of 14-kHz, 170-db sound on gas jets in the Reynolds number range from 21,000 to 192,000 and the Mach number range from 15 to 9 Nozzle exit was placed in the focus of an elliptical concentrator, in the second focus of which the sound source was placed The effect of sound was evaluated according to the ratio of axial velocities, the change in jet width, and the spectral characteristics with and without sound interaction Maximal jet excitation was obtained at Strouhal numbers from 25 to 3 For given Strouhal number, the effect of sonic interaction depends on the ratio of acoustic power acting on the jet to the power of the jet itself P T H

**A76-16745** # **Viscous flow around a rotationally oscillating circular cylinder** A Okajima (Kyushu University, Fukuoka, Japan), H Takata (Tokyo, University, Tokyo, Japan), and T Asanuma *Tokyo, University, Institute of Space and Aeronautical Science, Report* no 532, vol 40, Sept 1975, p 311-338 23 refs

Aerodynamic characteristics of a circular cylinder either stationary or rotationally oscillating around its axis in uniform viscous flow are studied by numerical calculation and by experiment The method and results of numerical solution of the Navier Stokes equations by the finite difference analogue are presented together with measurements for the lift and the drag forces acting on the cylinder made by towing test models in still fluid with Reynolds numbers ranging from 40 to 6100 Good agreement is obtained between the calculated results and the experimental ones at Reynolds numbers of 40 and 80, for the steady and unsteady aerodynamic parameters, the phenomenon of the so-called synchronization and so on Numerical calculations indicate that there may be a close relationship between the time-variation of the flow pattern and that of the lift force on an oscillating cylinder The influence of Reynolds number on the arodynamic parameters and the phenomenon of synchronization are investigated experimentally (Author)

**A76-16746** # **Viscous flow around a transversally oscillating elliptic cylinder** A Okajima (Kyushu University, Fukuoka, Japan), H Takata (Tokyo, University, Tokyo, Japan), and T Asanuma *Tokyo, University, Institute of Space and Aeronautical Science, Report* no 533, vol 40, Oct 1975, p 339-368 7 refs

Viscous effects of flow on the aerodynamic characteristic of an elliptic cylinder are investigated on the bases of a numerical solution as the Navier-Stokes equations for flow around both stationary and transversally oscillating elliptic cylinders at Reynolds numbers of 40 and 80 and measurements of the aerodynamic forces and pressure acting on an elliptic cylinder in the range of Reynolds numbers 40 to 20,000 Good agreement is obtained between the calculated results and the experimental ones for steady and unsteady aerodynamic parameters at Reynolds numbers 40 and 80 On the basis of the numerical results the time-variation of flow pattern around an elliptic cylinder is examined e g , locations of stagnation points The effects of angle of attack, Reynolds number and oscillatory frequency on aerodynamic parameters are discussed (Author)

**A76-16762** **Thermal effects in gas turbine rotors and stators during transient modes of operation I (Effets thermiques dans les rotors et stators de turbines à gaz lors des regimes transitoires I)** D Girault (Societe Generale de Constructions Electriques et Mecaniques Alsthom, Belfort, France) *Revue Française de Mécanique*, 1st Quarter, 1975, p 45-51 In French

The problems related to the thermal effects when a high-power gas turbine is started and stopped are discussed The techniques employed aim at the thermal insulation of the turbine disks and casings from the hot gas flow, thus requiring fewer parts to be subjected to severe thermal stresses while using common metals and alloys for the rotors and stators Starting and stopping programs are devised to ensure an acceptable life for the parts which make direct contact with hot combustion gases In addition to investigating the mechanical stresses due to thermal gradients, differential expansion of parts in the transient period and the evolution of temperatures in the rotor after the turbine is stopped should be taken into consideration S D

**A76-16782** # **Balancing of rigid rotors and mechanisms (Uravnoveshivanie zhestkikh rotorov i mekhanizmov)** V N Barke, V A Zakharov, V A Zenkevich, T P Kozlianinov, Ia I Korytysskii, M E Levit, E V Nikolaevskii, G N Petrov, B T Runov, and V P Roizman Moscow, Izdatel'stvo Mashinostroenie (Osnovy Balansirovochnoi Tekhniki Volume 1), 1975 527 p 61 refs In Russian

The fundamentals of modern balancing theory are systematically outlined, starting with simple concepts and proceeding to modern methods developed for complex mechanisms and rotor systems with elastic shafts The principles of operation of sophisticated balancing

stands and machines are described Methods of balancing rotating machines in the field are studied, along with methods for force balancing simple linkages, and methods of rotor-unbalance determination V P

**A76-16797** # **Response of an airfoil to turbulence when damping is moderate.** R Arho *ASME, Transactions, Series E Journal of Applied Mechanics,* vol 42, Dec 1975, p 905, 906

An approximate analytical integration method is presented for evaluation of the expression given by Liepmann (1952) for the mean square deflection of an aircraft wing under random lift For cases in which there is moderate damping due to the elastic structure of the wing the method yields more accurate results than the white-noise idealization Two examples are given C K D

**A76-16845** # **Decision problem involving the introduction of RTOL aircraft into commercial air transportation systems** G Schmitt and D M Miller (Virginia Polytechnic Institute and State University, Blacksburg, Va ) *Operations Research Society of America and Institute of Management Sciences, Joint National Meeting, Las Vegas, Nev , Nov 17-19, 1975, Paper* 28 p 20 refs

It is pointed out that developments in the air transportation industry related to increasing air traffic demand will make it necessary to make in the very near future a number of important decisions One possible solution to be considered in this connection involves the introduction of a new type of aircraft into the air traffic system A methodology which has been developed to assist decision makers in making decisions concerning this possibility is discussed Present conditions are examined along with RTOL aircraft characteristics and questions concerning a utilization of RTOL in the commercial air transportation system The solution procedure developed is applied to a small air transportation system with five major cities G R

**A76-16901 Symposium on Noise in Transportation, University of Southampton, Southampton, England, July 22, 23, 1974, Proceedings** Symposium sponsored by the Institute of Acoustics, IME, University of Southampton, RAeS, and Society of Environmental Engineers *Journal of Sound and Vibration,* vol 43, Nov 22, 1975 335 p

A transportation noise policy is considered along with an assessment of community noise, the future transportation noise environment in the United Kingdom, a brief review of air transport noise, the control of noise from surface transport, motor vehicle noise abatement through economic incentives, and aerodynamic noise sources Attention is also given to noise sources and their control in V/STOL aircraft, noise of advanced subsonic air transport systems, the effect of operating parameters on sources of vehicle noise, noise and vibration on board ship, an analysis of railway vehicle acoustics, the analysis and treatment of diesel-engine noise, and the effects of aircraft noise on man G R

**A76-16903 The future transportation noise environment in the United Kingdom.** E J Richards (Loughborough University of Technology, Loughborough, Leics , England) *(Institute of Acoustics, IME, University of Southampton, RAeS, and Society of Environmental Engineers, Symposium on Noise in Transportation, Southampton, England, July 22, 23, 1974 ) Journal of Sound and Vibration,* vol 43, Nov 22, 1975, p 147 155 13 refs

An investigation is conducted regarding the future trends in aircraft noise The feelings of people about aircraft noise are examined and a generalized curve of serious noise nuisance is established Approaches for reducing the noise at the airport are considered, taking into account the cost factors involved Questions concerning road transport noise are also investigated It is pointed out that in the case of the existing urban communities approaches for quieting the motor vehicle constitute the only solution of current noise annoyance problems G R

**A76-16937** # **Solution of two- and three-dimensional problems involving transonic flows past bodies (K resheniiu dvumernykh i prostranstvennykh zadach obtekaniia tel okolozvukovym potokom)** M Ia Ivanov *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki,* vol 15, Sept -Oct 1975, p 1222 1240 32 refs In Russian

A three-dimensional version of Godunov's (1970) explicit difference scheme is applied to the solution of problems involving sonic, transonic, and supersonic flows of an inviscid nonheat-conducting gas past two- and three-dimensional bodies Using this method, the steady flow pattern derives from the transient process as a function of time Flows are calculated for pointed bodies of circular and elliptical cross section, a circular cylinder, a cylinder face, and for configurations composed of cylinders and cones V P

**A76-16940** # **A numerical method for calculating three-dimensional flows past blunted bodies with a separated shock wave (Ob odnom chislennom metode rascheta prostranstvennogo obtekaniia zatuplennykh tel s otoshedshei udarnoi volnoi)** M M Golomazov and A P Ziuzin *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki,* vol 15, Sept -Oct 1975, p 1349 1355 7 refs In Russian

The steady three-dimensional supersonic flow of a perfect gas past blunted bodies is examined It is assumed that the bodies possess a symmetry plane and that the oncoming velocity vector is situated in this plane A numerical method for calculating the flow in the transonic region of the shock layer is proposed Calculations are carried out for an ellipsoid of revolution with an a/b ratio of 1 5 at angles of attack ranging from 0 to 90 degrees, and for segmental bodies at angles of attack from 0 to 30 degrees V P

**A76-17001** # **Potential flow past a biplane (Potencjalny oplyw dwuplata)** S Demczuk and W Potkanski (Wytwornia Sprzetu Komunikacyjnego, Mielec, Poland) *(Krajowa Konferencja Mechaniki Cieczy i Gazow, 1st, Jaszowiec, Poland, Dec 2-7, 1974 ) Instytut Lotnictwa, Prace,* no 62, 1975, p 3 19 15 refs In Polish

A method for determining the distribution of the lift over the wings of a biplane is presented The method is based on the generalized lift line theory and takes into account biplane interference, the deflection of the control surfaces, and the effect of fuselage type bodies on aerodynamic properties Some numerical results are compared with experimental results and those obtained by means of Prandtl's lift line method The lift distribution along the wings has been used to determine a number of aerodynamic coefficients of the biplane The theoretical and experimental results are in good agreement The method described enables the determination of aerodynamic characteristics of a single wing in the neighborhood of the ground (Author)

**A76-17005** # **Epoxy and polyurethane paint compositions for agricultural aircraft (Epoksydowe i poliuretanowe zestawy malarskie do samolotow rolniczych)** W Poninski *Instytut Lotnictwa, Prace,* no 62, 1975, p 81-93 7 refs In Polish

The progress made in Poland during the last two decades in the domain of paints for agricultural aircraft is discussed In view of the development of polyurethane paints in the world comparative tests were performed of the epoxy paints now in use and three different polyurethane paints The test methods are discussed, comprising tests with selected chemicals for plant protection and under conditions imitating the atmospheric influences The results obtained show that the properties of polyurethane paints are better than epoxy paints under the action of atmospheric and chemical agents as well. (Author)

**A76-17006** # **Limited-energy hydraulic starting system (Hydrauliczny uklad rozruchowy o ograniczonej energii)** H Pietruszka and K Kulinicz *Instytut Lotnictwa, Prace,* no 62, 1975,

p 95-112 9 refs In Polish

Two types of starting systems for turbine engines are defined limited-energy systems and systems with limited auxiliary drive power output Mathematical analogs are developed for the turbine engine as power plant to be started and for the limited-energy hydrostarting system Starting from cold and starting with engine warmed up are also modeled Agreement between experimental test data and analog model data is satisfactory within the limits of experimental error for test-bench performance, but caution is suggested on extrapolation of the results to all sets of performance conditions R D V

**A76-17171 On the amplification of broad band jet noise by a pure tone excitation** D Bechert and E Pfizenmaier (Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Turbulenzforschung, Berlin, West Germany) *Journal of Sound and Vibration,* vol 43, Dec 8, 1975, p 581-587 8 refs

It has been found experimentally that broad band jet noise can be amplified by a pure tone excitation as much as 6 to 7 dB The jet noise amplification effect takes place at sound pressure levels which are present in real aircraft engines The experimental investigation was restricted to a cold jet at high subsonic Mach numbers excited by a plane sound wave coming from inside the nozzle Based on a simplified mathematical model an attenuator has been constructed which is able to reduce the jet noise amplification significantly (Author)

**A76-17223 The Dash 7 at the airport** A F Toplis (de Havilland Aircraft of Canada, Ltd , Downsview, Ontario, Canada) *Airport Forum,* vol 5, Dec 1975, p 11-17 In English and German

The Dash 7, which is produced by a Canadian aerospace company, has a 50 passenger capacity The aircraft can be used for high-frequency operations on dense short-haul routes and for daily operations on routes with as few as 25 passengers per flight The low operational noise level of the aircraft and its STOL characteristics will make it possible to utilize for Dash 7 airports which are close to the populations to be served Attention is given to questions of aircraft layout and design, the powerplant, aspects of ground maneuverability, runway and taxiway loads, passenger handling, and cargo handling G R

**A76-17224 Impact of wide-body jets on cargo facilities** R F Stoessel (Management Enterprises, Inc , Corona del Mar, Calif ) *Airport Forum,* vol 5, Dec 1975, p 28-30, 32, 34, 35 In English and German

Aspects related to the use of an all-cargo aircraft are examined and the requirements for carrying cargo on passenger aircraft are considered An attempt is made to assign cargo-appeal ratings to a series of aircraft Advantages of the wide-body aircraft for the transportation of air cargo are discussed, taking into account changes in the characteristics of airport facilities required in connection with the greater capacity of the new aircraft type Such changes are to be considered in the design of a new international airport in Mexico City G R

**A76-17249 On the modification of subsystems in structural dynamics** S Mahalingam (Sri Lanka, University, Colombo, Sri Lanka) and R E D Bishop (University College, London, England) *Journal of Mechanical Engineering Science,* vol 17, Dec 1975, p 323-329

Suppose that it is required to find what effects some local modification would have on the vibration characteristics of a structure if a portion is to be replaced It is shown how, in theory at least, the modified characteristics can be found from a knowledge of those relating to the whole of the original structure and those relating only to the unit which is to be inserted (Author)

**A76-17332 A finite element method for the axisymmetric flow computation in a turbomachine** C Hirsch (Brussel, Vrje Universiteit, Brussels, Belgium) and G Warzee (Fonds National de la Recherche Scientifique, Brussels, Belgium) *International Journal for Numerical Methods in Engineering,* vol 10, no 1, 1976, p 93-113 18 refs

A mathematical model of a general turbomachine is set up in developing a finite-element method applicable to mixed-flow and radial-flow turbomachines and to turbines The basic equation is formulated as a quasi-harmonic equation for the stream function, and the axisymmetric radial equilibrium equation is computed The equations for meridional through-flow are formulated as a quasi harmonic nonlinear equation A severe under-relaxation factor is introduced into the iterative process to expedite convergence While results are stable, the relaxation factor affects the number of iterations required Predicted and experimental data for axial-flow turbocompressors agree closely The data are referable to subsonic flows, but transonic flows can be handled by employing a similar iterative procedure R D V

**A76-17337 Inertia loading in finite element analysis of structures subject to compound motion** J Barlow (Rolls-Royce /1971/, Ltd , Derby, England) *International Journal for Numerical Methods in Engineering,* vol 10, no 1, 1976, p 197-209

The problems associated with the stress analysis of structures subjected to body force loading due to compound motion are outlined An economic method for calculating equivalent nodal loading, for use in a finite element displacement analysis, is proposed in which the element discretization and consistent mass matrices are used to advantage The relevant equations, relating to the rigid body dynamics of compound motion, are appended in matrix notation Validity of the method is demonstrated by an analysis of the stresses, due to gyroscopic and centrifugal forces, in an aero engine blade model (Author)

**A76-17343 Fighter design philosophy** R M Braybrook *Air International,* vol 10, Jan 1976, p 15-21

Aspects of design philosophy leading to the development of the Cobra series and derivatives are discussed Special attention is given to the development of the LEX (leading edge extension) concept The relative advantages and disadvantages of straight and swept wings for attack aircraft with different capabilities and intended applications are considered together with the extent of thrust/weight improvement or degradation inherent in a twin-engined fighter design Factors affecting the proper selection of armaments for a given aerodynamic configuration are discussed C K D

**A76-17411 # The new Soviet airliner Jak-42 (Neues sowjetisches Verkehrsflugzeug Jak-42)** P Bork (Gesellschaft fur Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-okonomische Information der zivilen Luftfahrt,* vol 11, no 5, 1975, p 252-257 6 refs In German

The Jak-42 was designed to satisfy specific transportation requirements in the USSR of a new type The new aircraft is to serve industrial centers which are located at a great distance from large railway lines or air traffic routes Cases are considered in which a relative large number of passengers for flights in the range from 1,000 to 1,500 km are involved It is assumed that it is not possible to connect the centers economically to the main passenger routes by either railroad or motor traffic The design requirements for the aircraft are discussed along with the approaches used for the implementation of these requirements in the Jak-42 G R

**A76-17417 # The Dolphin airship with undulating propulsion - Comparison of undulator and propeller on the stand (Delphinluftschiff mit Wellantrieb - Vergleich von Weller und Luftschraube am Stand).** W Schmidt *Technisch-okonomische Information der zivilen Luftfahrt,* vol 11, no 5, 1975, p. 302-308 8 refs In German

The performance characteristics of the Dolphin airship and a helicopter are compared It is found that a Dolphin airship can lift a payload which is two or three times as heavy as that lifted by a helicopter, taking into consideration the same engine power for both vehicles The better performance of the Dolphin airship is possible because the undulator of the airship has to lift only the payload In the case of the helicopter, the weight of the aircraft itself constitutes a considerable part of the load which is to be lifted G R

**A76-17503** # **Calculation of unsteady transonic flow past an oscillating airfoil by a method of fractional steps (Calcul de l'écoulement instationnaire transsonique autour d'un profil oscillant par une méthode à pas fractionnaires)** P Laval (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *(Biennial Fluid Dynamics Symposium on Advanced Problems and Methods in Fluid Dynamics, 12th, Bialowieza, Poland, Sept 8-13, 1975) ONERA, TP* no 1975-115, 1975 29 p 14 refs In French

The problem of unsteady transonic flow over a symmetrical oscillating airfoil is solved by integrating numerically the exact unsteady equations in conservation form The method which is proposed is a modification of the method of fractional steps that was previously applied to the computation of steady transonic flow over an airfoil At some initial time a harmonic oscillatory motion about a fixed axis is imparted to the airfoil The displacements are assumed to be small to permit application of the slippage condition to the airfoil in its mean position By using symmetry conditions, the computations are carried out for half the field Three types of flow are calculated the asymptotic nonisentropic steady flow, an unsteady transient flow to avoid placing an abrupt discontinuity on the normal velocity at a given moment of time, and lastly, the true unsteady flow The results obtained for supercritical shock flows past a biconvex airfoil performing small-amplitudes rotational motions, show that the motions of unsteady forces are close to pure sinusoidal motions, although the shock motion is not sinusoidal, and that a steady-state solution can be obtained after two cycles (Author)

**A76-17513** # **Mathematical model of the vibrations induced by vortex shedding (Modèle mathématique du mouvement vibratoire engendré par un échappement tourbillonnaire)** E Szechenyi (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *La Recherche Aérospatiale,* Sept-Oct 1975, p 301 312 22 refs In French

A blunt cylindrical body subjected to a flow perpendicular to its axis will be excited by the unsteady lift forces due to vortex shedding A mathematical model has been developed to calculate these forces and the resulting response of the cylinder The model is based on simple physical concepts and uses results of experiments at large Reynolds numbers The comparison between theory and experiment is found satisfactory for a test carried out on a flexible cylinder in a wind tunnel (Author)

**A76-17528** # **Experiences at B A C /M A D/ Ltd with titanium casting.** M J Wynne and D J Duckworth (British Aircraft Corp, Ltd, Military Aircraft Div, Warton, Lancs, England) In International Titanium Casting Seminar, 1st, London, England, September 9, 10, 1974, Proceedings London, Titanium Metal and Alloys, Ltd, 1975 32 p

The feasibility of using titanium alloy castings for airplane engine parts is studied empirically Alpha/beta 6Al-4V common titanium alloy, with rammed graphite mold material, was used in the fabrication of engine hoist tubes, flap tracks, and arrester hook brackets The products were examined for static strength, fracture toughness, fatigue behavior, crack propagation, wear, and machinability Photomicrography, electron microprobe analysis, and radiography were also applied to the specimens The products are compared to wrought specimens and also to specimens made from other alloys Small flaws suggestive of gas porosity showed up in the cast specimens, but no cracks appeared and fatigue failure did not occur during tests The method is judged satisfactory subject to further tests and studies (on stress corrosion, crack propagation, weld repair techniques, properties of TIG and electron beam welded titanium castings) R D V

**A76-17533** # **Titanium castings - More cost effective than you think** E A Williams (TiTech International, Inc, Pomona, Calif) In International Titanium Casting Seminar, 1st, London, England, September 9, 10, 1974, Proceedings London, Titanium Metal and Alloys, Ltd, 1975 6 p

The article examines how costs can be cut effectively through the use of precision titanium castings Cost of metal removal, labor costs, and increasing materials costs are given, and castings costs are compared to machining costs, including processes incorporating numerical control The percentage composition of various structural parts and types of parts in the total airframe or aircraft cost is tabulated Metal removed by machining from forgings or billet stock for major structural parts can amount to 70-80% of the weight of the stock A 1973 USAF study showed that 30% potential savings could be achieved by reducing metal removal costs, combining some detail parts into one, narrowing excessive quality assurance and duplicate inspections, and using materials to better advantage R D V

**A76-17534** # **Historical quality assurance in titanium castings** A L Donlevy (TiTech International, Inc, Pomona, Calif) In International Titanium Casting Seminar, 1st, London, England, September 9, 10, 1974, Proceedings London, Titanium Metal and Alloys, Ltd, 1975 10 p

The article reviews the history of titanium casting from its beginnings in 1949 The shift from casting of commercially pure Ti to casting of Ti alloys and the benefits of scrap recycling are indicated Major improvements in the past five years are registered in both investment casting and sand casting of Ti alloy products, principally for the aerospace industry Remaining problems and inconsistencies are noted, and projections of future progress are presented A list of specifications and their identifying codes is appended (material specifications and supporting process or test specifications) R D V

**A76-17993** **A correlation between pressure and heat transfer distributions at supersonic and hypersonic speeds** J L Stollery (Cranfield Institute of Technology, Cranfield, Beds, England) and G T Coleman (Royal Aircraft Establishment, Farnborough, Hants, England) *Aeronautical Quarterly,* vol 26, Nov 1975, p 304 312 9 refs

The 'reference enthalpy' and local flat plate concepts are used to derive some simple expressions for the turbulent heat transfer rate distribution over an arbitrary body at supersonic and hypersonic speeds The connection between pressure and heat transfer rate is established and tested against a number of experimental data (Author)

**A76-18000** # **The Soviet YAK-40** G H Garbett *Aircraft Engineering,* vol 47, Dec 1975, p 4-19, 22-27, 29-35

The YAK-40 is an all-metal, low wing monoplane with semi-monocoque fuselage, cantilever wings, and a T-tail with a variable incidence horizontal stabilizer The aircraft is powered by three A-125 turbofan engines, the center one of which is provided with reverse thrust The maximum payload is 6000 lb, with a maximum take-off gross of 35,275 lb The cruising speed is 350 mph, average cruise altitude is 19000 ft The communication systems include VOR/ILS equipment, an ADF system, radio-altimeter system AL-101, a weather radar system and ATC transponder The navigational aids include a magnetic compass system consisting of a flux detector and a directional gyro, coupled by means of an amplifier intended to form a stable output signal in the direction of flight The aircraft has retractable tricycle landing gear C K D

**A76-18011** **On the drag of bodies of revolution at transonic speeds** V N Diesperov and Iu B Lifshits *(Prikladnaia Matematika i Mekhanika,* vol 39, Mar-Apr 1975, p 290-297) *PMM - Journal of Applied Mathematics and Mechanics,* vol 39, no 2, 1975, p 271-278 14 refs Translation

The present work investigates theoretically some aspects of the law of stabilization, which concerns the weak effect that the magnitude of the velocity of the main flow has on the deviation of the parameters at a body before the shock wave from their values at sonic velocity at infinity The present investigation also studies the flow behind the shock in order to clarify the nature of the dependence of the resistance of the body on the velocity of the main flow P T H

**A76-18096** **The coming era of the quiet helicopter /16th Cierva Memorial Lecture/** T R Stuelpnagel (Summa Corp , Hughes Helicopters Div , Culver City, Calif ) *Aeronautical Journal,* vol 79, Dec 1975, p 532-536 5 refs

Advances in the development of quietening technology are discussed using the light turbine helicopter as an example Objectives in quietening helicopters are ability to cruise unnoticed day or night 500 ft above city or residential areas, and ability to take off and land at urban heliports with an economically acceptable number of flights per day without disturbing neighbors as close as 1000 ft along the flight path and 150 ft to the sides In the OH-6/500 turbine helicopter reductions in the overall external sound pressure of 17 dB (to 20 dB) in hover and 14 dB (to 16 dB) in level flight have been attained The most significant reduction is achieved by reducing the rotor tip speed The main rotor is increased to 5 blades and the tail rotor to 4 blades with staggered spacing to compensate for the lowered rotor thrust An engine exhaust muffler, shrouded engine inlet, and finer tooth gears are among the other noise-reducing features The total weight penalty is 192 lb Quietening technology developed for the OH-6/500 is being incorporated in the design program of production helicopters capable of operation in either a normal or a quietening mode C K D

**A76-18097** **The significance of propulsion in commercial aircraft productivity /17th Sir Charles Kingsford-Smith Memorial Lecture/** B N Torell (United Technologies Corp , Pratt and Whitney Aircraft Div , East Hartford, Conn ) *Aeronautical Journal,* vol 79, Dec 1975, p 537-549

The development of engine technology is reviewed Economic productivity gains accompanying the introduction and development of the major types of power plants used in commercial aviation (piston, turboprop, turbojet, first and second generation turbofan) are analyzed Special attention is given to the economic impact of the development of alloys and construction techniques improving the high temperature performance of turbine engines The possible improvements in fuel consumption due to the development of new or improved engine cycles are assessed Advances in turbofan components, including improved turbine sealing and durability and increased fan and compressor efficiencies, together with increases in the bypass and pressure ratio may reduce fuel requirements 20% Other engine cycles that are under study are high overall pressure ratio turbofan, regenerative turbofan, regenerative intercooled turbofan, turboprop, and turboprop with regenerator C K D

**A76-18100** **Mil Mi-24 - The first Soviet combat helicopter** A Malzeyev *Interavia,* vol 31, Jan 1976, p 44, 45

The Soviet combat helicopter Mil Mi-24 is a basically derivative of earlier Soviet helicopter designs Stub wings incorporating 20 deg of incidence and 16 deg anhedral serve to carry the external hardpoints The five-blade main rotor has flapping and drag hinges, while the three-blade tail rotor is linked to the hub by flapping hinges only The powerplant appears to be a variant of the Glushenko GTD-3F turboshaft engine An increase in output to 1500 hp has probably been accomplished by raising the turbine entry temperature Gear operation is hydraulically activated The tricycle undercarriage is completely retractable The craft carries a 3-man crew and is capable of transporting an additional 16 combat troops A 12 mm calibre machine gun is mounted in the nose A variety of other armaments, including ground-to-air missiles and bombs of sizes ranging to 500 lb, may be carried Speeds over 160 knots can be attained C K D

**A76-18164** **The flow about the trailing edge of a supersonic oscillating aerofoil** P G Daniels (University College, London, England) *Journal of Fluid Mechanics,* vol 72, Dec 9, 1975, p 541-557 25 refs Research supported by the Science Research Council

The work analyzes the high Reynolds number (R), supersonic compressible flow in the neighborhood of the trailing edge of a plate performing high or low frequency, small amplitude sinusoidal oscillations The boundary layer flow matches with a conventional triple-deck region at the trailing edge It is found that the occurrence of separation at the trailing edge is dependent upon the magnitude of the product of the amplitude and the frequency of oscillation and that if this product is much smaller than the inverse fourth root of R, the flow is maintained right up to the trailing edge For frequencies much less than the fourth root of R, the results for a steady plate at incidence can be used to provide a precise condition for the occurrence of separation at the trailing edge P T H

**A76-18276** # **Aeronautics and astronautics in Europe. Balance and perspectives - The necessity for future cooperation in Europe and with the U.S (Luft- und Raumfahrt in Europa. Bilanz und Perspektiven - Über die Notwendigkeit zukunftiger Zusammenarbeit in Europa und mit USA)** J Trienes (Bundesministerium der Verteidigung, Bonn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept. 16-18, 1975, Paper 75-08* 36 p In German

The current status of aviation in West Germany is examined, taking into account developments related to the Airbus, VFW 614, MRCA, Alpha Jet, Roland, and Bo 105 The position of the German and the European aerospace and space industry in comparison to the U S is considered The conditions which make a future cooperation of European countries necessary are discussed, giving particular attention to military considerations The political, military, and financial reasons which make a cooperation within Europe mandatory, make a cooperation of Europe with the U S also highly desirable G R

**A76-18278** # **Product support A300.** P Triep (Messerschmitt-Bolkow-Blohm GmbH, Hamburg, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-011* 42 p In German

A description is presented of product support activities in the application phase of the Airbus project Attention is given to aspects of organization, the functions of the Airbus support division, the technical services, questions of technical liaison, field service, maintenance, service engineering, ground support equipment, support data management, the commercial group, warranty administration, spares service, and training facilities G R

**A76-18279** # **The introduction of the short-haul aircraft VFW 614 into the market (VFW 614 das Kurzstreckenflugzeug in der Markteinfuhrung)** R Riccius (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-012* 32 p In German

Work related to the development of the VFW 614 was started in 1961 It was intended to design a short-haul aircraft for about 40 passengers which was suited for applications in the developing countries involving low-density routes A brief review of the development of the aircraft by European aerospace companies is presented It is shown that the concept of the VFW 614 is

particularly suited for an employment in regional air traffic Attention is also given to aspects of aircraft operation, the low engine noise, military uses of the aircraft, and the employment of the aircraft as executive jet. G R

**A76-18280** **The status of MRCA flight tests (Stand der Flugerprobung MRCA)** K Knauer (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept. 16-18, 1975, Paper 75-013* 51 p. In German

