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A Selected Listing of NASA Scientific and Technical Reports for 1963

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Introduction

A Selected Listing of NASA Scientific and Technical Reports for 1963 assembles in one publication a listing of NASA reports that were announced in *Scientific and Technical Aerospace Reports (STAR)* during 1963 and were issued as part of the following NASA report series: *Technical Reports* (NASA *TR*), *Technical Notes* (NASA *TN*), *Special Publications* (NASA *SP*), *Contractor Reports* (NASA *CR*), and *Technical Translations* (NASA *TT*). It does not include a large body of NASA scientific and technical information reported in various journals, nor does it include less formal publications such as *Technical Memorandums* (NASA-*TM*).

The arrangement of this publication is the same as that of *STAR*. The first section contains the bibliographic citations and abstracts arranged by subject categories. The second section contains the five indexes (Subject, Corporate Source, Personal Author, Report/Accession Number, and Accession/Report Number) that have proved useful in *STAR*.

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NASA SP-7005

A SELECTED LISTING OF NASA SCIENTIFIC AND TECHNICAL REPORTS FOR 1963

SCIENTIFIC
and TECHNICAL
INFORMATION
DIVISION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D.C. 1964

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A Selected Listing of NASA Scientific and Technical Reports for 1963

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Includes administration and management; space law and related legal matters; legislative hearings and documents; and symposia or conferences of a broad or general nature.

N63-11137 National Aeronautics and Space Administration, Washington, D.C.

PROCEEDINGS OF THE SECOND NATIONAL CONFERENCE ON THE PEACEFUL USES OF SPACE, SEATTLE, May 8-10, 1962
Washington, GPO, Nov. 1962 272 p
(NASA-SP-8) GPO: $1.50

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N63-13184 National Aeronautics and Space Administration, Washington, D.C.

RESEARCH PROBLEMS PERTAINING TO AIRCRAFT OPERATIONS
William A. Mc Gowan and William S. Aiken, Jr., eds. March 1963 32 p
(NASA TN D-1596) OTS: $1.00

Research problems are presented under the following 12 categories: (1) vehicle performance, (2) vehicle structures, (3) vehicle powerplants, (4) fire hazards, (5) environment, (6) stability and control, (7) air traffic control and communication, (8) collision avoidance, (9) instrumentation, (10) medical and human factors, (11) crashworthiness, and (12) community relations. Specific recommendations of research studies needed in each of the categories are given and discussed. Author

N63-15357 National Aeronautics and Space Administration, Washington, D.C.

PROCEEDINGS OF THE SECOND NASA-INDUSTRY PROGRAM PLANS CONFERENCE, WASHINGTON, D.C., FEBRUARY 11-12, 1963

Walter L. Lingle, Jr., et al [1963] 221 p
(NASA SP-29) GPO: $1.25

The papers presented at this conference discuss the NASA projects currently in progress and studies being made of possible new projects. The purpose of these papers is to acquaint industry with these projects and provide information that will be of benefit to industry in planning research and development programs and in responding to future NASA requests for proposals. R.C.M.

N63-21126 National Aeronautics and Space Administration, Washington, D.C.

PROCEEDINGS OF THE CONFERENCE ON SPACE-AGE PLANNING. A PART OF THE THIRD NATIONAL CONFERENCE ON THE PEACEFUL USES OF SPACE, CHICAGO, MAY 1-9, 1963

1963 272 p
(NASA SP-40) GPO $2.00

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N63-21951 National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

MERCURY PROJECT SUMMARY INCLUDING RESULTS OF THE FOURTH MANNED ORBITAL FLIGHT, MAY 15 AND 16, 1963

Washington, NASA, Oct. 1963 435 p 84 refs
(Proj. Mercury)
(NASA SP-45) GPO $2.75

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N63-22264 National Aeronautics and Space Administration. Washington, D.C.

AEROELASTICITY SYMPOSIUM

(Gottingen, W. Germany, Max-Planck-Institut fur Stromungsforschung und Aerodynamische Versuchsanstalt, Sept. 1963 194 p 29 refs Transl. into ENGLISH of papers presented at Symp. on Aeroelasticity, Gottingen, Apr. 16-17, 1957
(NASA TT F-81) OTS: $3.00

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6. STATIC VIBRATION TESTS OF SAILPLANE WITH ELECTRONIC MEASURING INSTRUMENTS J. Schoen p 167-189 (See N63-22270 23-04)

02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc. *For related information see*: 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 11 Fluid Mechanics.

N63-10178 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC STABILITY INVESTIGATION OF PROPOSED PROJECT FIRE SPACE-VEHICLE AND REENTRY-PACKAGE CONFIGURATIONS AT MACH NUMBERS FROM 1.47 TO 4.63

Dennis E. Fuller and C. Donald Babb Washington, NASA, Nov. 1962 22 p 1 ref

(NASA TN D-1497) OTS: $0.75

Tests were conducted in the Langley Unitary Plan wind tunnel on proposed space-vehicle and reentry-package model configurations for Project Fire. Five different second-stage velocity-reentry-package combinations were investigated as part of the two-stage space-vehicle configuration. Only one reentry-package configuration was tested. Tests were performed through an angle-of-attack range from about −7° to 18°. The Reynolds number for these tests was held constant at 3.0×10^6 per foot. Author

N63-10628 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC STABILITY TESTS IN THE LANGLEY 24-INCH HYPERSONIC ARC TUNNEL ON A BLUNTED CONE AT A MACH NUMBER OF 20

Edwin F. Harrison Washington, NASA, Dec. 1962 22 p 7 refs

(NASA-TN-D-1508) OTS: $0.50

A compilation of experimental normal-force and pitching-moment coefficients is presented for a 9° semivertex-angle blunted cone at Mach numbers of 6.8, 9.6, 17, 17.3, 20, and 24 at angles of attack from −2.5° to 12.5°. The configuration had a truncated conical base and was designed as a 1/7-scale Scout project payload model. The investigation at a Mach number of 20 was the first force test conducted in the Langley 24-inch hypersonic arc tunnel. Author

N63-11513 National Aeronautics and Space Administration, Washington, D.C.

AERODYNAMICS OF SPACE VEHICLES

Robert W. Boswinkle, Jr., John P. Campbell, Mitchel H. Bertram, David E. Fetterman, Jr., John R. Henry, R. L. Trimpi, F. C. Grant, and Nathaniel B. Cohen 1962 57 p 120 refs Papers presented at Session Q of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)

(NASA-SP-23) GPO: $0.40

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N63-11617 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMIC CHARACTERISTICS IN GROUND EFFECT OF A LARGE-SCALE MODEL WITH A HIGH DISK-LOADING LIFTING FAN MOUNTED IN THE FUSELAGE

Richard A. deSavigny and David H. Hickey Washington, NASA, Jan. 1963 52 p 5 refs

(NASA TN D-1557) OTS: $1.50

The large-scale VTOL airplane model tested had a shoulder-mounted unswept-wing-of-aspect ratio 5. Characteristics of the model with and without the horizontal tail were obtained with the wing at 1.83 and 2.39 fan diameters from the simulated ground plane installed above the wind-tunnel floor. Test airspeeds ranged from 20 to 80 knots. Longitudinal forces and moments, some installed fan performance, static-pressure distributions on the fuselage, and downwash at the horizontal tail are presented. Author

N63-11779 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

JET EFFECTS ON ANNULAR BASE PRESSURE AND TEMPERATURE IN A SUPERSONIC STREAM

Milton A. Beheim, John L. Klann, and Richard A. Yeager Washington, NASA, 1962 42 p 15 refs

(NASA TR R-125) GPO: $0.55

The theoretical and experimental investigation was conducted with single jet configurations at free-stream Mach numbers of 2.0 and 1.6. Theoretical base-pressure ratios were generally less than experimental values, but were in closer agreement for the short-nozzle designs than for the full-length isentropic nozzles. In general, the predicted base-temperature ratios were greater than experimental values, and this deviation decreased with increasing ratio of jet total to base static pressure. This deviation was less at Mach 1.6 than at 2.0, and was less for high-area-ratio nozzles than for low-area-ratio designs. The effect of base bleed on base pressure could be predicted with good accuracy at low bleed-flow rates. Author

N63-11846 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS OF FOUR-DUCT TANDEM VTOL-AIRCRAFT CONFIGURATIONS

William A. Newsom, Jr. Washington, NASA, Jan. 1963 152 p 2 refs

(NASA TN D-1481) OTS: $3.00

This paper presents a summary of several wind-tunnel investigations conducted for the study of four similar VTOL-aircraft configurations, powered by four tilting ducted propellers arranged in tandem pairs. The results of the investigation indicated that aircraft of this type could have acceptable aerodynamic and static longitudinal- and lateral-stability characteristics in both transition and cruise flight. However, the lateral force due to sideslip was abnormally high and might have caused the aircraft to be too sensitive to side gusts. Author

N63-12287 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL AND THEORETICAL STUDIES OF THE EFFECTS OF CAMBER AND TWIST ON THE AERODYNAMIC CHARACTERISTICS OF PARAWINGS HAVING NOMINAL ASPECT RATIOS OF 3 AND 6

Edward C. Polhamus and Rodger L. Naeseth Washington, NASA, Jan. 1963 37 p 15 refs

(NASA TN D-972) OTS: $1.00

Low-speed wind-tunnel studies were made of the effects of camber and twist and the effects of aspect ratio on the aerodynamic characteristics of parawings. To determine the effects of camber and twist, tests were made both with the conventional conical-type canopy, which provides camber and washout, and with a cylindrical-type canopy which provides essentially zero camber and twist. With regard to aspect ratio, tests were made of parawings having aspect ratios of 3 and 6; the range was thereby extended well beyond that of previous investigations. The degree to which airfoil and wing theory can be used to predict the aerodynamic characteristics of parawings was also investigated. Results indicated that improvements in lift-drag ratio can be obtained both by the use of the cylindrical canopy and by the use of a high-aspect-ratio canopy. The aspect-ratio-6 cylindrical parawing provided a maximum lift-drag ratio of approximately 13.6. The results also indicated that, for

conical type canopies, improvements in the zero-lift pitching-moment characteristics could be obtained by use of the higher aspect ratio. With regard to theory, the results indicated that sufficient accuracy for preliminary design can be obtained by use of the Pankhurst method for camber effects and the Weissinger method for angle-of-attack and twist effects. Author

N63-12489 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A LARGE-SCALE WIND-TUNNEL INVESTIGATION OF A WINGLESS VERTICAL TAKE-OFF AND LANDING AIRCRAFT

David G. Koenig and James A. Brady Washington, NASA, Feb. 1963 49 p 4 refs
(NASA TN D-1335) OTS: $1.25

Results of tests on the wind-tunnel ground plane system at 0° sideslip are presented for airspeeds from 20 to 70 knots and exit vane angles between 33° and 70°. These results together with previously published results of tests at fixed ground height are combined in the present report to obtain certain conclusions concerning the performance, stability, and control of the aircraft. Author

N63-12701 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

STATIC AERODYNAMIC CHARACTERISTICS OF A SHORT BLUNT 10° SEMIVERTEX ANGLE CONE AT A MACH NUMBER OF 15 IN HELIUM

Melvin J. Fohrman Washington, NASA, Feb. 1963 37 p 12 refs
(NASA TN D-1648) OTS: $1.00

Force, moment, and shock-wave data were obtained on two blunt bodies, one having a flat base and the other a conical afterbody with a semivertex angle of 50°. The Reynolds number for the tests was 2.25×10^6 based on maximum body diameter, and the angle-of-attack range extended from 0° to 180°. The data were compared to modified Newtonian theory, theoretical values for a cone, a numerical flow-field analysis, and an approximate method for predicting the forebody shock wave. Author

N63-12950 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTIONS OVER THE FORWARD PORTION OF THE PROJECT FIRE SPACE-VEHICLE CONFIGURATION AT MACH NUMBERS FROM 0.25 TO 0.60

William P. Henderson Washington, NASA, Feb. 1963 28 p
(NASA TN D-1612) OTS: $0.75

An investigation was made in the Langley 7- by 10-foot transonic tunnel to determine the pressure distributions over a 0.0628-scale model of the forward portion of the Project Fire space-vehicle configuration. Tests were made at Mach numbers of 0.248, 0.395, and 0.585. Data are presented for the model at angles of attack ranging from -8° to 8° and at roll angles of 0°, 15°, 30°, 50°, and 90°. Author

N63-13105 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CALCULATIONS OF COMPRESSIBLE AVERAGE TURBULENT SKIN FRICTION

Mitchel H. Bertram Washington, NASA, 1962 34 p 23 refs
(NASA TR R-123) GPO: $0.40

Calculations have been carried out for a perfect-gas flow to show the effect of a wide range of parameters on the average skin friction on a flat plate in turbulent flow by the reference-temperature method (however, to some extent laminar flow was also treated). Some of the variables were Mach number, Reynolds number, and wall and free-stream temperature level for ratios of specific heats of 7/5 and 5/3. The effect of the blunt leading edge was calculated by assuming that the turbulent boundary layer is growing in the reexpanded flow behind a normal shock at various free-stream Mach numbers. Analogous to angle of attack, the pressure level on the plate was varied over a wide range to show the effect on skin friction for the plate with sharp and blunt leading edges. Relations which allow the results to be applied to cones and wings of tapered planform were shown. Author

N63-13106 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A PRELIMINARY THEORETICAL STUDY OF THE EXPANSION TUBE, A NEW DEVICE FOR PRODUCING HIGH-ENTHALPY SHORT-DURATION HYPERSONIC GAS FLOWS

Robert L. Trimpi Washington, NASA, 1962 31 p 12 refs
(NASA TR R-133) GPO: $0.40

A preliminary theoretical study was conducted of a new technique for producing high-enthalpy gas flows. The device considered utilizes an unsteady expansion process for the purpose of total-enthalpy multiplication. Analyses were conducted for both perfect and real air in equilibrium, assuming idealized diaphragm bursts, centered expansion waves, and continuum flow. Results of the study showed the expansion tube capable of outperforming the conventional shock tunnel by a factor of approximately 2 in velocity for the same test-section ambient density and pressure. The degree of dissociation is low at all phases of the thermodynamic cycle in the expansion tube; thus the test-section air has a good possibility of being in equilibrium. Maximum pressures involved in the cycle for duplicating a typical reentry from a lunar mission are low enough for existing pressure-vessel techniques. Both the known and anticipated advantages and disadvantages of this new concept are also discussed. Author

N63-13186 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPLORATORY INVESTIGATION OF THE EFFECT OF A FORWARD-FACING JET ON THE BOW SHOCK OF A BLUNT BODY IN A MACH NUMBER 6 FREE STREAM

David J. Romeo and James R. Sterrett Washington, NASA, Feb. 1963 46 p 12 refs
(NASA TN D-1605) OTS: $1.25

The effect of a forward-facing jet on the bow shock of a blunt body in a Mach 6 free stream was investigated experimentally. The models tested had forward-facing jets using air and helium exhausting at Mach numbers from 1 to 10.3 and were run through a range of the ratio of jet total pressure to free-stream total pressure of 0.03 (jet off) to 2.5. The ratio of body diameter to jet-exit diameter varied from 1.12 to 55.6 and the angle of attack was varied from 0° to 35°. The experimental results show that the main-stream shock can be affected by the jet in two significantly different ways. One way is simply to move the strong shock away from the body without altering its shape. The second and perhaps more interesting case occurs when the jet causes a large displacement of the main shock and considerably changes its shape. It was found that the ratio of jet total pressure to free-stream total pressure necessary to obtain the large displacements of the main-stream shock depended on the ratio of body diameter to jet-exit diameter and also on the jet-exit Mach number. The maximum amount the shock could be displaced in percent of body diameter was seen to increase with increasing jet-exit Mach number and also with decreasing ratio of body diameter to jet-exit diameter. For the models that were investigated through an angle-of-attack range, the displacement became very unsteady and fell

off sharply as the angle of attack was increased. Simplified theoretical considerations applied to the shock-displacement phenomena provide a possible explanation for the two different types of mainstream shock displacement. Theoretical curves show the regions where these types of displacement would occur for different exit Mach numbers and pressure ratios for a forward-facing jet in a Mach 6 stream. Author

N63-13562 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 6.77 OF A 9° CONE CONFIGURATION, WITH AND WITHOUT SPHERICAL AFTERBODIES, AT ANGLES OF ATTACK UP TO 180° WITH VARIOUS DEGREES OF NOSE BLUNTING

Luther Neal, Jr. Washington, NASA, Mar. 1963 25 p 19 refs
(NASA TN D-1606) OTS: $0.75

Force and moment tests have been conducted on both sharp and spherical blunted cone configurations having semivertex angles of 9° in the Langley 11-inch hypersonic tunnel at a Mach number of 6.77, a Reynolds number per inch of 135,000, and an angle-of-attack range from 0° to 180°. Analysis of the results indicates that a second stable trim condition can exist near $\alpha = 180°$ for flat-base cone configurations depending upon the fineness ratio of the cone. However, it appears that this condition may be prevented by the addition to the basic cones of spherical afterbody caps whose centers of curvature coincide with the respective moment references. A comparison of the experimental data with theory by using a combination of impact and modified Newtonian theory over different portions of the body shows that, except for the stable region at an angle of attack of 180° for the blunt cones, the method provides an adequate means of predicting the general trends of cone configurations throughout the entire 180° angle-of-attack range. Moreover, the actual magnitudes of the characteristics are predicted satisfactorily in many instances. At an angle of attack of 0°, however, the method significantly overpredicts the lift-curve slope C_{L_α} and the negative pitching-moment-curve slope C_{m_α} for the cones with large nose bluntness. Author

N63-13716 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC DRAG AND STABILITY CHARACTERISTICS OF TOWED INFLATABLE DECELERATORS AT SUPERSONIC SPEEDS

John T. Mc Shera, Jr. Washington, NASA, Mar. 1963 24 p 6 refs
(NASA TN D-1601) OTS: $0.75

A wind-tunnel investigation has been conducted to study the possibility of inflating balloon and cone devices to give the same drag and stability characteristics as their solid counterparts over the Mach number range from 2.00 to 4.65. The results include some effects of Mach number, tow-cable length, and inlet configurations on the drag and stability of these inflatable decelerators. Both the closed pressure-inflatable and self-inflatable (ram-air) decelerator configurations were fully inflated and had approximately the same drag and stability as their solid counterparts. The decelerator exhibits excellent stability in the supersonic wake region. The drag reaches a maximum and has little change with increases in tow-cable length when the decelerator reaches the supersonic wake region. Author

N63-13718 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF CROSS-SECTION SHAPE ON THE AERODYNAMIC CHARACTERISTICS OF BODIES AT MACH NUMBERS FROM 2.50 TO 4.63

Dennis E. Fuller, David S. Shaw, and Donald L. Wassum Washington, NASA, Mar. 1963 31 p 5 refs
(NASA TN D-1620) OTS: $0.75

An investigation has been made in the high-Mach-number test section of the Langley Unitary Plan wind tunnel to determine the aerodynamic characteristics of several bodies that differed only in cross section. All of the bodies had a fineness ratio of 10 and the same longitudinal cross-sectional area distribution. The cross-sectional shapes tested were a circle; ellipses with width-height ratios of ½:1, 1½:1, and 2:1; and flat-bottom and flat-top semiellipses. In addition, flat-bottom and flat-top bodies with triangular-shaped cross sections and rounded corners were tested. The tests were performed at Mach numbers from 2.50 to 4.63, and at Reynolds number per foot of 2.5×10^6. The results indicate that increasing the width-height ratio of the bodies provides substantial increases in lift and in lift-drag ratio. In addition, the results for the flat-top body with an unsymmetrical nose indicates the possibility of combining positive pitching moments at zero angle-of-attack with high lift-drag ratios. Author

N63-13788 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS FROM 0.40 TO 1.10 OF A BLUNTED RIGHT-TRIANGULAR PYRAMIDAL LIFTING REENTRY CONFIGURATION EMPLOYING VARIABLE-SWEEP WING PANELS

Bernard Spencer, Jr. Washington, NASA, Mar. 1963 70 p 10 refs
(NASA TN D-1518) OTS: $1.75

An investigation has been conducted in the Langley 7- by 10-foot transonic tunnel at Mach numbers from 0.40 to 1.10 on a right-triangular pyramidal-type reentry configuration employing variable wing sweep as a means of increasing lift and lift-drag ratio at subsonic speeds. Various means of longitudinal control were also tested in conjunction with the range of wing-panel sweep at a Mach number of 0.40. The results indicated that reducing the sweep of the wing panels from 80° to 0° at a Mach number of 0.40 increased the maximum lift-drag ratio of the basic configuration from 2.55 to 5.65 and increased the lift-curve slope from 0.0195 to 0.0565 with little or no change in the low-lift stability level for the configuration with all controls off. The configuration having 30° or 40° sweep provided the highest lift coefficient for the maximum angle-of-attack range of the investigation. Wing-panel leading-edge sweep angles below 30° indicated stalling and rapid losses in lift coefficient occurring at moderate angles-of-attack. Comparison of the longitudinal control characteristics of a high and low horizontal tail and a trailing-edge flap control indicated the highest values of control effectiveness for the high-positioned horizontal tail. Use of the trailing-edge flap control provided trim conditions throughout the angle-of-attack range. Author

N63-13791 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION OF THE DYNAMIC STABILITY OF A TOWED PARAWING GLIDER MODEL

Robert E. Shanks Washington, NASA, Mar. 1963 15 p 2 refs
(NASA TN D-1614) OTS: $0.50

An investigation of the dynamic stability characteristics of a towed parawing glider has been made in the Langley full-scale tunnel by means of free-flight model tests. The model was tested in its basic configuration (wing, risers, and a steel weight representing a payload) and with various amounts of vertical side area added in the plane of symmetry beneath the wing. The investigation showed that the basic configuration had unsatisfactory tow characteristics because of a large, constant-amplitude lateral oscillation which seemed to consist of a large amount of sidewise motion in proportion to the roll and yaw. It was found that the addition of vertical side area could provide satisfactory tow characteristics if the area was properly located. It should be pointed out that in this investigation the model did not have a cargo package of any appreciable dimensions and, therefore, only the aerodynamics of the wing and vertical panels were involved. For other configurations a somewhat different arrangement of side area might be necessary to achieve satisfactory tow. Author

N63-14029 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN EXPERIMENTAL EVALUATION OF AERODYNAMIC DAMPING MOMENTS OF CONES WITH DIFFERENT CENTERS OF ROTATION

William R. Wehrend, Jr. Washington, NASA, Mar. 1963 52 p 4 refs
(NASA TN D-1768) OTS: $1.50

The static and dynamic stability characteristics of a 12½° semivertex angle cone were studied. The cone was tested with both sharp and blunt tips and with a flat base and spherical segment afterbodies. The tests were performed at Mach numbers from 0.25 to 2.20 for angles-of-attack from −13° to +18°. The Reynolds number varied from 0.68 million to 1.54 million based on model base diameter. Presented are measurements of the normal force, axial force, base pressure, and pitching moment from the static tests, and the damping-in-pitch moment from the dynamic tests. The reduced frequency varied from 0.013 to 0.133 during the oscillatory tests.
Author

N63-14251 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

FEASIBILITY OF OPTIMIZING NOZZLE PERFORMANCE FOR ORBITAL-LAUNCH NUCLEAR ROCKETS

John R. Jack Washington, NASA, Apr. 1963 26 p 7 refs
(NASA TN D-1578) OTS: $0.75

Nozzle performance for orbital-launch nuclear rockets was evaluated for a range of operating conditions and nozzle geometries. From this study, conclusions were drawn concerning (1) optimum values of nozzle area ratio and operating pressure, (2) operating conditions for favorable nozzle heat transfer, and (3) the effects of deviations from optimum conditions. In general, the nozzle efficiency increases with both increasing divergence angle and increasing stagnation-pressure level. For a given set of conditions, however, the nozzle efficiency increases with increasing area ratio only until the gains in performance due to additional expansion are offset by the increase in convective heat transfer. The variation of specific impulse with pressure is maximized at a pressure level that depends upon the pressure at which the flow freezes. On the basis of heat transfer, operation on the low-pressure side of the optimum point is desirable. This mode of operation sacrifices very little in performance, but permits a substantial reduction in the throat heat flux. Author

N63-14427 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

REAL-GAS EFFECTS ON HYPERSONIC NOZZLE CONTOURS WITH A METHOD OF CALCULATION

Charles B. Johnson, Lillian R. Boney, James C. Ellison, and Wayne D. Erickson Washington, NASA, Apr. 1963 53 p 16 refs
(NASA TN D-1622) OTS: $1.50

A method is presented for computing the wall coordinates of a hypersonic nozzle with real-gas effects. Results of calculations at a Mach number of 17 for stagnation temperatures and pressures up to 5,000° R and 1,000 atmospheres are presented. A procedure for calculating both the inviscid contour and boundary-layer displacement thickness is presented along with a complete computer program written in FORTRAN language. Calculations are presented for a Mach-number-17 nozzle for nitrogen at various stagnation conditions to indicate the difference between the use of real-gas properties and the ideal gas with constant heat-capacity ratio. The effect of stagnation conditions on both the inviscid flow field and the growth of the displacement thickness has been investigated. Whereas the present results were obtained for nitrogen, the method of calculation presented could be applied to other gases with only slight modification.
Author

N63-14588 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN INVESTIGATION OF FLOW VISUALIZATION TECHNIQUES IN HELIUM AT MACH NUMBERS OF 15 AND 20

Charles E. Duller Washington, NASA, Apr. 1963 18 p 8 refs
(NASA TN D-1769) OTS: $0.50

This report presents an investigation which adapted the techniques developed for subsonic and supersonic flow visualization to a helium tunnel operating at Mach numbers of 15 and 20. Three techniques are discussed: (1) the fluorescent-oil film technique for making surface streamlines visible and for locating flow separation on a test body; (2) the white-lead technique for locating the stagnation point and streamlines radiating from the stagnation point on a test-body face at various angles-of-attack; and (3) the ionization technique for making visible the regions of flow separation and attachment on afterbodies. Results indicate that surface streamlines, stagnation points, and separated and attached flow over an afterbody may be made visible on a variety of test-body configurations in hypervelocity helium flow.
Author

N63-14589 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SPEED WIND-TUNNEL INVESTIGATION OF AN ANNULAR-JET CONFIGURATION IN GROUND PROXIMITY

James H. Otis, Jr., and Kenneth W. Goodson Washington, NASA, Apr. 1963 47 p 6 refs
(NASA TN D-1779) OTS: $1.25

An investigation to determine the ground-effect characteristics of a 42-inch-diameter annular-jet model, at forward speeds up to 100 feet per second, has been conducted in the 17-foot test section of the Langley 300-MPH 7- by 10-foot tunnel. Results indicated that at zero angle-of-attack a rapid increase in lift augmentation was obtained with forward speed, and this variation was relatively independent of the height-diameter ratio. Relatively large drag forces, of which the inlet momentum drag was a predominant factor, were measured at the higher velocity ratios. At the low height-diameter ratios and low velocity ratios, however, the total measured drag was less than the calculated inlet momentum drag. At the low velocity ratios, the rate of increase of the pitching-moment parameter, with respect to velocity ratio, decreased as the ground was approached.
Author

N63-14781 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.

