NASA SP-7037(83)

NASA SP-7037(83) Aeronautical Engineering Pages 135–187 MAY 1977

AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY WITH INDEXES

Supplement 83

MAY 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ACCESSION NUMBER RANGES

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

STAR (N-10000 Series)	N77-15974 - N77-17994
IAA (A-10000 Series)	A77-19299 - A77-22950

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(83)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 83

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in April 1977 in

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

Scientific and Technical Information Office
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D C
MAY 1977

This Supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, at the price code E02 ($4 75 domestic, $9 50 foreign).

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 360 reports, journal articles, and other documents originally announced in April 1977 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* and *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 (A77-10000 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 , (A77-10026), when requesting publications

STAR ENTRIES (N77-10000 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 Prices for hard copy (HC) and microfiche (MF) are indicated by a price code followed by the letters HC or MF in the *STAR* citation Price codes are given in the tables on page vii of the current issue of *STAR*

Microfiche[1] is available regardless of age for those accessions followed by a # symbol

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 paten5 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 $3 00 price, for those documents identified by a # symbol)

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

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

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) and microfilm 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

SUBSCRIPTION AVAILABILITY

This publication is available on subscription from the National Technical Information Service (NTIS) The annual subscription rate for the monthly supplements is $45 00 domestic, $75 00 foreign All questions relating to the subscriptions should be referred to NTIS, Attn Subscriptions, 5285 Port Royal Road, Springfield Virginia 22161

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
5285 Port Royal Road
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
Building
Washington, D C 20242

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

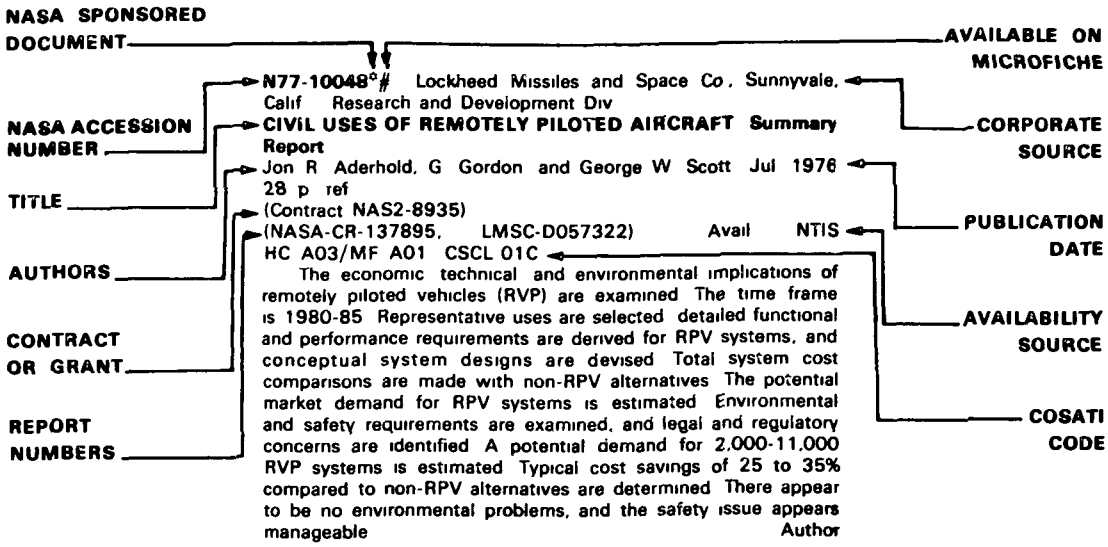
U S Geological Survey
345 Middlefield Road
Menlo Park, California 94025

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

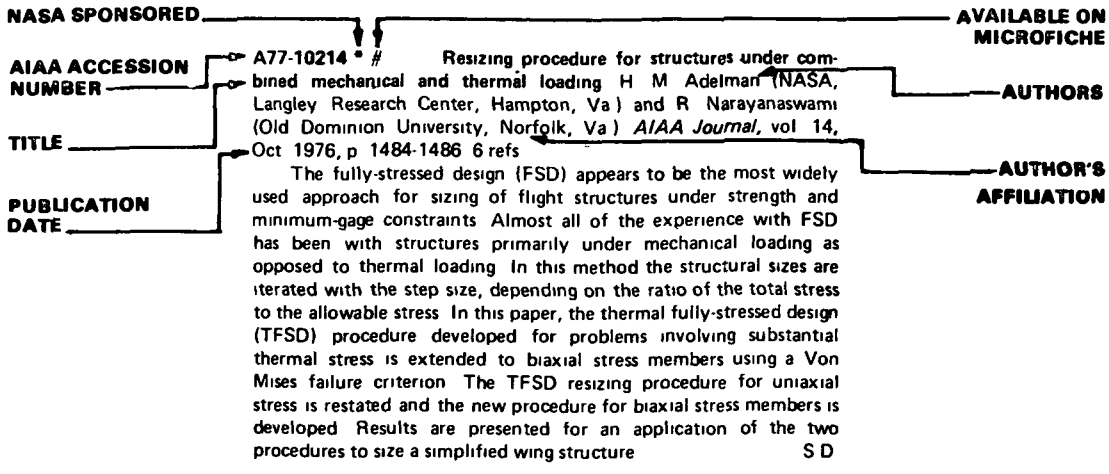
Zentralstelle fur Luftfahrtdoku-
mentation und -Information
8 Munchen 86
Postfach 880
Federal Republic of Germany

TABLE OF CONTENTS

TYPICAL CITATION AND ABSTRACT FROM *STAR*



TYPICAL CITATION AND ABSTRACT FROM *IAA*



AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 83)

MAY 1977

IAA ENTRIES

A77 19329 # **Optimal control of thrust and angle of attack of an aircraft performing a climb-acceleration maneuver (Optimal'noe upravlenie tiagoi i uglom ataki letatel'nogo apparata pri manevre pod'em-razgon)** V F Krotov and M M Khrustalev In *Problems of analytical mechanics and stability and control theories* Moscow, Izdatel'stvo Nauka, 1975, p 168 175 7 refs In Russian

The problem of optimal control of thrust and angle of attack is solved for an aircraft moving in a central gravitational field under the action of aerodynamic drag and engine thrust Allowance is made for variable mass, and the problem can be considered for a fixed range P T H

A77-19464 # **Aircraft environmental control problems as a result of air contamination** P F Halfpenny (Lockheed California Co , Burbank, Calif) *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Diego, Calif , July 12 15, 1976, Paper 76 ENAs 13* 9 p 9 refs Members, $1 50, nonmembers, $3 00

Particulates that occur naturally in the atmosphere in the form of dust and dirt as well as those particulates and vapors that are a result of industrial processes affect adversely aircraft environmental systems The sources of contaminants are considered along with some of the effects and the design features which can be employed to minimize the adverse effects Atmospheric dust ingested by the engines, APU's, and high pressure ground carts is the primary aircraft system source of contamination It is pointed out that the development of bleed ports which are effective in removing atmospheric contaminants is the long range optimum solution Until then, components must be designed and installed to make them more tolerant to dirt G R

A77-19471 # **Fluidic applications to aircraft environmental control systems** J E McNamara and J Eyth, Jr (U S Naval Material Command, Naval Air Development Center, Warminster, Pa) *American Society of Mechanical Engineers, Intersociety Conference on Environmental Svstems, San Diego, Calif , July 12-15, 1976, Paper 76-ENAs-21* 14 p Members, $1 50, nonmembers, $3 00

The environmental control system (ECS) of an aircraft is approached as a logical candidate for implementation of fluidic control technology without electrical interfaces, since the ECS utilizes air for various onboard functions (life support, cooling of electronic equipment, pressurization, defogging, and anti-g suits) A typical ECS is described, along with an account of a design approach to a fluidic ECS, and a discussion of ECS components Two variant approaches to ECS arrangements and ECS performance tests are examined in parallel The two fluidic ECS are compared and both are found to be satisfactory implementations R D V

A77 19492 # **Cooling methods for aircraft electronics equipment** J K Goldstein (Lockheed California Co , Burbank, Calif) *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Diego, Calif , July 12-15, 1976, Paper 76-ENAs-51* 8 p Members, $1 50, nonmembers, $3 00

Cooling of aircraft instruments, avionics, and other electronics will result in improved component reliability This paper explores several techniques of controlling the thermal environment of the equipment, including use of the existing aircraft air conditioning system, external conditioned air, and the addition of a separate avionics cooling package Each system is evaluated regarding cooling ability, cooling availability, and cost, providing a suitable criteria for a decision regarding cooling benefits and system selection (Author)

A77 19502 # **The Mini Boat - A life boat for helicopter crewmen** G P Gillespie (U S Naval Material Command, Naval Air Development Center, Warminster, Pa) *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Diego, Calif , July 12-15, 1976, Paper 76-ENAs-61* 6 p 5 refs Members, $1 50, nonmembers, $3 00 Navy-supported research

By taking advantage of advancements in the state-of-the-art of fabrics, the Naval Air Development Center has designed Mini Boats with center of mass below the center of buoyancy, as an alternative to current one man life raft (LR-1) for the potential helicopter crash survivors The Mini Boat concept has evolved through four stages by the trial and-error process All four stages make use of CO2 inflation-cells to partially inflate the boat, with complete inflation done orally The bail of the water is done by the crew men's helmets Thermal protection is also provided The fourth and the final form of Mini Boat is 50% lighter (3 lb), 66% less bulky and has a better stability and comfort than the LR-1 Compactification of the Mini Boat into 7 x 5 x 3 in package and future application of it to all Helos and Cargo/Transport Aircraft are also predicted A Y

A77-19649 # **Energy considerations in aeronautical transportation /The W Rupert Turnbull Lecture/** E P Cockshutt (National Research Council, Ottawa, Canada) *(Canadian Aeronautics and Space Institute, Annual General Meeting, Toronto, Canada, May 10 12, 1976) Canadian Aeronautics and Space Journal,* vol 22, Nov Dec 1976, p 284-297 13 refs

Data are reviewed which indicate that passenger transport by air involves energy expenditures comparable to automotive and rail modes It is demonstrated that stage length and load factor are the critical parameters in establishing energy costs, and that long-haul travel is well accommodated by current wide body transports It is suggested that the adoption of urban-oriented automobiles for city use, with the expanded use of aircraft for inter-city travel, could result in significant energy savings Along with such a development would be the evolution of energy-efficient short haul aircraft, based essentially on current technology (Author)

A77-19650 # **An avionics design philosophy for a Canadian coastal patrol aircraft** M Walker (Canadian Forces Air Navigation School, Winnipeg, Canada) *Canadian Aeronautics and Space Journal,* vol 22, Nov -Dec 1976, p 298 313 29 refs

To meet primary requirements, the coastal patrol avionics

should be optimized to perform detection, localization, and positive identification of maritime surface contacts, the gathering of surface contact intelligence, coersion (if necessary) against surface violators, and search and rescue With this in view, the intent of the present paper is to examine how an avionics suit can best be optimized to the coastal patrol role The major items covered are system design, the navigation subsystem, communications, sensors, radar, electronic support measures, ancillary systems, computer selection, airframe modifications, and flare chutes It is seen that the systems described will enable any light/medium transport to become a remarkably effective coastal patrol aircraft at a very reasonable cost V P

A77-19708 Flow in turbomachines with nonuniform inlet velocity distribution B G Dul'skii and A G Kukinov *(TsAGI, Uchenye Zapiski,* vol 5, no 3, 1974, p 18-27) *Fluid Mechanics - Soviet Research,* vol 5, Jan Feb 1976, p 51-62 Translation

The paper examines the flow characteristics of a turbomachine consisting of several blade cascades between flat walls, with an inlet channel velocity distribution which is nonuniform along the span of the blades and along the cascade front A perturbation of the velocity component normal to the cascade front at an infinite distance from the first cascade is studied as is the relation of velocity perturbations in front of and in back of the cascade and the relation of perturbations at the ends of the interblade channel B J

A77-19710 Efficiency of tangential boundary layer blowing in conical diffusers M O Frankfurt *(TsAGI, Uchenye Zapiski,* vol 4, no 5, 1973, p 50 55) *Fluid Mechanics - Soviet Research,* vol 5, Jan -Feb 1976, p 140-145 Translation

The effect of tangential boundary layer blowing on the flow structure and efficiency of a diffuser channel was investigated for diffusers with aperture angles of 10, 30, and 60 degrees and expansion ratios in the range from 3 to 8 Blowing was accomplished by ring slits situated at the diffuser inlet and various locations along its length Velocity profiles and pressure losses were measured Pressure losses were minimized with blowing at the inlet only P T H

A77-19732 # Self-similar representation of the structure of the gasdynamic region during discharge of a highly underexpanded gas jet into a hypersonic wake flow (Avtomodel'noe predstavlenie struktury gazodinamicheskoi oblasti pri istechenii sil'no nedorasshirennoi strui gaza v sputnyi giperzvukovoi potok) G A Khramov and S F Chekmarev *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Nov Dec 1976, p 94-99 6 refs In Russian

A77-19733 # Effect of a conical break in delta wings on aerodynamic characteristics (Vliianie konicheskogo izloma treugol'nykh kryl'ev na aerodinamicheskie kharakteristiki) A L Gonor, V V Kravets, and A I Shvets *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Nov -Dec 1976, p 100-104 11 refs In Russian

The paper reports the results of experimental investigations of the aerodynamical coefficients and pressure on the windward side of delta wings with a conical break A comparison was also made between the aerodynamic quality parameters of delta wings with conical break and of wing-cone models with caret shaped symmetric arrangement at a Mach number of 5 96 P T H

A77-19739 # Experimental investigation of the characteristics of small-dimensioned nozzles (Eksperimental'noe issledovanie kharakteristik malorazmernykh sopl) V A Butenko, Iu P Rylov, and V P Chikov *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Nov Dec 1976, p 137-140 7 refs In Russian

The momentum and discharge coefficients were determined experimentally for nozzles with boundary layer displacement thickness less than or equal to 1 mm in the range of Reynolds numbers from 200 to 7,000 The high degree of accuracy of the formula of Kuluva and Hosack (1971) for determining the discharge coefficient has been confirmed A formula is proposed for determining the momentum coefficient as a result of approximating the experimental data in the Reynolds number range studied P T H

A77-19742 # Study of the effect of nozzle shape on the characteristics of three-dimensional subsonic and supersonic flows (Issledovanie vliianiia formy sopla na kharakteristiki prostranstvennykh do- i sverkhzvukovykh techenii) V M Dvoretskii *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Nov -Dec 1976, p 147 151 10 refs In Russian

The characteristics of three dimensional subsonic and supersonic flows of an inviscid and nonheat-conducting gas in nozzles of complex shape were analyzed The investigation was based on numerical integration of a system of gas dynamics equations with the aid of monotonic finite difference schemes of first order accuracy Flow in the whole nozzle channel, including subsonic and supersonic regions, was computed, and the results show how a suitable choice of nozzle profile shape can affect the distribution of the nonuniformity characteristics of the flow P T H

A77-19743 # Investigation of strongly underexpanded submerged jets (K issledovaniiu sil'no nedorasshirennykh zatoplennykh strui) M Ia Ivanov and V I Kireev *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Nov Dec 1976, p 151 154 7 refs In Russian

The paper reports the results of a numerical study of the propagation of strongly underexpanded jets of an ideal gas in a submerged space at nozzle outlet Mach numbers slightly above unity At the same time, the angle of turn of the flow near the edge of the conical nozzle may exceed 90 deg, and the boundary of the jet goes beyond the outlet section It is shown that a self similarity parameter for the geometric dimensions of the computed flows is the square root of the pressure ratio The dependence of the longitudinal dimensions of such jets on Mach number at the nozzle outlet is close to linear The effect of the ratio of the specific heats on the shape of the jet boundary and the trailing shock wave is illustrated P T H

A77-19744 # Investigation of supersonic flow past elongated blunt bodies of elliptical cross section (Issledovanie sverkhzvukovogo obtekaniia udlinennykh zatuplennykh tel s ellipticheskoi formoi poperechnogo secheniia) A V Antonets and Iu M Lipnitskii *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* Nov Dec 1976, p 155-159 12 refs In Russian

The paper presents the results of some numerical calculations of the characteristics of the three dimensional flow of an ideal gas past blunt bodies whose cross sections are ellipses with constant or variable axis ratio along the length of the body Flow characteristics past an elliptic cone are compared with asymptotic characteristics for conical flows As one proceeds downstream, the pressure distribution over the meridional angle on the blunt elliptic cone approaches that of the asymptotic conic solution, but because of the entropy effect the values of the density and temperature differ by a factor of 3 Pressure distributions are compared which were obtained by exact calculations and by the method of local blunt cones Computed and experimentally determined aerodynamic coefficients are also compared P T H

A77-19746 # **Investigation of the size of the wake of a cone flying at hypersonic speed (Issledovanie razmerov sleda za konusom, letiashchim s giperzvukovoi skorost'iu)** S Iu Cherniavskii *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov -Dec 1976, p 161-163 8 refs In Russian

Experiments were conducted in a hermetic ballistic chamber in which a light gas gun was used to hurl a blunt cone through the air at Mach 12 The half aperture angle of the cone was 10 degrees, the base diameter was 9 mm, the radius of the blunt part was 0 06 of the base diameter, the Reynolds number was 0 3 x 10 to the 6th, the angle of attack range was 12 24 degrees Shadow photographs were taken to determine the mean width of the hypersonic wake and the mean-square deviation of its boundary B J

A77-19747 # **Calculation of base pressure in ejector nozzles of different length for the case of a zero ejection coefficient (Raschet donnogo davleniia v ezhektornykh soplakh razlichnoi dliny pri nulevom koeffitsiente ezhektsii)** N L Efremov and R K Tagirov *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov -Dec 1976, p 164-166 In Russian

A77-19764 * # **A numerical method for the exact calculation of airloads associated with impulsively started wings** J M Summa (Analytical Methods, Inc , Bellevue, Wash) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24 26, 1977, Paper 77-2* 12 p 23 refs Grant No NsG 2101

A numerical method is developed to calculate three-dimensional potential flows due to the steady and impulsive motion of isolated wing and wing-wing interaction problems The velocity potential is represented by a discrete set of constant-doublet quadrilaterals on wing and wake surfaces The exact surface boundary condition is enforced, and the solution is obtained in a step-by-step fashion, configurations being impulsively started from rest Free-wake geometries are generated for each time step with Rankine or Lamb viscous vortex segments used in wake-velocity calculations Sample results include calculated performance to steady state for a thick wing and indicial lift of a wing-wing interaction problem (Author)

A77 19765 # **Three-dimensional turbulent boundary layer calculations for swept wings** J D McLean (Boeing Commercial Airplane Co , Seattle, Wash) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-3* 15 p 12 refs

A computer program for the prediction of three-dimensional boundary layers has been developed for use in analyzing boundary layers on finite swept wings The program uses an implicit finite-difference method to solve the three-dimensional compressible boundary-layer equations for either laminar or turbulent flow In the turbulent case, a simple effective viscosity model is used for the turbulent shear stresses The accuracy of the numerical method and applicability of the turbulence model are demonstrated in comparisons with experimental test cases Computed results are presented for typical transport-type swept wings (Author)

A77-19766 # **Viscous perturbation effects on hypersonic unsteady aerodynamics** L E Ericsson (Lockheed Missiles and Space Co , Inc , Sunnyvale, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-5* 13 p 31 refs Contract No N62269-73-C-0713

In the present study a simplified approach, tailored to the particular flow conditions of interest for a tactical missile operating in the low hypersonic flow regime, has been used to determine the dynamic effects of hypersonic viscid inviscid interaction It is shown that the experimentally observed changes of the inviscid unsteady aerodynamics of finite thickness airfoils due to viscous effects can be computed in a direct, simple manner using an embedded flow concept Not only is the agreement good between present predictions and experimental static and dynamic data, the present perturbation method also gives results that are in close agreement with those obtained by use of Orlik Ruckemann's more exact theory (Author)

A77-19772 # **Flow measurements in leading edge vortices** P M Sforza, W Stasi, J Pazienza, and M Smorto (New York, Polytechnic Institute, Farmingdale, N Y) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-11* 12 p 10 refs ERDA-NSF-supported research

An experimental study of the vortex flow field over slender delta planforms with sharp leading edges is presented Complete velocity measurements in this three-dimensional flow field are obtained by means of a Conrad-type probe used in conjunction with a five-degree-of freedom traversing mechanism, flow visualization is achieved by an oil fog technique Effects of angle of attack, camber, sweepback, and other parameters are described An application of such flows, wind energy conversion by means of the vortex augmentor concept, is discussed (Author)

A77 19778 * # **Influence of fuel temperature on supersonic mixing and combustion of hydrogen** R C Rogers (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24 26, 1977, Paper 77-17* 11 p 12 refs

Results are presented from an experimental investigation of the influence of fuel stagnation temperature on the mixing and reaction of hydrogen injected transverse to a supersonic flow in a duct The hydrogen fuel was injected stoichiometrically at stagnation tempera tures of 300 K and 800 K from a row of five circular orifices in the duct wall Detailed measurements in the flow at the duct exit are used to determine the overall amount of mixing accomplished at each of three test conditions Static pressure distributions are used with duct wall temperatures and heat flux in a one dimensional analysis to deduce the fraction of fuel reacted along the duct Results from the one dimensional analyses of the tests with hot fuel indicated slightly more fuel reacted at the exit, however, differences in the accomplished mixing obtained from integrations of exit surveys were small (Author)

A77-19787 * # **Estimation of weapon-radius versus maneuverability trade-off for air-to-air combat** H J Kelley and L Lefton (Analytical Mechanics Associates, Inc , Jericho, N Y) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-35* 9 p 9 refs Contract No NAS2 8738

A chase in a horizontal plane between a pursuer with a large capture radius and a more maneuverable evading vehicle is examined with constant speed vehicle models An approximation to the 'sidestepping' maneuver of the Homicidal Chauffeur Game is modified to account for the effect of evader turning rate, and an estimate of capture radius required is so obtained which agrees remarkably well with Cockayne's point-capture result The maneuver assumes central importance for barrier surfaces appearing in the Game of Two Cars Results are given for required weapon capture-radius in terms of the maneuverability of the two vehicles Some calculations of capture radius are presented (Author)

A77-19796 # **Combustion modelling within gas turbine engines, some applications and limitations** J Odgers (Universite Laval, Quebec, Canada) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-52* 11 p 50 refs

A review is given of some of the more pertinent models postulated to describe the performance of gas turbine combustors Six different design/development stages are considered (1) the initial sizing of a combustor, (2) the initial development testing, (3) primary zone modelling, (4) secondary zone modelling, (5) dilution zone modelling, (6) changes due to the alteration of ambient conditions The models are assessed in scope, plausibility, experimentally, and in terms of time and economic justification For (1) it is suggested that a zero dimensional model will suffice, as also for (2) Item (3) will probably require a three-dimensional model, (4) and (5) will probably suffice with a one or two dimensional model For item (6) a zero order model might well be satisfactory If it can be produced with sufficient accuracy, a single complex (probably three-dimensional) model could adequately describe all items, (1) to (6) A short discussion deals with the need of future data, and the paper recommends the type of models which may be used currently, and those which are likely to be used in the future (Author)

A77-19799 * # **Airframe noise measurements by acoustic imaging** J M Kendall (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-55* 10 p 17 refs Contract No NAS7-100

Studies of the noise produced by flow past wind tunnel models are presented The central objective of these is to find the specific locations within a flow which are noisy, and to identify the fluid dynamic processes responsible, with the expectation that noise reduction principles will be discovered The models tested are mostly simple shapes which result in types of flow that are similar to those occurring on, for example, aircraft landing gear and wheel cavities A model landing gear and a flap were also tested Turbulence has been intentionally induced as appropriate in order to simulate full-scale effects more closely The principal technique involves use of a highly directional microphone system which is scanned about the flow field to be analyzed The data so acquired are presented as a pictorial image of the noise source distribution An important finding is that the noise production is highly variable within a flow field and that sources can be attributed to various fluid dynamic features of the flow Flow separation was not noisy, but separation closure usually was (Author)

A77-19800 * # **An experimental investigation of airframe component interference noise** P J W Block (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-56* 10 p 12 refs

Measurements of noise produced by a model of a wheel well (rectangular cavity), landing gear (wheel and strut), and flap at Mach numbers of 0 18 and 0 40 have been made in an anechoic flow facility Individual component noise and component interference noise are described in terms of the OASPL, spectra, and streamwise or flyover directivity patterns Areas of significant sound generation are illuminated and causes of these noise sources are suggested Results from an acoustic imaging technique are used to point out other source regions not discernible by simple far-field measurements (Author)

A77-19801 * # **Airframe noise of component interactions on a large transport model** J G Shearin and D J Fratello (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24 26, 1977, Paper 77 57* 9 p 6 refs

Airframe noise produced by aircraft components and their interactions on a model of a wide body transport was investigated in an open jet anechoic flow facility The two meter span model had leading edge and multigapped trailing edge flaps, undercarriage, and associated stowage compartments Each of these components were extended and retracted so their individual and interactive contributions to the measured airframe noise could be determined An analysis of variance was performed which revealed a statistical significance of the component interactions Various airframe noise reduction techniques were tried to reduce airframe noise The effects of these techniques on the model's lift and drag were also measured (Author)

A77 19813 # **Stability derivative measurements with magnetically suspended cone cylinder models** D Bharathan (Virginia, University, Charlottesville, Va) and S S Fisher *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77 79* 9 p 13 refs Grant No AF AFOSR 74-2705

In an initial feasibility study, stability derivatives for 5 and 7 caliber cone cylinder models have been measured at M = 0 071 and Re = 13,000 by suspending each model electromagnetically in a small subsonic wind tunnel, forcing it in periodic, combined pitching/heaving motion at frequencies near pitch resonance, and comparing its frequency response with flow to that without flow Drag coefficients are measured as well The apparatus and techniques employed are described, the analytical model used to extract the derivatives from the response data is outlined, typical response data are shown, comparisons are made with conventionally obtained, similar data from other facilities, and a general assessment of the technique is made (Author)

A77-19815 * # **Scramjet exhaust simulation technique for hypersonic aircraft nozzle design and aerodynamic tests** J L Hunt, N A Talcott, Jr , and J M Cubbage (NASA, Langley Research Center, High-Speed Aerodynamics Div , Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-82* 10 p 20 refs

Current design philosophy for scramjet powered hypersonic aircraft results in configurations with the entire lower fuselage surface utilized as part of the propulsion system The lower aft end of the vehicle acts as a high expansion ratio nozzle Not only must the external nozzle be designed to extract the maximum possible thrust force from the high energy flow at the combustor exit, but the forces produced by the nozzle must be aligned such that they do not unduly affect aerodynamic balance The strong coupling between the propulsion system and aerodynamics of the aircraft makes imperative at least a partial simulation of the inlet, exhaust, and external flows of the hydrogen burning scramjet in conventional facilities for both nozzle formulation and aerodynamic force data acquisition Aerodynamic testing methods offer no contemporary approach for such vehicle design requirements NASA-Langley has pursued an extensive scramjet/airframe integration R&D program for several years and has recently developed a promising technique for simulation of the scramjet exhaust flow for hypersonic aircraft Current results of the research program to develop a scramjet flow simulation technique through the use of substitute gas blends are described in this paper (Author)

A77-19819 # **Fluctuating pressure environment of a drag reduction spike** R A Guenther and J P Reding (Lockheed Missiles and Space Co , Inc , Sunnyvale, Calif) *American Institute of*

Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif, Jan 24-26, 1977, Paper 77-90 11 p 8 refs

Wind-tunnel measurements have been made of the fluctuating pressure environment in a region of spike induced flow separation Extremely large pressure fluctuations (36% of free-stream dynamic pressure) were measured on the sides of the spike base at transonic speeds which are related to the nonaxisymmetric vortical nature of the separated flow at angles of attack greater than zero Even higher pressure fluctuations were observed on the windward side of the nose cap at supersonic speeds and angles of attack of at least 7 deg This is the result of an intermittent shock shock interaction The method of Coe et al, (1972) of normalizing the spectral data with the local separated flow height was moderately successful in collapsing the data into a manageable number of characteristic spectra However, the spectra for the spike-induced separation at supersonic speeds agreed better with the results of Speaker and Ailman (1966) for two dimensional step-induced separation than they did with the three-dimensional ramp-induced separation of Coe et al Spectral peaks were observed that corresponded to Roberts critical subsonic wake flapping frequency (Author)

A77-19820 # **Hypersonic flow over indented nosetips** B L Reeves, A Todisco, T C Lin, and A Pallone (Avco Corp, Avco Systems Div, Wilmington, Mass) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting 15th, Los Angeles, Calif, Jan 24-26, 1977, Paper 77-91* 15 p 10 refs Contract No F04701-74 C-0208

A comprehensive series of experiments to obtain fundamental environmental data on passive nosetip shapes which can occur during reentry has been conducted Pressure and heating measurements were obtained for five models covering a sequence of indented nosetip shapes observed from recession data The models consisted of four steady flow indented shapes and one pulsating flow model A significant result of these tests is the important role played by entropy layer swallowing in determining heating levels on indented shapes Flow separation at hypersonic speeds increases the rate of swallowing and can result in as much as a 70% increase in local heating (Author)

A77-19821 # **Effects of vorticity amplification in two-dimensional and axisymmetric stagnation-point flows** R J Swigart (Aerospace Corp, El Segundo, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th Los Angeles, Calif, Jan 24 26, 1977, Paper 77-92* 12 p 22 refs

A theoretical investigation of the effects of free-stream vorticity on skin friction and heat transfer in the vicinity of the stagnation point in both two dimensional and axisymmetric stagnation-point flows has been carried out, the solution for the axisymmetric case being presented for the first time The vorticity is assumed added at the outer edge of the boundary layer, and its effect on boundary layer properties as it is convected through the boundary layer and stretched as it passes over the body is analyzed in detail In both the two dimensional and axisymmetric cases the effect of the added vorticity is to increase both the skin friction and heat transfer, the effect being more pronounced in the axisymmetric case (Author)

A77-19827 # **Reynolds number and nozzle afterbody configuration effects on model forebody and afterbody drag** A V Spratley, E R Thompson, and T L Kennedy (ARO, Inc, Arnold Engineering Development Center, Arnold Air Force Station, Tenn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif, Jan 24 26, 1977, Paper 77 103* 13 p 7 refs

An experimental investigation was conducted to study the Reynolds number and nozzle afterbody/boattail configuration effects on forebody and afterbody drag The model used was a sting mounted axisymmetric body with an area distribution typical of a high performance fighter aircraft Three boattail geometries were investigated at Mach numbers from 0 60 to 1 40 and over a characteristic Reynolds number range from 16 x 10 to the 6th to 57 x 10 to the 6th based on model length Generally, forebody drag was found to be independent of afterbody geometry Reynolds number had only a minimal effect on forebody and afterbody drag (Author)

A77-19830 # **An evaluation of jet simulation parameters for nozzle/afterbody testing at transonic Mach numbers** W L Peters and T L Kennedy (ARO, Inc, Arnold Air Force Station, Tenn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif, Jan 24-26, 1977, Paper 77 106* 12 p

The objective of this investigation was to evaluate various jet simulation parameters to establish a method of simulating the turbojet exhaust effects on aircraft aerodynamics Successful parameters were determined based on their ability to correlate afterbody pressure drag for jet flows with either jet total temperature, nozzle exit to throat area ratio, or nozzle divergence half angle as a variable Data were utilized from an isolated nozzle/afterbody model tested at free stream Mach numbers from 0 6 to 1 5 Jet simulation parameters were evaluated at jet total temperatures from 540 to 3300 R for a sonic nozzle Nozzle exit-to throat area ratios from 1 000 to 1 475 and nozzle divergence half angles from 0 to 10 deg were evaluated with a cold high pressure air jet flow (Author)

A77-19836 # **Aeromechanics of mission completion for structurally damaged aircraft** R R Snodgrass and R A Bates (USAF, Aeronautical Systems Div, Wright Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif, Jan 24-26, 1977, Paper 77 112* 11 p

An aeromechanical analysis method is developed to assess the mission completion capabilities of an aircraft after exposure to varying levels of blast, thermal, or fragmentation environments is established The major aerodynamic problem for the structures disciplines must first define the extent and modes of structural damage such that the added drag can be determined The aerodynamic procedure structurally surveys the aircraft for material, material gages and construction which relates to damage from an appropriate varying threat, allowing the damage and drag to increase until the system can just complete the assigned mission The results suggest a handbook method for the crew to assess the damage for degraded mission capabilities (Author)

A77-19837 # **A rational new approach to the response of an aircraft encountering non-Gaussian atmospheric turbulence** J C T Wang and S F Shen (Cornell University, Ithaca, N Y) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif, Jan 24 26 1977, Paper 77-115* 12 p 17 refs Grant No AF AFOSR 74 2659

Based on the techniques of expanding a random function in terms of statistically orthogonal random functionals, a method is developed for analyzing the response of an aircraft to a stationary weakly non-Gaussian atmospheric turbulence The atmospheric turbulence is characterized through the correlation functions, and no other ad hoc assumptions are necessary The expansion kernels enable us to construct various probability density functions of interest e g, the joint probability density function of the response velocity and acceleration To illustrate the method and demonstrate some of the effects due to the non Gaussian nature of atmospheric turbulence, the simple case of the plunging motion of a rigid aircraft in a turbulent gust is presented in detail (Author)

A77 19855 # **A general theory of turbulent combustion - The Lagrangian aspects** D B Spalding (Imperial College of Science and Technology, London, England) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-141* 10 p 44 refs

In the development of combustion theory the classical approach of chemical kinetics had been abandoned in favor of a new approach, called the Eulerian approach The classical approach, called the Lagrangian approach, had followed the temporal variations of the concentration and temperature of distinct parcels of matter In the Eulerian approach attention is focussed on space rather than on matter and the convective and diffusive transport of matter through this space is considered A current crisis in the theoretical study of combustion is related to difficulties regarding an application of the Eulerian approach in the case of turbulent reacting flows, in which the dependent variables are the time average concentrations of species and correlations A description is given of a turbulent combustion theory which attempts to overcome the difficulties by means of an approach which combines Eulerian and Lagrangian methods G R

A77-19857 # **Computation of low speed flow about an asymmetric nacelle at incidence** P Bansod (British Aircraft Corp , Ltd , Weybridge, Surrey, England) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-143* 11 p 15 refs

The low speed flow about an asymmetric nacelle was computed using the Cubic Spline Mode Source Singularity Method Theoretical results are compared with experimental data for a range of incidences at three fan face velocity ratios which corresponded to the through-flow flow condition, engine wind milling case and engine mass flow at take off Off-body flow direction plots were made in the plane of symmetry Boundary layer computations were presented for the forebody, inlet and diffuser (Author)

A77-19860 * # **Transonic performance of an auxiliary airflow system for axisymmetric inlets** N E Sorensen and E A Latham (NASA, Ames Research Center, Moffett Field, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-148* 6 p 5 refs

A large-scale model of an axisymmetric inlet with a centerbody auxiliary airflow system has been tested in the wind tunnel at transonic speeds The auxiliary system allows additional airflow (other than in the main duct formed by the cowl and translating centerbody) to pass through the centerbody of the inlet and combine with the main duct airflow on its way to the engine face The results of the tests are presented, and the inlet performance is compared to a closely related alternative inlet with a 'traveling' boundary-layer bleed system which precludes the use of a centerbody auxiliary airflow system The comparison shows that the auxiliary airflow inlet can supply 7 7% more engine face airflow at Mach number 1 0 and is 26% shorter than the traveling bleed inlet Even though maximum transonic airflow was not achieved at a comparable engine face mass-flow ratio of 0 580, a total-pressure distortion of 0 10 and a total-pressure recovery of 0 985 were achieved for the auxiliary airflow inlet while a recovery of only 0 965 was achieved for the traveling bleed inlet (Author)

A77-19864 * # **Effects of inviscid parallel shear flows on steady and unsteady aerodynamics and flutter** M H Williams, M R Chi, E H Dowell (Princeton University, Princeton, N J), and C S Ventres (Bolt Beranek and Newman, Inc , Boston, Mass) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-158* 10 p 14 refs Grant No NGR-31-001-197

A general theory of planar disturbances in inviscid parallel shear flows, analogous to thin wing theory in potential flows, has been developed Integral relations between surface pressure and deformation are obtained which are similar to, and can be solved by the same numerical methods as, those of potential flow Computed results are shown which illustrate the effects of a model turbulent boundary layer on various lifting and nonlifting surfaces, including an elastic panel in low supersonic flow and an airfoil control surface in subsonic flow (Author)

A77-19865 # **Analysis of unsteady airloads of helicopter rotors in hover** B M Rao (Texas A & M University, College Station, Tex) and P R Schatzle (Sandia Laboratories, Albuquerque, N Mex) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-159* 12 p 19 refs Grants No DAHC04-74-G-0184, No DAAG29-76-G-0241

A numerical lifting-surface method based on the velocity potential formulation has been developed for predicting the unsteady airloads on a hovering rotor in compressible flow using a realistic representation of the wake, Landgrebe's (1971) experimental/analytical model The steady state loads compare well with available experimental results for four-bladed rotors, while the spanwise variation of the unsteady aerodynamic derivatives obtained shows a characteristic peak in the outboard region of the blade due to the tip vortex (Author)

A77-19874 # **Advanced techniques for computation of supersonic flow** V V Rusanov (Akademiia Nauk SSSR, Institut Prikladnoi Matematiki, Moscow, USSR) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-173* 12 p 31 refs

A short review of the methods used for the computation of supersonic flows is given, and their development is discussed Some means for the improvement of the BVLR (Babenko, Voskresenskii, Lyubimov, Rusanov, 1964) algorithm are described which extend its sphere of application The problem of boundary conditions in high-order difference schemes is studied at length for an arbitrary nonlinear hyperbolic system written in conserved form A general method for constructing the boundary conditions in difference schemes is proposed The examples given in the paper show that for the accuracy given, the use of the third-order difference scheme requires much less computer time than the use of the first- and second-order schemes (Author)

A77-19875 # **An inviscid model for submerged transonic wall jets** N D Malmuth and W D Murphy (Rockwell International Science Center, Thousand Oaks, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-174* 13 p 14 refs Contract No N00014-76-C-0350

Nonlinear flow phenomena in transonic wall jets prototypical of propulsive lift devices such as lifting ejector augmenters and upper-surface blown wings have been studied using the Karman-Guderley (1962) model From modern line relaxation methods, an efficient computational method has been developed to treat the diversity of shock patterns produced by various wall shapes and exit conditions Associated with the algorithm is a far field determined analytically from the boundary value problem appropriate to subsonic conditions far downstream Numerical results for circular arc boattails indicate rapid relaxation of the wall-induced disturbances, even in the supersonic region Partially subsonic and supersonic jet

exit conditions lead to the anticipated wave interactions Studies of other shapes show that branch point singular behavior associated with satisfaction of a Kutta condition at the wall trailing edge is obtained by demanding continuity of the perturbation potential at this point (Author)

A77-19876 # **Flow survey behind wings** Z El-Ramly and W J Rainbird (Carleton University, Ottawa, Canada) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-175* 11 p 26 refs National Research Council of Canada Grant No A-7799