The first flight of the first MRCA prototype on August 14, 1974, represents an important event in the development of a European military aircraft The aircraft has been developed jointly by Great Britain, Italy, and Germany The design of the aircraft and its performance characteristics are discussed along with the flight test program and the test results Attention is given to the primary and the secondary control system, the hydraulic system, the electric system, the fuel system, and the flight characteristics of the aircraft G R

**A76-18281** # **The Alpha Jet Program (Das Alpha Jet-Programm)** E Gobel *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-014* 18 p In German

The paper reviews the definition phase of the program undertaken by France and West Germany to build an aircraft that would serve as a jet trainer and for air close support, and then gives a technical description of the aircraft and summarizes the current state of the development phase The airframe is of conventional construction based on the failsafe principle with an ultimate load of 12g The powerplants are two Larzac 04's, each with thrust to-weight ratio of 5 1, a thrust of 1350 Kp, and specific fuel consumption of 0 7 kg/Kp/hour Four prototypes of the aircraft have been tested or are undergoing tests Flight envelopes obtained in these tests are presented P T H

**A76-18285** # **The entire program for aeronautical research and technology of the federal government during the period from 1975 to 1978 (Das Gesamtprogramm Luftfahrt- forschung und -technologie 1975-1978 der Bundesregierung)** H Hertrich *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-020* 28 p In German

A draft of the entire program for aeronautical research and technology of the government of the Federal Republic of Germany was completed in February 1975 Organizational and budgetary questions related to an implementation of the program are examined and the current status of the aerospace industry in West Germany is considered Attention is given to aspects of a coordination of research conducted by the aerospace industry and by nonindustrial institutions General objectives of aeronautical research and tech nology are discussed along with the details of the proposed program G R

**A76-18287** # **Rotary-wing aircraft, today and in the future (Drehflugler heute und in der Zukunft)** K Pfleiderer (Messerschmitt-Bolkow Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-022* 51 p 26 refs In German

The article presents an overview of the status, technology, applications, market openings, and costs of rotary-wing craft in general, and of the helicopter in particular Topics covered include the range of applications in passenger and goods transportation, recent engineering developments, the noise spectrum of rotary-wing craft and noise abatement, the spectrum of research and development costs, and structural design materials R D V

**A76-18289** # **RPV - Perspectives of a military application (RPV - Perspektiven einer militärischen anwendung).** K Heilmann (Bundesministerium der Verteidigung, Bonn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept. 16-18, 1975, Paper 75-024* 45 p In German

Remotely piloted vehicles (RPV) are unmanned flight vehicles which are suited for a number of military uses Such uses include missions with a great risk factor Considered RPV missions are related to reconnaissance, air attack, and electronic warfare Employment possibilities for RPV depend on a number of vital techniques involving interference-free data transmission and target recognition An important factor is also the incorporation of RPV systems into existing military structures A description of various types of RPV is presented G R

**A76-18298** # **Recent contributions of German aeronautical research in the field of aircraft aerodynamics (Neuere Beitrage der deutschen Luftfahrtforschung auf dem Gebiet der Flugzeugaerodynamik)** D Hummel (Braunschweig, Technische Universitat, Braunschweig, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-036* 42 p 101 refs In German

Studies of profile flows involving incompressible and transonic flows are considered Attention is given to laminar profiles, profiles with flaps, maximum lift, the development of new profile forms, computational procedures for frictionless flows, the effect of friction, and shock-induced separation Flows around three-dimensional bodies are discussed, taking into account airfoil theory, slender bodies, boundary layers, and a computational procedure for frictionless flows A description of experimental techniques is also presented G R

**A76-18300** # **Recent contributions in research and development work on turbojet propulsion (Neuere Beitrage aus Forschung und Entwicklung auf dem Gebiet der Turboflugtriebwerke)** W Heilmann and G Winterfeld *Deutsche Gesellschaft fur Luft- und Raumfahrt, Jahrestagung, 8th, Bonn, West Germany, Sept 16-18, 1975, Paper 75-038* 39 p 18 refs In German

An overview of West German aviation propulsion research and industry, covering the postwar recovery, present and future tasks and perspectives, and presenting salient illustrative examples Differences in military and civilian specifications and the interplay between them, noise and pollution standards, and cutting of production costs (via increased reliance on castings, friction welding, electroerosion machining) are discussed Improvements in turbine and compressor design include reduction in the number and weight of blades, cooling design, two-spool bypass axial compressor systems, ways of raising the turbine entrance temperature, the use of variable engine geometry, and improvements in combustion chambers, blading design, engine cooling, and radial compressor design are covered R D V

**A76-18374** **Optimal configuration of rotor blades for horizontal wind energy converters (Die optimale Auslegung rotierender Flugel fur horizontale Windenergiekonverter)** W Weber (Stuttgart, Universitat, Stuttgart, West Germany) *Zeitschrift fur Flugwissenschaften,* vol 23, Dec 1975, p 443-447 8 refs In German

The paper proposes a formula for the total efficiency of a wind energy converter blade array and constructs on this basis a formula relating rotor blade configuration and efficiency with the aid of some auxiliary geometrical functions The resulting function was evaluated by computer, and curves are presented showing calculated efficiencies for various blade geometries as blade arrangement is varied P T H

**A76-18477** # **Supersonic high-temperature gas jet flow past a body into a supersonic wake (Obtekanie tela sverkhzvukovoi struei**

goriashchego gaza, vytekaiushchei v sputnyi sverkhzvukovoi potok) I M Mirzoev In Mechanics of deformable solids Baku, Izdatel'stvo Elm, 1975, p 41 53 8 refs In Russian

The paper deals with the supersonic flow around an aircraft and the interaction of the jet engine exhaust with the supersonic wake Shock wave profiles, formation of Prandtl Meyer rarefaction waves and pressure oscillations on the aircraft surface are calculated on the basis of gasdynamic equations The analysis lends itself to the problem of optimal nozzle arrangement for thrust augmentation B J

**A76-18516** # **Outlook on the acoustic characteristics of future subsonic aircraft (Prospective des qualités acoustiques des futurs avions subsoniques)** J Plenier (Societe Nationale Industrielle Aérospatiale, Toulouse, France) *Association Aéronautique et Astronautique de France, Congrès International Aéronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 49 p In French

The paper investigates the principal paths open to the aircraft designer to improve the noise characteristics of subsonic aircraft Three fundamental approaches are discussed (1) judicious choice of architecture, which, however, would necessitate long studies and prototype designs which the current European aerospace industry is not able to finance on the short term, (2) improving the low-speed performance but at the price of increasing the DOC, and (3) modification of take-off and landing procedures, which rests more in the hands of regulating authorities and airlines rather than the designer The overall cost picture of the battle for the environment is stressed P T H

**A76-18518** **The conversion of aircraft - Acoustic and performance benefits** J O Powers (FAA, Office of Environmental Quality, Washington, D C ) *Association Aéronautique et Astronautique de France, Congres International Aeronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 29 p 9 refs

The paper argues the need for acoustic conversion (retrofit) for reducing aircraft noise The conversion primarily deals with two areas of technology sound absorbing linings, and jet noise silencers Types of modification - moderate, nominal, and extensive - are illustrated by presenting noise performance figures for the B-727 quiet nacelle program Acoustic modification by engine refan is considered Conversion is examined for business aircraft, including the Jetstar and the Learjet B J

**A76-18519** # **The helicopter and the environment - Need for a compromise (Hélicoptère et environnement - Necessité d'un compromis)** G Petit (Société Nationale Industrielle Aérospatiale, Paris, France), Mr d'Ambra, and Mr Dedieu *Association Aéronautique et Astronautique de France, Congres International Aéronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 39 p 6 refs In French

Noise abatement problems are surveyed in relation to the growing market for nonmilitary helicopters in urban areas Acceptable noise levels for sectors of the population, noise level in relation to helicopter mass, noise generation mechanisms, ways of reducing noise, and airfoil studies are discussed Principal noise sources are isolated as (1) external (main rotor, tail rotor, propulsion engine(s)), and (2) cabin interior (gearbox) The noise spectrum of helicopters is analyzed into discrete frequencies associated with these major noise sources and broadbanded noise associated with the main rotor The problem of compromise between noise control measures and equipment and keeping production costs and operating costs down is considered R D V

**A76-18522** **Aircraft noise - The United States government point of view** C. R Foster (FAA, Office of Environmental Quality, Washington, D C ) *Association Aéronautique et Astronautique de France, Congrès International Aéronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 13 p

The three major U S government agencies dealing with aircraft noise control are the FAA, the EPA, and NASA The goal of the noise reduction program is twofold, comprising a short term goal and a long term goal The short term goal is to confine the area of severe noise impact around all U S airports to those areas over which the airport proprietor has control The long term goal is to reduce noise levels in the lesser impacted areas sufficiently to minimize interference with human activities These goals can be accomplished primarily through existing legislative authority The modification of aircraft operational procedures and the implementation of environmentally compatible land use programs are considered as methods for noise control Extensive systems analysis is seen as an aid to all noise control programs B J

**A76-18523** # **Research on aircraft noise - Test methods (La recherche sur le bruit des avions - Méthodes et moyens d'essais)** G Casandjian *Association Aeronautique et Astronautique de France, Congres International Aeronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 18 p In French

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

**A76-18524** **Supersonics and the environment** E H Burgess (Rolls-Royce Aero Engines, Inc , New York, N Y ) *Association Aeronautique et Astronautique de France, Congres International Aéronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 19 p

The effect that the Concorde and other supersonic transports might have on the environment is discussed A general description is given of the Concorde, with emphasis on design aerodynamic characteristics, and propulsion system configurations Noise suppression developments on Concorde are considered in detail, with attention paid to design and cost features SST and air pollution is examined, emphasizing the fact that exhaust smoke from Concorde has been virtually eliminated The impact of SST on the stratosphere, in particular, the threat to ozone, is touched upon Models for predicting the effect of emissions on the stratosphere are called generally inadequate Sonic booms are discussed, with a claim put forth that they are not as harmful as supposed B J

**A76-18525** # **Evaluation of reactions of dwellers in airport environs to aircraft noise (Evaluation des reactions des riverains au bruit des avions)** A Alexandre (Organisation de Cooperation et de Développement Economique, Paris, France) *Association Aéronautique et Astronautique de France, Congres International Aéronautique, 12th, Paris, France, May 29, 30, 1975, Paper* 16 p In French

It is theorized that aircraft noise produces an annoyance which is an indirect psychosociological effect resulting from direct physiological effects of noise, and leading to an open reaction which takes the form of complaint and protest The paper presents results of 20,000 interviews conducted on an international scale over the past decade and attempts to plot annoyance indices, with percentage of people very much annoyed as a function of noise intensity The sample has been processed by Guttman analysis and factorial analysis B J

**A76-18526** # **The CFM56 turbojet engine - Progress in the reduction of engine noise (Le turboreacteur CFM56 - Un progrès dans la réduction du bruit des moteurs)** J P Bernard and P Raffy (SNECMA, Paris, France) *Association Aéronautique et Astro-*

*nautique de France, Congres International Aéronautique, 12th, Paris, France, May 29-30, 1975, Paper* 33 p 12 refs In French

The CFM56 turbojet engine is a double-body, double-flow (functioning in separated flow and multiphase flow) engine with 10 tons of thrust Test facilities for examining the aerodynamic, internal and engine noise characteristics of the turbojet are described A facility for determining the effectiveness of acoustic attenuation treatment on the engine is included Most of the research was carried out in the framework of the Quiet Engine Program Maximal engine noise is plotted as a function of thrust, and noise spectra at landing approach, takeoff and intermediate flight are presented B J

**A76-18651 1975 report to the aerospace profession, Proceedings of the Nineteenth Symposium, Beverly Hills, Calif., September 24-27, 1975.** Symposium sponsored by the Society of Experimental Test Pilots *Society of Experimental Test Pilots, Technical Review,* vol 12, no. 4, 1975 249 p

F-15A spin tests are considered along with an A-10 progress report, the T34C turboprop trainer spin development program, an MRCA progress report, an F-16 progress report, a B-1 flight test progress report, a flight test report concerning a heavy lift helicopter flight control system, the air cushion landing system test program on the XC-8A, and the advanced medium STOL transport program Attention is also given to a pilot's view of the YC-14 aircraft, a YC-15 flight test progress report, the X-24B flight test program, the Space Shuttle Orbiter Approach and Landing Test Program, and Apollo-Soyuz, US-USSR joint mission results

G R

**A76-18652 F-15A spin tests** J E Krings (McDonnell Douglas Corp , St. Louis, Mo ) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif., Sept 24-27, 1975.) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 1-11

The goal of the F-15 High Angle of Attack Flight Test Program was to explore, understand and recover from any and all out of-control conditions anticipated during service use The plan was to progress in logical, conservative steps, from a one-g stall to wherever the airplane behavior led to. The recoverability of the F-15 allowed us systematic exploration of high AOA flight from stall to the steady flat spin In its primary role configuration, the F-15 has no angle of attack limits The operational use and recoverability was the primary consideration throughout the program (Author)

**A76-18653 A-10 progress report** H W Nelson (Fairchild Republic Co , Farmingdale, N Y ). *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif., Sept 24-27, 1975 ) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 12-28

The flight test programs for the A-10 aircraft are discussed, taking into account air to air refueling, problems with the GAU-8 30 mm cannon, the icing test, the freedom-from-flutter demonstration, and stall/post stall/spin avoidance tests Other tests considered are related to the 80% airloads demonstration, the demonstration of initial performance and flying qualities, and the demonstration of safe external store separations G R

**A76-18654 T34C turboprop trainer spin development program** R R Stone (Beech Aircraft Corp , Wichita, Kan ) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif., Sept. 24-27, 1975.) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 29-36

NASA Langley spin tunnel tests showed that the spin characteristics of the T34C aircraft needed to be improved NASA developed two spin fix devices, including 'rectangular strakes' and 'P-X soda straws', either of which promoted a stable, moderate spin mode An intensive two-month flight test program with 175 spins was conducted The objective of T34C development was achieved in the final configuration for both upright and inverted spins The objective involved the achievement of rudder-only recoveries from all spins at all loadings and thrust levels G R

**A76-18655 Multi role combat aircraft /MRCA/ progress report.** N Meister (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany) and P. Millett (British Aircraft Corp , Ltd , Weybridge, Surrey, England) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif., Sept 24-27, 1975.) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 37-41, 237-239

The maiden flight of the first MRCA prototype took place on August 14, 1974 The aircraft had been developed jointly by Great Britain, West Germany, and Italy as a replacement for currently used fighter aircraft in the air forces of the three countries. Military demands for the aircraft were mainly related to short takeoff and landing distances and to a high speed low level penetration capability. It is pointed out that four MRCA are presently flying. The fifth aircraft is very close to flight G R

**A76-18656 B-1 flight test progress report** C C Bock, Jr (Rockwell International Corp , El Segundo, Calif ) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif , Sept 24-27, 1975 ) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 59-67

The primary mission of the B-1 aircraft is low-altitude, high-speed penetration to a target The aircraft will also have the capability for high-altitude supersonic penetration A review is presented of the early portion of the Phase I flight test plan and the progress made to date is shown The first flight of the aircraft was conducted on December 23, 1974 Details concerning this flight and fourteen more test flights are discussed Flying qualities tests which follow will establish the low-altitude operating envelope for the B-1 G R

**A76-18657 Air cushion landing system /ACLS/ test program on the XC-8A** J H Brahney (USAF, Wright-Patterson AFB, Ohio) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif., Sept 24-27, 1975 ) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 79-95

The objective of the ACLS program is to determine the feasibility of using ground effect technology to provide aircraft with an all surface landing capability The approach investigated employs an air cushion instead of wheels as the ground contacting medium The ACLS was installed on a CC-115 Buffalo without interference to the basic aircraft configuration The test aircraft was designated XC-8A The major modifications to the aircraft include the air cushion system, the air supply package, the beta propeller system, and the wing float and skid assembly The XC-8A test program has reached the point where the total feasibility of the ACLS is being demonstrated G R

**A76-18658 A pilot's view of the YC-14 airplane** R L McPherson (Boeing Co , Seattle, Wash ) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif , Sept 24-27, 1975 ) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 99-116 8 refs

Two prototypes, designated the YC-14, are to be built for feasibility demonstrations of advanced STOL technology The aircraft are to operate from 2,000 feet semiprepared strips with acceptable safety margins, carrying a 27,000 pound payload on a 400 nautical mile radius mission with a landing and unrefueled takeoff at the midpoint The YC-14 is a twin engine, aft loading cargo aircraft similar in length and span to the KC-135 Details of aircraft design are discussed G R

**A76-18659 * X-24B flight test program** J A Manke (NASA, Flight Research Center, Edwards, Calif ) and M V Love (USAF, Edwards AFB, Calif ) *(Society of Experimental Test Pilots, Symposium, 19th, Beverly Hills, Calif , Sept 24-27, 1975 ) Society of Experimental Test Pilots, Technical Review,* vol 12, no 4, 1975, p 129-154

The X-24B is an air launched, rocket powered research aircraft A number of its design features constitute a tradeoff between

aerodynamics and heating considerations A vehicle description is given and test program objectives are discussed along with operational procedures and aspects of energy management Attention is also given to X-24B handling qualities, approach and landing, wind tunnel data and simulation, and proposed X-24C vehicle requirements G R

**A76-18683 * #** **Hypersonic incipient separation on delta wing with trailing-edge flap** D M Rao (National Aeronautical Laboratory, Bangalore, India, NASA, Langley Research Center, Hampton, Va ) *AIAA Journal*, vol 13, Oct 1975, p 1386 1388 9 refs Research supported by the Ministry of Technology of England

The paper reviews the experimental data on the incipient separation characteristics of planar delta wings of 75 degree sharp leading edges, with full-span trailing edge flap deflected into the windward flow The local Reynolds number range for these investigations covered laminar, transitional and turbulent conditions It is shown that, while turbulent boundary layer data correlates with two dimensional results, in the laminar and transitional cases, there is a nearly parallel shift to higher flap angles for incipient separation B J

**A76-18700** **Evolution of the TriStar family** E R Schuberth (Lockheed-California Co , Burbank, Calif ) *Shell Aviation News*, no 432, 1975, p 22-33

Major design features of the three engine short/medium range L-1011-1 TriStar and its derivative models (L 1011-100, L-1011-200, L-1011-250) are outlined The basic model was developed to transport about 250-345 passengers over typical routes of 300 to more than 3000 nautical miles The required passenger capacity and overall size limitations of the aircraft led to the selection of a large diameter fuselage (235 in ) The wing design was optimized to provide a minimum-cost cruise speed at Mach 0 85, and incorporates full span leading edge slats and double-slotted trailing edge flaps Selection of the S-duct aft-engine configuration led to improved aerodynamic configuration, reduced weight and drag, and excellent crosswind tolerance and pressure recovery Major improvements in payload and range have been attained in the derivative models primarily through increases in the maximum take-off weight and fuel-carrying capacity accompanied by increases in engine thrust The external configuration of the basic and derivative models is identical A fuselage-stretched derivative is under study C K D

**A76-18728 #** **Design and test of a highly-loaded three-stage, axial-flow compressor** R M Cook (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-6* 12 p Contract No N00140 73-C-0046

The aerodynamic design of a three-stage, axial-flow compressor is discussed herein This compressor was designed for use in a low-cost, ordnance quality, supersonic turbine engine The compressor was subsequently rig-tested with two different stator settings Compressor performance was established with both uniform and distorted inlet airflow A performance map is presented showing satisfactory design-point efficiency and high-speed surge margin Part-speed surge margin in excess of the objective was also measured Compressor performance comparisons with different stator settings and with distorted inlet airflow conditions are included showing good surge margin and good tolerance to inlet distortions (Author)

**A76-18729 #** **Unsteady wake measurements of airfoils and cascades.** B Satyanarayana *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-7* 9 p 15 refs Research supported by the Ministry of Defence (Procurement Executive)

An investigation has been undertaken to study the unsteady characteristics of airfoils and cascades at low-frequency parameters wherein the unsteady pressures, boundary layers, and wakes were measured in the presence of sinusoidally varying gust flow This paper presents mainly the time-mean and time-dependent wake profiles and comparisons of the wake losses obtained from the unsteady and time-mean wake profiles The chordwise unsteady pressure differentials are presented with results showing that the differential approaches zero at the trailing edge The experimental unsteady pressure distribution on an airfoil is compared with the predicted distributions The amplitudes of the unsteady pressures show good agreement except in the trailing edge region, however, the agreement of the phase angle is poor (Author)

**A76-18732 * #** **Langley facility for tests at Mach 7 of subscale, hydrogen-burning, airframe-integratable, scramjet models** W B Boatright, A P Sabol, D I Sebacher, S Z Pinckney, and R W Guy (NASA, Langley Research Center, High-Speed Aerodynamics Div , Hampton, Va ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-11* 13 p 22 refs

Modifications to a 20-megawatt arc-heated facility for testing a hydrogen-burning, airframe-integratable, subscale, scramjet model are described Arc-heated flow is mixed with unheated air to furnish a test flow duplicating Mach 7 flight (Stagnation temperature is 2220 K ) Modifications to the commercially available heater to improve survivability and smoothness are described Pitot profiles show uniform flow and a slightly thinner nozzle boundary layer than predicted Comparison of the tunnel boundary layer, which will be ingested by the engine model, with the boundary layer that a flight engine might ingest from its vehicle forebody shows a difference in the density distribution through the boundary layer Calculations of wall heating and transient wall temperatures of the engine model show that for a 30-sec burn, the heat sink model requires cooling at selected locations to avoid thermal stress, cycle-life problems Model performance predictions show that fuel equivalence ratio and nozzle exit area both have large effects on thrust Average inlet entrance Mach number (as affected by boundary-layer ingestion) has little effect on thrust (Author)

**A76-18735 * #** **Aircraft aerodynamic design and evaluation methods** J R Tulinius and R J Margason (NASA, Langley Research Center, Hampton, Va ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-15* 20 p 49 refs

This paper presents some practical methods for the aerodynamic design and evaluation of conventional aircraft High-lift methodology which provides improved takeoff and landing and transonic maneuvering performance is discussed Also, new techniques for estimating and minimizing cruise pressure drag are presented These include a far-field theory to minimize trimmed induced drag, theories to estimate the spanwise variation of drag due to thickness and lift, and a far-field theory to estimate total pressure drag In addition to the description of methods, aerodynamic design procedures are outlined and results from both the design and evaluation methods are presented (Author)

**A76-18736 * #** **A lifting surface theory for the analysis of nonplanar lifting systems** M I Goldhammer (McDonnell Douglas Corp , Long Beach, Calif ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-16* 12 p 16 refs Research sponsored by the McDonnell Douglas Independent Research and Development Program, Contract No NAS1-13991

A new nonlinear, nonplanar lifting surface theory is presented The method is regarded as a lifting surface theory in that the effects of wing thickness are neglected, but none of the usual small perturbation assumptions inherent in most other lifting surface theories are made The method represents nonplanar lifting systems by distributed vorticity, including the leading edge singular behavior characteristic of thin wings The method is well suited to the

computation of induced drag of nonplanar systems because leading edge suction is calculated from the leading edge singularity The method has been used to compute the induced drag benefit of winglets (vortex diffusers), and the agreement with NASA experimental data is excellent (Author)

**A76-18737 * #** **On the use of Pade approximants to represent unsteady aerodynamic loads for arbitrarily small motions of wings.** R Vepa (NASA, Langley Research Center, Hampton, Va ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76 17* 13 p 20 refs Grant No NGL-05-020-243

The general behavior of unsteady airloads in the frequency domain is explained Based on this, a systematic procedure is described whereby the airloads, produced by completely arbitrary, small, time-dependent motions of a thin lifting surface in an airstream, can be predicted This scheme employs as raw materials any of the unsteady linearized theories that have been mechanized for simple harmonic oscillations Each desired aerodynamic transfer function is approximated by means of an appropriate Pade approximant, that is, a rational function of finite degree polynomials in the Laplace transform variable Although these approximations have many uses, they are proving especially valuable in the design of automatic control systems intended to modify aeroelastic behavior (Author)

**A76-18738 * #** **Nonlinear slender wing aerodynamics** L E Ericsson and J P Reding (Lockheed Missiles and Space Co , Inc , Sunnyvale, Calif ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-19* 14 p 29 refs Contract No NAS8 28310

On present day high performance aircraft, a large portion of the lift is generated by leading edge vortices generated by flow separation off the highly swept leading edges of the lifting surfaces employed It has been shown in an earlier paper how the vortex effects can be superimposed on a modified slender wing theory to give the unsteady longitudinal characteristics of sharp edged delta wings up to very high angles of attack The present paper extends the previous analysis to include the effects of leading edge roundness and trailing edge sweep on the aerodynamic characteristics The paper also derives analytic means for prediction of the yaw stability of slender wings and the first order effects of Mach number Universal scaling laws are defined for rapid preliminary design estimates of the slender wing lift and rolling moment The results indicate that simple analytic tools can be developed to predict the aeroelastic characteristics of the space shuttle ascent configuration with its complicated flow field and aeroelastic cross-couplings (Author)

**A76-18739 #** **A new surface singularity method for multi-element airfoil analysis and design** D R Bristow (McDonnell Douglas Corp , St Louis, Mo ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C., Jan 26-28, 1976, Paper 76-20* 11 p 12 refs

A solution formulation is presented for arbitrary airfoil geometries in 2-D, incompressible, potential flow Using only a limited number of line segments to model the geometry, an accurate numerical solution to the direct (analysis) problem is obtained regardless of shape or thickness through application of a mean square singularity strength minimization From an arbitrary starting geometry, the inverse (design) problem is solved by iterating between the direct problem solution method and an inverse algorithm The algorithm uses geometry perturbation-velocity perturbation relationships that are accurate over a complete surface Examples of analysis and design solutions are presented for single and two-element airfoils (Author)

**A76-18754 * #** **Turbine vane leading edge gas film cooling with spanwise angled coolant holes** G J Hanus and M R L'Ecuyer (Purdue University, West Lafayette, Ind ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-43* 11 p 12 refs Grant No NGR-15-005-147

An experimental film cooling study was conducted on a 3x size model turbine vane Injection at the leading edge was from a single row of holes angled in a spanwise direction for two configurations of holes at 18 or 35 deg to the surface The reduction in the local Stanton number for injection at a coolant-to-mainstream density ratio of 2 18 was calculated from heat flux measurements downstream of injection Results indicate that optimum cooling occurs near a coolant-to-mainstream velocity ratio of 0 5 Shallow injection angles appear to be most beneficial when injecting into a highly accelerated mainstream (Author)

**A76-18757 #** **Catalytic combustors for gas turbine engines** T J Rosfjord (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-46* 9 p 5 refs

A catalytic combustor is a device in which chemical reactions initiated by a heterogeneous catalyst (catalytic surface) play an important role in the energy-release process Previous investigations have affirmed the feasibility of the concept for gas-turbine engine application This paper presents the current status of the catalytic combustor Basic principles of its operation and the manner in which they influence combustor design are discussed Component requirements are contrasted with currently available materials Specific applications being pursued in current and future programs are described, including an assessment of system advantages and potential problem areas (Author)

**A76-18768 #** **Simplified methods of predicting aircraft rolling moments due to vortex encounters** T M Barrows (U S Department of Transportation, Transportation Systems Center, Cambridge, Mass ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C., Jan 26-28, 1976, Paper 76-61* 9 p 16 refs

Computational methods suitable for fast and accurate prediction of rolling moments on aircraft encountering wake vortices are presented Appropriate modifications to strip theory are developed which account for the effects of finite wingspan It is shown that in the case of an elliptic wing the aspect ratio correction to the lift curve slope should be based on the semispan A reciprocal theorem is used to relate the rolling moment on a wing in an arbitrary downwash field to that on a wing in steady rolling motion Calculations are presented for a wing encountering a vortex with a Betz velocity distribution It is shown that the ratio of the spans of the generating and encountering aircraft is the most significant parameter in determining the possible hazard (Author)

**A76-18769 * #** **Vortex interactions in multiple vortex wakes behind aircraft** D L Ciffone (NASA, Ames Research Center, Moffett Field, Calif ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan. 26-28, 1976, Paper 76-62* 11 p 14 refs

A flow visualization technique has been developed which allows the nature of lift-generated wakes behind aircraft models to be investigated Several different configurations of a 0 61-m span model of a Boeing 747-type transport aircraft were tested to allow observation of typical vortex interactions and merging in multiple vortex wakes The vortices were identified by emitting tracer dyes from selected locations on the model Wing span loading and model attitude were found to effect both vortex motions within the wake and resulting far-field wake velocity Landing gear deployment caused a far-field reformation of vorticity behind a model configuration which dissipated concentrated vorticity in the near-field wake A modified landing configuration was developed which appeared to significantly alleviate the concentrated wake vorticity (Author)

**A76-18770 #** **Wind tunnel measurements of the trailing vortex development behind a sweptback wing - Effect of simulated**

**jet engines on the flow field** Z El-Ramly and W J Rainbird (Carleton University, Ottawa, Canada) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-63* 10 p 7 refs National Research Council of Canada Grant No A-7799

**A76-18771 * # A nonlinear finite-element analysis of wings in steady incompressible flows with wake roll-up** E O Suciu and L Morino (Boston University, Boston, Mass ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-64* 11 p 12 refs Grant No NGR-22 004 030

The problem of lifting surfaces and complex aircraft configurations in steady incompressible flow is considered For lifting surfaces the problem is formulated in terms of an integral equation relating the potential discontinuity on wing and wake to the normal derivative of the potential on the lifting surface For complex configurations the problem is formulated in terms of an integral equation relating the potential to its normal derivative on the surface of the aircraft The integral equation is approximated by a system of linear algebraic equations obtained by dividing the surfaces into small quadrilateral elements and by assuming the potential (or the potential discontinuity) and its normal derivative to be constant within each element The wake geometry is obtained by iteration by satisfying the condition that the velocity be tangent to the surface of the wake and that the potential discontinuity be constant along the streamlines (Author)

**A76-18778 * # Correlation of internal surface turbulence with far-field noise of the augmentor wing propulsive-lift concept** M D Falarski (NASA, Ames Research Center, U S Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif ), J F Wilby (Bolt Beranek and Newman, Inc , Canoga Park, Calif ), and T N Aiken (NASA, Ames Research Center, Moffett Field, Calif ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-79* 11 p 5 refs