METHOD FOR APPROXIMATING THE VACUUM MOTIONS OF SPINNING SYMMETRICAL BODIES WITH NONCONSTANT SPIN RATES

C. William Martz Washington, NASA, 1961 21 p 6 refs
(NASA TR R-115) GPO $0.35

A method for approximating the vacuum motions of spinning rigid symmetrical bodies with varying spin rates and inertias has been completed. The analysis includes the effects of time-varying thrust misalinements, mass unbalance, and jet damping. Results are given in the form of equations for space-referenced Euler angles, flight-path angles, body-referenced attitude rates, and earth-referenced vehicle-trajectory coordinates. The general solutions give insight into the separate effects of the variables and, in many cases, can be quickly used to determine the approximate ranges of the variables required for the desired solution to a given problem. In this respect, equations for determining maximum wobble have been derived for certain input conditions. The method has been shown to compare closely with the numerical solutions of two sample problems. The sample problems also illustrated the relatively large effect of pitch and yaw jet damping on body motions.
Author

N63-14871 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va

COLLECTION OF ZERO-LIFT DRAG DATA ON BODIES OF REVOLUTION FROM FREE-FLIGHT INVESTIGATIONS

William E. Stoney, Jr. Washington, NASA, 1961 190 p 32 refs (NASA TR R-100 supersedes NACA TN-4201) GPO: $1.75

A compilation is made of most of the zero-lift drag results obtained from free-flight measurements made by the Langley Pilotless Aircraft Research Decision on fin-stabilized bodies of revolution. The data are arranged on standard forms, which also contain the significant geometrical factors. Supplementary data have been provided to facilitate the determination of the body pressure drags from the measured total drags. Summary plots and discussions have been included to provide a unified and broad picture of the effects of body geometry on zero-lift drag. Author

N63-14872 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THEORETICAL PREDICTION OF THE EFFECTS OF VORTEX FLOWS ON THE LOADING, FORCES, AND MOMENTS OF SLENDER AIRCRAFT

J. Richard Spahr Washington, NASA, 1961 40 p 19 refs (NASA TR R-101) GPO: $0.45

A general calculative method based on slender-body theory is developed for predicting the paths of vortices in the presence of wing-body combinations at subsonic, transonic, and supersonic speeds, and the influence of the vortices on the loading, forces, and moments acting on the combinations. The method is applied to wing-body combinations to study the effects of vortex strength and initial position, combined angles of pitch and roll and wing aspect ratio on the vortex paths and induced loads. The results indicate that these effects were significant because of the dependence of the vortex paths and induced loads on the vortex strengths and on the proximity of the vortices to the surface of a wing-body combination. Comparisons of theoretical and experimental results indicated that the vortex paths and vortex-induced forces and moments for slender wing-body combinations were closely predicted by the slender body method but for nonslender combinations these characteristics were only approximated. The application of an alternate method based on reverse-flow theory improved the predictions of the vortex-induced forces and moments for the latter combinations but impaired those for slender combinations. The induced forces and moments on the nonslender combinations were sufficiently small that the total forces and moments could be predicted adequately through the use of either method. Author

N63-14972 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LAMINAR BOUNDARY-LAYER SEPARATION INDUCED BY FLARES ON CYLINDERS AT ZERO ANGLE OF ATTACK

Donald M. Kuehn Washington, NASA, 1962 17 p 7 refs (NASA TR R-146) GPO: $0.30

Laminar boundary-layer separation induced by conical flares on cylindrical bodies of revolution has been experimentally investigated in the Mach number range of 2.0 to 5.5 at Reynolds numbers, based on boundary-layer thickness, from 1×10^3 to 30×10^3. Geometric variables were nose shape, cylinder length, and flare angle; test variables were Mach number, Reynolds number, and heat transfer. The purpose of the investigation was to determine which of these variables most influences laminar boundary-layer separation on cylinder-flare configurations and to provide data that will aid in the prediction of laminar separation. The results showed that the tendency toward laminar separation decreased as Mach number or heat transfer to the model was increased and as Reynolds number or flare angle was decreased. Cylinder length and nose shape had no influence on the variation of Mach number for incipient separation with Reynolds number based upon boundary-layer thickness. Conditions for incipient separation on blunt- and sharp-nosed cylinders corrected, whether determined from properties in the free stream or at the model surface. Author

N63-15307 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC AERODYNAMIC CHARACTERISTICS OF A THREE-STAGE ROCKET VEHICLE HAVING VARIOUS FIN CONFIGURATIONS AT LOW SUBSONIC MACH NUMBERS AND ANGLES OF ATTACK UP TO 28°

Clarence A. Brown, Jr. and Lawrence E. Putnam Washington, NASA, Apr. 1963 27 p 7 refs (NASA TN D-1786) OTS: $0.75

The subsonic static aerodynamic characteristics of a 0.081- or 1/12.4-scale model of the Trailblazer II three-stage rocket vehicle were determined in the Langley low-turbulence pressure tunnel for application to the calculation of wind effects on vehicle trajectories. Included is a study of the effect of fin size and aspect ratio on the aerodynamic characteristics of the vehicle. The tests were made at Mach numbers near 0.2, at Reynolds numbers per foot from 7.06×10^6 to 9.01×10^6, and at angles-of-attack up to approximately 28°. Aerodynamic moments were taken about a point 34.555 inches (0.692 of the body length) aft of the model nose. This point corresponds to the center-of-gravity location of the loaded full-scale Trailblazer II configuration. The results showed that reducing the fin size at a fixed aspect ratio caused a decrease in lift and drag coefficients throughout the angle-of-attack range of the present investigation and a decrease in stability below an angle-of-attack of about 14°. Decreasing the fin aspect ratio at constant fin area resulted in a decrease in lift coefficient and stability below an angle-of-attack of about 14°. The results also show that all fin configurations were statically stable below an angle-of-attack of 14°, but that the configuration with fins of low aspect ratio and small area would be the least sensitive to ground winds at launch. Author

N63-15308 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va

AERODYNAMIC CHARACTERISTICS OF TOWED SPHERES, CONICAL RINGS, AND CONES USED AS DECELERATORS AT MACH NUMBERS FROM 1.57 TO 4.65

Nicholai Charczenko Washington, NASA, Apr. 1963 80 p 6 refs (NASA TN D-1789) OTS: $2.00

An investigation was made to determine the drag and stability characteristics of spheres, conical rings, cones, and modified cones when towed in the wake of several space-vehicle configurations. The tests were made over a Mach number range of 1.57 to 4.65, with variation in the following parameters: Reynolds number, trailing distance, ratio of decelerator base diameter to space-vehicle base diameter, cone angle, and size of disk added to the base of a cone. In the flow behind a space vehicle, the drag coefficient for a decelerator is closely related to its stability characteristics in that the drag values are greater where a decelerator is stable. The 80° cone with an attached disk whose diameter is 10 percent larger than the base diameter of the cone has the highest drag coefficient values of any of the stable decelerators tested in this series. Considerable increase in drag-coefficient values can be obtained by increasing the ratio of the decelerator base diameter to the space-vehicle base diameter. Author

N63-15527 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF NOSE BLUNTNESS, FINENESS RATIO, CONE ANGLE, AND MODEL BASE ON THE STATIC AERODYNAMIC CHARACTERISTICS OF BLUNT BODIES AT MACH NUMBERS OF 1.57, 1.80, AND 2.16 AND ANGLES OF ATTACK UP TO 180°

David S. Shaw, Dennis E. Fuller, and C. Donald Babb Washington, NASA, May 1963 78 p 12 refs (NASA TN D-1781) OTS: $2.00

Static aerodynamic data are presented for 34 blunt bodies which had nose bluntness of 0- (spherical), 50-, or 75-percent flat faces, fineness ratios of 1/2, 3/4, or 1, cone half-angles of 10°, 15°, or

20°, and bases which were flat, convex, or concave. Tests were performed in the Langley Unitary Plan wind tunnel at Mach numbers of 1.57, 1.80, and 2.16 and through an angle-of-attack range of 180°. The test Reynolds number per foot was about 1.24×10^6. The results indicate that, from a static stability standpoint, all the models tested are unsuitable for use as a passive entry vehicle if the vehicle is to enter in the nose-forward condition, since the stable trim points near 180° could not be eliminated by their inherent aerodynamic characteristics. Increases in nose bluntness or fineness ratio and decreases in cone half-angles lead to decreases in stability near angles-of-attack of 0°. The model base had no effect on the stability near an angle-of-attack of 0°. Increases in nose bluntness or fineness ratio and decreases in cone half-angles lead to increases in normal force for most of the angle-of-attack range of 180°. The model base had no effect on normal force up to about 90° and only slight effects from 90° to 180° where the convex-base models had the highest values of normal force. Increases in nose bluntness, fineness ratio, or cone half-angles generally lead to decreases in axial force for angles-of-attack near 0°. The effects of model base are apparent only for angles-of-attack from 90° to 180°, and at 180°, the concave-base models had the most negative axial force while the convex-base models had the least negative axial force. Author

N63-16289 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF BUFFET PRESSURES ON MODELS OF LARGE MANNED LAUNCH VEHICLE CONFIGURATIONS

George W. Jones, Jr., and Jerome T. Foughner, Jr. Washington, NASA, May 1963 71 p 8 refs
(NASA TN-D-1633) OTS: $1.75

Two rigid models, differing in size by a factor of 5, were tested at Mach numbers from 0.4 to 1.2, Reynolds numbers from 0.4×10^6 to 9.0×10^6 (based on second-stage diameter), and angles-of-attack from 0° to ±4°. Buffet problem areas on the vehicle were defined. The vehicle may have a venting problem at Mach numbers just below 1.0 and a problem in designing the structure to withstand high noise levels, but no serious structural-response problem. An evaluation of buffet scaling relationships derived from simple dimensional considerations lends confidence to the use of suitably scaled models in determining the buffet pressure characteristics of large launch vehicles. Author

N63-16297 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PERFORMANCE OF A PLUG NOZZLE HAVING A CONCAVE CENTRAL BASE WITH AND WITHOUT TERMINAL FAIRINGS AT TRANSONIC SPEEDS

Charles E. Mercer and Leland B. Salters, Jr. Washington, NASA, May 1963 26 p 5 refs
(NASA TN-D-1804) OTS: $0.75

The performance of a plug nozzle with concave central base, with and without terminal fairings, has been evaluated at transonic speeds. The overall efficiency decreased with increase in Mach number. The terminal fairings decreased the thrust minus drag at subsonic speeds but increased that for sonic and above-sonic speeds. The base flow pattern influenced the concave-base thrust but not the overall thrust minus drag. Author

N63-16425 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TABLES OF AERODYNAMIC COEFFICIENTS OBTAINED FROM DEVELOPED NEWTONIAN EXPRESSIONS FOR COMPLETE AND PARTIAL CONIC AND SPHERIC BODIES AT COMBINED ANGLES OF ATTACK AND SIDESLIP WITH SOME COMPARISONS WITH HYPERSONIC EXPERIMENTAL DATA

William R. Wells and William O. Armstrong Washington, NASA, 1962 277 p
(NASA TR R-127) GPO: $2.25

Closed-form expressions and tables composed from them are presented for complete and partial conic and spheric bodies at combined angle-of-attack and sideslip in Newtonian flow. Aerodynamic coefficients of these bodies are tabulated for various body segments over a range of angles-of-attack from 1° to 85° and angles-of-sideslip from 0° to 15°. Some comparisons between Newtonian predictions and hypersonic, experimental aerodynamic characteristics were made for conic bodies having various surface slopes, nose bluntnesses, and body cross sections to indicate the range of validity of the theory. In general, the theory is shown to agree quite well with experimental results for sharp-nose complete cones and for configurations having large blunted noses and steep surface slopes. However, agreement between theory and experiment generally is poor for the more slender, slightly blunted complete or half conic bodies and also sharp-nose half conic bodies where real-flow phenomena such as forebody interference, viscous forces, leeward surface contributions, or leading-edge pressure reductions may have significant effect. The agreement between theory and experiment for the bodies considered can be improved by using the stagnation-pressure coefficient behind a normal shock rather than 2 as the Newtonian coefficient, although for the sharp-nose half conic bodies there is no theoretical justification for this modification. Author

N63-16427 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SOME EFFECTS OF SIMULATED BENDING AND FOURTH-STAGE SIZE ON LOCAL PRESSURES AND NORMAL-FORCE DISTRIBUTIONS OF A MODEL OF A SCOUT CONFIGURATION AT A MACH NUMBER OF 3.10

Byron M. Jaquet Washington, NASA, May 1963 57 p 7 refs
(NASA TN-D-1799) OTS: $1.50

A wind-tunnel investigation was made at a Mach number of 3.10 to determine the effects of simulated body bending and size of the fourth stage on the normal-force distributions of a 0.02655-scale model of the Scout research vehicle. Pressures were measured, with the straight-center-line model, on a 13° base flare and on the horizontal-tail panels with and without the base flare. Normal-force, axial-force, and pitching-moment coefficients were determined for a straight-center-line model of the Scout with and without the base flare and fourth-stage modifications. Most of the tests were conducted for a Reynolds number per foot of 23.4×10^6. It was found that body bending primarily affected the normal-force distribution at an angle-of-attack of 0° although there was some effect of body bending on the variation of the normal-force distribution with angle-of-attack. (There were many regions along the body in which loadings were not measured.) An increase in cone angle and size of the fourth stage increased the local normal-force coefficient as would be expected. The pressures on the horizontal tail were affected to a large extent by the addition of the base flare. The flare under certain conditions doubled the pressure coefficient and appeared to cause an outward and forward shift in the tail center of pressure. Pressures on the flare were generally highest near the horizontal-tail panels. Total force and pitching-moment coefficients were found to be affected more by the addition of the 13° base flare than by fourth-stage modifications of the straight model. Since the data were obtained on the bent-center-line model with a mode-shape deflection magnified by a factor of 20, the significance of the changes in normal-force distribution due to body bending cannot be assessed without a dynamic analysis of the vehicle along the launch trajectory. Author

N63-17301 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CENTER-LINE PRESSURE DISTRIBUTIONS ON TWO-DIMENSIONAL BODIES WITH LEADING-EDGE ANGLES GREATER THAN THAT FOR SHOCK DETACHMENT AT MACH NUMBER 6 AND ANGLES OF ATTACK UP TO 25°

Theodore J. Goldberg, George C. Ashby, Jr., and James G. Hondros Washington, NASA, June 1963 56 p 5 refs (NASA TN-D-1793) OTS: $1.50

Centerline pressure distributions were obtained for two-dimensional sharp-nose parabolic arc, circular arc, and wedge bodies having a leading-edge angle greater than that for shock detachment (aerodynamically blunt bodies) at Mach number of 6 for angles of attack up to 25°. The maximum pressure coefficient was found to increase continuously from the shock-attachment value to the stagnation value behind a normal shock between leading-edge deflection angles of 42° and 51°. Only the data for contoured bodies having leading-edge angles of 66° or greater are correlated very well by the generalized Newtonian theory. However, at all angles of attack for all aerodynamically blunt bodies having curved surfaces, the agreement between the generalized Newtonian theory and the measured values of pressure coefficient was reasonably good for surface-deflection angles above 30°. This theory can be used to predict pressures on most two-dimensional bodies by the methods shown herein. With few exceptions, at a given deflection angle the pressure distributions rearward of the maximum pressure on the lower and upper surfaces of aerodynamically blunt wedges are essentially coincident with those of wedges having higher and lower half-angles, respectively. In addition, the pressure distributions of these wedges are in good agreement aft of the maximum pressure point with those of a flat plate at corresponding deflection angles to the lower surface above 53° and to the upper surface above 31°. Author

N63-17302 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS IN PITCH AT A MACH NUMBER OF 2.01 OF SEVERAL WING-BODY COMBINATIONS WITH WEDGE-SHAPED BODIES LOCATED ABOVE AND BELOW A 54.5° SWEPT DELTA WING

Odell A. Morris Washington, NASA, June 1963 23 p 4 refs (NASA TN-D-1823) OTS: $0.75

An investigation has been conducted at a Mach number of 2.01 to determine the aerodynamic characteristics in pitch of several model configurations with wedge-shaped bodies located above and below a 54.5° swept delta wing. The investigation included tests on bodies of wedge-shaped planform with variations in body wedge angle, body height, and body length. Measurement of the lift, drag, and pitching-moment coefficients for the various wing-body combinations were made through an angle-of-attack range of about −5° to 10°. The results of the investigation indicated that large changes in lift-drag ratio occurred as a result of the wing-body interference effects produced by the presence of the combined wedge-shaped bodies located above and below the delta wing. However, for all of the wedge-shaped bodies tested, addition of the body to the wing tended to reduce the maximum lift-drag ratio from that of the basic wing body combination. The interference effects of the two bodies in combination with the wing produced a favorable positive pitching-moment increment. For the range of body combinations tested, the magnitude of the lift-drag ratios is dependent to a great extent on the variation in body volume. Author

N63-17545 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRANSONIC INVESTIGATION OF THE STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF LOW-ASPECT-RATIO WING-BODY CONFIGURATIONS AT ANGLES OF ATTACK FROM 0° TO 90°

Charles D. Trescot, Jr., Lawrence E. Putnam, and Cuyler W. Brooks, Jr. Washington, NASA, June 1963 37 p 5 refs (NASA TN D-1947) OTS: $1.00

An investigation has been conducted in the Langley transonic blowdown tunnel to determine the effects of wing planform and other geometric parameters on the static longitudinal aerodynamic characteristics of winged vehicles suitable for reentry. Wing leading-edge radius and wing lower surface contour were also varied for several of the configurations during the investigation. The tests were made at Mach numbers of about 0.8, 1.01, and 1.18 for angles-of-attack that generally varied from about −4° to 91°. The results of the investigation indicate that, at a given test Mach number, planform variation for the basic models had a considerable effect on lift-curve slope at an angle-of-attack of 0° but had essentially no effect on maximum lift coefficient, lift-curve slope at an angle-of-attack of 90°, or maximum drag coefficient. The values of maximum lift-drag ratio for the circle model varied between 2.5 and 3.0 whereas those of the other basic planforms generally varied between 3 and 4. The basic planforms were longitudinally unstable below the angle-of-attack at which maximum lift was obtained and longitudinally stable above this angle-of-attack, the moment reference point being located at the centroid of planform area of each planform. Changing the leading edge of the 65° triangular model from cylindrical to square caused higher maximum drag and, generally, small positive increments in pitching moment through the test angle-of-attack range. Contouring the wing lower surface of the basic ellipse model to form the model designated as ellipse (convex) caused positive increments in pitching moment, decreases in lift coefficient and maximum drag coefficient, and small changes in stability. Contouring the wing lower surface of the 75° model to form a trihedron model caused large negative increments in pitching-moment coefficient, an increase in lift coefficient below and a decrease in lift coefficient above an angle-of-attack of 20°, and an increase in drag coefficient below an angle-of-attack of about 50°. The trihedron model had the lowest maximum lift-drag ratio of the configurations tested. Author

N63-18163 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRAILBLAZER I REENTRY-BODY WING-TUNNEL TESTS AT A MACH NUMBER OF 6.7 WITH THEORETICAL AERODYNAMICS AND A LIMITED DYNAMICS ANALYSIS

Herbert R. Schippell Washington, NASA, July 1963 25 p 6 refs (NASA TN D-1936) OTS: $0.75

The aerodynamic forces and moments of scale models of a Trailblazer I reentry configuration were experimentally determined in the Langley 11-inch hypersonic wind tunnel, at a Mach number of 6.7 in air. The reentry configuration is basically a 5-inch-diameter sphere with an aft-mounted short cylindrical appendage of less diameter than the sphere. The data obtained from the tests compare favorably with predictions made by a modified Newtonian theory, and the tests show that the configuration is statically unstable up to an angle-of-attack of about 30°, and becomes statically stable near an angle-of-attack of 90°. A limited theoretical analysis of the reentry body motions, using the measured data, shows that the aerodynamic moments interact with the body gyroscopic moments, and result in maximum angles-of-attack at maximum dynamic pressures. Author

N63-18467 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC AERODYNAMIC CHARACTERISTICS OF THREE ROCKET-VEHICLE CONFIGURATIONS AT MACH NUMBERS FROM 1.80 TO 4.63 INCLUDING SOME EFFECTS OF FIN SIZE, FIN CANT, AND AUXILIARY ROCKET MOTORS

Dennis E. Fuller and Gerald V. Foster Washington, NASA, July 1963 52 p 4 refs
(NASA TN D-1929) OTS: $1.50

Wind-tunnel tests were made to determine the effects of fin size, fin cant, and auxiliary rocket motors on two three-stage configurations at Mach numbers from 1.80 to 2.86, and the effects of fin size on one two-stage configuration at Mach numbers from 1.80 to 4.63. All tests were performed at a Reynolds number per foot of 2.5×10^6. The results indicate that, although there is a significant decrease in stability for the two three-stage models in the test Mach-number range, the change in stability level for the model having the same diameter for stages 1 and 2 (model 2) is only about one-half that for the model having stage 2 diameter smaller than that of stage 1 (model 1). In addition, the axial force at an angle-of-attack of 0° for model 2 is considerably lower than that for model 1 at all test Mach numbers. In general, the variation of the static directional-stability derivative (C_{n_β}) with Mach number for a given configuration is essentially the same as the variation of the static longitudinal-stability derivative with Mach number. Canting the vertical fins 2° on model 1 provided roll effectiveness and some increase in C_{n_β} throughout the test Mach-number range. Author

N63-18468 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC STABILITY CHARACTERISTICS OF MODELS OF THE BLUE SCOUT AND THE BLUE SCOUT, JR., RESEARCH VEHICLES AT MACH NUMBERS FROM 2.29 TO 3.75

Lloyd S. Jernell Washington, NASA, July 1963 29 p 4 refs
(NASA TN D-1931) OTS: $0.75

An investigation has been conducted at Mach numbers from 2.29 to 3.75 to determine the static longitudinal and lateral stability characteristics of a 0.067-scale model of the Blue Scout research vehicle, and a 0.10-scale model of the Blue Scout, Jr. The results indicated a slight forward shift in center of pressure with increasing Mach number for both complete models. A small amount of flare-fin interference effect was exhibited by the Blue Scout configuration. Also, an interference between the forward and rearward fins was evident on the Blue Scout, Jr., configurations. Both models indicated a relatively small positive effective dihedral near $\alpha = 0°$; however, at $\alpha = 5°$ the effective dihedral becomes highly negative, especially at the lower test Mach number. Author

N63-18500 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC LOADING CHARACTERISTICS OF A 1/10-SCALE MODEL OF THE THREE-STAGE SCOUT VEHICLE AT MACH NUMBERS FROM 1.57 TO 4.65

Lloyd S. Jernell Washington, NASA, July 1963 37 p 3 refs
(NASA TN D-1930) OTS: $1.00

An investigation has been conducted in the Langley Unitary Plan wind tunnel to determine the aerodynamic loading characteristics of a 1/10-scale model of a three-stage Scout vehicle, at Mach numbers from 1.57 to 4.65. For the angles-of-attack investigated, the data indicate that, in general, the major portion of the normal force is provided by the nose cone and the flared sections. However, for an angle-of-attack of 8°, at Mach numbers of 3.96 and 4.65, most of the normal force is provided by the aft cylindrical section. Author

N63-18889 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRANSONIC INVESTIGATION OF THE EFFECTS OF NOSE BLUNTNESS, FINENESS RATIO, CONE ANGLE, AND BASE SHAPE ON THE STATIC AERODYNAMIC CHARACTERISTICS OF SHORT, BLUNT CONES AT ANGLES OF ATTACK TO 180°

Cuyler W. Brooks, Jr., and Charles D. Trescot, Jr. Washington, NASA, Aug. 1963 41 p 6 refs
(NASA TN D-1926) OTS: $1.00

An investigation has been conducted in the Langley transonic blowdown tunnel to determine the effects of variations in Mach number, nose bluntness, fineness ratio, cone semiangle, and base shape on the static longitudinal characteristics of low-fineness-ratio blunted cones. The tests were made at Mach numbers from about 0.8 to 1.2, through an angle-of-attack range that generally varied from 0° to 180°. Reynolds number, based upon the base diameter, varied from 3.67×10^6 to 5.32×10^6. The results of the investigation indicate that all shapes tested have a stable trim point at an angle-of-attack of 180° that is undesirable for a passive entry body designed to enter along a purely ballistic path. Variations in Mach number, nose bluntness, cone semiangle, and base shape had no significant effect on the static stability, but increases in fineness ratio caused decreases in stability at angles-of-attack up to 45°, with the moment reference center located at two-thirds of the body length from the nose. Increases in fineness ratio and decreases in cone semiangle generally caused an increase in normal force over most of the test angle-of-attack range. Variations in nose bluntness and base shape had little or no effect on normal-force coefficient. At angles-of-attack up to about 160°, increases in fineness ratio generally caused a reduction in the absolute values of axial force. In general, variations in cone semiangle had little effect on axial force, except at angles-of-attack near 0° at Mach numbers of 0.8 and 1.2 and near 90° at M = 0.8. Variations in nose bluntness and base shape below 80° angle-of-attack had little or no effect on axial force, but at angles-of-attack from 80° to 180°, varying the base shape from convex to concave caused, in general, a large increase in the absolute values of axial force. Author

N63-21057 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC DAMPING OF A 0.02-SCALE SATURN SA-1 MODEL VIBRATING IN THE FIRST FREE-FREE BENDING MODE

Perry W. Hanson and Robert V. Doggett, Jr. Washington, NASA, Sept. 1963 36 p 7 refs
(NASA TN D-1956) OTS: $1.00

The aerodynamic damping of the sting-mounted scaled aeroelastic model was determined at Mach numbers from 0.70 to 2.87 by using an electrical power-input method. Two other configurations were investigated: one was the basic scaled model with rigid stabilizing fins added, and the other was the basic scaled model with fins, but with a winged spacecraft replacing the nose cone of the basic model. The experimental results are compared with those of some applicable theoretical methods. Author

N63-22115 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF CROSS-SECTION SHAPE ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A LOW-WAVE-DRAG HYPERSONIC BODY

Bernard Spencer, Jr., and W. Pelham Phillips Washington, NASA, Oct. 1963 40 p 8 refs
(NASA TN D-1963) OTS: $1.00

The effects on the longitudinal and lateral aerodynamic characteristics of changing body cross-sectional shape from circular to elliptic on a body having a fineness ratio of 10.00 are presented for low subsonic speeds. Also included are the effects of positive and negative camber for the circular body and for some of the elliptic bodies. Author

N63-22600 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DYNAMIC RESPONSE OF HAMMERHEAD LAUNCH VEHICLES TO TRANSONIC BUFFETING
Henry A. Cole, Jr. Washington, NASA, Oct. 1963 6 refs Contains portions of paper presented to the 7th Symp. of Ballistic Missile and Space Technol., Air Force Acad., Colo., 13–16 Aug. 1962
(NASA TN D-1982) OTS: $0.50

The static and dynamic buffeting characteristics of a particular launch vehicle with a payload diameter greater than the booster diameter are studied in detail through use of measurements on rigid, forced-oscillation, and free-oscillation models. The results are presented in the form of spectral densities and probability distributions. Dynamic transfer functions are used to show the amplification of buffeting loads due to unstable aerodynamic damping. Author

N63-22711 National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md
FLIGHT SHOCK AND VIBRATION DATA OF THE ECHO A-12 APPLICATION VERTICAL TESTS (AVT-1 AND AVT-2)
W. B. Tereniak and S. A. Clevenson (NASA Langley Research Center) Washington, NASA, Oct. 1963 26 p 4 refs
(NASA TN D-1908) OTS: $0.75

This paper presents shock and vibration data measured at the base of the spacecraft adapter during the flights of Echo A-12 Application Vertical Tests numbers 1 and 2 (AVT-1 and AVT-2). A modified Thor missile was employed as the launch vehicle for each flight. Also included are data obtained from a vibration survey performed on the AVT-2 spacecraft equipment compartment prior to flight. The two sets of flight data, the vibration flight acceptance test specification, and the results of the vibration survey are compared. It was found that levels and frequencies measured during the two flights were comparable and that the frequencies measured during flight were similar to those measured during the vibration survey. Author

N63-22945 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS AND SURFACE PRESSURE DISTRIBUTIONS FOR A 1/15-SCALE MODEL OF A MODIFIED FOUR-STAGE SCOUT VEHICLE
Thomas C. Kelly Oct. 1963 28 p 8 refs
(NASA TN D-2026) OTS: $0.75

Tests were conducted in the Langley 8-foot transonic pressure tunnel at Mach numbers from 0.60 to 1.20 and Reynolds numbers per foot of approximately 3.7×10^6. A comparison of the present results with those for the earlier Scout configuration is included. Author

N63-22946 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WATER-FILM COOLING OF AN 80° TOTAL-ANGLE CONE AT A MACH NUMBER OF 2 FOR AIRSTREAM TOTAL TEMPERATURES UP TO 3,000°R
Howard S. Carter Oct. 1963 34 p 8 refs
(NASA TN D-2029) OTS: $1.00

Film-cooling tests, with water as the coolant, were made on an 80° total-angle cone in a Mach 2 free jet at sea-level pressure. The tests were made at free-stream total temperatures from 1,500° to 3,000° R and at free-stream Reynolds numbers per foot from 8×10^6 to 3×10^6. With low coolant rates, the downstream end of the model became very hot. Increasing the angle-of-attack from 0° to 5° caused the water film on the model surface to become very asymmetrical. Author

N63-22948 National Aeronautics and Space Administration, Washington, D.C.
CONTRIBUTION TO THE THEORY OF JET ATOMIZATION [BEITRAG ZUR THEORIE DER STRAHLZERSTAUBUNG]
Gyorgy Sitkei Oct. 1963 34 p 9 refs Transl. into ENGLISH from Acta Technica (Hungary), v. 25, no. 1–2, 1959 p 87–117
(NASA TT F-129) OTS: $1.00

The external and internal forces acting upon a liquid jet are discussed. It is shown that the disintegration of the jet into drops is produced principally by the intense, large scale, turbulent pulsation acting as an internal force, and by the additional dynamic force acting externally on the motion of the particles in the frontal surface of the jet. On the basis of this analysis, quantitative relations are derived for the mean size of the drop diameter. A discussion is given of the conditions of the spray motion and a characteristic function is found that correctly describes the motion of the spray as a function of various parameters. A method is given for obtaining the approximate fuel distribution. Author

N63-23363 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL AND CALCULATED RESULTS OF A FLUTTER INVESTIGATION OF SOME VERY LOW ASPECT-RATIO FLAT-PLATE SURFACES AT MACH NUMBERS FROM 0.62 TO 3.00
Perry W. Hanson and Gilbert M. Levey Washington, NASA, Oct. 1963 25 p refs
(NASA TN D-2038; supersedes NASA TM X-53) OTS: $0.75

Two types of planforms, a delta and a delta with one-third span cut off, are used in this investigation. Three different panel aspect ratios, 0.728, 0.536, and 0.353, were tested for each type of planform. Each model had a 12-inch root chord, and was cantilevered from the tunnel wall. Generally, the clipped-tip-delta planforms were more susceptible to flutter throughout the Mach number range investigated. The lower aspect-ratio models fluttered at a higher value of the stiffness-altitude parameter than the higher aspect-ratio models for a given type of planform and a given Mach number. Author

N63-23681 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
DEVELOPMENT OF A SMOKE-TRAIL VEHICLE FOR APPLICATION TO WING-SHEAR MEASUREMENTS UP TO 80,000 FEET
Wade E. Lanford, Tom W. Perry, Jr., Hal T. Baber, Jr., and Franklin W. Booth Nov. 1963 26 p refs
(NASA TN D-2009) OTS: $0.75

A reliable, inexpensive, and relatively simple smoke-generating vehicle has been developed for extensive use at several missile ranges in a detailed wind-shear-measurement program. Details of the vehicle, which is capable of producing a luminiferous trail between the altitudes of 6,000 and 80,000 feet, are presented along with those of several other vehicles considered. Author

N63-23682 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN AEROELASTIC MODEL APPROACH FOR THE PREDICTION OF BUFFET BENDING LOADS ON LAUNCH VEHICLES
Robert V. Doggett, Jr., and Perry W. Hanson Washington, NASA, Oct. 1963 31 p refs
(NASA TN D-2022) OTS: $0.75

The relationships necessary for predicting full-scale buffet bending moments from wind-tunnel test data on dynamically scaled aeroelastic models are developed by using simple beam theory and generalized harmonic analysis. Wind-tunnel tests were made on two model configurations, each with a cylindrical afterbody. One had a blunted conical nose whereas the other had a bulbous nose. Some of the data obtained for the bulbous-nose configuration were scaled to full-scale values by using the derived scaling relationships. Author

N63-23684 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EFFECT OF CONTACT ANGLE AND TANK GEOMETRY ON THE CONFIGURATION OF THE LIQUID-VAPOR INTERFACE DURING WEIGHTLESSNESS
Donald A. Petrash, Ralph C. Nussle, and Edward W. Otto Washington, NASA, Oct. 1963 24 p refs
(NASA TN D-2075) OTS: $0.75

The results of this investigation with liquids that have contact angles of 0°, 40°, and 125° verified the contention that the contact angle remains unchanged from its 1-g value when the liquid is in a zero-g environment. In all tanks investigated (spheres, cylinders, and cones), the liquid–vapor interface tended toward a configuration of constant surface curvature meeting the tank walls at the contact angle. Author

N63-23686 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.
REYNOLDS NUMBER EFFECTS ON THE INDUCED PRESSURES OF CYLINDRICAL BODIES WITH DIFFERENT NOSE SHAPES AND NOSE DRAG COEFFICIENTS IN HELIUM AT A MACH NUMBER OF 24
Richard D. Wagner, Jr., and Ralph Watson Washington, NASA, Nov. 1963 43 p refs
(NASA TR R-182) OTS: $1.00

Exact, inviscid pressure distributions and shock shapes, obtained by the method of characteristics, are compared with experimental data. The results indicate a strong dependence of induced pressures upon Reynolds number, especially in the region immediately downstream of the nose-cylinder junction. The measured shock shapes revealed no discernible effect of Reynolds number variations. Author

N63-23788 **National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.**
SUPERSONIC INVESTIGATION OF NOZZLE HINGE MOMENTS OF A MODIFIED SATURN C-1 MODEL WITH AND WITHOUT JET FLOW
Nickolai Charczenko and Jerry L. Lowrey Washington, NASA, Nov. 1963 45 p refs
(NASA TN D-1962) OTS: $1.25

An investigation has been conducted in the Langley Unitary Plan wind tunnel to determine the nozzle hinge-moment coefficients for the Saturn C-1 vehicle with various shrouds at Mach numbers from 1.60 to 2.87. Nozzle hinge-moment coefficients were obtained from pressure measurements on one nozzle, with and without simulated jet flow. In addition, pressure measurements were obtained on one shroud and at the base of the model. A limited analysis of the results of this investigation indicates that the long shrouds result in small nozzle hinge-moment coefficients which are relatively independent of gimbal angle, Mach number, and jet flow. When the shrouds are shortened enough to allow significant impingement of the airstream on the nozzles, nozzle gimbal angle, Mach number, and jet flow become important factors in determining the magnitude of nozzle hinge-moment coefficients. Author

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

N63-10199 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT LOW SUBSONIC SPEEDS OF A HIGHLY SWEPT DELTA WING UTILIZING NOSE DEFLECTION FOR CONTROL
Bernard Spencer, Jr. Washington, NASA, Nov. 1962 28 p 8 refs
(NASA TN D-1482) OTS: $0.75

An investigation has been conducted on a delta wing-of-aspect ratio 1.33 to determine the longitudinal control characteristics associated with deflecting the apex section of the wing. In order to illustrate the effectiveness of this forward control, the longitudinal control characteristics are also presented for the wing with split flaps located at the trailing edge. Author

N63-10537 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HOVERING CHARACTERISTICS OF A ROTOR HAVING AN AIRFOIL SECTION DESIGNED FOR A UTILITY TYPE OF HELICOPTER
James P. Shivers and William J. Monahan Washington, NASA, Dec. 1962 22 p 11 refs
(NASA TN D-1517) OTS: $0.75

Static-thrust performance data are presented for a full-scale rotor having an NACA 63_1A012 airfoil thickness distribution in combination with an NACA 130 mean line for blade tip Mach numbers from 0.28 to 0.75. These results are compared with a previously investigated rotor having an NACA 63_2A015 airfoil thickness distribution in combination with an NACA 230 mean line. Author