Flow field surveys have been performed behind three different wings - a main wing, a rectangular wing, and a swept wing - in a low speed return circuit wind tunnel, up to 13 wing span downstream The results include the three mean velocity and vorticity components, complete definition of the viscous and vortical wake, and the detailed loading of one of the wings It is found that the vortical wake is contained within the viscous region of the wake The vortex *is never fully roll-up within the measuring range of the experiment* It is found that the Betz model of roll-up suggested for the experiment overestimates the tangential velocity and circulation near the vortex center, because it does not consider viscous effects The model, however, provides a good working tool since it gives reasonable predictions of the flow field over a range that would be of interest to a following aircraft B J

A77-19893 # **Penetration and break-up of liquid fuel jets in high subsonic speed airstreams** J A Schetz and A Padhye (Virginia Polytechnic Institute and State University, Blacksburg, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-201* 11 p 12 refs Grant No AF-AFOSR 74 2584

An experimental study of the penetration and break-up of liquid jets injected normal to high subsonic speed (M = 0 45 and 0 75) airstreams through injection ports of various geometries and sizes is reported The measurement techniques were primarily optical, employing 003 sec photos to produce 'streak' pictures for penetration measurements and 15 x 10 to the -9th sec photos to show the details of the break up process and some droplet size measurements The penetration data were successfully correlated using groupings of the variables and parameters suggested by a simple analysis (Author)

A77-19894 # **Detailed measurements of the periodically unsteady flow produced by rotor and stator wake interaction in a multistage turbomachine** D P Schmidt and T H Okiishi (Iowa State University of Science and Technology, Ames, Iowa) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24 26, 1977, Paper 77 202* 13 p 18 refs Grant No AF AFOSR 76 2916

To aid in the understanding of rotor and stator viscous wake interaction, slow and fast response instrumentation have been employed to obtain time-average and instantaneous periodic average flow field measurements between the blade rows in a low speed multistage axial-flow compressor Quantitative measurements indicate that the rotor blade wake pattern can vary significantly when influenced by an upstream stationary blade row and that relative circumferential positioning of the stationary blade rows can have considerable influence on downstream rotor and stator flow fields Differences in aerodynamic and acoustic characteristics resulting from changes in unsteady wake interaction patterns were observed (Author)

A77 19896 # **An experimental and numerical study of the 3-D mixing flows of a turbofan engine exhaust system** S F Birch, G C Paynter (Boeing Aerospace Co , Seattle, Wash), D B Spalding, and D G Tatchell (Concentration, Heat and Momentum, Ltd , London, England) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-204* 13 p 6 refs

An experimental and numerical study was conducted to investigate the use of 3-D viscous analysis for design of internal mixers for jet noise suppression Three flows, a full scale free mixer, a full scale lobed mixer and a model scale lobed mixer, were selected for study To insure a valid prediction, the analysis was applied to the selected flows without reference to or knowledge of the experimental results Details of the experiments, turbulence modeling, and determination of initial flow properties from engine operating properties are described The experimental and analytical results with a discussion as to the usefulness of the analysis for mixer design are presented (Author)

A77-19897 * # **Implicit finite-difference computations of unsteady transonic flows about airfoils, including the treatment of irregular shock-wave motions** W F Ballhaus (NASA, Ames Research Center, U S Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif) and P M Goorjian (Informatics Corp , Palo Alto, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-205* 11 p 17 refs

A computer code, LTRAN2, has been constructed that efficiently computes low frequency unsteady transonic flows about airfoils in motion The code solves the two dimensional, nonlinear, low-frequency, small-disturbance equation by an alternating-direction implicit (ADI) algorithm First, as a check on the code, LTRAN2 is used to solve the linear, low frequency, small disturbance equation The results are compared with known answers from linear theory Then nonlinear results are presented Tijdeman's experimental observations of shock wave motions resulting from airfoil flap oscillations are qualitatively reproduced by LTRAN2 These computations compare favorably with those of Magnus and Yoshihara and are obtained in substantially less computer time Also the underlying theory of the governing equation and the construction of the algorithm are discussed (Author)

A77-19899 # **Calculation of transonic wing flows by grid embedding** C W Boppe (Grumman Aerospace Corp , Bethpage, N Y) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77 207* 12 p 17 refs

This paper describes a new approach to the calculation of three dimensional inviscid transonic flows The computational procedure, which employs a finite difference relaxation scheme, differs from existing methods in two ways first, by choice of the flow governing equation and second, by a technique for embedding one computational grid structure within another Fine mesh calculations are performed only in regions near the wing where gradients are large and details are important This results in improved computational resolution and reduced computing time, as compared to current methodology In addition, the approach does not require global geometry fitting coordinate transformations These features provide flexibility for treating complex three dimensional geometries which, to date, have been impractical or impossible to compute Sample calculations for airfoils, wings, and canard wing combinations are included (Author)

A77-19900 * # **An approximate calculation of the strong interaction on a transonic airfoil** A Seginer and W C Rose (NASA, Ames Research Center, Moffett Field, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-210* 9 p 28 refs

This paper describes an interactive computational scheme that calculates the transonic flow field over an airfoil The inviscid flow, the turbulent boundary layer in the weak interaction region, and the elliptic flow in the strong interaction region are computed separately, and the solutions are matched iteratively in a direct, second order interaction scheme The pressure distribution, obtained from a transonic, small-perturbation solution, is prescribed on the boundary layer and the Navier Stokes equations and the ensuing displacement thicknesses are used to modify the inviscid flow The best overall results are obtained by using a turbulence model that eliminates the eddy viscosity in the strong interaction region Computed pressure distributions are compared with experimental data and with Navier Stokes solutions In weak interactions, the agreement with experimental data is very good, as it is also in strong interactions except for the pressures in the separated flow region There the agreement is qualitative only, and the pressure recovery is too high The results in both cases are superior or equal to those of the Navier Stokes solutions, and the present method is significantly faster (Author)

A77 19908 * # **Analytical study of viscous effects on transonic flow over boattail nozzles** R G Wilmoth (NASA, Langley Research Center, High Speed Aerodynamics Div , Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-223* 8 p 12 refs

An analytical study has been made of the effects of viscous/inviscid interactions on the transonic flow over boattail nozzles The theoretical method couples a relaxation solution of the full potential transonic flow equations with a conventional boundary-layer solution to account for displacement-thickness effects Surface pressures calculated on circular-arc boattails with solid jet plume simulators show good agreement with experiment for free stream Mach numbers less than 0 90 For separated flows, an empirical discriminating streamline model of the separation bubble gives good results until the onset of shock-induced separation, which occurs typically at a Mach number of about 0 90 (Author)

A77-19909 * # **Numerical solution of axisymmetric boattail flow fields with plume simulators** T L Holst (NASA, Langley Research Center, High-Speed Aerodynamics Div , Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-224* 14 p 17 refs

Turbulent separating flows over axisymmetric afterbody-boattail configurations with solid sting plume simulators are computed with a time-dependent finite-difference method to solve the compressible Navier-Stokes equations The Reynolds stress terms are replaced with a two-layer eddy viscosity model including a relaxation formula to model the nonequilibrium effects of the separated flow The mesh is aligned with the boattail body through an analytic transformation which accommodates a wide variety of boattail geometries Numerical results for a series of boattail geometries over a wide range of Reynolds number (140,000 to 140 million) are presented and, when possible, compared with experimental data or independent numerical results (Author)

A77-19977 **Prediction of the angular vibration of aircraft structures** J Lee and P W Whaley (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *(American Institute of Aeronautics and Astronautics and U S Air Force Wright Aeronautical Laboratory, Minisymposium on New Avenues for Progress in Aerospace Research Technology and Systems, Wright-Patterson AFB, Ohio, Mar 24, 1976) Journal of Sound and Vibration*, vol 49, Dec 22, 1976, p 541 549 11 refs

With the Bernoulli-Euler beam used as a theoretical model, qualitative relationships have been developed to predict the angular vibration from a prescribed linear vibration response Based on laboratory and flight test data, the overall accuracy of predictions is within + or - 20% of the angular vibration measurement Such a prediction capability may be considered very significant in that the prediction schemes are intended only for qualitative purposes In addition, due to the difficulties in obtaining accurate angular measurements, the present vibration data are limited to a gross confirmation of predictions (Author)

A77-19981 * # **Core noise measurements on a YF-102 turbofan engine** M Reshotko, A Karchmer, P F Penko, and J G McArdle (NASA, Lewis Research Center, V/STOL and Noise Div , Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24 26, 1977, Paper 77-21* 27 p 7 refs

Core noise from a YF 102 high bypass ratio turbofan engine was investigated through the use of simultaneous measurements of internal fluctuating pressures and far field noise Acoustic waveguide probes, located in the engine at the compressor exit, in the combustor, at the turbine exit, and in the core nozzle, were employed to measure internal fluctuating pressures Spectra showed that the internal signals were free of tones, except at high frequency where machinery noise was present Data obtained over a wide range of engine conditions suggest that below 60% of maximum fan speed the low frequency core noise contributes significantly to the far field noise (Author)

A77-19982 * # **Flap noise and aerodynamic results for model QCSEE over-the-wing configurations** W Olsen, R Burns, and D Groesbeck (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-23* 26 p 15 refs

Noise spectra in three dimensions and aerodynamic data were measured for a model of the NASA QCSEE (Quiet Clean Short-Haul Experimental Engine) over-the-wing configuration The effects of flap length, nozzle exhaust velocity, and nozzle geometry were determined using a single nozzle and wing-flap segment Related tests indicated that the scaled up model data would be representative of full scale flap noise with the QCSEE engine The scaled-up QCSEE model data imply that the noise goal will be very nearly attained (Author)

A77-19983 * # **Prediction of laminar and turbulent boundary layer flow separation in V/STOL engine inlets** D C Chou, R W Luidens, and N O Stockman (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-144* 17 p 8 refs

The paper provides a theoretical description of the development of the boundary layer on the lip and diffuser surface of a subsonic

inlet at arbitrary operating conditions of mass flow rate, freestream velocity and incidence angle Both laminar separation on the lip and turbulent separation in the diffuser are discussed The agreement of the theoretical results with model experimental data illustrates the capability of the theory to predict separation The effects of throat Mach number, inlet size, and surface roughness on boundary layer development and separation are illustrated (Author)

A77-20006 # **Electrical flight control for Boeing YC-14** M Scott (Marconi Elliott Avionics Systems, Ltd , Rochester, Kent, England) *Aircraft Engineering*, vol 49, Jan 1977, p 4 10

As part of the United States Air Force Advanced Medium STOL (AMST) program for modern tactical airlift in the 1980's, two prototype YC-14 aircraft are being manufactured by the Boeing Company with an advanced Electrical Flight Control System (EFCS) developed for them After a description of YC 14 AMST, which can commute without refuelling between two 2000 ft semi prepared runways 400 nm apart carrying 27,000 lbs and has USB (Upper Surface Blown) flap and lateral control 2 5 times more powerful than conventional aircraft, the technological background of YC-14 EFCS including the failure survival flight control system, is discussed The operational details of the flight control electronics involve computer units, interface units, optical coupler units, optical data links, a control display panel and a test/failure identification panel Further equipment details include the use of optical/electrical and electrical/optical interfacing circuits in optical data links, are presented The flight software design which is structured into integrated modules each programmable to 10,000 words, is also discussed A Y

A77-20025 **Fifty years later The new Helicostat (Cinquante ans après - Le nouvel 'Helicostat')** *Air et Cosmos*, vol 14, Jan 8, 1977, p 19 22, 40 In French

Revival of interest in the Helicostat, an arrangement using one or a pair of balloons for stabilization and one or several helicopter rotors for propulsion and guidance, is noted and old and new variants of Helicostat designs are described Arrangements with a helirotor flanked by two stabilizing balloons, and capable of transporting girders or logs, and a single balloon flanked by two pairs of rotors and capable of lifting and transporting a 30 ton cargo container, are described The enhanced stability of the craft (gentle descent even when fully loaded and with all engines failing) and cost estimates are emphasized The latter ('catamaran') arrangement is recommended for load transfer operations in congested ports with inadequate facilities R D V

A77-20080 * # **An analytical method for ride quality of flexible airplanes** R L Swaim, D K Schmidt (Purdue University, West Lafayette, Ind), P A Roberts (USAF, Washington, D C), and A J Hinsdale *AIAA Journal*, vol 15, Jan 1977, p 4 7 9 refs Grant No NsG 4003

A new and easily used method of aircraft ride quality analysis is developed, and its use is illustrated by a numerical example using DC 8 airplane equations of motion The method readily allows any type of stability augmentation system to be included for good handling qualities A particularly powerful method of specifying and achieving all roots of a desired closed loop characteristic equation by use of full state variable feedback is described and applied to the DC 8 example (Author)

A77-20085 * # **Nonlinear steady incompressible lifting-surface analysis with wake roll-up** E O Suciu and L Morino (Boston University, Boston, Mass) *AIAA Journal*, vol 15, Jan 1977, p 54 58 13 refs Grant No NGR-22 004 030

The problem of lifting surfaces in steady incompressible flow is considered in terms of an integral equation relating the potential discontinuity on wing and wake to the normal derivative of the potential (normal wash) on the lifting surface 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 discontinuity and the normal wash to be constant within each element The wake geometry is obtained through 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 Numerical results are in good agreement with existing ones (Author)

A77 20086 # **The development of flow boundary layers in turbomachines (Zur Frage der Entwicklung von Stromungsgrenzschichten in Turbomaschinen)** W Pache Darmstadt, Technische Hochschule, Fachbereich Maschinenbau, Dr Ing Dissertation, 1976 104 p 70 refs In German

An experimental investigation was conducted of the formation of two dimensional turbulent boundary layers on turbomachine components in unsteady (oscillating) flow conditions Experiments were conducted in a low-speed wind tunnel with a turbulence generator at a Mach number of 0 1 and a Reynolds number of 4 x 10 to the 5th Pneumatic pressure measurements and hot wire anemometry were used to study the development of boundary layers on both flat plates and airfoil profiles Experimental results were compared with those of a numerical method applied to the study of the formation of laminar boundary layers and to the formation of turbulent boundary layers in turbulent shear flow B J

A77-20093 # **On Newtonian flow past power-law bodies.** R M Barron (Windsor, University, Windsor, Ontario, Canada) *AIAA Journal*, vol 15, Jan 1977, p 117-119 6 refs

Hui (1973) has developed an iterative method for studying the steady Newtonian flow past two dimensional and axisymmetric bodies of any thickness at zero incidence The leading terms of Hui's solution for power law bodies are identical to those of Cole (1957) As Cole points out, these solutions have singularities such as zero density and infinite temperature at the airfoil surface, which arise because hypersonic small-disturbance theory does not account for the region of high entropy surrounding the body Using the method of matched asymptotic expansions, Ryzhov and Terent'ev (1970) have studied the flow in the entropy layer enveloping bodies supporting power-law shocks This paper obtains a uniformly valid solution under the Newtonian flow approximation by combining the outer solution of Cole and the inner solution of Ryzhov and Terent'ev A two dimensional symmetric airfoil of unit length chord placed in a uniform hypersonic stream of a perfect gas at zero incidence is considered B J

A77-20095 # **Incipient separation of leeward flow past a lifting plate in viscous hypersonic flow** S L Gai (Indian Institute of Technology, Bombay, India) *AIAA Journal*, vol 15, Jan 1977, p 122 124 9 refs

It is known that when a thin flat plate of finite chord is set at incidence to an oncoming supersonic/hypersonic stream, the flow on the expansion side can separate resulting in a trailing edge stall The stall depends on the angle of incidence, the Mach number, and the Reynolds number This paper shows for the case of an adiabatic flat plate at incidence in viscous hypersonic flow that a simple correlation exists between the critical angle of incidence at which separation would first appear and the fundamental viscous hyperson ic interaction parameter B J

A77-20122 # Starting systems for aircraft gas turbine engines (Puskovye sistemy aviatsionnykh gazoturbinnykh dvigatelei) B M Kats, E S Zharov, and V K Vinokurov Moscow, Izdatel'stvo Mashinostroenie, 1976 220 p 73 refs In Russian

The present work is concerned with the theory and design characteristics of various starting systems for aircraft gas turbine engines (GTEs) Key factors governing selection of type and parameters of starting systems are identified The influence of the starting characteristics of GTEs on the magnitude and behavior of the starting device power is assessed Standards are derived for selecting the power of starting devices for various types of GTEs Particular attention is directed to the analysis of design and characteristics for basic starting systems and their components, along with an evaluation of system effectiveness Recommendations on selection of starting system type and parameters are made for flight vehicles of different types and applications S D

A77 20123 # Applied gasdynamics /4th revised edition/ (Prikladnaia gazovaia dinamika /4th revised edition/) G N Abramovich Moscow, Izdatel'stvo Nauka, 1976 888 p 61 refs In Russian

The gasdynamic principles of the theory of jet engines and similar systems are outlined, and the theory of one-dimensional gas streams, which forms the basis for modern approaches to the design of jet engines, rotating machines, ejectors, wind tunnels, and test stands is covered in detail Special chapters are devoted to boundary layer theory and jet theory, and the use of these theories in the determination of the friction drag and velocity and temperature fields in nozzles, ejectors, combustion chambers, etc Chapters dealing with hypersonic flows, rarefied gas flows, and with the elements of magnetohydrodynamics are included with a view toward space applications V P

A77 20129 Symposium on Aeroelasticity in Turbomachines, Ecole Nationale Superieure de Techniques Avancees, Paris, France, October 18-23, 1976, Proceedings (Symposium sur l'Aeroelasticite dans les Turbomachines, Ecole Nationale Superieure de Techniques Avancees, Paris, France, October 18 23, 1976, Proceedings) Symposium sponsored by the International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz *Revue Francaise de Mécanique,* Special Issue and Supplement, 1976 210 p In French and English

Papers are presented on the hydrodynamic interaction between profile cascades, on flutter instability in an annular cascade on the flutter characteristics of transonic compressor blades, and on the torsional stall flutter of an airfoil Also considered are blade flutter in a subsonic turbine cascade, unsteady pressures on a harmonically oscillating staggered cascade in incompressible and compressible flow, and a study of choking flutter Rotor-stator interaction in a subsonic axial flow compressor stage, unsteady aerodynamic loading of rotor blades in a transonic axial flow compressor, and the use of thin-film transducers for measuring unsteady pressures in turbomachines are also examined B J

A77 20131 Preliminary reflections on the problems of aeroelasticity in turbomachines (Reflexions preliminaires sur les problemes d'aéroelasticite dans les turbomachines) M Roy *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mécanique,* Special Issue, 1976, p 7 9 In French

A general introduction is presented to the problem of flutter in turbomachines with emphasis on the fundamental difficulties associated with a theory of real flow in turbomachines and on the necessity, justified by practical experience, to use imperfect concepts of aeroelasticity in the analysis Particular attention is given to the basic process of aeroelasticity - the interaction or coupling of the essentially elastic deformation of the structure in question and the flow around the structure B J

A77-20137 Unsteady aerodynamic forces acting on loaded two-dimensional blades in nonuniform incompressible flows H Atassi (Notre Dame, University, Notre Dame, Ind) and M E Goldstein *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18 23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 47-56 19 refs Grant No AF AFOSR-74 2675

A complete systematic theory for inviscid incompressible flows about two-dimensional airfoils oscillating or subject to a periodic gust is developed which assumes that the fluctuating flow velocity is small compared with the mean flow velocity The unsteady flow is linearized about the full potential flow of the airfoils, and effects of the mean-flow angle of attack and the airfoil geometry are completely accounted for through the mean potential flow Some results are reported for application of the theory to the problems of a single airfoil in a periodic gust, an oscillating airfoil, a cascade of airfoils in a periodic gust, and a cascade of oscillating airfoils It is shown that even small angles of incidence would produce separation near the leading edge of a very thin airfoil in a gust and would invalidate inviscid-flow analyses, that flow conditions are significantly altered mainly at the leading edge as an airfoil oscillates from one position to another, and that the unsteady aerodynamic force and moment acting on a cascade of oscillating airfoils can be split into two components the wake induced component and the cascade response to the instantaneous upwash velocity F G M

A77 20138 Some recent developments in unsteady aerodynamics of a supersonic cascade M Kurosaka and I H Edelfelt (General Electric Co , Schenectady, N Y) *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 57 64 13 refs Contract No F44620 74 C 0043

Recent developments in the study of the unsteady aerodynamics of supersonic cascades are reviewed, emphasizing hitherto unpublished analytical results on supersonic unstalled flutter Characteristics and the physical mechanism of supersonic unstalled flutter are discussed, difficulties associated with the analysis of such flutter are examined, and the passage approach is outlined for circumventing the complication arising from the breakdown of acoustic theory in the far field in the case of low frequencies The analysis is extended to the higher frequency range, and analytical results are presented for the low frequency case as well as for the cumulative nonlinear effect of airfoil shape Results for isolated oscillating parabolic arc and flat plate airfoils are given which appear to explain the importance of airfoil shape in supersonic unstalled flutter F G M

A77 20139 On the analysis of the aerodynamic and flutter characteristics of transonic compressor blades M F Platzer (U S Naval Postgraduate School, Monterey, Calif), W R Chadwick, and P B Schlein *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris,*

France, Oct 18-23, 1976) Revue Française de Mecanique, Special Issue, 1976, p 65-72 20 refs Navy supported research

Studies of supersonic and transonic flows past oscillating cascades performed in the last four years are reviewed The basic governing equations and necessary boundary conditions are given, a method-of-characteristics solution is developed for supersonic flow past oscillating flat-plate cascades, and a purely analytical solution is obtained for the case of a periodic flow Approaches to supersonic and transonic flows which take thickness effects into account are evaluated Results are presented for a study of the stability of both supersonic and transonic cascades, which was carried out by computing blade lift and moment values as functions of the various blade parameters F G M

A77-20140 Comparison between theoretical and experimental results of torsional stall flutter of an airfoil H Tanaka (Tokyo, University, Tokyo, Japan), K Shinohara, and Y Hanamura *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticité dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Française de Mecanique,* Special Issue, 1976, p 81 88 10 refs

A theory for analyzing the stall flutter of an airfoil with leading edge separation is outlined which takes into account the unsteady pressure fluctuation behind the airfoil and which can be applied to various points of rotation Results obtained by this theory are compared with those obtained experimentally in a water tunnel at a Reynolds number of approximately 50,000 Good qualitative agreement is found between the theoretical and experimental results F G M

A77 20141 Experimental and theoretical investigations of the aerodynamic damping of turbojet rotor blade vibrations G S Pisarenko, A A Kaminer, and V A Balalaev *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18 23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 89-94 7 refs

Test of the aerodynamic damping of turbojet blade vibrations were conducted in subsonic and transonic air streams as well as in water streams Assuming that the blade cascade can be regarded as a single vibrating blade, aerodynamic damping is determined as the sum of the damping of three vibration modes bending, torsional, and bending torsional vibrations B J

A77-20142 Investigation of blade flutter in a subsonic turbine cascade A Kirschner, G Gyarmathy (Brown, Boveri et Cie AG, Baden, Switzerland), and C Pelet *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticité dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 97-104 5 refs

Experiments were performed to measure the aerodynamic damping of a linear subsonic turbine cascade under variable flow conditions for the cases of bending, torsional, and combined vibration modes Also considered was the effect of relative blade mass and moment of inertia (combined with the variable position of the torsional axis) on aerodynamic damping and the flutter boundary The development of the amplitudes of vibration, the interblade phase relations, and the modulation of self-excited vibratory motions were also examined The goal of the analytical effort was to develop a rapid approximate method for analyzing and predicting the aeroelastic behavior of the subsonic cascades B J

A77-20143 Unsteady aerodynamic forces in a rectilinear cascade of subsonic blades (Forces aerodynamiques instationnaires en grille rectiligne d'aubes subsonique) H Loiseau and J Nicolas (ONERA, Châtillon sous Bagneux, Hauts de Seine, France) *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aéroélasticité dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Française de Mecanique,* Special Issue, 1976, p 105 114 11 refs In French

The theoretical part of the investigation deals with an infinite rectilinear cascade, a uniform compressible subsonic two dimensional flow, moderate incidence, and pitching or translational oscillation without deformation The unsteady forces acting on all the blades are computed when one of them is in motion (the canonical configuration) The experimental part consists of wind tunnel measurements (in the free-stream Mach number range of 0 3 0 8) of global forces only on the blade in motion, and of pressure on the blade in motion and on the neighboring fixed blades Tests were conducted on Pfenninger Sulzer thick airfoils and on NACA 65 A 006 airfoils B J

A77 20144 Unsteady pressures on a harmonically oscillating staggered cascade in incompressible and compressible flow H Triebstein (Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt, Institut fur Aeroelastik, Gottingen, West Germany) *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroélasticite dans les Turbomachines, Paris, France, Oct 18 23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 115 122 13 refs

Measurements of the pressure distribution on a staggered plane cascade at zero angle of attack were carried out in a cascade wind tunnel with the purpose of investigating pitching and flapping oscillations at various reduced frequencies and at Mach numbers of 0 2, 0 4, and 0 6 The cascade considered had seven plates and a stagger angle of 60 degrees, the ratio between the plate depth and the plate spacing was 1 6, the individual plates had a depth of 0 08 m and a thickness of 0 006 m Experimental results confirm that the root singularity at the leading edge and the Kutta condition at the trailing edge represent suitable assumptions for the purpose of the theoretical determination of the pressure distributions B J

A77-20145 An experiment to measure moment coefficients for aerofoils oscillating in cascade D S Whitehead (Cambridge University, Cambridge, England), P J Watson, T Nagashima, and R J Grant *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 123-134

A test cascade rig is described which provides a practical way of measuring the moment coefficient for a blade in torsional vibration The blades in the test cascade are forced to vibrate by electromagnetic exciters, and the moment coefficient is deduced from the aerodynamic moment obtained by subtracting a 'wind-off' strain gauge reading from a 'wind on' reading Some typical experimental results are presented which show that available theories provide a satisfactory prediction of the behavior of flat unloaded blade sections F G M

A77-20146 * Stall flutter and nonlinear divergence of a two-dimensional flat plate wing J Dugundji (MIT, Cambridge, Mass) and K Aravamudan *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aéroélasticité dans les Turbomachines, Paris,*

France, Oct 18-23, 1976) Revue Francaise de Mecanique, Special Issue, 1976, p 135-142 11 refs USAF NASA supported research

Tests were conducted in a small wind tunnel to study the torsional stall flutter behavior of a two-dimensional flat plate wing pivoted about the midchord The nonlinear static divergence equilib rium properties of the wing were well predicted from the measured static moment characteristics Large amplitude limit cycles ranging from plus or minus 11 degrees to plus or minus 100 degrees were observed Stall flutter occurred above a critical value of a reduced frequency of about 2 Self-excitation occurred for initial angles of attack between 0 and 8 degrees Nondimensional harmonic coeffi-cients were extracted from the free transient vibration tests for amplitudes up to 80 degrees B J

A77-20147 Experimental aeroelastic investigations on a cascade in compressible flow P Bublitz (Deutsche Forschungs und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Aeroelastik, Gottingen, West Germany) *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 143-150 21 refs Research sponsored by the Kraftwerk-Union

Tests were performed in a high speed wind tunnel on a highly staggered cascade of relatively great solidity in conditions which reproduce the occurrence of violent blade vibrations in the last stage of stationary steam turbines The design of the test cascade was based on the following assumptions the worst flow conditions are to be expected in the tip region of the turbine blading, and the strongest stresses of the blades are produced by the unsteady aerodynamic forces also near the tip region It is found that the last stage of a large turbine can undergo buffet-oscillations before a reduction of mass flow leads to stall Due to this 'jump' effect, considerable dynamic loads are to be expected when the turbine is operating at or near the critical Mach number B J

A77-20148 A study on choking flutter Y Tanida (Tokyo, University, Tokyo, Japan) and Y Saito *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aéroélasticité dans les Turbo-machines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mécanique,* Special Issue, 1976, p 151-156

Tests involving strain-gage measurements and schlieren flow visualization were conducted in a blowdown test facility to study the nature of the choking flutter of an airfoil in transonic compressible flow The experiment indicates the importance of wall-distance effects on the airfoil instability and shows that the aerodynamic characteristics of airfoil choking in the transonic region are different from those in the subsonic region The same problem was also investigated by using a finite difference method to solve the one-dimensional unsteady characteristic equations for an airfoil oscillating about its midchord between parallel walls B J

A77-20151 Flow instability in supersonic compressors in the regime of low compression rate (Instabilites d'ecoulement dans les compresseurs supersoniques en regime de faible taux de compression) J Paulon (ONERA, Châtillon-sous Bagneux, Hauts de-Seine, France) *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroélasticite dans les Turbomachines, Paris, France, Oct 18-23, 1976) Revue Francaise de Mecanique,* Special Issue, 1976, p 177 184 7 refs In French

Experiments were devised to study supersonic flutter in annular transonic compressors operating at excess velocity with an excessive-ly open downstream gating It is shown that the flutter instabilities are due to the formation of a recompression shock near the exit of the interblade channels It is found that either a flow with a conical wave downstream of the cascade or shock waves confined in the channels and leading to separations corresponds to small oscillations of gating sections Experimental results are interpreted on the basis of a one dimensional flow model B J

A77 20153 On the unsteady aerodynamic rotor blade loading in a transonic axial flow compressor with steady state inlet distortion M Lecht (Deutsche Forschungs- und Versuchsanstalt fur Luft und Raumfahrt, Institut fur Luftstrahlantriebe, Cologne, West Germany) and H B Weyer *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aeroelasticite dans les Turbomachines, Paris, France, Oct 18 23, 1976) Revue Francaise de Mécanique,* Supple-ment, 1976, p 1 8

A single stage transonic compressor was investigated with a 120 deg screen induced upstream total pressure distortion and a sinusoidal preswirl distortion By means of a simple method which allows to correlate the measured flow field in front, between, and aft of the compressor stage the sectorwise operating conditions are evaluated and compared with the undistorted overall performance For 85 percent speed the unsteady response of the rotor blade element at 50 percent height is given in terms of the unsteady lift coefficient versus angle of attack The attempt has been made for an approach to the theory of a single airfoil subjected to transverse and chordwise gusts (Author)

A77-20154 Vortex streets in the wakes of subsonic and transonic turbine cascades O Lawaczeck, K A Butefish, and H J Heinemann (Deutsche Forschungs und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Stromungsmechanik, Gottingen, West Germany) *(International Union of Theoretical and Applied Mechanics and Association Technique pour la Turbine a Gaz, Symposium sur l'Aéroelasticite dans les Turbomachines, Paris, France, Oct 18 23, 1976) Revue Francaise de Mecanique,* Supplement, 1976, p 9-16 8 refs

During the transonic cascade research program in the DFVLR-AVA Gottingen it was found that the wake flow behind the blades of cascades and isolated profiles consists of vortex streets In the case of a special gas turbine cascade the frequencies and their strength of the vortices were measured in the subsonic and transonic flow regime A method is described to obtain besides the frequency of the vortices and the corresponding Strouhal number the width of the two vortex rows These values are given as function of the downstream Mach number and an appropriate Mach number at the trailing edge of the blade (Author)

A77-20238 Turbulence generated noise on either side of a double layer jet R Dash (Indian Institute of Technology, New Delhi, India) *Letters in Applied and Engineering Sciences,* vol 4, Dec 1976, p 431-442 12 refs

Ffowcs Williams' (1974) extension of Lighthill's (1952) aero-dynamic theory has been further developed to study the turbulence generated noise on both sides of a uniformly moving jet flow An aerodynamic zone of silence bordering the external sides of the vortex interfaces has been predicted An interesting feature is the distinct structure of the final radiation in the illuminated and shadow zones without any recourse to dimensional analysis (Author)

A77-20260 Helicopter motion Equation linearization A Fermelia (Hughes Aircraft Co , Aurora, Colo), D A Gyorog (U S Army, Rodman Laboratory, Rock Island Arsenal, Rock Island, Ill), and V J Flanigan (Missouri Rolla, University, Rolla, Mo) *IEEE Transactions on Aerospace and Electronic Systems,* vol AES 12,

Nov 1976, p 767-782 5 refs Research sponsored by the University of Missouri Rolla, U S Army, and NSF

Equations of helicopter motion are linearized about a prescribed nominal state Once the linearized system of equations is obtained, it is discretized and the output of the nonlinear system is compared to that of its linearized counterpart for validation The linear model so obtained is then used in investigating the stability and control characteristics of rotorcraft Three approaches to validation are described a static check, a homogeneous test case, and an objective function test in which an assigned pseudoflight path is compared to the state generated by the linear system and the error is fed into an objective functional to be minimized Appendices provide detail on the nonlinear equations of motion, the linearization procedure, life and drag curves, and validation results R D V

A77-20377 # **Fokker-VFW** J H de Koomen (Fokker VFW, Schiphol Airport, Netherlands) *Ruimtevaart,* vol 25, Dec 1976, p 22-33 In Dutch

Management of space projects and advances in space technology are reviewed Space-related activities of the Netherlands Fokker aircraft firm in the pre-ESA period (ESRO, ELDO) and within the framework of ESA programs are recounted, with the Astronomical Netherlands Satellite (ANS) taken as landmark project Among the Fokker developments sketched in the review are nutation dampers, components for GEOS, OTS, ARIANE, and Spacelab Collaboration with ERNO, the German based subdivision of Fokker-VFW, is mentioned R D V

A77-20439 # **Vertical takeoff lift augmentation - The 'sculptured deck' concept** P R Greene (Grumman Aerospace Corp , Bethpage, N Y) *Journal of Aircraft,* vol 14, Feb 1977, p 111-114 7 refs

Experimental results are presented which demonstrate that the lift of a hovering VTOL aircraft can be increased greatly by appropriately contouring the ground surface under the vehicle The augmented lift is created by redirecting the jet exhaust flow so that it impinges on the aircraft underbody One configuration of the ground plane is shown to augment the total upward force on the vehicle by a factor of 2 4 and at the same time increases the roll, pitch, and yaw stability of the aircraft The measurements were taken from a particular VTOL model and two types of ground plane, but the idea can be generalized to include arbitrary aircraft planform, any number of jets, any shape jet exit, and a wide assortment of ground plane topographies The high degree of design flexibility intrinsic to the concept may be sufficient to offset the serious problems of underbody heating, hot-gas reingestion, and the necessity of a prepared takeoff site (Author)

A77-20440 # **Dynamics of a slung load** L Feaster (Massachusetts, University, Amherst, Mass , U S Army, Washington, D C), C Poli, and R Kirchhoff (Massachusetts, University, Amherst, Mass) *Journal of Aircraft,* vol 14, Feb 1977, p 115-121 13 refs

The yaw damping coefficient of an 8 x 8 x 20 ft cargo container is experimentally determined by forced oscillation tests The result is then used in linearized small perturbation stability analyses of a slung load, considering both single-cable and two cable tandem suspension systems The effect of attaching stabilizing fins to the container and of incorporating a rotating wheel for stability augmentation is also theoretically investigated The results agree well with previous model and full-scale tests and also show that the two-cable tandem suspension system may offer a satisfactory means of transporting the standard cargo container throughout the speed range of most present day cargo helicopters (Author)

A77-20441 * # **Lateral equilibrium of asymmetrical swept wings - Aileron control vs geometric twist** T A Weisshaar (Virginia Polytechnic Institute and State University, Blacksburg, Va) *Journal of Aircraft,* vol 14, Feb 1977, p 122 127 13 refs Grant No NsG-2016

A static aeroelastic phenomenon unique to an aircraft with asymmetrically swept wings is discussed A simple formula is derived from the analysis of a highly idealized model The validity of this formula is examined through the use of a more sophisticated numerical analysis Among the results of this analysis are the following aileron settings of a few degrees are sufficient to trim such aircraft in roll-for g-flight, the use of built in twist in the form of initial negative dihedral provides an efficient alternative to aileron trim, if the wing is elastically tailored in a proper fashion, it may be possible to design a wing whose elastic deformation under airloads provides a form of self-trim in roll at the cruise q of the aircraft (Author)

A77-20443 # **Handling quality criterion for heading control** R H Hoh and I L Ashkenas (Systems Technology, Inc , Hawthorne, Calif) *Journal of Aircraft,* vol 14, Feb 1977, p 142-150 15 refs Contract No F33615-72 C 1456

A heading control criterion based on the aileron rudder sequencing required to achieve coordinated turns is presented Quantification of the aileron-rudder shaping is obtained by consideration of the ideal crossfeed which completely eliminates sideslip induced by aileron inputs The shaping and gain parameters based on this ideal crossfeed are defined and correlated with pilot opinion ratings Excellent correlation is obtained with data from simulation of STOL, fighter aircraft, and space shuttle vehicles (Author)

A77-20445 # **The scatter factor in the reliability assessment of aircraft structures** A M Freudenthal (George Washington University, Washington, D C) *Journal of Aircraft,* vol 14, Feb 1977, p 202 208 11 refs USAF supported research

The lack of reliability of the analytical methods of prediction of fatigue lives of structural parts and complete structures requires the use of 'scatter factors' to be applied to the results of full-scale fatigue tests of aircraft components and of structures under loading representative of conditions of service An attempt is made to define the scatter factor in probabilistic terms as the ratio between the best estimator of the fatigue life obtained in a small number of tests and the time to the first failure in a fleet of aircraft of specified size, at a specified reliability level It is shown that with this definition the scatter factor can be related to the result of a single full scale test of a complete structure and associated with a specific reliability level The effect of the minimum fatigue life on the scatter factor is studied and its significance demonstrated in a set of tables computed on the basis of the derived equations (Author)

A77-20446 # **Application of dimensional analysis to predict airplane stopping distance** M K Wahi (Boeing Commercial Airplane Co , Renton, Wash) *Journal of Aircraft,* vol 14, Feb 1977, p 209 214 9 refs Contract No F33657-74-C-0129

A new technique has been developed to predict airplane braking distance performance in terms of aircraft parameters, runway environment, and brake control systems performance A dimensional analysis technique was used to determine significant dimensionless groups or pi terms required to express the braking performance in equation form A hardware-analog brake control simulator was used to gather experimental data necessary to determine the constants and exponents in the performance equation Among the airplanes studied were the Boeing 727, 737, 747, the Lockheed C-141, and the McDonnell F 4 A prediction equation permits the calculation of stopping distance, assuming that proper information concerning airplane and weather parameters is available, as well as accurately measured tire runway friction coefficients (Author)

A77 20448 # **Static aeroelastic twist effects on helicopter rotor-induced velocity** K S Nagaraja and G A Pierce (Georgia Institute of Technology, Atlanta, Ga) *Journal of Aircraft,* vol 14, Feb 1977, p 217 219 8 refs

The static elastic twist and the mean inflow velocity distribution are determined by an approximate analytical technique in order to find the unsteady aerodynamic flowfield associated with a helicopter rotor, in hover or in vertical ascent, with low inflow conditions The inflow velocity thus found is then available for computing the wake spacing needed in arriving at the unsteady airloads Results based on a linearized solution yield a higher elastic twist distribution than an exact solution derived The inflow velocity distribution is thus accepted as higher than the exact distribution R D V

A77-20449 # **Airfoil design by optimization** P Ramamoor thy (National Aeronautical Laboratory, Bangalore, India) and K Padmavathi (Aeronautical Development Establishment, Bangalore, India) *Journal of Aircraft,* vol 14, Feb 1977, p 219 221 7 refs

An airfoil design technique is described which uses an analytical method for representing the airfoil contour by Wagner functions and a computational procedure for obtaining the values of the coeffi cients of expansion The method for approximating an airfoil contour by a Fourier type series of Wagner functions is briefly outlined, and a flow chart for airfoil design by optimization is given The design technique is validated by applying it to the NACA 0009 airfoil as well as to a typical airfoil that gives a 'roof top' pressure distribution Advantages of this technique over classical design methods are discussed F G M