A wind tunnel investigation was conducted to determine the nature, strength, and variation with airspeed of the acoustic sources of the augmentor wing propulsive-lift concept The augmentor wing overall noise is dominated by the high frequency jet mixing noise characteristic of the lobed primary nozzle The augmentor modifies the intensity and propagation characteristics of the jet sources, especially those that exist inside the augmentor The interaction of the turbulent flow with the augmentor creates low frequency, low-intensity surface noise and trailing edge noise These sources dominate any jet mixing noise that is present at the low frequencies and could become significant if the jet noise was suppressed by treating the augmentor with a lining tuned to the jet noise source location The far field noise of the untreated augmentor is unaffected by airspeed, however, this may not be the case when the jet noise is suppressed, because the trailing edge surface pressure and correla tions with far field noise do show a reduction with forward speed (Author)

**A76-18779 # Edge noise attenuation by porous-edge extensions** A J Bohn (Boeing Commercial Airplane Co , Seattle, Wash ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-80* 5 p

Results of tests of a special class of edge treatments a porous flow-wise extension of the trailing edge are presented The differences in noise levels radiated from solid edges and porous edge extension (i e , noise reductions) were found to be frequency dependent The noise reduction spectra were found to collapse into a single nondimensional spectrum The resistive impedance of the porous materials tested varied from approximately 20 to 160 cgs Rayls Distinctive changes in noise reduction spectra were induced by changing the basic geometry of the porous-edge extension An analogy is made between the observed noise reduction spectral characteristics of the edge treatment and those of an acoustically lined duct It is suggested that the mechanisms of noise reduction by the porous extensions are attributed to edge impedance control by an aerodynamic acoustic feedback mechanism (Author)

**A76-18780 * # Measured response of a complex structure to supersonic turbulent boundary layers** L Maestrello, J H Monteith, J C Manning (NASA, Langley Research Center, Hampton, Va ), and D L Smith (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-83* 11 p 13 refs

Measurements of the response of a large frame stringer panel excited by supersonic turbulent boundary layer are reported The statistical description of the wall pressure fluctuations in terms of the mean flow parameters governing the turbulent boundary layer is given These results can be used in the development of design criteria on the response of sidewall structure of a large airplane in supersonic flight, since both forcing field and structure are realistic Results indicate the significant importance of the modal coupling and the acoustic damping The acoustic damping plays a major role in the response of the structure (Author)

**A76-18789 # A relaxation solution for transonic flow over three-dimensional jet-flapped wings** W D Murphy and N D Malmuth (Rockwell International Corp , Thousand Oaks, Calif ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-98* 11 p 13 refs

An algorithm has been developed which treats transonic flow over jet-flapped wings of general planform within a small disturbance framework The numerical method represents a generalization of the relaxation solutions developed by Bailey and Ballhaus for unblown wings and the authors' previous work for two dimensional jet-flapped airfoils, and it incorporates a new far field which accounts for the vorticity on the jet Supercritical results presented for a variety of blown planforms indicate repeal of the Kutta condition, as in two dimensions, appreciable spanwise load carryover for partial span blowing, and reduction in lift augmentation due to sweepback Comparison of lift coefficients with experimental values show good agreement for various planforms (Author)

**A76-18790 * # On the computation of the transonic perturbation flow field around two- and three-dimensional oscillating wings** W H Weatherill, F E Ehlers (Boeing Commercial Airplane Co , Seattle, Wash ), and J D Sebastian (Boeing Computer Services, Inc , Seattle, Wash ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-99* 14 p 20 refs Contract No NAS1 13002

A finite difference method for solving the unsteady flow about harmonically oscillating wings is investigated The procedure is based on separating the velocity potential into steady and unsteady parts and linearizing the resulting unsteady differential equation for small disturbances Solutions are obtained using relaxation procedures It is determined that there is a limit on reduced frequency, which is a function of Mach number and size of mesh region, above which the relaxation procedures will not converge It is found that row line relaxation is more efficient than column relaxation and results are presented for a rectangular wing in harmonic pitch (Author)

**A76-18803 * # A survey of leeside flow and heat transfer on delta planform configurations** J C Dunavant, G D Walberg (NASA, Langley Research Center, Space Systems Div , Hampton, Va ), and K Y Narayan *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C, Jan 26-28, 1976, Paper 76-118* 14 p 20 refs

The dominant feature of hypersonic leeside flow fields is the presence of coiled vortices which are generated as the leeside boundary layer responds to the inviscid flow field Depending on geometric and stream parameters, the vortices can be completely

maintained within the boundary layer or can lie outside which is the more familiar case of rolled-up vortices associated with separated flow Three main areas are covered (1) fundamental leeside flow phenomena associated with inviscid flows, separation and vortex phenomena involving viscid-inviscid interactions on sharp-edged delta wings and cones, (2) the application of these fundamental concepts to delta-wing bodies such as the space shuttle, and (3) the opportunity and a proposed approach to use early shuttle orbiter entry flights to obtain leeside data (Author)

**A76-18831** # **An analysis of jet aircraft engine exhaust nozzle entrance profiles, accountability and effects** A P Kuchar (General Electric Co , Cincinnati, Ohio) and W Tabakoff (Cincinnati, University, Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-152* 12 p

Methods of averaging total pressure and temperature profiles at the entrance of jet engine exhaust nozzles were analytically evaluated The concept of 'conservation of ideal available thrust' was used to determine the best averaging technique Results show that pressure profiles should be mass weighted, and temperature profiles should be 'thrust' weighted to properly determine the actual ideal thrust available to the nozzle A brief analysis of profile effects on Converging-Diverging nozzle performance was conducted using both analytical and experimental approaches Results indicate that performance is unaffected by the presence of entrance profiles provided they are properly accounted for (Author)

**A76-18865** # **Aerodynamics of arbitrary wing body combinations with vortex lattice and slender body theory** J L Thomas and B Nerney *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26-28, 1976, Paper 76-198* 14 p 19 refs

A computer method for the aerodynamic analysis of generalized wing-body configurations in steady, subsonic, irrotational flows is presented The method is a combination of vortex lattice and slender body theory used in an iterative fashion The method was investi gated for several simple wing-body combinations, the iterations converged rapidly in the combined solutions and correct qualitative results were obtained The method is believed to be applicable, with slight modification, to the general wing-body combination in subsonic flow (Author)

**A76-18867** # **Fin design criteria for tail-rotor-off operation of the aerial scout helicopter** S W Ferguson, III (Texas A&M University, College Station, Tex ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D C , Jan 26 28, 1976, Paper 76-200* 11 p 6 refs

A method is presented for the optimum design of a fin to provide directional stability and control during tail-rotor-off operation of helicopters In this design, the effects of the fuselage, main rotor, and the vertical fin on static and dynamic stability are taken into account Application of this method is made to the currently used U S Army aerial scout helicopter, the Bell OH-58A, which was designed before tail-rotor-off guidelines were available The present capabilities of the OH-58A are evaluated, and potential design modifications which enhance the helicopter's performance in the tail-rotor-off flight mode are provided (Author)

**A76-18872** **Icing testing in the large Modane wind tunnel on a reduced-scale model of a helicopter rotor (Givrage en similitude d'un rotor d'hélicoptère dans la soufflerie S1-Ma)** C Armand and F Charpin *L'Aéronautique et l'Astronautique,* no 55, 1975, p 19 28 7 refs In French

Icing tests on full-scale models of parts of aircraft equipped with actual de-icing systems were carried out in the large Modane wind tunnel since 1962 During the last few years, the technique for similitude icing testing on reduced-scale models has been perfected and proved The operating range of this wind tunnel has been extended to include helicopter rotors Although detailed comparisons with flight tests are not available, it appears that the variations in such parameters as drag, thrust, and torque are similar to those given by flight data Some limitations are due to temperature minima and the annual available cold period Nevertheless, the total range of speeds during flight (except hovering) may be investigated without risk with this technique by observing during the icing period the behavior of all the parameters defining the simulated flight operation of the helicopter (Author)

**A76-18873** **Delta wings in a rarefied hypersonic air stream with sweep angle and incidence effects (Effets de flèche et d'incidence sur une aile delta en écoulement hypersonique raréfié)** D Durox (CNRS, Laboratoire d'Aérothermique, Meudon, Hauts-de-Seine, France) and J Allegre (Societé d'Etudes de Constructions de Souffleries, Simulateurs et Instrumentation Aérodynamique, Paris, France) *L'Aeronautique et l'Astronautique,* no 55, 1975, p 29-34 5 refs In French

As far as re-entry flights of hypersonic space vehicles are concerned, present results give some information on the aerodynamic and thermal behavior of a delta wing for sweep angles between 45 and 80 deg and angles of incidence up to 90 deg Experiments are performed in the strong-interaction regime Wall-pressure and heat-flux distributions are presented as well as aerodynamic force measurements The flow interaction level at the wing surface is related to the strength and disposition of the shock envelope about the vehicle, shock angles are given in the whole range of sweep angles and angles of incidence (Author)

**A76-18874** **The strategic bomber Rockwell B-1 (Le bombardier stratégique Rockwell B-1)** G Bruner (Centre de Documentation de l'Armement, Paris, France) *L'Aéronautique et l'Astronautique,* no 55, 1975, p 51-59 In French

Design features of the Rockwell B-1 strategic bomber are discussed, and its performance specifications are given The craft features a variable geometry wing with a spread of 42 m when fully deployed and 23 7 m when fully retracted The single unit controllable horizontal stabilizer is mounted at the base of the vertical fin against a torpedo-shaped streamlined body instead of on the fuselage as originally planned The bomber is powered by four General Electric F-101 turbofan engines of two-shaft design with a static thrust of 135000 daN and a bypass ratio in excess of 2 Special equipment includes Low Altitude Ride Control, which detects turbulence at low altitudes by accelerometers mounted in the fuselage, and a highly advanced Electrical Multiplex System controlling the supply of electricity to all subsystems The craft is capable of a maximum high-altitude speed of Mach 2 2 The empty weight is 73 tons, maximum payload is 34 tons C K D

# STAR ENTRIES

**N76-14018#** Advisory Group for Aerospace Research and Development, Paris (France)
**THE EFFECTS OF BUFFETING AND OTHER TRANSONIC PHENOMENA ON MANEUVERING COMBAT AIRCRAFT**
Jul 1975 276 p refs
(AGARD-AR-82) Avail NTIS HC $9 25

A number of papers were presented dealing with various aspects of buffeting its causes, and its effects on maneuvering combat aircraft Some of the subjects discussed include operational problems at transonic speeds, human factors engineering flow distribution at transonic speeds dynamic response under buffeting conditions, stability and control flight tests and wind tunnel techniques, and effects of configuration factors

**N76-14019** Royal Aircraft Establishment Bedford (England)
**THE OPERATIONAL PROBLEMS ENCOUNTERED DURING PRECISE MANEUVERING AND TRACKING**
B I L Hamilton *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 1-8

A summary of the main events that occur in air combat and affect its maneuvers and handling limitations was provided The basic phases and conduct of air combat were first reviewed The following phenomena that may affect precise maneuvering were defined and described buffeting wing rock wing drop or roll off', nose slice or 'yaw off nose wander or snaking pitch up and departure All these phenomena can occur in transonic flight and some of them may be found at the lower Mach numbers where air combat is usually conducted after a protracted engagement Other factors influencing air combat maneuvering are control forces, harmonization and pilot induced oscillations displays and workload The use of the following systems in tracking was described automatic flight controls and stability augmentation direct lift control and direct side force control reaction controls YJA

**N76-14021** Office National d Etudes et de Recherches Aerospatiales Paris (France)
**FLOW FIELD ASPECT OF TRANSONIC PHENOMENA**
B Monnerie *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 15-20

The aerodynamics aspects of flow field over a wing in transonic maneuvering flight were reviewed in order to investigate the problem of buffeting The case of a two-dimensional airfoil was first presented followed by a discussion of three-dimensional flows It was shown that most transonic troubles and particularly buffeting are due to the presence of more or less extended regions of separated flow These are directly or indirectly related to the shock waves which form on the aircraft in the transonic speed regime Prediction of what will occur in flight must be based on wind tunnel tests in view of the difficulty to theoretically predict flows with separated regions in the general case Taking into account the continuous increase in flight Reynolds numbers due to increasing aircraft size there is a need for higher Reynolds numbers wind tunnels Author

**N76-14022*** Advisory Group for Aerospace Research and Development Paris (France)
**DYNAMIC RESPONSE OF AIRCRAFT STRUCTURE**
*In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 21-44

(Contract NAS2-6475)

The physical and mathematical problems associated with the response of elastic structures to random excitations such as occurs during buffeting and other transonic phenomena were discussed The following subjects were covered (1) general dynamic system consisting of the aircraft structure the aerodynamic driving forces due to separated flow and the aerodynamic forces due to aircraft structural motion (2) structural and aerodynamic quantities of the dynamic system with special emphasis given to the description of the aerodynamic forces and including a treatment of similarity laws scaling effects and wind tunnel testing and (3) methods for data processing of fluctuating pressure recordings and techniques for response analysis for random excitation A general buffeting flutter model which takes into account the interactions between the separated and motion induced flows was presented Relaxations of this model leading to the forced vibration model were explained Author

**N76-14023** Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio
**STABILITY AND CONTROL STATUS FOR CURRENT FIGHTERS**
W G Williams and J L Lockenour *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 45-53

The current state-of-the-art of stability and control technology for maneuvering and precision tracking was discussed including basic aerodynamics and aerodynamic stability and control flight control system concepts and methods of prediction and analysis It was shown that the maximum useable maneuvering capability of present fighter aircraft is often limited to 'g' levels below the maximum aerodynamic lift capability by stability control and handling qualities degradations In addition handling qualities degradations often prohibit precision tracking although gross maneuvering may still be possible Automatic flight control systems (stability augmentation and command augmentation) are being employed to correct many of the bare airframe deficiencies and additional capability is being provided by advancements in the fire control systems Author

**N76-14024** Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio
**STABILITY AND CONTROL POTENTIAL FOR FUTURE FIGHTERS**
J L Lockenour and W G Williams *In* AGARD The Effect of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft 1975 p 54-62

Advanced stability and control concepts aimed at further improving maneuvering and precision tracking were presented The proposed new modes of control methods of generating the required forces and moments necessary to produce the motions flight control system concepts to implement the maneuvering modes and the additional impact of pilot factors were discussed Methods of prediction and analysis were also presented and recommendations were made regarding the concepts and areas of analysis which are considered to be most important Author

**N76-14025** Advisory Group for Aerospace Research and Development Paris (France)
**BUFFET DEFINITION AND CRITERIA**
*In its* The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 63-83

Two areas related to aircraft buffeting were discussed wing and tail buffet and bomb bay buffeting In the first area basic definitions were given followed by buffeting criteria for fighter and transport aircraft classification of wing flow and buffeting for various types of wings buffet onset and the severity of

buffeting and tail buffeting It was concluded that (1) for bubble flows the largest excitation is found just upstream of the reattachment point (2) for slender wings with sharp leading edges the buffeting is light but just measurable, (3) for swept wings buffeting measurements must be made on rigid models Bomb bay buffeting was defined as the specific dynamic behavior of an aircraft when excited by forces of random and harmonic nature due to flow separation in open bays or cavities A remarkable large change in mean pressures occurs for bays with a length/depth ratio of about six for which drag reises abruptly YJA

**N76-14026** Aeronautical Systems Div Wright-Patterson AFB Ohio
**BUFFET ANALYSIS**
P J Butkewicz *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 84-90

The methods available for transonic buffer analysis were reviewed The analysis methods were divided into two groups experimental model testing including associated empirical prediction methods and semi-empirical or theoretical procedures which require some flow field calculations Due to the complexity of the transonic flow about wings experiencing unsteady separation, wind tunnel testing is the primary tool for obtaining detailed information about the buffet intensity A serious problem however exists in applying the results to full scale due to improper boundary layer modelling at the relatively low test Reynolds numbers A buffet onset prediction method suitable for theoretical analysis was outlined and is primarily applicable to thick aft loaded airfoils which display a significant pressure rise from the shock and trailing edge and which therefore have a tendency for rear separation Author

**N76-14027** Aeronautical Systems Div , Wright-Patterson AFB, Ohio
**BUFFET FLIGHT TEST TECHNIQUES**
P J Butkewicz *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 91-98

Buffet instrumentation and flight test techniques were discussed Details of the instrumentation installed for buffet tests of a F-106A aircraft were given In general, flight instrumentation for buffet tests should include static pressure taps, total pressure and boundary layer rakes accelerometers, strain gauges, aircraft attitude sensors, high speed camera and wing tufts Particular attention must be paid to the application of wing tufts for flow visualization and for the mounting of the camera The schedule used in buffet flight testing should incorporate that sequence of aircraft configurations and Mach-altitude conditions which will provide the most rapid collection of data based on (1) the time required to attain the desired aircraft configuration and test condition and (2) the aircraft modification time required for the subsequent configurations Author

**N76-14029** Dornier-Werke G m b H Friedrichshafen (West Germany)
**INFLUENCE OF CONFIGURATION FACTORS ON BUFFETING**
H Max *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 104-107

Data concerning the effects of the geometrical configuration parameters, Reynolds number external stores and supercritical wing layout of an aircraft on its buffet boundaries and the buffet intensities was presented The following geometrical parameters were considered wing aspect ratio, taper ratio, sweep angle, relative maximum thickness of the wing root section and relative maximum camber of the wing section The effects of these parameters on buffeting were shown graphically An equation was given from which the light buffet lift coefficient may be estimated for a given wing at specific transonic Mach numbers and Reynolds numbers Author

**N76-14030** Aeritalia, Turin (Italy)
**IMPROVEMENT OF AIRCRAFT BUFFET CHARACTERISTICS**
G Bucciantini *In* AGARD The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 108-110

A series of provisions which can be taken to improve the buffet characteristics of an aircraft were described These include maneuver slats and flaps strakes aerodynamic fixing (notch sawtooth fence etc ) and vortex generators The effects of these devices were shown graphically A separate discussion on the possibility of tailplane buffet and suitable remedial actions was also given Author

**N76-14031** Advisory Group for Aerospace Research and Development Paris (France)
**CONCLUSIONS AND RECOMMENDATIONS**
*In its* The Effects of Buffeting and other Transonic Phenomena on Maneuvering Combat Aircraft Jul 1975 p 111-112

General conclusions and specific recommendations on aircraft buffeting problems were presented These include the need for (1) a total system analysis to determine the effects of buffeting during maneuvering flight (2) improved methods of viscous flow field and separation prediction, (3) comparing results from existing buffet onset prediction with wind tunnel and flight test data to determine their range of applicability (4) better understanding of wind tunnel perturbation effects (5) understanding of high speed stall progression (6) identification of the interaction between the random aerodynamic driving forces and the structural response forces, (7) understanding the basic and interacting phenomena on existing and emerging fighters and (8) isolating the effects of the various parameters more clearly broadening the spectrum of the various parameters and giving a better understanding of the physical process of buffeting Author

**N76-14032#** Advisory Group for Aerospace Research and Development Paris (France)
**APPROACH AND LANDING SIMULATION**
Oct 1975 68 p refs
(AGARD-R-632) Avail NTIS HC $4 50

Realism, validation and standardization of flight simulators are discussed External disturbances and visual and motion cues are evaluated as to their effect on pilot performance Filter design for the von Karman spectrum and pitching moment coefficient model for Boeing 747 aircraft are appended A bibliography with 58 references is included

**N76-14033** Advisory Group for Aerospace Research and Development, Paris (France)
**APPROACH AND LANDING SIMULATION, INTRODUCTION**
*In its* Approach and Landing Simulation Oct 1975 p 1-3 refs

Historical notes on flight simulation are presented, progressing from simplified and rudimentary displays to today s sophisticated simulators Primarily nonhardware aspects of simulation are discussed JAM

**N76-14034** Advisory Group for Aerospace Research and Development Paris (France)
**ELEMENTS OF APPROACH AND LANDING SIMULATION**

*In its* Approach and Landing Simulation Oct 1975 p 3-4

In simulations of the approach and landing flight regime aircraft models are simplified by the absence of significant aerodynamic effects of varying Mach number and only in the case of the very large very flexible airplane are aeroelastic effects rigorously considered In STOL and VTOL aircraft widely varying interactions between aerodynamics and propulsion are encountered in the range of speeds appropriate to approach and landing The importance of mathematical representation of atmospheric perturbations and the aircraft s response to them is discussed Simulator hardware elements are reviewed including

all the mechanisms that provide the pilot with means to input control commands to the computer system model of the aircraft and to assess the aircraft s response to either his inputs or other excitations J A M

**N76-14035** Advisory Group for Aerospace Research and Development, Paris (France)
**EXTERNAL DISTURBANCES**
*In its* Approach and Landing Simulation Oct 1975 p 4-14

External disturbance models are used to test the pilots reactions to given situations and to test the controllability of particular aircraft Wind profiles wind shear and atmospheric turbulence are used in the simulation The power spectra due to von Karman and to Dryden are discussed for turbulence simulation A cross power spectra is also considered relating the turbulence velocities in different directions as zero Various causes of errors in ILS guidance systems are included along with irregularities in runway conditions J A M

**N76-14036** Advisory Group for Aerospace Research and Development Paris (France)
**AIRCRAFT CHARACTERISTICS**
*In its* Approach and Landing Simulation Oct 1975 p 14-15

The types of data and the degree of detail used in modern simulations are discussed for large subsonic jet transports and powered lift STOL transports It is shown how aircraft characteristic models will differ depending on the significant aerodynamic structural and propulsion effects of the particular aircraft J A M

**N76-14039** Advisory Group for Aerospace Research and Development Paris (France)
**CONCLUDING REMARKS**
*In its* Approach and Landing Simulation Oct 1975 p 28-61 refs

The attempts at realism during flight simulation are discussed Validation and ample training of pilots are stressed Little standardization is noted among simulator testing and evaluation The main weak elements of flight simulation motion and visual cues are also considered A bibliography with 58 references is included J A M

**N76-14040** Ohio State Univ Columbus
**A CASCADE IN UNSTEADY FLOW Ph D Thesis**
Francis Richard Ostdiek 1975 277 p
Avail Univ Microfilms Order No 75-26635

Pressure distributions and pressure histories are determined on both surfaces of an airfoil in a cascade while it is undergoing a sinusoidal variation in angle of attack A low speed wind tunnel was constructed with a stationary five-blade cascade in a three by ten inch test section The airfoils were biconvex circular arc with 10% thickness and 12 deg turning and were spaced at 2 3 inches Each surface contained ten static pressure ports These signals along with tunnel side wall statics and upstream velocity were recorded on FM Tape digitized and reduced on a digital computer The pressure fluctuations over most of both surfaces were near sinusoidal and the cyclic average showed little dependence on frequency or velocity The pressures on both surfaces were adjusted by slow-moving waves and showed only a small change in phase angle with increased frequency Dissert Abstr

**N76-14045*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
**A STOL AIRWORTHINESS INVESTIGATION USING SIMULATIONS OF REPRESENTATIVE STOL AIRCRAFT Final Report**
Robert Rumold (Systems Technol Inc Mountain View, Calif ) John M Lehman (Systems Technol Inc Mountain View Calif ), Robert L Stapleford (Systems, Technol Inc Mountain View Calif ) Robert K Heffley (Systems Technol , Inc Mountain View, Calif ) Charles S Hynes and Barry C Scott (FAA Washington D C ) May 1975 253 p refs
(Contract NAS2-7926)
(NASA-TM-X-62498 FAA-RD-75-197) Avail NTIS HC $9 00 CSCL 01A

A simulator study of STOL airworthiness criteria for approach and landing was conducted using a series of different aircraft models These models were selected to isolate a single parameter or characteristic for evaluation Specific areas included were an evaluation of speed margins, a flight path margin evaluation, flare and landing technique the effects of touchdown zone constraints an evaluation of two different turbulence models an investigation of flight path/airspeed cross coupling and a study of the effects of short-term flight path response A detailed description of the simulation and the data obtained are included These data include performance measures pilot commentary and pilot ratings Author

**N76-14046*#** National Aeronautics and Space Administration Flight Research Center Edwards Calif
**FLIGHT TEST INVESTIGATION OF THE VORTEX WAKE CHARACTERISTICS BEHIND A BOEING 727 DURING TWO-SEGMENT AND NORMAL ILS APPROACHES Final Report**
L J Garodz Atlantic City N J NAFEC Oct 1975 139 p refs Prepared jointly with Natl Aviation Facilities Exptl Center
(NASA-TM-X-72908 FAA-NA-75-151) Avail NTIS HC $6 00 CSCL 01A

A series of flight tests were performed to evaluate the vortex wake characteristics of a Boeing 727 (B727-200) aircraft during conventional and two-segment ILS approaches Flights of the B727 equipped with smoke generators for vortex marking were flown wherein its vortex wake was intentionally encountered by a Lear Jet model 23 (LR-23) or a Piper Twin Comanche (Pa-30) and its vortex location during landing approach was measured using a system of photo-theodolites The tests showed that at a given separation distance there were no differences in the upsets resulting from deliberate vortex encounters during the two types of approaches Timed mappings of the position of the landing configuration vortices showed that they tended to descend approximately 91 meters (300 feet) below the flight path of the B727 The flaps of the B727 have a dominant effect on the character of the trailed wake vortex The clean wing produces a strong concentrated vortex As the flaps are lowered the vortex system becomes more diffuse Pilot opinion and roll acceleration data indicate that 4 5 nautical miles would be a minimum separation distance at which roll control could be maintained during parallel encounters of the B727 s landing configuration wake by small aircraft Author

**N76-14055#** Army Foreign Science and Technology Center, Charlottesville, Va
**CALCULATION OF THE AERODYNAMIC LOADING ON THE BLADE OF A MAIN ROTOR IN THE GENERAL CASE OF HELICOPTER FLIGHT**
A N Bazilevskii, I G Pavlov, and A K Yanko 30 Apr 1975 21 p refs Transl into ENGLISH from the book Voprosy Aerodinamiki i Electrogidrodinamiki Sbornik Nauchnykh Trudov USSR, no 6 1970 p 179-188
(AD-A014047 FSTC-HT-23-0431-75) Avail NTIS CSCL 01/1

Expressions for calculating the aerodynamic loading on a helicopter rotor blade are derived for the general case of helicopter flight along some curvilinear trajectory A one-rotor helicopter scheme is examined Rotor blade-fuselage interaction is not considered GRA

**N76-14057*#** California Univ , Berkeley Inst of Transportation and Traffic Engineering
**AN ANALYSIS OF SHORT HAUL AIRLINE OPERATING COSTS**
Adib Kanafani and Seyfollah Taghavi Oct 1975 101 p refs (Contract NAS2-7879)
(NASA-CR-137763) Avail NTIS HC $5 50 CSCL 05C

The demand and supply characteristics of short haul air transportation systems are investigated in terms of airline operating

costs Direct indirect and ground handling costs are included Supply models of short haul air transportation systems are constructed J M S

**N76-14058*#** California Univ , Berkeley Inst of Transportation and Traffic Engineering
**STUDIES IN THE DEMAND FOR SHORT HAUL AIR TRANSPORTATION**
Adib Kanafani, Geoffrey Gosling, and Seyfollah Taghavi Oct 1975 63 p refs
(Contract NAS2-7879)
(NASA-CR-137764) Avail NTIS HC $4 50 CSCL 05C

Demand is analyzed in a short haul air transportation corridor Emphasis is placed on traveler selection from available routes Model formulations estimation techniques and traffic data handling are included J M S

**N76-14059#** Advisory Group for Aerospace Research and Development Paris (France)
**AIRCRAFT FIRE SAFETY**
Oct 1975 330 p Partly in ENGLISH, partly in FRENCH Presented at the 45th Meeting of the AGARD Propulsion and Energetics Panel, Rome 7-11 Apr 1975
(AGARD-CP-166) Avail NTIS HC $10 00

Fire toxic and explosion hazards associated with aircraft accidents and fires are reviewed Specific areas discussed include prevention techniques the impact of changes in fuel specifications on aircraft fire safety and evaluation of test techniques for flame propagation and extinguishment Actual aircraft accidents are also reviewed and analyzed

**N76-14060** Royal Aircraft Establishment Farnborough (England) Materials Dept
**SAFETY FUEL RESEARCH IN THE UNITED KINGDOM**
R E Miller *In* AGARD Aircraft Fire Safety Oct 1975 10 p refs

Aircraft fuels which resist fire in a crash are investigated Emphasis is placed on polymeric additives which prevent fuel mist condition At 0 3% concentration these additives prevent kerosene fires under realistic crash conditions with both flame and heated duct ignition sources High internal phase ratio emulsions gave no fire resistance in these tests Methods of introducing the additive and the possible extent of water compatibility and filtration problems are discussed Author

**N76-14061** Southwest Research Inst San Antonio Tex US Army Fuels and Lubricants Research Lab
**STATUS OF RESEARCH ON ANTIMIST AIRCRAFT TURBINE ENGINE FUELS IN THE UNITED STATES**
W D Weatherford Jr and B R Wright *In* AGARD Aircraft Fire Safety Oct 1975 12 p refs

The physical compatibility and fire safety characteristics of fuel blends containing polymeric antimist agents are discussed in terms of reducing the frequency of in-flight and post-crash aircraft fires The experimental bench and larger scale evaluation procedures used and the experimental results obtained with several polymeric antimist additives are described Both fire safety and systems compatibility characteristics and problems are included Projections are made regarding the future direction of research on such antimist aircraft turbine fuels Author

**N76-14062** National Research Council of Canada Ottawa (Ontario) Fuels and Lubricants Lab
**WIDE-CUT VERSUS KEROSENE FUELS FIRE SAFETY AND OTHER OPERATIONAL ASPECTS**
R B Whyte and L Gardner *In* AGARD Aircraft Fire Safety Oct 1975 20 p refs

The relationships between fuel properties and safety and aircraft operation are summarized The specifications are compared for wide-cut and kerosene type fuels with emphasis on the properties which can affect operation and safety The difference in volatility and effects on ignition, combustion and explosion are discussed as well as other properties (fluidity cleanliness and vapor release) which can affect aircraft operations Ground operations (handling maintenance and engine starting) and flight operations (fire hazard, engine relight, fuel system icing and freezing, range and payload) are considered It is concluded that provided all necessary precautions are diligently enforced the risks involved in using wide-range fuel are at worst only marginally greater than with kerosene Author