N63-10800 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LOCAL PRESSURE DISTRIBUTION ON A BLUNT DELTA WING FOR ANGLES OF ATTACK UP TO 35° AT MACH NUMBERS OF 3.4 AND 4.7
Marvin Kussoy Washington, NASA, Dec. 1962 22 p 7 refs
(NASA-TN-D-1554) OTS: $0.75

The pressures on the windward surface of a delta wing, consisting of an elliptic paraboloid nose section and an elliptic cone afterbody, were investigated in air at Mach numbers of 3.4 and 4.7 and angles of attack up to 35°. The pressures obtained were compared with the predictions of two simple methods. In general, these methods bracketed the data, with the modified Newtonian flow and equivalent cone methods predicting pressures that were, respectively, lower and higher than those observed. Author

N63-10950 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TIME-DEPENDENT AIR FORCES ON WINGS WITH SUPERSONIC LEADING AND TRAILING EDGES AND SUBSONIC SIDE EDGES WITH APPLICATION TO A WING DEFORMING HARMONICALLY ACCORDING TO A GENERAL POLYNOMIAL EQUATION

Joseph A. Drischler Washington, NASA, Dec. 1962 63 p 21 refs (NASA-TN-D-1475) OTS: $1.75

The integral form of the velocity potential and pressure distribution for a wing, with supersonic leading edges and subsonic side edges, in supersonic flow is derived herein for a wing undergoing any arbitrary time-dependent deformations. The expressions are simplified by assuming harmonic deformations and then expanding the integrand of the velocity potential to the third power of frequency. The special case was treated for which the side edge was parallel to free stream, and the oscillations were such that the wing distortion could be represented by a polynomial of any desired degree in the span coordinate and third degree in the chordwise coordinate. Author

N63-12480 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SOME EFFECTS OF SWEEP AND ASPECT RATIO ON THE TRANSONIC FLUTTER CHARACTERISTICS OF A SERIES OF THIN CANTILEVER WINGS HAVING A TAPER RATIO OF 0.6

John R. Unangst and George W. Jones, Jr. Washington, NASA, Feb. 1963 58 p 3 refs
(NASA TN D-1594; supersedes NACA RM-L55I13a and NACA-RM-L53G10a) OTS: $1.50 (Declassified)

An investigation has been conducted in the Langley transonic blowdown tunnel of the effects of wing planform on the flutter speed at zero angle of attack and Mach numbers from 0.76 to 1.42. Wing planforms having taper ratios of 0.6, aspect ratios of 4, and sweep angles of 0°, 30°, 45°, 52.5°, and 60° were investigated, as were wings having taper ratios of 0.6, sweep angles of 45°, and aspect ratios of 2.4, 4, and 6.4. Experimental and analytical results are presented. Author

N63-12927 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN APPLICATION OF A NUMERICAL TECHNIQUE TO LIFTING-SURFACE THEORY FOR CALCULATION OF UNSTEADY AERODYNAMIC FORCES DUE TO CONTINUOUS SINUSOIDAL GUSTS ON SEVERAL WING PLANFORMS AT SUBSONIC SPEEDS

Harold N. Murrow, Kermit G. Pratt, and Joseph A. Drischler Washington, NASA, Feb. 1963 56 p 10 refs
(NASA TN D-1601) OTS: $1.50

The technique provides for the calculation of gust forces and forces due to motion and deformation on a consistent basis. Results presented include the following complex quantities: (a) spanwise distribution of section lift coefficient, (b) total lift coefficient, and (c) total pitching-moment coefficient. Calculations were made for two subsonic Mach numbers and a reduced-frequency range of 0 to 1.0. Author

N63-13100 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE MODEL WITH TWO HIGH DISK-LOADING FANS MOUNTED IN THE WING

David H. Hickey and Leo P. Hall Washington, NASA, Feb. 1963 79 p 6 refs
(NASA TN D-1650) OTS: $2.00

The aerodynamic characteristics and performance of direct lifting fans mounted in both wing panels of a large-scale VTOL airplane were investigated during low-speed flight. The model had a shoulder-mounted wing-of-aspect ratio 3.5. The effects on longitudinal characteristics of fan operation, of thrust control by means of deflecting the fan efflux, and of trailing-edge flap deflection were studied. Control power available from throttling the fans with differential exit louver deflection was also determined. The lifting-fan performance, three-component longitudinal characteristics, wing-surface static-pressure distributions, and downwash at the horizontal tail are included. Author

N63-13181 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE BENDING-MOMENT DISTRIBUTION OF CAMBERED-SPAN WING SYSTEMS HAVING MINIMUM INDUCED DRAG

Clarence D. Cone, Jr. Washington, NASA, Mar. 1963 32 p 2 refs
(NASA TN D-1505) OTS: $1.00

The basic integral equations for determining the bending-moment distributions of optimally-loaded cambered-span wing systems are derived and applied to the calculation of the moment distributions for the families of circular-arc and semiellipse camber forms. The effects of the type and amount of camber on the moment distribution are investigated, and it is shown that spanwise camber results in an appreciable increase in the local bending moment near the tips, as compared with that of flat wings furnishing equal lift. The quantitative relation between the magnitude of the bending moment and the induced-drag efficiency of cambered-span wings is developed. A simple analysis is carried out to establish the wing structural requirements dictated by the bending-moment distribution, and a procedure is outlined for determining the optimum chord distribution of the wing for obtaining minimum profile drag. Author

N63-13185 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION OF BLAST LOADING ON AN AIRFOIL IN MACH NUMBER 0.7 AIRFLOW WITH INITIAL ANGLE-OF-ATTACK CHANGE OF 20°

Harold B. Pierce and James C. Manning Washington, NASA, Feb. 1963 38 p 11 refs
(NASA TN D-1603) OTS: $1.00

An experimental investigation has been completed on the blast loading imposed on an airfoil in Mach number 0.7 flow by a blast wave which caused an initial angle-of-attack change of approximately 20°. Pressure distributions along one chord of the airfoil at intervals of 0.1 millisecond show the initial diffraction of the blast wave around the airfoil while subsequent distributions at intervals of 0.5 millisecond show the progress along the chord of a leading-edge vortex formed in the diffraction period. Normal-force coefficients obtained from the blast-test pressure distributions were substantially greater than those from wind-tunnel tests for a period of 10 milliseconds after blast-wave arrival. The investigation, the first conducted at the NASA Ground Blast Apparatus, consisted of two tests made under essentially the same conditions. Author

N63-13516 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

OFF-DESIGN AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS 1.61 AND 2.20 OF A SERIES OF HIGHLY SWEPT ARROW WINGS DESIGNED FOR MACH NUMBER 2.0 EMPLOYING VARIOUS DEGREES OF TWIST AND CAMBER

Wilbur D. Middleton and Russell B. Sorrells Washington, NASA, Mar. 1963 20 p 3 refs
(NASA TN D-1630) OTS: $0.50

A series of five highly swept arrow wings were tested to investigate their respective off-design performance. Aerodynamic characteristics of the family of wings, designed for Mach number 2.0, employing design lift coefficients of 0, 0.08, and 0.16, were measured at Mach numbers of 1.61 and 2.20 and a Reynolds number, based on the mean aerodynamic chord, of 4.4×10^6. A 70° swept arrow wing-of-aspect ratio 2.24 with moderate twist and camber (design lift coefficient of 0.08), which had produced the highest lift-drag ratio during design Mach number 2.0 tests, likewise produced the highest lift-drag ratios during the off-design tests. This wing gave maximum lift-drag ratios of 9.2, 8.8, and 8.4 at Mach numbers of 1.61, 2.05, and 2.20, respectively, compared with maximum lift-drag ratios of 8.1, 8.1, and 7.8 for the corresponding flat wing over the same Mach number range. Two twisted and cambered wings (of 70° and 75° leading-edge sweep) designed for a lift coefficient of 0.16 exhibited relatively minor superiority in lift-drag ratios over the flat wings throughout the Mach number range, and became approximately equal in maximum lift-drag ratio to the flat wings at a Mach number of 2.20.
Author

N63-13756 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYSIS OF THE DELTA-WING HYPERSONIC STABILITY AND CONTROL BEHAVIOR AT ANGLES OF ATTACK BETWEEN 30° AND 90°

David E. Fetterman and Luther Neal, Jr. Washington, NASA, Mar. 1963 59 p 25 refs
(NASA TN D-1602) OTS: $1.50

An experimental investigation has been conducted to determine the force, stability, and control characteristics of a 70°-sweep delta wing at a Mach number of 6.83. Nose incidence (provided by a forward panel 16 percent of the wing area) and a trailing-edge flap (36-percent wing area) were used as the trim devices. The results were obtained by integrating extensive pressure measurements over the windward surface of the wing and thereby making possible a determination of not only the total forces and moments produced but also contributions of the local nose, middle, and flap components, which facilitated a dependable analysis of the various behavior encountered. The scope of measurements included angles-of-attack between 30° and 90°, nose incidence values of 0°, 10°, and 20°, and flap deflections from 10° to -90°, at a Reynolds number of 0.60×10^6. The delta wing with undeflected nose panel was found to be stable and controllable with trailing-edge flaps at all angles-of-attack except in the region of $C_{L,max}$ where instability at trim resulted from overexpansion phenomenon over the trailing-edge flap. Nose incidence, fortunately, tends to overcome this instability at trim without significant effect on $C_{L,max}$. Extrapolations of the results to smaller flap areas indicated that the effects of varying flap area on trim stability, or instability, are small, except at extreme angles-of-attack, but with nose incidence of about 10°, trim stability and control can be achieved through an angle-of-attack of 90° with flap areas of about 15-percent wing area. A simple, semiempirical theory suitable for preliminary design purposes effectively predicts the force characteristics in an out of trim and, by extending the method to account for flap overexpansion effects, the unstable trim regions near $C_{L,max}$ and the curative effects of nose incidence can also be predicted.
Author

N63-14252 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTIONS ON THREE RIGID WINGS SIMULATING PARAWINGS WITH VARIED CANOPY CURVATURE AND LEADING-EDGE SWEEP AT MACH NUMBERS FROM 2.29 TO 4.65

Paul G. Fournier Washington, NASA, Apr. 1963 112 p 10 refs
(NASA TN D-1618) OTS: $2.50

An investigation has been made at Mach numbers from 2.29 to 4.65 in the Langley Unitary Plan wind tunnel to determine the chordwise pressure distribution at supersonic speeds of three parawing models through an angle-of-attack range from 0° to 70°. Three rigid metal models simulated a parawing which had a basic flat planform with leading edges swept back 45°. These configurations were developed to have one-half-circle, one-third-circle, and one-quarter-circle curvature of the semispan trailing edges when viewed from downstream and resulting leading-edge sweeps of 61.5°, 52.5°, and 48.6°. The results of the investigation are presented as curves of chordwise pressure distributions at four spanwise locations for each model.
Author

N63-15235 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS OF A FLEXIBLE-CANOPY PARAGLIDER MODEL AT A MACH NUMBER OF 4.5 FOR ANGLES OF ATTACK TO 360° AND SIDESLIP ANGLES FROM 0° TO 90°

Dewey E. Wornom and Robert T. Taylor Apr. 1963 26 p 7 refs
(NASA TN D-1776) OTS: $0.75

Force tests of a flexible-canopy paraglider model with a rigid frame have been conducted at a Mach number of 4.5 in the 2-foot hypersonic facility at the Langley Research Center. The aerodynamic characteristics were measured over an angle-of-attack range from 0° to 360°, for sideslip angles from 0° to 90°, at a Reynolds number of approximately 0.3×10^6 based on a model keel length of 5.75 inches. The variations of the aerodynamic coefficients with angle-of-attack at constant sideslip angles are presented with limited discussion. For the moment reference center selected, the data at zero sideslip showed that longitudinal trim occurred at an angle-of-attack of 45.5°, with a corresponding lift coefficient of 0.45 and a lift-drag ratio of 0.94. A maximum lift coefficient of 0.79 was obtained at an angle-of-attack of 68°. From visual observations of canopy action during the tests, abrupt load reversal was noted to occur around an angle-of-attack of 180°.
Author

N63-15389 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASUREMENTS OF FLOW ANGLES IN VICINITY OF TWO LIFTING FOREBODY CONFIGURATIONS AT A MACH NUMBER OF 2.01

Odell A. Morris and Francis E. Mc Lean Washington, NASA, May 1963 39 p 5 refs
(NASA TN D-1640) OTS: $1.00

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel, at a Mach number of 2.01, to determine the flow properties in the vicinity of two lifting-forebody configurations. Measurements of the downwash and sidewash angles generated by the models were made at angles-of-attack of about 1°, 3°, and 5° for a range of chordwise, spanwise, and vertical-probe positions. Surface pressures were also measured on the models at two chordwise stations for the same angle-of-attack range. Results of the tests showed that large and rapid changes in the measured downwash and sidewash angles occurred for both models with variation in the survey-probe position in the region of the model trailing edge. Comparison of the experimental surface pressures with the theoretical values showed only fair agreement for both model configurations; however, the agreement for model B with the most severe twist and camber shape was good, inasmuch as the designed uniform-pressure distribution across the span was obtained.
Author

N63-15771 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMIC CHARACTERISTICS OF A FULL-SCALE PROPELLER TESTED WITH BOTH RIGID AND FLAPPING BLADES AND WITH CYCLE PITCH CONTROL

Kenneth W. Mort and Paul F. Yaggy Washington, NASA, May 1963 34 p 3 refs
(NASA TN-D-1774) OTS: $1.00

Basic aerodynamic characteristics of the two propeller configurations are presented for free-stream velocities ranging from 0 to 140 knots and for angles-of-attack ranging from 0° to 70°. The differences in the characteristics of the two configurations were small. The effect of the cyclic pitch control on the aerodynamic characteristics and on the blade flapwise bending and trailing-edge tensile stress was examined at free-stream velocities ranging from 0 to 60 knots. The cyclic pitch control was about a single control axis, intended only to produce longitudinal trim and control. At hover conditions, the cyclic-control effectiveness of the rigid configuration was about twice that of the flapping configuration. By extrapolating the test results to conditions of maximum allowable blade stress, it was estimated that the maximum longitudinal-control capability, as limited by the allowable blade stresses, was greater for the rigid configuration than for the flapping configuration. Author

N63-15922 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif

LARGE-SCALE WIND-TUNNEL TESTS IN GROUND EFFECT OF A 35° SWEPTBACK WING JET TRANSPORT MODEL EQUIPPED WITH BLOWING BOUNDARY-LAYER-CONTROL TRAILING- AND LEADING-EDGE FLAPS

Kiyoshi Aoyagi and David H. Hickey. Washington, NASA, May 1963. 54 p. 3 refs

(NASA TN-D-1884) OTS: $1.50

Two chordwise and spanwise extents of trailing-edge flaps, with and without blowing boundary-layer control, were tested with the normal wing leading edge. A limited amount of data was obtained with the blowing boundary-layer-control leading-edge flap. Three-component longitudinal data and boundary layer control flow requirements are presented for several heights above ground. Also presented are data showing the effects of ground proximity on the trimmed lift coefficient of the model and on the calculated thrust-to-weight ratio required to maintain low-speed level flight with several trailing-edge flap configurations. Author

N63-16160 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va

QUALITATIVE EVALUATION OF EFFECT OF HELICOPTER ROTOR-BLADE TIP VORTEX ON BLADE AIRLOADS

James Scheiman and LeRoy H. Ludi. Washington, NASA, May 1963. 47 p. 8 refs

(NASA TN-D-1637) OTS: $1.25

A flight-test program was conducted to determine helicopter rotor-blade airloads by means of 49 pressure transducers in the blade. Two flight conditions are examined in detail. Important differences between the measured results and the results from uniform inflow theory are shown to be attributable to the blade trailing (tip) vortices. The vibratory blade loading is shown to be significantly influenced by the trailing vortex of the preceding blades. This influence produces harmonic blade loadings of all orders, and the percentage of the contribution to the higher harmonics is large. Author

N63-16185 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF AERODYNAMIC HEATING ON THE FLUTTER OF THIN FLAT-PLATE ARROW WINGS

Joseph M. Groen and Richard Rosecrans. Washington, NASA, May 1963. 24 p. 8 refs

(NASA TN-D-1788) OTS: $0.75

From the results of tests made in a heated wind tunnel at Mach 3, an experimental flutter boundary was obtained which showed the effect of aerodynamic heating. Induced thermal stress resulted in a loss of wing stiffness which lowered the flutter-velocity index by as much as one-third. The flutter boundary obtained also indicated the transient nature of the phenomenon. Test results are compared with calculated values of temperature and with natural frequencies of vibration and associated nodal patterns. Measured flutter points are compared with a calculated flutter boundary for an unheated wing. Author

N63-16288 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE THEORY OF INDUCED LIFT AND MINIMUM INDUCED DRAG OF NONPLANAR LIFTING SYSTEMS

Clarence D. Cone, Jr. Washington, NASA, 1962. 34 p. 7 refs

(NASA TR-R-139) GPO: $0.40

The basic theory of the induced lift and drag of nonplanar, circulation lifting systems is developed, and methods are evolved for determining the span force loading intensity necessary for minimum induced drag. It is shown that the aerodynamic efficiency of such optimally loaded systems can be expressed in terms of an effective aspect ratio which depends in value upon the spatial distribution of the vorticity of the system. Methods for determining the maximum effective aspect ratio of arbitrary lifting systems of given span by use of conformal transformation and electrical potential-flow analog techniques are developed and illustrated. The value of the induced-drag efficiency factor is determined for the families of circular, semiellipse, and complete-ellipse arcs and for several more complex forms. The results of the theory are interpreted in terms of the physical airfoil requirements necessary for successful realization of the theoretical induced-drag reductions. The practical application aspects of nonplanar wing systems are briefly considered. Author

N63-16428 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC EFFECTS OF MODIFYING WING INBOARD TRAILING-EDGE CAMBER OF A MODEL AT HIGH SUBSONIC SPEEDS

Richard J. Re. Washington, NASA, May 1963. 44 p. 5 refs

(NASA TN-D-1809) OTS: $1.25

An investigation has been made to determine the effect of a modification in the effective camber of the inboard wing sections near the trailing edge on the longitudinal aerodynamic characteristics of a model. The wing had discontinuous sweep at the leading edge, with quarter-chord sweep of 40° on the outboard portion. The wing was modified near the trailing edge so that the camber lines near the body were reflexed and merged [illegible] the original camber lines at the midsemispan. The wing was tested with contoured, cylindrical, and modified cylindrical body configurations. The contoured body configuration was tested with and without horizontal and vertical tails. The Mach number of the test ranged from 0.40 to 0.96 and the angle-of-attack ranged from −5° to 15°. Reynolds number per foot varied from 2.6×10^6 to 4.4×10^6. The modified wing trailing edge generally reduced the drag coefficient at low lift coefficients, but increased the drag coefficient in the range of lift coefficients for maximum lift-drag ratio, and resulted in lower values of maximum lift-drag ratio. The modification alleviated model pitch-up which occurred at a lift coefficient of about 0.45 at Mach numbers of 0.92, 0.94, and 0.96. In addition, the modified trailing edge increased the model angle-of-zero lift about 1° at all Mach numbers, and decreased the model pitching moment at zero angle-of-attack at all Mach numbers below 0.96. Author

N63-18135 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTIONS ON BLUNT DELTA WINGS AT ANGLES OF ATTACK TO 90° AND MACH NUMBER OF 6.85

Peter T. Bernot. Washington, NASA, July 1963. 40 p. 17 refs

(NASA TN D-1954) OTS: $1.00

Pressure distributions were obtained on four blunt delta-wing models having sweep angles of 50°, 70°, 75°, and 80° over an angle-of-attack range from 30° to 90°, and at a Mach

number of 6.85. In general, the pressures on the windward slab surfaces are constant for angles-of-attack up to about 50°. As angle-of-attack is increased further, pressure gradients occur on both the windward slab and leading-edge surfaces. Pressures on the windward leading edges decreased as distance from the wing apex increased, with significant pressure gradients occurring in the angle-of-attack range from 50° to 90°. Modified Newtonian theory yielded only fair agreement with the measured pressures. Effect of wing sweep angle is to raise the pressure level with decreasing sweep, but this trend diminishes at angles-of-attack greater than 60°. The effect of angle-of-attack is best characterized by the fact that 90 percent of the maximum pressure rise is attained at an angle-of-attack of 70°. The measured pressures on the model center line are bracketed by the five-term hypersonic approximation and modified Newtonian theory. Author

N63-18136 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF ROUNDING CORNERS AND LEADING EDGES ON THE WINDWARD-SURFACE PRESSURES OF A DELTA WING SWEPT 65° AT A MACH NUMBER OF 5.96 AT ANGLES OF ATTACK FROM 65° TO 115° AND ANGLES OF ROLL FROM 0° TO 25° AT 90° ANGLE OF ATTACK

Theodore J. Goldberg and Doris K. Blanchard Washington, NASA, July 1963 34 p 13 refs

(NASA TN D-1959) OTS: $1.00

Detailed pressures on the windward surface of two flat-plate delta wings swept 65° and with rounded corners (one having square leading edges and the other having rounded leading edges) were obtained at a Mach number of 5.96, through an angle-of-attack range from 65° to 115°, and at angles-of-roll from 0° to 25° at an angle-of-attack of 90°. These results were compared with those previously reported for a similar wing having sharp corners and square edges. At all attitudes tested, any effect on the pressure distributions caused by rounding the corners only, or by rounding the corners and leading edges, was confined to about the last 10 percent of the radial rays emanating from the centroid of the model. The normal-force coefficient was essentially unaffected by rounding the corners only, but was decreased by approximately 4 percent by rounding the corners and leading edges. Author

N63-18234 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

USE OF AERODYNAMIC PARAMETERS FROM NONLINEAR THEORY IN MODIFIED-STRIP-ANALYSIS FLUTTER CALCULATIONS FOR FINITE-SPAN WINGS AT SUPERSONIC SPEEDS

E. Carson Yates, Jr., and Robert M. Bennett Washington, NASA, July 1963 39 p 20 refs

(NASA TN D-1824) OTS: $1.00

The flutter characteristics for two untapered wings, one having 15° sweep and aspect ratio 5.34, the other having 30° sweep and aspect ratio 4.16, have been investigated analytically for Mach numbers up to 3.0. The calculations were based on the modified-strip-analysis method of NACA Research Memorandum L57L10, with the required aerodynamic parameters computed from linear theory, from shock-expansion theory, and from Busemann second-order theory. The results were compared with flutter experiments over the Mach-number range. Supersonic flutter speeds were satisfactorily predicted by the modified strip analysis, employing aerodynamic parameters computed from the nonlinear theories, but were high when supersonic linear theory was used. Flutter speeds calculated for subsonic Mach numbers by use of linear-theory aerodynamic parameters were in good agreement with experimental values. Author

N63-18499 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF A SEMISPAN TILTING-PROPELLER CONFIGURATION AND EFFECTS OF RATIO OF WING CHORD TO PROPELLER DIAMETER ON SEVERAL SMALL-CHORD TILTING-WING CONFIGURATIONS AT TRANSITION SPEEDS

Kenneth P. Spreemann Washington, NASA, July 1963 32 p 6 refs

(NASA TN-D-1815) OTS: $1.00

An investigation of the effects of changes in the ratio of wing chord to propeller diameter of three tilting-wing and tilting-propeller VTOL models has been conducted in the 17-foot test section of the Langley 300-mph 7- by 10-foot tunnel. The models had wing-chord–propeller-diameter ratios of 0.333, 0.208, and 0.125, with a single propeller 2.00 feet in diameter located at the wing tips. The investigation indicated that reductions in the ratio of wing chord to propeller diameter made small changes in lift, drag, and pitching moment; this indicates that, with the small ratios of wing chord to propeller diameter in this investigation, these configurations would realize small aerodynamic forces and moments in comparison with those realized from direct propeller thrust. The data are used in an analysis in which a full-scale aircraft is assumed to be in steady level flight. Author

N63-18666 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF FABRICATION-TYPE SURFACE ROUGHNESS ON TRANSITION ON OGIVE-CYLINDER MODELS AT MACH NUMBERS OF 1.61 AND 2.01

Paul W. Howard and K. R. Czarnecki Washington, NASA, July 1963 49 p 4 refs

(NASA TN D-1933) OTS: $1.25

An investigation has been made at Mach numbers of 1.61 and 2.01 over a range of free-stream Reynolds number per foot from about 0.5×10^6 to 4.5×10^6 to determine the effects of fabrication-type surface roughness on boundary-layer transition. Twelve types of surface roughness, including step, wave, crease, waffle, hemstitching, and swept configurations, were investigated. The tests were made on an ogive-cylinder body of fineness ratio 12.2, the roughness elements covering the cylindrical portion of the model. The results indicate that there was little or no difference in transition characteristics for the hemstitching and smooth-waffle type of surface roughness. For most of the other types of roughness configurations, surface roughness decreases the transition distance by approximately a constant percentage over the test Reynolds number per foot range. Transition distance decreases nearly linearly with roughness height for two-dimensional, protruding, unswept type of surface roughness. Generally, roughness shape has relatively small effects on transition, and Mach number has a small favorable effect. Sweptback type of surface roughness appears to have a larger detrimental effect on transition than the transverse or unswept type. Author

N63-18667 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SPEED INVESTIGATION OF CABLE TENSION AND AERODYNAMIC CHARACTERISTICS OF A PARAWING AND SPACECRAFT COMBINATION

William C. Sleeman, Jr. Washington, NASA, July 1963 60 p 9 refs

(NASA TN D-1937) OTS: $1.50

A low-speed investigation was made to obtain detailed information on longitudinal aerodynamic characteristics and cable tension loads for a parawing and spacecraft configuration. The 55° swept parawing represented an inflated-tube structure capable of being packaged in the spacecraft and of being

deployed for glide and flared landing recovery of the spacecraft. Three basic cable riggings were studied in order to simulate a glide configuration, a dive configuration, and a landing configuration. Tests were conducted over a range of dynamic pressure from 4 to 14 pounds per square foot for the glide and flare configurations at the design angle of attack for each configuration. Tests were also made over an angle-of-attack range above and below the design condition for all the configurations. Some of the tests were repeated with the model in an inverted position in order to investigate effects of wing weight. The maximum lift-drag ratio for the complete model was 2.7 and for the wing alone was 3.5. The longitudinal stability for the glide and flare configurations was high at angles of attack near the design angle for each configuration. For angles of attack somewhat below the design point, the diagonal cable became slack and the stability was about neutral. The cable-tension data for the design conditions indicated that approximately half of the total tension in all cables was carried in the cables going to the leading edge and the remaining half was carried in the three cables going to the center keel. Author

N63-19178 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF AN ELASTIC CANARD-FUSELAGE CONFIGURATION AS MEASURED IN AIR AND IN FREON-12 AT MACH NUMBERS UP TO 0.92

E. Carson Yates, Jr., and Maynard C. Sandford. Washington, NASA, July 1963. 182 p. 18 refs.
(NASA TN D-1792) OTS: $3.00

Longitudinal aerodynamic characteristics of a geometrically, dynamically, and elastically scaled model of the clipped-delta canard and forward fuselage of a projected nuclear-powered airplane have been investigated by means of force tests conducted in air and in Freon-12 (Dichlorodifluoromethane) in the Langley transonic dynamics tunnel. The statically balanced canard was tested in both restrained and free-floating conditions at several levels of dynamic pressure. The aerodynamic trends of the restrained canard were found to be generally typical of those for delta and clipped-delta planforms. Canard normal force coefficients measured in Freon-12 were higher than corresponding values measured in air, particularly at the higher Mach numbers. Moreover, the pitching-moment coefficients indicated that canard centers of pressure in Freon-12 were farther aft than those in air. The latter result, however, may be associated with large differences in Reynolds number between the tests in air and in Freon-12. The principal aeroelastic deformations observed were twisting of the torque tube and chordwise deflections of the canard. As Mach number increased, the free canard experienced appreciable reductions of normal-force coefficient and pitch angle. This behavior could lead to a severe tuck-under problem for the airplane. Author

N63-19604 National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center

INVESTIGATION OF PROPELLER-POWER-PLANT AUTOPRECESSION BOUNDARIES FOR A DYNAMIC-AEROELASTIC MODEL OF A FOUR-ENGINE TURBOPROP TRANSPORT AIRPLANE

Frank T. Abbott, Jr., H. Neale Kelly, and Kenneth D. Hampton. Washington, NASA, Aug. 1963. 68 p. 6 refs.
(NASA TN D-1806) OTS: $1.75

An experimental investigation was made of some of the parameters influencing the autoprecession phenomenon (a self-sustained, wobbling motion of the spinning propeller involving coupling of gyroscopic and aerodynamic forces). These parameters included propeller rotational speed, stiffness and structural damping of the powerplant assembly in the pitch and yaw planes, the ratio of pitch stiffness to yaw stiffness, simulated fuel load in the wings, and the location and number of autoprecessing powerplant assemblies. Author

N63-19737 National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center

LOW-SPEED INVESTIGATION OF THE EFFECTS OF WING SWEEP ON THE AERODYNAMIC CHARACTERISTICS OF PARAWINGS HAVING EQUAL-LENGTH LEADING EDGES AND KEEL

Rodger L. Naeseth and Thomas G. Gainer. Washington, NASA, Aug. 1963. 79 p. 16 refs.
(NASA TN D-1957) OTS: $2.00

The three basic parawings had flat-planform sweep angles of 35°, 45°, and 55°, and were made of fabric. The leading-edge sweep angles varied from 40° to 75°. Tests were made at an airspeed of 38.6 mph and a Reynolds number of approximately 1.5×10^6. The maximum test angle-of-attack range was from 14° to 53° for the wings having a canopy of 35° flat-planform sweep. A limited investigation of lateral characteristics was made for sideslip angles from approximately −5° to 16° for two angles-of-attack, and lateral stability derivatives were obtained for some configurations through an angle-of-attack range. In addition to measurement of forces and moments acting on the wing, measurements were made of apex hinge moments by means of a strain-gage balance in the spreader bar. Author

N63-22116 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL MEASUREMENTS OF PERFORMANCE BLADE MOTIONS, AND BLADE AIR LOADS FOR TANDEM ROTOR CONFIGURATIONS WITH AND WITHOUT OVERLAP

Robert J. Huston. Washington, NASA, Oct. 1963. 76 p. 16 refs.
(NASA TN D-1971) OTS: $2.00

Results of an investigation in the Langley full-scale tunnel of the performance, blade motions, and instantaneous blade air loads are presented for two tandem-rotor configurations for a range of tip-speed ratios from 0 to 0.28. Author

N63-22944 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WING PRESSURE MEASUREMENTS WITHIN THE PROPELLER SLIPSTREAM FOR A LARGE-SCALE V/STOL WIND-TUNNEL MODEL SIMULATING TRANSITION

Matthew M. Winston and Robert J. Huston. Oct. 1963. 115 p. 13 refs.
(NASA TN D-2014) OTS: $2.50

Wing pressure data on tilt-wing, tilt-wing-with-slat, and deflected-slipstream configurations, obtained during tests of the model in the Langley full-scale tunnel, are presented for an angle-of-attack range corresponding to transition flight of a vertical or short takeoff and landing (V/STOL) aircraft. Included are pressure data for a range of flap deflections and lift-drag conditions corresponding to longitudinal acceleration and deceleration. A limited analysis of the pressure measurements for the tilt-wing configuration is also included. Author

N63-22947 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEED OF THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A WINGED REENTRY VEHICLE HAVING A LARGE NEGATIVELY DEFLECTED FLAP-TYPE CONTROL SURFACE