A77-20573 Deutsche Gesellschaft fur Luft- und Raumfahrt, Shell Buckling Meeting, Meersburg, West Germany, April 29, 30, 1976, Reports and Discussion Contributions (Deutsche Gesellschaft fur Luft- und Raumfahrt, Schalenbeultagung, Meersburg, West Germany, April 29, 30, 1976, Vortrage and Diskussionsbeitrage) Edited by M Esslinger and B Geier Braunschweig, Deutsche Forschungs und Versuchsanstalt fur Luft- und Raumfahrt, 1976 206 p 70 refs In German $12 35

Buckling loads in the case of axial cylindrical tubes are considered along with buckling tests involving hyperbolic axisymmetric shells, the local load capacity of aircraft components, the carrying capacity of fiber-reinforced plastic panels, welding residual stresses and deformations in the case of the welding of thin-wall shells, and prebuckling forms involving isotropic circular cylinders Attention is also given to tolerances in container construction, shell buckling and aspects of safety, regulations concerning the buckling of cylinders under external pressure, buckling regulations for isotropic cylinders subjected to an axial load, the numerical determination of the buckling load of hemispheres and calottes with the aid of the multitarget method, and a criterion for the evaluation of the imperfection sensitivity in the case of general shells G R

A77-20603 Symposium on the Presentation of Information to Pilots, London, England, March 18, 1976, Proceedings Symposium sponsored by the Royal Aeronautical Society London, Royal Aeronautical Society, 1976 75 p S6 10

Papers are presented concerning the theory and practice of advanced displays to be used by pilots in aircraft guidance and control Relevant flight, engine, and system display requirements are identified New concepts are outlined which will help refine the still incomplete theory of perception Featured topics include investigation of the optimum use of advanced displays in future transport aircraft, perception problems related to presentation of information to pilots, and use of advanced aeronautical cartography for improved legibility and effectiveness of graphic displays S D

A77-20605 # **Flight information for airline pilots - The certification angle** R Rye and W L Horsley (Civil Aviation Authority, London, England) In Symposium on the Presentation of Information to Pilots, London, England, March 18, 1976, Proceedings London, Royal Aeronautical Society, 1976 10 p

An airworthiness authority is required to set minimum standards of airworthiness and to make sure that they are implemented and maintained The difficulties encountered in setting these standards for information display are discussed It is recomended to use a warning signal that is compatible both with the cause of its occurrence and with the human limitations of the crew In particular, it is required to use a central warning panel visible to both pilots with primary and secondary warnings, and a limited number of audible warnings to avoid confusion The warning should be repeated if the consequences of a wrong selection of control are hazardous It is also shown that the channels of communication through which line aircrews receive their basic operating data are not working as well as they could, due to discrepancies between the 'development and certification' world and the 'operational' world The Operations Manual should be recognized as the prime flight deck reference document, required to be carried on the airplane S D

A77-20606 # **Investigation into the optimum use of advanced displays in future transport aircraft** R E Hillman (British Aircraft Corp , Ltd , Weybridge, Surrey, England) and J W Wilson (Hawker Siddeley Aviation, Ltd , Hatfield, Herts , England) In Symposium on the Presentation of Information to Pilots, London, England, March 18, 1976, Proceedings London, Royal Aeronautical Society, 1976 21 p

The paper discusses potential improvements in flight deck instrumentation as related to flight, engine, and system displays to meet the requirements of next-generation transport aircraft The proposals take full account of the demonstrated capability for safe two crew operation of transport aircraft along with the frequent comment that in such aircraft the workload is already at the upper acceptable limit in critical conditions Only the monochrome cathode ray tube is considered to offer an acceptable risk for the advanced display field The inherent flexibility of electronic displays indicate that further significant improvements are possible through the suppression of untimely or unnecessary information and the consequent integration of relevant data on a smaller display area S D

A77-20608 # **Presenting information to the general aviation pilot** A Bramson In Symposium on the Presentation of Information to Pilots, London, England, March 18, 1976, Proceedings London, Royal Aeronautical Society, 1976 9 p

Following a review of the tasks of a single pilot operating a light aircraft on a definite flight mission, the paper examines basic flight, engine, systems, and navigational requirements for the safe and effective performance of a one man crew Common weaknesses in modern single and twin engine light aircraft are identified Recommendations are made to help the pilot perform three or more skilled functions simultaneously Major recommendations call for improved altimeter, color coded instruments whenever applicable, grouping together of all related controls and instruments, a simple fuel selector/fuel gage arrangement, all controls within the reach of the pilot, and improved methods of storing radio frequencies for quick recall to reduce workload S D

A77-20619 # **Remotely piloted vehicles - An Air Force view** J Mitchell (RAF, London, England) In Symposium on RPVs - Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 11 p

A description is given of the current operational roles of remotely piloted vehicles (RPV) RPV characteristics are examined, taking into account aspects of vulnerability/survivability, mission effectiveness, data links, guidance and control, and operational command and control Flight regimes at low altitude, medium altitude, and high altitude are considered Attention is given to reconnaissance, target acquisition and marking, electronic warfare, weapon delivery, air-to-air combat, defense suppression, RPV operating experience to date in the RAF, RPV problem areas, and the most fruitful areas for further study G R

A77-20620 # **R P Vs in the maritime environment** K D D Clitherow (Royal Navy, London, England) In Symposium on RPVs Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 8 p

A major threat to ships in the field of above water warfare at sea comes from missiles A number of approaches utilizing RPVs can be employed in meeting such a threat Attention is given to questions of target identification, the employment of RPVs for electronic countermeasures designed to destroy or deflect attacking missiles, the use of RPVs in antisubmarine warfare, RPV payloads, and problems related to the transportation of an RPV on a ship G R

A77-20621 # **The R P V in perspective** R Melling (Hawker Siddeley Aviation, Ltd , Brough, Yorks , England) In Symposium on RPVs - Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 7 p

The term RPV is used to cover a vehicle which incorporates some combination of remotely piloted, preprogrammed, and autonomous operating facilities Factors leading to an unmanned aircraft are examined and suitable roles for the RPV are considered The roles are related to target simulation, general surveillance, specific reconnaissance, artillery spotting, the creation of confusion, and jamming Research and development problems are also discussed, taking into account engines, sensors, navigation, remote control, the data link, and aspects of launch and recovery G R

A77-20622 # **Remotely piloted vehicles - The influence of system thinking on applied technology** A C Wesley (Ferranti, Ltd , Electronic Systems Dept , Edinburgh, Scotland) In Symposium on RPVs - Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 15 p

A description of the characteristics of RPV systems is presented Both fixed and rotating wing types are used The range of overall systems extends from single controlled vehicles operated locally to multiple vehicles operated by complex command posts having control of many vehicles which may penetrate deeply into enemy country Communication techniques and questions of navigation and flight control are also discussed along with electro-magnetic sensors and radar technology, electro-optical sensors, and aspects of data handling and processing G R

A77-20623 # **Convertible aircraft** W D Simpson (British Aircraft Corp , Ltd , Stevenage, Herts , England) In Symposium on RPVs Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 14 p

A convertible aircraft is defined as a machine which can be flown manned, but with a manual or remote override so that it may be controlled as an RPV In addition, it may also be flown unmanned as a conventional RPV Unmanned convertibles can be controlled either by a ground operator or from a manned convertible The basic aircraft will be a low cost, light fixed wing machine probably powered by a piston engine Suitable design characteristics for convertible aircraft are considered Attention is given to the operational use of convertible aircraft by the Army and the Navy G R

A77-20626 # **The Aerodyne - An R P V with multiple capability** A J White (Hawker Siddeley Dynamics, Ltd , Hatfield, Herts , England) and G Harms (Dornier GmbH, Friedrichshafen, West Germany) In Symposium on RPVs Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 21 p

The propulsion system of the Aerodyne uses a gas turbine engine to drive a ducted fan The static thrust obtained is sufficient to carry the weight of the vehicle Like the helicopter, the Aerodyne can hover, or take off and land vertically For forward flight the flaps which direct the fan output are gradually changed to the horizontal The development of an experimental Aerodyne vehicle by a German aerospace company is discussed Aerodyne configurations for maritime and battlefield operations are considered and a description is presented of a system concept for battlefield operation A computer in a command vehicle will be used for picture processing, Aerodyne tracking, mission planning, and for equipment testing and check-out G R

A77 20627 # **Skyspy - A ducted RPV fan** H S Ransom (Short Brothers and Harland, Ltd , Belfast, Northern Ireland) In Symposium on RPVs - Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 10 p

The essential elements of Skyspy include a fan, an engine to drive it, a duct enclosing the fan, control surfaces in the jet, and the closed loop control systems and sensors to govern the pitch, roll, yaw, and axial motions of the airframe The ability of Skyspy to hover or fly at very low speeds is an important factor in operations related to the surveillance of a static or slowly moving objective and search missions at low speeds Higher forward speeds can be obtained by inclination of the complete airframe The development of an experimental vehicle is discussed Attention is also given to the employment of Skyspy as a relay station, details concerning its payload, aspects of vehicle control, and takeoff and landing operations G R

A77-20628 # **B A C experience with small fixed wing and rotary wing R P Vs** R Stephenson (British Aircraft Corp , Guided Weapons Div , Bristol, England) In Symposium on RPVs - Roles and Technology, London, England, January 27, 1976, Proceedings London, Royal Aeronautical Society, 1976 14 p

A description is given of research programs conducted with the aid of the Big Wig model aircraft The aircraft has a high wing of 2 meters span and a useful payload of about 2 kg An investigation of electrostatic autostabilization techniques is reported Other experiments were related to the use of an optical beam riding system to guide a remotely piloted vehicle The development of a mini-RPV for surveillance or defense suppression roles is discussed along with the selection of a suitable model for rotary wing development studies The selected model was modified to improve its payload capacity while retaining mechanical reliability G R

A77-20629 Inter-noise 76, Proceedings of the International Conference on Noise Control Engineering, Washington, D C , April 5-7, 1976 Conference sponsored by the International Institute of Noise Control Engineering Edited by R L Kerlin (Pennsylvania State University, University Park, Pa) Poughkeepsie, N Y , Institute of Noise Control Engineering, 1976 558 p $35

The papers deal with recent developments in noise control and techniques for measuring and analyzing noise data General topics include advanced noise-control techniques, machinery noise reduction at the source, aircraft and airport noise, noise measurement and analysis, reduction of in-plant noise exposure, rail transportation noise, noise control engineering in buildings, materials and products for noise control, traffic noise abatement, community noise, international standards and legislative requirements for noise control, designing and planning for industrial noise control, and effects of noise on the individual and on society Specific papers discuss

real-time signal processing of noise data using cross property techniques, applications of coherence-function techniques in noise diagnosis and prediction, noise reduction procedures for centrifugal fans, structural acoustical considerations for aircraft, inlet noise reduction for gas turbine engines, requirements for ground-based forward-speed simulation in aircraft noise research, and effects of aircraft noise around several airports

F G M

A77-20633 Structural acoustic considerations for aircraft B L Clarkson (Southampton, University, Southampton, England) In Inter-noise 76, Proceedings of the International Conference on Noise Control Engineering, Washington, D C, April 5-7, 1976 Poughkeepsie, N Y, Institute of Noise Control Engineering, 1976, p 67-72

Acoustic pressure forces loading an aircraft structure, pressure fields close to a jet, jet impingement patterns in externally blown flap configurations, response of certain types of structures to excitation, design of structures to take heavy acoustic loading, and transmission of sound through a fuselage and into a cockpit are discussed Responses of composite materials, particularly carbon fiber and boron fiber reinforced plastics incorporated into aircraft skin structures, responses of integrally stiffened skin structures or honeycomb skin structures, or of the internal supporting structure or panel structures to the different modes of acoustic excitation are examined

R D V

A77-20634 * Survey of inlet noise reduction concepts for gas turbine engines D L Lansing and D Chestnutt (NASA, Langley Research Center, Hampton, Va) In Inter-noise 76, Proceedings of the International Conference on Noise Control Engineering, Washington, D C, April 5-7, 1976 Poughkeepsie, N Y, Institute of Noise Control Engineering, 1976, p 73-78

This paper presents an overview of advanced concepts for the suppression of noise in the inlets of gas turbine engines Noise suppression concepts are described, the directions of current research are reviewed, and problem areas requiring further work are indicated The discussion focuses on acoustic liners, high Mach number inlets, active acoustic absorption, water vapor injection, and blade row reflection

(Author)

A77-20652 Error model of an inertial navigation system for integrated navigation based on adjustment according to the method of least squares (Fehlermodell eines Inertialnavigationssystems fur die integrierte Navigation durch Ausgleichung nach der Methode der kleinsten Quadrate) D K Joos (Stuttgart, Universitat, Stuttgart, West Germany) In Symposium on Gyroscope Technology, Braunschweig, West Germany, March 31-April 1, 1976, Reports Dusseldorf, Deutsche Gesellschaft fur Ortung und Navigation, 1976, p 225-250 9 refs In German

None of the many navigational systems currently employed satisfies all the requirements of aviation The approach of 'integrated navigation' attempts to obtain a significant improvement of navigational accuracy and system reliability by means of a suitable integration of different systems of navigation The integrated navigation method developed by Ramsayer (1970) is considered The method is based on an error model of the employed coupled navigation system The procedure of model parameter determination involves the minimization of the sum of the squares of the differences between measured data and computed navigational parameter values The parameter estimation procedure is discussed and the error equations are examined The performance characteristics of the considered model are investigated with the aid of a computer simulation study

G R

A77-20654 The employment of the hybrid flight measurement system for measurements related to the study of a microwave landing system (Zum Einsatz des hybriden Flugmessystems bei der Vermessung eines Mikrowellenlandesystems) K Hurrass and B Stieler (Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt, Institut fur Flugfuhrung, Braunschweig, West Germany) In Symposium on Gyroscope Technology, Braunschweig, West Germany, March 31-April 1, 1976, Reports Dusseldorf, Deutsche Gesellschaft fur Ortung und Navigation, 1976, p 305-328 10 refs In German

A novel measurement system for the determination of the reference flight path of an aircraft in connection with the study of the microwave landing system DLS is discussed The system DLS has been proposed by the Federal Republic of Germany as a possible replacement for the currently used ILS The discussed flight path measurement system includes three cinetheodolites and a target tracking radar on the ground The ground sensors are supplemented by measuring devices carried by the aircraft used in the investigations The onboard devices include an inertial navigation system, a Doppler radar, and a barometric altimeter

G R

A77-20655 New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Symposium sponsored by the Institute of Navigation and U S Navy Washington, D C , Institute of Navigation, 1976 162 p Members, $15 , nonmembers, $20

The present collection of papers is concerned with advances in aerospace navigation, from the latest aerospace applications of celestial, radio, inertial and satellite navigation to the development of sophisticated navigation systems such as laser gyros Featured topics include improved navigation using adaptive Kalman filtering, navigation for sea based remotely piloted vehicles, ring laser gyro strapdown systems, and microwave holographic imaging of aircraft with spaceborne illuminating source Additional developments in software will further improve navigation accuracy in terms of prediction, correction and more complete control of the navigation process

S D

A77-20656 # Evaluation of the accuracy of community relative navigation organization concepts H J Rome (Lowell Technological Institute, Lowell, Mass) and J S Stambaugh (Dynamics Research Corp , Wilmington, Mass) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 4-10

A relative navigation system is one in which each platform determines its position, velocity, and heading with respect to other members of the task force, or community This type of system, which is based on a TDMA communications network, is a form of communications-navigation identification system Results are presented for an accuracy evaluation of the various ways in which the navigation function of such a system can be mechanized A covariance analysis simulator is used to evaluate various organization and mechanical concepts Two performance measures, relative range and pointing, are shown to define the accuracy of a relative navigation system It is shown that mechanizations involving one member whose platform is used to define the community navigation coordinate frame generally provide the most precise relative navigation Stationary references should be included as members of the community if available Mixing the types of dead reckoning systems in a community can degrade relative navigation performance due to filter modeling errors

S D

A77-20657 # Improved navigation using adaptive Kalman filtering L Chin and R Kaufmann (U S Naval Material Command, Naval Air Development Center, Warminster, Pa) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 11-20 42 refs

Basic Kalman Filtering is predicated on a knowledge of the statistics of the underlying noise processes When this information is incomplete or lacking, less stringent assumptions are made and then

adaptive Kalman filtering is applied to the problem The filter adapts itself to the unknown statistics and generates an improved estimate of the system states In the development of this method, correlation of the innovation sequence has been studied extensively in the past few years and many theoretical results have been obtained The application of these results to reduce errors in inertial navigation systems and the advantages and disadvantages are to be studied This paper examines the implementation of the innovation sequence approach to the solution of the adaptive Kalman filtering problem and the application of it to a typical long-range inertial navigation system with unknown noise statistics in an effort to improve system performance Results obtained through computer simulation form a basis for discussions which include implementation requirements, effectiveness in estimating reset parameters, and operational advantages and disadvantages (Author)

A77-20658 # **The new UTC Time Signals** R L Duncombe (Texas, University, Austin, Tex) and P K Seidelmann (U S Naval Observatory, Washington, D C) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976
Washington, D C , Institute of Navigation, 1976, p 21 24 6 refs

Beginning January 1, 1972, the standard time signal broadcasts no longer give directly the rotational position of the earth to an accuracy of 1/10 of a second of time, as had been done previously Instead, the new UTC (Coordinated Universal Time) Time Signals may depart from the rotational position of the earth by as much as 9/10 of a second To retrieve the rotational position of the earth to an accuracy of 1/10 of a second, it is necessary to apply a supplementary correction DUT1 (UT1 UTC) which is coded into the time signal itself Methods for using DUT1 in various applications are reviewed (Author)

A77 20659 # **Navigation to surveying accuracy with an inertial system** J R Huddle (Litton Systems, Inc , Woodland Hills, Calif) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 25 32 19 refs

The inertial surveyor is a self contained system regarded as a black box which is conveyed from point to point over the earth surface via helicopter or land vehicle, providing automatically position, azimuth and gravity disturbance measurements The paper traces the development of the inertial survey system and describes the present configuration and its theory of operation for position survey The discussion covers effects of system random errors, correlation of velocity and position error in open traverse, effects of systematic errors, and nature of residual survey error after traverse closure The accuracy that the system should be capable of achieving in the near future as derived from analysis is presented, and the probable developments to expect in inertial surveying in the future are discussed S D

A77-20662 # **Navigation for sea based RPVs** L Newman (U S Naval Material Command, Naval Navigation Laboratory, Warminster, Pa) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 48-51

Navigation instrumentation is necessary for each mission of sea based remotely piloted vehicle (RPV) The paper examines the impact of each phase of the mission, including launch at sea, traversal to the operations area, critical mission flight operations, and at sea recovery Constraints resulting from the use of existing navigation techniques are identified Launched from a carrier, RPV navigation systems requiring preflight data loading and initialization procedures have the benefit of support systems available for similar functions aboard manned aircraft The journey to the operations area may be navigated using a variety of methods ranging from remote control for line of-sight operations to completely preprogrammed flight controls for over-the-horizon traversals Included in the discussion are additional design requirements and limitations on RPV navigation system alternatives It is concluded that the constraints and requirements peculiar to sea-launched RPVs will challenge the limits of the state of the art of navigation S D

A77 20663 # **Advanced development program for the ring laser gyro navigator** K L Bachman (U S Naval Material Command, Naval Air Development Center, Warminster, Pa) and E W Carson (Honeywell, Inc , St Louis Park, Minn) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976
Washington, D C , Institute of Navigation, 1976, p 52-58

Results are presented for an advanced development program designed to provide base line data from which ring laser gyro strapdown production systems can be developed to achieve the maximum cost-of ownership benefits possible with this new technology It is shown that the ring laser gyro, with an inherent digital output and essentially unlimited input capability, provides an ideal solution for the strapdown gyro dynamic range problem The paper gives the functional description of an advanced development model for the ring laser gyro navigator consisting of an internal navigation unit (INU), control display unit (CDU), mode select unit, and battery The INU provides position, velocity, and attitude information to the CDU and other aircraft systems The INU consists of three orthogonal body mounted laser gyros and accelerometers, a digital computer, I/O electronics, sensor electronics, and a power supply Particular attention is given to the inertial sensors, electrical design, packaging configurations, software, and reliability and maintainability S D

A77-20665 # **A modular fail op fail safe strapped-down navigator** C R Giardina (Singer Co , Kearfott Div , Wayne, N J) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 69-74 9 refs

A redundant modular ring laser strapdown navigation system is presented with a full fail op fail safe capability Fail op fail safe is a term used to denote a system which will fully operate even after any two hard component failures have occurred or after any one soft and one hard (in that order) component failures have occurred The complete Modular Building Block Approach is used along with the application of a sequential multiple classification technique for sensor failure detection and isolation Reliability is found as a function of component reliabilities, probability of false alarm errors and probability of undetected failure errors (Author)

A77-20667 # **A proposition for an advanced aircraft navigation system for civil air transport** G Collin and J B Rigaudias (Compagnie Nationale Air France, Direction du Developpement Technique, Orly Aerogare, Val-de Marne, France) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976
Washington, D C , Institute of Navigation, 1976, p 80-85 9 refs

The paper shows that an advanced integrated aircraft navigation system should take into account network extension, aircraft flexibility, productivity improvements, air traffic system constraints, cost effectiveness, safety, and frequency spectrum constraints The main improvements in takeoff are discussed relative to bad weather conditions, aborted takeoff decision, and rotation control Navigation aspects in climb, cruise, and descent are examined in terms of accuracy capability and versatility Approach and landing are considered for routine autoland, all weather operations, and pitch control The proposed cost effective integrated navigation system is based on advanced distance measuring equipment (DME), advanced inertial navigation system (INS), and augmented instrument landing system (ILS) Advanced DME implies improved accuracy and capacity, repetitive coded message, channel listening, advanced INS

comprises low cost through strapdown mechanization and improved gyros, and augmented ILS incorporates smoothing and independent landing monitor, both based on INS Major advantages of such a system are noted S D

A77-20668 # **Automated Terminal Service** A G Zellweger and E J Koenke (FAA, Washington, D C) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 86-90

It is projected that 65 nontower airports will become tower candidates in the next ten years Substantial savings in operation and maintenance costs can be realized by delaying the installation of these towers by providing comparable tower service with an Automated Terminal Service (ATS) Concept definition and simulation of an ATS system have been completed and have received highly favorable pilot reaction Currently a test bed, consisting of a monopulse beacon Interrogation system, a minicomputer, a voice response system, and an ATC controller display, is being constructed Actual flight tests to determine the feasibility of the ATS concept will begin in the latter part of this year Studies to determine the cost effectiveness of ATS, to develop criteria for installing ATS at airports, and to define the detailed interface of ATS and the ATC system are underway (Author)

A77-20669 # **Automatic flight inspection of radio navigation facilities** B Litman (Ambac Industries, Inc , Garden City, N Y) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 91-96

Ground radio navigation aids provide the principal means of navigation for all aircraft in the national airspace system The current standard systems are VHF Omnidirectional Range and Tactical Air Navigation which provide bearing and distance information for enroute operation, and instrument landing system which provides high accuracy bearing and elevation with respect to individual runways The paper describes an automatic flight inspection system incorporating the advantages of several technologies that have become available for aircraft use An inertial navigation system, updated by a suitable distance measuring equipment ranging and other fixes, provides precise position An airborne general purpose digital computer does all analysis and provides all control of the system Display terminals are intended to present summary answers and provide operator interface with the system control Relatively untrained crews may be used since flight maneuvers, data analyses, and determination of acceptability are all performed by the computer S D

A77-20670 # **Correlation velocity sensor** F B Snyder (U S Naval Material Command, Naval Navigation Laboratory, Warminster, Pa) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 97 101C

A new technique for measuring aircraft velocity, the correlation velocity sensor, is being developed Feasibility of this technique was demonstrated through use of rudimentary experimental equipment that received extensive flight evaluations When compared to present Doppler velocity sensors, the correlation velocity sensor promises improved performance over smooth water as well as reduced acquisition and total life cycle costs Test data on the correlation equipment investigated are included (Author)

A77 20672 # **VTOL landing aid using low frequency near field techniques** F H Raab (Polhemus Navigation Sciences, Inc , Burlington, Vt) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 109-116 14 refs

A low frequency near field technique similar to that used in the SPASYN system can be used to make a precise, all weather landing aid for VTOL aircraft This system measures both position and orientation at all elevations and azimuths and has an operating range of up to 4 km The ground-based transmitter applies a nominal 200 watt signal to each of three orthogonal loop antennas which are buried in the landing pad or which are located nearby The carrier frequency is in the 1 to 10 kHz range and is modulated to provide for timing synchronization and multiplexing of the signals from the three antennas Coherent frequency shift keying allows transmission of identification, field strength and distortion information, and other useful data The receiver also employs a three-axis H field antenna and uses clipping or editing of impulsive VLF noise to improve the signal to noise ratio, as in an omega receiver Coherent detection is used to measure the signal components induced in each receiving antenna by each transmitting antenna, and position and orientation are computed digitally This system is easily interfaced or combined with omega and loran receivers (Author)

A77 20673 # **Three frequency difference OMEGA** R G Brown (Iowa State University of Science and Technology, Ames, Iowa) and R L VanAllen (USAF, Washington, D C , Iowa State University of Science and Technology, Ames, Iowa) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 117-124 9 refs Research supported by the Iowa State University of Science and Technology

A formula is presented for computing group delay synthetically from phase measurements made at three frequencies Wave theory indicates that the group delay calculated at the appropriate frequency should be relatively insensitive to the usual diurnal phase variations This is demonstrated with actual three-frequency phase data for the Trinidad North Dakota path The amount of data analyzed is too small to make positive comparisons with composite and other OMEGA configurations, but it is cautiously speculated that the resultant system accuracy using a calculated group delay would be comparable to composite OMEGA (Author)

A77 20674 * # **Simulation analysis of a microcomputer-based, low-cost omega navigation system** R W Lilley and R J Salter, Jr (Ohio University, Athens, Ohio) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 125 131 7 refs Grant No NGR 36 009 017

A status report is presented on a proposed low cost Omega Navigation System (ONS) based on a microcomputer (Available commercially) Minimum hardware and maximum software are designed for Electronic subsystems are discussed in detail, with block diagrams of the receiver and microcomputer interface modules, and a flowchart of the automatic synchronization process The system is designed as a precision navaid for general aviation in the $1000 price range R D V

A77 20675 # **Application of the Global Positioning System as an attitude reference for near earth users** V W Spinney (Rockwell International Corp , Autonetics Group, Anaheim, Calif) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 132 136

The NAVSTAR Global Positioning System (GPS) is a satellite based navigation system that will provide very accurate three-dimensional position fixing and timing information to properly equipped users, at all times, on or near the earth This paper examines a unique application of the GPS, wherein interferometer

principles employed in a multiple antenna configuration operate on selected incoming satellite signals to determine three dimensional attitude of the user system The basic measurement entity is the satellite signal phase shift differential (i e , range difference) between an antenna pair and a single satellite A minimum of three antennas and three satellites results in six independent differential measure ments from which the orientation of the antenna triad in an earth-fixed coordinate set is readily determined The basic attitude solution algorithm is developed, including a least-squares imple mentation for the overdetermined case with four operational satellites The user receiver measurement requirements commen surate with desired attitude accuracy are presented Attitude accuracy sensitivity to such factors as antenna calibration errors, absolute position uncertainty, and geometric dilution of precision are also examined (Author)

A77-20676 # **A navigation algorithm for the low-cost GPS receiver** P S Noe (Texas A & M University, College Station, Tex) and K A Myers (USAF, Avionics Laboratory, Wright Patterson AFB, Ohio) In New frontiers in aerospace navigation, Proceedings *of the Bicentennial National Aerospace Symposium, Warminster, Pa ,* April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 137-141 8 refs Contract No F44620-75-C-0031

The Global Positioning System (GPS) is a satellite navigation system currently under development by the Department of Defense A previous note described the numerical properties of a proposed navigation algorithm for the low-cost GPS receiver under static conditions This note evaluates performance of the algorithm in a realistic dynamic simulation of a typical flight profile for an Air Force C5A transport aircraft Numerical convergence and long term dynamic stability of the algorithm are demonstrated in a noise-free environment, typically, a single iteration of the algorithm maintains position estimate errors below 0 2 ft at each position fix for the duration of the flight Stochastic error models are implemented in the simulation to produce a realistic noisy environment, in this case, the algorithm provides navigation accuracies on the order of 400 ft In addition, the performance of two GPS satellite selection routines is compared in the simulations (Author)

A77-20678 # **Dual INS velocity error reduction through new damping techniques** L Newman (U S Naval Material Command, Naval Navigation Laboratory, Warminster, Pa) In New frontiers in aerospace navigation, Proceedings of the Bicentennial National Aerospace Symposium, Warminster, Pa , April 27, 28, 1976 Washington, D C , Institute of Navigation, 1976, p 148 155

Three alternative configurations for the reduction of velocity errors in dual inertial navigation systems through automatic feedback loop damping are considered These are (1) independent INS, in which one can, by keeping one system heavily damped, control reference velocity sensitivity while simultaneously retaining heavy damping on the indicated position, (2) INS velocity damped acceleration, which can be used to achieve improved gravity response with negligible reference velocity sensitivity penalty in a navigation suite with limited reference velocity errors, and (3) INS minus reference velocity damped acceleration with INS position damped velocity, which provides excellent gravity error control for systems with limited reference velocity errors B J

A77 20690 **Processor system configuration in the NOE helicopter environment** E L Griffin (Martin Marietta Aerospace, Orlando, Fla) In Annual Southeastern Symposium on System Theory, 8th, Knoxville, Tenn , Apr 26, 27, 1976, Proceedings New York, Institute of Electrical and Electronics Engineers, Inc , 1976, p 314 318 10 refs

Several possible configurations exist for the processing system that integrates the avionics and visionics subsystems for the night mission nap-of the-earth (NOE) military helicopter The military helicopter computational system must be lightweight, low cost, highly reliable, and easily maintained Enemy small arms fire is included as part of the reliability environment The discussion covers system environment and utilization, alternative system configura tions, processing system analysis, and candidate system evaluation Evaluation matrix results indicate that the selection of a Schottky central microprocessor configuration is the best for the NOE helicopter, and that the dual Schottky centralized processing system is the best candidate when a single-hit survivability is required S D

A77 20716 # **Aerodynamic design** I H Rettie (Boeing Co , Seattle, Wash) In Air transportation for the 1980's College Park, Md , University of Maryland, 1976, p 115-152

It is suggested that the following six factors will predominate in shaping the aircraft of the 1980s (1) costs (production, ownership, and operating), (2) fuel economy, (3) cruise speed capability, (4) community noise, (5) passenger comfort, and (6) cargo capability Aerodynamic design technology (implying wind tunnel testing) at Boeing is considered, giving attention to the use of the TEA 230 computer program for aerodynamic analysis (applied for example to wing flap design and to wing fin tip design) The configuration of the B7X7, typical of new aircraft to be introduced at the end of this decade, is examined B J

A77-20718 # **Structures and materials** M Stone (Douglas Aircraft Co , Long Beach, Calif) In Air transportation for the 1980's College Park, Md , University of Mary land, 1976, p 227-264 6 refs

The perspectives of aircraft materials and structures in the 1980s are considered with reference to work being done and foreseen at McDonnell Douglas Structural improvements are to focus on advanced composites, improvement in metal construction, bonding, and active controls at a lower cost Attention is also given to fracture control and to the applications of computer analysis to structural design In particular, a structural advanced design technique is considered which uses computer methods for structural modeling (G4GA), aerodynamic loading (MALS), and static strength optimiza tion (ARROW) B J

A77-20719 # **Effects of artificial stability on configuration design** R H Lange (Lockheed Georgia Co , Marietta, Ga) In Air transportation for the 1980's College Park, Md , University of Maryland, 1976, p 265 316 11 refs

The use of active controls for maneuver load alleviation in the development of transport aircraft in the 1980s is considered As part of the NASA Advanced Transport Technology Program, Lockheed conducted a relaxed static stability analysis including an assessment of the benefits to be derived from the application of advanced technologies such as low noise level propulsion systems, supercritical wing, advanced filamentary composite materials, and active controls Attention is also given to the JetStar redesign study, taking account of wing optimization, geometry constraints, and loads analysis B J

A77 20720 # **Advanced helicopter designs** R F Donovan (United Technologies Corp , Sikorsky Aircraft Div , Stratford, Conn) In Air transportation for the 1980's College Park, Md , University of Maryland, 1976, p 317-352

The three basic parameters which the helicopter designer can trade-off are discussed disc loading, blade loading, and power loading Attention is given to the mechanical design of a helicopter with emphasis on the rotor blade, antifriction bearings, the tail rotor, and the use of the bi-filar vibration absorber Forthcoming and conceptual designs are examined including the Army Utility Tactical Transport and the S-76 helicopter B J

A77-20724 # **An automatic-control air-jet propelled ACV** A Magazzu (Palermo, Universita, Palermo, Italy) *Hovering Craft and Hydrofoil,* vol 16, Nov 1976, p 13-21, 27 9 refs

An automatic control system for marine ACVs is suggested with aim of improving their seaworthiness Control is based on the modulation of the air-flow escaping from the air cushion The considerable air flow required is utilized for propulsion purposes A theoretical study of the system is made and, for the two-dimensional case, the equations are worked out for motion in a rough sea Finally, a numerical analysis is carried out, the results of which appear satisfactory The preliminary experiments in an especially designed test facility are well in compliance with theoretical expectations Extensive laboratory tests are at present in progress (Author)

A77 20867 # **Attitude control of a pilotless aircraft by radioactive probes (Contrôle d'attitude d'avion sans pilote par sonde radioactive)** J L Boulay and S Larigaldie (ONERA, Châtillon sous Bagneux, Hauts de Seine, France) *(NATO, AGARD, Reunion sur l'Instrumentation et le Guidage des Avions sans Pilote, Florence, Italy, Oct 4 8, 1976) ONERA, TP* no 1976 112, 1976 11 p In French

The servocontrol of the attitude of an RPV can be based on the natural electric field within the atmosphere The vehicle movements are detected, around the roll and pitch axes, by means of radioactive probes installed at the wing tips and at the front and back ends of the fuselage The electric signals provided by these probes are preprocessed, then mixed with the orders from the ground and directed to the aircraft servocontrols The study presented in this paper is mainly oriented towards the understanding of the physical mechanisms intervening in the use of radioactive probes, and on the perturbations due to spurious electric charges generated by the engine exhaust gases (Author)

A77-20868 # **Methods and techniques of vibration testing in flight (Methodes et techniques de l'essai de vibration en vol)** G Piazzoli (ONERA, Châtillon sous Bagneux, Hauts de Seine, France) *(NATO, AGARD, Symposium sur les Techniques d'Essais en Vol, Porz-Wahn, West Germany, Oct 11 15, 1976) ONERA, TP* no 1976 120, 1976 10 p 14 refs In French

Some general considerations are presented on the importance of flight tests in aeroelastic research Three methods for examining the subcritical dynamic stability of aircraft are considered those of harmonic, pulsed, and random vibration testing in flight Different techniques for excitation of vibration, and for measurement and signal processing are examined along with methods of computer processing and analysis Vibration tests on aircraft of different types light aircraft, subsonic transport, and Concorde are described B J

A77-20870 # **Pressures over a sharp edged air intake functioning in subsonic flow at reduced flowrate (Pressions sur une carene de prise d'air a levre mince fonctionnant en subsonique à debit réduit)** G Laruelle and P Levart (ONERA, Châtillon sous Bagneux, Hauts-de-Seine, France) *(NATO, AGARD, Symposium on the Prediction of Aerodynamic Loading, NASA Ames Research Center, Moffett Field, Calif , Sept 27-Oct 1, 1976) ONERA, TP* no 1976-127, 1976 13 p In French

A wind tunnel test set up has been designed for studying the flow around the cowl with sharp leading edge of an air intake functioning at subsonic velocity and with a reduced flowrate A comparison of the pressure fields around the intake lip, calculated in an approximate configuration for free flight and for that particular set up, shows that local flows are correctly simulated in the case of moderately reduced flowrates The forces acting on the air intake casing are dependent upon a separation bubble that forms on the external lip of the intake when the flowrate is sufficiently reduced Probe measurements performed along the external surface of the cowl make it possible to characterize the profile and thickness of the boundary layer, which is dependent on the bubble wake Fast response pressure measurements and a film of schlieren pictures reveal the unsteady character of the leading edge separation (Author)

A77-21320 **Shaping the flight behavior of the 747SP** J Waddell (Boeing Commercial Airplane Co , Renton, Wash) *Shell Aviation News,* no 438, 1976, p 22 25

Simulation testing and flight testing of the Boeing 747SP, a modified 747 with 47 ft of length removed, is described Design modifications imposed by the length alteration and the requirement of handling characteristics identical with the 747 are discussed, along with the input of the author and other pilots in adjusting the simulator facility for the program Modifications of the rudder, trailing edge flap system, some control surfaces, and re-indexing of the hydraulic artificial feel are mentioned Unusual climb ability is noted, the 747SP can climb 5000 ft higher than any other turbojet airliner on a typical mission (To 39,000 ft, and even to 45,000 ft after sufficient fuel is burned off) Stall tests, including tests with the stick full back, cross-wind landings, and approach operations are described R D V

A77-21324 # **Aircraft design 40 years after Juan de la Cierva (El proyecto de aeronaves 40 años despues de Juan de la Cierva)** J L Lopez Ruiz (Construcciones Aeronauticas S A , Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) *IAA/Ingeniería Aeronáutica y Astronáutica,* vol 28, Nov 1976, p 13 24 In Spanish

Aircraft design methodology, effects of computers on design practice, new developments in various fields (aerodynamics, propulsion, materials and structure, stability and control, on-board electronics and instrumentation) aiding aircraft design, aircraft industry trends, and aircraft design in Spain are reviewed A flowchart is presented of recommended design steps, a table of computers in aeronautical design service in West European nations is provided, and the fact that computers do not resolve all problems in aircraft design is underlined Steps to promote better organization of design work in Spain are outlined R D V

A77-21421 # **Precision DME for future landing systems - One solution** H Vogel (Standard Elektrik Lorenz AG, Stuttgart, West Germany) *Electrical Communication,* vol 51, no 4, 1976, p 249-253 6 refs

The paper shows that the recently designed L-band DME system is and will be in the near future an optimum solution as regards the number of channels, the available bandwidth, and present technology Flight tests have indicated that the distance measuring accuracy specified by ICAO for future landing systems can be achieved without modification to the internationally standardized DME specification Problems that should be solved in order to increase the accuracy of an L-band DME system are identified In particular, equipment measuring errors are discussed along with errors caused by interfering reflections S D

A77-21423 # **Communications with aircraft via satellite** R Aubelle and H Haberle (Standard Elektrik Lorenz AG, Stuttgart, West Germany) *Electrical Communication,* vol 51, no 4, 1976, p 264 269 7 refs

Effective surveillance of air traffic in large areas and control by a ground station presupposes long-range information transmission, which can be fullfilled by satellite communications A system configuration for data and voice communications with aircraft via satellite is proposed which is typical for present air space surveillance The proposed system for communications between a ground

station and aircraft is also applicable to communications between ships and one or more ground stations Proposals for multiple access network are discussed S D

A77-21586 Report concerning the status of the selection procedure for a new approach and landing system /MLS/ (Bericht uber den Stand des Auswahlverfahrens fur ein neues Anflug- und Landesystem /MLS/) Mr Bohr (Bundesanstalt fur Flugsicherung, Frankfurt am Main, West Germany) *Ortung und Navigation,* no 4, 1976, p 71-74 In German