**N76-14063** Royal Aircraft Establishment Farnborough (England)
**SYSTEMS PROBLEMS ASSOCIATED WITH THE USE OF SAFETY FUELS**
R H Walsh E A Timby and D J R Robinson *In* AGARD Aircraft Fire Safety Oct 1975 12 p

The performance of components in aircraft fuel systems is investigated when using crash-fire-resistant antimisting aircraft fuels The effect that the systems have on the fuels is also considered It is found that the use of safety fuels could result in a continual degradation of their crash-fire-resistant properties The degradation in the major components of the system is measured and the results are used to program a computer study to predict the state of the fuel remaining in the aircraft on landing following a full range flight Author

**N76-14064** Societe Nationale Industrielle Aerospatiale Toulouse (France)
**IGNITION PROOFING OF FUEL TANKS [INERTAGE DES RESERVOIRS DE CARBURANT]**
Georges Frechou *In* AGARD Aircraft Fire Safety Oct 1975 7 p In FRENCH

The following topics were discussed (1) causes of fires and flammability of fuels (2) precautions taken to reduce the risks and the resulting problems for the aircraft designers in view of the ever more stringent competitive requirements within the aviation industry (3) the advantage of ignition proofing fuel tanks It is shown that an effective way to ignition proof fuel tanks is to reduce the percentage of oxygen in the gaseous mixture above the fuel since this mixture will not be explosive if the oxygen percentage is below 9 or 10% This however requires that the fuel tanks be pressurized to prevent outside air from entering and furthermore, that the gases dissolved in the fuel should contain less than 10% oxygen It was concluded that the resulting design and operational problems do not outweight the expected benefits Y J A

**N76-14066** National Research Council of Canada, Ottawa (Ontario) Fuels and Lubricants Lab
**FLAME PROPAGATION IN AIRCRAFT VENT SYSTEMS DURING REFUELLING**
L Gardner and J K S Wong *In* AGARD Aircraft Fire Safety Oct 1975 9 p refs

An investigation was made to determine if ignition at the fuel system vent box of a large commercial aircraft during refuelling could result in flame propagation through the vent system and cause an explosion inside one of the fuel tanks The program was initiated as the result of an explosion during a commercial refuelling and was confined to investigating the type of series of aircraft involved utilizing a simulation of part of the vent system leading to the tank where the explosion originated The ability of the flame to propagate was demonstrated using wide-cut fuel and a 50/50 mixture of wide-cut fuel and kerosene No propagation occurred with kerosene nor with wide-cut fuel that had lost 5% of its light ends Flame propagation and explosion intensity were found to depend on mixture temperature fuel/air ratio mixture flow velocity and oxygen content of the air Author

**N76-14067** Falcon Research and Development Co Denver Colo
**DYNAMIC MODELING OF AIRCRAFT FUEL TANK ENVIRONMENTS AND VULNERABILITY**
Levelle Mahood *In* AGARD Aircraft Fire Safety Oct 1975 9 p refs

The environments, hazards, and vulnerability of regions adjacent to and within aircraft fuel tanks are discussed along with the importance and difficulties of developing fuel tank environment models to assess aircraft combat vulnerability and operating safety Various approaches to modeling the flammability of the ullage of an aircraft fuel tank are described Examples are given to illustrate various ways that dynamic effects radically alter equilibrium vapor conditions in the ullage The method of applying the fuel tank ullage environment model to computerized aircraft vulnerability programs is described Author

**N76-14068** Societe Nationale Industrielle Aerospatiale Suresnes (France)
**CABIN FINISHING MATERIALS IN CIVIL PASSENGER AIRCRAFT [LES MATERIAUX D'INTERIEUR CABINE DANS LES AVIONS DE TRANSPORT CIVILS]**
Andre Blavy *In* AGARD Aircraft Fire Safety Oct 1975 3 p In FRENCH

A review of the various types of cabin finishing materials used inside civil passenger aircraft and their properties was presented with special focus on their flammability and generation of toxic fumes when set fire The following facts were summarized (1) materials from which fires may be easily extinguished generally emit more smoke, (2) fire-proof materials often emit toxic fumes, (3) combustion of these materials due to their self-extinguishing properties result in oxygen depletion and carbon monoxide formation the primary cause of intoxication The primary emphasis should be placed on rapid extinguishing of any incipient fire YJA

**N76-14069*** National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif
**FIRE DYNAMICS OF MODERN AIRCRAFT FROM A MATERIALS POINT OF VIEW**
John A Parker Demetrius A Kourtides Richard H Fish and William J Gilwee Jr *In* AGARD Aircraft Fire Safety Oct 1975 11 p refs

A general approach for selecting polymers to increase fire safety in aircraft is described It is shown that polymer flammability and thermal protection capability are related to the molecular structure of the polymer and its thermochemical properties These criteria are used to develop advanced fire-resistant materials which can achieve increased survivability in both post-crash and in-flight fires The degree of fire hardening of materials depends greatly on the available heat load and fire threat present It is shown that improvements in fire safety can be achieved by the use of polymers possessing certain basic thermochemical parameters such as high char yield Author

**N76-14070** Royal Netherlands Aircraft Factories Fokker Schiphol-Oost Jr Engineer Materials and Processes Group
**CRITICAL EVALUATION OF TODAYS FIREPROOF TESTING OF AEROSPACE MATERIALS**
L M Godfried *In* AGARD Aircraft Fire Safety Oct 1975 10 p

The usefulness of the requirements and methods of tests for the judgement of materials or materials combinations in aerospace vehicle application is discussed It is shown that the application test requirements, and test methods criteria for materials sometimes provide questionnable fire safety Author

**N76-14072** Royal Aircraft Establishment Farnborough (England) Materials Dept
**SOME ASPECTS OF SMOKE AND FUME EVOLUTION FROM OVERHEATED NON-METALLIC MATERIALS**
A J Christopher *In* AGARD Aircraft Fire Safety Oct 1975 12 p refs

A dynamic system for assessing the smoke and fume emission characteristics of nonmetallic materials is described A sample of the material under examination is heated from ambient to 500 C in a stream of air The behavior of the material under in-flight electrical overheating conditions is simulated Sample temperature smoke density, and electrode response in a water bubbler are monitored Results obtained for various materials are presented and discussed Author

**N76-14074** Princeton Univ N J Guggenheim Labs
**FLAME SPREADING ACROSS MATERIALS A REVIEW OF FUNDAMENTAL PROCESSES**
William A Sirignano *In* AGARD Aircraft Fire Safety Oct 1975 12 p refs

A critical review of the existing researches on flame spread above solid combustible materials is given, both theory and experiment are considered Special attention is given to the determination of the rate-controlling mechanism for energy transfer ahead of the flame and therefore to the determination of the flame spreading rate The mechanism could be either gas-phase conduction radiation, gas-phase convection or some combination of these Important factors discussed include natural convective flows, orientation of the direction of flame spread with respect to gravity thickness of the burning material and the values of the conductivity, diffusivities heats of reaction and pyrolysis chemical kinetic constants and ambient oxygen concentration It is indicated how changes in these factors can produce changes in the rate-controlling mechanism Author

**N76-14076** Royal Aircraft Establishment, Farnborough (England) Engineering Physics Dept
**FIRE PROTECTION OF FUEL SYSTEMS IN COMBAT AIRCRAFT**
J A MacDonald and H W G Wyeth *In* AGARD Aircraft Fire Safety Oct 1975 15 p ref

The conditions which affect fire and explosion probability within aircraft fuel tanks and surrounding bays are examined Particular attention is given to the effect of fuel type target construction and other environmental conditions From a knowledge of the physical effects following projectile attack systems are suggested which could significantly reduce the risk of fire and explosion Author

**N76-14077** Air Force Aero Propulsion Lab Wright-Patterson AFB, Ohio Fuels and Lubrication Div
**AIRCRAFT FIRE PROTECTION TECHNOLOGY**
B P Botteri *In* AGARD Aircraft Fire Safety Oct 1975 15 p refs

Aircraft fire protection under natural and hostile (combat) flight environment conditions is discussed Achievement of fire protection capability is dependent upon a knowledge of ignition flammability, and reaction severity characteristics of the combustible materials present and use of this knowledge in the design of the aircraft Specific areas discussed include fire and explosion hazard assessment (including fire safe fuels) fire prevention design measures advanced fire and overheat detection systems, void space and dry bay fire suppression techniques, and fuel tank fire and explosion protection systems Author

**N76-14078** British Aircraft Corp Warton (England)
**FIRE PROTECTION OF MILITARY AIRCRAFT**
John Vincent *In* AGARD Aircraft Fire Safety Oct 1975 15 p

The problems associated with classical engine bay fire detection and suppression systems are examined along with airframe design constraints The primary and secondary fire problem is considered Statistical evidence from modern war shows that the highest proportion of aircraft kills is due to primary and secondary fire The application of possible fire suppressant methods is discussed The current structural and system design philosophy is questioned with respect to achieving improved fire protection of military aircraft Author

**N76-14080** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Porz (West Germany)
**FIRE FIGHTING AGENTS FOR LARGE AIRCRAFT FUEL FIRES**
R Fiala and K Dussa *In* AGARD Aircraft Fire Safety Oct 1975 10 p refs

For a critical evaluation of the properties of the different types of agents experiments were carried out using standardized small and large fuel fires (4 sq m and 200 sq m) The time until extinguishment occured and the amount of agent needed were measured Additionally the time which after a deliberate

reignition elapsed until the whole fuel surface was on fire again, was measured Results are discussed Author

**N76-14082** Federal Aviation Administration Atlantic City N J
**CHARACTERISTICS OF HALON 1301 DISPENSING SYSTEMS FOR AIRCRAFT CABIN FIRE PROTECTION**
Constantine P Sarkos *In* AGARD Aircraft Fire Safety Oct 1975 16 p refs

A cabin fire protection system using Halon 1301 an extinguishing agent previously tested and shown to be effective in suppressing and controlling fires in a simulated transport cabin section and a cargo compartment is investigated Tests were conducted in an obsolete but completely furnished DC-7 passenger cabin equipped with two candidate Halon 1301 dispensing systems modular nozzle and perforated tube Under no-fire conditions continuous measurements were made of the Halon 1301 concentration at approximately 20 locations measurements were also made of temperature, noise pressure, and visibility The modular nozzle system was judged to be best by virtue of its producing more rapid and effective agent distribution resulting in greater potential fire protection capability Halon 1301 was found to rapidly permeate all cabin airspaces including those shielded from the discharge streamlines Author

**N76-14085** Cranfield Inst of Technology (England)
**FIRE, FUEL AND SURVIVAL A STUDY OF TRANSPORT AIRCRAFT ACCIDENTS, 1955 - 1974**
A F Taylor *In* AGARD Aircraft Fire Safety Oct 1975 14 p refs

Accident summaries and reports are examined together with existing papers on the various aspects of fire safety the aim being to piece together a complete picture of the part fire has had in determining overall fatality rates in transport aircraft accidents Note is taken of the sensitivity of the fire death ratio to the number of high impact accidents with no chance of survival and of how this sensitivity may have clouded some past comparisons between fuels of different volatility It is indicated that in post impact fires the higher volatility fuels gasoline and wide-cut gasoline, have been responsible for proportionately more fire deaths than has low volatility kerosine thus confirming predictions based on theory and experiment Author

**N76-14086** Swissair Zurich (Switzerland)
**PASSENGER AIRCRAFT CABIN FIRES**
Willi Schurter *In* AGARD Aircraft Fire Safety Oct 1975 5 p

After a brief review of the established findings on the crash of a Swissair Coronado CV-990A in Wurenlingen Switzerland on February 21 1970 an analysis of the cabin fire preceding the crash is given including origin of fire, its propagation and effects on the aircraft systems A method of establishment of elevated local temperatures in cargo compartment and cabin by means of uncommon fractures as found in the wreckage is described The role played by the major aircraft systems is discussed Furthermore, since the smoke spreading in cabin and cockpit is considered the factor rendering the aircraft uncontrollable under the prevailing conditions the results of tests carried out simulating the smoke conditions are given Author

**N76-14087** Secretariat General a l Aviation Civile Paris (France)
**CRASH OF THE PP-VJZ AIRCRAFT [L'ACCIDENT DU PP-VJZ]**
P Guillevic *In* AGARD Aircraft Fire Safety Oct 1975 6 p In FRENCH

The results of investigations that followed the crashes of two aircraft (a Caravelle in 1968 and a Boeing 707 in 1973) following fires that started in rear washrooms were reported In both cases, it was concluded that fatalities were primarily caused by intoxication resulting from the inhalation of carbon monoxide and highly acidic toxic vapors such as chlorhydric acid and cyanhydric acid originating in the combustion of cabin finishing materials Y J A

**N76-14089*#** Virginia Univ Charlottesville Research Labs for the Engineering Sciences
**GENERAL AVIATION TECHNOLOGY ASSESSMENT**
Ira D Jacobson Oct 1975 52 p refs
(Grant NGR-47-005-202)
(NASA-CR-145979 ESS-4039-103-75, TR-403905) Avail NTIS HC $4 50 CSCL 01B

The existing problem areas in general aviation were investigated in order to identify those which can benefit from technological payoffs The emphasis was placed on acceptance by the pilot/passenger in areas such as performance, safety, handling qualities, ride quality etc Inputs were obtained from three sectors industry government and user although slanted toward the user group The results should only be considered preliminary due to the small sample sizes of the data Trends are evident however and a general methodology for allocating effort in future programs is proposed Author

**N76-14092#** National Transportation Safety Board Washington D C Bureau of Aviation Safety
**AIRCRAFT ACCIDENT REPORTS BRIEF FORMAT US CIVIL AVIATION, ISSUE NUMBER 5, 1974 ACCIDENTS FILE NUMBER 1-0008, 1-0030, 1-0036, 1-0039 THROUGH 1-0045, 3-3601 THROUGH 3-4106, 3-4108 THROUGH 3-4300**
16 May 1975 422 p
(PB-243421/5 NTSB-BA-75-2) Avail NTIS HC $11 00 CSCL 01B

Selected aircraft accident reports are presented The brief format presents the facts conditions circumstances and probable cause(s) for each accident phase of operation kind of flying injury index aircraft damage conditions of light pilot certificate injuries and causal factors GRA

**N76-14093#** National Transportation Safety Board Washington, D C
**AIRCRAFT ACCIDENT REPORT FEDERAL AVIATION ADMINISTRATION DOUGLAS DC-3C, N6 DUBOIS, PENNSYLVANIA 27 MARCH 1975**
25 Jun 1975 24 p
(PB-244224/2 NTSB-AAR-75-11, File-3-0288) Avail NTIS HC $3 50 CSCL 01B

About 1435 e d t March 27 1975 a Federal Aviation Administration Douglas DC-3 crashed during takeoff on the DuBois-Jefferson County Airport DuBois Pennsylvania The three cockpit occupants and one passenger were seriously injured The other seven cabin occupants sustained minor injuries The aircraft was destroyed The pilot inexperienced and unqualified in the DC-3 was making the takeoff with a 7-knot crosswind and with an unlocked tailwheel The National Transportation Safety Board determines that the probable cause of the accident was loss of control at takeoff because of the inexperience of the unqualified pilot making the takeoff and because of the failure of the experienced pilot in the right seat to assume timely control GRA

**N76-14094#** National Transportation Safety Board Washington D C Bureau of Aviation Safety
**AIRCRAFT ACCIDENT REPORT USAF CONVAIR VT-29D (CV-340) AND CESSNA 150H, N50430 NEWPORT NEWS, VIRGINIA 9 JANUARY 1975**
18 Jun 1975 31 p
(PB-244223/4, NTSB-AAR-75-10 File-3-0001) Avail NTIS HC $4 00 CSCL 01B

About 1836 e s t on January 9, 1974 a United States Air Force Convair VT-29D (CV-340) and a Cessna 150H collided in flight over the James River near Newport News Virginia at an altitude of 1 500 feet The five crewmembers and two passengers aboard the Cessna were killed Both aircraft were destroyed by the collision and subsequent impact with the water The Convair was executing a precision radar approach to Langley Air Force Base and was under the control of the Langley Ground Control Approach final controller The Cessna was on a local pleasure flight it was operating in accordance with visual flight rules and was not on a flight plan The National Transportation Safety

Board determines that the probable cause of this accident was the human limitation inherent in the see-and-avoid concept which can be critical in a terminal area with a combination of controlled and uncontrolled traffic GRA

**N76-14095#** Dunlap and Associates Inc, Inglewood Calif
**THE EFFECT OF LIGHTED DECK SHAPE ON NIGHT CARRIER LANDING Final Report**
Joseph W Wulfeck and John E Queen Jun 1975 56 p refs
(Contract N00014-72-C-0041, NR Proj 196-115)
(AD-A014057) Avail NTIS CSCL 01/2

The primary purpose of the experimental program reported was to explore the possibility of identifying a tunnel lighted deck shape which would minimize errors in judging it to be horizontal The secondary purpose was to compare errors in judgment of the horizontal between direct viewing and TV viewing Preliminary main and check experiments were conducted to establish the relation between generated glideslope (error in judging simulated lighted carrier deck shapes to be horizontal) and lighted deck shape GRA

**N76-14110#** Grumman Aerospace Corp, Bethpage, N Y Research Dept
**EXPERIMENTAL INVESTIGATION OF MULTIPLE JET IMPINGEMENT FLOWS APPLICABLE TO VTOL AIRCRAFT IN GROUND EFFECT**
William G Hill Jr and Richard C Jenkins Nov 1975 53 p refs
(RM-605) Avail NTIS HC $4 50

The flow fields created by multiple jets impinging on a ground plane are investigated with primary emphasis on flows pertinent to VTOL aircraft Experimental flows were produced by one, two, or four axisymmetric subsonic air jets Initial tests were conducted to evaluate free mixing of multiple jet clusters without ground impingement Whereas the multiple jets operating out of ground effect were found to have little influence on each other, significant mutual interference was found during ground impingement Author

**N76-14113*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
**THRUST AND WING LOADING REQUIREMENTS FOR SHORT HAUL AIRCRAFT CONSTRAINED BY ENGINE NOISE AND FIELD LENGTH**
Jeffrey V Bowles, Mark H Waters, and Thomas L Galloway Washington Jan 1976 40 p refs
(NASA-TN-D-8144 A-6113) Avail NTIS HC $4 00 CSCL 01A

Propulsion system and wing loading requirements are determined for a mechanical flap and an externally blown flap aircraft for various engine noise levels and two engine cycles Both aircraft are sized to operate from a 914m (3000 ft) runway and perform the same mission For each aircraft concept propulsion system sizing is demonstrated for two different engine cycles - one having a fan pressure ratio of 1 5 and a bypass ratio of 9 and the other having a fan pressure ratio of 1 25 and a bypass ratio of 17 8 The results presented include the required thrust-to-weight ratio, wing loading, resulting gross weight, and direct operating costs as functions of the engine noise level, for each combination of engine cycle and aircraft concept Author

**N76-14114#** Bell Helicopter Co Fort Worth, Tex
**RESULTS OF HELICOPTER FLIGHT TESTS OF A CIRCUMFERENTIAL CARBON OIL SEAL Final Report, 1 Jan 1973 - 1 Dec 1974**
Charles A Turner Jun 1975 16 p
(Contract DAAJ02-73-C-0035, DA Proj 1G1-62204-AA-72)
(AD-A013500, BHC-299-099-740, USAAMRDL-TR-75-23)
Avail NTIS CSCL 11/1

Two samples of a circumferential carbon seal design underwent flight tests in UH-1 and AH-1 type helicopters One sample was tested at Bell Helicopter's flight test facility and one sample was tested at Fort Rucker, Alabama Both seals operated successfully with no reported leakage for a total of 435 hours The seal tested at Bell Helicopter accrued 179 hours of successful operation in an AH-1G helicopter, including cold-weather testing down to -65F The seal installed at Fort Rucker operated for 256 hours and at the time of this report was still operating satisfactorily Author (GRA)

**N76-14115#** Kaman Aerospace Corp Bloomfield Conn
**ELASTIC PITCH BEAM TAIL ROTOR STUDY FOR LOH CLASS HELICOPTERS Final Report**
John D Porterfield and Frank B Clark Feb 1975 140 p refs
(Contract DAAJ01-73-C-0282)
(AD-A013501 R-1325) Avail NTIS CSCL 01/3

This report studies the feasibility of using the flexural concept of the Elastic Pitch Beam in the design of tail rotors for LOH class helicopters The goal is to provide reliability maintainability, repairability, and performance characteristics that are improved over those of current designs Specifically the designs studied included individually replaceable airfoil panels a minimum number of bearings, elastomeric bearings where bearings are required and composite materials to improve damage tolerance and repairability Comparative analyses were used to select the preferred configuration to be subjected to further study Author (GRA)

**N76-14116#** Uniroyal Tire Co Detroit Mich
**RADIAL PLY AIRCRAFT TIRES DESIGN, CONSTRUCTION, AND TESTING Final Report, Dec 1968 - Jan 1975**
C G W Spinti J J Licus D J Martin, and J S Wagner Jun 1975 210 p
(Contract F33657-68-C-1292 WM Proj 8-CIP-1913)
(AD-A013837 ASD-TR-75-23) Avail NTIS CSCL 01/3

The object of the program was to develop basic, general, radial ply aircraft tire design parameters and construction techniques Four (4) sizes of aircraft tires 20x4 4/12, 30x8 8/22, 44x16/28 and 20 00-20/22 P R were selected for the study A summary report of the literature survey and a design manual were issued for Phase I A total of 81 tires were built of which 49 were tested One 20x4 4/12 P R tire with revised tread shoulder configuration completed 200 mph qualification testing but the result could not be duplicated Best performance was obtained on the 44x16/28 P R tires An 8 actual ply 3 breaker tire completed 200 mph qualification testing The principle mode of failure on dynamic tests was separation between the tread and breakers Variations in the tread, breaker construction to improve dynamic performance were tested GRA

**N76-14117#** Army Aviation Engineering Flight Activity Edwards AFB Calif
**EVALUATION OF AN OH-58A HELICOPTER WITH AN ALLISON 250-C20B ENGINE Final Report, 17 Oct - 6 Dec 1974**
Tom P Benson, Robert M Buckanin Carl F Mittag and James E Jenks, Jr Apr 1975 86 p refs
(AD-A013861, USAAEFA-74-48) Avail NTIS CSCL 01/3

The United States Army Aviation Engineering Flight Activity conducted a limited performance and handling qualities evaluation of a Bell Helicopter Company OH-58A helicopter with an Allison 250-C20B engine installed The evaluation was conducted at Edwards Air Force Base and Bishop, California from 17 October through 6 December 1974 Twenty-two flights with 17 6 productive test hours were required for the evaluation Test results obtained with the Allison 250-C20B engine were compared with those previously obtained with the Allison 250-C20 engine and the standard T63-A-700 engine Primary performance improvement over the standard T63-A-700 engine was an increase in out-of-ground-effect hover ceiling from 4600 to 11,050 feet standard-day density altitude at a gross weight of 3000 pounds One deficiency and five shortcomings were noted Unsatisfactory handling qualities characteristics are inherent to the basic OH-58A helicopter and are not associated with the installation of the 250-C20B engine The engine/airframe compatibility characteristics (cooling and vibration levels) of the OH-58A helicopter with the 250-C20B engine are similar to the standard OH-58A helicopter with the T63-A-700 engine Within the scope of the test, the performance of the OH-58A helicopter with an Allison

250-C20B engine installed was improved over the basic OH-58A helicopter Handling qualities were essentially unchanged GRA

**N76-14119#** Lockheed-Georgia Co Marietta
**EVALUATION OF 3-D TURBULENCE TECHNIQUES FOR DESIGNING AIRCRAFT Final Report, 1 Oct. 1973 - 15 Apr 1975**
Frederick D Eichenbaum Jan 1975 85 p refs
(Contract F33615-74-C-3004, AF Proj 1367)
(AD-A013927, AFFDL-TR-74-151) Avail NTIS CSCL 01/1

A recently developed multiple input power spectral technique is applied to predict the response of a C-5A aircraft to three-dimensional turbulence Results are compared to the equivalent one-dimensional turbulence analysis, using corresponding C-5A dynamic response test data as a reference Load variations range from an increase of 3% to a decrease of 14% Because the coherence properties of the turbulence field are fully accounted for in the 3-d gust response analysis, theoretical results which depend upon the cross spectra between responses and probe-measured gust components tend to show a marked improvement over the 1-d case GRA

**N76-14126#** Douglas Aircraft Co, Inc Long Beach Calif
**AIRCRAFT NOISE DEFINITION PHASE 1 ANALYSIS OF THE EXISTING DATA FOR THE DC-8, DC-9 AND DC-10 AIRCRAFT Final Report, Oct 1972 - Aug 1973**
J S Goodman Aug 1973 255 p refs
(Contract DOT-FA73WA-3161)
(AD-A016278/4 MDC-J5973-Phase-1 FAA-EQ-73-5) Avail NTIS HC $10 00 CSCL 01/3

Acoustic and performance data were processed and analyzed for two JT3D turbofan-powered DC-8s, one with short and one with long fan ducts two DC-9s one with JT8D-7 and one with JT8D-9 engines and the DC-10-10 and DC-10-40 aircraft The acoustic data included reference-day effective perceived noise level and peak A-weighted sound level curves with empirically developed curves for adjusting the noise levels to temperatures from 30 F to 100 F with the relative humidity held constant at 70 percent The performance data include provisions for a temperature variation from 30 F to 100 F and runway altitude from sea level to 6000 feet Data accuracy is described in terms of assignable confidence limits Author

**N76-14127*#** National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
**NNEP THE NAVY NASA ENGINE PROGRAM**
Laurence H Fishbach and Michael J Caddy (Naval Air Develop Center) Dec 1975 36 p refs
(NASA-TM-X-71857, E-8606) Avail NTIS HC $4 00 CSCL 21E

A computer code capable of simulating almost any conceivable turbine engine is described This code uses stacked component maps and multiple flowpaths to simulate variable cycle engines with variable component geometry It is capable of design and off-design (matching) calculations and can optimize free variables such as nozzle areas to minimize specific fuel consumption Author

**N76-14129*#** General Electric Co, Cincinnati Ohio Aircraft Engine Group
**ADVANCED SUPERSONIC PROPULSION SYSTEM TECHNOLOGY STUDY, PHASE 2 Final Report**
R D Allan Dec 1975 94 p
(Contract NAS3-16950)
(NASA-CR-134913 R75AEG508) Avail NTIS HC $5 00 CSCL 21E

Variable cycle engines were identified based on the mixed-flow low-bypass-ratio augmented turbofan cycle, which has shown excellent range capability in the AST airplane The best mixed-flow augmented turbofan engine was selected based on range in the AST Baseline Airplane Selected variable cycle engine features were added to this best conventional baseline engine, and the Dual-Cycle VCE and Double-Bypass VCE were defined The conventional mixed-flow turbofan and the Double-Bypass VCE were on the subjects of engine preliminary design studies to determine mechanical feasibility, confirm weight and dimensional estimates, and identify the necessary technology considered not yet available Critical engine components were studied and incorporated into the variable cycle engine design Author

**N76-14130*#** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
**SOME COMPARISONS OF THE FLYOVER NOISE CHARACTERISTICS OF DC-9 AIRCRAFT HAVING REFANNED AND HARDWALLED JT8D ENGINES, WITH SPECIAL REFERENCE TO MEASUREMENT AND ANALYSIS PROCEDURES**
Robert N Hosier Jan 1976 80 p
(NASA-TM-X-72804) Avail NTIS HC $5 00 CSCL 20A

Flyover noise measurements were made (using Federal Aviation Regulations part 36 procedures) of two DC-9 aircraft one equipped with refanned JT8D-109 engines and the other equipped with hardwalled JT8D-9 engines NASA analyses show a refan centerline noise reduction of about 9 1 EPNdB and 10 0 EPNdB for takeoff with cutback and 50 deg flap landing approach, respectively A comparison of refan and hardwall PNLTM spectra shows that the refan noise reduction may be attributed to lower jet noise levels on takeoff and reduced high-frequency tonal content on landing approach A general description of the test procedures and results are included along with detailed descriptions of the measurement and analysis systems Author

**N76-14133#** Aircraft Research Association, Ltd, Bedford (England)
**SIMULATION TECHNIQUES FOR PYLON-MOUNTED TURBO-FAN ENGINES, VOLUME 1**
A E Harris and G I Pauley Oct 1975 93 p refs Sponsored by Min of Defence London
(ARA-36-Vol-1) Avail NTIS HC $5 00

The effectiveness of the various nacelle simulators used to represent underslung turbofan engine nacelles is discussed in terms of the pressure interferences in evidence on wings and pylons for Mach numbers from 0 6 to 0 8 Drag data obtained from a typical powered nacelle test are presented together with a discussion of the thrust and drag bookkeeping used A detailed description is given of the analysis of the powered nacelle internal and external characteristics Equations involved in the thrust and drag analysis of the powered nacelle test data are included Author

**N76-14134#** ARO, Inc Arnold Air Force Station Tenn
**JET NOISE A SURVEY AND A PREDICTION FOR SUBSONIC FLOWS Final Report, Jul 1973 - Sep 1974**
Philip T Harsha AEDC Aug 1975 78 p refs
(ARO Proj RF438 ARO Proj R32P)
(AD-A013794 ARO-ETF-TR-74-115 AEDC-TR-75-85) Avail NTIS CSCL 20/1

The state-of-the-art of the prediction of turbulent jet noise is surveyed This survey includes a description of the available experimental data on subsonic and supersonic cold and hot jets and of present theoretical treatments of the mechanisms of turbulent jet noise production A detailed analysis of the production of subsonic cold jet noise based on the acoustic analogy formulation is described, and results of computations using this analysis and a turbulent kinetic energy analysis of the jet flow field are presented and compared with representative experimental data GRA

**N76-14137*#** National Aeronautics and Space Administration Flight Research Center Edwards Calif
**STABILITY AND CONTROL DERIVATIVES OF THE T-37B AIRPLANE**
Mary F Shafer Sep 1975 31 p refs
(NASA-TM-X-56036) Avail NTIS HC $4 00 CSCL 01C