Paul G. Fournier. Oct. 1963. 22 p. 10 refs.
(NASA TN D-2030) OTS: $0.50

Results were obtained through an angle-of-attack range from −2° to 90° on a vehicle having flap-type control surfaces

which could be deflected from 0° to −105°. The Mach number range was from 0.60 to 0.90 with corresponding Reynolds numbers of 2.76×10^6 to 4.03×10^6 based on the basic-wing mean aerodynamic chord. Author

04 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc., and specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; safety devices; and stability and control. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

N63-10200 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRANSITION AND HOVERING FLIGHT CHARACTERISTICS OF A TILT-DUCT VTOL RESEARCH AIRCRAFT

Henry L. Kelly Washington, NASA, Nov. 1962 43 p 7 refs (NASA TN D-1491) OTS: $1.25

Flight test results are presented which describe some aerodynamic characteristics of a tilt-duct vertical-take-off-and-landing research aircraft. Results include data from the transition speed range (35 knots to 115 knots) and some qualitative results in the hovering flight region. Author

N63-10219 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LINEARIZED THEORY OF WIND-TUNNEL JET-BOUNDARY CORRECTIONS AND GROUND EFFECT FOR VTOL-STOL AIRCRAFT

Harry H. Heyson Washington, Superintendent of Documents, 1962 273 p 20 refs (NASA TR-R-124; For Tables of calculated interference factors see NASA TN D-933, NASA TN D-934, NASA TN D-935, and NASA TN D-936, N62-10016 01-02, N62-10017 01-02, N62-10018 01-02, N62-10019 01-02, respectively) GPO: $2.25

Interference factors are developed as a function of the degree to which the wake is deflected downward. At large wake deflections the interference may be much greater than indicated by classical theory. Methods are given for extending the present numerical results to tests involving multielement and finite-span models. The theory can be at least partially verified by means of available data. Tables of calculated interference factors are presented in NASA Technical Notes D-933, D-934, D-935, and D-936. Author

N63-10533 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PROPELLER SLIPSTREAM EFFECTS AS DETERMINED FROM WING PRESSURE DISTRIBUTION OF A LARGE-SCALE SIX-PROPELLER VTOL MODEL AT STATIC THRUST

Matthew M. Winston and Robert J. Huston Washington, NASA, Dec. 1962 68 p 13 refs (NASA TN D-1509) OTS: $1.75

An analysis has been made of static-pressure measurements on the wing and flaps of a general research model at zero free-stream velocity. For the tilt-wing configuration (zero flap deflection), the slipstream resulted in a spanwise variation in effective angle of attack of about 6° in a span of slightly less than 1 propeller diameter. For the deflected-slipstream configuration, the slipstream caused a 40-percent spanwise variation in effective thrust recovery and a 20° spanwise variation in effective thrust turning. Author

N63-10624 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYTICAL STUDY OF EFFECTS OF SOME AIRPLANE AND LANDING-GEAR FACTORS ON THE RESPONSE TO RUNWAY ROUGHNESS WITH APPLICATION TO SUPERSONIC TRANSPORTS

Norman S. Silsby Washington, NASA, Dec. 1962 26 p 1 ref (NASA-TN-D-1492) OTS: $0.75

Speeds investigated covered a range from 40 to 280 feet per second. Assumptions made for the analysis were (1) natural frequency of all tires were the same, (2) tires had no damping and possess a linear tire-deflection load curve, (3) all struts had linear damping and spring characteristics, and natural frequency and damping of all struts were the same, (4) rigid airplane structure, and (5) no aerodynamic forces. Parameters which were varied included gear wheel base, location of center of gravity, and radius of gyration. Author

N63-11123 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

OPERATIONAL EXPERIENCES AND CHARACTERISTICS OF THE X-15 FLIGHT CONTROL SYSTEM

Robert A. Tremant Washington, NASA, Dec. 1962 50 p 4 refs (NASA TN D-1402) OTS: $1.25

X-15 flight and simulator experiences with the manual flight control and stability augmentation system for the period from December 1958 to January 1962 are presented. The flight data extend to a Mach number of 6.04 and an altitude of 217,000 feet, and the simulator data cover the design flight envelope. The characteristics of the manual flight control system and the stability augmentation system are discussed, in conjunction with pilot evaluation, operational problems, modifications, and reliability. Pertinent X-15 flight history is included. Author

N63-12192 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

SOME OPERATIONAL ASPECTS OF USING A HIGH-PERFORMANCE AIRPLANE AS A FIRST-STAGE BOOSTER FOR AIR-LAUNCHING SOLID-FUEL SOUNDING ROCKETS

Victor W. Horton and Wesley E. Messing Washington, NASA, Jan. 1963 23 p 3 refs (NASA TN D-1279) OTS: $0.75

Five test vehicles were air-launched from an F-104A airplane to investigate some of the operational aspects and the practicability of using the energy input of the airplane as a first-stage booster for sounding rockets. A launch maneuver and launcher system were developed and matched to the airplane's capabilities so that suitable repectability of launch parameters was attained. Author

N63-12243 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SPIN INVESTIGATION OF A 1/20-SCALE MODEL OF AN UNSWEPT-WING, TWIN-ENGINE, OBSERVATION AIRPLANE

Henry A. Lee Washington, NASA, Jan. 1963 19 p 4 refs (NASA TN D-1516) OTS: $0.50

The effects of control settings and movements on the erect spin and recovery characteristics for the normal loading and the most rearward center-of-gravity loading (external wing tanks full) were determined. Also, tests were made to determine the effect on the spin and recovery characteristics of a large radar store, of empty and full external wing tanks, and of an asymmetrical condition when one empty or one full external wing tank is carried. Spin-recovery parachute tests were also performed. Author

N63-12247 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HANDLING QUALITIES AND OPERATIONAL PROBLEMS OF A LARGE FOUR-PROPELLER STOL TRANSPORT AIRPLANE

Hervey C. Quigley and Robert C. Innis Washington, NASA, Jan. 1963 48 p 12 refs

(NASA TN D-1647) OTS: $1.25

A flight investigation has shown that a 100,000-pound transport airplane equipped with blowing boundary-layer control on highly deflected flaps, drooped ailerons, and control surfaces can take off and land over a 50-foot obstacle in less than 1,500 feet and at speeds of less than 65 knots. It is indicated that some standard operational techniques and procedures should be changed for STOL operation. The airplane had satisfactory longitudinal and unsatisfactory lateral-directional handling qualities. Author

N63-13180 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LARGE-SCALE WIND-TUNNEL TESTS OF A CIRCULAR PLANFORM AIRCRAFT WITH A PERIPHERAL JET FOR LIFT, THRUST, AND CONTROL

Richard K. Greif and William H. Tolhurst, Jr. Washington, NASA, Feb. 1963 97 p 7 refs

(NASA TN D-1432) OTS: $2.25

Full-scale tests have been conducted in the Ames 40- by 80-foot wind tunnel to determine the performance, stability, and control characteristics of a research aircraft having a circular planform and employing a peripheral jet for lift, thrust, and control. The aircraft was 18 feet in diameter and 18 percent thick. Propulsion was provided by a 5-foot-diameter rotor which took in air through the wing upper surface and drove it through internal ducting to a peripheral nozzle designed to provide thrust vector control. Six-component aerodynamic data and propulsion-system flow data were obtained at various angles of attack over a range of jet-momentum coefficients from 0 to 3.4. Flight characteristics in the cruise configuration were determined at altitudes ranging from 12 feet 7 inches to 2 feet 8 inches. Transition-flight characteristics were studied only at the lowest ground height. Some effects of forward speed on rotor performance were also investigated. Author

N63-13251 National Aeronautics and Space Administration, Washington, D.C.

DEVELOPMENT OF SOUNDING ROCKETS IN JAPAN

Hideo Itokawa, et al Mar. 1963 159 p refs Transl. of articles from Seisan-Kenkyu (Tokyo), v. 12, no. 12, 1960

(NASA TT F-87) OTS: $3.00

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IX SOUNDING ROCKET MANAGEMENT AND ADMINISTRATION J. Shimomura p 149-156 (See N63-13260 07-01)

N63-13721 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NIKE APACHE PERFORMANCE HANDBOOK

Reed B. Jenkins Washington, NASA, Mar. 1963 25 p 5 refs

(NASA TN D-1699) OTS: $0.75

The configurational and mass characteristics of the Nike Apache two-stage solid-propellant sounding rocket system are described. Aerodynamic and performance data on the Nike Apache are presented for the various configurations commonly flown. Calculations of vehicle stability and of velocity, altitude, and range versus time and payload weight are presented graphically for use in determining maximum performance of any given configuration as a function of various parameters. Flight-test data on lateral and longitudinal accelerations during the boost phases are included. Author

N63-14429 National Aeronautics and Space Administration Flight Research Center, Edwards, Calif.

PRELIMINARY FLIGHT EVALUATION OF TWO UNPOWERED MANNED PARAGLIDERS

Garrison P. Layton, Jr., and Milton O. Thompson Washington, NASA, Apr. 1963 33 p 4 refs

(NASA TN D-1826) OTS: $1.00

Towed and free-flight tests were made with unpowered, manned paragliders to study the performance, stability, and control characteristics of a typical paraglider. The paragliders used had maximum lift-drag ratios greater than 3.5, and wing loadings of approximately 4.0 lb/sq ft. The airspeed range was limited by the rearward center-of-pressure shift at angles-of-attack above and below trim angle-of-attack. Performance data obtained from flight tests are presented and compared with analytical results. Center-of-gravity shift, accomplished by tilting the wing relative to the fuselage, was used for control. This method of control was adequate for towed and free flight as well as for flare and landing. The pilot's evaluation of the vehicle's handling qualities, and a discussion of development problems are presented. Author

N63-15050 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.

WING AND FLAP LOADS OBTAINED FROM A WIND-TUNNEL INVESTIGATION OF LARGE-SCALE V/STOL MODEL

Robert J. Huston, John F. Ward, and Matthew M. Winston Washington, NASA, Apr. 1963 90 p 10 refs

(NASA TN D-1634) OTS: $2.25

Wing and flap loads on tilt-wing, tilt-wing-with-slat, and deflected-slipstream configurations, obtained during tests of a large-scale model in the Langley full-scale wind tunnel, are presented for an angle-of-attack range corresponding to transition flight of a vertical or short takeoff and landing (V/STOL) aircraft. Included are wing root moments and shears, flap forces and moments, and partial-span wing pressure distributions for a range of flap deflections and lift-drag conditions corresponding to longitudinal acceleration and deceleration. The relationship between angle-of-attack and normal or chordwise bending moments at the root was found to be basically a cosine or sine function, respectively, but became modified significantly by the flow condition on the wing and by the balance of longitudinal forces. Normal and chordwise bending moments were relatively unaffected by deflection of the 30-percent-chord flaps; in contrast, the wing torsion was substantially affected by flap deflection and by the balance of longitudinal forces. Local areas of flow separation, principally behind upward traveling propeller blades, caused erratic movements in the spanwise centers of pressure. The addition of a 19-percent-chord partial-span slat to the tilt-wing configuration, in combination with

30° of flap deflection, resulted in the elimination of buffet caused by local areas of flow separation for the range of conditions covered.
Author

N63-15526 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SIMULATOR STUDY OF THE LATERAL-DIRECTIONAL HANDLING QUALITIES OF A LARGE FOUR-PROPELLERED STOL TRANSPORT AIRPLANE

Hervey C. Quigley and Herbert F. Lawson, Jr. Washington, NASA, May 1963 26 p 4 refs
(NASA TN D-1773) OTS: $0.75

The lateral and directional stability and control characteristics of a large four-propellered STOL transport airplane (the boundary-layer-control equipped NC-1308) have been studied on the landing approach simulator to determine changes in the characteristics that might be required to achieve satisfactory lateral-directional handling qualities. The study has shown that the handling qualities can be improved by increased directional stability and damping. A large increase in stability in conjunction with increased yaw rate damping gave some improvement, but the reduced directional response to rudder inputs prevented the configuration from being rated satisfactory by the evaluating pilots. A satisfactory configuration was achieved by doubling the basic directional stability and including a damping term which gave yawing moments proportional to rate change of sideslip.
Author

N63-15774 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MANEUVER ACCELERATIONS EXPERIENCED DURING ROUTINE OPERATIONS OF A COMMERCIAL TURBOJET TRANSPORT AIRPLANE

Paul A. Hunter and Mary W. Fetner Washington, NASA, May 1963 8 p 4 refs
(NASA TN-D-1801) OTS: $0.50

The incremental maneuver normal accelerations collected during both passenger-carrying operational flights and check and training flights of a four-engine turbojet commercial-transport airplane have been evaluated. The frequency of occurrence of maneuver accelerations per mile of flight for climb was approximately the same as that for descent. The frequency of occurrence for each of these two flight conditions was about ten times that during cruise. This tendency is typical of transport operations, particularly for the turbojet transports.
Author

N63-16430 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FULL-SCALE WIND-TUNNEL TESTS OF A MEDIUM-WEIGHT UTILITY HELICOPTER AT FORWARD SPEEDS

John L. Mc Cloud III, James C. Biggers, and Ralph L. Maki Washington, NASA, May 1963 31 p 8 refs
(NASA TN-D-1887) OTS: $0.75

Tests were conducted with the rotor on and off at speeds from 80 to 130 knots at various fuselage attitudes, and the lift, drag, pitching-moment, and power data are presented. The power data are discussed in terms of the rotor-off fuselage force data, and the wind-tunnel data are compared both with flight-test and computed rotor data.
Author

N63-18129 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SUBSONIC MEASUREMENTS OF STATIC AND DYNAMIC STABILITY DERIVATIVES OF SIX FLAT-PLATE WINGS HAVING LEADING-EDGE SWEEP ANGLES OF 70° TO 84°

Robert E. Shanks Washington, NASA, July 1963 30 p 8 refs
(NASA TN D-1822) OTS: $0.75

An investigation has been made to determine the low-speed static stability characteristics and the rolling and yawing dynamic stability derivatives of a series of thin flat-plate delta wings having leading-edge sweep angles of 70° to 84°. The investigation showed that the static longitudinal stability, the directional stability, and the effective dihedral increased with increasing sweep. The static lateral derivatives were linear at low angles-of-attack, but became increasingly nonlinear with increase in angle-of-attack and increase in sweep. The values of the rolling and yawing oscillation derivatives were generally small and relatively unaffected by sweep at the lower lift coefficients, but very large values of the derivative were obtained at the higher lift coefficients for the higher sweep angles. The theoretical prediction of the longitudinal stability, effective dihedral, and lateral oscillation derivatives (except C_{l_r}) at low lift coefficients is in fairly good agreement with the measured values.
Author

N63-18235 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYSIS OF VG AND VGH OPERATIONAL DATA FROM A TWIN-ENGINE TURBOPROP TRANSPORT AIRPLANE

Paul A. Hunter and Walter G. Walker Washington, NASA, July 1963 48 p 10 refs
(NASA TN D-1925) OTS: $1.25

An analysis has been made of operational data obtained with NASA VGH recorders from two twin-engine turboprop transport airplanes and with NASA VG recorders from two additional identical aircraft operated by a single airline on short-haul routes in the eastern part of the United States. These data are compared with VG and VGH data from two different types of twin-engine piston transport airplanes. The piston-engine operations, although similar to the turboprop operation, covered different geographical locations. In general, the turboprop experienced more severe gust and operational maneuver accelerations than did either of the piston-engine operations. Check-flight maneuver experiences were similar for the three operations. For the turboprop airplanes, the frequency of occurrence and maximum amplitudes of accelerations due to oscillatory motions were relatively low compared with the gust and maneuver accelerations experienced. Derived gust velocities for the turboprop operations were the most severe of the three operations. Information on airspeed practices indicated no significant differences between the three operations in rough air, the average speed in rough air being generally slightly higher than in smooth air. In contrast to past piston-engine practice, the turboprop exceeded the normal operating limit airspeed in a number of cases. Landing-impact accelerations for the turboprop, following modifications to the landing gear, were approximately 30 percent lower than the initial sample and almost identical to those for a twin-engine piston transport airplane for which data are available. In terms of relative frequency of occurrence, ground-operations accelerations are of primary importance for accelerations less than 0.4g, whereas for magnitudes greater than 0.4g, the landing impacts become of primary importance.
Author

N63-18658 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLIGHT OPERATING PROBLEMS AND AERODYNAMIC AND PERFORMANCE CHARACTERISTICS OF A FIXED-WING, TILT-DUCT, VTOL RESEARCH AIRCRAFT

Henry L. Kelley and Robert A. Champine Washington, NASA, July 1963 24 p 12 refs
(NASA TN D-1802) OTS: $0.75

The results of a flight investigation conducted at the Langley Research Center are presented. Included are some of the operating problems and related aerodynamic characteristics of

a tilt-duct, fixed-wing, vertical-takeoff-and-landing (VTOL) configuration. Buffet-boundary (stall onset) angles of attack, which limited the operational capabilities of this tilt-duct test aircraft, were found to vary considerably over the transition speed range, as well as with power setting. Generally, the stall-free operational range of angles of attack was decreased when operating at reduced power. Simulated ground-controlled landing approaches were investigated at various duct angles and glide-path angles by the use of three methods. The results of one method studied (that of increasing the duct angle by 10° upon intercepting the glide slope) indicated that satisfactory characteristics (handling and flying qualities and pilot work load) were possible with a fixed-wing, tilt-duct fan configuration. When this approach method is used, the duct-angle setting on the glide path was 60° and the airspeed was between 50 knots and 60 knots, depending on the glide angle used. Also presented is an extension of flight-test results in an earlier report which includes stability, control, and performance characteristics recorded over a speed range from 15 to 122 knots which includes duct angles from 80° to 0°. Author

N63-18663 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SOME FLIGHT CHARACTERISTICS OF A DEFLECTED SLIPSTREAM V/STOL AIRCRAFT
Howard L. Turner and Fred J. Drinkwater III. Washington, NASA, July 1963. 38 p. 13 refs
(NASA TN-D-1891) OTS: $1.00

The Ryan VZ-3RY V/STOL test vehicle was flight tested over the airspeed range from 80 knots to below 6 knots. The deflected slipstream concept proved to be better suited to STOL than VTOL operation. Adverse ground effects prevented operation close to the ground at speeds less than 20 knots and below approximately 15 feet altitude. Steep glide slopes to landing (up to −16°) at approximately 40 knots were achieved, but steep, slow, descending flight did not appear feasible. Full-span leading-edge slats markedly increased the descent capability and reduced the minimum level-flight speed. Author

N63-19278 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MEASUREMENTS OF THE RESPONSE OF TWO LIGHT AIRPLANES TO SONIC BOOMS
Domenic J. Maglieri and Garland J. Morris. Washington, NASA, Aug. 1963. 36 p. 12 refs
(NASA TN D-1941) OTS: $1.00

A joint FAA-USAF-NASA investigation has been made to determine the acceleration response near the center of gravity of two light airplanes, a Piper Colt and Modified Beech C-45H, to sonic-boom overpressures varying from around 1 to 16 lb/sq ft. The test airplanes were exposed to the sonic booms while parked on the ground, in cruising flight, in turns, and in flight near stall. Acceleration increments were less than ±0.2 g in the normal, transverse, or longitudinal direction, had periods of about 0.1 second, and were damped out in less than 2 cycles. No aircraft rigid-body motions were detected, and the primary source of the response to sonic booms was thought to be structural. Somewhat higher responses were measured for the Piper Colt than for the Modified Beech C-45H, and were attributed to the lighter wing loading of the Colt. Responses to the sonic booms appeared to be so small as to have no significance as regards structural loads or airplane control, and generally were negligible in comparison with responses resulting from routine operations such as takeoff, landing, and flight in light turbulence. Author

N63-19736 National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center
FULL-SCALE WIND-TUNNEL INVESTIGATION OF A FLEXIBLE-WING MANNED TEST VEHICLE
Joseph L. Johnson, Jr., and James L. Hassell, Jr. Washington, NASA, Aug. 1963. 73 p. 7 refs
(NASA TN D-1946) OTS: $2.00

The performance and static stability and control characteristics of a flexible-wing manned test vehicle were determined in an investigation conducted in the Langley full-scale tunnel through an angle-of-attack range of the keel from about 14° to 44° for power-on and power-off conditions. Comparisons of the wind-tunnel data with flight-test data, obtained with the same airplane, were made in a number of cases. Author

N63-20607 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va
FLIGHT-AND FORCE-TEST INVESTIGATION OF A MODEL OF AN AERIAL VEHICLE SUPPORTED BY TWO UNSHROUDED PROPELLERS
Robert H. Kirby. Washington, NASA, Sept. 1963. 27 p. 6 refs
(NASA TN D-1965) OTS: $0.75

The model in its basic configuration consisted of a box-like body in the center, with the two propellers mounted in tandem on struts ahead of and behind the body, and fixed with respect to the airframe so that the propeller plane of rotation was horizontal for hovering flight. A dynamic stability and control investigation showed that the controls-fixed hovering motions of the model were unstable oscillations in pitch and roll. However, since the periods of the oscillations were relatively long, the model could be controlled fairly easily in hovering without artificial stabilization. The basic model was difficult to control at the higher forward speeds but was easy to fly when horizontal and vertical tails were added. Author

N63-20890 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va
A SIMULATOR STUDY OF AIRSPACE REQUIREMENTS FOR THE SUPERSONIC TRANSPORT
Richard H. Sawyer. Washington, NASA, Sept. 1963. 23 p. 1 ref
(NASA TN D-1964) OTS: $0.75

An investigation was conducted to study the horizontal airspace requirements for a supersonic transport during changes in heading at a VORTAC station. The vertical deviations from cruising altitude during turning flight were also studied. The investigation was made with use of a fixed-base aircraft simulator programed to represent a delta-wing supersonic transport having a canard control. Manual flight control was used to effect changes in heading up to 45° for bank angles of 15°, 30°, and 45°. The tests were conducted at a Mach number of 3.0 at an altitude of 67,000 feet. Measurements were made of the horizontal and vertical displacements from the flight path, and of the primary control deflections. Author

N63-22117 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
AERODYNAMIC AND CONTROL-SYSTEM CONTRIBUTIONS TO THE X-15 AIRPLANE LANDING-GEAR LOADS
Richard B. Noll, Calvin R. Jarvis, Chris Pembo, Wilton P. Lock, and Betty J. Scott. Washington, NASA, Oct. 1963. 35 p. 6 refs
(NASA TN D-2090) OTS: $1.00

The effect of the X-15 manual flight control and stability augmentation systems on the horizontal-tail load, and the effect of wing-flap position on the wing load during touchdown are investigated. Methods for significantly reducing the maximum

total load on the main gear during landings are described. Data from typical X-15 landings and from landings in which modified touchdown techniques were used are presented and compared. Author

N63-23125 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
IN-FLIGHT SHOCK-WAVE PRESSURE MEASUREMENTS ABOVE AND BELOW A BOMBER AIRPLANE AT MACH NUMBERS FROM 1.42 TO 1.69
Domenic J. Maglieri, Virgil S. Ritchie, and John F. Bryant, Jr. Washington, NASA, Oct. 1963 48 p 18 refs
(NASA TN D-1968) OTS: $1.25

In-flight shock-wave pressure surveys have been made above and below a bomber airplane at distances of approximately 1,300 to 2,000 ft, and also below the bomber airplane at distances of about 4,600 to 9,100 ft. Measured pressure signatures are presented for the bomber airplane in the Mach number range from 1.42 to 1.69 with a gross-weight range from about 83,000 to 117,000 lb. A detailed description is given of the unique instrumentation probe used to obtain the pressure measurements along with the corresponding static and wind-tunnel calibrations. Author

05 ASTRONOMY AND ASTROPHYSICS

Includes celestial mechanics; and radioastronomy. *For related information see*: 12 Geophysics, and 29 Space Sciences.

N63-10769 National Aeronautics and Space Administration, Washington, D. C.
THE MAGNETIC FIELD OF THE CRAB NEBULA AND ITS CENTRAL STAR (MAGNITNOYE POLE KRABOVIDNOY TUMANNOSTI I TSENTRAL'NOY ZVEZDY)
S. B. Pikel'ner (Crimean Astrophys. Obs., USSR Acad. of Sci.) Nov. 1962 28 p 26 refs Transl. from Astron. Zh. (Moscow), v. 33, no. 6, 1956 p 785-799
(NASA-TT-F-112) OTS: $0.75

This paper includes discussions of the following subdivisions: observations of polarization, estimation of the field from the spectrum form, estimation of the field from energy density, distribution of optical and radio emission, estimating the mass of the envelope, influence of the expansion of the envelope on the spectrum of the particles, the nature of the field, and the magnetic field of the star. Author

N63-10796 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CALCULATION OF EPHEMERIDES FROM INITIAL VALUES
Karl Stumpff Washington, NASA, Dec. 1962 28 p
(NASA-TN-D-1415) OTS: $0.75

A method is presented for calculating undisturbed ephemerides (coordinates of location and velocity) of a planet or a comet when its initial time values are given. The orbital elements need not be known for this method, which is applicable, without formal variations, for all types of orbits. The singularity of classical methods is avoided by the transfer from elliptical to hyperbolic orbits. In place of Kepler's equation, a transcendent *main equation* appears. It is valid for all types of orbits and becomes rational for circular and parabolic orbits. The formulas for the calculation of location and velocity coordinates are simple and well suited for electronic computers. The optimal area for application (small and medium intermediate times) coincides with the requirements for orbit determination, orbit correction, and the calculation of special perturbations. Author

N63-11505 National Aeronautics and Space Administration, Washington, D. C.
CELESTIAL MECHANICS AND SPACE FLIGHT ANALYSIS
Clarence R. Gates, Paul R. Peabody, William M. Kaula, Thomas W. Hamilton, and William G. Melbourne 1962 42 p 65 refs Papers presented at Session I of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962
(See N63-11501 03-29)
(NASA-SP-15) GPO: $0.35

CONTENTS:

1. INTRODUCTION. CELESTIAL MECHANICS: HISTORICAL BACKGROUND C. R. Gates (JPL) 2 p
2. APPLICATIONS OF NUMERICAL ANALYSIS AND COMPUTER TECHNIQUES IN CELESTIAL MECHANICS P. R. Peabody (JPL) 6 p
3. ANALYSIS OF SATELLITE ORBITS FOR GEOPHYSICAL EFFECTS W. M. Kaula (NASA, Goddard Space Flight Center) 11 p 39 refs
4. APPLICATIONS OF CELESTIAL MECHANICS TO SPACECRAFT FLIGHT T. W. Hamilton (JPL) 8 p 3 refs
5. SPACE FLIGHT OPTIMIZATION W. G. Melbourne (JPL) 13 p 23 refs

N63-12074 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON LAGRANGE'S THEORY OF THE THREE-BODY PROBLEM
Karl Stumpff Washington, NASA, Jan. 1963 15 p 3 refs
(NASA TN D-1417) OTS: $0.50

Lagrange's famous studies of the three-body problem are redeveloped in modern mathematical expressions. This new portrayal of a very old problem of celestial mechanics gives rise to various considerations which can be very useful for the practical computation. In particular, the nine elements of the "reduced" three-body problem are defined as a symmetrically constructed system of three groups of three elements each, and their differential equations are shown. A byproduct of this study is a representation of the coefficients of the equation of the fourth degree for Lagrange's quantity p in symmetrical form. Author

N63-13794 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE CHARACTERISTICS OF DISTANT COMETS
Bertram Donn Washington, NASA, Mar. 1963 10 p 21 refs Previously processed as a preprint; for abstract see N63-13875 08-28
(NASA TN D-1671) OTS: $0.50

An analysis of spectroscopic observations and colors of comets with heliocentric distances greater than 3.5 AU indicates that only sunlight scattered from solid grains can explain the data. The orientation and curvature found by Osterbrock in two comets are consistent with Bessel-Bredichin theory of comet tails. Because of these characteristics, Brandt's use of these comet tails to study the interplanetary medium is not valid. Author

N63-17314 Geophysics Corp. of America, Bedford, Mass.
PLANETARY AERONOMY IX: THE DARK SIDE AIRGLOW OF VENUS
Neville Jonathan and George Doherty Feb. 1963 44 p 6 refs (NASA Contract NASw-395)
(NASA CR-14; GCA-TR-63-1-N) OTS: $4.60 ph, $1.52 mf

The luminescence on the dark side of Venus, strong emissions in the region 4400 A to 4410 A, is analyzed to determine whether it is a product of chemical reactions. The results of several investigations of the chemiluminescence arising from the reaction of carbon monoxide with atomic oxygen are summarized and compared. A mechanism is proposed to explain the airglow which involves two distinct two-body reactions resulting in the formation of both radiative and nonradiative carbon dioxide molecules. A recommendation is made to study the reactions at higher temperatures but it is noted that, at room temperatures, the luminescence is a factor of 2000 less than that caused by the O + NO reaction. D.E.R.