Five proposals for a new landing system, which will replace the currently employed ILS, have been submitted to the All Weather Operations Panel for an evaluation study The French proposal was not further investigated because the system considered in it with its more global characteristics does not correspond to the properties envisaged for the ILS successor system The proposals submitted by the U S and Australia have, in practice, been combined to one system design There are, therefore, still three system configurations in competition, including the U S -Australian Time Reference Scanning Beam approach, the Doppler-Microwave Landing System of Great Britain, and the DME Landing System of West Germany Developments related to the evaluation and the comparison of the three systems are discussed G R

A77-21587 Measures for enhancing safety in general aviation in the areas of air traffic control, navigation, and meteorology (Massnahmen zur Erhohung der Sicherheit der allgemeinen Luftfahrt auf dem Gebiet der Flugsicherung, Navigation und Meteorologie) D Brunner (Braunschweig, Technische Universitat, Braunschweig, West Germany) *Ortung und Navigation,* no 4, 1976, p 99-108 In German

Two significant accident categories in the case of general aviation are related to *landing accidents and bad weather accidents* An examination of the bad weather accidents shows that in the majority of cases the aircraft involved had the navigational equipment which would have made it possible to avoid the accident by continuing the flight according to instrument flight rules Measures for enhancing safety in general aviation should, therefore, give particular attention to an improvement of the training of the pilot Short-term, intermediate-term, and long-term approaches for improving the capability of the pilot are discussed G R

A77-21592 Today's system - Inertial Omega (Le système d'aujourd'hui - Oméga inertie) P Hugon *Navigation* (Paris), vol 25, Jan 1977, p 45 57 In French

Hybrid navigational systems incorporating an Omega receiver and a backup system (Doppler radar, satellite receiver, VOR DME type azimuth-distance system) are discussed, the need for such systems is expounded, information processing in such hybrid systems, and low-cost alternatives to inertial techniques are discussed and evaluated The AN/ARN 115 and ONS 201 systems are considered as non inertial alternatives Routes can be traced on the basis of data from two Omega networks alone, and formulas and errors for the procedure are discussed R D V

A77-21593 Regulation of the air traffic control system (La regulation dans le système de controle du trafic aérien) J F Vivier *Navigation* (Paris), vol 25, Jan 1977, p 82 97 In French

Major tasks of an air traffic control (ATC) system are reviewed, and charts are provided of decision loops and system control loops Demand and capacity, local or global, of ATC systems are discussed along with hierarchy of priorities, rate of arrivals, and conditions of arrivals (presence of prior arrivals on runway) are discussed Conditions uprange and downrange of approach markers and their effect on ATC system performance are dealt with R D V

A77-21594 The aero engine and its progress Fifty years after Griffith F W Armstrong (National Gas Turbine Establishment, Farnborough, Hants , England) *Aeronautical Journal,* vol 80, Dec 1976, p 499-520 25 refs

After a historical review of the development of gas turbine aero-engines during the last 50 years and a discussion of Dr A A Griffith's contributions, the paper considers the present status of aero engine technology and the shape of its future evolution The vital role of the powerplant in the development of aviation is stressed, noting the use in large commercial subsonic transport aircraft of the RB 211 engines, the military supersonic combat aircraft with Spey engines, and the helicopters with Gem shaft power engines The turbofan engines which operate high pressure ratio single fans, and have tip speeds within the region of 450 m/s are outlined and the improvements in both thermal and propulsive *efficiency in subsonic flights since the inception of jet propulsion,* are noted The high performance powerplants of the three major combatant classes of the military aircraft are also discussed with general emphasis on their life-cycle cost reduction The evolution of the VTOL concept and the description of commercial engines are also included A Y

A77-21683 Aircraft identification by moment invariants S A Dudani (Hughes Research Laboratories, Malibu, Calif), K J Breeding, and R B McGhee (Ohio State University, Columbus, Ohio) *IEEE Transactions on Computers,* vol C-26, Jan 1977, p 39 46 17 refs Grant No AF AFOSR-71 2048

Although many systems for optical reading of printed matter have been developed and are now in wide use, comparatively little success has been achieved in the automatic interpretation of optical images of three-dimensional scenes This paper is addressed to the latter problem and is specifically concerned with automatic recognition of aircraft types from optical images An experimental system is described in which certain features called moment invariants are extracted from binary television images and are then used for automatic classification This experimental system has exhibited a significantly lower error rate than human observers in a limited laboratory test involving 132 images of six aircraft types Preliminary indications are that this performance can be extended to a wider class of objects and that identification can be accomplished in one second or less with a small computer (Author)

A77-21755 # CCVs - Active control technology creating new military aircraft design potential M A Ostgaard and F R Swortzel (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *Astronautics and Aeronautics,* vol 15, Feb 1977, p 42-51 10 refs

Advanced flight control technology is continuing to emerge as a substantial driver in the design optimization of both future military and civil aircraft Inclusion of the flight control system specialist with specialists in structures, aerodynamics and propulsion during preliminary design produces a synergistic benefit This design philosophy has become known as the control configured vehicle (CCV) approach to design, or the application of active control technology Results are presented of the LAMS (Load Alleviation and Mode Stabilization) concepts as applied to the B-52 aircraft for analysis, development, and flight demonstration The potential of active control is also assessed It is shown that a new generation of fighting aircraft can be the product of military R&D on integrated displays, control, and weapon-delivery systems S D

A77-21869 # Radiocommunication in air navigation H A Laett (Radio-Suisse, Ltd , Berne, Switzerland) In World telecommunication forum, Technical Symposium, Geneva, Switzerland, October 6-8, 1975, Proceedings Geneva, International Telecommunication Union, 1975, p 3 5 2 1 3 5 2 3

The requirements and constraints an air navigation system must satisfy and the technical and operational environment it must work in are considered The distinction between auto-navigation and apo-navigation is discussed Typical examples of the former are

examined including the automatic direction finder, VOR, DME, and ILS Apo-navigation, primarily radar, is discussed with emphasis on MTI and secondary surveillance radar It is concluded that present air navigation systems are inconsistent and incongruous, but that any enhancement is slow and painful, and must be done with the highest integrity B J

A77-21874 # **Predicting the loading of tail planes in the preliminary phase of aircraft design (Sulla previsione del peso degli impennaggi nella fase preliminare del progetto dei velivoli)** S Chiesa and G Guerra (Torino, Politecnico, Turin, Italy) *Ingegneria*, Nov -Dec 1976, p 317-325 18 refs In Italian

Statistically derived formulas for estimating the load on aircraft tail planes early in project design are studied, with a review of the pertinent literature An analytical technique for deducing horizontal tail load is worked out The influence, by no means negligible, exerted by static and dynamic compensation masses can be evaluated by proceeding to calculate loads on the structure separately, and then deducing the weight of the masses in question in sequence R D V

A77-21876 # **Improvement of the structure-dynamical properties of aircraft with CCV systems (Verbesserung der strukturdynamischen Eigenschaften von Flugzeugen mit CCV-Systeme)** H Zimmermann (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) *Deutsche Gesellschaft fur Luft und Raumfahrt, Symposium CCV-Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-237* 25 p 7 refs In German

A description is presented of the CCV technologies ride quality control, maneuver load control, gust load alleviation, fatigue reduc tion, and flutter control The considered approaches provide a means to reduce stresses on the aircraft and its human occupants Accelerations are reduced, the operational life of the aircraft is enhanced, and dynamical instabilities are transferred to higher speeds Significant results and conclusions regarding the considered technologies are presented and the obtained improvements of the structure dynamical performance are discussed G R

A77-21877 # **Direct side force control - Possibilities and problems of an application in the case of fighter aircraft (Direkte Seitenkraftsteuerung-Moglichkeiten und Probleme eine Anwendung bei Kampfflugzeugen)** H Wunnenberg and G Sachs (Dornier GmbH, Friedrichshafen, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium CCV Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-239* 28 p 12 refs In German

Investigations concerning the possibility of an application of direct side force control (DSFC) techniques in the case of the Alpha-Jet are reported The principles of operation of DSFC devices are examined, taking into account the application of a side force as a means to obtain lateral acceleration for a directional change of the flight path or a lateral displacement A brief description is presented of wind tunnel studies of a number of principal DSFC design solutions for the Alpha-Jet Attention is given to simulation tests carried out with the objective to determine the limits for the technical boundary conditions of hardware implementation Unsolved problems are also considered along with future investigations G R

A77-21878 # **Realization problems concerning reliable CCV flight guidance systems (Realisierungsprobleme von zuverlassigen CCV-Flugfuhrungssystemen)** W Meyer (Bodenseewerk Geratetechnik GmbH, Uberlingen, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium CCV-Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-243* 16 p In German

Realization problems concerning reliable CCV flight guidance systems related to mission performance in the case of two failures are currently satisfied with the aid of quadruplex systems System realization possibilities involving the use of concepts of proven reliability are discussed, taking into account a pure quadruplex system, a quadruplex electronic system with a triplex regulation system, and a digital quadruplex system with integrated monitoring function Relations concerning the economics of analog and digital systems are presented in a graph Realization possibilities with future reliability concepts are considered, giving attention to aspects of failure self-detection in automatic flight guidance systems, a programmable automatic supervisor system, and dissimilar redundance concepts Possibilities regarding an occurrence of systematic error and software errors are also explored G R

A77-21879 **Possibilities and solution methods of CCV technology (Moglichkeiten und Losungsansatze der CCV-Technologie)** G Lobert (Messerschmitt Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium CCV-Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-236* 86 p 19 refs In German (MBB-UFE-1262-O)

Questions of artificial longitudinal stability are investigated, taking into account aspects of two-dimensional flow, three-dimensional flow, the dimensioning of the elevator unit, and the effect of aerodynamic improvements Approaches for obtaining artificial lateral stability are discussed along with problems of active flutter control Attention is also given to active gust load alleviation, maneuver and gust load control, and direct lift and side force control A description is presented of a German CCV experimental program which has the objective to prepare the CCV technology for the next generation of military aircraft G R

A77-21880 **Design criteria and characteristics of operational CCV flight guidance systems (Entwurfskriterien und -merkmale operationeller CCV-Flugfuhrungssystemen)** R Hotz and G Kissel (Messerschmitt Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium CCV-Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-242* 29 p In German (MBB UFE-1271-O)

The results of an investigation concerning the reliability of currently used aircraft are briefly considered It was found that the reliability of the servomotor is the dominant factor for flight safety Configurational requirements are examined, taking into account the importance of servounits, the role of elements for the detection of failure, and approaches to reduce servounit related difficulties by means of a suitable partitioning of the control surfaces Requirements regarding the flight guidance system are partly related to a retention of functional capabilities in the case of a component failure, simplicity of maintenance and testing requirements, and an aircraft configuration design which makes it possible to compensate the failure of one control surface with the aid of the remaining control surfaces G R

A77-21881 # **Flight characteristics studies related to the employment of direct power steering in longitudinal motion (Fliegbarkeitsuntersuchungen zur Anwendung der direkten Kraftsteuerung in der Langsbewegung)** D Hanke and H H Lange (Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Flugmechanik, Braunschweig, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium CCV-Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-238* 31 p 15 refs In German

The employment of a power control parameter for the improvement of longitudinal aircraft guidance capabilities makes it necessary to extend the currently used flight characteristics criteria The basic employment possibilities of direct lift control are considered and definitions are presented of additional flight characteristics parameters for coupled and uncoupled flight path guidance A description is given of flight path tracking tests and ILS landing approaches involving a use of the in-flight simulator HFB 320

Statistical performance parameters of the pilot aircraft system and a subjective evaluation provided by the pilot are used as evaluation criteria It is found that an employment of direct lift control leads to an improvement of the flight path guidance accuracy G R

A77-21882 **Maneuver load control and gust load alleviation - Design and application possibilities (Manoverlaststeuerung und Boenerleichterung - Auslegung und Anwendungsmoglichkeiten)** U Butter (Messerschmitt-Bolkow Blohm GmbH, Ottobrunn, West Germany) and B Krag (Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium CCV-Technologien, Munich, West Germany, Sept 17, 1976, Paper 76-240* 52 p 15 refs In German (MBB-UFE-1261-O)

The systems investigated have the objective to reduce the bending stresses of the wing by means of a redistribution of the lift forces and to reduce the acceleration for the pilot's seat with the aid of gust effect compensation measures Additional flap systems are used for direct lift control A separate gust control device can be utilized for the regulation of the system components It is also possible to employ an integrated flight control system for conventional guidance functions and the objectives of maneuver load control and gust load alleviation G R

A77-21887 # **Testing equipment available in France for studying aircraft and engine noise (Moyens d'essais existant en France, pour l'etude des bruits de moteurs et d'avions)** P Lienard (ONERA, Châtillon-sour-Bagneux, Hauts-de Seine, France) *Association Aéronautique et Astronautique de France and Groupement des Acousticiens de Langue Francaise, Colloque d'Acoustique Aeronautique, 5th, Toulouse, France, May 19 21, 1976, Paper* 17 p 11 refs In French

An overview is presented of ground testing equipment for studies of aircraft noise and aircraft engine noise The design of anechoic chambers and various soundproof enclosures, open-air test benches for studying ground effects, a jet silencer test bench, equipment for simulating in flight effects, a rail track 'aerotrain' for testing noise generators at high translational velocity, noise caissons, a siren reverbatory test bench, and a ducted fan facility are described The article also deals with sound suppression equipment in wind tunnel facilities, an acoustical metrology laboratory, and a quality control bench for acoustical materials R D V

A77-21893 # **Techniques employed in analyzing turbojet noise (Techniques utilisees dans l'analyse du bruit des turboreacteurs)** R Berteloot, J P Bernard, and P Deneuville (SNECMA, Paris, France) *Association Aeronautique et Astronautique de France and Groupement des Acousticiens de Langue Française, Colloque d'Acoustique Aéronautique, 5th, Toulouse, France, May 19 21, 1976, Paper* 35 p 6 refs In French

Noise generated by fully assembled turbojet engines and by engine components separately or by mockups and techniques and equipment for isolating and measuring the noise are studied, along with methods for forecasting noise in the case of components difficult to isolate The design and use of antinoise baffles, directional acoustic antennas, microphonic probes, wall-flush microphones, acoustical telescopes, and other techniques are described extensively Application of the techniques to separation of noise sources in a CFM56 turbojet engine is described by way of illustration R D V

A77-21951 **Half-plane scattering applied to ILS grading criteria** J T Godfrey, H F Hartley, R A Moore (Westinghouse Electric Corp , Baltimore, Md), and G J Moussally (Westinghouse Electric Corp , Pittsburgh, Pa) *IEEE Transactions on Aerospace and Electronic Systems,* vol AES-13, Jan 1977, p 2-9 22 refs U S Department of Transportation Contract No FA74WA-3353

A technique for calculating the derogation in the difference in depth of modulation (DDM) signal, used for aircraft glide slope guidance, due to slightly rough ground surfaces is developed The contributions to the scattered signal from diffuse and specular scatter are treated separately The diffuse derogation is calculated based on empirical data, and an average variation is presented The specular contributions to the variation in the signal is calculated based on expanding the half plane diffraction solution in terms of the ground roughness A specular scattered deviation about the mean signal is then obtained by statistically averaging over normally distributed ground heights Results of the analysis indicate that substantial relaxation in grading criteria can be effected (Author)

A77 22002 **YC-14 flight test progress report** R L McPherson (Boeing Co , Seattle, Wash) and D Bittenbinder (USAF, Flight Test Center, Edwards AFB, Calif) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 1-7

Preliminary test results on the YC-14 STOL craft are reported (CF-6 engines) The performances of the blowing system for powered lift, the 3-channel digital stability augmentation system, fly-by-wire digital flight control system, blown flaps handling, and thrust reversed landing within 2000 ft are described Airspeed changes during test flight are recounted, and full-load landings are described Emergency crew egress was tested by dummy ejection Flight handling was also monitored by a TV camera mounted in the vertical fin to view the top of the YC-14 Checkout of onboard systems (airstarts, normal and manual landing gear extension, hydraulic and electrical actuation systems, avionics) are mentioned R D V

A77 22003 **YC-15 development and test highlights** W R Casey (Douglas Aircraft Co , Long Beach, Calif) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 8-24

The testing program for the YC-15 STOL transport is described These are the first transports to fly with a supercritical wing, the first to demonstrate externally blown flap (EBF) powered lift, and the first to demonstrate routine STOL maneuvers onto and off a 2000 ft runway Backside STOL operation (altitude controlled by thrust, airspeed controlled by attitude) and operation of the DLC (direct lift control) spoilers are described Approach and landing tests, stall tests, engine-out tests in stall and landing, mid-air refueling tests, air parachute drop tests (10 tons, low altitude), and operations off an unimproved airfield are described R D V

A77-22004 **B-1 flight test progress report no 2** E Sturmthal (USAF, Flight Test Center, Edwards AFB, Calif) and T D Benefield (Rockwell International Corp , El Segundo, Calif) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 25-33

Phase I steps in the testing of the B-1 offensive penetrating bomber are detailed Three B-1 test prototypes were available for the flight tests, one of them instrumented for offensive avionics integration tests Tests were run on basic flight systems (automatic flight control, engine air inlet controls, electrical and hydraulic systems) and performance (air refueling, and expansion of air refuel envelope, simulation weapons separation and delivery with scoring by ground radar, blind manual letdown from altitude into terrain following, speeding up to Mach 1 4) Severe engine vibration at 37 Hz and its elimination by rescheduling of the secondary exhaust nozzle area are described R D V

A77-22005 **F-18 multi-mission aircraft** G W Lenox (U S Navy, National Aircraft Standards Committee, Washington, D C) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept. 22-25, 1976) Society of Experimental Test Pilots,*

Technical Review, vol 13, no 2, 1976, p 34-41

Progress in the test program is indicated, and important features of the single-seater aircraft-carrier-based fighter bomber designed to supplement, not replace, the F-14 are described The digitally multiplexed four-wire fly-by wire controls, with mechanical backup to the rolling tail, nonblown flap system, right-to-left quick interchangeability of engines, radar system design, interchangeable three CRT displays with multiple display, target acquisition and lock-on, option information functions, and IR and laser hardware are outlined The design-to-cost policy, with no cost overruns contemplated, is underlined R D V

A77-22006 F-5E spin susceptibility test J H Taylor (USAF, Flight Test Center, Edwards AFB, Calif) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 43-59

Entry into, and recovery from, spin and stall configurations are tested and reported on Two spin modes are examined, one aerodynamically recoverable oscillatory mode and a fast flat mode probably not recoverable (on the basis of wind tunnel results and flight test results) Emphasis was placed on determining aircraft susceptibility to departure from controlled flight and to spin entry The post stall flight regime, inverted pitch hang-up, and limitations assigned in the outline of handbook procedures were examined, along with training and combat maneuvers likely to eventuate in a dangerous flat spin, deployment of the spin recovery parachute, and recovery procedures for post-stall gyrations and spins R D V

A77-22007 Flight testing the fighter CCV R C Ettinger (USAF, Flight Test Center, Edwards AFB, Calif) and D Thigpen (General Dynamics Corp , St Louis, Mo) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 60 78

Progress in the flight testing program for the modified YF-16 control configured vehicle (CCV) fighter aircraft is outlined Advantages to be derived from the CCV concept include increased load factor without increasing angle of attack, fuselage pointing for weapon aiming, possibly in an integrated fire/flight control system, turning without banking, translation sideways at constant velocity to compensate for crosswinds during air to-ground weapons deliveries, automatic gust alleviation, blended maneuver enhancement, and altering velocity in air combat without broadcasting the plane of motion Six pilot-commanded control modes and an automatic control mode are described The tactical value of the flat turn mode, direct lift mode, and fuselage aiming modes is highlighted R D V

A77-22008 Progress report on the Viggen with emphasis on man-machine design U Frieberg (Saab-Scania AB, Linkoping, Sweden) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 79-92

Radar displays, automatic controls for air combat maneuvers, audible warnings for pilots, and differences in variants of the Viggen design are discussed Automatic controls and alarm annunciations are provided for missions involving terrain following or steep dives to low altitude, audibly distinct tone warnings for stall hazard or ground proximity are used The R8MA engine can be refuelled with the engine running Advantages of the 30 mm Oerlikon armament (projectile weight, effective range, impact energy) are detailed The on-board radar offers full Doppler look-down capability for detecting hostile aircraft flying at minimum altitude some distance off Cockpit displays and radar operation are discussed at some length R D V

A77-22009 Development of a small high-aspect-ratio canard aircraft B Rutan (Rutan Aircraft Factory) *(Society of Experimental Test Pilots, Symposium, 20th, Beverly Hills, Calif , Sept 22-25, 1976) Society of Experimental Test Pilots, Technical Review,* vol 13, no 2, 1976, p 93 101

A canard configuration light aircraft for the homebuilders' and sport aircraft designers' market is described The design, controls, and aerodynamic performance of the canard foreplane and vertical winglets are explained Elevators on the canard double as landing flaps The canard is designed to prevent entry into natural stall Roll and pitch control systems are combined into elevons on the canard wing, while the main (rear) wing has no control surfaces or flaps Angle-of-attack limiting design of the two-seater VariEze aircraft is discussed Special features of amateur aircraft design practice are highlighted R D V

A77-22045 A theoretical investigation of laminar wakes behind airfoils and the resulting noise pattern A Fathy, M I Rashed (Cairo, University, Cairo, Egypt), and E Lumsdaine (Tennessee, University, Knoxville, Tenn) *Journal of Sound and Vibration,* vol 50, Jan 8, 1977, p 133 144 10 refs NSF Grant No OIP-74-21450

A theoretical investigation of the wake pattern downstream of airfoils under predominantly laminar flow conditions and the resultant noise generation is presented Under these conditions the wake is dominated by a Karman vortex street A method is developed to theoretically predict the vortex shedding frequency by relating the wake pattern to the airfoil boundary layer parameters through the momentum equation The generated noise is found to be dominated by a pure tone at the vortex shedding frequency The results obtained with the present approach were found to agree quite well with experimental results obtained by other investigators (Author)

A77-22116 # Operational problems of supersonic aircraft (Betriebsprobleme von Uberschallverkehrsflugzeugen) P Bork (Gesellschaft fur Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-okonomische Information der zivilen Luftfahrt,* no 5, 1976, p 251-261, 265 18 refs In German

A description is presented of a number of problems which are connected with the conduction of supersonic flight operations The flight profile of the Tu-144 is examined, taking into account aspects of fuel consumption and the effect of the atmospheric temperature on the permissible aircraft speed Attention is also given to questions of suitable flight altitude, the importance of meteorological considerations, the required fuel reserve, aspects of flight preparation, the system of navigation, problems of flight safety, requirements concerning the fuel and the material used in aircraft construction, aircraft operational life considerations, the economy of supersonic aircraft operations, questions of airport adaptation to supersonic traffic, maintenance, radiation hazards, and environmental protection issues G R

A77-22117 # Winter-related service operations on airports (Winterdienst auf Verkehrsflughafen) H Gruner (Gesellschaft fur Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-okonomische Information der zivilen Luftfahrt,* no 5, 1976, p 262-265 In German

Approaches used to maintain airport operations during the winter are discussed The procedures employed to remove snow and ice from the critical areas of the airport include mechanical, chemical, and thermal methods A description is presented of various techniques and the design of the employed equipment Attention is given to the use of methanol, urea, and equipment for melting the ice by means of a hot air jet G R

A77-22118 # Experience with the VOR navigation system in the German Democratic Republic II (Erfahrungen mit dem VOR-

Navigationssystem in der DDR II). W Trempler and H Richter (Gesellschaft fur Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-okonomische Information der zivilen Luftfahrt,* no 5, 1976, p 266-282 In German

Questions related to the decision to install in the Friedland area of the German Democratic Republic an additional VOR unit for an improvement of VOR navigation conditions are discussed Technical variants in connection with the selection of VOR ground installations are considered and problems related to the location selection process are examined Attention is given to a consideration of geographical environmental effects on VOR operation, requirements concerning antenna position and antenna design, questions of radiation distribution, economic considerations, and aspects of installation location testing with a mobile VOR unit G R

A77-22119 # **The employment of aircraft on operational areas in the case of differing surface conditions (Der Einsatz von Flugzeugen auf Betriebsflachen bei unterschiedlichen Oberflachenbedingungen)** B Glockner (Gesellschaft fur Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-okonomische Information der zivilen Luftfahrt,* no 5, 1976, p 283-289 In German

The surface conditions of runways and taxiways have a pronounced effect on the braking characteristics Information regarding the physical relations involved can provide the basis for an optimal utilization of the various means available for retarding or stopping the aircraft The principles of operation and the efficiency of the aircraft brake mechanism are investigated, taking into account the coefficient of friction and wheel slippage effects Questions concerning the occurrence and the effects of lateral forces are examined Physical processes related to aquaplaning effects are also studied G R

A77-22120 # **The technical concept of the IL-62M II - Fuel system (Die technische Konzeption der IL-62M II - Brennstoffanlage)** A Leshchinev, D Borisov, and A Sidorov *(Grazhdanskaia Aviatsiia,* 1976, p 22, 23) *Technisch okonomische Information der zivilen Luftfahrt,* no 5, 1976, p 290-293 In German (Translation)

The IL-62M aircraft has a greater payload and a longer range than the IL-62 The increase in range was obtained with the aid of a number of technical improvements related to the aerodynamic characteristics of the aircraft and the installation of engines with a smaller fuel consumption An additional fuel tank with a capacity of 5,000 liters was also provided The design of the fuel system of the IL-62 is described together with the operational principles Attention is also given to a device for determining the fuel reserve of the aircraft by means of a capacitance method G R

A77-22121 # **The propulsion system of the aircraft Z-37 I (Die Antriebsanlage des Flugzeugs Z-37 I)** E Schesky (Dresden, Hochschule fur Verkehrswesen, Dresden, East Germany) *Technisch-okonomische Information der zivilen Luftfahrt,* no 5, 1976, p 297-304 In German

The propulsion system of the aircraft Z 37 consists of the propeller V 520, the engine M 462-RF, and a number of control and regulation systems The thrust provided by the propulsion system is determined by a number of parameters, which are affected to a large extent by maintenance factors and the pilot Objective, design, and principles of operation of the propulsion system are discussed and a description is given of characteristic technical-economical parameter values for a comparison of the considered system with other aircraft propulsion systems G R

A77-22145 Advanced composites manufacturing as influenced by design A L Mills (USAF, Materials Laboratory, Wright Patterson AFB, Ohio) and C Tanis (Vought Corp , Dallas, Tex) *SAMPE Quarterly,* vol 8, Jan 1977, p 22-29 Contract No F33615 73-C 5066

An advanced composite outer wing panel for the A-7D aircraft has been designed, fabricated and tested The objective of the program was to develop a flight qualified, all composite structure compatible with design constraints and restrictions caused by form, fit, and function requirements of the existing metal wing assembly These requirements were coupled with a philosophy of minimum risk to permit in-service evaluation of the wings with unrestricted flight During the detail design phase a number of design requirements were encountered which were unforeseen during the conceptual design These requirements influenced the manufacturing approach, the projected manhour costs, and the anticipated weight savings A summary of these requirements and their effect will be presented (Author)

A77-22146 Teflon airframe bearings - Their advantages and limitations F J Williams (Rockwell International Corp , Los Angeles, Calif) *SAMPE Quarterly,* vol 8, Jan 1977, p 30-37

The military services along with the suppliers and users have established the term 'TFE liner' to describe the type of bonded liner used extensively in Teflon-lined bearings for airframe applications The paper presents a description of various types of TFE liners and an analysis of their advantages and limitations The composition and construction of TFE liners varies considerably from firm to firm, but in all of today's liners Teflon is incorporated in some manner as the common component TFE liners range from 0 009 to 0 018 inch in thickness It is shown that the high load capacities and low wear rates of TFE liners are primarily the result of the fabric and/or the resin system used The unique advantages of TFE-lined bearings are that they require no maintenance during their useful life, that they have no corrosion problems as do many of the bonded solid film lubricants, that they accept edge loading, and that they have a reasonably predictable life Limitations of TFE lined bearings are discussed in terms of wear life due to operating and environmental conditions, contamination from fluids, and installation damage S D

A77-22166 Development of materials used in gas turbine engines - R and D guide lines and proposals for a priority scheme P Esslinger and H Huff (Motoren- und Turbinen-Union Munchen GmbH, Munich, West Germany) *(Zeitschrift fur Werkstofftechnik,* vol 7, May 1976, p 167 177) *Revue Internationale des Hautes Températures et des Refractaires,* vol 13, no 3, 1976, p 172-180 Translation

Materials development programs for engines, specifically gas turbine engines, and their basic aims are reviewed, and a hierarchy of priorities for planning such programs is devised Relevant topics are categorized and possible future engine design developments are treated, with emphasis on cooling technology for turbine blading, studies of fracture surfaces, testing of cracks, and casting problems Priority schemes for budget allotment and for research and development time are worked out for current and future-oriented plans, with attention given to general development targets, high gas temperatures, reduced weight, cost cutting, enhanced reliability, longer service life, and elimination of weak spots A priority-assigning formula incorporating level of technical progress, probability of success, and urgency is derived R D V

A77-22181 Gas turbine emission control - A systems approach A J Teller (Teller Environmental Systems, Inc , Worcester, Mass) *Air Pollution Control Association, Journal,* vol 27, Feb 1977, p 148, 149 11 refs

Stationary turbine engines in peak power installations or jet engine cells are known to produce particulate emissions, noise, and NOx The paper outlines the design and performance capabilities of a nucleator system developed for opacity, particulate, and noise

reduction The device has been operating for the past three years in a jet engine test cell with 17,000 lb thrust engine use The overall nucleator system consists of a boundary flow augmenter that reduces flow by 30-40% compared with conventional augmenters, a jet peripheral quench system, a nuclear collector mounted on the periphery of the exhaust stack so that no ducting is required, and a cooling tower and solids recovery system for total water loop operation Because of earlier peripheral quenching, there is no explosive hazard The nucleator system provided reduction of opacity from turbine operation to less than 10% Particulate emissions were reduced to the order of 0 003 gr/scf Sound levels were reduced on the order of 50% The installed cost for a single jet engine test cell for a 17,000 lb thrust engine was about $600,000

S D

A77-22205 # **A numerical technique for subsonic flows past three dimensional canard-wing configurations with edge separations** O A Kandil, D T Mook (Virginia Polytechnic Institute and State University, Blacksburg, Va), and A H Nayfeh *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-1* 8 p 20 refs Grant No DAAG29 76-G-0034

A nonlinear vortex-lattice method is developed to compute the distributed and total-load coefficients on different models of canard-wing configurations in steady, low subsonic inviscid flows Several techniques are presented to ensure rapid convergence of the force-free wakes These include addition of an artificial viscosity to the vortex lines and/or utilization of the vortex-core concept Examples include delta and delta-like configurations with a variety of relative angles of attack, relative positions and relative areas Force free wake configurations, pressure distributions and total-load coefficients are presented These results agree closely with the experimental data Extension to long coupled canard-wing configurations is also included (Author)

A77-22206 * # **On aerodynamic coupling between lateral and longitudinal degrees of freedom** K J Orlik-Ruckemann (National Aeronautical Establishment, Unsteady Aerodynamics Laboratory, Ottawa, Canada) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-4* 13 p 6 refs Contract No NASw-2780

An oscillatory technique for routine measurement of all the direct, cross and cross-coupling moment derivatives due to pitching and yawing has been developed and a series of comprehensive results at Mach numbers 0 7 and 0 25 and at angles of attack up to 40 deg has been obtained in a large wind tunnel It was found that some of the dynamic cross coupling derivatives, that at low angles of attack were all zero, at higher angles of attack could reach values that rendered the pertinent cross-coupling terms in the equations of motion comparable in magnitude to the well-established damping terms Large nonlinear variations with angle of attack were observed in many of the measured derivatives including the important damping-in pitch and damping in yaw derivatives It was concluded that it may be desirable to include some dynamic cross-coupling derivatives, and the functional variation with angle of attack of many derivatives, in the equations of motion, and to consider all these equations simultaneously, rather than in separate longitudinal and lateral groups (Author)

A77-22207 # **The transmission of acoustic plane-waves at a jet exhaust** R H Schlinker (United Technologies Research Center, East Hartford, Conn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-22* 14 p 16 refs Research sponsored by the United Technologies Corp

Prediction of core engine noise levels in the far field of a power plant installation requires an understanding of the transmission coefficient for the internal acoustic waves incident at the jet exhaust The present experimental study, conducted at model scale, addresses this question for an acoustic plane wave Higher order acoustic modes were not considered since, in typical engines, these modes are usually cut-off, and therefore attenuated before reaching the nozzle exit The study covered a range of subsonic jet velocities corresponding to Mach numbers of 0, 24, 43, and 70 Results show that the plane-wave mode component of core engine noise is transmitted at the jet exhaust with minimal attenuation over the Mach number range relevant to engine operating conditions (Author)

A77-22215 * # **Jet noise source modification due to forward flight** R S Larson, C J McColgan, and A B Packman (United Technologies Corp , Pratt and Whitney Aircraft Group, East Hartford, Conn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-58* 9 p 13 refs Contract No NAS3-17866

The effects of forward flight on the turbulence characteristics of a jet in a co-flowing stream have been determined for a 2 22 inch circular jet in a 36 inch free jet wind tunnel The nozzle exit velocity was 400 ft/sec, and the tunnel velocity was set at 0, 40, 120 and 200 ft/sec Measurements of flow properties including mean velocity, turbulence intensity and spectra, convection velocity, integral length scale, and convected integral time scale were carried out using two linearized hot wires Results were used to predict changes due to flight in the jet acoustic sources The noise reductions for a cold jet with a velocity of 1000 ft/sec, due to the change in acoustic sources in flight, agreed well at all angles with measured noise reductions (Author)

A77-22221 * # **Wind tunnel test and calibration techniques for the measurement of damping and dynamic cross derivatives due to pitching and yawing** E S Hanff and K J Orlik-Ruckemann (National Aeronautical Establishment, Ottawa, Canada) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-80* 12 p 6 refs Contract No NASw 2780

The paper shows how the oscillatory apparatus described previously by Orlik-Ruckemann et al (1974) for determining cross and cross-coupling moment derivatives due to pitching and yawing oscillation is strengthened, extensively modified, and adapted to permit operation in a large continuous-flow wind tunnel Particular attention is given to an electromagnetic three-degrees-of freedom calibrating system developed to verify the validity of the experimental method and the various aspects of data reduction procedure Typical results from calibration tests and from a series of wind tunnel experiments are presented The only significant limitation is that the apparatus can only be used for models that are relatively small and have a conically shaped longitudinal cavity S D

A77-22227 # **Nacelle installation analysis for subsonic transport aircraft** W B Gillette (Boeing Commercial Airplane Co , Seattle, Wash) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-102* 8 p 5 refs

Techniques for the use of subsonic panel aerodynamics methods for nacelle integration on transport type aircraft have been developed and validated against experimental data These techniques are described first for the isolated powered nacelle in both interference-free and high interference conditions The underwing pylon mounted nacelle is then described in detail with emphasis on the three-dimensionality of the flow field and on the need for proper representation of the powered nacelle's exhaust plume The overwing upper surface blowing and pylon-mounted nacelles are also discussed, with emphasis on the use of analysis in the design process (Author)

A77-22228 # **Surface pressure fluctuation measurements in attached transitional/turbulent boundary layers at supersonic and hypersonic speeds** J R Howe (General Electric Co , Philadelphia, Pa) and A L Laganelli *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-113* 16 p 18 refs Contract No F33615-75-C 3065

Acoustic pressure fluctuation data have been acquired at AEDC on a 7 0 degree half cone-angle model, utilizing both sharp and blunt nosetips Measurements were obtained at Mach 4 and 8 for several values of freestream Reynolds number and model angle of attack, with and without mass injection for the blunt configuration Stationary zones of laminar, transitional, and turbulent flow over the model were achieved Resulting power-and-cross-power spectral densities as well as root-mean-square fluctuating pressure data are compared to previous high speed measurements, as a means of defining aeroacoustic environments appropriate for application to re-entry vibration response analyses (Author)

A77 22030 **Brewster angle for an E-polarized electromagnetic wave interacting with a moving dielectric medium** P K Mukherjee (Delhi, University, Delhi, India) *Journal of Applied Physics,* vol 48, Feb 1977, p 592 595 8 refs Research supported by the Department of Atomic Energy of India

The Brewster angle phenomenon of total transmission has been investigated with reference to an E polarized electromagnetic wave interacting with a dielectric half space moving along the interface Analytical conditions are derived for the existence of Brewster angles It is shown how the Brewster angles are modified by replacing the incident region (in which the incident electromagnetic wave is propagated) with an isotropic or a uniaxially anisotropic plasma The Brewster angles are found to behave in a remarkably different fashion under various conditions Numerical results for the Brewster angles, showing their dependence on the nondimensional velocity of the medium, are presented for several values of the physical parameters (Author)

A77-22231 # **Boundary layer transition flight test observations** A M Berkowitz, C L Kyriss, and A Martellucci (General Electric Co , Philadelphia, Pa) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-125* 42 p 36 refs Contract No F33615-76-C-3010

A historical review regarding the evolution of flight test boundary layer transition correlations in connection with the development of operational ballistic reentry vehicles in the U S is presented, taking into account the time periods from 1956 to 1961, from 1961 to 1971, and from 1971 to the present time Questions of transition data evaluation are discussed, taking into account transition data selection criteria, angle of attack effects, vehicle geometry characteristics, on-board sensors, redundant transition altitude sensors, vehicle classifications, and aspects of local flow property determination A correlation evaluation is also conducted, giving attention to the ground test, the flight test, wall cooling effects, nose related parameters, and bluntness correlations G R

A77-22234 # **The turbulent wake behind slender propeller driven bodies at angle of attack** J A Schetz, E B Daffan, and A K Jakubowski (Virginia Polytechnic Institute and State University, Blacksburg, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-133* 11 p 7 refs ARPA-supported research

Three effects on turbulent wakes behind propeller-driven bodies are examined in detail The first is the effect of pitch angle The second is the addition of an appendage such as a submarine 'sail' to an axisymmetric body The third is the replacement of a single propeller by an equivalent set of side-by-side counterrotating propellers Testing was conducted in a six-foot wind tunnel at a Reynolds number of 440,000, based on the model diameter Measurements of total pressure, static pressure, flow angularity, axial turbulence, radial turbulence, and radial shear stress were made at discrete points across the wake at three downstream stations These measurements yielded the velocity components, axial turbulence intensity, radial turbulence intensity, and radial shear stress through the wake The measurements were taken using a yawhead pressure probe, a standard pitot-static probe, and an x-hot-wire probe (Author)

A77-22235 # **Application of boundary layer blowing to suppress strong shock induced separation in supersonic inlets** W F Wong (Northrop Corp , Hawthorne, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-147* 10 p

An experimental study was conducted to investigate the application of boundary layer blowing to suppress strong shock-induced separation in supersonic inlets A tangential blowing system consisting of a single row of aft-facing discrete jets was tested on an isolated external compression inlet model at a free-stream Mach number of 2 and a unit Reynolds number of 10 million The blowing boundary-layer-control concept was shown to control successfully strong shock-induced separation with terminal shock strength approaching Mach 2 The single blowing location was able to provide control over a wide range of mass-flow ratio Results obtained with cold flow showed near-ideal inlet performance was achieved with an excess blowing momentum coefficient of 1 5-2 0 for terminal shock strength in the range from Mach 1 6 to about 2 Increasing the jet spacing and/or blowing temperature resulted in a decrease in control effectiveness for terminal shock locations near the blowing exit (low mass-flow ratio) The loss in effectiveness is apparently related to reduced mixing of the blowing jets and the incoming boundary layer for these two conditions (Author)