Subsonic stability and control derivatives were determined by a modified maximum likelihood estimator from flight data for the longitudinal and lateral-directional modes of the T-37B airplane Data from two flights in which 166 stability and control maneuvers were performed were used in the determination The configurations investigated were zero flaps gear up half flaps gear up full flaps gear up and zero flaps gear down Author

**N76-14141#** Calspan Corp, Buffalo, N Y
**FLIGHT INVESTIGATION OF FIGHTER SIDE-STICK FORCE-DEFLECTION CHARACTERISTICS Final Report, Sep. 1974 - May 1975**
G Warren Hall and Rogers E Smith May 1975 94 p refs (Contract F33615-73-C-3051 AF Proj 8219)
(AD-A013926, CALSPAN-AK-5280-F-8, AFFDL-TR-75-39) Avail NTIS CSCL 01/3

A flight investigation of fighter side-stick controller force-deflection characteristics was performed using the USAF NT-33A variable stability airplane equipped with a variable feel side stick The simulated airplane and control system characteristics were representative of a modern high performance fighter employing a side-stick controller Up-and-away tasks including formation air-to-air tracking and acrobatic maneuvering, and landing approach tasks were evaluated by two pilots Four values of nonlinear pitch and roll side-stick force-command gain resulting in different response per force ratios were evaluated with different side-stick force-deflection gradients including a rigid side stick GRA

**N76-14408#** Tokyo Univ (Japan) Inst of Space and Aeronautical Science
**VISCOUS FLOW AROUND A ROTATIONALLY OSCILLATING CIRCULAR CYLINDER**
Atsushi Okajima (Kyushu Univ), Hiroyuki Takata and Tsuyoshi Asanuma Sep 1975 29 p refs
(ISAS-532) Avail NTIS HC $4 00

Aerodynamic characteristics of a circular cylinder either stationary or rotationally oscillating around its axis in uniform viscous flow were analyzed by numerical calculation and by experiment The method and results of numerical solution of the Navier-Stokes equations by the finite difference analog are presented measurements for the lift and the drag forces acting on the cylinder made by towing test models in still fluid in a range of Reynolds number Re=40 to 6100 are included Good agreement was obtained between the calculated results and the experimental ones at Reynolds numbers Re=40 and 80 concerning the steady and unsteady aerodynamic parameters and the phenomenon of the so-called synchronization It becomes clear from numerical calculation that there may be a close relationship between the time-variation of the flow pattern and that of the lift force on an oscillating cylinder The influence of Reynolds number on the aerodynamic parameters and the phenomenon of synchronization were examined Author

**N76-14464*#** Rensselaer Polytechnic Inst Troy N Y Tribology Lab
**EVALUATION OF MATERIALS AND DESIGN MODIFICATIONS FOR AIRCRAFT BRAKES**
T L Ho F E Kennedy and M B Peterson Jan 1975 65 p refs
(Grant NGR-33-018-152)
(NASA-CR-134896) Avail NTIS HC $4 50 CSCL 11G

A test program is described which was carried out to evaluate several proposed design modifications and several high-temperature friction materials for use in aircraft disk brakes The evaluation program was carried out on a specially built test apparatus utilizing a disk brake and wheel half from a small het aircraft The apparatus enabled control of brake pressure velocity, and braking time Tests were run under both constant and variable velocity conditions and covered a kinetic energy range similar to that encountered in aircraft brake service The results of the design evaluation program showed that some improvement in brake performance can be realized by making design changes in the components of the brake containing friction material The materials evaluation showed that two friction materials show potential for use in aircraft disk brakes One of the materials is a nickel-based sintered composite while the other is a molybdenum-based material Both materials show much lower wear rates than conventional copper-based materials and are better able to withstand the high temperatures encountered during braking Additional materials improvement is necessary since both materials show a significant negative slope of the friction-velocity curve at low velocities Author

**N76-15014*#** Massachusetts Inst of Tech, Cambridge Flight Transportation Lab
**AN ASSESSMENT OF LIGHTER THAN AIR TECHNOLOGY Final Report**
Joseph F Vittek Jr, ed Jun 1975 84 p Final Report of Interagency Workshop on Lighter than Air Vehicles Monterey *Calif, Sep 1974 Sponsored in part by Navy,* DOT and FAA (Grant NsG-2024)
(NASA-CR-137799, FTL-R75-1) Avail NTIS HC $5 00 CSCL 01B

The workshop on LTA is summarized The history and background are reviewed The workshop reports for the following working groups are presented policy, market analysis, economics operations and technology F O S

**N76-15015*#** Massachusetts Inst of Tech, Cambridge
**PROCEEDINGS OF THE INTERAGENCY WORKSHOP ON LIGHTER THAN AIR VEHICLES**
Joseph F Vittek, Jr ed Jan 1975 692 p refs Proc held at Monterey Calif Sep 1974 Sponsored in part by Navy, DOT and FAA
(Grant NsG-2024)
(NASA-CR-137800 FTL-R75-2) Avail NTIS HC $16 25 CSCL 01B

Papers presented at the workshop are reported Topics discussed include economic and market analysis technical and design considerations, manufacturing and operations, design concepts airship applications and unmanned and tethered systems

**N76-15016*** Massachusetts Inst of Tech Cambridge
**BASIC RELATIONSHIPS FOR LTA ECONOMIC ANALYSIS**

Raymond A Ausrotas *In its* Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 1-6 refs

CSCL 05C

Operating costs based on data of actual and proposed airships for conventional lighter than air craft (LTA) are presented An economic comparison of LTA with the B-47F is included and possible LTA economic trends are discussed Author

**N76-15017*** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
**PRELIMINARY ESTIMATES OF OPERATING COSTS FOR LIGHTER THAN AIR TRANSPORTS**
C L Smith and M D Ardema *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 7-19 refs
CSCL 05C

A preliminary set of operating cost relationships are presented for airship transports The starting point for the development of the relationships is the direct operating cost formulae and the indirect operating cost categories commonly used for estimating costs of heavier than air commercial transports Modifications are made to the relationships to account for the unique features of airships To illustrate the cost estimating method the operating costs of selected airship cargo transports are computed Conventional fully buoyant and hybrid semi-buoyant systems are investigated for a variety of speeds payloads ranges and altitudes Comparisons are made with aircraft transports for a range of cargo densities Author

**N76-15018*** Holland America Line Rotterdam (Netherlands)
***COMPARATIVE AIRSHIP ECONOMICS***
Robert Harthoorn *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 21-30 refs

CSCL 05C

As future LTA vehicles will be doomed right from the start if they do not fill a real need some differences in transport philosophy between design engineers on the one hand and freight forwarders on the other are discussed Watching rising costs of energy necessary to transport our cargo from A to B and realizing that this price of energy is always included in the product's

selling price at B the apparent correlation between installed specific tractive force per unit of cargo weight and pure freighting cost are contemplated Very speedy and progressive Airship designs are mistrusted because the key to any low cost transport tool is to design it for its given task only without any unnecessary sophistication Author

**N76-15019*** Goodyear Aerospace Corp Akron Ohio
**EFFECT OF PRESENT TECHNOLOGY ON AIRSHIP CAPABILITIES**
Robert T Madden *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 31-40

CSCL 01B

The effect is presented of updating past airship designs using current materials and propulsion systems to determine new airship performance and productivity capabilities New materials and power plants permit reductions in the empty weights and increases in the useful load capabilities of past airship designs The increased useful load capability results in increased productivity for a given range i e either increased payload at the same operating speed or increased operating speed for the same payload weight or combinations of both Estimated investment costs and operating costs are presented to indicate the significant cost parameters in estimating transportation costs of payloads in cents per ton mile Investment costs are presented considering production lots of 1, 10 and 100 units Operating costs are presented considering flight speeds and ranges Author

**N76-15020*** Southern California Aviation Council Inc Pasadena
**AIRSHIP ECONOMICS**
Richard D Neumann and L R Mike Hackney *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 41-52 refs
CSCL 05C

Projected operating and manufacturing costs of a large airship design which are considered practical with today's technology and environment are discussed Data and information developed during an 18-month study on the question of feasibility, engineering, economics and production problems related to a large metalclad type airship are considered An overview of other classic airship designs are provided, and why metalclad was selected as the most prudent and most economic design to be considered in the 1970-80 era is explained Crew operation ATC and enroute requirements are covered along with the question of handling maintenance and application of systems to the large airship Author

**N76-15021*** Southern California Aviation Council, Inc Pasadena
**SOME ECONOMIC TABLES FOR AIRSHIPS**
Richard D Neumann *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 53-61

CSCL 05C

During the course of the Southern California Aviation Council study on lighter than air it was determined that some form of economic base must be developed for estimation of costs of the airship The tables are presented Author

**N76-15022*** Cranfield Inst of Technology (England)
**A STUDY OF DESIGN TRADE (OFFS) USING A COMPUTER MODEL**
Stephen Coughlin *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 63-73 ref

CSCL 01B

The interaction between the efficiency of the structural design and the cost of the structure used was studied It is shown that future effort is best directed at producing a low cost structure of medium efficiency, but with the ability to withstand normal service wear The trade-off between aerodynamic drag and structure weight in selecting a length to diameter ratio for the hull is evaluated along with the implications of power plan type and fuel cost on the economics of the airship The choice of lifting gas is considered Author

**N76-15023*** Naval Academy, Annapolis Md
**AN ECONOMIC COMPARISON OF THREE HEAVY LIFT AIRBORNE SYSTEMS**
Bernard H Carson *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 75-85 refs

CSCL 05C

Current state of art trends indicate that a 50-ton payload helicopter could be built by the end of the decade However alternative aircraft that employ LTA principles are shown to be more economically attractive, both in terms of investment and operating costs for the ultra-heavy lift role Costing methodology follows rationale developed by airframe manufacturers, and *includes learning curve factors* Author

**N76-15024*** Massachusetts Inst of Tech Cambridge
**AN APPROACH TO MARKET ANALYSIS FOR LIGHTER THAN AIR TRANSPORTATION OF FREIGHT**
Paul O Roberts Henry S Marcus, and Jean H Pollock (Babson Coll , Babson Park, Mass ) *In its* Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 87-110 refs

CSCL 05C

An approach is presented to marketing analysis for lighter than air vehicles in a commercial freight market After a discussion of key characteristics of supply and demand factors a three-phase approach to marketing analysis is described The existing transportation systems are quantitatively defined and possible roles for lighter than air vehicles within this framework are postulated The marketing analysis views the situation from the perspective of both the shipper and the carrier A demand for freight service is assumed and the resulting supply characteristics are determined Then, these supply characteristics are used to establish the demand for competing modes The process is then iterated to arrive at the market solution Author

**N76-15025*** Aerospace Developments, London (England)
**MARKET ASSESSMENT IN CONNECTION WITH LIGHTER THAN AIR**
John E R Wood *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 111-121

CSCL 05C

A review of the marketability of the airship is given, and the relative energy consumption and speed potential of the airship is compared to other modes and guidelines to areas of initial development are also provided, together with a brief historical review Author

**N76-15026*** Massachusetts Inst of Tech Cambridge
**BASIC RELATIONSHIPS FOR LTA TECHNICAL ANALYSIS**

Raymond A Ausrotas *In its* Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 123-131 refs

CSCL 01B

An introduction to airship performance is presented Static lift equations are shown which when combined with power requirements for conventional airships, allow parametric studies of range, payload, speed and airship size It is shown that very large airships are required to attain reasonable speeds at transoceanic ranges Author

**N76-15027*** Naval Air Development Center, Warminster Pa
**THE EFFECTS OF SELECTED MODERN TECHNOLOGICAL CONCEPTS ON THE PERFORMANCE AND HANDLING CHARACTERISTICS OF LTA VEHICLES**
Carmen J Mazza *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 133-146 refs

CSCL 01B

The results of an airship design sensitivity study are presented A wide variety of airship design concepts, including the classical and high aero-lift augmented-hybrids are examined with regard to specific technological improvements and consequent gains in

performance stability and control and flying qualities Variations in size payload power required and airspeed are quantitatively analyzed for airships representing aero-to-buoyant lift ratios of zero to 3 0 over a range of technology improvements implying reduced drag, reduced structural weight fractions and lighter more efficient propulsion systems Qualitatively, future airships are discussed in terms of stability control and flying qualities requirements dictated by projected demands for vastly improved operational effectiveness and ease of handling Such topics include stability augmentation systems load-alleviation systems and total computer state-sensing and controls management systems It was shown that for the most part highly refined conventional designs offer attractive gains in both performance and ease of handling Hybrid airships represent a good potential for missions requiring the transport of heavy payloads at higher airspeeds over shorter ranges without the capability for sustained hover and vertical flight Author

**N76-15028*** Goodyear Aerospace Corp Akron, Ohio
**BOUNDARY LAYER CONTROL FOR AIRSHIPS**
*F A Pake and S J Pipitone In* MIT *Proc of the Interagency* Workshop on Lighter than Air Vehicles Jan 1975 p 147-155 refs

CSCL 01A

An investigation is summarized of the aerodynamic principle of boundary layer control for nonrigid LTA craft The project included a wind tunnel test on a BLC body of revolution at zero angle of attack Theoretical analysis is shown to be in excellent agreement with the test data Methods are evolved for predicting the boundary layer development on a body of revolution and the suction pumping and propulsive power requirements These methods are used to predict the performance characteristics of a full-scale airship The analysis indicates that propulsive power reductions of 15 to 25 percent and endurance improvements of 20 to 40 percent may be realized in employing boundary-layer control to nonrigid airships Author

**N76-15029*** Transportation Technology Inc , Marblehead, Mass
**AIRSHIP STRESSES DUE TO VERTICAL VELOCITY GRADIENTS AND ATMOSPHERIC TURBULENCE**
Duncan Sheldon *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 157-168 refs

CSCL 01A

Munk's potential flow method is used to calculate the resultant moment experienced by an ellipsoidal airship This method is first used to calculate the moment arising from basic maneuvers considered by early designers, and then expended to calculate the moment arising from vertical velocity gradients and atmospheric turbulence This resultant moment must be neutralized by the transverse force of the fins The results show that vertical velocity gradients at a height of 6000 feet in thunderstorms produce a resultant moment approximately three to four times greater than the moment produced in still air by realistic values of pitch angle or steady turning Realistic values of atmospheric turbulence produce a moment which is significantly less than the moment produced by maneuvers in still air Author

**N76-15030*** Woodward (Donald E ) Alexandria Va
**AN AERODYNAMIC LOAD CRITERION FOR AIRSHIPS**

Donald E Woodward *In* MIT Proc of the Interagency Workshop *on Lighter than Air Vehicles Jan* 1975 p 169-176 *refs*

CSCL 01A

A simple aerodynamic bending moment envelope is derived for conventionally shaped airships This criterion is intended to be used much like the Naval Architect s standard wave for preliminary estimates of longitudinal strength requirements It should be useful in tradeoff studies between speed fineness ratio block coefficient structure weight, and other such general parameters of airship design Author

**N76-15031*** Naval Ordnance Lab , White Oak Md
**THE PLANAR DYNAMICS OF AIRSHIPS**
Frank J Regan *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 177-186 refs

CSCL 01A

The forces and moments acting upon a LTA vehicle are considered in order to develop parameters describing planar motion Similar expressions for HTA vehicles will be given to emphasize the greater complexity of aerodynamic effects when buoyancy effects cannot be neglected A brief summary is also given of the use of virtual mass coefficients to calculate loads on airships Author

**N76-15032*** Ketron, Inc Arlington Va
**FLOATING VS FLYING A PROPULSION ENERGY COMPARISON**
Fendall Marbury *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 187-197 refs

CSCL 01B

Floating craft are compared to those that fly Drag/weight for floaters is shown to be proportional to v squared/L while for flyers it is independent of size and speed The transportation market will therefore assign airships to lower speeds than airplanes and will favor large airship sizes Drag of an airship is shown to be only 11 percent of submarine drag at equal displacement and speed raising the possibility that airships can compete with some types of ships Author

**N76-15033*** McMaster Univ , Hamilton (Ontario)
**LONG FLUID FILLED BAGS SUSPENDED BY LINE FORCES**
M L Mullins and J L Duncan *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 199-208 refs Sponsored in part by Natl Res Council of Canada

CSCL 01A

A previous analysis of fluid filled storage bags is extended to the case of a long fluid filled cylindrical membrane supported by uniform line loads Cross-sectional shape stiffness of the support system and stress resultants in the membrane are determined The application of the numerical results to problems arising in the design of nonrigid airships is discussed Author

**N76-15034*** Utah Univ Salt Lake City
**COMPUTER AIDED FLEXIBLE ENVELOPE DESIGNS**
Ronald D Resch *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 209-215

CSCL 01A

Computer aided design methods are presented for the design and construction of strong, lightweight structures which require complex and precise geometric definition The first flexible structures is a unique system of modeling folded plate structures and space frames It is possible to continuously vary the geometry of a space frame to produce large clear spans with curvature The second method deals with developable surfaces, where both folding and bending are explored with the observed constraint of available building materials and what minimal distortion result in maximum design capability Alternative inexpensive fabrication techniques are being developed to achieve computer defined enclosures which are extremely lightweight and mathematically highly precise Author

**N76-15035*** Naval Air Development Center, Warminster Pa Air Vehicle Technology Dept
**LTA APPLICATION OF A LONG TRAILING WIRE HIGH SPEED/LOW WEIGHT REELING SYSTEM**
D F Werb *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 217-222

CSCL 01A

The successful development of a unique yet simple reeling system for handling long trailing tensile members at high speeds is described This high speed when combined with the system simplicity low weight and effective motive power consumption make this reeling system particularly attractive to LTA planners and designers for numerous LTA missions Author

**N76-15036*** National Aeronautics and Space Administration Washington, D C

**LTA STRUCTURES AND MATERIALS TECHNOLOGY**

Norman J Mayer *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 223-241 refs

CSCL 01C

The state-of-the-art concerning structures and materials technology is reviewed It is shown that many present materials developments resulting from balloon and aircraft research programs can be applied to new concepts in LTA vehicles Both buoyant and semi-buoyant vehicles utilize similar approaches to solving structural problems and could involve pressurized non-rigid and unpressurized rigid structures System designs common to both and vital to structural integrity include much of the past technology as well Further research is needed in determination of structural loads especially in future design concepts Author

**N76-15037*** Du Pont de Nemours (E I) and Co, Wilmington, Del

**POTENTIAL CONTRIBUTION OF HIGH STRENGTH, HIGH MODULUS ARAMID FIBERS TO THE COMMERCIAL FEASIBILITY OF LIGHTER THAN AIR CRAFT**

D L G Sturgeon and T K Venkatachalam *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 243-255 refs

CSCL 11D

Kevlar aramid fiber fabric, rope and cable performance are reviewed along with the economics relevant to the material, structural, and reliability aspects of lighter than air craft Author

**N76-15038*** Southern California Aviation Council Inc Pasadena

**AIRSHIP CONSTRUCTION**

John Roda *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 257-259

CSCL 01C

Forty-four years ago the first successful metal airship was completed and delivered to the United States Navy the ZMC-2 Between those years and the present very little effort or serious consideration has been given to the manufacture, design construction, or economic impact of airships It is important to retain and exploit the small but continually diminishing pool of airship talent that will expedite the success of the United States in what is now a pioneering venture The relative simplicity of airship construction, utilizing the tremendous technical advances of the last 44 years, leads to the conclusion that this form of transportation holds great promise for reducing costs of military missions and improving the international competitive position of the United States in commercial applications Author

**N76-15039*** Aerling, Bedford Ind

**OPERATIONAL CONSIDERATIONS FOR THE AIRSHIP IN SHORT-HAUL TRANSPORTATION**

Charles D Walker *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 261-266 refs

CSCL 12B

The airship s problems and the possibilities for their solution in a short-haul transportation environment are surveyed The problems are derived from both past experience and envisioned operation Problems relative to both fully buoyant and semi-buoyant configurations are considered and their origins in principle discussed Also addressed in this paper are the state-of-the-art technologies with the potential of providing answers to the airship s operational difficulties Author

**N76-15040*** Maiersperger (Walter P) Monterey Calif

**DESIGN ASPECTS OF ZEPPELIN OPERATIONS FROM CASE HISTORIES**

Walter P Maiersperger *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 267-283 refs

CSCL 12B

Some widely held beliefs concerning the practicability of rigid airships in air carrier operations are discussed It is shown by a review of past operational experience and some basic aerostatic theory, their actual record and the reasons for their demise Problems of atmospheric density and temperature variations, meteorological factors aerodynamic stability and control, and mooring difficulties are discussed and related to actual case histories Structural and flight efficiencies are compared to airplane efficiencies for airplanes contemporary with the zeppelin as well as modern designs The difficulty of supporting new, commercial airship developments on an economic basis is made clear Author

**N76-15041*** California Dept of Transportation Sacramento

**LIGHTER THAN AIR A LOOK AT THE PAST, A LOOK AT THE POSSIBILITIES**

William F Shea *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 285-295 refs

CSCL 12B

A brief history of the flight by LTA including the development of the zeppelin is presented Safety and economy are discussed along with power requirements and production techniques The problem of ground handling facilities for very large airships are briefly mentioned F O S

**N76-15042*** Walker (Hepburn Jr), Vero Beach, Fla

**MOORING AND GROUND HANDLING RIGID AIRSHIPS**

Hepburn Walker Jr *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 297-310 refs

CSCL 01E

The problems of mooring and ground handling rigid airships are discussed A brief history of Mooring and Ground Handling Rigid Airships from July 2, 1900 through September 1 1939 is included Also a brief history of ground handling developments with large U S Navy nonrigid airships between September 1 1939 and August 31, 1962 is included wherein developed equipment and techniques appear applicable to future large rigid airships Finally recommendations are made pertaining to equipment and procedures which appear desirable and feasible for future rigid airship programs Author

**N76-15043*** Naval Air Systems Command Washington D C

**A NEW CONCEPT FOR AIRSHIP MOORING AND GROUND HANDLING**

John C Vaughan *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 311-321 refs

CSCL 01E

Calculations were made to determine the feasibility of applying the negative air cushion (NAC) principle to the mooring of airships Pressures required for the inflation of the flexible trunks are not excessive and the maintenance of sufficient hold down force is possible in winds up to 50 knots Fabric strength requirements for a typical NAC sized for a 10-million cubic foot airship were found to be approximately 200 lbs/in Corresponding power requirements range between 66-HP and 5600-HP No consideration was given to the internal airship loads caused by the use of a NAC and further analysis in much greater detail is required before this method could be applied to an actual design, however, the basic concept appears to be sound and no problem areas of a fundamental nature are apparent Author

**N76-15044*** Slate All Metal Dirigible Co, Glendale Calif

**THE SLATE ALL METAL AIRSHIP**

Claude C Slate and Richard D Neumann (Southern Calif Aviation Council Inc) *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 323-330

CSCL 01C

The development of the Slate all metal airship City of Glendale built and completed in 1930 is presented The airship facilities are discussed Pertinent data which led to other engineering accomplishments for aviation are shown The SMD-100 concept

is presented along with a brief commentary on the costs and problems involved in such an airship design and the application of the hoisting and elevator facilities to airship development
Author

**N76-15045*** Turbomachines Inc , Irvine, Calif
**STATE OF THE ART OF METALCLAD AIRSHIPS**
V H Pavlecka and John Roda *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 331-349 refs
CSCL 01C
Metalclad airship development of the past history are considered along with the immediate prospects for continuation of the development of these airships The metalclad airships promise high safety even in highly inclement weather are capable of high speeds, while lifting high useful loads Metalclad airships which in first cost would compare favorably with the costs of sea-going ships and in operating costs promise to be lower than airplanes
Author

**N76-15046*** Aerospace Developments London (England)
**THE AEROSPACE DEVELOPMENTS CONCEPT**
John E R Wood *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 351-358

CSCL 01C
The viability of using airships for the transport of natural gas, and the initial design of such a system, the airship and its associated subsystems together with a continuing economic analysis of the project were investigated Investigations, on a funded basis, were also carried out into the application of the airship for A S W and A E W uses, and a further investigation into the transport of mineral concentrates for an Australasian mining concern was completed
Author

**N76-15047*** Papst-Motoren KG St Georgen (West Germany)
**METHOD FOR TRANSPORTING IMPELLENT GASES**
Hermann Papst *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 359-367

CSCL 05C
The described system DAL comprises a method and a device for transportation of buoyant impellent gases, without the need for expensive pipes and liquid tankers The gas is self air-lifted from its source to a consignment point by means of voluminous light hollow bodies Upon release of the gas at the consignment point the bodies are filled with another cheap buoyant gas (steam or heated air) for the return trip to the source In both directions substantial quantities of supplementary freight goods can be transported Requirements and advantages are presented
Author

**N76-15048*** McMaster Univ , Hamilton (Ontario)
**THE DESIGN AND CONSTRUCTION OF THE CAD-1 AIRSHIP**
H J Kleiner R Schneider (Can Airship Develop Corp ), and J L Duncan *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 369-394 refs

CSCL 01C
The background history, design philosophy and Computer application as related to the design of the envelope shape stress calculations and flight trajectories of the CAD-1 airship now under construction by Canadian Airship Development Corporation are reported A three-phase proposal for future development of larger cargo carrying airships is included
Author

**N76-15049*** Goodyear Aerospace Corp Akron Ohio
**A LTA FLIGHT RESEARCH VEHICLE**
Fred R Nebiker *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 395-404

CSCL 01C
An Airship Flight Research Program is proposed Major program objectives are summarized and a Modernized Navy ZPG3W Airship recommended as the flight test vehicle The origin of the current interest in modern airship vehicles is briefly discussed and the major benefits resulting from the flight research program described Airship configurations and specifications are included
Author

**N76-15050*** Airfloat Transport Ltd , Guildford (England)
**THE AIRFLOAT HL PROJECT**
Edwin Mowforth (Surrey Univ ) *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 405-414

CSCL 01C
A design study is described for a large low-cost rigid airship intended primarily for the movement of large indivisible loads (cargo) between industrial sites A survey of the ship and its overall performance is followed by accounts of the operational procedures for the above function and for an alternative application to unit module transfer between fixed terminals A final section indicates the estimated costs of construction and operation Safety factors are also considered Lifting devices such as winches hoists are shown and described, and airship configurations are also shown
Author

**N76-15051*** United Technical Industries El Segundo, Calif
**THE BASIC CHARACTERISTICS OF HYBRID AIRCRAFT**

J B Nichols *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 415-430 refs

CSCL 01C
The transportation of very heavy or very bulky loads by airships, and the ability to carry out extended duration flights at low speeds and low costs was studied Structural design and weight factors for airship construction are examined The densities of various light gases to be used in airships are given along with their lifting capacities The aerodynamic characteristics of various airship configurations was studied Propulsion system requirements for airships are briefly considered
J R T

**N76-15052*** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
**A SEMIBUOYANT VEHICLE FOR GENERAL TRANSPORTATION MISSIONS**
C Dewey Havill and Michael Harper *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 431-439
CSCL 01C
The concept of a small semibuoyant, lifting-body airship with either a disposable or nondisposable buoyant fluid is discussed Estimations of fuel consumption payload capability power requirements and productivity are made and compared to other flight systems Comparisons are made on the basis of equal cost vehicles The assumption is made that, to a first-order approximation, the costs of developing procuring and operating a commercial air transport vehicle are proportional to vehicle empty weight It must be noted that no historical cost data exist for the lifting-body airship and therefore these comparisons must be considered preliminary
Author

**N76-15053*** Aereon Corp , Princeton N J
**THE DYNAIRSHIP**
William McElwee Miller, Jr *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 441-455

CSCL 01C
A feasibility analysis for the construction and use of a combination airplane-airship named Dynairship' is undertaken Payload capacities fuel consumption and the structural design of the craft are discussed and compared to a conventional commercial aircraft (a Boeing 747) Cost estimates of construction and operation of the craft are also discussed The various uses of the craft are examined (i e in police work materials handling and ocean surveillance) and aerodynamic configurations and photographs are shown
J R T

**N76-15054*** Flugwissenschaftliche Fachgruppe Goettingen e V (West Germany)

**SOME ASPECTS OF HYBRID-ZEPPELINS**
Paul-Armin Mackrodt *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 457-464 refs

CSCL 01C

To increase an airship's maneuverability and payload capacity as well as to save bouyant gas it is proposed to outfit it with a slender delta-wing which carries about one half of the total take-off weight of the vehicle An optimization calculation based on the data of LZ 129 (the last airship which saw passenger-service) leads to a Hybrid-Zeppelin with a wing of aspect-ratio 1 5 and 105 m span The vehicle carries a payload of 40% of it s total take-off weight and consumes 0 8 t fuel per ton payload over a distance of 10000 km Author

**N76-15055*** *Piasecki Aircraft Corp Philadelphia, Pa*
**ULTRA-HEAVY VERTICAL LIFT SYSTEM THE HELI-STAT**

Frank N Piasecki *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 465-476 refs

CSCL 01C

A hybrid VTOL airship which is combined with helicopters is evaluated The static lift of the airship supports approximately the full empty weight of the entire assembly The helicopter rotors furnish the lift to support the payload as well as the propulsion and control about all axes Thus existing helicopters, with no new technology required can be made to lift payloads of ten times the capacity of each one alone and considerably more than that of any airship built so far A vehicle is described which has a 75-ton payload based on four existing CH-53D helicopters and an airship of 3,600,000 cu ft The method of interconnection is described along with discussion of control instrumentation, drive system and critical design conditions The vertical lift and positioning capabilities of this vehicle far exceed any other means available today, yet can be built with a minimum of risk development cost and time Author

**N76-15056*** Dynapods Inc , New Orleans, La
**THE VARIABLE DENSITY AIRCRAFT CONCEPT**
A C Davenport *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 477-483

CSCL 01C

In the variable density aircraft concept the aircraft's density is varied by varying its volume This is accomplished by combining a variable volume hull, which is called the dynapod, with intrinsic means for the controlled variation of a mass of working fluid or substance within the aircraft The dynapod is a hinged structure and follows the volumetric variations of the working fluid The result is a variable density hull which with the attachment of power plants, etc becomes a variable density aircraft Author