N63-17550 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COSMIC-RAY-INDUCED STABLE AND RADIOACTIVE NUCLIDES IN METEORITES
Michael E. Lipschutz Washington, NASA, June 1963 12 p 38 refs For presentation at the Symp. on Space Radiation of the American Soc. for Testing and Materials, Atlantic City, June 23–28, 1963
(NASA TN D-1844) OTS: $0.50

Meteorites, the only extraterrestrial solid objects currently available on the earth, are being extensively studied by many investigators. Data now available enable us to reconstruct some features of that period when meteorites were exposed to cosmic rays. A brief discussion of meteoritic types is followed by presentation of the results of radiochemical and mass-spectrometric investigations on meteorites. From the amounts of cosmogenic stable and radioactive species present, conclusions can be drawn concerning the duration of cosmic ray exposure, the spectrum and intensity of the incident cosmic ray flux, the preatmospheric size and shape of the meteorites, and the terrestrial history of these objects. Also, a brief discussion of some, as yet unanswered, questions concerning meteorites is presented Author

N63-18128 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ON A CONSISTENT SYSTEM OF ASTRODYNAMIC CONSTANTS
Helmut G. L. Krause Washington, NASA, July 1963 49 p 58 refs
(NASA TN D-1642) OTS: $1.25

An internally consistent system of astrodynamic constants is derived, based upon theoretical coupling relationships and the most recent available experimental data. A previously existing discrepancy in the value of the gravitational parameter of the earth (as derived by different methods) has been eliminated. Likewise, several inconsistencies in the previously available system of lunar constants have been removed. An error study of each constant is presented; both relative and absolute probable errors are listed. The results of this study can be summarized in the given list of astrodynamic constants. Author

N63-19371 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COMPUTATION OF GENERAL PLANETARY PERTURBATIONS, PART I
Lloyd Carpenter Washington, NASA, Aug. 1963 35 p 24 refs
(NASA TN D-1898) OTS: $1.00

A computer program for automatic computation of first-order general planetary perturbations is described. The program is based on Hansen's theory as given in the Auseinandersetzung. As examples, the general perturbations of six minor planets are given Author

N63-22710 National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.
MODELS FOR STARS OF VERY LOW MASS
Shiv S. Kumar Washington, NASA, Oct. 1963 29 p 4 refs
(NASA TN D-1907) OTS: $0.75

Completely convective models have been constructed for stars of masses 0.09, 0.08, 0.07, 0.06, 0.05, and 0.04 (solar units), taking into account the nonrelativistic degeneracy of the stellar material. The properties of these models are presented in tabular form and in the form of graphs. It is shown that there is a lower limit to the mass of a main sequence star. The stars with mass less than this limit become completely degenerate stars or "black" dwarfs as a consequence of the gravitational contraction, and, therefore, they never go through the normal stellar evolution Author

06 AUXILIARY SYSTEMS

Includes fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters. *For primary propulsion systems see* 27 Propulsion. *For related information see* 08 Communications; 09 Electronics; 10 Facilities, Research and Support; 15 Instrumentation and Photography; and 22 Navigation and Guidance

N63-10180 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EXPERIMENTAL INVESTIGATION OF A 90° FLAT-PLATE MAGNETIC TRIODE FOR DIRECT ENERGY CONVERSION
Richard R. Cullom Washington, NASA, Nov. 1962 14 p 5 refs
(NASA TN D-1532) OTS: $0.50

An approach to decreasing the interelectrode space charge of a magnetic triode was tested by using a shaped magnetic field to improve triode performance. The shaped field was designed to restrict the electrons to circular orbits and thus to decrease electron-electron collisions and/or electron scattering. A percentagewise improvement in the triode output power was observed with the shaped magnetic field. This improvement in the performance, however, was not of sufficient magnitude to make this particular triode a practical energy converter because the grid power loss was of greater magnitude than the power output. Author

N63-11511 National Aeronautics and Space Administration, Washington, D. C.
POWER FOR SPACECRAFT
Newell D. Sanders, Charles A. Barrett, Daniel T. Bernatowicz, Thomas P. Moffitt, Andrew E. Potter, Jr., and Harvey J. Schwartz 1962 27 p Papers presented at Session 0 of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)
(NASA-SP-21) GPO: $0.25

CONTENTS:

1. POWER FOR SPACECRAFT N. D. Sanders, C. A. Barrett, D. T. Bernatowicz, T. P. Moffitt, A. E. Potter, Jr., and H. J. Schwartz (NASA. Lewis Research Center) 26 p

N63-11741 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

USE OF A SEALED SILVER-CADMIUM BATTERY ON EXPLORER XII

T. J. Hennigan and A. O. Apelt Washington, NASA, Jan. 1963 9 p Previously processed as ARS Paper-2509-62; for abstract see N63-10258 01-06

(NASA TN D-1543) OTS: $0.50

Since silver-cadmium cells may be constructed entirely free of magnetic materials, a secondary silver-cadmium battery was used on Explorer XII satellite which was launched in 1961 to study radiation and magnetic fields. A program has been carried out at Goddard Space Flight Center to determine the feasibility of using the battery in this space application. The operation of the power system on Explorer XII is outlined, and cycling data, telemetered from the satellite, are presented. The first application of a silver-cadmium battery on a satellite was very satisfactory; in flight, no deterioration of the battery power supply was observed. Author

N63-12948 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

POWER INPUT TO A SMALL FLAT PLATE FROM A DIFFUSELY RADIATING SPHERE WITH APPLICATION TO EARTH SATELLITES: THE SPINNING PLATE

Fred G. Cunningham Washington, NASA, Feb. 1963 46 p 1 ref (NASA TN D-1545) OTS: $1.25

A general derivation is presented for the radiation from a uniformly radiating sphere incident on a small flat plate, spinning about an axis not coincident with its normal. The results are presented as a function of the separation of the bodies, the orientation of the plate, and the orientation of the spin axis. In addition, a series of curves is given which represents the power input from earth radiation to one side of a spinning flat plate (averaged over a spin period) for a range of altitude from 200 km to 32,000 km. These curves are based upon the assumption that the earth is a uniform diffuse emitter radiating as a blackbody at a temperature of 250°K. Author

N63-13219 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYTICAL STUDY OF A SIMPLE ATTITUDE CONTROL SYSTEM FOR A FINNED VEHICLE

Jack E. Harris Washington, NASA, Mar. 1963 35 p 4 refs (NASA TN D-1608) OTS: $1.00

An analytical study was made of a finned-vehicle first-stage attitude control system incorporating an attitude error feedback signal and simple forward-loop compensation. The effects of various compensation networks on system performance are compared for flight conditions, ranging from dynamic pressures of 100 lb/sq ft to 3,200 lb/sq ft. A simple tandem compensation network that enables the control system to obtain good response characteristics to attitude command inputs and to maintain satisfactory path control when subjected to wind disturbance is discussed. Author

N63-15237 National Aeronautics and Space Administration, Washington, D.C.

HYDRAULIC DESIGN OF AIR COOLING SYSTEMS FOR MULTI-STAGE GAS TURBINES BY USING ELECTRIC MODELS (GIDRAVLICHESKIY RASCHET SISTEM VOZDUSHNOGO OKHLAZHDENIYA MNOGOSTUPENCHATYKH GAZOVYKH TURBIN PRI POMOSCHI ELEKTRICHESKIKH MODELEY)

I. T. Shvets, Ye. P. Dyban, and V. N. Klimenko Apr. 1963 15 p 10 refs Transl. by Faraday Translations from Teploenerg. (Moscow), no. 9, Sept. 1960 p 14-17

(NASA TT F-78) OTS: $0.50

By use of the described model, the time required to compute the design of a cooling system of a two-stage gas-turbine rotor was reduced 10- to 12-fold, and the labor involved in determining the rates of flow of air through elements of the cooling system of a four-stage rotor was reduced to about 1/20 to 1/25. Author

N63-15770 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ANALYTICAL STUDY OF TURBINE-GEOMETRY CHARACTERISTICS FOR ALKALI-METAL TURBOELECTRIC SPACE POWER SYSTEMS

Arthur J. Glassman and S. M. Futral Washington, NASA, May 1963 31 p 7 refs

(NASA TN D-1710) OTS: $0.75

This investigation was made primarily to determine the general effects of turbine-inlet temperature and working fluid on such turbine-geometry characteristics as number of stages, diameter, and rotative speed for a turboelectric space-power system producing 1 megawatt of electric power. The analysis showed that turbine-inlet temperature and working fluid exert significant effects on turbine geometry. Smaller diameter turbines that require an increasing number of stages were obtained by increasing turbine-inlet temperature. The required number of stages increased with decreasing working-fluid molecular weight. For any given temperature, turbine-stage diameters for cesium, rubidium, and potassium were nearly equal, but were considerably larger for sodium. Rotative speed, for any given number of stages, increased with temperature. Use of materials with higher ratios of strength to density, and use of increasing rather than constant diameters from the first to the last stage resulted in significantly fewer stages. Author

N63-18131 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EARTH REFLECTED SOLAR RADIATION INCIDENT UPON AN ARBITRARILY ORIENTED SPINNING FLAT PLATE

Fred G. Cunningham Washington, NASA, July 1963 39 p 8 refs

(NASA TN D-1842) OTS: $1.25

A general derivation is given for the earth-reflected solar radiation input to a flat plate — a solar cell paddle, for example — which is spinning about an axis coincident with the axis of symmetry of the satellite to which it is affixed. The resulting equations are written for the general case, so that arbitrary orientations of the spin axis with respect to the earth-satellite line, and arbitrary orientations of the normal to the plate with respect to the spin axis, can be treated. The equations governing the integration limits are given. The appendixes contain: the results, in graphical form, of two representative examples; the general computer program for the calculation, given in FORTRAN notation; and the results of a calculation of the distribution of albedo energy on the proposed Echo II satellite. The value of the mean solar constant used is 1.395×10^6 erg/cm^2-sec; the mean albedo of the earth is assumed to be 0.34; and the earth is assumed to be a diffuse reflector.

Author

N63-20315 National Aeronautics and Space Administration, Washington, D.C.

HANDBOOK OF SPACE-RADIATION EFFECTS ON SOLAR-CELL POWER SYSTEMS

William C. Cooley and Robert J. Janda (Exotech, Inc.) 1963 120 p 146 refs

(NASA Contract NASw-598)

(NASA SP-3003) OTS: $2.50

Areas of space-radiation effects covered in this handbook are: (1) radiation damage to solar cells, (2) correlation of satellite test data on solar-cell performance, (3) design methods for solar-cell power systems, (4) radiation effects on solar-cell

cover slide materials and adhesives, (5) space-radiation effects on transistors and diodes, and (6) summary of the space-radiation environment. P.V.E.

N63-20602 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A METHOD TO OPTIMIZE THE SOLAR CELL POWER SUPPLY FOR INTERPLANETARY SPACECRAFT
Grady B. Nichols Washington, NASA, Sept. 1963 21 p
(NASA TN D-1846) OTS: $0.75

The purpose of this paper is to present a generalized approach to the development of an optimized solar-cell power supply. This method was developed for use on a spin-stabilized spacecraft requiring no control system or orientation mechanism for the solar panels. An optimized power supply is considered to be one that has the proper orientation of solar panels for maximum power output with minimum solar-cell weight. In the method described here, the area of each solar panel is expressed as a vector in general terms; the solar energy is also expressed as a vector. The power output at any instant is then merely the summation of the dot (inner) product of each area vector and the solar vector. Author

N63-20606 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THEORETICAL CONSIDERATIONS FOR A PRELIMINARY DESIGN OF A SOLAR CELL GENERATOR ON A SATELLITE
Bernard J. Saint-Jean Washington, NASA Sept. 1963 32 p 1 ref
(NASA TN D-1904) OTS: $1.00

This report presents the preliminary calculations necessary for choosing a solar-cell generator from the two design types possible: with solar cells on the satellite skin, or with solar cells on both sides of independent paddles. For each of those two types, numerical results of their aspect ratios are included to permit a direct comparison. Author

N63-21890 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
THERMIONIC EMISSION FROM CESIUM-COATED ELECTROSTATIC ION-THRUSTER ELECTRODES
Thaine W. Reynolds and Edward A. Richley Washington, NASA, Sept. 1963 35 p 12 refs
(NASA TN D-1879) OTS: $1.00

An analysis was made of the possible thermionic electron-emission currents attainable from cesium-coated tungsten accelerator electrodes in ion thrustors. Both an axisymmetric and a rectangular electrode configuration were examined for accelerator temperatures near the values yielding maximum emission. The electron-emission behavior was substantially the same for both configurations. An electron-emission current equal to about 4 percent of the ion-beam current is possible for cases where the neutral-cesium flux to the accelerator electrode comes directly from the ionizer. If a background gas pressure of cesium can build up in the interelectrode space, thermionic electron-emission currents as high as 40 percent of the ion-beam current can result. These values of electron current are of sufficient magnitude to obscure measurements of the true ion-impingement currents on the accelerator electrode. In actual thrustor operation, maintaining the accelerator at a temperature ±100° K away from that at which peak electron emission occurs, could reduce the electron emission current by about an order of magnitude. Author

N63-22861 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A METHOD FOR ANALYZING NONLINEAR CLOSED-LOOP CONTROL SYSTEMS WITH STATIONARY STOCHASTIC INPUTS
Wilfred J. Minkus (Ph.D. Thesis—Stanford U.) Washington, NASA, Oct. 1963 48 p 3 refs
(NASA TN D-2061) OTS: $1.25

This study presents a method for investigating the response of a closed-loop nonlinear control system, subject to a stationary stochastic input with additive zero-mean white Gaussian noise. An analytic technique for obtaining an approximate expression for the autocorrelation functions at the input and output of the nonlinearity, as well as other parts of the system's loop, is proposed. This analysis leads to an expression for the root-mean-square error between the input and output of the system. Author

07 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis. *For related information see* 18 Materials, Metallic; 19 Materials, Nonmetallic; and 26 Propellants and Combustion.

N63-13189 National Aeronautics and Space Administration, Washington, D.C.
GAS CHROMATOGRAPHIC MEASUREMENT OF TRACE CONTAMINANTS IN A SIMULATED SPACE CABIN
Herbert C. McKee, John W. Rhoades, Ralph J. Wheeler, and H. P. Burchfield (Southwest Research Inst.) Mar. 1963 42 p 9 refs (Contract NASw-150)
(NASA TN D-1825) OTS: $1.25

Methods have been developed for sampling the air in a simulated space cabin and analyzing it for trace contaminants by gas chromatography. Compounds which were identified during five simulated flights include acetaldehyde, acetone, methanol, [illegible]anol, Freon-11, Freon-12, Freon-22, methyl chloride, and dimethyl sulfide. The presence of Freon-114, isoprene, acetylene, ethylene oxide, carbon tetrachloride, methyl ethyl ketone, benzene, and toluene is also suspected, although identity has not been confirmed unequivocally. Several additional unidentified compounds were also present. A number of unidentified peaks appeared transiently during the malfunction of a waste disposal unit. Thus, gas chromatography has great potential value for monitoring the atmosphere within space capsules for metabolic products as well as for other contaminants introduced accidentially. Chemical tests were made for the presence of inorganic compounds in the atmosphere during two additional simulated flights. The presence of sulfate ion, chloride ion, chlorine, sulfur dioxide, ammonia, and ozone in trace amounts was confirmed. Author

N63-14403 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EFFECT OF OXYGEN ON MECHANICAL PROPERTIES OF TUNGSTEN
Joseph R. Stephens Washington, NASA, Apr. 1963 24 p 15 refs
(NASA TN D-1581) OTS: $0.75

The effect of oxygen on the mechanical properties of commercial polycrystalline tungsten and zone-refined single-crystal tungsten was evaluated by means of tensile tests of oxygen-doped specimens in the ductile-to-brittle transition temperature range. The effect of

oxygen as a surface oxide that might be encountered in normal working and forming operations was evaluated by means of a three-point loading bend test at room temperature. Results showed that the commercial recrystallized rods containing 4 parts per million (ppm) oxygen had a ductile-to-brittle transition temperature (based on 50-percent reduction in area) of 450° F. Increasing the oxygen concentration to 10, 30, and 50 ppm increased the transition temperature to 660°, 840°, and 1020° F, respectively. The oxygen additions also produced a progressive lowering of the ultimate tensile strength. The mechanism for the effect of oxygen on the transition temperature and ultimate tensile strength is believed to be that of segregation of the oxygen atoms at the grain boundaries. The oxygen additions also caused a progressive lowering of the yield strength, which is believed to result from the interaction of oxygen with carbon atoms or other impurity atoms present in the tungsten lattice. Oxygen additions to the single-crystal specimens had a slight effect on ductile-to-brittle transition temperature. There was very little change in the ultimate tensile strength or yield strength of the single-crystal specimens as a result of increasing the oxygen concentration. These results on high-purity single crystals support the belief that the detrimental effect of oxygen on ductility and tensile strength of polycrystalline tungsten is a result of grain boundary segregation of the oxygen. A surface oxide that resulted from heating the specimens in oxygen at 1000° F did not affect the ductility of the tungsten rod. Oxidizing the rods at 1500° F increased the ductility of the bend specimens, which is believed to be a result of the removal of surface defects from the ground rod. Author

N63-16164 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TABULATED VALUES OF BOND DISSOCIATION ENERGIES, IONIZATION POTENTIALS, AND ELECTRON AFFINITIES FOR SOME MOLECULES FOUND IN HIGH-TEMPERATURE CHEMICAL REACTIONS

Charles J. Schexnayder, Jr. Washington, NASA, May 1963 63 p 113 refs

(NASA-TN-D-1791) OTS: $1.75

Values of the bond dissociation energies, ionization potentials, and electron affinities that were taken from the literature are presented in tables for some monatomic, diatomic, and polyatomic molecules which are found in many high-temperature chemical reactions including combustion reactions. Much of the information came from literature published after 1950, which either reported experimental and theoretical energy values or gave a review of previous literature on the subject. Author

N63-17313 Geophysics Corp. of America, Bedford, Mass.

PLANETARY AERONOMY VIII: A CONGERIES OF ABSORPTION CROSS SECTIONS FOR WAVELENGTHS LESS THAN 3000 Å

E. D. Schultz, A. C. Holland, and F. F. Marmo Nov. 1962 103 p 106 refs

(NASA Contract NASw-395; Contract AF 33(657)-9199)

(NASA CR-15; GCA-TR-62-15-N) OTS: $9.10 ph, $3.29 mf

Experimental data on the absorption of solar vacuum ultraviolet radiation by atmospheric gases, which is of primary importance in the study of planetary aeronomy, is compiled. Available absorption curves and tabulations, in the spectral region from 100 A to 3000 A, of various authors were collected and identified. Summaries of these authors' studies are included and the respective spectral regions studied are given. An accompanying discussion of the absorption characteristics, together with a historical sketch of each gas considered, is presented. N.E.A

N63-17316 Geophysics Corp. of America, Bedford, Mass.

PLANETARY AERONOMY XI: ABSOLUTE INTENSITY MEASUREMENTS IN THE VACUUM ULTRAVIOLET

J. A. R. Samson Mar. 1963 28 p 6 refs

(NASA Contract NASw-395)

(NASA CR-7; GCA-TR-63-3-N) OTS: $2.60 ph, $1.04 mf

Absolute intensity measurements of vacuum ultraviolet radiation are made using the technique of photoionizing rare gases and assuming that their photoionization yield is unity. It was concluded that the relative photoionization yields of the rare gases with respect to one another is unity. Therefore, absolute intensity measurements will be independent of the rare gas that is used, provided that proper experimental care is observed. N.E.A.

N63-17320 Geophysics Corp. of America, Bedford, Mass.

PLANETARY AERONOMY XIV: ULTRAVIOLET ABSORPTION OF SO_2: DISSOCIATION ENERGIES OF SO_2 AND SO

P. Warneck, F. F. Marmo, and J. O. Sullivan May 1963 25 p 17 refs

(NASA Contract NASw-701)

(NASA CR-10; GCA-TR-63-13-N) OTS: $2.60 ph, $0.95 mf

The absorption intensities of SO_2 were measured in the wavelength region 2000 to 3100 A, employing the hydrogen continuum as the source and at selected wavelengths utilizing the mercury line spectrum. The pressure dependence of the absorption intensity was investigated at 1849, 2537, and 3131 Å. The existence of an absorption continuum in the spectral region 1700 to 2300 Å has been established, and attributed to the dissociation of SO_2 forming SO and a ground state oxygen atom. The onset of the continuum provides an upper limit value to the dissociation energy of SO_2. The implications upon the SO_2 and SO dissociation energies are discussed. Author

N63-17544 National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

STUDY OF THE NONEQUILIBRIUM FLOW FIELD BEHIND NORMAL SHOCK WAVES IN CARBON DIOXIDE

John T. Howe, John R. Viegas, and Yvonne S. Sheaffer Washington, NASA, June 1963 40 p 18 refs

(NASA TN D-1885) OTS: $1.00

Chemical-reaction rate coefficients for the dissociation of CO_2 and CO are estimated by use of collision theory and are compared with experimental results obtained at low temperatures. The effect of varying the number of square terms of energy effective in collisions on the rate coefficients is examined. The estimated rate coefficients are employed to study the interdependent chemical-rate processes for the dissociation of CO_2 and its components (including five chemical species) coupled with the fluid flow behind a normal shock wave. Solutions of the differential equations are obtained for shock speeds up to 10 km/sec at 10^2 to 10^{-4} standard atmospheric density by three methods. Thus, results of two simplified methods (one of which leads to a closed-form solution) are compared with those of an exact method. Chemical relaxation effects for shock waves in CO_2 are compared with those in N_2 and O_2. Results for CO_2 are presented in the form of flow-field profiles of pressure, temperature, density, enthalpy, and species concentration, and in the form of a relaxation distance behind the shock as a function of shock speed and ambient density. Author

N63-17548 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
INVESTIGATION OF CATALYST BEDS FOR 98-PERCENT-CONCENTRATION HYDROGEN PEROXIDE
Jack F. Runckel, Conrad M. Willis, and Leland B. Salters, Jr. Washington, NASA, June 1963 80 p 19 refs
(NASA TN D-1808) OTS: $2.00

An investigation of the effect of variation in screen composition and arrangement on the performance of 90- and 98-percent-concentration hydrogen peroxide catalyst beds has been made. Conventional catalyst beds with certain modifications were found to be suitable for use with 98-percent-concentration hydrogen peroxide. Up to 25 silver screens were used without excessive melting of silver, provided they were located at the upstream end of the bed. The use of 40-mesh silver screens afforded better starting response characteristics than 20-mesh screens. The use of 2-percent-concentration samarium nitrate, in lieu of 10 percent, was found to be adequate for treatment of silver screens under certain conditions. Bed life was sufficient for reaction-control-rocket missions. The tests covered environmental temperatures from 35° F to 82° F and a chamber pressure range from 100 to 315 pounds per square inch absolute.
Author

N63-18233 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio
THERMAL DECOMPOSITION OF SOME LINEAR PERFLUOROALKANES IN AN INCONEL BOMB
William L. Fielder Washington, NASA, July 1963 16 p 5 refs
(NASA TN D-1744) OTS: $0.50

Perfluoropropane was heated in an Inconel bomb between 663° and 1033° C. Up to about 750° C the products were, essentially, 1 mole of perfluoroethane, some perfluoroisobutene, and some polymeric fluorocarbon per mole of decomposed perfluoropropane. The rates of the decomposition reaction were observed between 670° and 719° C. The rate equation was calculated. Perfluoroethane was heated in the Inconel bomb between 746° and 990° C. Up to 824° C, 2 moles of polymeric fluorocarbon and 1 mole of metal fluoride per mole of decomposed perfluoroethane were produced. The rate equation was calculated from the data observed between 747° and 807° C. Carbon tetrafluoride was heated between 936° and 1090° C. Only a polymeric fluorocarbon and a metal fluoride were obtained. The rates of the decomposition were observed between 930° and 990° C. The rate equation was calculated.
Author

N63-18464 National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENTAL STUDIES OF BOWEN'S DECARBONATION SERIES, II. P-T UNIVARIANT EQUILIBRIA OF THE REACTION: FORSTERITE + CALCITE = MONTICELLITE + PERICLASE + CO_2
L. S. Walter Washington, NASA, July 1963 10 p 16 refs
(NASA TN D-1843) OTS: $0.50

The P-T univariant equilibrium curve for reaction A, calcite + forsterite = monticellite + periclase + CO_2, has been experimentally determined to pass through the points: 725° C, 1300 psi_{CO_2}; 850° C, 440 psi_{CO_2} and 925° C, 10,000 psi_{CO_2}. The curve is coincident, within the limits of experimental error, with curves for reactions B and C: 2 calcite + forsterite + diopside = 3 monticellite + $2CO_2$, and calcite + diopside = akermanite + CO_2, respectively. The P_{CO_2}–T field of stability of the assemblage monticellite-forsterite-calcite-CO_2 which lies between the curves for reactions A and B is thus very small. The forsterite-calcite assemblage is usually produced by contact metamorphism by granitic rock types. Equilibrium pressure curves for reaction A are derived.
Author

N63-18662 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio
EXPERIMENTAL INVESTIGATION OF CHEMICAL REGENERATION OF SURFACES IN SIMULATED THERMIONIC DIODES
Helmut F. Butze and Arthur L. Smith Washington, NASA, July 1963 21 p 4 refs
(NASA TN D-1877) OTS: $0.50

An investigation was conducted to determine the feasibility of combating the sublimation of emitter material in thermionic diodes by means of chemical reactions, designed to transport the sublimed material from the collector back to the emitter. Tests were conducted in a system consisting of a tungsten emitter, a tungsten collector, and chlorine gas. A sapphire light pipe embedded in the collector was used to monitor the deposition and, subsequently, the removal of condensed tungsten from the collector surface. At emitter temperatures of about 2170° to 2550° K and collector temperatures of about 1460° to 1730° K, previously deposited tungsten was removed from the collector at partial pressures of chlorine of 10^{-4} torr and greater. The experimental results were consistent with those obtained in analytical studies, that suggested chemical transport reactions involving halogens as a possible mechanism for maintaining the structural integrity of emitter and collector surfaces.
Author

N63-19650 National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center
COMPATIBILITY OF CESIUM VAPOR WITH SELECTED MATERIALS AT TEMPERATURES TO 1200° F
Jospey M. Lamberti and Neal T. Saunders Washington, NASA, Aug. 1963 44 p 21 refs
(NASA TN D-1739) OTS: $1.25

The test materials (refractory metals; iron-base, nickel-base, and copper-base alloys; precious metals; light metals; and some nonmetals) were tested for 48 hours at 500°, 800°, and 1200° F in cesium atmospheres at pressures of approximately 0.5, 28, and 267 torr, respectively. For comparison, control samples were tested under similar conditions of time and temperature in a vacuum of approximately 10^{-6} torr. The results of metallurgical examination of the test samples are reported, and, in some cases, the mode of reaction is postulated.
Author

N63-21484 National Aeronautics and Space Administration, Washington, D. C.
CHEMICAL EQUILIBRIA AND REACTION RATES AT HIGH PRESSURES
M. G. Gonikberg 1963 217 p 487 refs Transl. into ENGLISH of the book "Khimicheskoe ravnovesie i skorost' reaktsii pri vysokikh davleniyakh," 2nd ed. Moscow Acad. of Sci., 1960
(NASA TT F-95) OTS: $2.25

Various scientific aspects of applying high pressures in chemical reactions are discussed. The main laws governing chemical reactions under pressure are presented and are exemplified on several reactions of inorganic and mainly organic chemistry. Features of chemical reactions under pressure which cannot at present be understood or theoretically interpreted are also presented. Subjects covered in the manual include: chemical equilibria at high pressure, reaction rates at high pressure, and the effect of pressure on the rate and composition of products of complex chemical reactions.
P V E

08 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propogation. *For tracking stations see*: 10 Facilities, Research and Support. *For related information see*: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation and Photography; and 22 Navigation and Guidance.

N63-10177 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

TRACKING SYSTEMS, THEIR MATHEMATICAL MODELS AND THEIR ERRORS. PART I - THEORY

F. O. Vonbun and W. D. Kahn Washington, NASA, Oct. 1962 47 p 7 refs

(NASA TN D-1471) OTS: $1.25

This paper treats the errors associated with the position and velocity of a satellite or spacecraft when tracked by all types of present day tracking systems. These errors are based upon uncertainties in measurements made with the systems as well as uncertainties in the systems' location on the earth. The subject of these errors is treated in two parts. The present paper is mainly a theoretical treatment which establishes the necessary mathematical models and the method employed for solving the errors. A rigorous derivation of the "Method of Least Squares" is also presented for completeness since it is used to a large extent. Author

N63-13097 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A PRECISION ENDLESS-LOOP MAGNETIC TAPE RECORDER FOR SPACE APPLICATIONS

R. C. Falwell, K. W. Stark, and A. F. White Washington, NASA, Feb. 1963 20 p 3 refs

(NASA TN D-1542) OTS: 0.75

The tape recorder developed for the Tiros satellites is a miniaturized, low-power, two-speed recorder whose endless-loop tape cartridge stores 200 feet of ¼-inch lubricated magnetic tape. A two-phase 137.5-cps 14-vac hysteresis synchronous motor, requiring less than 0.300 watt, drives the tape at 0.4 inch/second for recording. During playback, a 500-rpm motor requiring less than 1 watt drives the tape at 12 inches/second. A transistorized d-c speed control unit maintains better than 1 percent regulation of this motor. Speed reduction from the motors to the capstan drive is obtained with reduction pulleys utilizing polyester film belts. Frictional drag from components not used during certain operating cycles is minimized by using spring clutches which prevent power drain on the motor. The record motor operates continuously, and spring clutches allow this motor to be overridden during the playback mode. Flutter and wow are maintained below 2.5 percent peak to peak from 0 to 1000 cps. This exceptional performance is made possible by an extremely accurate gyro-type capstan assembly. The capstan has maximum runouts of 5×10^{-5} inches and the assembly uses the duplex bearing and integral race technique. The bearings in this assembly are preloaded by means of a fixed center distance. This recorder has survived sinusoidal vibration at 10g from 0 to 2000 cps for ½ hour, and random vibration at 20g rms from 0 to 2000 cps for 4 minutes. A time-sharing switch, operated from the record mode reduction system, time-divides the information to be recorded. A playback timing switch, operated through a 16,650-to-1 gear reduction from the playback motor, activates a microswitch that cuts off power to the motor and resets the record mode electronics after a playback cycle of 3.33 minutes. Author

N63-13187 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SELF-ERECTING FLEXIBLE FOAM STRUCTURES FOR SPACE ANTENNAS

Victor L. Vaughan, Jr., and Edward L. Hoffman Washington, NASA, Mar. 1963 17 p 1 ref

(NASA TN D-1610) OTS: $0.50

The concept of using flexible foam for the erecting mechanism and supporting structure of erectable Yagi disk antenna-elements for use in a space environment has been investigated. Tests were made to determine the recovery and stress-strain properties of the foams as they pertain to the erectable elements, and the effects of some vacuum and simulated solar radiation on these properties. Full-scale erectable Yagi disk antenna-elements were investigated for packaging and erection ability, vibration damping in a vacuum, and temperature differential in a vacuum. The electrical performance characteristics of the erectable elements were compared with those of a standard element. There were no significant detrimental effects of the simulated space environment on the recovery properties and resilience of the foam. The packaging, erection, damping, and temperature differential properties of the erectable elements were acceptable within the tolerances necessary for normal antenna performance. The electrical performance characteristics of the undisturbed erectable elements were essentially the same as those of a standard element. Author

N63-18462 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

IN-FLIGHT AERODYNAMIC NOISE MEASUREMENTS ON A SCOUT LAUNCH VEHICLE

David A. Hilton, Emidio M. Bracalente, and Harvey H. Hubbard Washington, NASA, July 1963 19 p 11 refs

(NASA TN D-1818) OTS: $0.50

The results of free-flight surface-pressure measurements are presented for a Scout launch vehicle for Mach numbers up to about 4, free-stream dynamic pressures up to about 2,300 lb/sq ft, and Reynolds numbers based on vehicle length up to about 400 million. Useful data from two onboard microphones up to the time of second-stage ignition were telemetered to the ground station for recording and analysis. The overall surface-noise levels were noted to increase roughly as the dynamic pressure increased, but did not vary markedly as a function of Mach number. However, a Mach-number effect on the spectral content of the surface-noise pressures was noted as a general result of the tests. In particular, the spectra at the higher Mach numbers contained relatively more high-frequency noise and relatively less low-frequency noise than spectra measured at low speeds. The results of the tests are compared with available data from other free-flight studies. Author

09 ELECTRONICS

Includes circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory. *For related information see*: 06 Auxiliary Systems; 08 Communications; 15 Instrumentation and Photography; 22 Navigation and Guidance; and 25 Physics, Solid-State.

N63-10182 National Aeronautics and Space Administration, Washington, D.C.

MODES OF CONTROL

C. A. Harvey (Minneapolis-Honeywell Regulator Co.) Nov. 1962 15 p 1 ref Previously processed as preprint; for abstract see N62-14861 13-19

(NASA TN D-1589) OTS: $0.50

A linear autonomous system with a single control variable is considered. There are, in general, several modes of control for such a system. The concepts of single component regulation and multiple component regulation are defined. The relation between these modes of control is developed and an example is given to illustrate this relation. Author

N63-12704 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

MICROPOWER TRANSISTOR LOGIC CIRCUITS

John C. Sturman Washington, NASA, Feb. 1963 71 p 20 refs (NASA TN D-1462) OTS: $1.75

An analysis of low-power logic circuits suitable for satellite and space-vehicle use is presented. Special attention is given to two basic circuits differing from those normally used in that two transistors alternately clamp the output to the supply voltage or to ground. One circuit is adopted from a high-efficiency multivibrator; the other is an original circuit specifically developed for micropower use. Author

N63-13101 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A MAGNETIC CORE VOLTAGE-TO-FREQUENCY CONVERTER

Stephen Paull Washington, NASA, Feb. 1963 17 p 2 refs (NASA TN D-1677) OTS: $0.50

In a pulse frequency modulation (PFM) telemetering system, there is a need for a subcarrier oscillator with these characteristics: (1) operating frequency a linear function of a d.c. input control voltage, (2) high input impedance, (3) square wave output with constant amplitude over the entire frequency range, and (4) frequency stability within one cycle during gated on-off operation. This paper describes a method for controlling the frequency of a square-loop magnetic core oscillator by means of a d.c. voltage to give a voltage-to-frequency converter with the above characteristics. Various design considerations are discussed; and a voltage controlled oscillator that operates from 15 to 5 kc as the input control voltage varies from 0 to + 5 volts is used as the design example. Author

N63-14210 National Aeronautics and Space Administration, Washington, D.C.