A77 22238 * # **Nonlinear, unsteady aerodynamic loads on rectangular and delta wings** E H Atta, O A Kandil, D T Mook, and A H Nayfeh (Virginia Polytechnic Institute and State University, Blacksburg, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-156* 8 p 16 refs Grant No NGR-47 004-090

Nonlinear unsteady aerodynamic loads on rectangular and delta wings in an incompressible flow are calculated by using an unsteady vortex-lattice model Examples include flows past fixed wings in unsteady uniform streams and flows past wings undergoing unsteady motions The unsteadiness may be due to gusty winds or pitching oscillations The present technique establishes a reliable approach which can be utilized in the analysis of problems associated with the dynamics and aeroelasticity of wings within a wide range of angles of attack (Author)

A77 22239 # **Pressure distribution on the trailing edge of a semi-infinite airfoil oscillating in a shear layer** J E Yates (Aeronautical Research Associates of Princeton, Inc , Princeton, N J) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-157* 37 p 13 refs Contracts No F44620-75-C-0010, No N00014-76-C-0576

The paper investigates the problem of a semi-infinite airfoil

oscillating in an idealized two-step potential flow model of a parallel shear flow Two trailing edge boundary conditions are considered the Kutta condition, and a zero vortex shedding or no Kutta condition The solution is valid for small shear layer velocity defect, and numerical results have been obtained for arbitrary reduced frequency and shear layer thickness It is found that in steady flow, the trailing edge pressure is uniformly attenuated by the shear layer The unsteady pressure amplitude is attenuated and the phase of the pressure is significantly changed by the shear layer Compressibility has a significant effect on the form of the pressure distribution as the acoustic wave number becomes comparable to the reciprocal flap length B J

A77-22240 * # A subsonic flow investigation on a research body at high angles of attack M H Clarkson (NASA, Ames Research Center, Moffett Field, Calif , Florida, University, Gainesville, Fla), G N Malcolm, and G T Chapman (NASA, Ames Research Center, Aerodynamic Research Branch, Moffett Field, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-180* 13 p 17 refs

Tests conducted in the Ames 12 foot pressure wind tunnel on a rotating research body at angles of attack of 45 to 90 deg yielded results that were inconsistent with simple cross flow theory Consequently, force and pressure distribution tests along with oil and sublimation flow-visualization studies were conducted in the same tunnel on a nonrotating model to attempt to explain the behavior observed in the rotary tests These studies indicate that at appropriate conditions of Reynolds number and angle of attack, inflectional instabilities occur in the boundary layer that materially affect separation and, hence, the aerodynamic forces Calculations of cross-flow Reynolds numbers are made and compared with other works on inflectional instability (Author)

A77-22244 * # Investigations related to the inviscid-viscous interaction in transonic flows about finite 3-D wings W Kordulla (NASA, Ames Research Center, Moffett Field, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-209* 14 p 48 refs

Inviscid small-disturbance theory has been shown to predict three-dimensional transonic flows about finite wings reasonably well as long as viscous effects are negligible In order to include these effects, the inviscid small-disturbance solution of Bailey and Ballhaus (1975) has been combined with a finite-difference solution for Prandtl's boundary-layer equations This solution employs the conditionally stable Krause (1968) scheme, implicit in the direction normal to the wall, to cope with the domain-of-dependence problem that arises for reverse cross flow To be consistent with the inviscid-flow solution, the boundary layer is computed in the representative wing planform plane which is transformed into rectangular shape in the computational domain The flow has been assumed turbulent, and a scalar eddy-viscosity model is adopted The interaction between inviscid and viscous flow is modeled with the help of the displacement surface which is added to the geometric wing shape Sample distributions of displacement thickness for swept wings are presented for weak and strong interaction cases (Author)

A77-22248 # Prediction of pressure distributions on axisymmetric bodies in transonic flow S F Yaros (ARO, Inc , Arnold Air Force Station, Tenn) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 15th, Los Angeles, Calif , Jan 24-26, 1977, Paper 77-226* 10 p 15 refs

A numerical investigation is reported of pressure-distribution predictions on arbitrary bodies of revolution in transonic flow, including both boundary-layer displacement and exhaust-plume entrainment effects The approach taken is a viscous/inviscid iterative one involving an integral boundary-layer program and an inviscid transonic program For attached boundary layers, the calculation procedure has been fully automated for both subcritical and supercritical cases, and predicted pressure distributions agree well with experimental data The entrainment effect of a real plume was modeled using mass-conservation considerations to determine an effective plume displacement thickness (Author)

A77-22260 Vibration tests on aircraft engines D S Elenevskii, R S Bekbulatov, L M Mel'nikov, B A Rogozhkin, and I G Sipukhin *(Problemy Prochnosti,* May 1976, p 37-40) *Strength of Materials,* vol 8, no 5, Feb 1977, p 541-544 Translation

The paper examines methodological problems regarding full-scale vibration testing of engines and their different sections on electrodynamical rigs under predetermined and random excitation A complex of full scale vibration tests is described, including power unit, automatic systems for programmed control of excitation, data acquisition systems, and systems for analog and digital processing of test results The complex has been in service for several years and yielded good results in testing aircraft engines S D

A77-22266 Fatigue of gas-turbine blades made of heat-resistant casting alloys B F Balashov, A N Petukhov, A N Arkhipov, and B V Volodenko *(Problemy Prochnosti,* May 1976, p 65-73) *Strength of Materials,* vol 8, no 5, Feb 1977, p 570-578 10 refs Translation

Fatigue test results are presented for profile and root sections of gas turbine blades made from cast nickel alloys ZhS6K, ZhS6U, and VZhL12U at normal and elevated temperatures Particular attention is given to the effect of structural and technological factors on the fatigue of the blades It is shown that the fatigue of the profile and locking connections of cast blades increases with increasing test temperature Fatigue strength is greatly affected by the scale factor, where the endurance limit is decreased with an increase in dimensions Asymmetry of loading cycle and stress concentration have a lesser effect Statistical characteristics pertaining to the distribution of the endurance limits of blade attachments are presented S D

A77-22449 # The principles of aerodynamics (Osnovy aerodinamiki) L Kh Kokunina Moscow, Izdatel'stvo Transport, 1976 208 p In Russian

This textbook discusses the fundamentals of aerodynamics with attention given to the basic notions and laws of aerodynamics, aerodynamic forces, aerodynamic characteristics of the wing and the aircraft, and the basics of high-speed aerodynamics Also considered are propeller dynamics, flight dynamics (steady and unsteady aircraft motion), the equilibrium, stability, and controllability of aircraft, and the fundamentals of the aerodynamics of helicopters and rockets B J

A77-22450 # Practical aerodynamics of the Yak-18T airplane (Prakticheskaia aerodinamika samoleta Iak-18T) K N Laletin, G T Ganus, Iu P Ivanov, L M Nikolaev, and V G Russakov Moscow, Izdatel'stvo Transport, 1976 216 p In Russian

Some aspects of the general low-speed aerodynamics and the practical aerodynamics of the Yak-18T trainer are examined, along with its balancing, stability, and steady and unsteady flight characteristics Particular attention is given to flight operations, the characteristics of piloting the plane (including acrobatics), and to the interpretation of the physical process that occur during the various flight conditions Some emergency situations (icing, forced landing, engine or control system malfunctions, etc) are examined, and appropriate pilot actions are outlined V P

A77-22541 # **Inspection of the working order of airplanes and helicopters Handbook (Kontrol' tekhnicheskoi ispravnosti samoletov i vertoletov Spravochnik)** V G Aleksandrov, Iu A Glazkov, A G Aleksandrov, and P N Sidorkin Moscow, Izdatel'stvo Transport, 1976 360 p In Russian

The handbook deals with modern inspection methods used in civil aviation It covers such topics as types of inspection, technical specifications of airworthiness, repair, and maintenance norms, techniques for detecting malfunctions of technological systems, subsystems, and elements, methods of inspecting feed lines, manifolds, joints of various type, fuel contamination, etc , optimal methods of inspecting fuselages, gas turbines, and their elements Much attention is given to modern optical material testing (flaw detection) and inspection methods V P

A77-22662 **A wing for the Airbus** D H Dykins (Hawker Siddeley Aviation, Ltd , Hatfield, Herts , England) *Physics in Technology,* vol 7, Nov 1976, p 246-253

The process and some of the problems in the design of the A-300 wing for the Airbus are described Attention is given to the effects of Reynolds number and the wind tunnel program partly developed to test Reynolds number effects High speed tests were performed at a Reynolds number of 6 x 10 to the 6th and involved the following model types unswept wing, sectional two-dimensional model with pressure plotting, half model of wing and fuselage, and complete model of wing plus fuselage and tail unit The objectives of the low speed program were a high stalling lift coefficient and a high efficiency (lift/drag) at incidences just below the stall Low speed tests were performed on the following model types swept parallel-chord half model, complete model, half model, and swept parallel chord half model B J

A77-22668 **Maximum rotor thrust capabilities, articulated and teetering rotors** K B Amer and S V LaForge (Hughes Helicopters, Culver City, Calif) *American Helicopter Society, Journal,* vol 22, Jan 1977, p 11, 12 7 refs

Evidence that a two-blade teetering rotor can attain a higher rotor thrust limit than an articulated rotor can is claimed Effects of power level during a pullup, rpm increase during the pullup, and reduction of forward speed during the pullup are accounted for These effects are considered crucial parameters for determining blade stall limits The maximum thrust capabilities of teetering and articulated rotors are shown to be equal when these effects are taken into account R D V

A77-22669 **Advancing blade concept /ABC/ development** A J Ruddell (United Technologies Corp , Sikorsky Aircraft Div , Stratford, Conn) *(American Helicopter Society, Annual National Forum, 32nd, Washington, D C , May 1976) American Helicopter Society, Journal,* vol 22, Jan 1977, p 13-23 5 refs

A brief review of the principles and development of the Advancing Blade Concept is presented Aircraft and control system configurations are defined Load sharing between rotors and the distribution of lift on the advancing and retreating blades can be adjusted in flight The coaxial rotor system is providing significantly better hover performance than a single rotor, with low noise levels A summary of pertinent rotor loads and stresses and their relationship to blade tip clearance is presented Variations of differential cyclic pitch between rotors effectively moves the center of lift of each rotor (Author)

A77 22670 **A prescribed wake lifting surface hover performance analysis** J D Kocurek and J L Tangler (Bell Helicopter Textron, Fort Worth, Tex) *(American Helicopter Society, Annual National Forum, 32nd, Washington, D C , May 1976) American Helicopter Society, Journal,* vol 22, Jan 1977, p 24-35 11 refs

The application of lifting surface theory to the calculation of rotor hover performance, and the development of an improved prescribed wake representation resulting from schlieren flow visualization studies of model rotor wakes are described Qualitative comparisons between lifting line and lifting surface methods show the tendency of the lifting line to react excessively when a vortex passes close to a blade The flow visualization studies reveal wake sensitivity to thrust coefficient, number of blades, and twist not identified in previous investigations The need to include a recirculation mechanism in the analytical model to provide inflow in addition to that available from the prescribed wake structure is established A possible source of the recirculation is demonstrated to be the result of vortex interaction and wake expansion immediately below the well-defined near wake (Author)

A77-22678 * # **Vortex interactions and decay in aircraft wakes** A J Bilanin, M E Teske, and G G Williamson (Aeronautical Research Associates of Princeton, Inc , Princeton, N J) *AIAA Journal,* vol 15, Feb 1977, p 250-260 37 refs Contracts No NAS1 13932, No F33615-73-C-3138

The dynamic interactions of aircraft wake vortices are investigated using both inviscid and viscous models The phenomenon of vortex merging resulting in the rapid aging of a vortex wake is examined in detail It is shown that the redistribution of vorticity from convection and diffusion during merging is a mechanism effective in reducing the hazard of a wake Inviscid computations show that the merging phenomenon may be sensitive to small changes in spanwise load distribution and that the fuselage vortex shed from the wing-fuselage junction can play a significant role in promoting merging of wing-tip and flap vortices Vortex wake-merging computations using a second-order closure model of turbulent transport indicate that a low-hazard wake occurs when the generating aircraft flap and wing-tip vortices of the same strength and sign This optimum is achieved when the flap vortex is located outboard approximately 40% of the distance to the tip vortex (Author)

A77-22679 # **On the not-so-slender wing theory** D D Liu (Northrop Corp , Hawthorne, Calif) *AIAA Journal,* vol 15, Feb 1977, p 261-263 14 refs

A simple method for obtaining the body potentials of a 'not so-slender' wing and their antisymmetric (lifting) potentials directly in the physical plane is presented which is based on an uncovered asymptotic property of a line-source structure near the body axis, with the slender-body solution being the lowest-order term It is shown that the subsequent higher-order terms involve no newer functional relation than that already found in the slender-body solution General recurrence formulas are derived for the particular not-so-slender body potentials in the linearized field of subsonic, supersonic, and sonic flows Analytical near-field sonic-flow solutions are obtained for the configuration of slender pointed wings F G M

A77-22685 * # **Derivation of an integral equation for transonic flows** W Ogana (NASA, Ames Research Center, Moffett Field, Calif) and J R Spreiter (Stanford University, Stanford, Calif) *AIAA Journal,* vol 15, Feb 1977, p 281-283 10 refs

It is noted that the nonlinear partial differential equation for the perturbation velocity potential and boundary conditions describing steady inviscid compressible transonic flow past a thin two-dimensional airfoil can be transformed into a singular integro-differential equation and that differentiation of the latter yields an

integral equation Two forms of this integral equation currently exist one for the singularity that is enclosed in an infinitely long strip of vanishing thickness and the other for the singularity that is enclosed in a vanishing circle In the present article, a more general integral equation is derived by enclosing the singularity in a vanishing rectangular cavity of arbitrary aspect ratio The two existing forms of this equation are deduced as special cases distinguished by the respective values for the aspect ratio (infinity for the first form and unity for the second) F G M

A77-22708 # **System identification for nonlinear aerodynamic flight regimes** W E Hall, Jr and N K Gupta (Systems Control, Inc , Palo Alto, Calif) *Journal of Spacecraft and Rockets,* vol 14, Feb 1977, p 73-80 26 refs Contract No N00014-72-C-0328

A development for the identification of aerodynamic forces and moments in nonlinear regimes is presented, with applications to simulated and flight test response data This development is a two-step method The first step is the application of an algorithm which determines the order and coefficients of polynomial expansions of the nonlinear aerodynamic forces and moments which characterize the nonlinear flight regime The second step is the use of a nonlinear six-degree-of-freedom maximum-likelihood algorithm which accurately estimates the values of the polynomial coefficients This method has been applied to simulated and flight-test data for a twin-engine swept-wing fighter aircraft in stall/poststall aerodynamic regimes (Author)

A77-22728 # **Operational requirements for advanced fighter aircrew displays** J K Ready (U S Navy, Washington, D C) In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 18-39

In the present paper, it is attempted to provide insight into how a Navy fighter pilot thinks in the air and what type of information he needs Some ideas on improving and simplifying the pilot's management of cockpit data are proposed The types of display essential to provide the needed information to a pilot in a simple, accurate, reliable form are examined V P

A77-22729 # **Cockpit information requirements - Common elements** R J McCusker In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 48 52

The specific information which a pilot needs to conduct a particular mission phase is discussed Improvements are suggested that would permit the pilot to fully utilize the potential of the systems available to him V P

A77-22730 # **The maneuvering flight path display** J F Watler, Jr (Northrop Corp , Hawthorne, Calif) and G W Hoover In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 215-230

Integrated visual displays are understood to mean displays which present only 'solution' information, i e , the information which represents the solution to an equation, rather than the parameters or variables involved in the equation The present paper deals with an advanced aircraft display concept of this type, known as the Maneuvering Flight Path Display The basis of the concept, the functions and characteristics of its elements, its projected applications, its information content, and its status of development are discussed, along with the activities planned to establish conclusively its operational feasibility The display will be used in all modes of flight Presently, it is being mechanized for use in air combat maneuvering V P

A77-22733 # **Solid state Helmet Mounted Display and Head Position Sensing System** J Campbell and I F Cooper (Marconi Elliott Avionics Systems, Ltd , Rochester, Kent, England) In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 289 306

The Marconi Elliott Helmet System incorporates a Helmet Mounted Display and a Helmet Optical Position Sensor The system provides a powerful aid for extending the capability of the pilot by designating a ground target, slewing sensors (such as IR, LLTV), and radar, or guiding a missile by simply looking in the desired direction The Helmet Mounted Display, used independently, provides a highly effective system for displaying warnings as well as some types of flight control data In the present paper the system and its elements are discussed V P

A77-22734 # **A helmet-mounted light emitting diode /LED/ display applied to the aircraft maneuverability problem** W F Moroney and P E Mullowney (U S Navy, Pacific Missile Test Center, Point Mugu, Calif) In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 307-313

The Helmet Mounted Display examined in the present paper uses a light-emitting diode array as the display medium The display will be used to present an energy maneuverability display format similar to that developed by McDonnell Douglas The need for such a display is demonstrated, and the potential uses of the display are outlined V P

A77-22736 # **Evaluating the characteristics of luminous colored cockpit displays** J Burns (Du Mont Electron Tubes and Devices Corp , Clifton, N J) In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 338 349

The theoretical and experimental investigation described was focused on developing displays that satisfy some basic pilot's needs created by evolution in navigation conditions The study has made possible to define a Detection Index that permits easy and rapid evaluation of the efficiency of screen display systems under the luminous environment typical of airplanes in flight An example is given for a tactical situation where color is used as a warning device to an operator engrossed in his workload V P

A77-22737 # **Integrated color display system** L D Evans (Lockheed California Co , Burbank, Calif) and S Storper (Loral Electronics Systems, Yonkers, N Y) In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 350 362

The use of multipurpose displays has enhanced the integration and presentation of multiple sensor information Color enhancement allows immediate perception of validity and provides the potential to increase operator efficiency The need for development of useful symbology through research is indicated V P

A77-22738 # **Tactical air applications for advanced multisensor imagery processing and display techniques** E L Cloud and T A Stinnett (Westinghouse Defense and Electronic Systems Center, Baltimore, Md) In Advanced Aircrew Display Symposium, 3rd, Patuxent River, Md , May 19, 20, 1976, Proceedings Patuxent River, Md , U S Naval Air Systems Command, Naval Air Test Center, 1976, p 363-379

The dynamic experimentation described was centered on real-time viewing of integrated multisensor (IR and TV) tactical imagery

both in color and black and white, and on the application of display processing techniques, such as level slicing and surface differentiation The experiments showed that electronically processed multisensor imagery results in a significant reduction in operator response time and increased accuracy for target detection and recognition It also facilitates the assimilation of additional information content V P

A77-22756 # **Design of military aircraft for minimum cost of ownership** A S Delahunty (British Aircraft Corp , Ltd Preston, Lancs , England) In Symposium on Equipment and Systems Design for Minimum Cost of Ownership, London, England, March 16, 1976, Proceedings London, Royal Aeronautical Society, 1976 11 p , Discussion, p C1-C6

Problems that confront the military aircraft designer as opposed to the civil aircraft designer are identified The discussion covers reduction of unit design costs, reduction of maintainability costs, reduction of training costs, and aircraft effectivity with respect to kill probability Unit cost reduction should not be achieved at the expense of increased cost of aircraft maintenance Design for reduced maintenance and training costs can best be attained by user/designer consultations at a very early stage of design S D

A77-22929 # **Jet engine nozzles (Sopla reaktivnykh dvigatelei)** D A Mel'nikov, U G Pirumov, and A A Sergienko In Aeromechanics and gas dynamics Moscow, Izdatel'stvo Nauka, 1976, p 57-75 13 refs In Russian

The results of theoretical and experimental studies of gas flows in jet engine nozzles are summarized The flow characteristics in the subsonic, transonic, and supersonic sections of such nozzles are briefly discussed Methods of designing the sections of an optimal nozzle are described, along with theoretical and experimental methods of determining the principal components of thrust losses The results presented are used to develop a method of profiling optimal jet engine nozzles V P

A77-22934 # **Calculation of supersonic laminar flow about a blunt body and the flow in the wake (Raschet sverkhzvukovogo laminarnogo obtekaniia zatuplennogo tela i techeniia v sliede)** N S Kokoshinskaia, B M Pavlov, and V M Paskonov In Aeromechanics and gas dynamics Moscow, Izdatel'stvo Nauka, 1976, p 160-171 25 refs In Russian

A finite-difference technique for solving the complete unsteady-state system of Navier Stokes equations is used to study the structure of viscous-gas flows about axisymmetric blunt bodies of finite size and the flows in their wakes The problem considered is that of an equilibrium supersonic flow of viscous gas about a blunt axisymmetric conic section at zero angle of attack and Reynolds numbers ranging from 200 to 10,000 A steady-state solution in the flow region perturbed by the body is obtained by the cited technique, and methods are outlined for obtaining a numerical solution in a greatly extended region of space containing shock waves, boundary layers, reverse-circulation flows, and wakes Some numerical results are presented for the flow about a spherically blunt cylinder and a blunt 10-deg conic section These results show that flow structure in the near and far wakes can be computed only if the effect of the bow shock is taken into account F G M

STAR ENTRIES

N77-15977*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
A BRIEF DESCRIPTION OF THE JAMESON-CAUGHEY NYU TRANSONIC SWEPT-WING COMPUTER PROGRAM FLO 22 Interim Report
Antony Jameson David A Caughey, Perry A Newman, and Ruby M Davis Dec 1976 34 p refs
(NASA-TM-X-73996) Avail NTIS HC A03/MF A01 CSCL 01A

A computer program for analyzing inviscid isentropic transonic flow past 3-D swept configurations is presented Some basic aspects of the program are (1) the free-stream Mach number is restricted only by the isentropic assumption, (2) weak shock waves are automatically located wherever they occur in the flow (3) the finite-difference form of the full equation for the velocity potential is solved by the method of relaxation, after the flow exterior to the airfoil is mapped to the upper half plane (4) the mapping procedure allows exact satisfaction of the boundary conditions and use of supersonic free stream velocities, (5) the finite difference operator is locally rotated in supersonic flow regions so as to properly account for the domain of dependence and (6) the relaxation algorithm was stabilized using criteria from a time-like analogy Author

N77-15978*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
JET EXHAUST AND SUPPORT INTERFERENCE EFFECTS ON THE TRANSONIC AERODYNAMIC CHARACTERISTICS OF A FIGHTER MODEL WITH TWO WIDELY SPACED ENGINES
William B Compton, III Washington Dec 1976 135 p
(NASA-TM-X-3424, L-10808) Avail NTIS HC A07/MF A01 CSCL 01A

Jet exhaust nozzle installation, and model support interference effects on the longitudinal aerodynamic characteristics of a twin-engine fighter model were determined Realistic jet exhaust nozzle configurations and a reference configuration with a simulated vertical-tail support were tested Free-stream Mach number was varied from 0 6 to 1 2 and model angle of attack from 0 deg to 9 deg The jet exhaust affected drag more than it affected lift and pitching moment The largest effects occurred at a Mach number of 0 9 and for the afterburning mode of exhaust nozzle operation The combined differences between the aerodynamic characteristics of the realistic and reference configurations (which were due to afterbody and nozzle contours, jet operation, and simulated reference support interference) were considerably different from those for the jet interference alone Author

N77-15979*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
PRESSURE DISTRIBUTION ON A 1- BY 3-METER SEMI-SPAN WING AT SWEEP ANGLES FROM 0 DEG TO 40 DEG IN SUBSONIC FLOW
Long P Yip and Gary L Shubert Washington Dec 1976 176 p refs
(NASA-TN-D-8307, L-10969) Avail NTIS HC A09/MF A01 CSCL 01A

A 1- by 3-meter semispan wing of taper ratio 1 0 with NACA 0012 airfoil section contours was tested in the Langley V/STOL tunnel to measure the pressure distribution at five sweep angles 0 deg 10 deg 20 deg 30 deg and 40 deg, through an angle-of-attack range from -6 deg to 20 deg The pressure data are presented as plots of pressure coefficients at each static-pressure tap location on the wing Flow visualization wing-tuft photographs are also presented for a wing of 40 deg sweep A comparison between theory and experiment using two inviscid theories and a viscous theory shows good agreement for pressure distributions normal forces, and pitching moments for the wing at 0 deg sweep Author

N77-15980*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
EFFECTS OF WING LEADING-EDGE RADIUS AND REYNOLDS NUMBER ON LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF HIGHLY SWEPT WING-BODY CONFIGURATIONS AT SUBSONIC SPEEDS
William P Henderson Dec 1976 54 p refs
(NASA-TN-D-8361 L-11017) Avail NTIS HC A04/MF A01 CSCL 01A

An investigation was conducted in the Langley low turbulence pressure tunnel to determine the effects of wing leading edge radius and Reynolds number on the longitudinal aerodynamic characteristics of a series of highly swept wing-body configurations The tests were conducted at Mach numbers below 0 30, angles of attack up to 16 deg and Reynolds numbers per meter from 6 57 million to 43 27 million The wings under study in this investigation had leading edge sweep angles of 61 7 deg, 64 61 deg and 67 01 deg in combination with trailing edge sweep angles of 0 deg and 40 6 deg The leading edge radii of each wing planform could be varied from sharp to nearly round Author

N77-15981*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
A NONLINEAR THEORY FOR AIRFOILS WITH TRAILING-EDGE JET FLAP
Raymond L Barger Washington Dec 1976 16 p refs
(NASA-TN-D-8368 L-11126) Avail NTIS HC A02/MF A01 CSCL 01A

A nonlinear procedure for computing the pressure distribution on an airfoil with a trailing edge jet flap is described The method is not restricted to thin airfoils or shallow jet-deflection angles Correlation with experiment indicates that the characteristics of the pressure distribution are predicted by the theory but the effect of entrainment is overpredicted with the entrainment coefficient used Author

N77-15982*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
LOW SPEED WIND TUNNEL INVESTIGATION OF FLIGHT SPOILERS AS TRAILING-VORTEX-ALLEVIATION DEVICES ON AN EXTENDED-RANGE WIDE BODY TRI-JET AIRPLANE MODEL
Delwin R Croom, Raymond D Vogler, and John A Thelander Washington Dec 1976 53 p refs
(NASA-TN-D-8373, L-11104) Avail NTIS HC A04/MF A01 CSCL 01A

An investigation was made in the Langley V/STOL tunnel to determine, by the trailing wing sensor technique, the effectiveness of various segments of the existing flight spoilers on an extended-range wide-body tri-jet transport airplane model when they were deflected as trailing-vortex-alleviation devices On the transport model with the approach flap configuration, the four combinations of flight-spoiler segments investigated were effective in reducing the induced rolling moment on the trailing wing model by as much as 25 to 45 percent at downstream distances behind the transport model of 9 2 and 18 4 transport wing spans On the transport airplane model with the landing

flap configuration, the four combinations of flight-spoiler segments investigated were effective in reducing the induced rolling moment on the trailing wing model by as much as 35 to 60 percent at distances behind the transport model of from 3 7 to 18 4 transport wing spans, 18 4 spans being the downstream limit of distances used Author

N77-15983*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
AUGMENTATION OF MANEUVER PERFORMANCE BY SPANWISE BLOWING
Gary E Erickson (George Washington Univ) and James F Campbell Jan 1977 239 p refs
(NASA-TM-X-73998) Avail NTIS HC A11/MF A01 CSCL 01A

A generalized wind tunnel model was tested to investigate new component concepts utilizing spanwise blowing to provide improved maneuver characteristics for advanced fighter aircraft Primary emphasis was placed on high angle of attack performance stability, and control at subsonic speeds Spanwise blowing on a 44 deg swept trapezoidal wing resulted in leading edge vortex enhancement with subsequent large vortex-induced lift increments and drag polar improvements at the higher angles of attack Small deflections of a leading edge flap delayed these lift and drag benefits to higher angles of attack In addition, blowing was more effective at higher Mach numbers Spanwise blowing in conjunction with a deflected trailing edge flap resulted in lift and drag benefits that exceeded the summation of the effects of each high lift device acting alone Asymmetric blowing was an effective lateral control device at the higher angles of attack Spanwise blowing on the wing reduced horizontal tail loading and improved the lateral-directional stability characteristics of a wing-horizontal tail-vertical tail configuration Author

N77-15986*# Illinois Univ, Urbana-Champaign Dept of Aeronautical and Astronautical Engineering
ON SOME STRUCTURE-TURBULENCE INTERACTION PROBLEMS Final Report, Jan. - Dec. 1976
Shoji Maekawa and Y K Lin Dec 1976 116 p refs
(Grant NsG-1264)
(NASA-CR-149461) Avail NTIS HC A06/MF A01 CSCL 01A

The interactions between a turbulent flow structure, responding to its excitation were studied The turbulence was typical of those associated with a boundary layer, having a cross-spectral density indicative of convection and statistical decay A number of structural models were considered Among the one-dimensional models were an unsupported infinite beam and a periodically supported infinite beam The fuselage construction of an aircraft was then considered For the two-dimensional case a simple membrane was used to illustrate the type of formulation applicable to most two-dimensional structures Both the one-dimensional and two-dimensional structures stueid were backed by a cavity filled with an initially quiescent fluid to simulate the acoustic environment when the structure forms one side of a cabin of a sea vessel or aircraft Author

N77-15987*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
TRANSONIC WIND-TUNNEL TESTS OF A LIFTING PARACHUTE MODEL
Jerome T Foughner, Jr, James F Reed (Sandia Labs, Albuquerque, N Mex), and Eleanor C Wynne Dec 1976 19 p refs
(NASA-TM-X-73982) Avail NTIS HC A02/MF A01 CSCL 01A

Wind-tunnel tests have been made in the Langley transonic dynamics tunnel on a 0 25-scale model of Sandia Laboratories 3 96-meter (13-foot), slanted ribbon design lifting parachute The lifting parachute is the first stage of a proposed two-stage payload delivery system The lifting parachute model was attached to a forebody representing the payload The forebody was designed and installed in the test section in a manner which allowed rotational freedom about the pitch and yaw axes Values of parachute axial force coefficient, rolling moment coefficient, and payload trim angles in pitch and yaw are presented through the transonic speed range Data are presented for the parachute in both the reefed and full open conditions Time history records of lifting parachute deployment and disreefing tests are included Author

N77-15991# National Aerospace Lab, Amsterdam (Netherlands) Scientific Services
REVIEW OF THE APPLICATION OF HODOGRAPH THEORY TO TRANSONIC AEROFOIL DESIGN AND THEORETICAL AND EXPERIMENTAL ANALYSIS OF SHOCK-FREE AEROFOILS
J W Boerstoel 10 Jun 1976 27 p refs Presented at the IUTAM Symp Transsonicum II, Goettingen, West Ger, 8-13 Sep 1975 Sponsored by Neth Agency for Aerospace Programs
(NLR-MP-75033-U) Avail NTIS HC A03/MF A01

After an introductory sketch of hodograph theory, the mathematical concepts, on which a few modern hodograph methods for computational airfoil design are based, are summarized The mathematical methods used lead to two different types of computation procedures, these are discussed Typical computation results of a few advanced airfoils are shown As far as available, typical experimental results are also presented An attempt is made to summarize what maximum thickness ratio's of shock-free airfoils can be realized at a given design point according to present-day knowledge An analysis of the leading edge shape of an interesting type of airfoil shows that the applicability of finite difference methods for the design of such airfoils should be considered a more difficult matter than perhaps is generally appreciated It is concluded that a computational design method for shock-free airfoils based on hodograph theory is nowadays a valuable tool for transonic airfoil and wing designers Author (ESA)

N77-15992# National Aerospace Lab, Amsterdam (Netherlands) Scientific Services
REMARKS ON THE SUITABILITY OF VARIOUS TRANSONIC SMALL PERTURBATION EQUATIONS TO DESCRIBE THREE-DIMENSIONAL TRANSONIC FLOW, EXAMPLES OF COMPUTATIONS USING A FULLY-CONSERVATIVE ROTATED DIFFERENCE SCHEME
J VanDerVooren J W Slooff, G H Huizing, and A VanEssen 24 Oct 1975 13 p refs Presented at IUTAM Symp Transsonicum II, Goettingen, West Ger 8-13 Sep 1975
(NLR-MP-75039-U) Avail NTIS HC A02/MF A01

Different transonic small perturbation equations, currently used for the calculation of transonic flow over wing-fuselage configurations are reviewed An equation is presented which has this proper mass conservative form The importance of this property is illustrated by investigating the shock relations of the various equations for three typical shocks, viz normal shocks, strong shocks on an infinite-yawed wing and so-called forward weak shocks downstream of which the flow remains supersonic These latter shocks are swept back and are part of the three-shock pattern which can occur under certain circumstances on the upper surface of a lifting wing A fully-conservative rotated difference scheme for transonic small perturbation equations is introduced Examples of computations illustrate the large influence of this scheme on shock strength and position as compared to a non-conservative scheme Results for a wing on which a three-shock occurs are also presented Author (ESA)

N77-15993# National Aerospace Lab, Amsterdam (Netherlands) Scientific Services
HODOGRAPH THEORY AND SHOCK FREE AIRFOILS
J W Boerstoel 10 Mar 1976 33 p refs Presented at the ONR Conf Transonic Flow, Univ of Calif, 30-31 Mar 1976 Sponsored by Neth Agency for Aerospace Programs
(NLR-MP-76002-U) Avail NTIS HC A03/MF A01

An outline is given of the most important topics of the hodograph theory on which the NLR computational procedure

for the design of supercritical shock free airfoils is based In particular, the analysis procedures are sketched The following elements of the theory are discussed or touched upon partial differential equations and mapping formulas, particular solutions Chaplygin functions operational methods, two-sheeted nature of hodograph surface, Tricomi boundary value problems (existence, uniqueness, Tricomi singularities), the NLR hodograph procedure and Tricomi boundary value problems and numerical experience with the solution procedure Computational and experimental results published in some of the references are reviewed Author (ESA)

N77-15994# National Aerospace Lab , Amsterdam (Netherlands) Fluid Dynamics Div

ON THE MOTION OF SHOCK WAVES ON AN AIRFOIL WITH OSCILLATING FLAP IN TWO-DIMENSIONAL TRANSONIC FLOW

H Tijdeman 14 Mar 1975 40 p refs Sponsored by Neth Agency for Aerospace Programs

(NLR-TR-75038-U) Avail NTIS HC A03/MF A01

Results are presented of measurements of the periodical motion of the shock waves on a NACA 64A006 airfoil with harmonically oscillating trailing-edge flap of 25 % of the chord in two-dimensional attached transonic flow in order to predict unsteady loads on oscillating wing in transonic flow It is shown that three different types of shock wave motion can be distinguished An analytical model is developed, with which a satisfactory explanation can be given of the observed three types of shock wave motion This analytical model includes the effect of streamwise pressure gradients ahead of the shock wave and remains - in contrast with earlier unsteady shock wave models - valid for low frequencies and quasi-steady flow Author (ESA)

N77-15996# European Space Agency, Paris (France)

LAMINAR SEPARATION NEAR THE TRAILING EDGE OF A THIN PROFILE

Rene Schmitt Dec 1976 132 p refs Transl into ENGLISH of 'Decollement Laminaire au Voisinage du Bord de Fuite d'un Profil Mince , ONERA Paris Report ONERA-NT-1976-3 1976 Original report in FRENCH previously announced as ESA-98184 (ESA-TT-343, ONERA-NT-1976-3) Avail NTIS HC A07/MF A01

The laminar separation taking place around the wedge-shaped trailing edge of a thin wing placed in an incompressible, two-dimensional flow at very high Reynolds numbers was studied by the method of matched asymptotic developments In the case where the dihedral effect is more important than the loss of the adherence effect, a three-layer scheme was developed around the separation point In the lower layer, where viscous effects are predominant, the flow is governed by a universal canonical problem containing only one parameter, related to the separation location The calculation of the asymptotic behaviors of the solution of the canonical problem, at infinity both upstream and downstream of the viscous sublayer, is mainly dealt with Author (ESA)

N77-15998# Analytical Methods, Inc , Bellevue, Wash

AN INVESTIGATION OF SEPARATION MODELS FOR THE PREDICTION OF MAXIMUM LIFT Interim Technical Report

B Maskew and F A Duorak 30 Jun 1976 30 p *refs*

(Contract DAAG29-76-C-0019)

(AD-A027359 ARO-13225 1-EX) Avail NTIS HC A03/MF A01 CSCL 20/4

The research reported here has as its objective the development of a separation model which can be incorporated into existing viscous/potential flow interaction analysis This would provide an engineering analysis tool which would be of considerable use to both rotary and fixed wing aerodynamicists To implement this study, three separation models were considered The different models investigated and the results to date are described Author (GRA)

N77-16000# Naval Postgraduate School, Monterey, Calif

LIFTING SURFACE THEORY FOR WINGS OF ARBITRARY PLANFORM M S Thesis

John Leroy Parks Mar 1976 67 p refs

(AD-A028449) Avail NTIS HC A04/MF A01 CSCL 01/1

This theory permits the calculation of pressure distributions over a thin airfoil in steady, inviscid, incompressible flow, or given a desired chordwise pressure distribution the camber line of an ideal wing can be determined The method treats the circulation about the wing as a continuous vortex sheet of variable strength covering the wing planform and trailing downstream to infinity The results of the present numerical solution for the pressure distribution solution are not conclusive However the solution for the camber line of an ideal wing is in reasonable agreement with published two dimensional results GRA

N77-16003# National Aviation Facilities Experimental Center, Atlantic City, N J

EVALUATION OF HALON 1301 SYSTEM FOR POSTCRASH AIRCRAFT INTERNAL CABIN FIRE PROTECTION Final Report, May - Dec 1975

Richard Hill and Paul N Boris Oct 1976 38 p refs

(AD-A032150/5 FAA-NA-76-21, FAA-RD-76-132) Avail NTIS HC A03/MF A01 CSCL 01/2

The use of a Halon 1301 fire-suppression system was evaluated in regard to increasing escape time during a ground crash situation with an internal cabin fire Tests were conducted in a DC7 fuselage varying the exit configurations, and fire size at agent discharge Smoke temperature, carbon monoxide oxygen, and Halon 1301 levels were continuously monitored during the tests at various locations throughout the cabin A sampling system for collecting hydrogen flouride (Halon 1301's primary decomposition product) was used Samples at four locations were taken every 30 seconds, for 5 minutes after discharge The use of a curtain to inhibit the spread of HF was also examined The results indicated that in order to minimize the HF concentrations, the fire should be extinguished prior to the opening of cabin exits The use of a curtain to partition the cabin greatly reduced the spread of HF from the fire zone to the protected section Test results also indicated that a system malfunction causing Halon 1301 concentrations less than those needed to extinguish a fire could produce very high HF levels Author

N77-16007# Mitre Corp , Atlantic City N J

INTERFACE DEFINITION DABS ENGINEERING MODEL/ ATC (NAFEC) TERMINAL HARDWARE CONFIGURATION, VOLUME 4

Royal A Westcott Nov 1975 43 p refs

(Contract DOT-FA69NS-162)

(AD-A025234/6, MTR-4221-Vol-4, FAA-RD-75-159-Vol-4) Avail NTIS HC A03/MF A01 CSCL 17/7