**N76-15057*** International Bank for Reconstruction and Development, Washington, D C
**ROLES OF AIRSHIPS IN ECONOMIC DEVELOPMENT**
George J Beier and Gerardo Cahn Hidalgo *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 485-498 refs
CSCL 05C

It is proposed that airships of known and tested technology could, in some cases, perform routine transport missions more economically than conventional transport modes If infrastructure for direct surface transport is already in place or if such infrastructure can be justified by the size of the market and there are no unusual impediments to constructing it then the airships of tested technology cannot normally compete If, however, the surface routes would be unusually expensive or circuitous or if they involve several transhipments, or if the market size is too small to spread infrastructure costs of conventional transport, the airships of tested technology present a workable alternative A series of special cases are considered The cases though unusual are not unique, there are several similar possible applications which in total would provide a reasonably large market for airships Author

**N76-15058*** Cranfield Inst of Technology (England)
**THE APPLICATION OF THE AIRSHIP TO REGIONS LACKING IN TRANSPORT INFRASTRUCTURE**
Stephen Coughlin *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 499-507 ref

CSCL 12B

The requirements for two areas of airship application are considered The first of these are those countries where there is a need to move consignments that are too large for the existing transport systems, the second are those regions where ground characteristics have resulted in an area totally devoid of transport The needs of the second group are considered in detail since they also require transport to provide social as well as economic growth With this problem in mind a philosophy is put forward for using airships in conjunction with LASH vessels A specimen design is outlined and the initial costs estimated Author

**N76-15059*** Hackney Associates Sierra Madre Calif
**AIRSHIP LOGISTICS THE LTA VEHICLE, A TOTAL CARGO SYSTEM**
L R Mike Hackney (Southern Calif Aviation Council Inc ) *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 531-538 refs

CSCL 12B

*Design considerations for logistics are dealt with as they* pertain to the large rigid LTA vehicle as either a commercial or military cargo carrier Pertinent factors discussed are (1) the basic mission (2) types of payload (3) the payload space in regards to configuration and sizing its capacity and its loadability A logistic capability comparison of selected cargo airships versus jumbo jets is also made Author

**N76-15060*** Combustion Engineering, Inc Windsor, Conn
**THE TRANSPORT OF NUCLEAR POWER PLANT COMPONENTS**
S J Keating, Jr *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 539-549

CSCL 12B

The problems of transporting nuclear power plant components to landlocked sites where the usual mode of transport by barge cannot be used are considered Existing methods of ground-based overland transport are discussed and their costs presented Components are described and traffic density projections made to the year 2000 Plots of units transported versus distance transported are provided for units booked in 1973 and booked and proposed in 1974 It is shown that for these cases overland transport requirements for the industry will be over 5,000,000 ton-miles/year while a projection based on increasing energy demands shows that this figure will increase significantly by the year 2000 The payload size, distances and costs of existing overland modes are significant enough to consider development of a lighter than air (LTA) mode for transporting NSSS components Author

**N76-15061*** Arkansas Univ , Fayetteville
**AIRSHIPS FOR TRANSPORTING HIGHLY VOLATILE COMMODITIES**
Miles Sonstegaard *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 551-558 refs

CSCL 12B

Large airships may prove feasible as carriers of commodities that move as gases or cryogenic liquids buoyant gaseous cargo could be ballasted with liquid cargo Airships are compact in shape, operate in a rarified medium, and hence can be fast and perhaps economic carriers of costly cryogenic tanks The high-pressure gas pipeline has excessive surface area when carrying hydrogen and excessive fluid density when carrying natural gas, while the cryogenic ocean tanker runs in a dense medium and makes gravity waves But the airship despite its fluid dynamic advantages faces problems of safety weather and altitude control Author

**N76-15062*** Environic Foundation International Notre Dame Ind

**ENVIRONIC IMPLICATIONS OF LIGHTER THAN AIR TRANSPORTATION**

Patrick Horsbrugh *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 563-570 refs

CSCL 12B

The advent of any new system of transportation must now be reviewed in the physical context and texture of the landscape Henceforward all transportation systems will be considered in respect of their effects upon the environment to ensure that they afford an environic asset as well as provide an economic benefit The obligations which now confront the buoyancy engineers are emphasized so that they may respond to these ethical and environic urgencies simultaneously with routine technical development Author

**N76-15063*** Naval Air Systems Command Washington D C

**AEROCRANE A HYBRID LTA AIRCRAFT FOR AERIAL CRANE APPLICATIONS**

Russel G Perkins, Jr and Donald B Doolittle (All Am Eng Co) *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 571-584 refs

CSCL 01C

The Aerocrane, a hybrid aircraft combines rotor lift with buoyant lift to offer VTOL load capability greatly in excess of helicopter technology while eliminating the airship problem of ballast transfer In addition the Aerocrane concept sharply reduces the mooring problem of airships and provides 360 deg vectorable thrust to supply a relatively large force component for control of gust loads Designed for use in short range ultra heavy lift missions, the Aerocrane operates in a performance envelope unsuitable for either helicopters or airships Basic design considerations and potential problem areas of the concept are addressed Author

**N76-15064*** Air Force Cambridge Research Labs L G Hanscom Field Mass

**UNMANNED POWERED BALLOONS**

Arthur O Korn *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 585-594 refs

CSCL 01C

In the late 1960 s several governmental agencies sponsored efforts to develop unmanned powered balloon systems for scientific experimentation and military operations Some of the programs resulted in hardware and limited flight tests others to date have not progressed beyond the paper study stage Balloon system designs, materials propulsion units and capabilities are briefly described and critical problem areas are pointed out which require further study in order to achieve operational powered balloon systems capable of long duration flight at high altitudes Author

**N76-15065*** Naval Ordnance Lab , White Oak, Md

**SPECIAL PROBLEMS AND CAPABILITIES OF HIGH ALTITUDE LIGHTER THAN AIR VEHICLES**

P R Wessel and F J Petrone *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 595-603 refs

CSCL 01C

Powered LTA vehicles have historically been limited to operations at low altitudes Conditions exist which may enable a remotely piloted unit to be operated at an altitude near 70,000 feet Such systems will be launched like high altitude balloons, operate like nonrigid airships, and have mission capabilities comparable to a low altitude stationary satellite The limited lift available and the stratospheric environment impose special requirements on power systems hull materials and payloads Potential nonmilitary uses of the vehicle include communications relay, environmental monitoring and ship traffic control Author

**N76-15066*** La Grue Volante, Chaville (France)

**A PRACTICAL CONCEPT FOR POWERED OR TETHERED WEIGHT-LIFTING LTA VEHICLES**

M Alain Balleyguier *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 605-612

CSCL 01C

A concept for a multi-hull weightlifting airship is presented The concept is based upon experience in the design and handling of gas-filled balloons for commercial purposes it was first tested in April 1972 In the flight test, two barrage balloons were joined side-by-side with an intermediate frame and launched in captive flight The success of this flight test led to plans for a development program calling for a powered, piloted prototype a follow-on 40 ton model, and a 400 ton transport model All of these airships utilize a tetrehedric three-line tethering method for loading and unloading phases of flight, which bypasses many of the difficulties inherent in the handling of a conventional airship near the ground Both initial and operating costs per ton of lift capability are significantly less for the subject design than for either helicopters or airships of conventional mono-hull design Author

**N76-15067*** Sheldahl Co , Northfield Minn Tethered Aerostat Systems

**A REVOLUTIONARY AND OPERATIONAL TETHERED AEROSTAT SYSTEM ILLUSTRATING NEW LTA TECHNOLOGY**

James A Menke *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 613-622

CSCL 01C

An operational tethered aerostat system which demonstrates utility of LTA systems, is described It was made possible by development of a reliable tethered aerostat that is used to support broadcast equipment at an altitude of 10 000 feet Two elements of the TCOM system the aerostat and mooring station are particularly relevant to the LTA Workshop They demonstrate the feasibility of using LTA vehicles in real operational all-weather applications and, in addition illustrate an advance in the overall technology base of LTA The aerostat and the mooring station, including their technical design features and demonstrated performance characteristics are described Author

**N76-15068*** Sheldahl Co Northfield, Minn Structures and Materials Engineering

**TECHNOLOGY UPDATE TETHERED AEROSTAT STRUCTURAL DESIGN AND MATERIAL DEVELOPMENTS**

Robert G Witherow *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 623-635

CSCL 01C

Requirements exist for an extremely stable high performance all-weather tethered aerostat system This requirement has been satisfied by a 250 000 cubic foot captive buoyant vehicle as demonstrated by over a year of successful field operations This achievement required significant advancements in several technology areas including composite materials design aerostatics and aerodynamics structural design, electro-mechanical design vehicle fabrication and mooring operations This paper specifically addresses the materials and structural design aspects of pressurized buoyant vehicles as related to the general class of Lighter Than Air vehicles Author

**N76-15069*** Raven Industries Inc , Sioux Falls S Dak

**TWO LIGHTER THAN AIR SYSTEMS IN OPPOSING FLIGHT REGIMES: AN UNMANNED SHORT HAUL, HEAVY LOAD TRANSPORT BALLOON AND A MANNED, LIGHT PAYLOAD AIRSHIP**

R A Pohl *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 637-650

CSCL 01C

Lighter Than Air vehicles are generally defined or categorized by the shape of the balloon payload capacity and operational flight regime Two balloon systems that are classed as being in opposite categories are described One is a cable guided, helium filled, short haul, heavy load transport Lighter Than Air system

with a natural shaped envelope The other is a manned, aerodynamic shaped airship which utilizes hot air as the buoyancy medium and is in the light payload class While the airship is in the design/fabrication phase with flight tests scheduled for the latter part of 1974, the transport balloon system has been operational for some eight years Author

**N76-15070*** Mosher Balloon Systems Inc Eugene, Ore
**BALLOON LOGGING WITH THE INVERTED SKYLINE**
C Frank Mosher *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 651-666

CSCL 01C

There is a gap in aerial logging techniques that has to be filled The need for a simple safe sizeable system has to be developed before aerial logging will become effective and accepted in the logging industry This paper presents such a system designed on simple principles with realistic cost and ecological benefits Author

**N76-15071*** Military Sealift Command Washington D C Program Development Div
**LOTS OF LTA APPLICATIONS**
Jay S Brown *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 667-677 refs

CSCL 01C

Current problems facing the logistical planner in utilizing the new ships of the modern intermodal sea transportation systems in a logistics-over-the-shore (undeveloped) environment are described Then the employment of two potential LTA vehicle systems are described and discussed as significant parts of possible solutions to this range of logistical problems Vulnerability aspects of these LTA vehicles are also briefly addressed because of their possible employment near combat areas Author

**N76-15072*** Developmental Sciences, Inc City of Industry, Calif
**REMOTELY PILOTED LTA VEHICLE FOR SURVEILLANCE**

Gerald R Seemann, Gordon L Harris, and Glen J Brown *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 679-683

CSCL 01C

Various aspects of a remotely piloted mini-LTA vehicle for surveillance monitoring and measurement for civilian and military applications are considered Applications operations and economics are discussed Author

**N76-15073*** Southern California Aviation Council Inc , Pasadena
**LTA BIBLIOGRAPHY**
Richard D Neumann *In* MIT Proc of the Interagency Workshop on Lighter than Air Vehicles Jan 1975 p 685-688 refs

CSCL 05B

This bibliography includes publications which deal with airship design, engineering stress calculations, and historical information Author

**N76-15074** Kansas Univ Lawrence
**EXPERIMENTAL INVESTIGATION OF SEPARATED FLOW FIELDS ON AN AIRFOIL AT SUBSONIC SPEEDS**
**Ph D Thesis**
Hemmige Chintamani Seetharam 1975 119 p
Avail Univ Microfilms Order No 76-1303

Detailed measurements of flow fields associated with low speed turbulent boundary layers were made for the 17% thick GA(W)-1 airfoil section The data include extensive pressure and velocity surveys of the pre- and post-separated regions on the airfoil and the associated wake The boundary layer characteristics including regions of separation of the airfoil are also presented The results indicate steep gradients of displacement thickness momentum thickness and the separation streamline from the point of separation to the trailing edge of the airfoil The tests reveal that the region of flow reversal terminates within a surprisingly short distance of less than 20% chord downstream from the trailing edge for the test range of angle of attack A physical model for the separated turbulent boundary layer flow over the airfoil is proposed Potential flow models are also proposed which may provide pressure distributions to initiate a complete potential-viscous flow computation of the separated flow over airfoils Dissert Abstr

**N76-15076** Mississippi State Univ , State College
**CALCULATION AND ANALYSIS OF THE DEVELOPMENT OF THE TURBULENT BOUNDARY LAYER ON A THICK SYMMETRICAL ROTATING BODY OF LARGE SPAN**
**Ph D Thesis**
Lawrence J Mertaugh, Jr 1975 164 p
Avail Univ Microfilms Order No 76-82

The development of the turbulent boundary layer over a rotating body such as a helicopter blade or other large aspect ratio propellers is analyzed The role of the body thickness and the location of the axis of rotation in the development of the turbulent boundary layer is considered A computer program developed to allow the needed calculations is described Verification of the capabilities of the computer program are provided by comparisons of the computed results with selected sets of experimental data The results justify the use of the computer program to analyze the turbulent boundary layer over a rotating body The computer results for rotating bodies are provided for a rotating flat plate and a rotating elliptic cylinder with a thickness ratio of 0 5 Results show that the three-dimensional effects on a rotating body are small The changes in the computed boundary layer characteristics due to changes in the location of the axis of rotation are also small All of these three-dimensional effects increase with body thickness Dissert Abstr

**N76-15077*#** Boston Univ , Mass Dept of Aerospace Engineering
**A NEW UNIFIED APPROACH TO ANALYZE WING-BODY-TAIL CONFIGURATIONS WITH CONTROL SURFACES IN STEADY, OSCILLATORY AND FULLY UNSTEADY, SUBSONIC AND SUPERSONIC FLOWS**
Kadin Tseng and Luigi Morino [1975] 30 p refs
(Grant NGR-22-004-030)
(NASA-CR-146073) Avail NTIS HC $4 00 CSCL 01A

A general formulation for the analysis of steady and unsteady, subsonic and supersonic potential aerodynamics for arbitrary complex geometries is presented The theoretical formulation, the numerical procedure and numerical results are included In particular, generalized forces for fully unsteady (complex frequency) aerodynamics for an AGARD coplanar wing-tail interfering configuration in both subsonic and supersonic flows are considered Author

**N76-15078*#** Boston Univ Mass Dept of Aerospace Engineering
**FULLY UNSTEADY SUBSONIC AND SUPERSONIC POTENTIAL AERODYNAMICS FOR COMPLEX AIRCRAFT CONFIGURATIONS WITH APPLICATIONS TO FLUTTER**
Kadin Tseng and Luigi Morino [1975] 31 p refs
(Grant NGR-22-004-030)
(NASA-CR-146067) Avail NTIS HC $4 00 CSCL 01A

A general formulation is presented for the analysis of steady and unsteady subsonic and supersonic aerodynamics for complex aircraft configurations The theoretical formulation, the numerical procedure, the description of the program SOUSSA (steady, oscillatory and unsteady, subsonic and supersonic aerodynamics) and numerical results are included In particular, generalized forces for fully unsteady (complex frequency) aerodynamics for a wing-body configuration, AGARD wing-tail interference in both subsonic and supersonic flows as well as flutter analysis results are included The theoretical formulation is based upon an integral equation which includes completely arbitrary motion Steady and oscillatory aerodynamic flows are considered Here small-amplitude fully transient response in the time domain is considered This yields the aerodynamic transfer function (Laplace transform of the fully unsteady operator) for frequency domain

analysis This is particularly convenient for the linear systems analysis of the whole aircraft Author

**N76-15080*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif

**EXPERIMENTAL AERODYNAMIC CHARACTERISTICS FOR SLENDER BODIES WITH THIN WINGS AT ANGLES OF ATTACK FROM 0 DEG TO 58 DEG AND MACH NUMBERS FROM 0.6 TO 2 0**

Leland H Jorgensen and Michael H Howell Washington Jan 1976 127 p refs

(NASA-TM-X-3309, A-6150) Avail NTIS HC $6 00 CSCL 01A

An experimental investigation was conducted in the Ames 6-by-6-Foot Wind Tunnel to measure the static aerodynamic characteristics for bodies of circular and elliptic cross section with various thin flat-plate wings, Eighteen configuration combinations were tested at Mach numbers of 0 6, 0 9, 1 2, 1 5, and 2 0 at angles of attack from 0 deg to 58 deg The data demonstrate that taper ratio and aspect ratio had only small effect on the aerodynamic characteristics, especially at the higher angles of attack Undesirable side forces and yawing moments, which developed at angles of attack greater than about 25 deg were generally no greater than those for the bodies tested alone As for the bodies alone, the side forces and yawing moments increased as the nose fineness ratio increased and/or as the subsonic Mach number decreased Author

**N76-15082*#** National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif

**ON THE FORMULATION OF THE AERODYNAMIC CHARACTERISTICS IN AIRCRAFT DYNAMICS**

Murray Tobak and Lewis B Schiff Washington Jan 1976 72 p refs Presented at lectures on Aircraft Stability and Control, Brussels, 12-16 May 1975

(NASA-TR-R-456, A-6008) Avail NTIS HC $4 50 CSCL 01A

The theory of functionals is used to reformulate the notions of aerodynamic indicial functions and superposition Integral forms for the aerodynamic response to arbitrary motions are derived that are free of dependence on a linearity assumption Simplifications of the integral forms lead to practicable nonlinear generalizations of the linear superpositions and stability derivative formulations Applied to arbitrary nonplanar motions, the generalization yields a form for the aerodynamic response that can be compounded of the contributions from a limited number of well-defined characteristic motions, in principle reproducible in the wind tunnel Further generalizations that would enable the consideration of random fluctuations and multivalued aerodynamic responses are indicated Author

**N76-15083*#** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

**A REVIEW OF THE NASA V-G/VGH GENERAL AVIATION PROGRAM**

Joseph W Jewel, Jr and Garland J Morris Washington Dec 1975 83 p refs

(NASA-TN-D-8058, L-10355) Avail NTIS HC $5 00 CSCL 01A

The V-G and VGH data collected from a wide variety of general aviation airplanes since the inception of the NASA V-G/VGH General Aviation Program in 1962 are presented These data were analyzed to obtain information on the gust and maneuver loads, on the operating practices, and on the effects of different types of operations on these parameters Author

**N76-15084*#** National Aeronautics and Space Administration Langley Research Center Langley Station, Va

**AN INVESTIGATION OF SEVERAL NACA 1-SERIES INLETS AT MACH NUMBERS FROM 0 4 TO 1 29 FOR MASS FLOW RATIOS NEAR 1 0**

Richard J Re Washington Dec 1975 110 p refs

(NASA-TM-X-3324 L-10497) Avail NTIS HC $5 50 CSCL 01A

An investigation to determine the performance of eight NACA 1-series inlets at massflow ratios near 1 0 was conducted in the Langley 16-foot transonic tunnel The inlet diameter ratios (ratio of inlet diameter to maximum diameter) were 0 85 and 0 89 for an inlet length ratio (ratio of inlet length to maximum diameter) of 1 0 Inlet lip radius varied from 0 061 cm to 0 251 cm and internal contraction area ratio (ratio of inlet area to throat area) varied from 1 006 to 1 201 Reynolds number based on model maximum diameter ranged from 3 600 000 at a Mach number of 400,000 to 5 900 000 at a Mach number of 1 29 The results indicate that nearly uniform pressure distributions on a given inlet were obtained over a limited range of mass-flow ratios and Mach numbers When inlet lip thickness was increased by means of lip radius or contraction ratio, the inlet critical Mach number decreased Drag-divergence Mach number inferred from forebody pressure integrations was above 0 94 for most of the inlets tested Author

**N76-15085*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va

**LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A DEFLECTED-THRUST PROPULSIVE-LIFT TRANSPORT MODEL**

Danny R Hoad Washington Nov 1975 185 p refs Prepared in cooperation with Army Air Mobility R and D Lab , Hampton, Va

(NASA-TM-X-3234, L-10106) Avail NTIS HC $7 50 CSCL 01A

A wind-tunnel investigation was conducted to determine the effect of deflecting the engine exit of a four-engine double-slotted flap transport to provide STOL performance Longitudinal aerodynamic data were obtained at various engine exit positions and deflections . The data were obtained at three flap deflections representing cruise take-off, and landing conditions for a range of angles of attack and various thrust coefficients Downwash angles at the location of the horizontal tail were measured The data are presented without analysis or discussion Photographs of the test configurations are shown Author

**N76-15086*#** National Aeronautics and Space Administration Langley Research Center, Langley Station Va

**LOW SPEED WIND TUNNEL INVESTIGATION OF A FOUR-ENGINE UPPER SURFACE BLOWN MODEL HAVING SWEPT WING AND RECTANGULAR AND D-SHAPED EXHAUST NOZZLES**

William C Sleeman, Jr and William C Hohlweg (George Washington Univ) Washington Dec 1975 117 p refs

(NASA-TN-D-8061 L-10173) Avail NTIS HC $5 50 CSCL 01A

A low speed investigation was conducted in the Langley V/STOL tunnel to determine the power-on static-turning and powered-lift aerodynamic performance of a four engine upper surface blown transport configuration Initial tests with a D-shaped exhaust nozzle showed relatively poor flow-turning capability, and the D-nozzles were replaced by rectangular nozzles with a width-height ratio of 6 0 The high lift system consisted of a leading edge slat and two different trailing-edge-flap configurations A double slotted flap with the gaps sealed was investigated and a simple radius flap was also tested A maximum lift coefficient of approximately 9 3 was obtained for the model with the rectangular exhaust nozzles with both the double slotted flap deflected 50 deg and the radius flap deflected 90 deg Author

**N76-15087*#** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

**LOW SPEED WIND TUNNEL INVESTIGATION OF SPAN LOAD ALTERATION, FORWARD-LOCATED SPOILERS, AND SPLINES AS TRAILING-VORTEX-HAZARD ALLEVIATION DEVICES ON A TRANSPORT AIRCRAFT MODEL**

Delwin R Croom and R Earl Dunham, Jr Washington Dec 1975 47 p refs

(NASA-TN-D-8133, L-10568) Avail NTIS HC $4 00 CSCL 01A

The effectiveness of a forward-located spoiler a spline, and span load alteration due to a flap configuration change as

trailing-vortex-hazard alleviation methods was investigated For the transport aircraft model in the normal approach configuration the results indicate that either a forward-located spoiler or a spline is effective in reducing the trailing-vortex hazard The results also indicate that large changes in span loading, due to retraction of the outboard flap, may be an effective method of reducing the trailing-vortex hazard Author

**N76-15088*#** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
**AERODYNAMIC CHARACTERISTICS OF A POWERED, EXTERNALLY BLOWN FLAP STOL TRANSPORT MODEL WITH TWO ENGINE SIMULATOR SIZES**
William G Johnson, Jr Washington Nov 1975 292 p refs (NASA-TN-D-8057 L-10129) Avail NTIS HC $9 25 CSCL 01A

The low-speed aerodynamic characteristics are investigated of a general research model - a swept-wing jet-powered STOL transport with externally blown flaps The model was tested with four-engine simulators mounted on pylons under the 9 3-percent-thick supercritical airfoil wing Two sets of air ejectors were used to provide data with large and small engines Tests were conducted in the Langley V/STOL tunnel over an angle-of-attack range of -4 deg to 22 deg and a thrust-coefficient range from 0 to approximately 4 The effects are described of power wing leading-edge slat configuration, T-tail and low horizontal-tail positions and double-slotted flap deflection Additional untrimmed and trimmed engine-out data and tail-body data are included Author

**N76-15089*#** Chrysler Corp , New Orleans La Space Div
**MATED AERODYNAMIC CHARACTERISTICS INVESTIGATION FOR 0 04-SCALE MODEL BOEING 747 CAM/EXTERNAL TANK (MODEL AX1284 E-5) COMBINATION IN THE UNIVERSITY OF WASHINGTON AERONAUTICAL LABORATORY F K KIRSTEN WIND TUNNEL (CA11)**
Nov 1975 337 p Prepared in cooperation with Boeing Co , Seattle
(Contract NAS9-13247)
(NASA-CR-141835 DMS-DR-2236) Avail NTIS HC $10 00 CSCL 01A

Experimental investigations of the aerodynamic characteristics of a 0 04-scale external tank (ET) force model in combination with a 0 04-scale Boeing 747 force model were conducted Test purposes were (1) to determine ET airloads for selected configurations and (2) to determine the effectiveness of ET position, incidence, and support structure and 747 vertical stabilizing surfaces on stability control, and performance of 747/ET combinations The 747 was tested alone to establish baseline data and to verify test results Six-component aerodynamic force and moment data were recorded for the 747 CAM and ET combination Six-component force and moment data were also recorded for the ET, which was mounted on an internal balance supported by the 747 Data were recorded for angles of attack from -4 deg to +24 deg in 2 deg increments and angles of sideslip of - deg to + or - 20 deg Testing was conducted at Mach 0 15 with dynamic pressure deg at 36 psf and unit Reynolds number of 1 3 million per foot Photographs of test configurations are shown Author

**N76-15090#** Royal Aircraft Establishment, Farnborough (England) Aerodynamics Dept
**NON-LINEAR DYNAMIC-MOTION CHARACTERISTICS OF A SERIES OF MISSILE CONFIGURATIONS FROM SIMULATED FLIGHT BEHAVIOUR AT MACH NUMBERS OF 1 6 AND 2 0**
I M Titchener London Aeron Res Council 1975 63 p refs Supersedes RAE-TR-73145 ARC-35185
(ARC-R/M-3764 RAE-TR-73145 ARC-35185) Avail NTIS HC $4 50 HMSO £3 50 PHI $13 57

Models of a series of related missile configurations representative of current trends in design of maneuverable missiles were tested in a dynamic simulator to determine the damped free oscillatory response to a range of prescribed settings of the controls Nonlinear oscillatory-motion histories measured in a wind tunnel/flight dynamics simulator are analyzed The resulting dynamic-motion characteristics for large-amplitude motions in the pitch plane are discussed in relation to the aerodynamic features of the various configurations tested, and a simple dimensionless mathematical model is specified Author (ESA)

**N76-15091#** Imperial Coll of Science and Technology, London (England)
**CALCULATIONS OF THE STEADY CONICAL FLOW PAST A YAWED SLENDER DELTA WING WITH LEADING-EDGE SEPARATION**
D I Pullin London Aeron Res Council 1975 49 p refs Supersedes ARC-33963
(ARC-R/M-3767, ARC-33963) Avail NTIS HC $4 00, HMSC £3 90, PHI $15 12

The vortex-sheet model of leading-edge separation is extended to the calculation of steady conical flow past a yawed slender delta wing Introducing yaw destroys the symmetry property inherent in the unyawed problem necessitating that the two leading-edge vortex sheets be treated as independent but mutually interacting singularity distributions in the cross-flow plane of the slender-body theory From the calculations, predictions are obtained of the variation of the principal quantitative flow characteristics - including the two primary vortex core positions and the wing rolling-moment coefficient - with the incidence and yaw parameters Comparison of these predictions with experimental data is reasonable qualitatively but only fair quantitatively the discrepancies being attributed to the neglect, in the flow model, of the effects of the secondary separation system on the windward side of the wing The range of the present calculations is to some extent limited by failure of the solution technique at lower values of the incidence parameter Author (ESA)

**N76-15092#** Royal Aircraft Establishment, Bedford (England) Aerodynamics Dept
**MEASUREMENTS OF THE THREE-DIMENSIONAL INCOMPRESSIBLE TURBULENT BOUNDARY LAYER INDUCED ON THE SURFACE OF A SLENDER DELTA WING BY THE LEADING-EDGE VORTEX**
L F East London Aeron Res Council 1975 63 p refs Supersedes RAE-TR-73141, ARC-35269
(ARC-R/M-3768 RAE-TR-73141, ARC-35269) Avail NTIS HC $4 50 HMSO £3 26 PHI $12 60

Data obtained in the three-dimensional turbulent boundary layer on the upper lifting surface of a large half-delta model at incidence are presented The flow studied approximates closely conic conditions and consequently the quantity of data required to define it is not as great as it would be in a general three-dimensional flow The flow just outside the boundary layer is shown to be in fair agreement with a published inviscid theory for conic flows about lifting bodies The boundary layer data are restricted to mean flow properties measured with conventional pitot and static probes The shear stress profiles are derived from the mean flow data by the use of the momentum equations Although of rather limited accuracy this analysis adds further support to the very limited published evidence that in general the Reynolds stress is not parallel to the velocity gradient Author (ESA)

**N76-15093#** Royal Aircraft Establishment, Bedford (England) Aerodynamics Dept
**THE APPLICATION OF A SURFACE FLOW-VISUALISATION TECHNIQUE IN FLIGHT**
P L Bisgood London Aeron Res Council 1975 21 p refs Supersedes RAE-TR-74022 ARC-35554
(ARC-R/M-3769, RAE-TR-74022, ARC-35554) Avail NTIS HC $3 50 HMSO £1 10 PHI $4 30

Some exploratory experiments on flight adaptation of the oil-flow technique of visualizing the flow, to a slender-wing research aircraft HP-115 are described The results obtained are discussed and a comparison made with wind tunnel measurements The technique yielded repeatable results which when compared with data from other sources indicated that the visualizations achieved were valid Author (ESA)

**N76-15094#** Royal Aircraft Establishment, Farnborough (England) Structures Dept

**MEASUREMENTS OF OSCILLATORY AERODYNAMIC HINGE MOMENTS FROM THE RESPONSE OF A WIND TUNNEL MODEL TO TURBULENT FLOW**

G B Hutton, D A Drane and D R Gaukroger London Aeron Res Council 1975 19 p refs Supersedes RAE-TR-73130-Rev ARC-35231

(ARC-CP-1317, RAE-TR-73130-Rev, ARC-35231) Avail NTIS HC $3 50, HMSO 50p, PHI $2 15

Control surface hinge moment derivatives were evaluated from analysis of the response of a wind tunnel model to turbulence in the tunnel flow and these were compared with derivatives obtained from steady state oscillatory measurements on the same model The comparison shows that the basic dynamic data (natural frequency and damping) obtained from both techniques are in close agreement However small differences in the data lead to rather larger differences in the value of the aerodynamic derivatives ESA