TRANSISTORIZED VOLTAGE STABILIZER (STABILIZATOR NAPRYAZHENIYA NA POLUPROVODNYKH ELEMENTAKH)

I. M. Gershuni and A. N. Karaulov Apr. 1963 14 p 2 refs Transl. by Faraday Translations from Tsifrovaya Tekhn. i Vychislitel'nye Ustroystva (USSR), no. 3, 1962 p 110-115 (NASA TT F-155) OTS: $0.50

A seven-transistor voltage stabilizer with an output power of about 25 watts is described. Due to a relatively high amplification factor and the use of a current-stabilizing two-terminal network, the circuit insures a stabilization factor of the order of $2 \cdot 10^3$ to $3 \cdot 10^3$, the corresponding output resistance being not more than 0.005 ohm. By introducing a feedback coupling into the balancing stage of the amplifier, it is possible to limit the drift in output voltage associated with temperature changes to 3.3 mv/degree. Author

N63-16392 National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md

SPECTRALLY SELECTIVE PHOTODETECTORS FOR THE MIDDLE AND VACUUM ULTRAVIOLET

Lawrence Dunkelman, Walter B. Fowler, and John P. Hennes Washington, NASA, May 1963 13 p 32 refs Presented at the meeting of the Opt. Soc. of Am., Los Angeles, Oct. 1961 Submitted for Publication (NASA TN D-1759) OTS: $0.50

Numerous "solar blind" photodetectors have been developed in recent years. Measurements made on several phototubes with photocathodes of rubidium-tellurium, cesium-tellurium, cesium-iodine and copper-iodine are described. Cathode quantum efficiencies for semitransparent cathodes of rubidium-tellurium or cesium-tellurium range from 10^{-1} to 10^{-2} photoelectrons/quantum in the middle and vacuum ultraviolet, with long wavelength responses of less than 10^{-4} photoelectrons/quantum beyond about 3500A. By combining solar-blind cathodes with windows of LiF, CaF_2, or fused silica, detectors with relatively flat quantum efficiencies can be produced, marked by high sensitivities in specific ultraviolet spectral regions and by very low sensitivities at all longer wavelengths. Author

N63-18459 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

POWER TRANSISTOR COOLING IN A SPACE ENVIRONMENT

James E. A. John and John J. Hilliard Washington, NASA, July 1963 13 p 9 refs (NASA TN D-1753) OTS: $0.50

The cooling of power transistors was investigated in a space environment, where the only available mode of heat transfer is conduction to a heat sink and radiation from the heat sink to space. An attempt was made to minimize the thermal resistance between the transistor case and the heat sink, so that the transistor would dissipate as much power as possible while maintaining its temperature within the maximum tolerable level to prevent thermal runaway. Further, it was necessary to electrically insulate the transistor from the heat sink. Beryllium oxide washers provided electrical insulation and added very little to the thermal resistance between case and sink, the BeO being a good heat conductor. However, the problem of contact thermal resistance at each interface arose, especially in vacuum; this contact resistance provided practically all the thermal resistance between case and sink. The effect on the contact resistance of surface pressure, insertion of foil, and soldering was examined. It was concluded that, for the most efficient cooling, indium foil should be inserted at each interface, the indium foil having the effect of reducing the contact resistance in vacuum by a factor of 8. Author

N63-22572 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

SHEATH NEAR A PLANE ELECTRODE BOUNDING A COLLISIONLESS PLASMA IN A MAGNETIC FIELD NASA Technical Note

Arthur W. Goldstein NASA, Washington, D.C., Oct. 1963 39 p (NASA TN D-1992) OTS: $1.00

The entire transition region is treated as a unit by velocity-distribution functions. Self-consistent fields, currents, and charges are determined, as well as all components of the nonisotropic pressure tensors of ions and electrons. Numerical results are shown for hydrogen plasma. Author

N63-22709 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

GALVANOMAGNETIC EFFECTS IN POLYCRYSTALLINE MANY VALLEY SEMICONDUCTORS

John H. Marburger III Washington, NASA, Oct. 1963 28 p 16 refs (NASA TN D-1840) OTS: $0.75

Formal transport theory is used to derive expressions for the isothermal conductivity, Hall conductivity, and magnetoconductivity of semiconductors with anisotropic multivalley band structure. The theory is applied to quasi-isotropic polycrystalline materials and developed for arbitrary statistics and magnetic field strengths. An annotated bibliography is included. Author

10 FACILITIES, RESEARCH AND SUPPORT

Includes airports, lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations. *For related information see*: 06 Auxiliary Systems.

N63-10535 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRELIMINARY EVALUATION OF TWO JET-TRANSPORT SIMULATORS FOR THE INVESTIGATION OF LANDING-CONTACT CONDITIONS

Harold L. Crane Washington, NASA, Nov. 1962 21 p 3 refs
(NASA TN D-1495) OTS: $0.50

In order to determine whether jet-transport flight simulators would be suitable for research on factors which affect airplane landing-contact conditions, about 50 landings were recorded on each of two existing simulators of different manufacture. It was found that the vertical velocities at landing were much greater for the simulators than for the actual airplanes and, therefore, that these simulators, without further refinement, would not be suitable for this research application. Author

N63-10794 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESCRIPTION AND PRELIMINARY CALIBRATION TESTS OF A SMALL ARC-HEATED HYPERSONIC WIND TUNNEL

William B. Boatwright, Roger B. Stewart, and John E. Grimaud Washington, NASA, Dec. 1962 36 p 15 refs
(NASA-TN-D-1377) OTS: $1.00

A description, modification history, and results of preliminary calibration tests in a small hypersonic arc-heated wind tunnel are presented. Results obtained with different arc-heater configurations are described, and it is shown that the use of a 12,000-gauss magnetic field to rotate the arc offers distinct advantages over an arc-heater configuration with a 4,000-gauss magnetic field. Comparisons of the different configurations are made with regard to performance, steadiness, electrode erosion, and contamination. Results of pitot-pressure surveys in the 5° half-angle conical nozzle and the cylindrical test section of this tunnel at a stagnation pressure of 12 atmospheres and a stagnation temperature of 3,600° K are presented. Measurements of the total heat transferred to a section of the tunnel which included the throat are compared with theoretical predictions. Author

N63-13098 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN, OPERATION, AND TESTING CAPABILITIES OF THE LANGLEY 11-INCH CERAMIC-HEATED TUNNEL

Otto F. Trout, Jr. Washington, NASA, Feb. 1963 33 p 23 refs
(NASA TN D-1598) OTS: $1.00

General design problems are reviewed for ceramic heat exchangers operating at temperatures up to 4,500° R for heating air for supersonic free jets and wind tunnels. Supersonic water-cooled nozzles and premixed-gas combustion equipment have been designed for this type of facility. A description of the Langley 11-inch Mach 6 ceramic-heated tunnel and the Langley 4-inch Mach 4 ceramic-heated airjet utilizing a 4,500° R zirconia heat exchanger is presented. Author

N63-13182 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

LOW-POWER TEST OF THE PLUM BROOK REACTOR

Harold W. Giesler, Harry J. Reilly, and William A. Poley Washington, NASA, Feb. 1963 50 p 11 refs
(NASA TN D-1560) OTS: $1.25

The initial criticality and subsequent low-power tests of the NASA Plum Brook Reactor core are described. Results of control-rod calibrations, flux mapping, and other measurements are given. The minimum critical size core was found to consist of 11 elements in a 3 x 3 + 2 lattice containing about 1.78 kilograms of uranium 235. The cold clean 3 x 9 core with 168-gram elements had an excess reactivity of 12.0 percent. The maximum differential reactivity worth of the bank of five fueled shim-control rods was measured to be about 2 percent reactivity per inch, and the total worth of each automatically controlled regulating rod was not more than 0.6 percent reactivity. The reactor temperature coefficient was an average of -0.0075 percent reactivity per °F over the range 70° to 170° F. The void coefficient was -0.25 percent reactivity for each percent moderator void, for up to 8 percent total moderator void. Thermal neutron flux traverses of the core indicated the highest fluxes to be in elements LB-6, LC-6, and LD-6, and that the flux peaking increased about 50 percent as the rods were inserted halfway into the core. The relative distributions and the magnitudes of the fluxes were also determined, both in the core and outside the core. Gamma heating measurements were made, and some of the results are shown. Author

N63-14811 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

SIMILITUDE IN THERMAL MODELS OF SPACECRAFT

S. Katzoff Washington, NASA, Apr. 1963 29 p 3 refs
(NASA TN D-1631) OTS: $0.75

Scaling criteria for the design and testing of thermal models of spacecraft are discussed. Four dimensionless similitude parameters are derived concerning radiation, internal heat generation, thermal conductivities of materials, and heat capacities of materials. Difficulties in achieving accurate simulation are pointed out, and methods of effecting comprises without seriously affecting the validity of the data are suggested. The most difficult problems appear to be the accurate scaling of thermal conductivity and heat capacity. For manned spacecraft, some additional discussion is given of similitude criteria for the convective heat transfer. Author

N63-15345 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

A 6-INCH SUBSONIC HIGH-TEMPERATURE ARC TUNNEL FOR STRUCTURES AND MATERIAL TESTS

Ronald D. Brown and L. Ross Levin Washington, NASA, Apr. 1963 33 p 13 refs
(NASA TN D-1621) OTS: $1.00

A subsonic arc tunnel utilizing three-phase a.c. water-cooled copper electrodes has been developed at Langley Research Center to evaluate materials under simulated reentry conditions. The tunnel is capable of producing a range of stagnation pressures from 0.16 to 1.0 atmospheres and stagnation temperatures up to 4400° K for periods of time up to 90 seconds. Heat-transfer rates up to 70 Btu/ft^2-sec can be obtained on a 3-inch-diameter flat-face body in the 6-inch-diameter stream. Ablation materials can be evaluated in the stream at stagnation enthalpies up to 4000 Btu/lb. Three commercially available materials, Teflon, nylon, and Fluorogreen, were tested as ablation materials in the 6-inch subsonic arc tunnel, and the results are in reasonable agreement with theoretical predictions and previously published experimental data. Author

N63-15562 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

MOVING-COCKPIT-SIMULATOR STUDY OF PILOTED ENTRIES INTO THE EARTH'S ATMOSPHERE FOR A CAPSULE-TYPE VEHICLE AT PARABOLIC VELOCITY

John W. Young and Lawrence E. Barker, Jr. Washington, NASA, May 1963 11 p 1 ref
(NASA TN D-1797) OTS: $0.50

A description is presented of a moving-cockpit-simulator study relating to entry guidance for a low-lift-drag-ratio vehicle entering the earth's atmosphere at parabolic velocity. The primary goal of this study was to determine the effect of angular motions on the ability of the pilot to perform the maneuvers required during super-

circular entry, and to compare the pilot's performance on the moving simulator with that obtained from similar entries on a fixed-base simulator Consideration was also given to the development of a minimum instrument display for which the pilot used motion cues to aid him in performing the entry maneuvers The study established a pilot preference for the moving simulator rather than a fixed-base simulator Author

N63-15563 National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

A PRELIMINARY STUDY OF HANDLING-QUALITIES REQUIREMENTS OF SUPERSONIC TRANSPORTS IN HIGH-SPEED CRUISING FLIGHT USING PILOTED SIMULATORS

Maurice D White, Richard F Vomaske, Walter E Mc Neill, and George E Cooper Washington, NASA, May 1963 31 p 13 refs (NASA TN D-1888) OTS $0 75

Two different simulators were used in a piloted motion simulator study to obtain preliminary handling-qualities data on a supersonic transport in cruising flight at a Mach number of 3 0 Results indicate that, for configurations currently being considered for the supersonic transport, augmentation of the rotational damping characteristics is likely to be required around all three axes, the greatest increment being required for the yaw axis The static stability characteristics, however, appear to require less augmentation than the damping characteristics The problem of limiting the sideslip excursions following abrupt loss of thrust of an outboard podded engine contributed greatly to the requirements for directional damping and stability The satisfactory handling-qualities characteristics defined for a transport airplane by this study differ from those defined in previous studies of fighter-type airplanes, and indicate a need for a separate appraisal of transport handling-qualities requirements Accurate appraisal of the effects of large disturbances of the airplane requires simulator capabilities that reproduce translational as well as rotational motions Author

N63-19177 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

TECHNIQUES USED TO MEASURE THE HYDRAULIC CHARACTERISTICS OF THE NASA PLUM BROOK REACTOR

Joseph M Savino and Chester D Lanzo Washington, NASA, Aug 1963 73 p 4 refs (NASA TN D-1725) OTS $2 00

Details are given on techniques employed to measure the reactor flow characteristics Test results include a discussion of a flow problem that was encountered and the changes that corrected it Once the modifications were made, coolant flow rates and pressure distributions of all the reactor components satisfied design requirements for full-power and shutdown operations Removable rakes with total- and static-pressure probes measured the velocity and static-pressure distributions among the fuel-cooling channels of the assemblies and rod Similar probes for use in the core tests were perfected, and found to be accurate, fast responding, and highly dependable Velocity and static-pressure distributions and overall pressure losses were within design requirements A pair of simulated fuel assemblies, each containing a turbine flowmeter, were built to have the same overall pressure loss against flow rate characteristics as the typical Plum Brook Reactor fuel assemblies These instruments measured the steady flow rates in all the fuel-assembly positions of the core to within 1 percent Flow rates were measured throughout the coastdown period The time required for the flow rate to decrease to 10 percent of the full flow value was 15 seconds Author

11 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; 13 Heat Transfer and Thermodynamics; and 24 Physics, Plasma.

N63-10206 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTION INDUCED ON A FLAT PLATE AT A FREE-STREAM MACH NUMBER OF 1.39 BY ROCKETS EXHAUSTING UPSTREAM AND DOWNSTREAM

Abraham Leiss Washington, NASA, Nov. 1962 55 p 6 refs (NASA TN D-1507; supersedes NASA TM X-129) OTS: $1.50

Results are presented of jet effects obtained on a flat plate located adjacent to a rocket jet exhausting at a Mach number of 3, both downstream and upstream into a free-stream flow at a Mach number of 1.39. Pressure measurements on the flat plate were tabulated for 11 test positions and rocket-exit total-pressure ratios from 6 to 60. Author

N63-10336 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

CAVITATION AND NONCAVITATION PERFORMANCE OF AN 80.6° FLAT-PLATE HELICAL INDUCER AT THREE ROTATIONAL SPEEDS

Donald M. Sandercock, Richard F. Soltis, and Douglas A. Anderson Washington, NASA, Nov. 1962 82 p 14 refs (NASA TN D-1439) OTS: $2.25

A flat-plate helical inducer with a tip helix angle of 80.6° was operated at three rotor speeds in water in order to obtain the performance of this type of inducer and to observe any scale effects associated with a change in speed. The test rotor had three blades, a tip diameter of 5 inches, and a hub-tip radius ratio of 0.5. Both hub and tip radii were held constant across the rotor. Similar inlet flow conditions were maintained at the three different speeds by operating at constant values of normalized net positive suction head. The performance results are presented as overall performance and as radial distributions of both flow conditions (at rotor inlet and outlet) and selected blade-element performance parameters. In addition to indicating performance levels, the radial distributions describe the type of flow patterns occurring across the rotor and show the radial variations of flow conditions a succeeding blade row, or pump, would have to accept over a range of operating conditions. Author

N63-11514 National Aeronautics and Space Administration, Washington, D.C.

GAS DYNAMICS IN SPACE EXPLORATION

H. Julian Allen, Alvin Seiff, Thomas N. Canning, Glen Goodwin, and John T. Howe 1962 52 p 110 refs Papers presented at Session R of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29) (NASA-SP-24) GPO: $0 40

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3. RECENT DEVELOPMENTS IN THE CHEMISTRY AND THERMODYNAMICS OF GASES AT HYPERVELOCITIES T. N. Canning (NASA. Ames Research Center) 8 p 15 refs
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N63-12245 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A VISUAL STUDY OF A TWO-PHASE FLOW IN A VERTICAL TUBE WITH HEAT ADDITION

Yih Yun Hsu and Robert W. Graham Washington, NASA, Jan. 1963 23 p 14 refs

(NASA TN D-1564) OTS: $0.75

A visual study of two-phase flow with heat addition from the wall has been performed in two glass-tube geometries. The flow regimes of bubbly, slug flow and transition from slug to annular flow were recorded by a high-speed motion-picture camera. Appreciable differences between adiabatic two-phase flow, or two-component flow, and nonadiabatic two-phase flow were observed. These differences emphasize the interaction of the heat transfer and the hydrodynamics in two-phase flow and the inadequacy of adiabatic studies in the accuracy portrayal of the flow model. Author

N63-12262 National Aeronautics and Space Administration, Washington, D.C.

GAS DYNAMICS AND PHYSICS OF COMBUSTION A Collection of Articles

R. Hardin and A. S. Predvoditelev (Acad. of Sci. USSR), eds. Jerusalem, 1962 176 p 46 refs Transl. by A. Barouch of book "Gazodinamika i fizika goreniya" Moscow, Izdatel'stvo Akad. Nauk SSSR, 1959

(Published for NASA and NSF)

(NASA TT F-79) OTS: $1.75

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N63-12478 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

HEAT TRANSFER IN LAMINAR FLOWS OF INCOMPRESSIBLE FLUIDS WITH $Pr \to 0$ AND $Pr \to \infty$

Ernst W. Adams Washington, NASA, Feb. 1963 42 p 23 refs

(NASA TN D-1527) OTS: $1.25

Exact closed-form solutions of the boundary-layer equations can be derived for the Nusselt number Nu(x) at the leading edge $x = 0$ and, in the limits $Pr \to 0$ and $Pr \to \infty$, on the surface $x \geq 0$ of arbitrary bodies in planar uniform flow. Exact and approximate solutions for Nu(x)/Nu(0) in the range of $0 < Pr < \infty$ are compared to the results of the $Pr \to 0$ and the $Pr \to \infty$ methods. It is shown theoretically and confirmed by the numerical results that the $Pr \to 0$ method yields an upper limit for Nu(x)/Nu(0). The presented examples show that the $Pr \to \infty$ method yields a lower limit for Nu(x)/Nu(0) in case of slender bodies. In the cases for which similarity solutions exist, both methods yield the exact solution for $Nu(x)/Nu(x^*)$ where x^* is any reference station. By use of exact stagnation point solutions for $Nu(0)/\sqrt{Re}$, the $Pr \to 0$ and the $Pr \to \infty$ methods may be applied to obtain engineering estimates of the heat-transfer parameter $Nu(x)/\sqrt{Re}$. Author

N63-12930 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THEORETICAL INVESTIGATION OF UNSTEADY DIFFUSION WITH RECOMBINATION IN A TERNARY MIXTURE OF DIATOMIC MOLECULES, DISSOCIATED ATOMS, AND AN INERT GAS

Walter A. Reinhardt Washington, NASA, Feb. 1963 35 p 6 refs

(NASA TN D-1651) OTS: $1.00

An experiment is suggested wherein measurements can be made on parameters leading to the determination of the homogeneous reaction and diffusion rates of oxygen atoms. This is done by studying the decay in the periodic time variation in concentration of atoms. The system to be investigated includes a ternary gas mixture of diatomic molecules, dissociated atoms, and an inert gas. A theoretical investigation is made, starting with equations obtained from rigorous kinetic theory and chemical kinetics, of the unsteady diffusion and recombination processes applicable to the experiment. Boundary conditions are investigated. A qualitative result is given which illustrates the dependence of the decay in the concentration variation on sink strength and frequency. Author

N63-13792 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SURFACE PRESSURE DISTRIBUTIONS INDUCED ON A FLAT PLATE BY A COLD AIR JET ISSUING PERPENDICULARLY FROM THE PLATE AND NORMAL TO A LOW-SPEED FREE-STREAM FLOW

Raymond D. Vogler Washington, NASA, Mar. 1963 33 p 6 refs

(NASA TN D-1629) OTS: $1.00

An investigation was made to determine the pressure distribution on the surface of a flat plate induced by a round cold-air jet and a rod. Data are presented as pressure-coefficient contours on the plate for various jet and free-stream veleocities associated with transition flight speeds of VTOL aircraft. The jet produces a region of positive pressures upstream of the jet and a larger region of negative pressures laterally and downstream of the jet. This negative pressure

field extends 8 or 10 jet diameters from the jet, is intensified by an increase in jet velocity, and is swept downstream by an increase in free-stream velocity. Author

N63-13949 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECTS OF AIR CONTENT AND WATER PURITY ON LIQUID TENSION AT INCIPIENT CAVITATION IN VENTURI FLOW

Robert S. Ruggeri and Thomas F. Gelder Washington, NASA, Mar. 1963 46 p 7 refs
(NASA TN D-1459) OTS: $1.25

Cavitation of demineralized, tap, and distilled water was induced on the walls of a venturi having a 1.377-inch throat diameter in a closed-return liquid tunnel. The occurrence and magnitude of local tensile stresses in the liquid at incipient-cavitation conditions were studied over a range of air content. Local tensile stresses at incipience of visible cavitation were independent of water type and air content, and ranged from 5 to 23 feet of water for free-stream velocities from 20 to 45 feet per second, respectively. Tensile stresses at incipience of audible cavitation varied considerably with air content of the water but were generally less than those obtained at the visible threshold. Visible incipient cavitation was of the fixed type and always occurred as a practically instantaneous burst of vapor bubbles in the region of minimum pressure. Venturi cavitation was unsteady for all degrees of cavitation and stream velocities studied. Author

N63-14207 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXTENSION OF ESTIMATED HYPERSONIC FLOW PARAMETERS FOR HELIUM AS A REAL GAS

Wayne D. Erickson Washington, NASA, Apr. 1963 23 p 5 refs
(NASA TN D-1632) OTS: $0.75

The various hypersonic flow parameters for helium have been estimated by use of the Beattie-Bridgeman equation-of-state for helium at stagnation pressures up to 50,000 lb/sq in. abs and stagnation temperatures up to 10,000° F. Calculations were limited to densities below the critical density. The results were obtained to establish reasonable estimates of the departure from ideal-gas behavior over a broad practical range of stagnation pressure and temperature at Mach numbers up to 100. The results are presented as correction factors which are to be applied to ideal-gas parameters for a specific-heat ratio of 5/3. Author

N63-14278 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A COMPARISON OF EXPERIMENTAL AND THEORETICAL RESULTS FOR THE COMPRESSIBLE TURBULENT-BOUNDARY-LAYER SKIN FRICTION WITH ZERO PRESSURE GRADIENT

John B. Peterson, Jr. Washington, NASA, Mar. 1963 56 p 29 refs
(NASA TN D-1795) OTS: $1.50

Seven theories of compressible turbulent-boundary-layer skin friction were compared with experimental data in order to determine their accuracy. The seven theories used for comparison were those of Van Driest; Wilson and Van Driest; Cope, Monaghan, and Johnson; and Winkler and Cha; and the T' methods of Sommer and Short, Monaghan, and Eckert. The data were obtained from 21 sources, and covered a range of Mach numbers up to 10, and Reynolds number up to 68×10^6 at zero heat transfer and 100×10^6 with heat transfer. The comparison between the theories and experiment was made on one curve by performing a transformation on the experimental data, and the results showed that the Sommer and Short T' method most accurately matched the experimental data. Curves to aid in the calculation of skin friction by the Sommer and Short T' method are presented. Also presented are two new methods of finding the virtual origin of the compressible turbulent boundary layer. Author

N63-15323 National Aeronautics and Space Administration. Washington, D.C.

ON THE FLOW STRUCTURE WITHIN A CONSTANT PRESSURE COMPRESSIBLE TURBULENT JET MIXING REGION

W. L. Chow and H. H. Korst (Illinois U.) Apr. 1963 33 p 11 refs
(NASA Grant NsG-13-59)
(NASA TN D-1894) OTS: $1.00

Results are presented from the numerical calculations carried out to produce detailed information on the kinematic, dynamic, dissipative, and thermodynamic characteristics of a uniform half-infinite stream, mixing with a quiescent fluid of the same composition. An effective Prandtl number of $Pr_t = 1$ is assumed for the constant pressure, nonisoenergetic turbulent mixing process. The ratio of specific heat becomes absorbed by selecting Crocco number instead of Mach number as measure for the compressibility, thus allowing generalization of the results to any perfect nonreacting gas having constant specific heat. After identifying a functional form for the streamwise component of the velocity profile, a single empirical mixing parameter becomes well defined and can be absorbed in a rational presentation of structural details of jet mixing regions, such as the vertical-velocity component, temperature and density distribution, integrals describing flow of mass, momentum, mechanical energy, the transfer of shear work and heat across individual streamlines, as well as local and integrated dissipation rates for mechanical energy. Author

N63-15509 National Aeronautics and Space Administration, Washington, D.C.

AN INVESTIGATION OF RESONANT, NONLINEAR, NONPLANAR FREE SURFACE OSCILLATIONS OF A FLUID

R. E. Hutton Washington, NASA; May 1963 67 p 5 refs
(NASA Contract NASr-80)
(NASA TN D-1870) OTS: $1.75

A theoretical investigation was conducted of the motion of fluid in a tank, subjected to lateral harmonic vibration at a frequency in the neighborhood of the lowest resonant frequency of the mass of fluid. The investigation indicates that nonplanar fluid motion is due to a nonlinear coupling between fluid motions parallel and perpendicular to the plane of excitation, and that this coupling takes place through the free-surface waves. These theoretical conclusions were experimentally confirmed using a cylindrical tank about 12 inches in diameter and partially filled with water to a depth of about 9 inches. Author

N63-15561 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

RATE OF LIQUID JET BREAKUP BY A TRANSVERSE SHOCK WAVE

Gerald Morrell Washington, NASA, May 1963 28 p 13 refs
(NASA TN D-1728) OTS: $0.75

The breakup of a single water jet by a transverse shock was studied experimentally in a 2.7- by 2.7-inch shock tube equipped with a variable-length high-pressure section. High-speed backlighted photographs were analyzed to obtain breakup time and liquid deformation. Breakup time decreased regularly with an increase in gas velocity and increased with jet radius. The extent of deformation was a linear function of the ratio of Weber number to the square root of Reynolds number based on initial jet radius. A theoretical model was developed based on stripping from a liquid-phase boundary layer, and an explicit function for breakup time resulted. The calculated breakup times were found to be in fair agreement with the measured values. Author

N63-15693 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

PERFORMANCE CAPABILITY OF SINGLE-CAVITY VORTEX GASEOUS NUCLEAR ROCKETS

Robert G. Ragsdale Washington, NASA, May 1963 70 p 20 refs
(NASA TT D-1579) OTS: $1.75

An analysis was made to determine the maximum powerplant thrust-to-weight ratio possible with a single-cavity vortex gaseous reactor in which all the hydrogen propellant must diffuse through a fuel-rich region. An assumed radial temperature profile was used to represent conduction, convection, and radiation heat-transfer effects. The effect of hydrogen property changes due to dissociation and ionization was taken into account in a hydrodynamic computer program. It is shown that, even for extremely optimistic assumptions of reactor criticality and operating conditions, such a system is limited to reactor thrust-to-weight ratios of about 1.2×10^{-3} for laminar flow. For turbulent flow, the maximum thrust-to-weight ratio is less than 10^{-3}. These low thrusts result from the fact that the hydrogen flow rate is limited by the diffusion process. The performance of a gas-core system with a specific impulse of 3000 seconds and a powerplant thrust-to-weight ratio of 10^{-2} is shown to be equivalent to that of a 1000-second advanced solid-core system. It is therefore concluded that a single-cavity vortex gaseous reactor in which all the hydrogen must diffuse through the nuclear fuel is a low-thrust device and offers no improvement over a solid-core nuclear-rocket engine. To achieve higher thrust, additional hydrogen flow must be introduced in such a manner that it will bypass the nuclear fuel. Author

N63-15762 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

BOUNDARY-LAYER DISPLACEMENT EFFECTS IN AIR AT MACH NUMBERS OF 6.8 AND 9.6

Mitchel H. Bertram. Washington, NASA, 1959. 27 refs
(NASA TR R-22; Supersedes NACA-TN-4133) GPO: $0.40

Measurements are presented for pressure gradients induced by a laminar boundary layer on a flat plate in air at a Mach number of 9.6, and for the drag of thin wings at a Mach number of about 6.8 and zero angle-of-attack. The pressure measurements at a Mach number of 9.6 were made in the presence of substantial heat transfer from the boundary layer to the plate surface. The measured pressure distribution on the surface of the plate was predicted with good accuracy by a modification to insulated-plate displacement theory which allows for the effect of the heat transfer and temperature gradient along the surface on the boundary-layer displacement thickness. The total drag of thin wings with square and delta planforms was measured at a nominal Mach number of 6.8 over a reasonably wide range of Reynolds numbers. The total drag was found to be greater than can be explained by adding a classical value of laminar skin friction to the estimated pressure drag. The difference is, in general, explained by the increase in skin friction (20 to 40 percent) caused by the boundary-layer-induced pressures. Author

N63-15768 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

HYDROMAGNETIC STAGNATION-POINT BOUNDARY LAYER WITH ARBITRARY PRESSURE GRADIENT AND MAGNETIC FIELD

Willis H. Braun. Washington, NASA, May 1963. 36 p. 13 refs
(NASA TN-D-1703) OTS: $1.00

The series-expansion method of H. Gortler is applied to the two-dimensional stagnation flow about symmetric bodies with symmetric distributions of magnetic field. Numerical computations are presented from which skin friction and heat transfer can be calculated through third-order in a modified surface coordinate, provided the external velocity, magnetic field, and enthalpy are known. A small magnetic Reynolds number is assumed, the Prandtl number is taken to be unity. The three chosen values of an interaction parameter represent magnetic fields in which the component normal to the wall has values at the stagnation point that are zero, small, and large. Author

N63-16162 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

NUMERICAL SOLUTION OF AXIALLY SYMMETRIC POISSON EQUATION: THEORY AND APPLICATION TO ION-THRUSTER ANALYSIS. APPENDIX C: IBM 7090 ION-THRUSTOR FORTRAN CODE AND BLOCK DIAGRAM.

Vladimir Hamza and Carl D. Bogart. Washington, NASA, May 1963. 59 p. 4 refs
(NASA TN-D-1711) OTS: $1.50

The axially symmetric Poisson equation is solved for mixed boundary conditions by a method of successive approximations in which the differential equation is replaced by finite-difference equations. Properties of the resulting matrix are studied. The theory of "regular splittings" is applied together with the Cyclic Chebyshev Semi-Iterative Method to solve the matrix equation. Also included is a numerical example, solved on an IBM-7090 computer, for a hollow, cylindrical ion beam. Author

N63-16186 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC INTERACTION EFFECTS AHEAD OF RECTANGULAR SONIC JETS EXHAUSTING PERPENDICULARLY FROM A FLAT PLATE INTO A MACH NUMBER 6 FREE STREAM

David J. Romeo. Washington, NASA, May 1963. 30 p. 9 refs
(NASA TN-D-1800) OTS: $0.75

The aerodynamic interaction effects ahead of a three-dimensional rectangular jet exhausting perpendicularly from a flat plate have been investigated at a free-stream Mach number of 6. The interaction pressure distribution ahead of the slot center line was similar to, and approached quantitatively, the results of a two-dimensional jet slot. The ratio of aerodynamic to reaction normal force was sizable and, in general, was largest at the smallest slot widths and largest jet pressure ratios. The aerodynamic normal-force coefficient was comparable to two-dimensional results if the ratio of slot span to slot width was kept above a value dictated by the slot width. This value increased rapidly as the slot width decreased. Author

N63-16601 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL INVESTIGATION OF THE SLOSH-DAMPING EFFECTIVENESS OF POSITIVE-EXPULSION BAGS AND DIAPHRAGMS IN SPHERICAL TANKS

Andrew J. Stofan and Irving E. Sumner. Washington, NASA, June 1963. 20 p. 10 refs
(NASA TN-D-1712) OTS: $0.50

An experimental investigation was conducted to evaluate the slosh-damping effectiveness of positive expulsion bags and diaphragms in spherical tanks ranging in size from 9.5 to 32 inches in diameter. The scaling effects for sloshing forces and damping ratios were determined for the butyl rubber positive-expulsion devices tested. The maximum slosh forces that occur at the first natural-mode frequency increased with an increase in excitation amplitude and decreased as the diaphragm material thickness increased. The damping ratio (or logarithmic decrement) was found to be essentially independent of the excitation amplitude and increased with an increase in diaphragm material thickness. The second natural-mode force peak and the fluid swirl at the natural-mode frequencies, which were observed for the unrestricted liquid sloshing, were completely suppressed. Author

N63-16745 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

VIBRATIONAL-NONEQUILIBRIUM FLOW OF NITROGEN IN HYPERSONIC NOZZLES

Wayne D. Erickson. Washington, NASA, June 1963. 29 p. 10 refs
(NASA TN-D-1810) OTS: $0.75

Quasi-one-dimensional calculations of the free-stream flow parameters in hypersonic nozzles for nitrogen with consideration of vibrational-nonequilibrium effects have been carried out. The results were obtained for stagnation temperatures from 1,000° K to 5,000° K, and are presented in the form of charts that may be used to estimate the vibrational-nonequilibrium effect of nitrogen in a hypersonic nozzle. The corresponding frozen-flow and equilibrium-flow results are also presented. Author

N63-16746 National Aeronautics and Space Administration, Washington, D.C.