The hardware interfaces described are required between the Discrete Address Beacon System (DABS) Engineering Models, to be installed at or near the National Aviation Facilities Experimental Center (NAFEC), and the Terminal Automation Test Facility (TATF) at NAFEC This interface will be used to support DABS development tests and the Upgraded Third Generation System Tests including the Intermittent Positive Control (IPC) *Phase II tests* Author

N77-16012 Texas Univ Arlington

AN ANALYSIS OF AN APPLICATION OF AEROSPACE SYSTEMS ENGINEERING PROCESS AS IT AFFECTS DESIGN Ph D Thesis

John G Heit 1976 327 p

Avail Univ Microfilms Order No 76-30314

The effect of the systems engineering process on aerospace development programs was ascertained Any factors that impeded its effectiveness were identified The specific function under investigation was the design process The research methodology was formulated around case studies of two aerospace development programs The evaluation of the systems engineering process was accomplished through a comparison of the resultant data Both programs were developed under the weapon systems management concept Dissert Abstr

N77-16013*# McDonnell Aircraft Co St Louis, Mo
LIFT/CRUISE FAN V/STOL TECHNOLOGY AIRCRAFT DESIGN DEFINITION STUDY VOLUME 1 TECHNOLOGY FLIGHT VEHICLE DEFINITION
William J OBrien 18 Nov 1976 238 p
(Contract NAS2-9245)
(NASA-CR-151931 MDC-A4551-Vol-1) Avail NTIS HC A11/MF A01 CSCL 01C

Concept design is presented for two types of lift/cruise fan technology V/STOL aircraft turbotip fans and the other using machanically driven fans The turbotip research technology aircraft reflects maximum usage of existing airframe components The propulsion system consists of three turbotip fans pneumatically interconnected to three gas generators Thrust modulation is accomplished by use of energy transfer and control system and thrust reduction modulation This system can also be operated in the two engine/three fan mode The mechanical RTA is virtually identical to the turbotip RTA with the exceptions that a different propulsion system and aft fuselage/tail are used Both aircraft meet or exceed all of the mission performance guidelines and reflect a low cost low risk approach Author

N77-16014*# McDonnell Aircraft Co , St Louis, Mo
LIFT/CRUISE FAN V/STOL TECHNOLOGY AIRCRAFT DESIGN DEFINITION STUDY VOLUME 2 PROPULSION TRANSMISSION SYSTEM DESIGN
William J OBrien 18 Nov 1976 60 p
(Contract NAS2-9245)
(NASA-CR-151932, MDC-A4551-Vol-2) Avail NTIS HC A04/MF A01 CSCL 01C

Two types of lift/cruise fan technology aircraft were conceptually designed One aircraft used turbotip fans pneumatically interconnected to three gas generators and the other aircraft used variable pitch fans mechanically interconnected to three turboshaft engines The components of each propulsion transmission system were analyzed and designed to the depth necessary to determine areas of risk development methods performance, weights and costs The types of materials and manufacturing processes were identified to show that the designs followed a low cost approach The lift/cruise fan thrust vectoring hoods, which are applicable to either aircraft configuration, were also evaluated to assure a low cost/low risk approach Author

N77-16015*# McDonnell Aircraft Co St Louis, Mo
LIFT/CRUISE FAN V/STOL TECHNOLOGY AIRCRAFT DESIGN DEFINITION STUDY VOLUME 3 DEVELOPMENT PROGRAM AND BUDGETARY ESTIMATES
William J OBrien 18 Nov 1976 29 p
(Contract NAS2-9245)
(NASA-CR-151933 MDC-A4551-Vol-3) Avail NTIS HC A02/MF A01 CSCL 01C

The aircraft development program, budgetary estimates in CY 1976 dollars, and cost reduction program variants are presented Detailed cost matrices are also provided for the mechanical transmission system turbotip transmission system and the thrust vector hoods and yaw doors Author

N77-16016*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
A SIMPLIFIED ANALYSIS OF PROPULSION INSTALLATION LOSSES FOR COMPUTERIZED AIRCRAFT DESIGN
Shelby J Morris, Jr Walter P Nelms, Jr and Rodney O Bailey Aug 1976 74 p refs
(NASA-TM-X-73136 A-6608) Avail NTIS HC A04/MF A01 CSCL 01C

A simplified method is presented for computing the installation losses of aircraft gas turbine propulsion systems The method has been programmed for use in computer aided conceptual aircraft design studies that cover a broad range of Mach numbers and altitudes The items computed are inlet size, pressure recovery, additive drag, subsonic spillage drag bleed and bypass drags auxiliary air systems drag, boundary-layer diverter drag, nozzle boattail drag and the interference drag on the region adjacent to multiple nozzle installations The methods for computing each of these installation effects are described and computer codes for the calculation of these effects are furnished The results of these methods are compared with selected data for the F-5A and other aircraft The computer program can be used with uninstalled engine performance information which is currently supplied by a cycle analysis program The program including comments, is about 600 FORTRAN statements long, and uses both theoretical and empirical techniques Author

N77-16019*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
A FOREBODY DESIGN TECHNIQUE FOR HIGHLY INTEGRATED BOTTOM-MOUNTED SCRAMJETS WITH APPLICATION TO A HYPERSONIC RESEARCH AIRPLANE
C L W Edwards Washington Dec 1976 30 p refs
(NASA-TN-D-8369, L-11265) Avail NTIS HC A03/MF A01 CSCL 01C

A rapid and simple inviscid technique for designing forebodies which produce uniformly precompressed flows at the entrance for bottom-mounted scramjets was developed so that geometric constraints resulting from design trade-offs can be effectively evaluated The flow fields resulting from several forebody designs generated in support of a conceptual design for a hypersonic research airplane have been analyzed in detail Three-dimensional characteristics calculations were used to verify the uniform flow conditions For the designs analyzed, uniform flow was maintained over a wide range of flight conditions (Mach numbers from 4 to 10, angles of attack of 6 and 10 deg) corresponding to the scramjet operation flight envelope of the research airplane Author

N77-16048*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
A FLIGHT INSTRUMENTATION SYSTEM FOR ACQUISITION OF ATMOSPHERIC TURBULENCE DATA
Charles W Meissner Jr Dec 1976 22 p refs
(NASA-TN-D-8314, L-10596) Avail NTIS HC A02/MF A01 CSCL 01D

A flight instrumentation system for the acquisition of atmospheric turbulence data is described Airflow direction transducers and an impact pressure transducer are the primary instruments for measuring vertical and lateral gust velocity, and a sensitive incremental pressure transducer is used to measure longitudinal gust velocity Airplane motions sensed by an inertial platform are subtracted from the primary measurements during postflight data reduction to yield true gust velocity time histories Salient engineering features of the instrumentation are discussed, and a complete description of the instrumentation is presented Author

N77-16049# Army Missile Research, Development and Engineering Lab Redstone Arsenal, Ala Advanced Sensors Directorate
A LAUNCH TRANSIENT EXPERIMENT FOR IMAGING SEEKERS
C E Kulas and G D Wylie 17 May 1976 50 p refs
(DA Proj 1M3-62303-A-214)
(AD-A028625 RE-76-33) Avail NTIS HC A03/MF A01 CSCL 17/8

This report discusses the launch transient experiment which has been developed for evaluating the ability of an imaging

seeker to maintain target lock-on through the environment of a helicopter launched missile The details of the experiment are presented as well as the most current information available on the types of inputs to use to simulate the launch conditions
Author (GRA)

N77-16050# Advisory Group for Aerospace Research and Development, Paris (France)
VISUAL PRESENTATION OF COCKPIT INFORMATION INCLUDING SPECIAL DEVICES USED FOR PARTICULAR CONDITIONS OF FLYING
G Perdriel Nov 1976 85 p refs Partly in FRENCH and ENGLISH Conf proc held at Athens 20-24 Sept 1976
(AGARD-CP-201 ISBN-92-835-0181-0) Avail NTIS HC A05/MF A01

Cockpit human factor engineering is discussed describing display devices navigational instruments, and weapon systems Conditions such as size determination, target recognition imaging techniques, and pilot performance are discussed

N77-16051# Royal Aircraft Establishment Farnborough (England) Dept of Flight Systems
THE DEVELOPMENT OF AIRCRAFT INSTRUMENTS
E J Lovesey *In* AGARD Visual Presentation of Cockpit Information Including Special Devices Used for Particular Conditions of Flying Nov 1976 15 p refs

Avail NTIS HC A05/MF A01

A brief history of the development of aircraft cockpit instrument layouts is presented listing some of the short-comings of current instrument displays An indication of probable trends for future aircraft information presentations is also given Author

N77-16052# Service Technique de l Aeronautique Paris (France)
EVALUATION OF COCKPIT LIGHTING [CRITIQUE DE L'ECLAIRAGE DES POSTES DE PILOTAGE]
L D Heynemann and J P Chevaleraud (Centre Principal d Expertises Medicales du Personnel Navigant, Paris) *In* AGARD Visual Presentation of Cockpit Information Including Special Devices Used for Particular Conditions of Flying Nov 1976 9 p In FRENCH
Avail NTIS HC A05/MF A01

Present standards regarding the lighting of cockpits (instruments, control panels, instrument panels) are discussed Some of these regulations are criticized in reference to flight conditions Solutions concerning the presentation of flight information is described Transl by B B

N77-16053# Forschungsinstitut fuer Anthropotechnik Meckenheim (West Germany)
COMPARATIVE EXPERIMENTAL EVALUATION OF TWO-DIMENSIONAL AND PSEUDO-PERSPECTIVE DISPLAYS FOR GUIDANCE AND CONTROL
In AGARD Visual Presentation of Cockpit Information Including Special Devices Used for Particular Conditions of Flying Nov 1976 15 p refs
Avail NTIS HC A05/MF A01

The relative advantages of two and three dimensional displays are discussed A fixed base simulation of a Do 28 airplane was used Performance and eyepoint of regard measures were recorded as well as subjective ratings It is shown that in flying a complex mission both displays have about the same accuracy M C F

N77-16054# Advisory Group for Aerospace Research and Development Paris (France)
THE MALCOLM HORIZON
K E Money, R E Malcolm, and P J Anderson *In its* Visual Presentation of Cockpit Information Including Special Devices Used for Particular Conditions of Flying Nov 1976 3 p ref

Avail NTIS HC A05/MF A01

The Malcolm Horizon is a bar of light which shines across the instrument panel of an aircraft cockpit driven by motors so as to move in a manner corresponding to the real horizon outside the aircraft The motion is controlled by servo-motors which are driven by signals derived from the gyro platform of the aircraft A series of simulator trials and flight trials have been carried out on the device in an attempt to evaluate it and further develop it and to evaluate aircrew performance while using the device The trials showed that the bar of light is very compelling is in constant view regardless of where the gaze may be directed and does not interfere with the normal reading of the instruments All of the pilots who have flown with the Malcolm Horizon reacted positively and would welcome the addition of this device to the cockpit Author

N77-16056# Pacific Missile Test Center Point Mugu, Calif
TERRAIN FOLLOWING USING STEREO TELEVISION
In AGARD Visual Presentation of Cockpit Information Including Special Devices Used for Particular Conditions of Flying Nov 1976 10 p refs
Avail NTIS HC A05/MF A01

An experiment was conducted to determine whether low altitude terrain following flight could be accomplished better with stereo television than with conventional two-dimensional television Nine subjects, both pilots and nonpilots flew a simulated F-4 aircraft using only the information supplied by an air-to-ground television system The simulation system consisted of 12- by 30-foot 2 000 1 scale terrain model a gantry system carrying the television camera a moving base cockpit and associated computer hardware that provided the proper control stick responses The subject s task was to fly as low as possible across a 9 mile flight corridor without going below 250 feet above ground level A single path that varied from sea level to 4 000 feet and at a constant airspeed of 300 knots was flown by all subjects The subjects could control only the vertical dimension of the aircraft s flight Author

N77-16060 Pennsylvania State Univ University Park
PROPELLED TIME-DEPENDENT FORCES DUE TO NONUNIFORM INFLOW Ph D Thesis
Donald E Thompson 1976 223 p
Avail Univ Microfilms Order No 76-29684

Various aspects of the time-dependent forces and moments generated by marine propellers due to operating a nonuniform velocity field were analyzed The response of a propeller to both a spatially and temporally nonuniform flow field was considered The propeller time-dependent response to each type of nonuniform flow was treated analytically and predictions were made which were compared to experimentally determined values of unsteady propeller thrust Two fundamentally different analytical approaches were considered for predicting response to spatial variations in the inflow One approach employed a modified unsteady, two-dimensional airfoil theory The second approach employed a lifting surface theory An experimental program was conducted in which measurements of the time-dependent thrust generated by a series of propellers operating in a strut wake were made
Dissert Abstr

N77-16063# Boeing Commercial Airplane Co Seattle, Wash
THE 727/JT8D JET AND FAN NOISE FLIGHT EFFECTS STUDY Final Report
Luis F Munoz Aug 1976 292 p refs
(Contract DOT-FA71WA-2637)
(AD-A031877/4 D6-44145 FAA-RD-76-110) Avail NTIS HC A13/MF A01 CSCL 21/5

A study was conducted to define specific ground to flight effects on the noise of a low bypass ratio engine The analysis was based on acoustic data recorded during the FAA-sponsored 727 Noise Retrofit Feasibility Program Two configurations a baseline and an ejector suppressor nacelle were included in the study Noise flight effects were obtained by comparing JT8D ground static and 727/JT8D flight acoustic data Procedures

are defined for normalizing static and flight data to common conditions The analysis considered both jet and fan noise characteristics for five engine power settings The results will provide a guideline for establishing flight effects technology
Author

N77-16064# National Aviation Facilities Experimental Center Atlantic City N J
AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS FOR EXHAUST EMISSIONS FROM TWO CLASSES OF AIRCRAFT TURBINE ENGINES Final Report, Feb 1974 - Aug 1975
Louis Allen and Gerald R Slusher Oct 1976 111 p refs
(AD-A031923/6 FAA-NA-76-16, FAA-RD-76-149) Avail NTIS HC A05/MF A01 CSCL 21/5

Correction coefficients to reduce the production of exhaust emissions to standard day conditions for ambient temperature and humidity were developed for two classes of aircraft turbine engines Correlation and multiple regression methods were utilized in the analysis of emission measurements recorded from two turbine engines operated under naturally occurring environmental conditions starting in the winter and continuing through the summer season Correction factors were established for the emission index (EI) and power index (PI) for carbon monoxide (CO) total hydrocarbons (THC), and nitrogen oxides (NOx) for each of five engine power conditions of idle, approach, cruise, maximum continuous, and takeoff Ambient temperature produced the deominant effect on all gaseous emissions EI and PI for THC required the greatest magnitude of ambient temperature correction factors Humidity had a significant secondary effect on the generation of NOx
Author

N77-16065# Sperry Vickers Troy Mich Aerospace-Ordnance-Marine Div
HIGH SPEED HYDRAULIC STARTER MOTOR FOR AIRCRAFT AUXILIARY POWER UNIT Final Technical Report, 8 Jan 1973 - 1 Nov 1975
Harry T Johnson and Nicholas F Pederson Wright-Patterson AFB Ohio AFAPL Mar 1976 74 p refs
(Contract F33615-73-C-2003 AF Proj 3145)
(AD-A027413 AFAPL-TR-76-23 Rept-9-5011-100) Avail NTIS HC A04/MF A01 CSCL 21/5

The purpose of this research program was to develop a vane type hydraulic starter motor for aircraft high-speed auxiliary power units The goals were to achieve a starter cutoff speed of 50,000 RPM and an inlet pressure capability of 8000 PSIG maximum using MIL-H-5606 hydraulic oil as the working fluid A balanced three element single eccentric vane motor has been designed and proved capable of operation at 30 000 RPM and 3000 PSIG The 0 145 cu in /rev prototype motor had a 72% torque efficiency at the noted conditions Although the design goals proved unattainable the unique vane motor design demonstrated that high speed hydraulic motor operation is feasible The inability of the vane tip/cam ring interface to survive the high vane tip surface speed and loading represents the major problem that must be eliminated if the goal conditions are to be achieved Use of highly wear resistant vane and cam ring materials did not provide a solution to this difficult lubrication problem The vane motor was not evaluated at the projected thermal extremes (-65 F to +130 F) and the proposed hydraulic starter system demonstration was not conducted when the operational limits were found to be far less than the original starter motor objectives
Author (GRA)

N77-16066# Kentucky Univ Lexington Dept of Engineering Mechanics
THERMO-MECHANICAL STRESS ANALYSIS OF ADVANCED TURBINE BLADE COOLING CONFIGURATION Interim Report, 1 May 1975 - 30 Apr 1976
F J Rizzo and D J Shippy May 1976 50 p refs
(Grant AF-AFOSR-2824-75 AF Proj 9782)
(AD-A027718, UKY-TR95-76-EM12, AFOSR-76-0841TR) Avail NTIS HC A03/MF A01 CSCL 21/5

A thermo-mechanical stress analysis capability, based on the Boundary Integral Equation Method (BIE) is developed and described The method of numerical implementation involves second order surface element discretization with second order variation of key variables over the elements The capability is varified on a number of test problems in preparation for application *to a thermo-mechanical stress analysis problem for a transpiration* cooled turbine blade
GRA

N77-16067# ARO Inc Arnold Air Force Station Tenn
VARIABLE-AREA SUBSONIC DIFFUSER STUDY Final Report, 1 Jul 1975 - 30 Jun 1976
Delbert Taylor and David A Duesterhaus AEDC Sep 1976 35 p refs
(ARO Proj R32P-A9A)
(AD-A029352, ARO-ETF-TR-76-75, AEDC-TR-76-126) Avail NTIS HC A03/MF A01 CSCL 21/5

An experimental development program was conducted to investigate the performance of a variable-area subsonic diffuser The project goal was to improve the static pressure rise ratio of exhaust gas diffusers used with subsonic high-bypass-ratio, front fan engines during direct-connect testing in ground test facilities A one-tenth scale model of the TF-39 turbofan engine was used in the experiment Diffuser performance data were recorded during model engine operation with cold air at five simulated power settings with five diffuser configurations Test cell and engine cowl surface pressures were recorded to determine the influence of the exhaust gas diffuser on these pressures Data from all configurations were analyzed to determine the effect of the exhaust gas diffusers on test cell and engine cowl pressures and to determine the diffuser pressure rise ratio Test cell and engine surface pressure data were not affected by the diffuser configuration The static pressure rise ratio of one variable-area diffuser configuration tested exceeded that of all others and a conventional 5-deg half-angle subsonic diffuser
Author (GRA)

N77-16068*# National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
EFFECT OF DROOPED-NOSE FLAPS ON THE EXPERIMENTAL FORCE AND MOMENT CHARACTERISTICS OF AN OBLIQUE WING
Edward J Hopkins and George H Lovette Washington Nov 1976 142 p refs
(NASA-TM-X-3398, A-6461) Avail NTIS HC A07/MF A01 CSCL 01C

Six-component experimental force and moment data are presented for a low aspect ratio oblique wing equipped with drooped-nose flaps and mounted on top of a body of revolution These flaps were investigated on the downstream wing panel with the nose drooped 5 deg 10 deg, 20 deg, and 30 deg, and on both wing panels with the nose drooped 30 deg It was to determine if such flaps would make the moment curves more linear by controlling the flow separation on the downstream wing panel at high lift coefficients The wing was elliptical in planform and had an aspect ratio of 6 0 (based on the unswept wing span) The wing was tested at sweep angles of 45 deg and 50 deg throughout the Mach number range from 0 25 to 0 95 The drooped-nose flaps alone were not effective in making the moment curves more linear, however a previous study showed that Kruger nose flaps improved the linearity of the moment curves when the Kruger flaps were used on only the downstream wing panel equipped with drooped-nose flaps deflected 5 deg
Author

N77-16070# National Aerospace Lab , Amsterdam (Netherlands) Structures and Materials Div
APPLICATION OF ACTIVE CONTROLS FOR THE REDUCTION OF FATIGUE LOADS [TOEPASSING VAN ACTIVE CONTROLS VOOR DE VERLAGING VAN VERMOEIIENGSBELASTINGEN]
J B deJonge 15 Dec 1975 40 p refs In DUTCH, ENGLISH summary Sponsored by Neth Agency for Aerospace Programs (NLR-TR-75163-U) Avail NTIS HC A03/MF A01

The working principles of active control systems are explained Specific attention is paid to the possibilities of reducing fatigue loads by means of active controls Active controls may be and are being used to increase the fatigue life of aircraft with inadequate fatigue performance It is shown that the weight saving that can be obtained with non-critical active control systems is very limited Substantial gains can be obtained only from critical active controls applied in a rigorous CCV-concept
Author (ESA)

N77-16071# Calspan Corp Buffalo, N Y
A FLIGHT INVESTIGATION OF CONTROL, DISPLAY, AND GUIDANCE REQUIREMENTS FOR DECELERATING DESCENDING VTOL INSTRUMENT TRANSITIONS USING THE X-22A VARIABLE STABILITY AIRCRAFT VOLUME 1 TECHNICAL DISCUSSION AND RESULTS Final Report, May 1973 - Sep 1975
J Victor Lebacqz and Edwin W Aiken Sep 1975 244 p refs 2 Vol
(Contract N00019-73-C-0504)
(AD-A029051, CALSPAN-AK-5336-F-1-Vol-1) Avail NTIS HC A11/MF A01 CSCL 01/3

The third flight research program using the variable stability X-22A aircraft was undertaken to investigate control display, and guidance requirements for VTOL instrument transitions The primary purpose of the experiment was to provide meaningful data related to the interaction of aircraft control system and displayed information characteristics on pilot rating and performance during a steep decelerating descending transition from a representative forward velocity (100 Kt) to the hover completely under instrument conditions Thirty-eight in-flight evaluations were performed of combinations of five generic display presentations, ranging from position-information-only to four-axis control directors, and five levels of control augmentation systems ranging from rate-augmentation-only to decoupled longitudinal and vertical velocity responses and automatic configuration changes In addition, new guidance developments of fundamental importance to VTOL instrument terminal area operations including an Independent Thrust Vector Inclination Command (ITVIC) and a procedure for automatically switching between airspeed and ground speed tracking to account for headwinds and crosswinds, were conceived designed and demonstrated during the experiment
GRA

N77-16072# Calspan Corp Buffalo N Y
A FLIGHT INVESTIGATION OF CONTROL, DISPLAY, AND GUIDANCE REQUIREMENTS FOR DECELERATING DESCENDING VTOL INSTRUMENT TRANSITIONS USING THE X-22A VARIABLE STABILITY AIRCRAFT VOLUME 2 BACKGROUND INFORMATION AND SUPPORTING DATA Final Report, May 1973 - Sep 1975
J Victor Lebacqz and Edwin W Aiken Sep 1975 252 p refs 2 Vol
(Contract N00019-73-C-0504)
(AD-A028874 CALSPAN-AK-5336-F-1-Vol-2) Avail NTIS HC A12/MF A01 CSCL 01/3

The third flight research program using the variable stability X-22A was undertaken to investigate control, display and guidance requirements for VTOL instrument transitions The primary purpose of the experiment was to provide meaningful data related to the interaction of aircraft control system and displayed information characteristics on pilot rating and performance during a steep decelerating descending transition from a representative forward velocity (100 Kt) to the hover completely under instrument conditions Thirty-eight in-flight evaluations were performed of combinations of five generic display presentations ranging from position-information-only to four-axis control directors, and five levels of control augmentation systems ranging from rate-augmentation-only to decoupled longitudinal and vertical velocity responses and automatic configuration changes GRA

N77-16171# National Aviation Facilities Experimental Center, Atlantic City N J
AN EVALUATION OF WINDOW GLASS FOR AIR TRAFFIC CONTROL TOWER CABS Final Report, Mar 1974 - Aug 1975
Lee E Paul J Roy Bradley, and Donald A Martin Oct 1976 43 p refs
(AD-A031924/4, FAA-NA-76-13, FAA-RD-76-105) Avail NTIS HC A03/MF A01 CSCL 11/7

Seven samples of commercially available glass were evaluated to determine their suitability for use in air traffic control tower cabs Spectral transmissivity measurements were made on each sample for all wavelengths in the visible spectrum A small experimental tower cab was constructed near the NAFEC airport, and controllers evaluated the samples in the tower cab under day night dawn and dusk viewing conditions The controller ratings were analyzed and evaluated in terms of the optical transmissivity of the samples and the type of window, i e , single pane and double pane There were differences in the ratings of the samples and the relative merit of the samples depended, in part on the time of day the ratings were made An unexpected factor in the ratings was the appearance of internal reflections in the double pane windows at night
Author

N77-16272# Boeing Aerospace Co Seattle Wash
HIGH VOLTAGE DESIGN GUIDE FOR AIRBORNE EQUIPMENT Final Report, 26 Sep 1975 - Jun 1976
William G Dunbar and Joseph W Seabrook Wright-Patterson AFB Ohio AFAPL Jun 1976 218 p refs
(Contract F33615-76-C-2008 AF Proj 3145)
(AD-A029268 AFAPL-TR-76-41 Rept-1) Avail NTIS HC A10/MF A01 CSCL 09/1

The report supplies the theoretical background and design techniques needed by an engineer who is designing electrical insulation for high-voltage high-power components equipment and systems on aircraft A literature survey and abundant bibliography identify references that provide further data on the subjects of partial discharges corona field theory and plotting voids and processes for applying insulation Both gaseous and solid insulations are treated Cryogenic and liquid design notes are included Tests and test equipment for high voltage insulation and equipment are defined Requirements of test plans and procedures for high-voltage high-power equipment are identified and illustrated by examples Suggestions for high-voltage specifications are provided Very few of the Military and Government specifications deal with system voltages above 10kv, thus most aircraft high-voltage specifications will have to be derived from the power industry specifications and standards produced by ASTM IEEE and NEMA
GRA

N77-16279# Rome Air Development Center Griffiss AFB N Y
A SHORT BACKFIRE ANTENNA FITTED WITH A WAVEGUIDE FEED
John A Strom and Hermann W Ehrenspeck May 1976 56 p refs
(AF Proj 5635)
(AD-A028910 RADC-TR-76-148) Avail NTIS HC A04/MF A01 CSCL 09/5

A short backfire antenna incorporating an open-ended waveguide as its feed mechanism has been measured experimentally in three different structural configurations A complete set of curves describing the directivity sidelobe levels and half-power beamwidths as a function of frequency as well as a few of the more important radiation patterns are presented for each case The effects obtained by varying parameters such as disk diameter and waveguide spacing are discussed especially with regard to the directive gain and area illumination efficiency Recommendations are made on techniques for fabrication impedance-matching and arraying antennas of this type for possible airframe applications
Author (GRA)

N77-16297# Office National d Etudes et de Recherches Aerospatiales, Paris (France)
LAMINAR SEPARATION NEAR THE TRAILING EDGE OF

A THIN PROFILE Ph D Thesis - Paris Univ
Rene Schmitt 1976 112 p refs In FRENCH, ENGLISH summary Report will also be announced as translation (ESA-TT-343)
(ONERA-NT-1976-3, ISSN-0078-3781) Avail NTIS HC A06/MF A01

The laminar separation taking place around the wedge-shaped trailing edge of a thin wing placed in an incompressible, two-dimensional flow at very high Reynolds numbers was studied by the method of matched asymptotic developments In the case where dihedral effect is more important than the loss of adherence effect, a three-layer scheme was developed around the separation point In the lower layer where viscous effects are preponderant, the flow is governed by a universal canonical problem containing only one parameter related to the separation location The calculation of the asymptotic behavior of the solution of the canonical problem, at infinity both upstream and downstream of the viscous sublayer is mainly dealt with Author (ESA)

N77-16356# Battelle Columbus Labs, Ohio
AIRCRAFT PROPULSION LUBRICATING FILM ADDITIVES BOUNDARY LUBRICANT SURFACE FILMS, VOLUME 3 Final Report, 1 Dec 1974 - 30 Apr 1976
C M Allen, E Drauglis W A Glaeser C A Alexander and R J Jakobsen May 1976 119 p refs
(Contract F33615-73-C-2026 AF Proj 3048)
(AD-A029267 AFAPL-TR-73-121-Vol-3) Avail NTIS HC A06/MF A01 CSCL 11/8

The report summarizes the research prior to that described in Volume III and presents the results of the most recent research in some detail This covers a broad spectrum of data on mechanical properties using a sensitive stick-slip friction apparatus the detection of molecular order and orientation in quiescently formed solution films using frustrated-multiple-internal-reflection infrared spectroscopy (FMIR) and in the determination of the thermodynamic properties of selected film species using ellipsometric techniques Experiments were performed on rubbed stearic acid films on three substrates--iron, chromium and copper Using carefully controlled surface contact conditions, very pure iron and chromium substrates were used to form surface films from straight-chain hydrocarbon solutions and ester-commercial additive systems The mechanical properties - friction shear stress and damping - were studied utilizing films formed in situ This is also true for the measurement of thermodynamic properties though no dynamic rubbing contact was involved in the ellipsometric determinations GRA

N77-16376*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
NONLINEAR CURVATURE EXPRESSIONS FOR COMBINED FLAPWISE BENDING, CHORDWISE BENDING, TORSION AND EXTENSION OF TWISTED ROTOR BLADES
Raymond G Kvaternik and Krishna R V Kaza (George Washington Univ Hampton Va) Dec 1976 37 p refs
(NASA-TM-X-73997) Avail NTIS HC A03/MF A01 CSCL 13M

The nonlinear curvature expressions for a twisted rotor blade or a beam undergoing transverse bending in two planes torsion, and extension were developed The curvature expressions were obtained using simple geometric considerations The expressions were first developed in a general manner using the geometrical nonlinear theory of elasticity These general nonlinear expressions were then systematically reduced to four levels of approximation by imposing various simplifying assumptions and in each of these levels the second degree nonlinear expressions were given The assumptions were carefully stated and their implications with respect to the nonlinear theory of elasticity as applied to beams were pointed out The transformation matrices between the deformed and undeformed blade-fixed coordinates, which were needed in the development of the curvature expressions were also given for three of the levels of approximation The present curvature expressions and transformation matrices were compared with corresponding expressions existing in the literature Author

N77-16864*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
SUBJECTIVE ASSESSMENT OF SIMULATED HELICOPTER BLADE-SLAP NOISE
Ben William Lawton Washington Dec 1976 55 p refs
(NASA-TN-D-8359 L-11137) Avail NTIS HC A04/MF A01 CSCL 20A

The effects of several characteristics of helicopter blade slap upon human annoyance are examined Blade slap noise was simulated by using continuous and impulsive noises characterized by five parameters The number of sine waves in a single impulse the frequency of the sine waves, the impulse repetition frequency the sound pressure level (SPL) of the continuous noise, and the idealized crest factor of the impulses Ten second samples of noise were synthesized with each of the five parameters at representative levels The annoyance of each noise was judged by 40 human subjects Analysis of the subjective data indicated that each of the five parameters had a statistically significant effect upon the annoyance judgments The impulse crest factor and SPL of the continuous noise had very strong positive relationships with annoyance The other parameters had smaller but still significant effects upon the annoyance judgments Author

N77-16865# MAN-Acoustics and Noise Inc Seattle, Wash
NOISE CERTIFICATION CONSIDERATIONS FOR HELICOPTERS BASED ON LABORATORY INVESTIGATIONS Final Report
Jul 1976 127 p refs
(Contract DOT-FA74WAI-490)
(AD-A032028/3, MAN-1014, FAA-RD-76-116) Avail NTIS HC A07/MF A01 CSCL 20/1

The following topics are discussed (1) An engineering calculation procedure which validly and reliably reflects annoyance to helicopter operations (2) estimates of noise exposure levels which could be compatible with human activities in areas surrounding heliports, (3) noise exposure modeling for helicopter noise and (4) certification measurement approaches for helicopter noise certification The basics of the program involved human response evaluations of conventional takeoff and landing (CTOL) aircraft noise, simulations of helicopter noise emphasizing slap or pulsating noise effects, and recordings of a wide variety of helicopter operations The main conclusion is that PNdB with the FAR-36 duration correction reliably reflects annoyance to helicopter noise No correction for slap or tone is required Also, dB A sub D is almost as effective as PNdB sub D for measuring effects of helicopter noise (duration effects are included) Elimination of heavy slap is equivalent to a maximum of a 2 to 3 dB A reduction relative to annoyance response Author

N77-16867# Bolt Beranek and Newman, Inc Cambridge Mass
DATA BASE FOR PREDICTING NOISE FROM CIVIL AIRCRAFT FLIGHT PROFILE PREDICTION
William J Galloway, John F Mills, and Anthony B Hays Mar 1976 64 p refs
(Contract EPA-68-01-2265)
(PB-257638/7, BBN-2746) Avail NTIS HC A04/MF A01 CSCL 01B

A method for calculating flight profiles for any conventional fixed wing aircraft operating condition likely to occur in the vicinity of an airport is described and performance parameters are provided for aircraft operating in the U S civil fleet The method uses certain simplifying assumptions for ease of computation, but provides adequate accuracy for predicting of the noise exposure produced by a complex set of operations around an airport GRA

N77-16942# National Bureau of Standards Washington, D C Physical Chemistry Div
EVALUATED NUMERICAL DATA FOR THE SST AND CHLOROFLUOROCARBON PROBLEMS A CASE STUDY OF HOW TO HELP THE ENGINEER AND THE MODELLERS

David Garvin and Robert F Hampson *In* AGARD Advan in Retrieval Technol as Related to Inform Systems Dec 1976 6 p refs
Avail NTIS HC A08/MF A01

Activities of the Chemical Kinetics Information Center in support of the Climatic Impact Assessment Program are reported These include planning identification of needed measurements and available measurements determination of the needs of users evaluation of data interpretation of results for non-specialists and distribution of tables of rate data This type of role is suitable for an information analysis center in any large scale interdisciplinary program Author

N77-16986*# Pratt and Whitney Aircraft, East Hartford Conn
AERODYNAMIC AND ACOUSTIC TESTS OF DUCT-BURNING TURBOFAN EXHAUST NOZZLES Final Report
Hilary Kozlowski and Allan B Packman Washington NASA Dec 1976 141 p refs
(Contract NAS3-17866)
(NASA-CR-2628 PWA-5296) Avail NTIS HC A07/MF A01 CSCL 01B

The static aerodynamic and acoustic characteristics of duct-burning turbofan (DBTF) exhaust nozzles are established Scale models having a total area equivalent to a 0 127 m diameter convergent nozzle simulating unsuppressed coannular nozzles and mechanically suppressed nozzles with and without ejectors (hardwall and acoustically treated) were tested in a quiescent environment The ratio of fan to primary area was varied from 0 75 to 1 2 Far field acoustic data perceived noise levels and thrust measurements were obtained for 417 test conditions Pressure ratios were varied from 1 3 to 4 1 in the fan stream and from 1 53 to 2 5 in the primary stream Total temperature varied from 395 to 1090 K in both streams Jet noise reductions relative to synthesized prediction from 8 PNdB (with the unsuppressed coannular nozzle) to 15 PNdB (with a mechanically suppressed configuration) were observed at conditions typical of engines being considered under the Advanced Supersonic Technology program The inherent suppression characteristic of the unsuppressed coannular nozzle is related to the rapid mixing in the jet wake caused by the velocity profiles associated with the DBTF Since this can be achieved without a mecnanical suppressor significant reductions in aircraft weight or noise footprint can be realized Author

N77-16988# Wichita State Univ, Kans Dept of Aeronautical Engineering
AN EXPERIMENTAL INVESTIGATION OF THE AERODYNAMICS OF THE KLINE-FOGLEMAN AIRFOIL
Charles McFarland May 1976 66 p refs
(AR-76-5) Avail NTIS HC A04/MF A01 CSCL 01A

Aerodynamics of the Kline-Fogleman airfoil were investigated with emphasis on the flow patterns of the airfoil and its performance in comparison to conventional delta wings Smoke tunnel testing two and three dimensional flow visualization, and three dimensional force measurements were included Results indicate that neither the flow patterns nor the performance of the Kline-Fogleman airfoil differ considerably from the conventional delta wing Author

N77-16989*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
THEORETICAL PARAMETRIC STUDY OF THE RELATIVE ADVANTAGES OF WINGLETS AND WING-TIP EXTENSIONS
Harry H Heyson, Gregory D Riebe and Cynthia L Fulton 14 Jan 1977 74 p refs
(NASA-TM-X-74003) Avail NTIS HC A04/MF A01 CSCL 01A

For identical increases in bending moment a winglet provides a greater gain in induced efficiency than tip extension Winglet toe angle allows design trades between efficiency and root moment A winglet shows the greatest benefit when the wing loads are heavy near the tip Washout diminishes the benefit of either tip modification and the gain in induced efficiency becomes a function of lift coefficient thus heavy wing loadings obtain the greatest benefit from a winglet, and low-speed performance is enhanced even more than cruise performance Both induced efficiency and bending moment increase with winglet length and outward cant The benefit of a winglet relative to a tip extension is greatest for a nearly vertical winglet Root bending moment is proportional to the minimum weight of bending material required in the wing thus it is a valid index of the impact of tip modifications on a new wing design Author

N77-16990*# Scientific Translation Service Santa Barbara Calif
TRANSONIC ROTOR AERODYNAMICS FUNDAMENTALS OF THE THEORY
W H Isay Washington NASA Feb 1977 42 p refs Transl into ENGLISH of Transsonische Rotoraerodyn Grundlagen einer Theorie Inst fuer Schiffbau der Hamburg Univ, West Ger, Rept-337 Feb 1976 33 p
(Contract NASw-2791)
(NASA-TT-F-17395, Rept-337) Avail NTIS HC A03/MF A01 CSCL 01A

A theory is developed in order to calculate the pressure distribution on the blades of a helicopter rotor in forward flight Neglecting the influence of viscosity the velocity-potential is obtained as well as the pressure field wave equations with a nonlinear term Following the theory of wave equations the influence of accelerated moving shocks on the flow is represented by sink-distributions on the shock surfaces similarly the loading and thickness-effects of the rotor blades are described by dipoles and source-sink-distributions on the foils Author

N77-16992*# National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio
EFFECTS OF TIP CLEARANCE ON OVERALL PERFORMANCE OF TRANSONIC FAN STAGE WITH AND WITHOUT CASING TREATMENT
Royce D Moore and Walter M Osborn Feb 1977 26 p refs
(NASA-TM-X-3479 E-8945) Avail NTIS HC A03/MF A01 CSCL 01A

The overall performance of a transonic fan stage is presented for various tip clearances, with and without casing treatment The stage was tested with a solid casing, and with open skewed slots and closed skewed slots in the casing over the rotor blade tips Four nominal nonrotating rotor blade tip clearances from 0 061 to 0 178 centimeter were used For all three casings, the pressure ratio and efficiency decreased with increasing tip clearance The stall margin for a given casing also decreased with increasing clearance At design speed and a given tip clearance, the highest stall margin was obtained with the open-slot casing, and the lowest stall margin was obtained with the solid casing Author

N77-16993*# National Aeronautics and Space Administration Marshall Space Flight Center Huntsville, Ala
NUMERICAL SOLUTIONS OF NAVIER-STOKES EQUATIONS FOR THE STRUCTURE OF A TRAILING VORTEX
A C Jain Jan 1977 66 p refs
(NASA-TM-X-73361) Avail NTIS HC A04/MF A01 CSCL 01A