**N76-15095#** Royal Aircraft Establishment, Bedford (England) Aerodynamics Dept

**A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE EXTERNAL-FLOW, JET-AUGMENTED FLAP**

P R Ashill London Aeron Res Council 1975 52 p refs Presented at the AGARD Propulsion and Energetics Conf *Schliersee, Ger Sep 1973* Supersedes RAE-TR-74089 ARC-35650

(ARC-CP-1319, RAE-TR-74089 ARC-35650) Avail NTIS HC $4 50 HMSO £1 20, PHI $4 90

A semi-empirical method for predicting the jet deflection angle and the thrust recovery factor, i e the factor that is applied to the momentum flux leaving the exit of the engine nacelle to allow for turning and spreading losses is described The method is based on an analysis of a series of tests performed on a wing body and injector-powered nacelle under static conditions The formulae derived from the analysis are combined with a theory which is based on the jet-flap analogy, to provide estimates of the forces and moments acting on wings with external flow jet-augmented flaps in forward flight Comparisons are made between this method and wind-tunnel data obtained Author (ESA)

**N76-15099#** Association Aeronautique et Astronautique de France Paris

**PERFORMANCE OPTIMIZATION AND AERODYNAMICS OF PROPULSIVE AND SUSTAINING SYSTEMS IN CYCLIC MODE [AERODYNAMIQUE DES SYSTEMES PORTANTS ET PROPULSIFS EN REGIME DE FONCTIONNEMENT PERIODIQUE OPTIMISATION DE LEURS PERFORMANCES]**

G Coulmy T S Luu, and L Malavard 1975 76 p refs In FRENCH

(AAAF-NT-75-5 ISBN-2-7170-0323-1) Avail NTIS HC $5 00 CEDOCAR, Paris FF 25 (France and EEC) FF 29 (others)

A unified theory of propulsive/sustaining systems is presented using the vorticity theory for sustentating surfaces under unsteady flow Optimum functioning was found to correspond to a Newmann type boundary condition for velocity potential both in stationary and unsteady flight The numerical method used takes advantage of discretized distribution of singularities from which performance and yield indices are derived The inverse problem of the deformation to be given to the surface in order that the required law be satisfied was carried out by the singularity method Applications to lifting rotors, oscillatory wings and rotary wings were investigated ESA

**N76-15102#** Avions Marcel Dassault-Breguet Aviation Saint-Cloud (France)

**TRIDIMENSIONAL LINEARIZED SUPERSONIC FLOW COMPUTATIONS [CALCULS D'ECOULEMENTS TRIDIMENSIONNELS EN SUPERSONIQUE LINEARISE]**

P Schein Paris Assoc Aeron et Astronautique de France 1975 51 p refs In FRENCH

(AAAF-NT-75-17, ISBN-2-7170-0335-5) Avail NTIS HC $4 50, CEDOCAR, Paris FF 25 (France and EEC) FF 29 (others)

The method of finite differences is applied to tridimensional linearized supersonic flow computations for the case of fuselage-engine integration at air inlet distortion level The basic equations approximation, and linearization procedures are reviewed The discretization process, boundary conditions and stability conditions are detailed, and the computation flow diagram is outlined Results are compared with actual experiments ESA

**N76-15103#** Societe Nationale Industrielle Aerospatiale, Paris (France)

**ROTOR AERODYNAMICS WAKE EQUILIBRATING [AERODYNAMIQUE DES ROTORS MISE EN EQUILIBRE DU SILLAGE]**

B Courjaret Assoc Aeron et Astronautique de France 1975 27 p refs In FRENCH Presented at the 11th Assoc Aeron et Astronautique de France Colloq d-Aerodyn Appl, Boreaux 6-8 Nov 1974 Sponsored by Direc de Rech des Moyens d'Essais

(AAAF-NT-75-18, ISBN-2-7170-0336-3) Avail NTIS HC $4 00, CEDOCAR, Paris FF 15 (France and EEC) FF 19 (others)

The equilibrium of a turbulent wake for a rotor in axial translational motion was used to obtain a better theoretical prevision of the local working point incidences The advantages of the method are shown to increase with specific rotor loading corresponding to a significant shrinkage of the turbulent zone The solution of the integral equations is outlined and the results give the wake shape, and the velocity distribution along the rotor blade ESA

**N76-15104#** Societe Nationale Industrielle Aerospatiale, Paris (France)

**ON THE COMPUTATION OF TWO-DIMENSIONAL TRANSONIC FLOW WITH BOUNDARY LAYER [CALCULS BIDIMENSIONNELS TRANSSONIQUES AVEC COUCHE LIMITE]**

J Bousquet Assoc Aeron et Astronautique de France 1975 34 p refs In FRENCH

(AAAF-NT-75-20, ISBN-2-7170-0340-1) Avail NTIS HC $4 00 CEDOCAR, Paris FF 25 (France and EEC) FF 29 (others)

To solve the discrepancy between the results from perfect fluid transonic computations and experiments relating to pressure distribution in shock presence, a method taking into account the viscous effects in the computation of two-dimensional transonic flow with boundary layer was developed The Garabedian-Korn perfect fluid method is presented and its validity limits in the presence of shocks are discussed The influence of viscosity on the shock intensity as well as on the boundary layer displacement was investigated theoretically and applied to transonic flow over lifting airfoils The reliability of this computation method is emphasized and its integration into a supercritical wing computerized simulation line is presented ESA

**N76-15106#** Aeronautical Research Inst of Sweden Stockholm Aerodynamics Dept

**A WIND TUNNEL TEST OF SYMMETRIC LOADS ON TWO WING-BODY COMBINATIONS AT MACH NUMBERS 4 AND 7 Final Report**

Erik Larson 1975 65 p refs

(Contract INK-11-12-73197)

(FFA-TN-AU-636) Avail NTIS HC $4 50

The forces in the symmetry plane on two wingbody combinations and on the body alone were measured at low angles of attack by a watercooled balance at Mach numbers 4 and 7 An attempt was made to inspect and overcome some of the difficulties in predicting component loads on wing-body combinations by short-cut methods at small to medium high angles of attack, less than 15 deg The usefulness of the slender body theory together with the cross flow and Newtonian theory in the preparation of this kind of short-cut method is however perhaps not yet fully exploited Author (ESA)

**N76-15108#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany) Inst fuer

Aeroelastik

**WIND TUNNEL TEST TECHNIQUES FOR THE MEASUREMENT OF UNSTEADY AIRLOADS ON OSCILLATING LIFTING SYSTEMS AND FULL-SPAN MODELS**

Hans Foersching 30 Jul 1975 53 p refs Presented at the Discussion on Unsteady Aerodyn at the AGARD Fluid Dyn Panel Meeting Goettingen West Ger, 27-30 May 1975

(DLR-FB-75-51) Avail NTIS HC $4 50, DFVLR Cologne DM 25

Wind tunnel test techniques for the measurement of unsteady airloads on oscillating lifting systems and full-span models are briefly discussed The basic principles of measurement, general guidelines of model design and test instrumentation, and other important features for the measurement of dynamic stability derivatives flutter coefficients and unsteady pressure distributions are described and illustrated with some typical test results

Author (ESA)

**N76-15109#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Abteilung Rettungs- und Bergungssysteme

**THEORETICAL INVESTIGATION OF THE FILLING PROCESS OF A FLEXIBLE PARACHUTE-PAYLOAD SYSTEM Ph.D Thesis - Tech Univ Brunswick**

Kuang-Hua Fu Aug 1975 123 p refs In GERMAN ENGLISH summary

(DLR-FB-75-56) Avail NTIS HC $5 50, DFVLR Cologne DM 51 20

The behavior of a flexible parachute-payload system during the filling process and the following transition to a quasi-steady state was investigated for plane motion A method was developed with which the parachute performance data (opening shock force, filling time, and speed of payload at the completion of filling) can be calculated for optional system parameter values and initial values Further the influence was investigated of modeling and geometric parameters as well as that of the initial values on the parachute performance data It is shown that the load factor first increases with increasing mass ratio attains a maximum and then decreases The load factor increases linearly with increasing Froude number, the amount of increase depends on the mass ratio Author (ESA)

**N76-15110#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany) Inst fuer Aeroelastik

**UNSTEADY PRESSURES ON A HARMONICALLY OSCILLATING, STAGGERED CASCADE PART 1. INCOMPRESSIBLE FLOW**

Hermann Triebstein Volker Carstens, and Joachim Wagener 1 Sep 1975 70 p refs In GERMAN, ENGLISH summary Report will also be announced as translation 2 Vol

(DLR-FB-75-57-Pt-1) Avail NTIS HC $4 50 DFVLR, Cologne DM 32 70

Measurements of unsteady airloads on harmonically oscillating cascade airfoils are discussed Special emphasis is given to the test technique and the test set-up The measurements were performed in the cascade-windtunnel of the DFVLR-AVA at Goettingen on a plate-like staggered cascade consisting of seven plates at harmonically pitching oscillations about two different pitching axes, and at flapping oscillations of both the whole cascade and one flat plate only The measurements were performed at zero angle of attack, at a stagger angle of 60 deg, and at a Mach number of 0 2, the oscillation frequencies were 10 30 and 70 cps thus yielding reduced frequencies from 0 04 to 0 26 and a Reynolds number of 340 000 Some of the test results were critically compared with corresponding theoretical results For part 2, see N76-15111 Author (ESA)

**N76-15111#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany) Inst fuer Aeroelastik

**UNSTEADY PRESSURES ON A HARMONICALLY OSCILLATING, STAGGERED CASCADE PART 2 COMPRESSIBLE FLOW**

Hermann Triebstein Volker Carstens, and Joachim Wagener 30 Jul 1975 90 p refs In GERMAN ENGLISH summary Report will also be announced as translation 2 Vol

(DLR-FB-75-58-Pt-2) Avail NTIS HC $5 00 DFVLR Cologne DM 41 60

Measurements of unsteady airloads on harmonically oscillating cascade airfoils are discussed Special emphasis is given to the test technique and the test set-up The measurements were performed in the cascade-windtunnel of the DFVLR-AVA at Goettingen on a plate-like staggered cascade consisting of seven plates at harmonically pitching oscillations about two different pitching axes, and at flapping oscillations of both the whole cascade and one flat plate only The measurements were performed at zero angle of attack at a stagger angle of 60 deg and at Mach numbers 0 4 and 0 6 the oscillation frequencies were 10 30 and 70 cps thus yielding frequencies of 0 012 to 0 126 and Reynolds numbers 720 000 and 1,080,000 Some of the test results were critically compared with corresponding theoretical results Author (ESA)

**N76-15117#** Aerospace Research Labs, Wright-Patterson AFB Ohio

**SEPARATION AHEAD OF CONTROLS ON SWEPT WINGS Interim Report, Apr 1973 - Apr 1975**

Louis G Kaufman II and L Michael Freeman Jun 1975 53 p refs

(AF Proj 7064)

(AD-A014240 ARL-75-0134) Avail NTIS CSCL 01/3

Shock-induced flow-separation ahead of trailing edge controls on swept wings is investigated with emphasis on the effects of boundary layer transition on the location and shape of the separation line Experimental results were obtained by using forward facing steps mounted on swept-leading-edge flat-plate wing models in the ARL Mach 6 Tunnel for model running length Reynolds numbers varying from 0 9 to 33 million The data support qualitatively a proposed strip-type method for estimating, the extent and shape of the three dimensional region of separated flow ahead of controls on swept wings

Author (GRA)

**N76-15118#** Air Force Systems Command Wright-Patterson AFB Ohio Foreign Technology Div

**SOVIET NUCLEAR BLIMPS**

31 Jul 1975 7 p Transl into ENGLISH from Aeronautica (Italy), v 19, no 9 15 Mar 1974 p 3

(AD-A014310 FTD-ID(RS)I-1637-75) Avail NTIS CSCL 01/3

Reports concerning a Soviet atomic propelled blimp are briefly discussed The blimp is capable of carrying 1800 passengers at a cruising speed of 300 km Author

**N76-15119#** Air Force Systems Command, Wright-Patterson AFB Ohio Foreign Technology Div

**SOME AERODYNAMIC PROBLEMS RAISED BY THE AIRSHIP**

Louis Cabot 22 Jul 1975 26 p Transl into ENGLISH from Off Nat Etud Rech Aerosp Note Tech (Chatillon), no 1312, 1973 p 1-15

(AD-A014401, FTD-ID(RS)I-1618-75) Avail NTIS CSCL 01/1

After recalling the aerodynamic peculiarities of the free and the tethered balloon, the paper gives a survey of the airship aerodynamic characteristics, as recorded on old machines (especially the Akron), in wind tunnel and in flight The unstable nature of the airframes is emphasized as well as the associated piloting problem GRA

**N76-15122#** National Aviation Facilities Experimental Center, Atlantic City, N J

**CHARACTERISTICS OF HALON 1301 DISPENSING SYSTEMS FOR AIRCRAFT CABIN FIRE PROTECTION Final Report, Jan - Nov 1973**

Constantine P Sarkos Sep 1975 126 p refs

(FAA Proj 181-521-020)

(AD-A017061/3, FAA-NA-74-59, FAA-RD-75-105) Avail NTIS HC $5 50 CSCL 01/3

The two Halon 1301 dispensing systems, modular nozzle and perforated tube were designed and installed in an obsolete but completely furnished CD7 passenger cabin For each system agent distribution was continuously measured during discharge and for a period of 10 minutes at approximately 20 locations throughout the unpressurized cabin The effect of Halon 1301 discharge on cabin temperature noise pressure, and visibility was also measured The modular system was judged to be best by virture of its producing more rapid and effective agent distribution resulting in greater potential fire-protection capability Installation of the Halon 1301 dispensers along the ceiling for both systems minimized the known possible transient adverse effects upon passengers from agent concentration overshoot discharge noise overpressure and reduced temperature Halon 1301 was found to rapidly permeate all cabin airspaces including those shielded from the discharge streamlines The effect of agent leakage through opened emergency exits was investigated It was determined that even under such unfavorable conditions of operation a high-rate discharge system would provide a reasonably good degree of inerting protection over a representative evacuation period Author

**N76-15123#** Army Mobility Equipment Research and Development Center, Fort Belvoir, Va

**GENERIC AIRBORNE FIRE SUPPRESSION SYSTEM Final Technical Report, Dec 1970 - Jun 1973**

William J McNamara Wright-Patterson AFB Ohio DOD Aircraft Ground Fire Suppression and Rescue Office May 1975 70 p (AD-A014226, DOD-AGFSRS-75-2) Avail NTIS CSCL 13/12

This report describes the development design fabrication, installation and testing of a generic airborne fire suppression system This was an experimental device specifically designed to permit inflight operation for testing and evaluation of suppressing and/or extinguishing aircraft crash ground fires from a hovering UH-1H helicopter GRA

**N76-15124#** National Transportation Safety Board Washington D C Bureau of Aviation Safety

**AIRCRAFT ACCIDENT/INCIDENT REPORTS BRIEF FORMAT, SUPPLEMENTAL ISSUE 1974**

27 Jun 1975 124 p

(PB-244115/2 NTSB-BA-75-3) Avail NTIS HC $5 50 CSCL 01B

Reports are given of aircraft accidents and incidents that occurred in 1974 and have not been included in a prior issue of briefs Included are three U S air carrier accidents, 28 U S air carrier incidents, 99 U S general aviation accidents and 38 U S general aviation incidents Four foreign air carrier accidents, one foreign air carrier incident and 12 foreign general aviation accidents that were investigated by the National Transportation Safety Board are also included GRA

**N76-15125#** Dayton Univ Research Inst , Ohio

**AIRFIELD PARAMETER STUDY AND CATEGORIZATION SYSTEM RELATED TO AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE Final Report**

David J Iden and Jerry B Reeves Jun 1975 125 p refs (Contract F33657-72-C-0491)

(AD-A014225, DOD-AGFSRS-75-1) Avail NTIS CSCL 13/12

This report presents a discussion of the characteristics of airfields/helicopter pads which are related to the aircraft ground fire suppression and rescue (AGFSR) operation at DoD installations The basic elements of the AGFSR system are described and a plan for rating airfields/helicopter pads according to their AGFSR needs is presented The principal factor in the system is the maximum representative fuel fire area which is a direct function of aircraft fuel capacity GRA

**N76-15126#** Naval Aerospace Medical Research Lab Pensacola, Fla

**ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1971 RELATIVE INCIDENCE AND COST**

W Carroll Hixson and Emil Spezia 11 Jun 1975 36 p refs Sponsored in part by Army Aeromedical Res Lab , Fort Rucker Ala

(MF51524005)

(AD-A014423 NAMRL-1218 USAARL-75-21) Avail NTIS CSCL 01/2

The report is the fifth in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in Regular Army UH-1 helicopter operations Incidence and cost data presented for fiscal year 1971 include a total of 31 major and minor orientation-error accidents (15 of which were fatal), resulting in 44 fatalities, 52 nonfatal injuries, and a total UH-1 aircraft damage cost of $6 337,446 GRA

**N76-15127#** Payne, Inc Annapolis, Md

**EXTENDED MEASUREMENTS OF AERODYNAMIC STABILITY AND LIMB DISLODGEMENT FORCES WITH THE ACES-2 EJECTION SEAT Final Report, 1 Nov 1973 - 31 Jan 1975**

Fred W Hawker and Anthony J Euler Wright-Patterson AFB Ohio AMRL Jul 1975 95 p refs

(Contract F33615-74-C-4015 AF Proj 7231)

(AD-A014432, Working-Paper-119-11 AMRL-TR-75-15) Avail NTIS CSCL 01/3

The ACES-2 seat was mounted in a wind tunnel in various attitudes of pitch and yaw The hand and foot rests were equipped with means to measure limb dislodgement forces Overall forces and moments were measured at the seat mount Human subjects were used as seat occupants for gross force and moment data on the seat/occupant combination as well as limb dislodgement force measurements Anthropomorphic dummies were used for an extended range of yaw angles around to 180 degrees Only gross force and moment data for the seat/occupant combination were taken with the dummy subjects The limb dislodgement results are complementary to earlier tests at low pitch angles and show general reductions in magnitude as the pitch angle is increased GRA

**N76-15128#** National Transportation Safety Board Washington, D C Bureau of Aviation Safety

**LISTING OF AIRCRAFT ACCIDENTS/INCIDENTS BY MAKE AND MODEL. US CIVIL AVIATION 1973**

18 Jun 1975 178 p

(PB-244520/3 NTSB-AMM-75-1) Avail NTIS HC $7 50 CSCL 01B

The publication contains a listing of all U S civil aviation accidents/incidents occurring in CY 1973 sorted by aircraft make and model Included are the file number aircraft registration number date and location of the accident aircraft make and model and injury index for all 4,405 accidents/incidents occurring in this period GRA

**N76-15129#** National Transportation Safety Board Washington, D C Bureau of Aviation Safety

**BRIEFS OF ACCIDENTS INVOLVING MIDAIR COLLISIONS US GENERAL AVIATION 1973**

18 Jun 1975 43 p

(PB-244521/1 NTSB-AMM-75-2) Avail NTIS HC $4 00 CSCL 01B

Included are 24 accident files 12 of which involve fatal accidents The brief format presents the facts, conditions, circumstances and probable cause(s) for each accident Additional statistical information is tabulated by kind of flying phase of operation injury index aircraft damage pilot certificate, injuries and causal factor(s) GRA

**N76-15130#** National Transportation Safety Board Washington D C Bureau of Aviation Safety

**BRIEFS OF ACCIDENTS INVOLVING TURBINE POWERED AIRCRAFT US GENERAL AVIATION 1973**

18 Jun 1975 74 p

(PB-244522/9 NTSB-AMM-75-3) Avail NTIS HC $4 50 CSCL 01B

Included are 102 accident briefs 24 of which involve fatal accidents The brief format presents the facts conditions

circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation injury index, aircraft damage pilot certificate injuries and cause/factor(s) GRA

**N76-15131#** National Transportation Safety Board Washington, D C Bureau of Aviation Safety
**BRIEFS OF ACCIDENTS INVOLVING ROTORCRAFT US GENERAL AVIATION 1973**
18 Jun 1975 150 p
(PB-244523/7, NTSB-AMM-75-4) Avail NTIS CSCL 01B

Reports of U S General Aviation Rotorcraft accidents occurring in 1973 are presented Included are 277 accident briefs 28 of which involve fatal accidents The brief format presents the facts conditions circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident phase of operation, injury index, aircraft damage, pilot certificate injuries and causal factor(s) GRA

**N76-15132#** National Transportation Safety Board Washington D C Bureau of Aviation Safety
**BRIEFS OF FATAL ACCIDENTS INVOLVING WEATHER AS A CAUSE/FACTOR US GENERAL AVIATION 1973**
18 Jun 1975 275 p
(PB-244524/5, NTSB-AMM-75-5) Avail NTIS HC $9 00 CSCL 01B

The publication contains reports of all fatal U S general aviation accidents involving weather as a cause/factor for the year 1973 Included are 272 fatal accidents in the brief format This format presents the facts conditions, circumstances and probable cause(s) for each accident Additional statistical information is tabulated on all accidents involving weather as a cause/factor by the type of accident phase of operation, injury index, aircraft damage, pilot s certificate injuries and cause/factor(s) GRA

**N76-15133#** National Transportation Safety Board, Washington, D C Bureau of Aviation Safety
**BRIEFS OF ACCIDENTS INVOLVING ALCOHOL AS A CAUSE/FACTOR US GENERAL AVIATION 1973**
18 Jun 1975 34 p
(PB-244525/2 NTSB-AMM-75-6) Avail NTIS HC $4 00 CSCL 01B

General Aviation accidents occurring in 1973 involving alcohol impairment as a cause/factor are reported The brief format presents the facts conditions circumstances and probable cause(s)/factor(s) for each accident Additional statistical information is tabulated by type of accident phase of operation injury index, aircraft damage, pilot certificate injuries and causal factor(s) GRA

**N76-15134#** National Transportation Safety Board, Washington, D C Bureau of Aviation Safety
**BRIEFS OF ACCIDENTS INVOLVING MISSING AND MISSING LATER RECOVERED AIRCRAFT US GENERAL AVIATION 1973**
18 Jun 1975 95 p
(PB-244526/0 NTSB-AMM-75-7) Avail NTIS HC $5 00 CSCL 01B

General aviation missing and missing later recovered accidents occurring in 1973 are reported The brief format presents the facts, conditions, circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident phase of operation injury index aircraft damage, pilot certificate, injuries and causal factor(s) GRA

**N76-15135#** National Transportation Safety Board Washington D C
**BRIEFS OF ACCIDENTS INVOLVING CORPORATE/EXECUTIVE AIRCRAFT US GENERAL AVIATION 1973**
18 Jun 1975 69 p
(PB-244527/8, NTSB-AMM-75-8) Avail NTIS HC $4 50 CSCL 01B

Reports of U S general aviation corporate/executive aircraft accidents occurring in 1973 are reported Included are 94 accident Briefs 24 of which involve fatal accidents The brief format presents the facts conditions circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident phase of operation, injuries and causal/factor(s) GRA

**N76-15136#** National Transportation Safety Board Washington, D C Bureau of Aviation Safety
**BRIEFS OF ACCIDENTS INVOLVING AMATEUR/HOME BUILT AIRCRAFT US GENERAL AVIATION 1973**
18 Jun 1975 71 p
(PB-244528/6, NTSB-AMM-75-9) Avail NTIS HC $4 50 CSCL 01B

The publication contains reports of U S general aviation accidents involving amateur/home built aircraft occurring in 1973 Included are 116 accident Briefs, 30 of which involve fatal accidents The brief format presents the facts, conditions, circumstances and probable cause(s)/factors(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation, injury index, aircraft damage, pilot certificate, injuries and causal/factor(s) GRA

**N76-15137#** National Transportation Safety Board, Washington, D C Bureau of Aviation Safety
**BRIEFS OF ACCIDENTS INVOLVING AIR TAXI OPERATIONS US GENERAL AVIATION 1973**
18 Jun 1975 114 p
(PB-244529/4, NTSB-AMM-75-10) Avail NTIS HC $5 50 CSCL 01B

General aviation air taxi accidents occurring in 1973 are reported The brief format presents the facts, conditions, circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident phase of operation injury index aircraft damage, pilot certificate, injuries and causal/factors(s) GRA

**N76-15138#** National Transportation Safety Board Washington D C Bureau of Aviation Safety
**BRIEFS OF ACCIDENTS INVOLVING AERIAL APPLICATION OPERATIONS US GENERAL AVIATION 1973**
18 Jun 1975 266 p
(PB-244530/2 NTSB-AMM-75-11) Avail NTIS HC $9 00 CSCL 01B

General aviation aerial application accidents occurring in 1973 The brief format presents the facts conditions circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation, injury index aircraft damage, pilot certificate injuries and causal/factor(s) GRA

**N76-15145#** Air Force Flight Dynamics Lab , Wright-Patterson AFB, Ohio
**THE EFFECTS OF STABILITY AUGMENTATION ON THE GUST RESPONSE OF A STOL AIRCRAFT DURING A CURVED MANUAL APPROACH Ph D Thesis Final Report, Jun 1971 - May 1975**
Milton B Porter Jun 1975 228 p refs
(AF Proj 8219, AF Proj 1986)
(AD-A014301, AFFDL-TR-75-63) Avail NTIS CSCL 20/4

The multiple precision approach paths which are possible with microwave landing systems pose new lateral separation problems for the simultaneous optimum curved approach trajectories Separation criteria for these new multiple paths will be influenced by aircraft path tracking performance Manually piloted STOL aircraft will be particularly sensitive to atmospheric turbulence during precision tracking In this study a parametric variation of the open loop poles of a STOL aircraft was made using stability augmentation system (SAS) gains, and the gust response of the manually piloted aircraft was analyzed at points on an MLS approach path The study was reduced to two quadratic optimal control problems for linear infinite time stochastic systems (1) to compute the SAS gains using a rate-model-in-the-performance-index pole placement algorithm, and (2) to calculate the pilot gains and system gust response using a quadratic optimal pilot model Both the SAS and pilot gains calculation yielded reasonable low gains for all cases and the four lateral-directional

poles and the longitudinal short period poles could be placed accurately The most significant improvement in lateral error was achieved by increasing roll stability The variation in lateral path error with bank angle was also significant and the nature of the variation was strongly influenced by the specific augmented poles There was a conflict between good conventional flying qualities and optimum gust response since increased dutch roll frequency yielded the greatest reduction in the objectionable lateral and directional mode cross coupling while increasing the lateral gust response error GRA

**N76-15146#** Advisory Group for Aerospace Research and Development Paris (France)
**HANDLING QUALITIES SPECIFICATION DEFICIENCIES**
A G Barnes Nov 1975 23 p refs
(AGARD-AR-89) Avail NTIS HC $3 50

A summary is presented on the contributions received from NATO nations on the deficiencies of six different handling qualities specifications They are Mil-H-8501 Mil-F-8785-B, TSS-3, Mil-F-83300 AR 577, AvP 970 The purpose was to determine those portions of the various handling qualities specifications which were inadequate or overly restrictive The result shows that there were not a great many severe deficiencies and those that were found were not entirely unexpected The collected comments illustrate the difficulty of collecting information from design or certification authorities which quantifies flying qualities Difficulties arise because the information needed to compare an early aircraft design with a current specification is often not available, also there is a reluctance to publicize information which might show a particular aircraft in a bad light The need for further research is shown Author

**N76-15147#** Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France)
**COMPARISON OF WIND TUNNEL TESTS AND FLIGHT TESTS OF AN EXECUTIVE AIRCRAFT [COMPARAISON DES ESSAIS EN SOUFFLERIE ET DES ESSAIS EN VOL POUR UN AVION EXECUTIVE]**
J Maestrati Paris Assoc Aeron et Astronautique de France 1975 24 p In FRENCH
(AAAF-NT-75-14, ISBN-2-7170-0332-0) Avail NTIS HC $3 50 CEDOCAR, Paris FF 15 (France and EEC) FF 19 (others)

Wind tunnel tests and flight tests of the Falcon business aircraft were compared The direct method involves comparing the unitary curves obtained from the two tests, whereas the indirect method consists of establishing from the wind tunnel tests a basic set of adjusted parameters which are converted into the same time based parameters recorded on flight test tapes, using flight mechanic equations and a simulation program The comparison of the two methods is presented and the results of longitudinal and lateral tests are discussed ESA

**N76-15148#** Institute for Defense Analyses, Arlington Va Program Analysis Div
**CHANGES IN HELICOPTER RELIABILITY/ MAINTAINABILITY CHARACTERISTICS OVER TIME VOLUME 1 BASIC REPORT Final Report**
Norman J Asher, John Donelson, and Gerald F Higgins Mar 1975 307 p refs 2 Vol
(Contract DAHC15-73-C-0200)
(AD-A014469, S-451-Vol-1, IDA/HQ-75-17098-Vol-1) Avail NTIS CSCL 01/3

This two volume report examines the growth (or lack of it) in reliability and maintainability (R and M) characteristics of past helicopter programs and organizes the data so that they can be used as bases for predicting the R and M characteristics of future helicopter programs Six types of R and M data are presented (1) failure rates, (2) component-removal rates, (3) mishap rates, (4) maintenance-action rates, (5) operational availability and (6) maintenance man-hours Volume one also contains much data on past helicopter programs so that they will be available for use by analysts GRA

**N76-15149#** Institute for Defense Analyses, Arlington, Va Program Analysis Div
**CHANGES IN HELICOPTER RELIABILITY/ MAINTAINABILITY CHARACTERISTICS OVER TIME VOLUME 2 DATA SUBMITTED BY HELICOPTER MANUFACTURERS Final Report**
Norman J Asher John Donelson and Gerald F Higgins Mar 1975 323 p 2 Vol
(Contract DAHC15-73-C-0200)
(AD-A014470 S-451-Vol-2 IDA/HQ-75-17099-Vol-2) Avail NTIS CSCL 01/3

The second volume of a two-volume report on helicopter performance and maintenance contains data from three aircraft manufacturers on reliability and maintainability (R and M) Much of the information is in graphic and tabular form Monthly and summary statistics are given directed toward predicting the R and M characteristics of future helicopter programs GRA