EXPERIMENTAL AND THEORETICAL STUDIES ON THE FORMATION OF DETONATION WAVES IN VARIABLE GEOMETRY TUBES

Loren E. Bollinger, Michael C. Fong, James A. Laughrey, and Rudolph Edse (Ohio State U., Rocket Research Lab.) June 1963 81 p 17 refs

(NASA Grant NsG-44-60)

(NASA TN-D-1983) OTS: $2.25

Detonation induction distances were obtained experimentally for hydrogen–oxygen mixtures having fuel concentrations of 45, 66.67, and 75 percent hydrogen at initial pressures of 1 and 5 atmospheres in a detonation tube with variable internal geometry. When three stainless-steel rods of different diameters were located concentrically in the initiation region of a tube, the induction distances decreased as the diameter of the rods was increased. Increased turbulence and the generation of stronger pressure waves from the various geometrical configurations cause significant decrease in detonation induction distances in variable geometry tubes of the type investigated. When a combustion wave reaches an area discontinuity or a rod-insert, pressure waves are generated which strongly influence the transition process from deflagration to detonation. The mechanism of turbulence generation is quite important when obstacles are placed in the flow field. Author

N63-16990 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON THE BREAKDOWN VOLTAGES OF SOME ELECTRONEGATIVE GASES AT LOW PRESSURES

Stefan Schreier. Washington, NASA, June 1963 11 p 15 refs

(NASA TN-D-1761) OTS: $0.50

The breakdown voltages of five Freon gases and SF_6 were measured at low pressures between parallel plates to determine their insulating properties under these conditions, and especially to find their minimum breakdown voltages. It was found that the advantages of these gases over air are much less at low pressures than at atmospheric pressure or higher and that the use of these gases as insulators at low pressures is therefore limited. Preliminary investigations revealed, however, that the vapors of compounds that are liquid at normal temperature and pressure, such as FC-75, maintain their dielectric strength much better than do electronegative gases as the pressure is reduced, and thus seem to be promising for use as insulators at low pressures. Author

N63-17551 National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

THE PROPAGATION OF PLANE ACOUSTIC WAVES IN A RADIATING GAS

Barrett Stone Baldwin, Jr. (Ph.D. Thesis–Stanford U.) Washington, NASA, 1962 58 p 35 refs

(Supported by NSF Grant)

(NASA TR R-138) GPO: $0.55

A study is made of the interaction of thermal radiation with fluid flow in the acoustic approximation. The analysis is developed for the case of a frequency-dependent absorption coefficient of a gas in thermal equilibrium and for quasi-equilibrium radiation. A previously given solution for the case of sinusoidal variations in position of an adjacent wall is used in superposition to find the response for an impulsive motion of the wall. Results are also given for the response to a sudden temperature change of a fixed wall. The validity of the linear approximation of the original nonlinear equations is investigated. The validity of other approximations, used in the derivations, is also examined. Author

N63-18471 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

SIMILARITY SOLUTIONS FOR SMALL CROSS FLOWS IN LAMINAR COMPRESSIBLE BOUNDARY LAYERS

Ivan E. Beckwith. Washington, GPO, 1961 28 p 8 refs

(NASA TR R-107) GPO: $0.40

The compressible laminar boundary-layer equations for an arbitrary three-dimensional body are reduced to a form analogous to the corresponding equations for axisymmetric flow. This simplification results from the use of a streamline coordinate system and the assumption that the component of boundary-layer flow normal to the external streamline (cross flow) is small. The streamwise skin friction and heat-transfer distributions on the arbitrary body are then independent of the cross flow. Formulas for computing these distributions are adapted from a local similarity method originally derived for a body of revolution. Author

N63-19179 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

DIRECTIONAL BEHAVIOR OF EMITTED AND REFLECTED RADIANT ENERGY FROM A SPECULAR, GRAY, ASYMMETRIC GROOVE

John R. Howell and Morris Perlmutter. Washington, NASA, Aug. 1963 43 p 7 refs. Previously announced as a preprint, see N62-12889 08-21

(NASA TN D-1874) OTS: $1.25

The directional emissivity and directional reflectivity of a specular, gray, isothermal groove are analyzed. A general method of analysis based on images of surfaces is given. The apparent directional emissivity, which is shown to be equal to the apparent directional absorptivity for any isothermal cavity, is presented as a function of groove parameters and the emissivity of the material. The apparent directional reflectivity is presented as a function of these parameters and the angle-of-incidence of the incident radiation. The results indicate that the directional radiant properties are strongly dependent on the shape of the local macroscopic surface structure, which is considered large relative to the wavelengths of the radiant energy. It is shown that the radiant-energy interchange between surfaces can be directed and controlled by proper design of these surfaces. Author

N63-19608 National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center

APPLICATION OF DORODNITSYN'S INTEGRAL METHOD TO NONEQUILIBRIUM FLOWS OVER POINTED BODIES

Jerry C. South, Jr. Washington, NASA, Aug. 1963 44 p 20 refs

(NASA TN D-1942) OTS: $1.25

Dorodnitsyn's integral method is used to obtain an approximate solution to the supersonic nonequilibrium flow over pointed bodies with attached shock waves. The partial differential equations governing the flow are converted to an approximate set of ordinary equations, which are solved by numerical integration starting at the body tip. Detailed analytical and numerical results for the first approximation are presented, considering the vibrational relaxation of a diatomic gas over a wedge or cone. It is shown that the first approximation yields (1) the exact flow-variable gradients at the wedge tip, (2) expressions for the flow-variable gradients at the cone tip which are in agreement with extrapolations of characteristics calculations, (3) a good

approximate algebraic solution for frozen or equilibrium conical flow; and (4) an approximate expression for the nonequilibrium-flow stream function which affords a means of obtaining variations across the shock layer of the temperature and vibrational energy. Numerical results for both the wedge and cone compare favorably with identical cases computed by the method of characteristics. Author

N63-20604 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

STUDY OF THE EFFECT OF A CLOSED-END SIDE BRANCH ON SINUSOIDALLY PERTURBED FLOW OF LIQUID IN A LINE

William Lewis, Robert J. Blade, and Robert G. Dorsch. Washington, NASA, Sept. 1963. 20 p. 4 refs.
(NASA TN D-1876) OTS: $0.50

Classical undamped acoustic-wave theory was used to determine analytical relations among sinusoidal perturbations of pressure and flow at the ends of a hydraulic-transmission line having a closed-end branch of arbitrary length attached at an arbitrary point. Experimental data were obtained for the equilateral case (a branch half as long as the main line connected to the main line at the midpoint) at mean flow speeds of 5 to 10 feet per second. Measured pressure-perturbation ratios agreed closely with analytical predictions. At frequencies for which the branch length was an odd multiple of 1/4 wavelength, waves in the main line were almost completely reflected at the junction point. Author

N63-21073 National Aeronautics and Space Administration, Washington, D.C.

APPLIED FLUID DYNAMICS [PRIKLADNAYA GIDROGAZODINAMIKA]

I. P. Ginzburg. 1963. 264 p. 69 refs. Transl. into ENGLISH 1958 Izdatel'stvo Leningradskogo Universiteta
(Published for NASA and NSF)
(NASA TT F-94, IPST Cat. 809) OTS: $2.75

"Applied Fluid Dynamics" discusses some of the problems of fluid mechanics which are frequently met with in the engineering design of various assemblies and engineering installations. New methods are presented for the solution of the problems of steady and unsteady flow of liquids and gases in pipes, their influx from vessels, problems of the filling and emptying times of vessels, the effect of a jet on a barrier, water hammer problems and other problems of fluid mechanics.
C. L. W.

N63-22114 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EVALUATION OF AN ELECTROMAGNETIC SHOCK TUBE FOR GENERATING STRONG SHOCKS IN AIR

James F. Roach. Washington, NASA, Oct. 1963. 39 p. 35 refs.
(NASA TN D-1953) OTS: $1.00

The shocks were driven by the discharge of a high-voltage low-inductance capacitor bank. A rotating-mirror camera was used to examine the highly luminous flow generated by the low-pressure discharge. Luminous front speeds between 0.4 and 4.0 cm/μsec were obtained in a range of initial shock-tube pressures from 10 to 1,000 microns of mercury. The luminous waves were reflected off a downstream plug, and the reflected speeds were found to be roughly a factor of 2 greater than those predicted by one-dimensional equilibrium shock theory. Time-integrated spectra of the discharge were obtained in the spectral region 3,500 Å to 5,000 Å. Author

N63-23358 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INVESTIGATION OF THE VIBRATION CHARACTERISTICS OF PRESSURIZED THIN-WALLED CIRCULAR CYLINDERS PARTLY FILLED WITH LIQUID

John S. Mixson and Robert W. Herr. 1962. 39 p. refs. Previously processed as a thesis; for abstract see N62-13600, 10-32.
(NASA TR R-145) GPO: $0.45

Equations are derived for the calculation of the natural frequencies of shell vibration of pressurized, thin-walled, circular cylinders which are empty, partly filled, or full of liquid. In this type of vibration the axis of the cylinder is undeformed and the cross-section shape deforms during the vibration. The derivation follows a Rayleigh–Lagrange procedure, in which expressions for kinetic and potential energy are developed in terms of the displacements of the cylinder, the displacement shapes are assumed, and Lagrange's equations are applied to give a set of linear, simultaneous equations of motion which, upon substitution of simple harmonic motion, yield a frequency determinant. Both calculated and experimental results show that when the cylinders are greater than half full, their frequencies are less than half of the corresponding frequencies of cylinders when empty. Also, the damping of a water-filled cylinder was found experimentally to be less than the damping of the empty cylinder. Author

12 GEOPHYSICS

Includes auroral phenomena; upper atmosphere studies; oceanography; cartography; geodesy; and geomagnetism. *For Van Allen belts see*: 28 Space Radiation. *For related information see*: 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

N63-10988 National Aeronautics and Space Administration, Washington, D.C.

SPECTRAL, ELECTROPHOTOMETRICAL, AND RADAR RESEARCHES OF AURORAE AND AIRGLOW

V. I. Krasovskiy, ed. Dec. 1962. 78 p. 6 refs. Transl. of "Spektral'nyye, elektrofotometricheskiye i radiolokatsionnyye issledovaniya polyarnykh siyaniy i svecheniya nochnogo neba" IGY Program, Section IV, No. 5, Academy of Sciences, USSR (Moscow) 1961
(NASA-TT-F-106) OTS: $2.00

The contents, fourteen articles, were presented at a special seminar of the Section on the Physics of the Upper Atmosphere of the Atmospheric Physics Institute of the Academy of Sciences, USSR, held on April 25-27, 1960. Author

N63-11503 National Aeronautics and Space Administration, Washington, D.C.

GEOPHYSICS AND ASTRONOMY IN SPACE EXPLORATION

Eleanor C. Pressly, Robert E. Bourdeau, George H. Ludwig, James E. Kupperian, Jr., and Nelson W. Spencer. 1962. 45 p. 96 refs. Papers presented at Sessions F and G and of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962. (See N63-11501, 03-29)
(NASA-SP-13) GPO: $0.35

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N63-12159 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE IMPEDANCE OF AN ELECTRICALLY SHORT ANTENNA IN THE IONOSPHERE

H. A. Whale Washington, NASA, Jan. 1963 11 p 4 refs Presented at The Inst. of Phys. and The Phys. Soc. Conf. on "The Ionosphere", London, July 1962
(NASA TN D-1546) OTS: $0.50

Measurements from rocket flights are used to show that the impedance of a short antenna operating above the local plasma frequency can be predicted if the following factors are considered: (1) the formation of an ion sheath around the antenna and the vehicle, (2) the enhancement of this sheath when large RF voltages are applied to the antenna, and (3) the loading that apparently arises from electroacoustic waves excited in the medium by the RF field close to the antenna. Sufficient design data are included to calculate the effect of the ionosphere on both the resistive and reactive parts of the impedance of a short antenna. Author

N63-12702 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A MODEL OF THE QUIET IONOSPHERE

J. Carl Seddon Washington, NASA, Feb. 1963 14 p 13 refs
(NASA TN D-1670) OTS: $0.50

Analysis of high-altitude-rocket electron and ion density measurements suggests a simple model of the quiet ionosphere. Near $h_{max}F_2$ the profile is given by the "α-Chapman" function, that is, the Chapman electron density equation with sec $\chi = 1$ and the scale height H a constant. A method is given for determining $h_{max}F_2$, $N_{max}F_2$, and H from N(h) data obtained from ionograms. Well above the peak, the profile is taken to have a constant exponential slope of 200 km during the day and 150 km at night. If simultaneous nearby measurements of the total electron content are available, a more accurate slope may be computed to provide the profile up to about 1000 km altitude. Author

N63-13719 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NOTE ON THE THICKNESS OF THE HELIUM ION LAYER

S. J. Bauer Washington, NASA, Mar. 1963 7 p 18 refs
(NASA TN D-1686) OTS: $0.50

On the basis of recent experimental results as well as theoretical considerations of the temperature dependence of the light constituents (hydrogen and helium) in the upper atmosphere, a model of the helium ion belt—the heliosphere—is constructed. The thickness of the helium ion layer varies significantly with atmospheric temperature: about 2000 km at 1600° K and only about 200 km at 600° K. Correspondingly, charged particle profiles in the topside ionosphere may show a slope corresponding to He^+ at high temperature, but not at low temperatures when the thickness of the helium ion layer is comparable to or less than the scale height of helium ions. Author

N63-13720 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PRELIMINARY MEASUREMENTS OF TEMPERATURES AND WINDS ABOVE 50KM OVER WALLOPS ISLAND, VIRGINIA

William Nordberg and Wendell Smith Washington, NASA, Mar. 1963 15 p 19 refs
(NASA TN D-1694) OTS: $0.50

Seventeen successful rocket grenade experiments were conducted at Wallops Island, Va. (38°N lat.), during the period July 1960 to June 1962. The purpose of these soundings was to describe further the atmosphere above 40 km within the framework of a previous analysis based on the IGY results at high and low latitudes. The soundings were distributed through all seasons; some were conducted in conjunction with sodium release (above 80 km) and small meteorological-rocket experiments (below 50 km). Preliminary results from the first ten grenade soundings are presented here. Comparison of grenade with sodium results shows an abrupt change in the physical nature of the circulation pattern between 70 and 80 km. Below this altitude, the previously described seasonal circulation pattern exists while above it no regular seasonal variations can be detected. The most characteristic phenomenon for this region is the very narrow jet-stream-like band of wind at the 100-km level combined with extremely high wind shears. The temperature structure at Wallops Island indicates the same mesospheric heating in wintertime as has been observed at Churchill. During periods of undisturbed easterly circulation, summer temperature profiles at Wallops Island exhibit the same features as typical low-latitude profiles previously observed. When the easterly circulation becomes disturbed, the temperature profile becomes very similar to previously observed summertime profiles at Churchill. During wintertime, the atmosphere over Wallops Island still lies within the region of a strong cyclonic vortex. Author

N63-13821 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE MAGNETIC FIELD OF THE QUIET-TIME PROTON BELT

Syun-Ichi Akasofu, Sydney Chapman (Alaska U.), and Joseph C. Cain Washington, NASA, Mar. 1963 7 p 4 refs Previously announced as a preprint, see N63-11783 04-12
(NASA TN D-1674) OTS: $0.50

The distortion of the earth's magnetic field produced by the proton belt is discussed. The magnetic field is calculated numerically, to a first approximation, for an analogous model belt, in a steady state. In the equatorial plane, at the earth's surface, it is estimated that the magnetic field produced by this belt is of the order of 38 gammas; it is directed southward. The maximum field reduction is of the order of 72 gammas at 4.1 earth radii; this is 15.5 percent of the dipole field intensity at this point. Beyond 6.7 earth radii, the belt increases the earth's field. Author

N63-13838 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

FIRST TOPSIDE SOUNDINGS OF THE IONOSPHERE

J. E. Jackson, R. W. Knecht (Natl. Bur. of Standards), and S. Russell (Cutler Hammer. Airborne Instr. Lab.) Washington, NASA, Mar. 1963 18 p 6 refs
(NASA TN D-1538) OTS: $0.50

The first radio-pulse soundings of the topside of the ionosphere were obtained during two recent rocket flights at the NASA Wallops Island, Virginia, facility. These tests are part of the NASA topside sounder satellite program, whose primary objective is to investigate the ionosphere above the height of the F2 maximum. On June 24, 1961, a two-frequency radio-pulse sounder was carried to an altitude of about 1060 km by a four-stage solid-propellant rocket. Reflections from the topside of the ionosphere were obtained on one or both frequencies during 13 of the 15 minutes the payload was above the maximum electron density level in the ionosphere. Unexpected effects were observed as the sounder passed through the levels in the ionosphere where the plasma frequency was equal to the sounding frequency; some evidence of ionization irregularities at altitudes between 700 and 950 km was obtained. A second rocketborne sounder was launched during disturbed ionospheric conditions on October 13, 1961, with the same type of vehicle. "Spread F" returns were obtained during the first portion of the flight, in addition to the normal topside echoes. This paper presents the results of the rocket tests and reviews the overall NASA topside sounder satellite program. Author

N63-13859 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A STUDY OF THE FREE OSCILLATIONS OF THE EARTH

Gordon J. F. Mac Donald and Norman F. Ness Washington, NASA, 1962 49 p 53 refs

(NASA TR-R-136) GPO: $0.50

Published observations on the toroidal oscillations of the earth dre critically reviewed. A supplementary analysis of the record obtained by the Lamont strain seismometer is presented. Eleven toroidal modes are identified and it is concluded that the periods are known to within one percent. A perturbation scheme involving the ratio of the earth's angular velocity to the resonant frequency is used in calculating the effects on the resonant frequency due to the earth's rotation. The perturbations of the toroidal oscillations due to core-mantle interaction are treated in detail. Author

N63-14012 National Aeronautics and Space Adminstration, Washington, D.C.

INTERNATIONAL GEOPHYSICAL YEAR BIBLIOGRAPHY OF LITERATURE PUBLISHED IN RUSSIAN IN 1960

R. F. Zatrutina and L. S. Rubina Mar. 1963 195 p 1172 refs Transl. of the book "Mezhdunarodnyy geofizicheskiy god. Bibliograficheskiy ukazatel' literatury na russkom yazyke za 1960 g.", 4th ed. Moscow, Acad of Sci., 1961

(NASA TT F-109) OTS: $3.00

This bibliography contains about 1,200 references to publications issued in 1960. All nongeophysical data are excluded; it contains only material based on observations and experiments carried out as part of the IGY program, including the International Geophysical Cooperation period (1959). Author

N63-14027 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ELECTRON DENSITY DISTRIBUTION IN THE UPPER F-REGION

S. Chandra Washington, NASA, Mar. 1963 12 p 16 refs

(NASA TN D-1751) OTS: $0.50

A modified Chapman function with a variable scale height gradient has been found to be in good agreement with the electron-density distribution obtained experimentally within the height range of about 100 km below the F_2 peak to an altitude of about 700 km. The scale height distribution derived from this model is also consistent with the neutral-gas scale height of the 1961 COSPAR International Reference Atmosphere. Author

N63-14273 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

WIND FLOW IN THE 80-400 KM ALTITUDE REGION OF THE ATMOSPHERE

George C. Ragsdale and Peter E. Wasko Washington, NASA, Mar. 1963 40 p 54 refs

(NASA TN D-1573) OTS: $1.25

Wind data were obtained in the 80- to 400-km ionospheric region of the atmosphere, and summarized into useful forms for interpretation and deducing wind flow characteristics in these high atmospheric regions for use in space-vehicle-design studies. As a first approximation, the deductions of the wind flow characteristics in the region, based on this study, can be applied to the Cape Canaveral, Florida, area. The most important wind measurement techniques presently used are described. Wind data obtained by the sodium vapor trail method are presented and discussed with respect to wind direction, wind speed, wind vector, and wind shear characteristics. Monthly mean zonal and meridional cross sections for the 30- to 40-degree-latitude belt were constructed for the 80- to 200-km region and interpreted. Additional winds above 200 km from ionospheric drift measurements and from some recent sodium vapor trail measurements are used to deduce wind flow conditions in the 200- to 400-km region. The most important deductions of the wind flow characteristics in the 80- to 400-km region are summarized. Author

N63-15692 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

AN EVALUATION OF DETAIL WIND DATA AS MEASURED BY THE FPS-16 RADAR/SPHERICAL BALLOON TECHNIQUE

James R. Scoggins Washington, NASA, May 1963 34 p 4 refs

(NASA TN D-1572) OTS: $1.00

This report presents and evaluates a method for measuring detail winds at high altitudes with an accuracy several times better than any current operational all-weather system. The method presented consists of tracking an aluminized spherical balloon with the FPS-16 radar, and subsequent data reduction and analysis to obtain wind data. Two techniques for reducing tracking data to obtain wind data are presented. These consist of statistical and polynomial approaches for eliminating measurement errors in the tracking data. Computer programs for data reduction were developed and are presented in outline form. Author

N63-16163 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ION SHEATH EFFECTS NEAR ANTENNAS RADIATING WITHIN THE IONOSPHERE

H. A. Whale Washington, NASA, May 1963 16 p 8 refs Submitted for Publication

(NASA TN-D-1746) OTS: $0.50

A theoretical treatment of the electron displacement in the vicinity of a linear cylindrical antenna immersed in the ionosphere has been developed. This treatment explains the surprisingly thick ion sheaths observed experimentally when large RF voltages are applied to the antenna The force that displaces the electrons is obtained from numerical solutions to the nonlinear differential equation describing their motion, and the results are consistent with the observations. Author

N63-16292 National Aeronautics and Space Administration, Washington, D.C.

THE EFFECT OF REFRACTION ON THE SETTING SUN AS SEEN FROM SPACE IN THEORY AND OBSERVATION

Winifred Sawtell Cameron, John H. Glenn, M. Scott Carpenter, and John A. O'Keefe May 1963 10 p 3 refs

(NASA TN-D-1721) OTS: $0.50

The theory of refraction predicts that the setting sun or moon, as seen from space, should be highly flattened. The Mercury Project Manned Space Flights MA-6 and MA-7 have provided photographs of the phenomenon. To compare theory with observation, B. Garfinkel's Method I of computing refraction for large zenith distances was used to construct theoretical solar profiles for four true-zenith distances of the center of the setting sun for comparison with the photographs taken by Glenn and Carpenter. Author

N63-16994 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

TESSERAL HARMONICS OF THE GRAVITATIONAL FIELD AND GEODETIC DATUM SHIFTS DERIVED FROM CAMERA OBSERVATIONS OF SATELLITES

William M. Kaula Washington, NASA, June 1963 20 p 28 refs

(NASA TN D-1848 OTS: $0.75

Baker–Nunn Camera observations of satellites 1959 $\alpha 1$ over 315 days, 1959 η over 105 days, and 1960 $\iota 2$ over 294 days were analyzed for 35 spherical harmonic coefficients of the earth's gravitational field and for position shifts of six geodetic datums. Of the three satellites, only 1960 $\iota 2$ appeared to have a sufficiently good observation distribution and small enough drag effects to yield significant results. The datum shifts obtained have standard deviations averaging ± 25 m in each coordinate. The gravitational harmonic coefficients obtained appear to be appreciably different from zero for indices (n, m) at (2,2), (3,1), (4,1) and (4,3). Author

N63-17141 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE MAGNETIC FIELD OF THE RADIATION BELTS
Syun-Ichi Akasofu (Alaska U.) and Joseph C. Cain Washington, NASA, June 1963 10 p 5 refs
(NASA TN D-1762) OTS: $0.50

The magnetic fields produced by various types of belts of trapped particles are presented, in both tabular and graphical forms. Author

N63-17311 Geophysics Corp. of America, Bedford, Mass.
PLANETARY AERONOMY VI: ELECTRON TEMPERATURES IN THE IONOSPHERE
M. B. Mc Elroy, R. J. Moffett (Queen's U.), and A. Dalgarno Nov. 1962 62 p 26 refs
(NASA Contract NASw-395)
(NASA CR-12; GCA-TR-62-11-N) OTS: $6.60 ph, $2.06 mf

Detailed calculations are described of the rate of heating of the ambient electrons arising from solar ultraviolet radiation, and it is shown that the resulting difference between the electron temperature and the gas temperature at noon in a quiet ionosphere may reach a maximum value lying between 800° K and 1500° K at an altitude near 200 km, but the difference vanishes below about 120 km and above about 400 km. Author

N63-17317 Geophysics Corp. of America, Bedford, Mass.
PLANETARY AERONOMY XII: THE ROLE OF INTERPLANETARY DEBRIS IN PLANETARY ATMOSPHERES: I. SODIUM IN THE EARTH'S ATMOSPHERE
F. F. Marmo and H. K. Brown Mar. 1963 38 p 19 refs
(NASA Contract NASw-395)
(NASA CR-13; GCA-TR-63-4-N) OTS: $3.60 ph, $1.34 mf

Investigations of planetary atmospheres are conducted to explain the extraterrestrial origin of sodium. First, sodium in the Earth's atmosphere is examined to check the validity of the physical-mathematical model, boundary conditions, and parametric values employed. Second, with identical debris influx rates assumed for both Venus and Mars, the distribution of sodium in their atmospheres is calculated. All computations are presented on a relative scale for ready comparison. Results indicate that there is considerable more free sodium in the atmospheres of Venus and Mars than that which exists in the Earth's atmosphere. This is apparently due to the fact that the total oxygen contents of the atmospheres of Venus and Mars are believed to be about 1 part in 10^5 of that of Earth. I.v.L.

N63-17318 Geophysics Corp. of America, Bedford, Mass.
PLANETARY AERONOMY XIII: ELECTRON AND ION TEMPERATURES IN THE IONOSPHERE
A. Dalgarno Apr. 1963 20 p 12 refs
(NASA Contract NASw-701)
(NASA CR-8; GCA-TR-63-11-N) OTS: $1.60 ph, $0.80 mf

The relationships between the temperatures of the electrons, positive ions, and neutral particles of the ionosphere are discussed. On the basis of the heating due to solar ultraviolet radiation, it is felt that the electron and ion temperatures will become equal at high altitudes, and that both tend to increase above the neutral particle temperature. Anomalously high values of the electron temperature, accompanied by a red glow, are predicted to occur in the region of 400 km during the dawn period. The expected diurnal and latitudinal variations of the electron temperature are described. Author

N63-18458 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLES IN THE INNER VAN ALLEN BELT
Wilmot N. Hess Washington, NASA, July 1963 40 p 71 refs
(NASA TN D-1749) OTS: $1.25

A survey is given of the high-energy particle populations in the inner radiation belt. The experiments which have given information about particles are discussed, and the best experimental information about particle fluxes and spectra is presented. Calculations are given which indicate what particle sources and loss processes are most important. The role of neutrons in making the inner belt is considered in detail, and the need for particle acceleration and/or other sources of particles is shown. Author

N63-18472 National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.
THEORETICAL DETERMINATION OF THE FORM OF THE HOLLOW PRODUCED IN THE SOLAR CORPUSCULAR STREAM BY INTERACTION WITH THE MAGNETIC DIPOLE FIELD OF THE EARTH
John R. Spreiter and Benjamin R. Briggs Washington, GPO, 1961 29 p 16 refs
(NASA TR R-120) GPO: $0.40

The interaction between a neutral stream of ionized solar corpuscles and a three-dimensional magnetic dipole representing the geomagnetic field is investigated. It is assumed that the stream is confined to the exterior and the magnetic field to the interior of a hollow, the boundary of which is defined by a thin current sheath. An approximate method of solution is applied, and results are presented for the coordinates of the trace of the boundary of the hollow in the meridian plane containing the sun–earth line and the dipole axis for several relative orientations. Results are also presented for the trace in the equatorial plane for the case in which the dipole axis is normal to the sun–earth line. The corresponding problem in two dimensions is also considered, and it is shown that the analogous approximate results are in good agreement with the results indicated by an exact solution of the same basic equations. Author

N63-19605 National Aeronautics and Space Administration. Greenbelt, Md. Goddard Space Flight Center
MASS SPECTROMETRIC INVESTIGATIONS OF THE ATMOSPHERE BETWEEN 100 AND 227 KILOMETERS ABOVE WALLOPS ISLAND, VIRGINIA
Edith Meadows-Reed and Charles R. Smith Washington, NASA Aug. 1963 18 p 23 refs
(NASA TN D-1851) OTS: $0.50

The diffusive separation of argon and nitrogen was measured by means of a Bennett radiofrequency mass spectrometer carried on an Aerobee-150A rocket, NASA 4.14, launched at 1141 EST, November 15, 1960. The primary purpose of the spectrometer measurements was to obtain temperate-latitude diffusive-separation data to compare with those measurements obtained in the arctic (Fort Churchill, Canada) during the International Geophysical Year. The results indicated that diffusive separation occurred above about 111 km, and that the altitude profile of the A/N_2 ratio is somewhat similar to that obtained during the two night flights in the arctic atmosphere. Author

N63-20603 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE INFRARED HORIZON OF THE PLANET EARTH
R. A. Hanel, W. R. Bandeen, and B. J. Conrath Washington, NASA, Sept. 1963 25 p 18 refs
(NASA TN D-1850) OTS: $0.75

Horizon sensors are essential elements in the orientation systems of many space vehicles and satellites. The design of horizon sensors, as well as an evaluation of their capabilities and limitations, requires a knowledge of the spectral radiance

emitted by the earth. This report investigates the discontinuity between the surface, the atmosphere, and outer space for various latitudinal, seasonal, climatic, and meteorological conditions. Calculations are carried out for the following five spectral intervals: the water vapor band from 6.33 to 6.85 microns, the ozone band from 8.9 to 10.1 microns, the atmospheric window from 10.75 to 11.75 microns, the carbon dioxide band from 14 to 16 microns, and finally the rotational water vapor band from 21 to 125 microns. The superior properties of the carbon dioxide band and the rotational water vapor region for horizon-sensor purposes are shown. Author

N63-21271 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A MICROMETEOROID VELOCITY DETECTOR

Frank Neuman (Stanford U.) Washington, NASA, Sept. 1963 58 p 13 refs

(NASA TN D-1977) OTS: $1.50

A feasibility study for a particular type of particle velocity detector is made. The detector considered consists of two light screens with known spacing. A particle penetrating the successive light screens scatters light which is detected by means of photomultiplier tubes. The time difference between the photomultiplier tube outputs is a measure of the particle velocity. Author

N63-21272 National Aeronautics and Space Administration, Washington, D.C.