The structure and decay of a trailing vortex were analyzed during the numerical solutions of the full Navier-Stokes equations Unsteady forms of the governing equations were recast in terms of circulation vorticity, and stream function as dependent variables, and a second upwind finite difference scheme was used to integrate them with prescribed initial and boundary conditions The boundary conditions at the outer edge and at the outflow section of the trailing vortex were considered Different models of the flow were postulated and solutions were obtained describing the development of the flow as integration proceeds

in time A parametric study was undertaken with a view to understanding the various phenomena that may possibly occur in the trailing vortex Using the Hoffman and Joubert law of circulation at the inflow section, the results of this investigation were compared with experimental data for a Convair 990 wind model and a rectangular wing With an exponentially decaying law of circulation at the inflow section and an adverse pressure gradient at the outer edge of the trailing vortex, solutions depict vortex bursting through the sudden expansion of the core and/or through the stagnation and consequent reversal of the flow on the axis It was found that this bursting takes place at lower values of the swirl ratio as the Reynolds number increases
Author

N77-16994*# McDonnell-Douglas Corp Long Beach Calif
A GENERAL METHOD FOR CALCULATING THREE-DIMENSIONAL COMPRESSIBLE LAMINAR AND TURBULENT BOUNDARY LAYERS ON ARBITRARY WINGS
Topical Report, Nov 1973 - Mar 1976
Tuncer Cebeci, Kalle Kaups and Judy A Ramsey Washington NASA Jan 1977 87 p refs
(Contract NAS1-12821)
(NASA-CR-2777) Avail NTIS HC A05/MF A01 CSCL 01A

The method described utilizes a nonorthogonal coordinate system for boundary-layer calculations It includes a geometry program that represents the wing analytically and a velocity program that computes the external velocity components from a given experimental pressure distribution when the external velocity distribution is not computed theoretically The boundary layer method is general however and can also be used for an external velocity distribution computed theoretically Several test cases were computed by this method and the results were checked with other numerical calculations and with experiments when available A typical computation time (CPU) on an IBM 370/165 computer for one surface of a wing which roughly consist of 30 spanwise stations and 25 streamwise stations, with 30 points across the boundary layer is less than 30 seconds for an incompressible flow and a little more for a compressible flow
Author

N77-16996*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
FLIGHT MEASUREMENTS OF LIFTING PRESSURES FOR A THIN LOW-ASPECT-RATIO WING AT SUBSONIC, TRANSONIC, AND LOW SUPERSONIC SPEEDS
Thomas A Byrdsong Washington Feb 1977 120 p refs
(NASA-TM-X-3405 L-10722) Avail NTIS HC A06/MF A01 CSCL 01A

Pressure distributions in the form of differential pressure coefficients are presented for several wing chordwise and spanwise stations Also presented are the results of limited analysis which show aircraft configuration effects Mach number effects on the local wing loadings comparisons of selected measured wing pressures with predicted pressures, and comparisons of wing loadings during right-turn and left-turn maneuvers Author

N77-16999*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
ANALYSIS OF THE DEVELOPMENT OF DYNAMIC STALL BASED ON OSCILLATING AIRFOIL EXPERIMENTS
Lawrence W Carr Kenneth W McAlister and William J McCroskey Washington Jan 1977 104 p refs Prepared in cooperation with Army Air Mobility Lab Moffett Field Calif
(NASA-TN-D-8382 A-6674) Avail NTIS HC A06/MF A01 CSCL 01A

The effects of dynamic stall on airfoils oscillating in pitch were investigated by experimentally determining the viscous and inviscid characteristics of the airflow on the NACA 0012 airfoil and on several leading-edge modifications The test parameters included a wide range of frequencies Reynolds numbers and amplitudes-of-oscillation Three distinct types of separation development were observed within the boundary layer each leading to classical dynamic stall The NACA 0012 airfoil is shown to stall by the mechanism of abrupt turbulent leading-edge separation A detailed step-by-step analysis of the events leading to dynamic stall, and of the results of the stall process, is presented for each of these three types of stall Techniques for flow analysis in the dynamic stall environment are discussed A method is presented that reduces most of the oscillating airfoil normal force and pitching-moment data to a single curve independent of frequency or Reynolds number Author

N77-17000*# Boeing Commercial Airplane Co , Seattle, Wash
SUPERSONIC PRESSURE MEASUREMENTS AND COMPARISON OF THEORY TO EXPERIMENT FOR AN ARROW-WING CONFIGURATION
Marjorie E Manro Nov 1976 700 p refs
(Contract NAS1-14141)
(NASA-CR-145046 D6-44224) Avail NTIS HC A99/MF A01 CSCL 01A

A wind tunnel test of an arrow-wing-body configuration consisting of flat and twisted wings as well as leading- and trailing-edge control surface deflections was conducted at Mach numbers from 1 54 to 2 50 to provide an experimental pressure data base for comparison with theoretical methods Theory-to-experiment comparisons of detailed pressure distributions were made using a state-of-the-art inviscid flow, constant-pressure-panel method Emphasis was on conditions under which this theory is valid for both flat and twisted wings Author

N77-17008# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Zentralabteilung Niedergeschwindigkeits-Windkanaele
FLOW EFFECTS AT CROSS BLOWN LIFTING JETS OF V/STOL AIRCRAFT AND THEIR REACTION ON AERODYNAMIC FORCES AND MOMENTS OF THE NACELLE
Ph D Thesis - Tech Hochschule, Aachen
Guenter Viehweger 9 Jul 1976 114 p refs In GERMAN ENGLISH summary
(DLR-FB-76-34) Avail NTIS HC A06/MF A01, DFVLR, Cologne, DM 44 80

Systematic basic studies on the near and far effects of cross blown single and twin lifting jets were performed with the aid of a principle model The different effects are described in detail The number of the experimental parameters was reduced to the most essential ones angle of attack flight and the jet velocities as well as the jet diameter distance between the twin jets, location of the wing relative to the jets and the fuselage, and ground distance Emphasis is on the results of systematic pressure distribution measurements on the fuselage surface, especially in the close vicinity of the jet exits From these results functions on the influence of the parameters were deduced Author (ESA)

N77-17012# Naval Ship Research and Development Center, Bethesda, Md Aviation and Surface Effects Dept
THE DESIGN OF A TWO-DIMENSIONAL, HIGH-ENDURANCE AIRFOIL WITH A GIVEN THICKNESS DISTRIBUTION AND REYNOLDS NUMBER Final Report
Douglas A Lien Jun 1976 77 p
(AD-A027968 AERO-1221 DTNSRDC-76-0015) Avail NTIS HC A05/MF A01

A design procedure has been developed for determining the shape of a high-endurance airfoil 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 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 A practical set of performance characteristics based on these parametric curves led to a reasonable airfoil shape GRA

N77-17015# Martin Marietta Labs, Baltimore Md
INTEGRATION OF THE 3-D HARMONIC KERNEL Interim Report
Peter F Jordan Jun 1976 24 p refs
(Contract F44620-73-C-0041, AF Proj 9781)
(AD-A029550 MML-TR-76-46C, AFOSR-76-0948TR) Avail NTIS HC A02/MF A01 CSCL 20/4

Currently the singular integral that arises in the analysis of oscillating lifting surfaces is evaluated by approximate methods and considerable scatter exists between the results of different methods In this paper, the application of an accurate approach to the Falkner finite element method is described and some numerical results are compared with two current levels of approximation Analytical difficulties that remain to be resolved are briefly discussed Author (GRA)

N77-17016# ARO, Inc, Arnold Air Force Station, Tenn
COMPARISON OF TWO METHODS USED TO MEASURE AERODYNAMIC LOADS ACTING ON CAPTIVE STORE MODELS IN WIND TUNNEL TESTS Final Report, Apr 1973 - May 1976
R E Dix Sep 1976 262 p refs
(AF Proj 2567 ARO Proj PF419)
(AD-A030208, ARO-PWT-TR-76-55, AEDC-TR-76-122) Avail NTIS HC A12/MF A01

In a series of wind tunnel tests, measurements were made of the aerodynamic loads acting on eight different store configurations supported in and near the external captive position on a 1/20-scale model of the F-4C aircraft Store models included blunt and contoured afterbody shapes, stable and unstable configurations and large (pylon-mounted) and small (rack-mounted) configurations Six components of forces and moments were measured using two methods of supporting the store models an internal bracket support technique (IBS) and a dual sting support technique Some characteristics of the interference flow field of the aircraft were also inferred GRA

N77-17019# Dornier-System G m b H Friedrichshafen (West Germany)
SAFETY OF TRANSPORT AIRCRAFT Final Report, 1 Jun 1974 - 30 Nov 1975
Horst Grieser, Hans-Joerg Hertweck, Roland Keppeler Hans-Joachim Koehler, Wolfgang Koehler Gerd Lowak Konrad Steininger Josef Thomas and Heinz Winter Bonn Bundesmin fuer Forsch u Technol Aug 1976 356 p refs In GERMAN, ENGLISH summary Prepared jointly with DFVLR Cologne
(Contract BMFT-LFF-27)
(BMFT-FB-W-76-07) Avail NTIS HC A16/MF A01 ZLDI Munich, DM 74 35

The main subjects investigated are investigations on accidents and incidents operational considerations of the terminal control area (conventional landing and take-off procedures and proposals for modified and new procedures) analysis of the landing procedures by consideration of pilot handling, and proposals for improving the safety in the terminal control area Author (ESA)

N77-17020# National Transportation Safety Board, Washington D C Bureau of Aviation Safety
GENERAL AVIATION ACCIDENTS INVOLVING AEROBATICS, 1972 - 1974
20 Jul 1976 102 p
(PB-257747/6 NTSB-AAS-76-4) Avail NTIS HC A06/MF A01 CSCL 01B

There were 105 accidents involving aerobatics which occurred in various small, fixed wing U S general aviation airplanes during the period 1972 through 1974 Detailed statistical information is given regarding the number of injuries, kind of flying type of accident, accident causes and pilot experience The adequacy and applicability of airworthiness standards relating to aerobatic certification the fundamental importance of proper aerobatic training and orientation and regulatory controls applicable to airshows was evaluated GRA

N77-17022# IIT Research Inst Chicago, Ill
IDENTIFICATION OF CRITICAL FAILURES AND COST EFFECTIVE RELIABILITY IMPROVEMENT APPROACHES Final Report, Jul 1975 - Apr 1976
Kent J Kogler Jun 1976 77 p
(Contract DAAJ01-75-C-1087)
(AD-A028333, IITRI-E6338-FR, DRSAV-TR-76-26) Avail NTIS HC A05/MF A01 CSCL 01/3

This report represents the results of an analysis to identify safety critical items in Cargo Utility and Attack helicopters Included in the report is a detailed failure mode analysis which quantitatively identifies critical modes of failure (both hardware and human) whose occurrence (singly or in combination) can cause hazard in flight The identified failure modes are ranked in terms of criticality Improvement recommendations are made and a method is developed to assess their cost effectiveness Improvement recommendations are ranked in terms of cost effectiveness Author (GRA)

N77-17025# Polhemus Navigation Sciences Inc Burlington Vt
AN EXTENDED RANGE SENSOR PACKAGE (ESP) Final Report
Aurale R DeRuyck and Jack Kuipers Wright-Patterson AFB Ohio AMRL Jul 1976 49 p ref
(Contract F33615-73-C-0106 AF Proj 5973)
(AD-A027850 AMRL-TR-73-59) Avail NTIS HC A03/MF A01 CSCL 01/4

Details efforts to develop a long-range attitude sensor capable of detecting azimuth elevation roll and bearing of a sensor with respect to a radiator at ranges up to 100 feet applicable to transferring coordinates to a remote station for alignment or docking System employs a medium-frequency nutating magnetic field to sense attitude and bearing at extended ranges through any nonmagnetic nonconducting medium Author (GRA)

N77-17027# Strategic Air Command Offutt AFB Nebr
GIANT CHANGE FINAL REPORT, KC-135 DUAL INS TEST Final Report, Nov 1975 - Mar 1976
Terence G Bajuk 15 Jul 1976 87 p
(AD-A028788) Avail NTIS HC A05/MF A01 CSCL 05/9

The Strategic Air Command conducted a test to determine the feasibility of reducing the size of the KC-135 crew complement while maintaining mission effectiveness This test investigated the possibility of using a three man crew (pilot copilot and boom operator) with the copilot assuming the navigation duties with the aid of a dual Inertial Navigation System (INS) The exercise term assigned the test was GIANT CHANGE GRA

N77-17028# Facility Checking Squadron (1866th) (AFCS), Richards-Gebaur AFB, Mo
TRACALS EVALUATION REPORT COMMUNICATIONS STATION EVALUATION REPORT, KADENA AB, JAPAN, 4 MARCH - 16 MARCH 1976 Final Report
Bruce E Wallachy 30 Jul 1976 102 p
(AD-A029713, Rept-76/66C-63) Avail NTIS HC A06/MF A01 CSCL 17/2

A Traffic Control and Landing Systems (TRACALS) Communications Station Evaluation was performed at Kadena AB Japan (1962 Comm Sq) from 4 March through 16 March 1976 The purpose of the evaluation was to define the capabilities and limitations of the air traffic control VHF/UHF communications systems Included in this report are results and analysis of equipment checks, loop test line level diagrams for the RAPCON and control tower systems line of sight coverage data analysis of airborne measurements and plots of UHF radiation patterns In addition there is included a discussion of transmitter and receiver frequency accuracy test equipment VHF isolators RAPCON keying system modification to AN/GRT-18 transmitters and Rivet Switch receiver output levels The data and diagrams in this report can be used as guides for anticipated performance of the communications system at Kadena AB until there is an addition, deletion, relocation of equipment, or change in horizon

profile which would affect the system The principles presented are valid for other locations using the same communications equipment Author (GRA)

N77-17029* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif
HINGELESS HELICOPTER ROTOR WITH IMPROVED STABILITY Patent
Robert A Ormiston, William G Bousman Dewey H Hodges and David A Peters, inventors (to NASA) Issued 28 Dec 1976 11 p Filed 10 Oct 1974 Supersedes N74-34475 (12 - 24 p 2899)
(NASA-Case-ARC-10807-1, US-Patent-3 999 886
US-Patent-Appl-SN-513612, US-Patent-Class-416-104
US-Patent-Class-416-141, US-Patent-Class-416-138) Avail US Patent Office CSCL 01C

Improved stability was provided in a hingeless helicopter rotor by inclining the principal elastic flexural axes and coupling pitching of the rotor blade with the lead-lag bending of the blade The primary elastic flex axes were inclined by constructing the blade of materials that display non-uniform stiffness, and the specification described various cross section distributions and the resulting inclined flex axes Arrangements for varying the pitch of the rotor blade in a predetermined relationship with lead-lag bending of the blade, i e , bending of the blade in a plane parallel to its plane of rotation were constructed
Official Gazette of the U S Patent Office

N77-17030*# Boeing Commercial Airplane Co , Seattle Wash
TRANSPORT AIRPLANE FLIGHT DECK DEVELOPMENT SURVEY AND ANALYSIS REPORT AND RECOMMENDATIONS Final Report
D K Graham Jan 1977 45 p refs
(Contract NAS1-13267)
(NASA-CR-145121 D6-44314) Avail NTIS HC A03/MF A01 CSCL 01C

Results of a survey and analysis of research and development work related to improving transport airplane flight deck equipment and aircrew performance is reported Research and development related to flight deck advancement in general, as well as that concerned directly with terminal area operations is described and discussed Author

N77-17031*# Kanner (Leo) Associates, Redwood City Calif
INVESTIGATION OF THE STEADY-STATE BEHAVIOR OF TWO DELTA-WING HANG GLIDERS
N Rigamonti and H Pflugshaupt Washington NASA Feb 1977 101 p refs Transl into ENGLISH of 'Untersuchung der Stationaeren Flugzustaende von Zwei Delta-Haengegleitern , Rept FO-1255 eidgenoessisches Flugzeugwerk, Emmen, Switzerland, Aug 1975 91 p
(NASA-TT-F-17394 FO-1255) Avail NTIS HC A06/MF A01 CSCL 01C

Investigations are reported for the flight behavior of two full size hang gliders in the 7x5 low speed wind tunnel Flight characteristics at small angles of attack and the influence of the pilot's position in the swing seat are explored In addition to showing the aerodynamic coefficients in modes of representation designed specifically for these craft, the relative safeties of the Delta-Plane and Chandelle Competition 16 are compared The latter proves to be more stable and tends to enter a luffing dive more readily Author

N77-17032# Committee on Aeronautical and Space Sciences (U S Senate)
AIRCRAFT FUEL EFFICIENCY PROGRAM
Washington GPO 1976 28 p Rept for Comm on Aeronautical and Space Sci , 94th Congr , 2d Sess 17 Feb 1976
(S-Rept-94-633 GPO-57-010) Avail US Capitol Senate Document Room

A technology plan is described for developing fuel-efficient aircraft Inputs were obtained from industry, NASA research centers and other governmental agencies Six major programs are defined engine component improvement, composite primary structures turboprops, laminar flow control, fuel conservative transport, and the fuel conservative engine Funding requirements and benefits are discussed A R H

N77-17034*# AVCON Aviation Consultants, Inc Broomfield, Colo
OPERATIONAL REQUIREMENTS FOR FLIGHT CONTROL AND NAVIGATION SYSTEMS FOR SHORT HAUL TRANSPORT AIRCRAFT
John A Morrison Nov 1976 142 p refs
(Contract NAS2-9028)
(NASA-CR-137975) Avail NTIS HC A07/MF A01 CSCL 01C

Operational procedures for use in an assumed short haul transport route were evaluated The curved path approaches in airline use by large jet airplanes were studied The characteristics of these approaches were included in development of operational procedures for transitions and approaches by a jet STOL transport These procedures were used in a simulation experiment and were satisfactory for autoflight operation A minimum turn radius of 3 000 ft for a 180 final turn was determined for the wind conditions tested The accuracy of the approaches was very good Author

N77-17035*# Boeing Co Seattle Wash Military Airplane Development Organization
FOLLOW-ON STUDIES FOR DESIGN DEFINITION OF A LIFT/CRUISE FAN TECHNOLOGY V/STOL AIRPLANE, VOLUME 1 Final Report
Jan 1977 277 p refs
(Contract NAS2-9277)
(NASA-CR-137976 D180-20487-1-Vol-1) Avail NTIS HC A13/MF A01 CSCL 01C

A three engine three fan V/STOL airplane was designed for use as a Research Technology Airplane in proof-of-concept of a candidate configuration for use as a Navy multimission airplane Use of mechanically interconnected variable pitch fans is made to accommodate power transfer for flight control in hover and to provide flight capability in the event of a single engine failure The airplane is a modification of a T-39A transport Design definition is provided for high risk propulsion components and a development test program is defined Author

N77-17036*# Boeing Aerospace Co Seattle, Wash Military Airplane Development Organization
WIND TUNNEL AND GROUND STATIC TESTS OF A 094 SCALE POWERED MODEL OF A MODIFIED T-39 LIFT/CRUISE FAN V/STOL RESEARCH AIRPLANE
D Hunt J Clinglan V Salemann, and E Omar Jan 1977 305 p refs
(Contract NAS2-9178)
(NASA-CR-151923 D180-20338-1) Avail NTIS HC A14/MF A01 CSCL 01C

Ground static and wind tunnel test of a scale model modified T-39 airplane are reported The configuration in the nose and replacement of the existing nacelles with tilting lift/cruise fans The model was powered with three 14 cm diameter tip driven turbopowered simulators Forces and moments were measured by an internal strain guage balance Engine simulator thrust and mass flow were measured by calibrated pressure and temperature instrumentation mounted downstream of the fans The low speed handling qualities and general aerodynamic characteristics of the modified T-39 were defined Test variables include thrust level and thrust balance, forward speed, model pitch and sideslip angle at forward speeds, model pitch, roll, and ground height during static tests lift/cruise fan tilt angle, flap and aileron deflection angle, and horizonal stabilizer angle The effects of removing the landing gear, the lift/cruise fans, and the tail surfaces were also investigated Author

N77-17037*# Boeing Commercial Airplane Co , Seattle, Wash Dept of Preliminary Design

OBLIQUE WING TRANSONIC TRANSPORT CONFIGURATION DEVELOPMENT Final Report
Jan 1977 162 p refs
(Contract NAS2-7031)
(NASA-CR-151928, D6-75793) Avail NTIS HC A08/MF A01 CSCL 01C

Studies of transport aircraft designed for boom-free supersonic flight show the variable sweep oblique wing to be the most efficient configuration for flight at low supersonic speeds Use of this concept leads to a configuration that is lighter, quieter and more fuel efficient than symmetric aircraft designed for the same mission Aerodynamic structural weight, aeroelastic and flight control studies show the oblique wing concept to be technically feasible Investigations are reported for wing planform and thickness pivot design and weight estimation engine cycle (bypass ratio) and climb descent and reserve fuel Results are incorporated into a final configuration Performance, weight and balance characteristics are evaluated Flight control requirements are reviewed, and areas in which further research is needed are identified Author

N77-17038*# Douglas Aircraft Co Inc Long Beach Calif
DEVELOPMENT OF TECHNOLOGY FOR THE FABRICATION OF RELIABLE LAMINAR FLOW CONTROL PANELS ON SUBSONIC TRANSPORTS
Oct 1976 214 p refs
(Contract NAS1-14408)
(NASA-CR-145125 MDC-J4546) Avail NTIS HC A10/MF A01 CSCL 01C

The feasibility of using porous composite materials (Kevlar Doweave, and Leno Weave) as lightweight efficient laminar flow control (LFC) surface materials is compared to the metallic 319L stainless Dynapore surfaces and electron beam drilled composite surfaces Areas investigated include (1) selection of the LFC-suitable surface materials structural materials and fabrication techniques for the LFC aircraft skins, (2) aerodynamic static air flow test results in terms of pressure drop through the LFC panel and the corresponding effective porosity (3) structural design definition and analyses of the panels, and (4) contamination effects on static drop and effective porosity Conclusions are presented and discussed Author

N77-17039# Bristol Univ (England) Dept of Aeronautical Engineering
CARBON FIBRE REINFORCED PLASTIC SANDWICH BEAM CONSTRUCTION IN THE MAIN WING STRUCTURE OF A MAN POWERED AIRCRAFT B S Thesis
H R Al-Agha and D C Velupillai May 1976 91 p refs
(BU-197) Avail NTIS HC A05/MF A01

In this entirely theoretical report, a framework similar to the wing box of the man powered aircraft Puffin 2 is analyzed for the in-flight loading imposed upon it Design curves for the framework members, with carbon fiber reinforced plastic and honeycomb sandwich construction are also produced A suggested wind box design is presented, it shows a 45% weight saving over the comparable part of Puffin 2 This produces a reduction of about 7% in the total aircraft weight Author (ESA)

N77-17040# Boeing Commercial Airplane Co, Seattle, Wash
DESIGN AND ANALYSIS OF WINGLETS FOR MILITARY AIRCRAFT Final Report, 16 Jun - 25 Nov 1975
K K Ishimitsu N VanDevender R O Dodson, P C Brault, B A Byers, R P Johnson, R P Syring, M P Schaefer, D R Endorf, and C McGinnis 3 Feb 1976 216 p refs
(Contract F33615-75-C-3123, AF Proj 1431)
(AD-A029345 D6-41799, AFFDL-TR-76-6) Avail NTIS HC A10/MF A01 CSCL 01/3

A study of the design and analysis on winglets for military Aircraft has been completed The program consisted of investigating analytically winglet concepts for application to the KC-135 and C-141 designing and building winglets for an 0 035 and 0 070 scale model KC-135, and conducting a structural feasibility investigation of the winglet installation on the KC-135 The analysis of the winglets showed a 14% reduction in induced drag for the KC-135 and a 11% reduction for the C-141 The structural design study of the KC-135A winglet installation estimated a 592 lb weight increase An 8 4% improvement was estimated in M(L/D) sub MAX and an 8 1% improvement in range factor for the KC-135A An 0 070 scale half span KC-135 wind tunnel model has been tested in the NASA 8 ft Transonic Tunnel Preliminary unpublished test data have substantiated the analytical procedures used by The Boeing Company to determine the aerodynamic characteristics and performance benefits from winglets on the KC-135 aircraft Author (GRA)

N77-17041# Naval Air Test Facility Lakehurst, N J
MARK 2 NOSE-GEAR-LAUNCH SYSTEM HARDWARE EVALUATION REPORT Final Report, 13 Nov 1971 - 31 Mar 1976
Frederick R Sander 5 Aug 1976 31 p refs
(AD-A029020 NATF-EN-1139) Avail NTIS HC A03/MF A01 CSCL 01/3

This report presents the final hardware evaluation test findings for the Mark 2 nose-gear-launch system The evaluation was conducted concurrently with the CVN 68 catapult evaluation tests on the TC13 Mod 1 catapult site The report describes the deficiencies and discrepancies found in the system Incorporation of the recommended changes to these deficient items would improve operations and maintainability Author (GRA)

N77-17042# Naval Air Test Center, Patuxent River, Md Rotary Wing Aircraft Test Directorate
FLIGHT TEST DEVELOPMENT OF A HELICOPTER-TOWED SURFACE DELIVERY
J H Edris and G E Clarke Jul 1976 21 p refs
(AD-A028637 NATC-TM-76-2-RW NATC-RW-9R-76) Avail NTIS HC A02/MF A01 CSCL 01/3

The requirement for the U S Coast Guard to rapidly deploy antipollution equipment to offshore or remote sites generated a proposal to utilize an HH-3F helicopter to tow a planing hull Fast Surface Delivery (FSD) sled The proposal was unique in that the mass of the towed surface vessel equalled or exceeded the mass of towing helicopter The U S Naval Air Test Center undertook the design and fabrication of prototype hardware and the development of towing techniques and a recommended flight envelope The design was driven by a requirement for the towing equipment to be two man transportable manually operable and easily removable Two significant features of the resulting design were the use of a Kevlar 49 towing cable and the development of a quick-release hook capable of repeated releases at rated load Flight testing revealed two families of power required curves as functions of the FSD sled operation as a displacement or planing hull There was also a measurable sensitivity to the center of gravity location of the FSD sled FSD sled reactions to sea states caused divergent oscillations in tow tension which could be easily damped by pilot technique The development and test program demonstrated the suitability of helicopters to perform as a high-speed towing vehicle for very rapid overwater delivery of payloads not otherwise air transportable or rapidly surface deliverable Author (GRA)

N77-17043# Naval Air Development Center Warminster, Pa Air Vehicle Technology Dept
INVESTIGATION OF LARGER THAN A SIZE DIMENSIONAL CONFIGURATIONS Final Report
R J Anderson and C O Reitz 10 Dec 1975 42 p refs
(AD-A029024 NADC-75295-30) Avail NTIS HC A03/MF A01 CSCL 01/3

An investigation to determine the practicality of establishing alternate dimensional constraints for ASW stores too large for A size but not so large as to require B size dimensions is presented Considered are stores deployable from the P-3C, S-3A and LAMPS aircraft Elongation of the A size sensor is a readily implemented means of increasing volume without requiring aircraft modification Author (GRA)

N77-17044# Kamatics Corp, Bloomfield Conn
PREPRODUCTION TEST PROGRAM, KAFLEX DRIVE SHAFT COUPLING FOR UH-1 HELICOPTER, PHASES 8, 9 AND 10 Final Technical Report, Jun - Dec 1975

C J Wirth 13 Feb 1976 130 p refs
(Contract DAAJ01-75-C-1110)
(AD-A028202, KC-123175, USAAVSCOM-TR-76-36) Avail NTIS HC A07/MF A01 CSCL 01/3

Report on the final phases of a program to evaluate a replacement for the main driveshaft coupling of the UH-1 helicopter The candidate coupling is based on the Kaflex design principle which uses flexing metal elements instead of sliding contact members eliminating the need for lubrication maintenance, and offering longer endurance life The reported program phases are Demonstration of a fail safe feature bench endurance test, and flight testing Author (GRA)

N77-17046# Human Engineering Labs, Aberdeen Proving Ground, Md
AN INVESTIGATION OF COCKPIT LIGHTING FOR COMPATIBILITY WITH USE OF NIGHT-VISION GOGGLES, AN/PVS-5 Final Report
Harry R Stowell Jul 1976 22 p refs
(AD-A029212, HEL-TM-26-76) Avail NTIS HC A02/MF A01

Cockpit lighting in U S Army helicopters was investigated for compatibility with use of night-vision goggles AN/PVS-5 Instrument-lighting systems in existing Army helicopters, e g eyebrow lighting post lighting are not suitable for use with night-vision goggles A comparatively simple flood-lighting system can provide suitable lighting in the cockpit of existing helicopters for reading instruments with night-vision goggles The most suitable instrument-lighting system for use with the goggles is integral instrument lighting, however, indicator lights need to be modified so they are compatible with the goggles Methods were investigated for instantaneously refocussing the goggles inside the cockpit Luminance levels compatible for use with night-vision goggles are stated in photometric terms Author (GRA)

N77-17047# Frankford Arsenal Philadelphia, Pa
VIBRATION MEASUREMENTS ON THE ROTOR SHAFT OF THE UH-1 HELICOPTER
Harvey I Goldman Feb 1976 21 p
(DA Proj 1F2-63206-D-043)
(AD-A028924 FA-TR-76009) Avail NTIS HC A02/MF A01 CSCL 01/3

This report describes a program of in-flight vibration measurements carried out on a platform mounted atop the rotor mast on the UH-1M helicopter Results of a real time analysis of the data are presented which reveal that a low level of vibration exists at that site making it a good location for the future placement of fire control instrumentation A mechanical impedance study is also presented which shows that much of the high frequency present in the acceleration-time histories is a result of resonances in the tested platform Author (GRA)

N77-17048# Bell Helicopter Co Fort Worth, Tex
HELICOPTER DRIVE SYSTEM ON-CONDITION MAINTENANCE CAPABILITY UH-1/AH-1 Final Report, Jul 1974 - Jun 1975
G E Knudsen and J R Keating Jul 1976 249 p refs
(Contract DAAJ02-74-C-0060 DA Proj 1F2-62203-AH-86)
(AD-A028032, BHC-299-939-0, USAAMRDL-TR-75-52) Avail NTIS HC A11/MF A01 CSCL 01/3

The objective of this study was to assess the capability of main transmissions, intermediate gearboxes tail rotor gearboxes, main rotor hubs and swashplates on the UH-1 and AH-1 to operate with no scheduled overhaul periods Overhaul and accident records inspection procedures, and the functional capability of the caution and warning subsystem and its condition-monitoring devices were examined, and failure mode, effects and criticality analyses were performed to determine if any part or assembly failure modes would limit on-condition maintenance capability This report concludes that UH-1/AH-1 helicopter drive system components have a capability for replacement for overhaul on an on-condition basis and that the overhaul intervals could be extended for some components or eliminated for others The report includes recommendations for further study GRA

N77-17049# Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kans
ANALYSIS OF PHASE IIB OF FE 43 8 Final Report
William I Parks Robert A Davidson, and Rudolph J Pabon Feb 1976 82 p refs
(AD-A028816, CACDA-TR-3-76) Avail NTIS HC A05/MF A01 CSCL 01/3

The effectiveness of the Scout helicopter employed as an aerial observation platform was determined Factors used to assess this effectiveness were Scout-to-target range, Scout tactics, target motion and level of aerial observer training and experience Variables recorded during the experiment and used for this analysis included observer task times Scout exposure times, observer's artillery fire direction and adjustment errors and threat force s ability to locate the Scout position Results of analysis indicate those factors that had a significant effect on the measures of effectiveness and define an optimum operating procedure for artillery fire support missions using the Scout helicopter Under the most favorable conditions encountered in Phase IIB the aerial observer was exposed to the target an average of approximately 50 seconds in order to successfully complete detection, location call for fire, and subsequent artillery adjustment GRA

N77-17050# Quest Research Corp McLean, Va
RESEARCH ON SMART TARGET FOR AERIAL COMBAT PART 1. GENERAL DESCRIPTION Final Report
Wright-Patterson AFB, Ohio AMRL Aug 1976 70 p refs
(Contract F33615-74-C-4053 AF Proj 7222)
(AD-A029171 AMRL-TR-75-82-Pt-1) Avail NTIS HC A04/MF A01 CSCL 05/8

The object of this research effort was to provide a responsive target for air combat simulation on the Dynamic Environment *Simulator located at Aerospace Medical Research Laboratory* Accomplishment of this effort required review of alternative aerial combat maneuvering models to establish an acceptable technical approach for the Smart Target tactics model An aircraft model was then developed using dynamics representative of an F-4E or J aircraft from aerodynamic tables The models were incorporated in a computer program that will be implemented by AMRL Author (GRA)

N77-17051# Quest Research Corp, McLean, Va
RESEARCH ON SMART TARGET FOR AERIAL COMBAT PART 2 TECHNICAL DESCRIPTION Final Report
James Kuhns Wright-Patterson AFB Ohio AMRL Aug 1976 147 p refs
(Contract F33615-74-C-4053 AF Proj 7222)
(AD-A029172 AMRL-TR-75-83-Pt-2) Avail NTIS HC A07/MF A01 CSCL 05/8

This document contains the technical description of the SMART TARGET program which is part of an air-to-air combat simulator implemented on the Dynamic Environmental Simulator located at Aerospace Medical Research Laboratory This document, when used in conjunction with machine listings of the software, provides the technical information which a competent programmer/analyst requires to use, correct and/or modify the software described Part 1 of this report describes in detail the tactical model employed within this program Author (GRA)

N77-17052# Quest Research Corp, McLean, Va
RESEARCH ON SMART TARGET FOR AERIAL COMBAT PART 3 INTERFACE DOCUMENTATION Final Report
James Kuhns Wright-Patterson AFB, Ohio AMRL Aug 1976 16 p
(Contract F33615-74-C-4053 AF Proj 7222)
(AD-A029173 AMRL-TR-75-84-Pt-3) Avail NTIS HC A02/MF A01 CSCL 05/8

Three functions must be interfaced with the responsive target computer program for this target to operate in real time First the program must be tied to a real clock The integration interval employed in the program is 0 1 second thus a 0 1-second clock

rate must be provided to the system Second, the position, velocity, and attitude information concerning the state of the opponent must be provided to the program The information will be obtained from analog voltages ranging from -10 to 10 volts that will be read into the Pacer 100 by an analog to digital converter Third, the position and attitude of the target must be presented to the pilot in the opponent aircraft These variables will also be provided as analog voltages and require a digital to analog conversion step Author (GRA)

N77-17054# Lockheed-California Co Burbank
REXOR ROTORCRAFT SIMULATION. VOLUME 3. USER'S MANUAL *Final Report*
W D Anderson Jul 1976 229 p
(Contract DAAE11-66-C-3667)
(AD-A028417 LR-27463-Vol-3, USAAMRDL-TR-76-28c-Vol-3) Avail NTIS HC A11/MF A01 CSCL 01/3

This report describes a rotorcraft nonlinear simulation called REXOR and is divided into three volumes The first volume is a development of rotorcraft mechanics and aerodynamics The second is a development and explanation of the computer code required to implement the equations of motion The third volume is a user s manual and contains a description of code input/output as well as operating instructions The REXOR math model has been written for a single four-bladed, gyro-controlled hingeless-rotor helicopter with additional capability for analysis of teeter or hinge-offset rotor systems with conventional controls and two or four blades The helicopter modeled may be conventional in design winged or compounded Modeling emphasis is on an accurate main rotor description with additional degrees of freedom to describe the rest of the helicopter REXOR has been implemented on IBM 360 and CDC 6000 series equipment The operating instructions are primarily based on the 360 equipment usage with additional instructions to show use on the 6000 series equipment Author (GRA)

N77-17055# Kaman Aerospace Corp Bloomfield Conn
ELASTIC PITCH BEAM TAIL ROTOR FOR LOH Final Report
John D Porterfild and Frank B Clark Jul 1976 91 p refs
(DA Proj 1F1-63204-DB-38)
(AD-A028415 R-1332 USAAMRDL-TR-75-41) Avail NTIS HC A05/MF A01 CSCL 01/3

This report uses the results of Contract DAAJ01-73-C-0282 (P3L) Elastic Pitch Beam Tail Rotor Study for LOH Class Helicopters and Contract DAAJ01-72-C-0006 Elastic Pitch Beam Tail Rotor, for selecting the most promising concepts to establish detailed designs that are applicable to LOH class helicopters The designs studied herein included removable/replaceable blade airfoil shells damage/erosion-resistant leading edge and damage tolerant/repairable trailing edge The elimination of bearings was an important design objective, where bearings were required, consideration was given to the use of elastomeric bearings Improvements in reliability and maintainability, repairability, cost, performance and producibility along with interchangeability with existing tail rotor systems were also prime considerations in the design selection Author (GRA)

N77-17056# Air Force Packaging Evaluation Agency Wright-Patterson AFB Ohio
DESIGN AND TESTING OF THE H-53, 450-GALLON AUXILIARY FUEL TANK CONTAINER
Richard T Gibbons Jun 1976 18 p
(AFPEA Proj 75-P7-37)
(AD-A028283 DSPD-76-10) Avail NTIS HC A02/MF A01 CSCL 01/3

HQ TAC/LGT has proposed through WR-ALC/DSP a container design project to the Air Force Packaging Evaluation Agency (AFPEA) relative to development of a transport device/container for auxiliary fuel tanks used with the H-53 helicopter The container(s) are essential to rapid deployment of the H-53 in contingency response situations Since the helicopter cannot be ferried worldwide, and still meet planning/timing considerations the H-53 is partially disassembled and moved via the C-5 Galaxy aircraft The helicopter however, will not fit into the C-5 with its auxiliary fuel tanks attached also, to be air-shippable, these tanks must be purged of jet fuel fumes in accordance with AFM 71-4 This is a process normally involving 72 hours The AFPEA has developed a sturdy handling device/container that will allow the H-53 tanks to be safely moved when partially filled with jet fuel This container has been subjected to strenuous vibration and mechanical handling tests along with the fit and function tests and as a system it is fully qualified to satisfy the design criteria The current cost of this container is well under $350 including labor and materials GRA

N77-17057*# Scientific Translation Service, Santa Barbara, Calif
HEAD-UP PILOTING AIDS
G deSury Washington NASA Jan 1977 16 p Transl into ENGLISH from Rev Tech Thomson-CSF (France), v 6, no 3, Sep 1974 p 787-798
(Contract NASw-2791)
(NASA-TT-F-17389) Avail NTIS HC A02/MF A01 CSCL 01D

The advantages of piloting based on the velocity vector were discussed The advantages of presenting information on head-up displays were listed and descriptions were given of the various models produced Two types of displays were described (1) displays serving as piloting aids in good visibility, and (2) displays serving as automatic piloting and flight path monitors, it being possible for the pilot to take over the aircraft if necessary Author

N77-17058*# Kanner (Leo) Associates Redwood City Calif
ELECTRONIC HEAD-UP DISPLAY AT PILOT'S EYE LEVEL
M Beranovsky Washington NASA Feb 1977 36 p refs Transl into ENGLISH from Zravodaj VZLU (Czechoslovakia) no 6, 1971 p 5-17
(Contract NASw-2790)
(NASA-TT-F-17390) Avail NTIS HC A03/MF A01 CSCL 01D

Features of head-up displays, providing indications of aircraft instrument data in a symbolic form at the pilot s eye level are described and the advantages of this method of indication are emphasized A basic block diagram of the display is presented with a short description of the function of the individual units involved Attention is also given to methods for the indication of instrument data and to main indication principles A review is given of instrument data and the symbols as used in instruments of this type A brief explanation of individual symbols is also presented Author