**N76-15150#** Marine Corps Washington, D C
**DA APPROVED SMALL DEVELOPMENT REQUIREMENT FOR A FAMILY OF EXTERNAL HELICOPTER SLINGS, 5,000 TO 60,000 POUND CAPACITY**
25 Jul 1975 18 p
(AD-A014430, MCO-3900 4A) Avail NTIS CSCL 01/3

The report describes the requirements, purpose and operational characteristics of a helicopter sling GRA

**N76-15151#** Air Force Systems Command Wright-Patterson AFB, Ohio Foreign Technology Div
**FATIGUE AND AIRPLANES**
Bu Chen 24 Jul 1975 16 p Transl into ENGLISH from Hang Kung Chih Shih (Chinese People s Republic) no 5, 1974 p 12-15
(AD-A014308, FTD-ID(RS)I-1602-75) Avail NTIS CSCL 01/3

Fatigue failure due to cyclic loads is discussed in terms of crack propagation Preventive measures by aircraft design, and fatigue tests are described F O S

**N76-15152#** Air Force Systems Command Wright-Patterson AFB, Ohio Foreign Technology Div
**MONOGRAPHY**
Jiri Moravec 22 Jul 1975 34 p Transl into ENGLISH from Letectvi-Kosmonautika (Czechoslovakia) no 22, 1974 p 24/864-30/870
(AD-A014304, FTD-ID(RS)I-1518-75) Avail NTIS CSCL 01/3

The translation gives a brief technical description with a few drawings and operational data of the Russian MIG-17 aircraft GRA

**N76-15153#** Naval Ship Research and Development Center Bethesda Md Aviation and Surface Effects Dept
**THE DEVELOPMENT OF A TWO-DIMENSIONAL, HIGH ENDURANCE AIRFOIL WITH GIVEN THICKNESS DISTRIBUTION AND REYNOLDS NUMBER Final Report**
George S Pick and Douglas A Lien Jun 1975 58 p refs (WF32421212)
(AD-A014126 ASED-1208, NSRDC-4670) Avail NTIS CSCL 01/3

A design procedure has been developed that permits a high-endurance airfoil shape to be determined for a given initial thickness distribution and chord length Reynolds number The Strand method, which is based on the Stratford theory of incipient separation and the optimization principle of the calculus of variations, was utilized to yield an optimized velocity distribution Upper surface lift was maximized by the resultant distribution however, the total lift was not maximized because of restrictions on the thickness distribution A generalized parametric study of the upper surface velocity lift and drag characteristics for various flow conditions resulted in a series of preliminary design curves These were used to select appropriate design lift coefficients and L/D ratios for further study After the basic performance characteristics had been selected a linear theory was used to determine the camber distribution of the airfoil The velocity distribution that corresponded to the initial thickness and camber

distribution obtained from the linear theory was then utilized as the initial input to a fully nonlinear theory (the James airfoil design method) to determine the final airfoil shape Several iterations of the input were designed to determine the final airfoil shape Several iterations of the input were necessary to obtain an output velocity distribution that was close to the desired one The Von Doenhoff separation criterion was applied to the lower surface to determine whether separation would occur at the design condition Computations showed that the flow was fully attached GRA

**N76-15154#** Grumman Aerospace Corp Bethpage N Y
**MANUFACTURING OF TITANIUM AIRFRAME COMPONENTS BY HOT ISOSTATIC PRESSING Final Report, Apr 1974 - Apr 1975**
Robert H Witt and Joel Magnuson Apr 1975 98 p refs
(Contract N00019-74-C-0301 AF Proj D828)
(AD-A014130) Avail NTIS CSCL 01/3

This program has demonstrated the feasibility of producing titanium airframe components by hot isostatic pressing (HIP) of titanium alloy powder Task 1 culminated in the manufacture of an F-14A fuselage brace to near net shape with critical dimensions within the print tolerance In addition, Task 2 demonstrated that aerospace design requirements could be met by Ti-6Al-6V-2Sn and Ti-6Al-4V as produced by HIP Tensile, fatigue and toughness data are presented which show that annealed plate properties can be attained or exceeded Excellent fracture toughness ($K_{1c}$) was obtained for Ti-6-6-2 Recommendations are presented for the manufacture of a pilot lot as the continuation of the present effort Author (GRA)

**N76-15155#** McDonnell Aircraft Co , St Louis Mo
**HIGH ACCELERATION COCKPIT CONTROLLER LOCATIONS VOLUME 1 PROGRAM SUMMARY Final Technical Report, Jun - Dec 1974**
R E Mattes and C F Asiala May 1975 165 p refs 3 Vol
(Contract F33615-74-C-3093 AF Proj 6190)
(AD-A014810 MDC-A2960-Vol-1 AFFDL-TR-75-58-Vol-1)
Avail NTIS CSCL 01/3

A controller-throttle design integration program was conducted for an advanced fighter concept with direct lift, direct side force and high acceleration maneuvering capabilities Several controller-throttle configuration design alternatives were evaluated in a high acceleration cockpit mock-up by USAF pilots in a static simulation evaluation phase Cockpit and controller functional capabilities were tailored to satisfy operational needs for normal flight and combat phases and were evaluated within the context of a fighter mission Objective and subjective data including reach and vision envelopes, task performance times, and pilot preferences from paired comparison and interview questionnaires were utilized to rank the configurations evaluated Several principal areas for future high acceleration cockpit development were defined Author (GRA)

**N76-15156#** McDonnell Aircraft Co St Louis Mo
**HIGH ACCELERATION COCKPIT CONTROLLER LOCATIONS VOLUME 2 TEST PLAN Final Technical Report, Jun - Dec 1974**
C F Asiala and S L Loy May 1975 80 p refs 3 Vol
(Contract F33615-74-C-3093 AF Proj 6190)
(AD-A014811, MDC-A2960-Vol-2 AFFDL-TR-75-58-Vol-2)
Avail NTIS CSCL 01/3

A high acceleration cockpit/controller design and integration program was conducted using a full scale design aid Alternate cockpit/controller configurations were developed for comparison using this full scale design aid in a formally structured evaluation including mission related task elements Crew station and controller characteristics were thus related to operator needs in a mission context for advanced fighter concepts Author (GRA)

**N76-15157#** McDonnell Aircraft Co St Louis Mo
**HIGH ACCELERATION COCKPIT CONTROLLER LOCATIONS VOLUME 3 ONSITE PILOT EVALUATIONS Final Technical Report, Jun - Dec 1974**
R E Mattes and C F Asiala May 1975 45 p ref 3 Vol
(Contract F33615-74-C-3093, AF Proj 6190)
(AD-A014812, MDC-A2960-Vol-3, AFFDL-TR-75-58 Vol-3)
Avail NTIS CSCL 01/3

A high acceleration cockpit evaluation program was conducted for an advanced fighter concept Program effort included evaluations within the context of a mission scenario by a total of 40 operational pilots in a static design aid Various specific areas of the concept were evaluated as well as the overall need/utility of the crew station Result allowed identification of those areas where future research and development effort should be focused GRA

**N76-15164#** Societe Nationale Industrielle Aerospatiale Toulouse (France) Dept Aerodynamique Experimentale
**INTERACTION OF GE CF6-50 JET REACTORS WITH THE AIRBUS BODY DURING CRUISING FLIGHT WIND TUNNEL SIMULATION [INTERACTION DES JETS DES REACTEURS GE CF6-50 SUR LA CELLULE DE L'AIRBUS EN CROISIERE - SIMULATION EN SOUFFLERIE]**
M Saiz Paris Assoc Aeron et Astronautique de France 1975 41 p refs In FRENCH
(AAAF-NT-75-15 ISBN-2-7170-0333-9) Avail NTIS HC$4 00
CEDOCAR, Paris FF 25 (France and EEC) FF 29 (others)

The interaction of double flux aircraft reactors of over 50 000 pounds thrust, as used in large passenger aircraft such as the European A 300 B Airbus, with the aircraft body, was studied The balance of the drag and thrust components of the body-propulsive unit combination is discussed, and the experimental techniques for determining such interactions are described Model simulation tests with a motorized nacelle in a supersonic wind tunnel are detailed Finally the use of pressure measurements made to check the validity of the experimental method and to derive the value of the reactor jet interaction during cruising flight is discussed ESA

**N76-15166#** Honeywell Inc Minneapolis Minn Systems and Research Center
**TURBINE ENGINE CONTROL SYNTHESIS VOLUME 1 OPTIMAL CONTROLLER SYNTHESIS AND DEMONSTRATION Final Technical Report, 30 Jun 1972 - 15 Mar 1975**
C R Stone N E Miller, M D Ward and R D Schmidt Mar 1975 340 p refs 3 Vol
(Contract F33615-72-C-2190, AF Proj 3066)
(AD-A014229 F0164-FR-Vol-1 AFAPL-TR-75-14-Vol-1) Avail NTIS CSCL 21/5

The objective was to determine whether optimal control synthesis methods provide superior means for designing jet engine controllers The methods design controllers with more capability and/or can be exploited to provide less expensive hardware For newer kinds of engines the cost to design should be less than for presently used methods Volume I summarizes optimal control design methodology A paper design of a command and disturbance controller shows that good power lever command response can be achieved the same controller is designed to be insensitive to inlet duct buzz A command controller is synthesized and wind tunnel tested This controller is a good approximation to time optimal with surge-stall TT4 and flameout constraints Small-amplitude control responses are precise There is strong stability GRA

**N76-15167#** Honeywell Inc , Minneapolis Minn Systems and Research Center
**TURBINE ENGINE CONTROL SYNTHESIS VOLUME 2 SIMULATION AND CONTROLLER SOFTWARE Final Technical Report, 30 Jun 1972 - 15 Mar 1975**
C R Stone N E Miller and M D Ward Mar 1975 292 p refs 3 Vol
(Contract F33615-72-C-2190, AF Proj 3066)
(AD-A014230 F0164-FR-Vol-2 AFAPL-TR-75-14-Vol-2) Avail NTIS CSCL 21/5

The objective was to determine whether optimal control synthesis methods provide superior means for designing jet engine controllers The methods design controllers with more capability and/or can be exploited to provide less expensive hardware For newer kinds of engines the cost to design should be less

than for presently used methods Volume 2 contains three Appendices Appendix A contains the details of engine math models The software for the wind tunnel controller is presented in Appendix B Appendix C contains a derivation of rate model following GRA

**N76-15168#** Honeywell, Inc., Minneapolis, Minn Systems and Research Center
**TURBINE ENGINE CONTROL SYNTHESIS VOLUME 3. EXPERIMENTAL ENGINE IDENTIFICATION AND MODELING Final Technical Report, 30 Jun 1972 - 15 Mar 1975**
R B Beale and N E Miller Mar 1975 163 p refs 3 Vol
(Contract F33615-72-C-2190, AF Proj 3066)
(AD-A014231 F0164-FR-Vol-3, AFAPL-TR-75-14-Vol-3) Avail NTIS CSCL 21/5

This program develops a practical design procedure for turbine engine control systems based on multivariable control theory This volume describes a practical procedure for experimentally obtaining high-fidelity linear engine models from frequency response measurements This procedure satisfies the modeling requirements for high-bandwidth control systems which are needed in the future for better regulation of surge margins and disturbances A dynamic transfer matrix model of the GE-J85-13 engine is obtained at three engine operating speeds The instrumentation is described for obtaining tape-recorded engine responses Fourier filtering and servoanalysis techniques are demonstrated An algorithm is described for identifying dynamic states and transfer functions from frequency responses GRA

**N76-15169#** ARO, Inc., Arnold Air Force Station, Tenn
**TURBINE ENGINE EXHAUST NOZZLE PERFORMANCE WITH NONUNIFORM INLET FLOW Final Report, Jul 1973 - Jun 1974**
S Wehofer and R J Matz AEDC Aug 1975 60 p refs
(ARO Proj RF442)
(AD-A014261, ARO-ETF-TR-75-43, AEDC-TR-75-82) Avail NTIS CSCL 21/5

The internal fluid dynamic performance of various turbine engine exhaust nozzle configurations was experimentally investigated Nine fixed-geometry exhaust nozzle models representative of contemporary turbofans operating at various power levels were evaluated with uniform inlet conditions and with radial nonuniformities in total pressure and total temperature The test conditions are representative of both low bypass turbofan and turbojet tailpipe flows The effects of nozzle throat lip geometry on nozzle performance were evaluated Also the results obtained from the experimental phase were compared with the performance predicted from a numerical analysis developed at the Arnold Engineering Development Center The major conclusion is that nozzle performance coefficients cannot be ascribed to a given nozzle configuration without some specification of the nozzle inlet flow conditions and coefficient referencing procedures Author (GRA)

**N76-15170#** Technology Inc., Dayton, Ohio
**INTEGRATED AEROSPACE ENGINE MANAGEMENT FOUNDATIONS IN ESTIMATION AND PREDICTION OF ENGINE REMOVALS Final Report, 15 May - 22 Aug 1974**
Laurence L George ARL Jun 1975 74 p refs
(Contract F33615-73-C-4155, AF Proj 7071)
(AD-A014368 ARL-75-0137) Avail NTIS CSCL 21/5

Aerospace engine management is an exceedingly complicated problem with important consequences Analytical management techniques may have potential application in a future, integrated engine management system Fundamental to any such system is information about engine lives and the number of engine replacements required to meet flying hour program requirements In this report the engine management problem is described in the context of a production system producing flying hours This perspective shows the necessity for engine life information since the engines produce flying hours The maximum likelihood estimator of a multi-risk engine life cumulative distribution function with inspections has been derived It may be an improvement over the actuarial method now used, and information about usage removals and inspection removals is also available from the maximum likelihood estimator An hierarchical sequence of families of distributions has been constructed for ease of sequential likelihood ratio testing for more information about the engine life distributions GRA

**N76-15174#** Air Force Systems Command Wright-Patterson AFB Ohio Foreign Technology Div
**COMPARISON OF TURBOJET, TURBOROCKET, AND RAMJET AS A PROPULSION SYSTEM FOR LONG RANGE AIRPLANES AT MACH NUMBERS BETWEEN 2 AND 4**
E Riester 31 Jul 1975 38 p refs Transl into ENGLISH from Deut Luft- und Raumfahrt Forschungsbericht (West Ger.), no 38 1972 p 1-36
(AD-A014312 FTD-ID(RS)I-1653-75) Avail NTIS CSCL 21/5

In the Mach number range between 2 and 4 a transition to another propulsion system is expected for long range airplanes Limited to the cruise range, the turbojet, the turborocket and the ramjet are investigated Considering also the additional drag engines are compared, whose air flow rates have the same cross section area for the undisturbed flow in front of the engine It is shown that even with modern component technology, the turbojet is the optimum propulsion system only up to the Mach number 3 5 Above this Mach number the ramjet becomes more effective The turborocket is interesting at high Mach numbers because of its high thrust density although its specific impulse is somewhat less GRA

**N76-15176*#** National Aeronautics and Space Administration Flight Research Center Edwards, Calif
**SUBSONIC STABILITY AND CONTROL DERIVATIVES FOR AN UNPOWERED, REMOTELY PILOTED 3/8-SCALE F-15 AIRPLANE MODEL OBTAINED FROM FLIGHT TEST**
Kenneth W Iliff, Richard E Maine and Mary F Shafer Washington Jan 1976 32 p refs
(NASA-TN-D-8136 H-905) Avail NTIS HC $4 00 CSCL 01C

In response to the interest in airplane configuration characteristics at high angles of attack an unpowered remotely piloted 3/8-scale F-15 airplane model was flight tested The subsonic stability and control characteristics of this airplane model over an angle of attack range of -20 to 53 deg are documented The remotely piloted technique for obtaining flight test data was found to provide adequate stability and control derivatives The remotely piloted technique provided an opportunity to test the aircraft mathematical model in an angle of attack regime not previously examined in flight test The variation of most of the derivative estimates with angle of attack was found to be consistent particularly when the data were supplemented by uncertainty levels Author

**N76-15459** Polish Academy of Sciences, Warsaw
**GENERALIZED MODEL OF A ROTOR ON FLEXIBLE SUPPORTS [UOGOLNIONY MODEL WIRNIKA NA PODATNYCH PODPORACH]**
Agnieska Muszynska 7 Jun 1975 29 p refs In POLISH
Avail Issuing Activity

A physical and mathematical model is described of a single-piece rotor (with a disk mounted on the shaft) spinning on two massive sliding bearings The bearings are located on anisotropic flexible supports A numerical analysis is presented which includes equations of motion, equilibrium equations, hydrodynamic equations, and matrices Transl by M J S

**N76-15468#** United Technologies Corp., Stratford, Conn Sikorsky Aircraft Div
**THE 3000-HP ROLLER GEAR TRANSMISSION DEVELOPMENT PROGRAM VOLUME 3 ROLLER GEAR MANUFACTURE Final Report**
G F Gardner and K R Cormier Jul 1975 293 p refs
(Contract DAAJ02-69-C-0042, DA Proj 1G1-62207-AA-72)
(AD-A014135 SER-50897-Vol-3
USAAMRDL-TR-73-98C-Vol-3) Avail NTIS CSCL 13/9

This report presents a survey of the manufacturing methods

used in the production of the roller gear transmission The bulk of the material contained herein deals with the roller gear components of the transmission because of the unique manufacturing problems they presented No attempt is made to describe in detail the more conventional manufacturing processes employed in the program The most significant aspect of the manufacture of the roller gear components was the extensive use of electron beam welding This method of assembly was completely satisfactory with respect to holding critical dimensional tolerances, however, weld integrity, particularly in certain highly stressed joints, was a continual problem Although weld joint design certainly contributed to the problems encountered the presence of weld voids was certainly a major factor in the weld related fractures GRA

**N76-15469#** United Technologies Corp, Stratford, Conn Sikorsky Aircraft Div
**THE 3000-HP ROLLER GEAR TRANSMISSION DEVELOPMENT PROGRAM VOLUME 5 AIRCRAFT TIEDOWN TESTING Final Report**
G F Gardner and D O Adams Jul 1975 150 p refs
(Contract DAAJ02-69-C-0042, DA Proj 1F1-62207-AA-72)
(AD-A014267 UTRC/S611653-Vol-5
USAAMRDL-TR-73-98E-Vol-5) Avail NTIS CSCL 13/9

This report presents the results of a helicopter tiedown test program The primary purpose of this test was to evaluate a roller gear transmission in an aircraft installation and to conduct a 50-hour tiedown test at a power spectrum equivalent to helicopter military usage The roller gear transmission transmits 3,000 hp at 203 rpm to a helicopter main rotor head The transmission is powered by two General Electric axial-flow turboshaft engines each producing 1 870 hp at 18 966 rpm A 19 85 1 roller gear unit is the final reduction stage in the transmission GRA

**N76-15486#** Freudenthal (Alfred M ), Chevy Chase, Md
**RELIABILITY ASSESSMENT OF AIRCRAFT STRUCTURES BASED ON PROBABILISTIC INTERPRETATION OF THE SCATTER FACTOR Final Report, 1 Sep 1973 - 1 Mar 1975**
Alfred M Freudenthal Apr 1975 58 p
(Contract F33615-74-C-5003, AF Proj 7351)
(AD-A014359 AFML-TR-74-198) Avail NTIS CSCL 01/3

The 'scatter factor' S as used in fatigue design of aircraft is defined as the ratio between the location parameter (estimate) of the 'population' of all aircraft, obtained from n full-scale tests, and the first failure in a fleet of m aircraft Introducing the Third Asymptotic distribution of smallest values for the fatigue life of the population this definition produces a Pareto-type distribution of the scatter-factor on the basis of which S can be related to the numbers n and m and the reliability level R Tables of S for different combinations of n, m, R and the 'minimum fatigue life are evaluated Useful values of the scatter factor for different materials and purposes are suggested GRA

**N76-15487#** Rail Co Hunt Valley, Md
**DEVELOPMENT PROGRAM FOR AN AIRCRAFT RELIABILITY AND MAINTAINABILITY SIMULATION (ARMS) MODEL VOLUME 1 PROGRAM DESCRIPTION Final Report, Jun 1974 - Dec 1975**
William C Friese Jul 1975 143 p refs
(Contract DAAH02-73-C-0090 DA Proj 1F1-62205-A-119)
(AD-A014102, USAAMRDL-TR-75-26A) Avail NTIS CSCL 01/3

The Aircraft Reliability and Maintainability Simulation (ARMS) model concept was developed by the U S Army Air Mobility Research and Development Laboratory, Eustis Directorate The ARMS model is a management tool which permits observation of the impact of a proposed action prior to implementation The model is used to simulate aircraft operating in user-defined operational and maintenance scenarios It is designed to allow the user almost complete flexibility in defining aircraft components with their associated failure rates and repair requirements and in defining necessary resources such as ground support equipment GRA

**N76-15489** Polish Academy of Sciences, Warsaw
**INVESTIGATION OF COMBINED VIBRATION OF A ROTOR BY THE BALBI MEAN METHOD [BADANIE DRGAN KOMBINOWANYCH WIRNIKA METODA USREDNIANIA BALBIEGO]**
Agnieszka Muszynska 29 Aug 1975 20 p refs In POLISH
Avail Issuing Activity

An approximation method is presented for solving problems of combined constant vibrations which result from application of self-induced vibrations or vibrations forced by the action of centrifugal forces of inertial and gravitational forces A numerical analysis is given using Balbi s mean method Transl by M J S

**N76-15501#** Royal Aircraft Establishment Farnborough (England) Structures Dept
**THE EFFECTS OF LOAD DWELLS DURING FATIGUE CRACK PROPAGATION**
London Aeron Res Council 1975 14 p refs Supersedes RAE-TR-74163, ARC-35906
(ARC-CP-1318, RAE-TR-74163 ARC-35906) Avail NTIS HC $3 50, HMSO 25p, PHI $1 15

To substantiate the increase of endurance a research program was undertaken to investigate the effect of dwells in fatigue loading on crack propagation rate in thin sheet Al 2% Cu specimens The fatigue loading used was a simplified flight-by-flight load sequence and in tests including dwell periods, dwells were either at steady tension or at zero load It is shown that dwells in fatigue loading significantly reduced crack growth rates, dwells at a steady load were possibly more beneficial than dwells at zero load Possible mechanisms are discussed and further research programs are outlined which should provide a better understanding of these mechanisms Author (ESA)

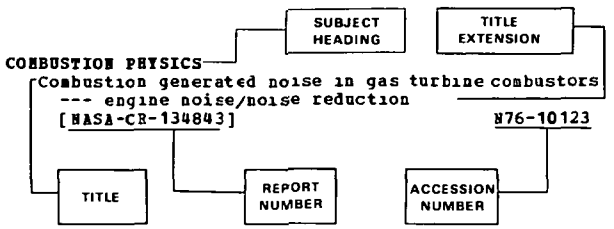
**N76-15904#** Army Aviation Systems Command, St Louis, Mo
**ARMY AVIATION RDT AND E PLAN EXECUTIVE SUMMARY Edition No 4**
Jul 1975 23 p refs
(AD-A014196) Avail NTIS CSCL 01/3

The Army Aviation Research Development Test and Engineering (RDT and E) Plan is the U S Army Aviation Systems Command (USAAVSCOM) response to the requirement for a Consolidated R and D Plan (CRDP), which constitutes Block 13a in the Life-Cycle Management Model (LCMM) as described in the Joint CDC/AMC Materiel Need Procedures Handbook, March 1972 This Plan is prepared and maintained by AVSCOM on a continuing basis to address the short- and long-range RDT and E activities directed to achieving the Army objectives for which AVSCOM is responsible This Plan presents a time-phased analysis and presentation of the scientific and technological programs required to support the development of advanced airmobile systems responsive to the future needs of the Army This document sets forth plans and objectives for Army aviation research and development activities for the FY76-95 period with particular emphasis on the period from the present to 1980 Current R and D efforts in Army air mobility are directed primarily toward the development of a family of vertical and short takeoff and landing aircraft to fulfill identified requirements in the land combat functions of mobility, intelligence, firepower, combat service support and command control and communications The Plan (either the classified or unclassified version) is quite voluminous because of the broad scope of activities and the wide variety of technologies and disciplines that constitute the totality of the air vehicle technology GRA

# SUBJECT INDEX



## Typical Subject Index Listing




The title is used to provide a description of the subject matter When the title is insufficiently descriptive of the document content a title extension is added separated from the title by three hyphens The NASA or AIAA accession number is included in each entry to assist the user in locating the abstract in the abstract section of this supplement If applicable a report number is also included as an aid in identifying the document

# A

## B

# C

# D



# E

# F

# G

# H



# I

## J



## K



## L

# M

# N



# O

# P

# Q



# R

# S

# T

## U



## V



## W

## X

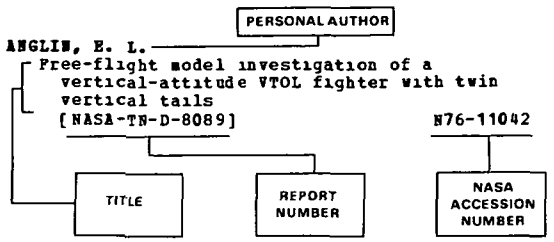


## Y

# PERSONAL AUTHOR INDEX



## Typical Personal Author Index Listing




Listings in this index are arranged alphabetically by personal author The title of the document provides the user with a brief description of the subject matter The report number helps to indicate the type of document cited (e g NASA report translation NASA contractor report) The accession number is located *beneath and to the right of the title e g N76 11042 Under any one author s* name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first

## C



## D

## E



## F



## G

# H

# M

## N



## O



## P

## Q



## R



## S

# T

## V



## W

## Y



## Z

# 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





NASA-Langley, 1976

| 1 Report No. | 2 Government Accession No | 3 Recipient's Catalog No |
|---|---|---|
| NASA SP-7037 (69) | | |

| 4 Title and Subtitle | 5 Report Date |
|---|---|
| AERONAUTICAL ENGINEERING<br>A Special Bibliography (Supplement 69) | April 1976 |
| | 6 Performing Organization Code |
| 7. Author(s) | 8 Performing Organization Report No |
| | 10 Work Unit No. |
| 9 Performing Organization Name and Address<br>National Aeronautics and Space Administration<br>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 bibliography lists 305 reports, articles, and other documents introduced into the NASA scientific and technical information system in March 1976.

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

| 19 Security Classif. (of this report) | 20 Security Classif. (of this page) | 21 No. of Pages | 22 Price* |
|---|---|---|---|
| Unclassified | Unclassified | 88 | $4.00 HC |

*For sale by the National Technical Information Service, Springfield, Virginia 22161

# PUBLIC COLLECTIONS OF NASA DOCUMENTS

## DOMESTIC

NASA distributes its technical documents and bibliographic tools to ten special libraries located in the organizations listed below Each library is prepared to furnish the public such services as reference assistance, interlibrary loans, photocopy service, and assistance in obtaining copies of NASA documents for retention

**CALIFORNIA**
University of California, Berkeley
**COLORADO**
University of Colorado, Boulder
**DISTRICT OF COLUMBIA**
Library of Congress
**GEORGIA**
Georgia Institute of Technology, Atlanta
**ILLINOIS**
The John Crerar Library, Chicago
**MASSACHUSETTS**
Massachusetts Institute of Technology, Cambridge
**MISSOURI**
Linda Hall Library, Kansas City
**NEW YORK**
Columbia University, New York
**PENNSYLVANIA**
Carnegie Library of Pittsburgh
**WASHINGTON**
University of Washington, Seattle

NASA publications (those indicated by an "*" following the accession number) are also received by the following public and free libraries

**CALIFORNIA**
Los Angeles Public Library
San Diego Public Library
**COLORADO**
Denver Public Library
**CONNECTICUT**
Hartford Public Library
**MARYLAND**
Enoch Pratt Free Library, Baltimore
**MASSACHUSETTS**
Boston Public Library
**MICHIGAN**
Detroit Public Library
**MINNESOTA**
Minneapolis Public Library
**MISSOURI**
Kansas City Public Library
St Louis Public Library
**NEW JERSEY**
Trenton Public Library
**NEW YORK**
Brooklyn Public Library
Buffalo and Erie County Public Library
Rochester Public Library
New York Public Library
**OHIO**
Akron Public Library
Cincinnati Public Library
Cleveland Public Library
Dayton Public Library
Toledo Public Library
**OKLAHOMA**
Oklahoma County Libraries, Oklahoma City
**TENNESSEE**
Memphis Public Library
**TEXAS**
Dallas Public Library
Fort Worth Public Library
**WASHINGTON**
Seattle Public Library
**WISCONSIN**
Milwaukee Public Library

An extensive collection of NASA and NASA-sponsored documents and aerospace publications available to the public for reference purposes is maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 750 Third Avenue, New York, New York, 10017

## EUROPEAN

An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England By virtue of arrangements other than with NASA, the British Library Lending Division also has available many of the non-NASA publications cited in *STAR* European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols "#" and "*", from ESRO/ELDO Space Documentation Service, European Space Research Organization, 114, av Charles de Gaulle, 92-Neuilly-sur-Seine, France

# NASA CONTINUING BIBLIOGRAPHY SERIES

| NUMBER | TITLE | FREQUENCY |
|---|---|---|
| NASA SP--7011 | AEROSPACE MEDICINE AND BIOLOGY<br>Aviation medicine, space medicine, and space biology | Monthly |
| NASA SP-7037 | AERONAUTICAL ENGINEERING<br>Engineering, design, and operation of aircraft and aircraft components | Monthly |
| NASA SP-7039 | NASA PATENT ABSTRACTS BIBLIOGRAPHY<br>NASA patents and applications for patent | Semiannually |
| NASA SP--7041 | EARTH RESOURCES<br>Remote sensing of earth resources by aircraft and spacecraft | Quarterly |
| NASA SP-7043 | ENERGY<br>Energy sources, solar energy, energy conversion, transport, and storage | Quarterly |
| NASA SP-7500 | MANAGEMENT<br>Program, contract, and personnel management, and management techniques | Annually |

***Details on the availability of these publications may be obtained from:***

**SCIENTIFIC AND TECHNICAL INFORMATION OFFICE**

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

**Washington, D.C. 20546**