N77-17059* National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
REVERSE PITCH FAN WITH DIVIDED SPLITTER Patent
Leroy H Smith Jr inventor (to NASA) (GE, Cincinnati, Ohio) Issued 1 Feb 1977 6 p Filed 21 Apr 1975 Sponsored by NASA
(NASA-Case-LEW-12760-1, US-Patent-4,005,574
US-Patent-Appl-SN-569925, US-Patent-Class-60-226A
US-Patent-Class-60-228) Avail US Patent Office CSCL 21E

A guide vane arrangement is described for improving gas turbine performance in the reverse thrust mode This flow straightening method produces low losses in the fluid entering a core engine during reverse thrust operations and allows large supercharging of the core engine during forward thrust
Official Gazette of the U S Patent Office

N77-17060*# General Electric Co Cincinnati Ohio Dept of Advanced Engineering and Technology Programs
SINGLE-STAGE, LOW-NOISE, ADVANCED TECHNOLOGY FAN VOLUME 4 FAN AERODYNAMICS SECTION 1 RESULTS AND ANALYSIS

T J Sullivan I Silverman and D R Little Feb 1977 156 p refs
(Contract NAS3-16813)
(NASA-CR-134892, Doc-R76AEG565-Vol-4) Avail NTIS HC A08/MF A01 CSCL 20A

Test results at design speed show fan total pressure ratio weight flow and adiabatic efficiency to be 2 2, 2 9, and 1 8% lower than design goal values The hybrid acoustic inlet (which utilizes a high throat Mach number and acoustic wall treatment for noise suppression) demonstrated total pressure recoveries of 98 9% and 98 2% at takeoff and approach Exhaust duct pressure losses differed between the hardwall duct and treated duct with splitter by about 0 6% to 2 0% in terms of fan exit average total pressure (depending on operating condition) When the measured results were used to estimate pressure losses a cruise sfc penalty of 0 68%, due to the acoustically treated duct, was projected Author

N77-17061*# General Electric Co Cincinnati, Ohio Dept of Advanced Engineering and Technology Programs
SINGLE STAGE, LOW NOISE, ADVANCED TECHNOLOGY FAN VOLUME 4 FAN AERODYNAMICS SECTION 2 OVERALL AND BLADE ELEMENT PERFORMANCE DATA TABULATIONS
T J Sullivan Feb 1977 340 p refs
(Contract NAS3-16813)
(NASA-CR-134893 Doc-R76AEG566-Vol-4) Avail NTIS HC A15/MF A01 CSCL 20A

For abstract see N77-17060

N77-17063*# National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio
PREDICTION OF LAMINAR AND TURBULENT BOUNDARY LAYER FLOW SEPARATION IN V/STOL ENGINE INLETS
D C Chou (Iowa Univ), R W Luidens, and N O Stockman 1977 16 p refs Presented at 15th Aerospace Sci Conf Los Angeles, 24-26 Jan 1977, sponsored by AIAA
(NASA-TM-X-73575 E-9028) Avail NTIS HC A02/MF A01 CSCL 21E

A description is presented of the development of the boundary layer on the lip and diffuser surface of a subsonic inlet at arbitrary operating conditions of mass flow rate, free stream velocity and incidence angle Both laminar separation on the lip and turbulent separation in the diffuser are discussed The agreement of the theoretical results with model experimental data illustrates the capability of the theory to predict separation The effects of throat Mach number inlet size and surface roughness on boundary layer development and separation are illustrated Author

N77-17064*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
CORE NOISE MEASUREMENTS ON A YF-102 TURBOFAN ENGINE
Meyer Reshotko Allen Karchmer, Paul F Penko, and Jack G McArdle 1977 27 p refs Presented at 15th Aerospace Sci Meeting, Los Angeles, 24-26 Jan 1977, sponsored by AIAA
(NASA-TM-X-73587, E-9050) Avail NTIS HC A03/MF A01 CSCL 20A

Core noise from a YF-102 high bypass ratio turbofan engine was investigated through the use of simultaneous measurements of internal fluctuating pressures and far field noise Acoustic waveguide probes, located in the engine at the compressor exit in the combustor, at the turbine exit and in the core nozzle, were employed to measure internal fluctuating pressures Spectra showed that the internal signals were free of tones except at high frequency where machinery noise was present Data obtained over a wide range of engine conditions suggest that below 60% of maximum fan speed the low frequency core noise contributes significantly to the far field noise Author

N77-17065*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
FLAP NOISE AND AERODYNAMIC RESULTS FOR MODEL QCSEE OVER-THE-WING CONFIGURATIONS
W Olsen R Burns and D Groesbeck 1977 26 p refs Presented at 15th Aerospace Sci Meeting Los Angeles 24-26 Jan 1977 sponsored by AIAA
(NASA-TM-X-73588, E-9051) Avail NTIS HC A03/MF A01 CSCL 21E

Noise spectra in three dimensions and aerodynamic data were measured for a model of the NASA quiet clean short-haul experimental engine (QCSEE) over-the-wing configuration The effects of flap length nozzle exhaust velocity and nozzle geometry were determined using a single nozzle and wing-flap segment The scaled-up model data is representative of full scale flap noise with the QCSEE engine Author

N77-17066*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
COMPOSITE HUBS FOR LOW COST GAS TURBINE ENGINES
C C Chamis 1977 14 p refs Presented at the 32d Annual Conf of the Reinforced Plastics of Composites Inst Washington, D C, 8-11 Feb 1977, sponsored by the Soc of the Plastics Ind
(NASA-TM-X-73578 E-9038) Avail NTIS HC A02/MF A01 CSCL 21E

A detailed stress analysis was performed using NASTRAN to demonstrate theoretically the adequacy of composite hubs for low cost turbine engine applications Composite hubs are adequate for this application from the steady state stress view point Author

N77-17068*# National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
THE EFFECT OF FORWARD SPEED ON J85 ENGINE NOISE FROM SUPPRESSOR NOZZLES AS MEASURED IN THE NASA-AMES 40- BY 80-FOOT WIND TUNNEL
Adolph Atencio Jr Washington Feb 1977 67 p refs
(NASA-TN-D-8426 A-6592) Avail NTIS HC A04/MF A01 CSCL 20A

An investigation to determine the effect of forward speed on the exhaust noise from a conical ejector nozzle and three suppressor nozzles mounted behind a J85 engine was performed in a 40- by 80-foot wind tunnel The nozzles were tested at three engine power settings and at wind tunnel forward speeds up to 91 m/sec (300 ft/sec) In addition outdoor static tests were conducted to determine (1) the differences between near field and far field measurements (2) the effect of an airframe on the far field directivity of each nozzle and (3) the relative suppression of each nozzle with respect to the baseline conical ejector nozzle It was found that corrections to near field data are necessary to extrapolate to far field data and that the presence of the airframe changed the far field directivity as measured statically The results show that the effect of forward speed was to reduce the noise from each nozzle more in the area of peak noise but the change in forward quadrant noise was small or negligible A comparison of wind tunnel data with available flight test data shows good agreement Author

N77-17069*# California Univ , Berkeley
POLLUTANT FORMATION IN FUEL LEAN RECIRCULATING FLOWS Ph.D Thesis Final Report
Robert W Schefer and Robert F Sawyer Washington NASA Dec 1976 232 p refs
(Grant NsG-3028)
(NASA-CR-2785 UCB-ME-76-5) Avail NTIS HC A11/MF A01 CSCL 21E

An opposed reacting jet combustor (ORJ) was tested at a pressure of 1 atmosphere A premixed propane/air stream was stabilized by a counterflowing jet of the same reactants The

resulting intensely mixed zone of partially reacted combustion products produced stable combustion at equivalence ratios as low as 0 45 Measurements are presented for main stream velocities of 7 74 and 13 6 m/sec with an opposed jet velocity of 96 m/sec inlet air temperatures from 300 to 600 K, and equivalence ratios from 0 45 to 0 625 Fuel lean premixed combustion was an effective method of achieving low NOx emissions and high combustion efficiencies simultaneously Under conditions promoting lower flame temperature, NO2 constituted up to 100 percent of the total NOx At higher temperatures this percentage decreased to a minimum of 50 percent Author

N77-17070*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
INTERNAL FLOW CHARACTERISTICS OF A MULTISTAGE COMPRESSOR WITH INLET PRESSURE DISTORTION
Claude E DeBogdan, John E Moss, Jr , and Willis M Braithwaite Washington Feb 1977 39 p refs
(NASA-TM-X-3446, E-8848) Avail NTIS HC A03/MF A01 CSCL 21E

The measured distribution of compressor interstage pressures and temperatures resulting from a 180 deg inlet-total-pressure distortion for a J85-13 turbojet engine is reported Extensive inner stage instrumentation combined with stepwise rotation of the inlet distortion gave data of high circumferential resolution The steady-state pressures and temperatures along with the amplitude, extent and location of the distorted areas are given Data for 80 90, and 100 percent of rotor design speed are compared with clean (undistorted) inlet flow conditions to show pressure and temperature behavior within the compressor Both overall and stagewise compressor performances vary only slightly when clean and distorted inlet conditions are compared Total and static pressure distortions increase in amplitude in the first few stages of the compressor and then attenuate fairly uniformly to zero at the discharge Total-temperature distortion induced by the pressure distortion reached a maximum amplitude by the first two stages and decayed only a little through the rest of the compressor Distortion amplitude tended to peak in line with the screen edges and, except for total and static pressure in the tip zone, there was little swirl in the axial direction Author

N77-17072# Messerschmitt-Boelkow-Blohm G m b H , Hamburg (West Germany) Unternehmensbereich Hamburger Flugzeugbau
THEORETICAL AND EXPERIMENTAL INVESTIGATION OF NOISE SHIELDING FOR JET ENGINES Final Report
Hansjochen Boesch Guenter Woelfer Burckhard Kiekebusch and Jochen Scheerer Bonn Bundesmin fuer Forsch u Technol Aug 1976 301 p refs In GERMAN, ENGLISH summary
(Contract BMFT-523-8891-LFF-29)
(BMFT-FB-W-76-09) Avail NTIS HC A14/MF A01, ZLDI, Munich, DM 62 80

Experimental investigations of the possibilities of shielding jet engine noise through changes to aircraft configuration were carried out with a 1 10 scale aircraft half-model Several configurations with the engines mounted above the wing were investigated in a reflection free room A fan model with nacelle having the same scale as the aircraft model was used as a noise source The results from these investigations were used to optimize a computer program developed for the Europlane project, for the calculation of noise emission from noise shielded configurations In addition to the acoustic measurements, aerodynamic interference effects were investigated for noise shielded nacelle configurations on a typical transport aircraft having a transonic wing profile Author (ESA)

N77-17074# Pratt and Whitney Aircraft East Hartford, Conn
COMPRESSOR CRITICAL RESPONSE TIME DETERMINATION STUDY Final Report, 15 Jun 1975 - 15 Apr 1976
R S Massawy, G A Banks, and C R Weber Wright-Patterson AFB Ohio AFAL 30 Jun 1976 57 p refs
(Contract F33615-75-C 2036 AF Proj 5415)
(AD-A028882 PWA-5415 AFAL-TR-76-45) Avail NTIS HC A04/MF A01 CSCL 21/5

Critical response time may be defined as the time period or duration of a compressor inlet flow distortion required for a significant effect on compressor stability The knowledge of this time period is important as a basis for evaluating time variant inlet distortion data for its potential impact on compressor stall margin This period can be related to the time required for fluid to travel the length of a compressor by defining a reduced frequency parameter Critical response time can be defined for any compressor once the critical value of reduced frequency is ascertained Results of a mathematical model of a compressor system demonstrate that the critical value of reduced frequency is between 1 0 and 5 0 An inspection of available data indicates that a value of approximately 2 0 is the critical value GRA

N77-17076# Detroit Diesel Allison Indianapolis Ind Diesel Allison Div
DEVELOPMENT OF A RETRACTABLE VANE STARTING PUMP INTEGRATED WITHIN A VAPOR CORE FUEL PUMP TURBINE ENGINE TECHNOLOGY DEMONSTRATOR COMPONENT DEVELOPMENT PROGRAM, PROJECT 668A CONTROLS DEVELOPMENT PROGRAM (PART 5) Final Technical Report, Jul 1973 - Jul 1975
N L Downing K H Pech and G W Jahrstorfer Wright-Patterson AFB, Ohio AFAPL Jul 1975 295 p
(Contract F33657-73-C-0618, AF Proj 668A)
(AD-A029032 DDA-EDR-8555-Pt-5, AFAPL-TR-75-85) Avail NTIS HC A13/MF A01 CSCL 21/5

This report documents a conceptual development program the bulk of which was performed by Chandler-Evans Controls Systems Division of Colt Industries as sub-contractor to the Detroit Diesel Allison Div of GMC This Air Force funded program demonstrates the feasibility of integrating a starting fuel pump with an existing centrifugal pump to serve as a main engine fuel pump for a joint technology demonstrator turbofan engine A retracting vane concept was designed to provide starting fuel flow up to a speed where the vanes retract and the vapor core pump takes over An inlet throttle valve controls pump output to meet engine demand The combined pump was fabricated and tested at all speeds up to and including max speed of 28,000 rpm and met light off transition and max flow and pressure requirements Weight and cost estimates are 50% of present-state-of-the art pumps This report contains detailed design information and preliminary test results that dictated redesign and the final successful test results In addition to favorable cost and weight estimates, appreciable reduction of fuel heating is demonstrated due to its inlet throttled non-bypassing operating mode Author (GRA)

N77-17078# Purdue Univ , Lafayette Ind Combustion Lab
CHARACTERISTIC TIME CORRELATION OF EMISSIONS FROM CONVENTIONAL AIRCRAFT TYPE FLAMES Final Report
J H Tuttle M B Colket and A M Mellor May 1976 144 p refs
(Grant EPA-R-802650-02)
(PB-258269/0, PURDU-CL-76-05) Avail NTIS HC A07/MF A01 CSCL 21B

The overall combustion process occurring within a liquid spray fueled burner was analyzed in terms of the ongoing dominant subprocesses, with particular emphasis on those subprocesses deemed most critical to pollutant emissions Liquid fuel evaporation, turbulent mixing and chemical reaction were each considered separately and were characterized by time scales which typify the importance of each subprocess An axisymmetric burner consisting of a flame stabilized in the wake of a disc with a liquid fuel spray injected into the wake region from the center of the disc was considered experimentally GRA

N77-17081*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio

AIRCRAFT PISTON ENGINE EXHAUST EMISSION SYMPOSIUM

Sep 1976 373 p Symp held in Cleveland, 14-15 Sep 1976 (NASA-CP-2005 E-9010) Avail NTIS HC A16/MF A01 CSCL 21E

A 2-day symposium on the reduction of exhaust emissions from aircraft piston engines was held on September 14 and 15, 1976 at the Lewis Research Center in Cleveland Ohio Papers were presented by both government organizations and the general aviation industry on the status of government contracts emission measurement problems, data reduction procedures flight testing, and emission reduction techniques

N77-17082*# Environmental Protection Agency, Washington D C

DEVELOPMENT OF EPA AIRCRAFT PISTON ENGINE EMISSION STANDARDS

William Houtman *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 1-22 refs

Avail NTIS HC A16/MF A01 CSCL 21E

Piston engine light aircraft are significant sources of carbon monoxide in the vicinity of high activity general aviation airports Substantial reductions in carbon monoxide were achieved by fuel mixture leaning using improved fuel management systems The air quality impact of the hydrocarbon and oxides of nitrogen emissions from piston engine light aircraft were insufficient to justify the design constraints being confronted in present control system developments Author

N77-17083*# Environmental Protection Agency, Washington, D C Office of Mobile Source Air Pollution Control

APPLICATION OF AUTOMOBILE EMISSION CONTROL TECHNOLOGY TO LIGHT PISTON AIRCRAFT ENGINES

David Tripp and George Kittredge *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 23-44 refs

Avail NTIS HC A16/MF A01 CSCL 21E

The possibility was evaluated for achieving the EPA Standards for HC and CO emissions through the use of air-fuel ratio enleanment at selected power modes combined with improved air-fuel mixture preparation, and in some cases improved cooling Air injection was also an effective approach for the reduction of HC and CO particularly when combined with exhaust heat conservation techniques such as exhaust port liners Author

N77-17086*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

SUMMARY REPORT ON EFFECTS AT TEMPERATURE, HUMIDITY, AND FUEL-AIR RATIO ON TWO AIR-COOLED LIGHT AIRCRAFT ENGINES

Erwin E Kempke Jr *In its* Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 85-120 refs

Avail NTIS HC A16/MF A01 CSCL 21E

Five different engine models were tested to experimentally characterize emissions and to determine the effects of variation in fuel-air ratio and spark timing on emissions levels and other operating characteristics such as cooling misfiring roughness power acceleration etc The results are given of two NASA reports covering the Avco Lycoming O-320-D engine testing and the recently obtained results on the Teledyne Continental TSIO-360-C engine Author

N77-17087*# Federal Aviation Administration, Washington D C

EMISSIONS DATA BY CATEGORY OF ENGINES

Joan Barriage William Westfield and Eric E Becker *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 121-140

Avail NTIS HC A16/MF A01 CSCL 21E

Exhaust gas pollutant emissions data under test stand conditions were obtained for the following (1) full-rich baseline test (7-mode cycle) (2) lean-out tests for each power mode, and (3) different spark settings The test data were also used to create a theoretical 5-mode cycle baseline The emissions data in the framework of the theoretical 5-mode cycle were emphasized There is no significant difference in the test results produced by data exhibited on the 7-mode cycle or 5-mode cycle The 5-mode cycle was slightly more conservative for the carbon monoxide pollutant than the 7-mode cycle The data were evaluated to determine which mode(s) had the greatest influence on improving general aviation piston engine emissions Improvements that were achieved as a result of making lean-out adjustments to the fuel metering device were (1) taxi mode only, (2) taxi and approach modes combined and (3) leaning-out of the climb mode to best power Author

N77-17088*# Avco Lycoming Div Williamsport Pa

AVCO LYCOMING EMISSION AND FLIGHT TEST RESULTS

Larry C Duke *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 141-178

Avail NTIS HC A16/MF A01 CSCL 21E

The Avco Lycoming flight test program for reduced emissions was conducted to determine and document the lean fuel schedule limits for current production aircraft based on flight safety Based on analysis of the emissions profile Avco Lycoming proposed to evaluate the effect of leaner schedules in the idle/taxi, climb, and approach modes These modes were selected as areas where it was felt that possible improvements could be made with the greatest improvement in cyclic emissions reduction The fuel systems to produce these leaner stepped fuel schedules were tailored specifically for the flight test Author

N77-17089*# Teledyne Continental Motors Mobile, Ala

TELEDYNE CONTINENTAL MOTORS EMISSIONS DATA AND ANALYSIS AND FLIGHT TEST RESULTS

Bernard Rezy *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 179-208

Avail NTIS HC A16/MF A01 CSCL 21E

Five different engine models were tested covering combinations of all engine categories in current production in the range from 100 to 435 brake horsepower Engines were divided into five major types carbureted, fuel injected direct drive geared, and turbocharged Emissions data were categorized by three separate fuel system schedules baseline, case 1, and case 2 Baseline was defined as the average fuel flow rate established by the fuel system s production tolerance band when operated with the mixture control at the full-rich position Case 1 was defined as the minimum allowable fuel flow rate established by the engine certification Case 2 was defined as the fuel rate corresponding to the leanest fuel-air ratio obtainable before a safety limit occurred with the engine operating on a propeller test stand Safety limits that developed during testing were cylinder-head overheating or inadequate acceleration from a given mode of operation Author

N77-17090*# Cessna Aircraft Co , Wichita Kans

FLIGHT TEST SUMMARY OF MODIFIED FUEL SYSTEMS

Bruce G Barrett *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 209-224

Avail NTIS HC A16/MF A01 CSCL 21E

Two different aircraft designs, each with two modified fuel control systems, were evaluated Each aircraft was evaluated in a given series of defined ground and flight conditions while quantitative and qualitative observations were made During this program some ten flights were completed and a total of about 13 hours of engine run time was accumulated by the two airplanes The results of these evaluations with emphasis on the operational

and safety aspects were analyzed Ground tests of the engine alone were not able to predict acceptable limiting lean mixture settings for the flight envelopes of the Cessna Models 150 and T337 Author

N77-17091*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
INTRODUCTION TO NASA CONTRACTS
Erwin E Kempke, Jr *In its* Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 225-226

Avail NTIS HC A16/MF A01 CSCL 21E
The NASA Lewis Research Center issued requests for proposal to Avco Lycoming and Teledyne Continental Motors for a contractual effort to establish and demonstrate engine modifications to reduce exhaust emissions safely with minimum adverse effects on cost, weight, and fuel economy The secondary objective was reducing fuel consumption Author

N77-17092*# Teledyne Continental Motors, Mobile, Ala
TCM AIRCRAFT PISTON ENGINE EMISSION REDUCTION PROGRAM
Bernard Rezy *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 227-254

(Contract NAS3-19755)
Avail NTIS HC A16/MF A01 CSCL 21E
The technology necessary to safely reduce general aviation piston engine exhaust emissions to meet the EPA 1980 Emission Standards with minimum adverse effects on cost, weight, fuel economy and performance was demonstrated A screening and assessment of promising emission reduction concepts was provided, and the preliminary design and development of those concepts was established A system analysis study and a decision making procedure were used by TCM to evaluate, trade off and rank the candidate concepts from a list of 14 alternatives Cost emissions and 13 other design criteria considerations were defined and traded off against each candidate concept to establish its merit and emission reduction usefulness A computer program was used to aid the evaluators in making the final choice of three concepts Author

N77-17096*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
EMISSIONS AND NEW TECHNOLOGY PROGRAMS FOR CONVENTIONAL SPARK-IGNITION AIRCRAFT ENGINES
William T Wintucky *In its* Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 295-314

Avail NTIS HC A16/MF A01 CSCL 21E
A long-range technology plan in support of general aviation engines was formulated and is being implemented at the Lewis Research Center The overall program was described and that part of the program that represents the in-house effort at Lewis was presented in detail Three areas of government and industry effort involving conventional general-aviation piston engines were part of a coordinated overall plan (1) FAA/NASA joint program (2) NASA contract exhaust emissions pollution reduction program, and (3) NASA in-house emissions reduction and new technology program Author

N77-17097*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
ALTERNATIVE GENERAL-AIRCRAFT ENGINES
William A Tomazic *In its* Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 315-328

Avail NTIS HC A16/MF A01 CSCL 21E
The most promising alternative engine (or engines) for application to general aircraft in the post-1985 time period was defined and the level of technology was cited to the point where confident development of a new engine can begin early in the 1980's Low emissions multifuel capability and fuel economy were emphasized Six alternative propulsion concepts were considered to be viable candidates for future general-aircraft application the advanced spark-ignition piston, rotary combustion, two- and four-stroke diesel, Stirling, and gas turbine engines Author

N77-17098*# Piper Aircraft Corp , Lockhaven, Pa
SUMMARY OF THE GENERAL AVIATION MANUFACTURERS' POSITION ON AIRCRAFT PISTON ENGINE EMISSIONS
J Lynn Helms *In* NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 329-336

Avail NTIS HC A16/MF A01 CSCL 21E
The General Aviation Manufacturers recommended that the EPA rescind the aircraft piston engine emissions regulations currently on the books The reason was the very small emission reduction potential and the very poor benefit-cost ratio involved in this form of emission reduction The limited resources of this industry can far better be devoted to items of much greater benefit to the citizens of this country - reducing noise, improving fuel efficiency (which will incidently reduce exhaust emissions), and improving the safety, operational and economic aspects of aircraft, all far greater contributions to our total national transportation system Author

N77-17099*# Avco Lycoming Div Williamsport, Pa
REVIEW OF MEASUREMENT AND TESTING PROBLEMS
In NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 337-356

Avail NTIS HC A16/MF A01 CSCL 21E
Good instrumentation was required to obtain reliable and repeatable baseline data Problems that were encountered in developing such a total system were (1) accurate airflow measurement, (2) precise fuel flow measurement and (3) the instrumentation used for pollutant measurement was susceptible to frequent malfunctions Span gas quality had a significant effect on emissions test results The Spindt method was used in the piston aircraft emissions program The Spindt method provided a comparative computational procedure for fuel/air ratio based on measured emissions concentrations Author

N77-17100*# Teledyne Continental Motors, Mobile Ala
REVIEW OF MEASUREMENT AND TESTING PROBLEMS
In NASA Lewis Res Center Aircraft Piston Eng Exhaust Emissions Symp Sep 1976 p 357-378

Avail NTIS HC A16/MF A01 CSCL 21E
The exhaust emission test was designed to measure hydrocarbons, carbon monoxide, and oxides of nitrogen concentrations and determine mass emissions through calculations during a simulated aircraft landing-takeoff cycle The calculations required to convert exhaust emission concentrations (raw emission measurements) into mass emissions were emphasized Author

N77-17102*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va
THE EFFECT OF VARIATIONS IN CONTROLS AND DISPLAYS ON HELICOPTER INSTRUMENT APPROACH CAPABILITY
Frank R Niessen James R Kelly, John F Garren Jr Kenneth R Yenni and Lee H Person Washington Feb 1977 43 p refs
(NASA-TN-D-8385, L-10982) Avail NTIS HC A03/MF A01 CSCL 01C
A flight investigation was conducted with a variable stability helicopter to determine the effects of variations in controls and displays on helicopter instrument approach capabilities The baseline instrument approach task was a decelerating approach to a hover along a 6 deg glide slope Pilot evaluations were obtained for both the constant speed part of the task and the deceleration and hover part of the task The attitude stability augmentation system (SAS) was strongly preferred over the rate

SAS because the aircraft had a divergent pitch response From a display variation standpoint it was not possible to decelerate to a hover in a consistent manner, regardless of the control system employed with situation information only In particular, the deceleration and hover part of the task was unacceptable without flight director command information Author

N77-17103*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
APPLICATION OF A MODIFIED COMPLEMENTARY FILTERING TECHNIQUE FOR INCREASED AIRCRAFT CONTROL SYSTEM FREQUENCY BANDWIDTH IN HIGH VIBRATION ENVIRONMENT
John F Garren Jr Frank R Niessen, Terence S Abbott, and Kenneth R Yenni Jan 1977 21 p refs
(NASA-TM-X-74004) Avail NTIS HC A02/MF A01 CSCL 01D

A modified complementary filtering technique for estimating aircraft roll rate was developed and flown in a research helicopter to determine whether higher gains could be achieved Use of this technique did, in fact permit a substantial increase in system frequency bandwidth because, in comparison with first-order filtering it reduced both noise amplification and control limit-cycle tendencies Author

N77-17104# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Abteilung Flugmechanik der Flaechenflugzeuge
STABILIZATION, GUST ALLEVIATION AND VIBRATION DAMPING OF AN ELASTIC AIRCRAFT MODEL MOVING IN THE WIND TUNNEL Ph D Thesis - Tech Univ., Brunswick
Gernot Hoffmann 11 Aug 1976 110 p refs In GERMAN, ENGLISH summary Report will also be announced as translation (ESA-TT-359)
(DLR-FB-76-44) Avail NTIS HC A06/MF A01 DFVLR Cologne, DM 49 60

For an elastic aircraft model, which can move in the wind tunnel with several degrees of freedom, the development and practical test of a multivariable controller is discussed The controller stabilizes the elevation and the pitch angle, alleviates vertical gusts and improves the damping of the first elastic mode *The control system synthesis depends on principles of optimization* and simulation in the state space Some low order linear filters are needed to meet the technical conditions Author (ESA)

N77-17105# Rockwell International Corp Cedar Rapids Iowa Collins Radio Group
COMPASS COPE FLIGHT CONTROL SYSTEM REDUNDANCY STUDY Final Report, Sep - Dec 1975
R F Tribuno, J A Klein, D R Stover and K G Martin Wright-Patterson AFB, Ohio AFFDL 8 Apr 1976 119 p refs
(Contract F33615-73-C-3051, AF Proj 1957)
(AD-A029021 S-76-2 AFFDL-TR-76-59) Avail NTIS HC A06/MF A01 CSCL 01/3

This report presents the result of study conducted by Collins Radio Co under contract to Calspan Corporation, to define and discuss flight control system reliability requirements monitoring techniques and fault analysis Also included are hardware and software reliability implementation tradeoff discussions, configuration redundancy candidates and recommendations for further study Author (GRA)

N77-17106# Analytical Sciences Corp., Reading, Mass
HIGH ANGLE OF ATTACK OF STABILITY AND CONTROL Annual Technical Report, 1 Feb 1975 - 31 Jan 1976
Robert F Stengel John R Broussard James H Taylor and Paul W Berry 7 Apr 1976 296 p refs
(Contract N00014-75-C-0432 NR Proj 215-237)
(AD-A027877 TASC-TR-612-1, ONR-CR-215-237) Avail NTIS HC A13/MF A01 CSCL 01/4

High-performance aircraft are susceptible to degraded flying qualities during maneuvering flight for a number of reasons, including aerodynamic nonlinearities, inertial coupling and rapidly changing flight conditions Lateral-directional modes of motion coupled with longitudinal motions in asymmetric flight and high angle of attack can lead to instability and adverse control response The pilot must adapt his control strategies to varying aircraft dynamics and his work load is high, consequently improper piloting procedures could occur, leading to inadvertent loss of control GRA

N77-17107# Air Force Flight Test Center Edwards AFB, Calif
A NEW METHOD FOR TEST AND ANALYSIS OF DYNAMIC STABILITY AND CONTROL Final Report
Christopher J Nagy May 1976 241 p refs
(AD-A029039, AFFTC-TD-75-4) Avail NTIS HC A11/MF A01 CSCL 01/1

This report presents a new method of dynamic stability and control test and analysis which uses several computer programs to perform derivative extraction and characteristic analysis The report covers the advantages of this method and the elements (test conditions, instrumentation, preferred maneuvers) required for success In addition, complete user guide information is presented to allow setup and execution of these programs Finally, a section is included on interpreting and evaluating the results Author (GRA)

N77-17175# Syracuse Univ., N Y
A TECHNOLOGY PLAN FOR ELECTROMAGNETIC CHARACTERISTICS OF ADVANCED COMPOSITES Phase Report, 1 Apr 1975 - 1 Apr 1976
J Allen (South Fla Univ), W Gajda (Notre Dame Univ) D Griffin (Adelaide Univ) R Harrington R Heintz (Rochester Inst of Technol) E Joy (Georgia Inst of Technol) J Lyon (Mich Univ Ann Arbor) and W Walker (Rochester Inst of Technol) Griffiss AFB, N Y RADC Jul 1976 160 p
(Contract F30602-75-C-0121 AF Proj 4540)
(AD-A030507, RADC-TR-76-206 RIT-EE-76-101) Avail NTIS HC A08/MF A01 CSCL 11/4

The report presents a program for the development of the fundamental technology for the assessment of the electromagnetic compatibility (EMC) effects of the use of advanced composite materials in aircraft A survey of the electromagnetic impact of the use of advanced composite materials in aircraft is given Electromagnetic hazards (lightning nuclear blast EMP, precipitation static and radar) are described and related to the shielding performance of advanced composite materials In addition the effects of composite materials on antenna performance is discussed The measurement of basic electrical properties and the definition and measurement of shielding effectiveness is treated in detail Finally and most importantly, future study tasks are defined which aim to develop electromagnetic environment analysis capability for existing and future aircraft systems using advanced composite materials Author (GRA)

N77-17227# Avco Lycoming Div., Stratford, Conn
EVALUATION OF ISOTHERMAL FORGINGS FOR T53 IMPELLERS Final Technical Report, 16 Jun - 16 Dec 1976
Elizabeth K Knauf and Louis J Fiedler Watertown Mass AMMRC 16 Dec 1975 51 p refs
(Contract DAAG46-75-C-0078)
(AD-A030469 USAAVSCOM-R-76-21, AMMRC-CTR-76-14) Avail NTIS HC A04/MF A01 CSCL 21/5

The primary objective of this program was to evaluate isothermal forgings of Ti-6Al-4V alloy in the form of near-net shaped T53 impellers and determine their potential technical and economic advantages over conventional forgings An evaluation of mechanical properties showed the isothermal forging properties to meet current forging specifications Finish machining of one forging was conducted using the current production process This revealed a time saving of 2 1 standard hours over the conventional forging a savings primarily in rough machining Partially formed vanes are not realized as an advantage by the current milling process due to the cam controlled action of the cutter in the existing machining facility, i e several Gorton milling

machines A cost analysis of alternative vane milling methods, i e numerical and/or adaptive control, has led to the conclusion that a process modification would not be cost effective due to current high efficiency of the Gorton mill It is therefore recommended that a partial vane contour be included in the forged shape only to the extent that is effective in reducing input material cost without increasing forging costs
Author (GRA)

N77-17281*# Perkin-Elmer Corp Danbury Conn Optical Technology Div
RECON 6 A REAL-TIME, WIDE-ANGLE, SOLID-STATE RECONNAISSANCE CAMERA SYSTEM FOR HIGH-SPEED, LOW-ALTITUDE AIRCRAFT
Richard L Labinger *In* JPL Conf on Charge-Coupled Device *Technol and Appls* 1976 p 129-134

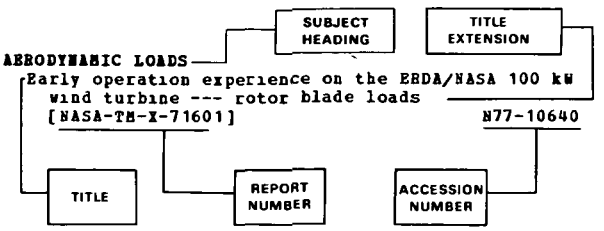
Avail NTIS HC A11/MF A01 CSCL 14E
The maturity of self-scanned solid-state multielement photosensors makes the realization of real time' reconnaissance photography viable and practical A system built around these sensors which can be constructed to satisfy the requirements of the tactical reconnaissance scenario is described The concept *chosen is the push broom strip camera system -- RECON 6 --* which represents the least complex and most economical approach for an electronic camera capable of providing a high level of performance over a 140 deg wide continuous swath at altitudes from 200 to 3,000 feet and at minimum loss in resolution at higher altitudes
Author

N77-17356*# *Stanford Univ, Calif* Guidance and Control Lab
ON THE APPLICABILITY OF INTEGRATED CIRCUIT TECHNOLOGY TO GENERAL AVIATION ORIENTATION ESTIMATION Final Report
Daniel B DeBra and Michael G Tashker Dec 1976 77 p refs
(Contract NAS2-9083)
(NASA-CR-151952) Avail NTIS HC A05/MF A01 CSCL 09C
The criteria of the significant value of the panel instruments used in general aviation were examined and kinematic equations were added for comparison An instrument survey was performed to establish the present state of the art in linear and angular accelerometers pressure transducers, and magnetometers A very preliminary evaluation was done of the computers available for data evaluation and estimator mechanization The mathematical model of a light twin aircraft employed in the evaluation was documented, the results of the sensor survey and the results of the design studies were presented
Author

N77-17446# Naval Postgraduate School Monterey, Calif
STUDY AND DESIGN OF FLIGHT DATA RECORDING SYSTEMS FOR MILITARY AIRCRAFT M S Thesis
Lloyd Norman Baetz Jun 1976 129 p refs
(AD-A028862) Avail NTIS HC A07/MF A01 CSCL 01/2
Investigation of aircraft wreckage does not provide crash investigators with adequate information Crash-protected flight recorder data is invaluable when determining accident cause factors Inertial navigation systems provide an excellent source of highly accurate flight parameters Nonvolatile solid state memory is available which can replace failure prone magnetic tape recording in flight recorder systems Microprocessors are available with the capability of compressing flight data for solid state memory storage Data compression trials indicate that a flight data recording system using microcomputer preprocessing and nonvolatile solid state memory is feasible
GRA

N77-17608*# *Columbia Univ, New York* Noise Research Unit
A COMPARISON OF A LABORATORY AND FIELD STUDY OF ANNOYANCE AND ACCEPTABILITY OF AIRCRAFT NOISE EXPOSURES
Paul N Borsky Washington NASA Feb 1977 73 p refs (Grant NsG-1164)
(NASA-CR-2772) Avail NTIS HC A04/MF A01 CSCL 20A
Residents living in close, middle and distant areas from JFK Airport were included in a field interview and laboratory study Judgments were made of simulated aircraft noise exposures of comparable community indoor noise levels and mixes of aircraft Each group of subjects judged the levels of noise typical for its distance area Four different numbers of flyovers were tested less than average for each area the approximate average the peak number, or worst day and above peak number The major findings are (1) the reported integrated field annoyance is best related to the annoyance reported for the simulated approximate worst day exposure in the laboratory, (2) annoyance is generally less when there are fewer aircraft flyovers, and the subject has less fear of crashes and more favorable attitudes toward airplanes (3) beliefs in harmful health effects and misfeasance by operators of aircraft are also highly correlated with fear and noise annoyance, (4) in direct retrospective comparisons of number of flights noise levels and annoyance subjects more often said the worst day laboratory exposured more like their usual home environments and (5) subjects do not expect an annoyance-free environment Half of the subjects can accept an annoyance level of 5 to 6 from a possible annoyance range of 0 to 9, 28% can live with an annoyance intensity of 7 and only 5% can accept the top scores of 8 to 9
Author

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

M

N

O

P

Q

R

S

T

U

V

W

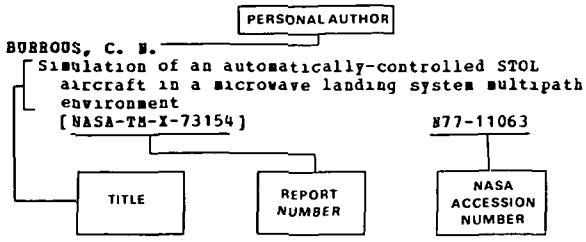
X

Y

Z

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 N77 11063 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

I

J

K

L

M

N

O

P

R

S

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

1. Report No.	2. Government Accession No	3. Recipient's Catalog No.
NASA SP-7037 (83)		

4 Title and Subtitle	5 Report Date
AERONAUTICAL ENGINEERING A Special Bibliography (Supplement 83)	May 1977 6. Performing Organization Code

7 Author(s)	8 Performing Organization Report No.
	10 Work Unit No

9 Performing Organization Name and Address	11. Contract or Grant No
National Aeronautics and Space Administration Washington, D. C. 20546	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 360 reports, articles, and other documents introduced into the NASA scientific and technical information system in April 1977.

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

19 Security Classif (of this report)	20 Security Classif (of this page)	21. No of Pages	22. Price*
Unclassified	Unclassified	118	$4.75 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

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON D C 20546

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

SPECIAL FOURTH CLASS MAIL
Book

POSTAGE AND FEES PAID
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
NASA-451

U.S.MAIL

POSTMASTER If Undeliverable (Section 158 Postal Manual) Do Not Return

NASA CONTINUING BIBLIOGRAPHY SERIES

NUMBER	TITLE	FREQUENCY
NASA SP--7011	AEROSPACE MEDICINE AND BIOLOGY Aviation medicine, space medicine, and space biology	Monthly
NASA SP-7037	AERONAUTICAL ENGINEERING Engineering, design, and operation of aircraft and aircraft components	Monthly
NASA SP-7039	NASA PATENT ABSTRACTS BIBLIOGRAPHY NASA patents and applications for patent	Semiannually
NASA SP--7041	EARTH RESOURCES Remote sensing of earth resources by aircraft and spacecraft	Quarterly
NASA SP-7043	ENERGY Energy sources, solar energy, energy conversion, transport, and storage	Quarterly
NASA SP-7500	MANAGEMENT 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