IONOSPHERIC WINDS: MOTIONS INTO NIGHT AND SPORADIC *E* CORRELATIONS

N. W. Rosenberg, H. D. Edwards, and J. W. Wright (Georgia Inst. of Tech.) Sept. 1963 19 p 10 refs Presented at the COSPAR Meeting, Warsaw, June 1963

(NASA Grant NsG-304-63)

(NASA TN D-2114) OTS: $0.50

The persistence of night winds and shears for more than 5 hours after sunset at altitudes between 100 and 150 km was evaluated. Comparisons are made between the winds and shears observed under night conditions with those for the preceding twilight period. These data tend to verify the correlation between wind shear and sporadic E. Author

N63-22602 National Aeronautics and Space Administration, Washington, D.C.

THE DIFFERENTIATION OF RARE-EARTH ELEMENTS IN THE MAGMATIC PROCESS [DIFFERENTSIATSIYA REDKOZEMEL'NYKH ELEMENTOV V MAGMATICHESKOM PROTSESSE]

Yu. A. Balashov 1963 23 p 23 refs Transl. into ENGLISH from Khim. Zemnoy Kory: Tr. Geokhimicheskoy Konf., Posvyashchennoy Stoletiyu so dyna Rozhdeniya Akad. V. I. Vernadskogo (Moscow), v. I, 1962 p 352-365

(NASA TT F-179) $0.75

Results of studies made on the distribution of rare-earth elements in the magmatic process, using a series of alkaline intrusions in the Kola Peninsula, the syenitic complex of Kzyl-Ompul, and the Susamyr granitoid batholith, are presented. The following areas of study are discussed: (1) distribution of rare-earth elements in alkaline rocks, alkaline intrusions of agpaitic type, alkaline intrusions of miaskitic type, alkaline intrusions of the intermediate type, and general distribution patterns of rare-earth elements in alkaline rocks, (2) distribution of rare-earth elements in intrusive complex of increased alkalinity, (3) distribution of rare-earth elements in granitoids of geosynclinal type of differentiation, and (4) two directions in evolution of composition of rare-earth elements: principal feature of their geochemistry at magmatic stage P V E.

N63-23678 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION TOPSIDE SOUNDER PROGRAM

L. J. Blumle, R. J. Fitzenreiter, and J. E. Jackson Washington, NASA, Nov. 1963 23 p refs

(NASA TN D-1913) OTS: $0.75

The Topside Sounder Program is reviewed with particular emphasis upon the fixed-frequency topside sounder satellite. A comparison of the design of the *fixed*-frequency topside sounder with that of the Alouette (1962 $\beta\alpha$), the recent Canadian *swept*-frequency topside sounder, reveals the complementary features of their scientific objectives and the basic differences in the technologies employed. Author

13 HEAT TRANSFER AND THERMODYNAMICS

Includes ablation; cooling; heating; and other thermal effects. *For aerothermodynamics see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings, Rotors, and Control Surfaces. *For combustion see*: 26 Propellants and Combustion. *For related information see*: 11 Fluid Mechanics.

N63-10173 National Aeronautics and Space Administration, Washington, D.C.

HEAT-TRANSFER CHARACTERISTICS OF SEVERAL RADIATOR FINNED-TUBE CONFIGURATIONS

W. J. Minkowycz (Minnesota U.) and E. M. Sparrow Nov. 1962 47 p 6 refs

(NASA TN D-1435) OTS: $1.25

An analytical study was performed to provide information on the heat loss to space from three radiator finned-tube configurations in which there is radiant interaction between fins and tubes. Numerical results for the heat-transfer characteristics of these configurations were obtained under the condition that the surfaces are blackbody radiators. A comparison showed the heat-loss results for the various configurations to be of very similar magnitude for equal fin weight. A method of analysis for the case of nonblack diffuse surfaces was also formulated. Author

N63-10175 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ON THE EFFECT OF HEAT ADDITION IN THE EMPIRICAL CORRELATION OF VOID FRACTIONS FOR STEAM-WATER FLOW

Uwe H. von Glahn and Richard P. Polcyn Washington, NASA, Nov. 1962 38 p 13 refs

(NASA TN D-1440) OTS: $1.00

An empirical equation is presented that closely approximates experimentally measured void fractions in steam-water flow obtained with heat addition to the fluid in terms of the steam quality, the ratio of the density of the fluid phases, a heat-addition parameter, and a fluid-property parameter. Author

N63-10207 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HELIUM FILM COOLING ON A HEMISPHERE AT A MACH NUMBER OF 10

Robert E. Dannenberg Washington, NASA, Nov. 1962 27 p 13 refs

(NASA TN D-1550) OTS: $0.75

A shock-tunnel investigation has been made of the heat-transfer rate to a hemisphere at a stagnation temperature of 8,700° R. Models tested were equipped for tangential injection of

a helium film coolant in the stagnation region. Thermocouple measurements were made of the reduction in local heat transfer for various coolant flow rates and two injection arrangements. The range of the ratio of velocities at the helium-air interface at injection was from 1.2 to 6. Author

N63-10534 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HEAT TRANSFER AND PRESSURE DISTRIBUTIONS ON A HEMISPHERE-CYLINDER AND A BLUFF-AFTERBODY MODEL IN METHANE-AIR COMBUSTION PRODUCTS AND IN AIR

Irving Weinstein Washington, NASA, Dec. 1962 32 p 7 refs
(NASA TN D-1503) OTS: $1.00

Heat-transfer and pressure-distribution data were obtained for hemisphere-cylinders and bluff-afterbody models. The tests were conducted in the test medium of methane-air combustion products and in air alone at Mach numbers from 6 to 9. The results show that the data obtained in the combustion products are in reasonably good agreement with the data obtained in air alone, and can be predicted satisfactorily with existing theories. Author

N63-10733 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

HEAT TRANSFER TO A SPHERE WITH A RETROROCKET EXHAUSTING INTO A FREE STREAM; MACH 2.0 AND 0.8

Robert A. Wasko Washington, NASA, Nov. 1962 20 p 3 refs
(NASA TN-D-1535) OTS: $0.50

A sphere with a flush-mounted lox - JP-4 retrorocket was tested in the Lewis 8- by 6-foot tunnel at freestream Mach numbers of 2.0 and 0.8 for a range of angle of attack, combustion-chamber pressure, and oxidant-fuel ratio. Effects of test variables on the spherical surface heat flux, heat-transfer coefficients, recovery temperatures, and static pressures are presented. Author

N63-10798 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A FREE-FLIGHT INVESTIGATION OF ABLATION OF A BLUNT BODY TO A MACH NUMBER OF 13.1

Clyde W. Winters, William G. Witte, Bernard Rashis, and Russell N. Hopko Washington, NASA, Dec. 1962 23 p 11 refs
(NASA-TN-D-1500) OTS: $0.75

A five-stage rocket-propelled research-vehicle system was flown to a maximum Mach number of 13.1 at an altitude of approximately 78,000 feet to determine ablation characteristics of Teflon in free flight. Continuous in-flight measurements were made using sensors developed by the National Aeronautics and Space Administration. The sensors were located on the blunted face of a nose cone constructed from Teflon, with one at the stagnation point and two others at a surface distance of 0.62 radius on opposite sides of the stagnation point. The ablated-length measurements were in close agreement with analytical predictions. The analytical predictions, upon inclusion of the pertinent material property values, should be applicable to other materials as well as Teflon. Author

N63-10991 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HEAT-TRANSFER AND PRESSURE MEASUREMENTS ON A FLAT-PLATE SURFACE AND HEAT-TRANSFER MEASUREMENTS ON ATTACHED PROTUBERANCES IN A SUPERSONIC TURBULENT BOUNDARY LAYER AT MACH NUMBERS OF 2.65, 3.51, and 4.44

Paige B. Burbank, Robert A. Newlander, and Ida K. Collins Washington, NASA, Dec. 1962 424 p 15 refs
(NASA TN D-1372) OTS: $6.00

The influence of surface projections, both totally and partially immersed in a turbulent boundary layer, on the distribution of heat-transfer coefficients has been determined on 20 configurations. Surface projections cause separations of the local flow; the extent of these separations both upstream and downstream and the magnitude of the resultant interference heat-transfer coefficients are dependent upon the size and cross-sectional shape of the projection, Mach number, Reynolds number, and boundary-layer thickness. The configurations of this investigation include both three-dimensional simple shapes and hardware-type configurations tested on a flat plate with a turbulent-boundary-layer-thickness variation of approximately 10 to 1. The extent of the interference region can be defined by static-pressure measurements, oil-flow technique, or by heat-transfer measurements. Author

N63-11742 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

NITROGEN AND OXYGEN ATOM RECOMBINATION AT OXIDE SURFACES AND EFFECT OF TESLA DISCHARGE ON RECOMBINATION HEAT TRANSFER

George M. Prok Washington, NASA, Jan. 1963 19 p 27 refs
(NASA TN D-1567) OTS: $0.50

Recombination coefficients for nitrogen and oxygen atoms on metallic oxides of calcium, copper, chromium, germanium, iron, and zinc were determined over a small temperature range. Also, the effect caused by a Tesla discharge on the recombination heat transfer of nitrogen and oxygen atoms at surfaces of copper, copper oxide, iron, iron oxide, calcium oxide, and zinc oxide was observed. The recombination coefficient results show that the recombination efficiency of a surface can increase, decrease, or remain constant with increasing temperature, depending on the surface and the recombining atoms. The Tesla discharge always caused a decrease in the recombination heat transfer of oxygen atoms; the average decrease was about 12 percent. For nitrogen atoms, the Tesla discharge caused a maximum increase in the recombination heat transfer of 6.4 percent at a zinc oxide surface and a maximum decrease of 43.7 percent at a copper oxide surface. Author

N63-12597 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECT OF LARGE-AMPLITUDE OSCILLATIONS ON HEAT TRANSFER

Charles E. Feiler and Ernest B. Yeager Washington, GPO, 1962 26 p 26 refs
(NASA TR R-142) GPO: $0.40

The heat transfer from a heated flat plate to an airstream having large-amplitude flow oscillations was studied. The oscillation frequency was varied from 34 cps to 680 cps. The root-mean-square oscillation amplitude was as much as 65 percent of the mean flow rate. In the presence of oscillations, the heat-transfer coefficient was increased by as much as 65 percent when compared with the coefficient at the same mean flow rate in the absence of oscillations. High-speed schlieren movies of the thermal boundary layer revealed that flow reversal occurred near the plate surface at each frequency during a portion of the period of oscillation. The mean flow velocity ranged from about 30 to 100 feet per second. Author

N63-13950 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL PRESSURES AND TURBULENT HEAT-TRANSFER COEFFICIENTS ASSOCIATED WITH SINUSOIDAL PROTUBERANCES ON A FLAT PLATE AT A MACH NUMBER OF 3

Charles P. Shore, Sidney C. Dixon, and George E. Griffith Washington, NASA, Mar. 1963 29 p 7 refs
(NASA TN D-1626) OTS: $0.75

An exploratory investigation was made to determine the local effects on aerodynamic heating produced by three-dimensional sinusoidal-type skin buckles of various depths. Tests were made at a Mach number of 3.0, a stagnation pressure of 200 pounds per square inch absolute, a stagnation temperature of 500° F, and a free-stream Reynolds number per foot of approximately 14×10^6. Temperatures were obtained from one set of test specimens, pressures

from another. The test results, presented in terms of Stanton numbers and pressure coefficients, show that marked increases or decreases in aerodynamic heating and pressure can result from changes in contour produced by skin buckles. Author

N63-13965 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

SUBCOOLED BOILING HEAT TRANSFER UNDER FORCED CONVECTION IN A HEATED TUBE

S. Stephen Papell Washington, NASA, Mar. 1963 23 p 14 refs (NASA-TN D-1583) OTS: $0.75

Single- and two-phase heat-transfer data were obtained by using distilled water flowing through an Inconel X resistance-heated tube. The nonboiling data were correlated with a Colburn-type equation that was modified to include the boiling phenomena by means of three significant parameters obtained by dimensional analysis from basic considerations. Comparable heat-transfer data from reference sources, covering a broad range of conditions, were used in the development of the correlation. The reference data and the limited data obtained from the experimental program extended the generality of the correlation to cover a range of pressure from 16 to 2000 pounds per square inch, heat flux from 0.026 to 56.0 Btu per square inch per second, fluid velocity from 1.33 to 204 feet per second, and subcooling from 6° to 336° F. Liquid-ammonia data were included to demonstrate the applicability of the correlation to fluids other than water. Comparisons were made between wall temperatures at the incipience of boiling as predicted by an analytically derived equation and the experimental data. Author

N63-15051 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXPERIMENTAL STUDY OF THE BEHAVIOR OF SPHERES ABLATING UNDER CONSTANT AERODYNAMIC CONDITIONS

Robert R. Howell Washington, NASA, Apr. 1963 16 p 4 refs (NASA TN D-1635) OTS: $0.50

Five spheres constructed of ablative material, with diameters of 0.6 inch to 2.0 inches, were subjected to aerodynamic heating to determine the physical behavior of such bodies as they are reduced toward zero volume by the ablation process. Three of the bodies were tested in hypersonic flow, one was tested in supersonic flow, and one was tested in subsonic flow. The stagnation-point heating rate for the tests varied between 52 and 565 Btu/(sq ft)(sec). The Reynolds number based on model diameter varied between 1.0×10^4 and 9.6×10^4. Results indicate that the recession rate of the stagnation point is essentially constant over the life span of such bodies, regardless of the magnitude and character of the convective heating imposed. There was an apparent tendency for the average radius of the ablating face to increase slightly with time at supersonic and hypersonic speeds and to decrease with time at the subsonic speed. In the supersonic tests, no noticeable loss of material occurred over the downstream surface of the bodies. In the subsonic test, however, loss on the downstream surface equaled that over the forward surface. A discussion of the measured recession rate of the stagnation point is presented. Author

N63-15303 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXPERIMENTAL INVESTIGATION OF SEVERAL ABLATION MATERIALS IN AN ELECTRIC-ARC-HEATED AIR JET

Andrew J. Chapman Washington, NASA, Apr. 1963 39 p 13 refs (NASA TN D-1520) OTS: $1.00

An investigation to determine the ability of several ablation materials to reduce surface heat transfer in an electric-arc-heated airstream has shown that ammonium chloride has a higher heat of ablation, and thus greater ability to reduce surface heat transfer, at stagnation enthalpy potential below 8,500 Btu/lb than Teflon, nylon, Avcoat 19, or GE-124. The trend of results indicates that, for stagnation enthalpy potential above 8,500 Btu/lb, nylon would have a higher heat of ablation than ammonium chloride because of an increased transpiration effect. Results obtained for a wide range of test stream conditions with subsonic and supersonic flow from the present investigation and several references indicate that the heat of ablation is primarily sensitive to stagnation enthalpy potential. Author

N63-15471 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A STUDY OF THE EFFECT OF MULTI-G ACCELERATIONS ON NUCLEATE-BOILING EBULLITION

Robert W. Graham and Robert C. Hendricks Washington, NASA, May 1963 31 p 10 refs (NASA TN D-1196) OTS: $0.75

The effects of multi-g accelerations directed toward a heater surface for near-saturated and subcooled nucleate pool boiling were studied in a centrifuge. High-speed motion pictures and heat-transfer data were obtained in the test program. Subcooling effects were observed to be more significant than the acceleration effects. Acceleration did not appreciably influence the overall heat transfer when the nucleate boiling was characterized by vapor columns or bubble conglomerates. Acceleration did, however, influence the heat transfer in the vicinity of a site for discrete bubbles near the thermal threshold of nucleate boiling. For this case, maximum bubble size, growth rate, frequency, and site activation were influenced by the acceleration magnitude. Author

N63-15507 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE AND HEAT-TRANSFER MEASUREMENTS ON THE FLAT FACE OF A BLUNTED 10° HALF-CONE BODY (SEMIDISK) AT A MACH NUMBER OF 6.15

P. Calvin Stainback Washington, NASA, May 1963 22 p 10 refs (NASA TN D-1628) OTS: $0.75

An experimental investigation was conducted to evaluate the flow characteristics of the front face of a 10° half-cone blunted approximately 85 percent with respect to the base radius. The front face was flat and inclined at an angle of 60° with respect to the original axis of the cone. The instrumented portion of the model was essentially a semidisk. Tests were conducted at a nominal Mach number of 6.15 and a nominal stagnation temperature of 450° F for an angle-of-attack range of 0° to 60°. The test-section Reynolds number was varied from 0.67×10^6 to 5.25×10^6 per foot for the heat-transfer tests and was 6.92×10^6 per foot for the pressure tests. The results indicated that the pressure and heat-transfer characteristics of the front face, at all angles-of-attack, were qualitatively similar to those of a disk normal to the free-stream velocity. The stagnation-point location was found to vary approximately linearly with angle-of-attack in the range investigated. The average heat-transfer coefficient over the face was essentially constant for the angle-of-attack range of this investigation, and approximately equal to the average coefficient of a disk situated normal to the free-stream velocity. Author

N63-16688 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL INVESTIGATION OF ROCKET-ENGINE ABLATIVE-MATERIAL PERFORMANCE AFTER POSTRUN COOLING AT ALTITUDE PRESSURES

R. James Rollbuhler Washington, NASA, June 1963 29 p 6 refs (NASA TN D-1726) OTS: $0.75

A rocket-engine nozzle made of ablative material was tested as part of a hydrogen-oxygen rocket engine, which fired repeatedly in a vacuum environment. After each run, the nozzle cooled at low pressure. Its ablative behavior in subsequent runs did not differ appreciably from that of an identical ablative nozzle tested under similar conditions, but cooled at 1-atmosphere pressure. Author

N63-17514 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ON THE EMPIRICAL CORRELATION OF CRITICAL BOILING HEAT FLUX FOR CHANNELS OF VARIOUS CROSS SECTIONS AND ORIENTATION

Uwe H. von Glahn Washington, NASA, June 1963 22 p 9 refs (NASA TN D-1656) OTS: $0.75

A correlation study is made of some of the experimental maximum heat-flux data (burnout condition) with net vapor generation. The data studied were obtained with water flow through circular tubes, rectangular channels, and annular tubes. Vertically upward, horizontal, and 45° inclined flow directions are considered. All channels were uniformly heated in the direction of flow. Correlation is achieved through modification of an existing empirical relation by the use of an additional channel-shape factor. The empirical relation itself consists of an enthalpy ratio and a function consisting of several dimensionless groups containing variables that include mass velocity, channel geometry, and fluid-property terms. All fluid-property terms are evaluated at the fluid saturation temperature associated with the burnout condition. Author

N63-18137 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOCAL HEAT TRANSFER AND RECOVERY TEMPERATURES ON A YAWED CYLINDER AT A MACH NUMBER OF 4.15 AND HIGH REYNOLDS NUMBERS

Ivan E. Beckwith and James J. Gallagher Washington, GPO, 1961 26 p 26 refs
(NASA TR R-104, supersedes NASA MEMO 2-27-59L)
GPO: $0.40

Local heat transfer, equilibrium temperatures, and wall static pressures have been measured on a circular cylinder at yaw angles of 0°, 10°, 20°, 40°, and 60°. The Reynolds-number range of the tests was from 1×10^6 to 4×10^6 based on cylinder diameter. Increasing the yaw angle from 0° to 40° increased the stagnation-line heat-transfer coefficients by 100 to 180 percent. A further increase in yaw angle to 60° caused a 40-percent decrease in stagnation-line heat-transfer coefficients. At zero yaw angle, the boundary layer over the entire front half of the cylinder was laminar, but at yaw angles of 40° and 60° it was evidently completely turbulent, including the stagnation line, as determined by comparison of local heat-transfer coefficients with theoretical predictions. At all yaw angles, the peak heat-transfer coefficient occurred at the stagnation line and the chordwise distribution of heat-transfer coefficient decreased monotonically from this peak. The theoretical heat-transfer distributions for both laminar and turbulent boundary layers are calculated directly from simple quadrature formulas derived in the present report. Author

N63-18162 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

MEASUREMENT OF THE HEAT TRANSFER TO BODIES OF REVOLUTION IN FREE FLIGHT BY USE OF A CATCHER CALORIMETER

Gary T. Chapman and Charles T. Jackson, Jr. Washington, NASA, July 1963 39 p 8 refs
(NASA TN D-1890) OTS: $1.00

A new experimental technique has been used to study the total heat transfer to a hemisphere and a blunted cone. Aluminum models were gun-launched at speeds up to 11,000 fps, allowed to decelerate aerodynamically to a few hundred feet per second, and caught, and the total aerodynamic heat input was measured in the recovered models with a calorimeter. These measurements showed that for the trajectories flown, that portion of the initial kinetic energy which goes into heating the body was larger for the configuration with the smaller drag. The data were further analyzed on the basis of the trajectories traversed, yielding heat-transfer rates as a function of velocity. These rates for the various configurations were compared with one another and again showed that the configuration with the higher drag had the lower heating rates. Further, the experimental heating rates for the hemisphere agreed well with the theoretical convective heating of the front face. Author

N63-18470 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HEAT TRANSFER TO BLUNT CONICAL BODIES HAVING CAVITIES TO PROMOTE SEPARATION

Frank J. Centolanzi Washington, NASA, July 1963 20 p 5 refs (NASA TN D-1975) OTS: $0.50

A wind-tunnel investigation of the heat transfer to conical configurations with cavities to promote boundary-layer separation was conducted at Mach numbers ranging from 3.98 to 5.79, and Reynolds numbers of 0.12 to 0.19 million based on model diameter. Both sharp and blunt cones were tested. The results show that the presence of a cavity changes the distribution of heat transfer considerably. From the standpoint of total heat transfer there is an adverse effect of separating the boundary layer because heat transfer in the reattachment region is high and affects a considerable fraction of the total surface area. Wall cooling had a strong influence on the flow over some of the models with cavities. On some models, extreme wall cooling caused the transition point to move upstream. In one case, extreme wall cooling caused completely attached flow over a model which had a separated laminar boundary layer under adiabatic conditions. Under certain test conditions, the flow over a model with a cavity was found to pulsate. With pulsating flow, the distribution of heat transfer is similar to that observed for steady separated flow. Author

N63-18894 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

COMPARISON OF EXPERIMENTAL TO PREDICTED HEAT TRANSFER ON A BELL-SHAPED NOZZLE WITH UPSTREAM FLOW DISTURBANCES

Anthony Fortini and Robert C. Ehlers Washington, NASA, Aug. 1963 37 p 10 refs
(NASA TN D-1743) OTS: $1.00

An experimental investigation has been conducted to determine and compare the effects of upstream flow disturbances on the heat-transfer film coefficient in a Rao type nozzle with air at 300 pounds per square inch absolute and 1000 R. These disturbances caused a large change in the film coefficient and created difficulties for heat-transfer predictions. Two approaches are used for comparison: a boundary layer model and a Nusselt-number correlation method. Author

N63-19651 National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center

A COMPARATIVE ANALYSIS OF CONVECTIVE HEAT TRANSFER IN A NUCLEAR ROCKET NOZZLE

Harvey E. Neumann and Paula J. Bettinger Washington, NASA, Aug. 1963 28 p 17 refs
(NASA TN D-1742) OTS: $0.75

A detailed analysis of the gas-side heat-transfer coefficient associated with a nuclear rocket nozzle is presented. The purpose of this study was to compare the predicted heat-flux distributions obtained from conventional turbulent flow correlations with those obtained from boundary-layer theory. The effects of initial boundary-layer thickness, radial gradients of free-stream velocity, wall-temperature distribution, and nozzle geometry on predicted heat flux are considered. The results show that the heat-flux predictions from a Nusselt number correlation that comprehends radial gradients of free-stream velocity are in fair agreement with predictions from boundary-layer theory except in regions of the convergent section. The predicted heat-flux distribution in the convergent section is found to be sensitive to the initial boundary-layer development.

At the throat and in the divergent section, the heat flux is found to be relatively independent of initial boundary-layer thickness. The nozzle geometry and distribution of mass flow per unit area strongly affected the heat-flux distribution. Differences in predicted heat flux of the order of 100 percent may be encountered in the divergent section when radial gradients of mass flow per unit area are ignored and one-dimensional flow is assumed. Author

N63-19865 National Aeronautics and Space Administration, Washington, D.C.

EFFECT OF THE RADIANT HEAT COMPONENT ON HEAT TRANSFER IN VACUUM SUBLIMATION [VLIYANIYE LUCHISTOY SOSTAVLYAYUSHCHEY NA KHARAKTER TEPLOOBMENA PRI SUBLIMATSII V VAKUUME]

P. A. Novikov. Aug. 1963. 11 p. 3 refs. Transl. from Inzhenerno-Fiz. Zhur. (Minsk), v. 5, no. 12, 1962, p. 80–83.

(NASA TT-F-178) OTS: $0.50

The object of this paper is to determine the effect of the radiant component of the total heat balance on the nature of the heat and mass transfer for a constant temperature of the vacuum chamber walls and variable pressure of the ambient medium. The experiments on the sublimation of a naphthalene sphere at different pressures of the ambient medium show that the specific radiant heat flux increases monotonically with decrease in the total pressure, whereas the total heat flux varies with the pressure in accordance with a more complicated law. As for the contribution of the radiant component to the total heat transfer, it assumes different values as the pressure varies.

N63-20324 National Aeronautics and Space Administration, Washington, D.C.

HEAT TRANSFER WITH LAMINAR FLOW IN CONCENTRIC ANNULI WITH CONSTANT AND VARIABLE WALL TEMPERATURE AND HEAT FLUX

R. E. Lundberg, W. C. Reynolds, and W. M. Kays (Stanford U.). Aug. 1963. 212 p. 27 refs.

(NASA Grant NsG-52-60)

(NASA TN D-1972) OTS: $3.50

Consideration is given to the general problem of heat transfer in a concentric annulus with hydrodynamically fully-established laminar flow. The differential equation for the temperature field is solved for special or fundamental boundary conditions, under the assumptions that the fluid in the annulus is incompressible, has constant properties, and that internal viscous generation is negligible. An apparatus for the experimental study of heat transfer to air with constant heat flux at either or both of the boundary walls is described. A comparison of the experimentally determined values with those predicted by the theory is presented and exhibits good agreement. Author

N63-20608 National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

THERMAL RADIATION FROM ABLATION PRODUCTS INJECTED INTO A HYPERSONIC SHOCK LAYER

Roger A. Craig and William C. Davey. Washington, NASA, Sept. 1963. 34 p. 17 refs.

(NASA TN-D-1978) OTS: $1.00

Small blunt-nosed plastic projectiles were launched at high velocities in air past photoelectric devices which recorded the resulting radiation. Part of this radiation was found to be due to ablation products injected into the boundary layer. A simple mathematical model was developed to describe the boundary-layer injection-diffusion process, and equations were derived for the surface heating from this source for vehicles of spherical geometry. The test results were used to evaluate empirical constants in the equations for three ablation materials: a polycarbonate resin, a char-forming plastic; and a high-density polyethylene. Author

N63-22111 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio

EFFECT OF VARIABLE THERMAL PROPERTIES ON ONE-DIMENSIONAL HEAT TRANSFER IN RADIATING FINS

Norbert O. Stockman and John L. Kramer. Washington, NASA, Oct. 1963. 45 p. 5 refs.

(NASA TN D-1878) OTS: $1.25

An equation is derived for the temperature distribution in a rectangular fin of infinite width, and of finite length and thickness, that assumes one-dimensional conduction along the finite length and radiation from both sides to an equivalent sink temperature, with material emissivity and conductivity given as functions of temperature. Results in the form of a radiating effectiveness and temperature distribution are presented for several materials and surface coatings with linearly varying conductivity and emissivity. The percent error in radiating effectiveness as a result of assuming constant properties is also given for these cases. A correlation is obtained that permits simple calculation of the heat rejected by a fin of variable conductivity and variable emissivity from the readily available data for a fin with constant properties. Author

N63-22712 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

SPECTROMETRIC MEASUREMENTS OF GAS TEMPERATURES IN ARC-HEATED JETS AND TUNNELS

David H. Greenshields. Washington, NASA, Oct. 1963. 23 p. 13 refs.

(NASA TN D-1960) OTS: $0.75

The selection of spectrometric techniques for the measurement of stream temperatures in arc-heated facilities is discussed with respect to the properties of the gas stream. Representative temperature measurements are presented which demonstrate the effects of optical thickness, stream composition, and temperature gradients on spectrometric measurements. In addition, the results of these spectrometric measurements are compared with nonspectrometrically-determined temperatures. Author

N63-22862 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio

ESTIMATED VISCOSITIES AND THERMAL CONDUCTIVITIES OF GASES AT HIGH TEMPERATURES

Roger A. Svehla. Washington, Govt. Print. Off., 1962. 121 p. 145 refs.

(NASA TR-R-132) GPO: $1.00

Viscosities and thermal conductivities, suitable for heat-transfer calculations, were estimated for about 200 gases in the ground state from 100° to 5000° K and 1-atm pressure. Free radicals were included, but excited states and ions were not. Calculations for the transport coefficients were based upon the Lennard-Jones (12-6) potential for all gases. Force constants were used to calculate both the viscosities and thermal conductivities tabulated in this report. If the same set of force constants is used for both viscosity and thermal conductivity, there is a large degree of cancellation of error when these properties are used in heat-transfer equations such as the Dittus-Boelter equation. It is, therefore, concluded that the properties tabulated in this report are suitable for heat-transfer calculations of gaseous systems. Author

N63-23715 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio

THERMODYNAMIC PROPERTIES TO 6000° K FOR 210 SUBSTANCES INVOLVING THE FIRST 18 ELEMENTS

Bonnie J. Mc Bride, Sheldon Heimel, Janet G. Ehlers, and Sanford Gordon. Washington, NASA, 1963. 332 p. refs.

(NASA SP-3001) OTS: $5.00

Consistent tables of thermodynamic properties at temperatures from 0° to 6000° K were compiled for 210 gaseous and condensed species involving the elements with atomic numbers of 1 to 18. The tables give the following thermodynamic functions for the standard state: heat capacity at constant pressure, sensible enthalpy, entropy, sensible free energy, and the sum of sensible enthalpy and chemical energy at 0° K, as well as values of the enthalpy changes and the logarithms of the equilibrium constants. Author

14 HUMAN BEHAVIOR

Includes crew training and evaluation; piloting; and psychological factors. *For simulators see*: 10 Facilities, Research and Support. *For related information see*: 16 Life Sciences.

N63-10181 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A STUDY OF A PILOT'S ABILITY TO CONTROL DURING SIMULATED STABILITY AUGMENTATION SYSTEM FAILURES

Melvin Sadoff Washington, NASA, Nov. 1962 36 p 11 refs (NASA TN D-1552) OTS: $1.00

A comparison of fixed- and moving-cab centrifuge results suggests that moving-cockpit flight simulators should be used for a realistic evaluation of the transient effects of stability augmenter failures since simulator motions generally interfered with the ability of the pilots to adapt to the failures. The pilot was engaged in a simple tracking task when the failures occurred. Simple pilot models are used in the analysis and prediction of the transient effects of failures. Author

N63-10626 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STUDY OF HUMAN PILOTS' ABILITY TO DETECT ANGULAR MOTION WITH APPLICATION TO CONTROL OF SPACE RENDEZVOUS

Roy F. Brissenden Washington, NASA, Dec. 1962 17 p 7 refs (NASA-TN-D-1498) OTS: $0.50

Tests were made of light objects moving on a low-intensity star background. Six subjects with normal vision participated in the tests conducted inside an inflatable 53-foot darkened radome. Various initial reference separations and rates of object motion that would be anticipated in space rendezvous were utilized. Author

N63-12703 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF THE VISUAL BOUNDARY FOR IMMEDIATE PERCEPTION OF VERTICAL RATE OF DESCENT

Lindsay J. Lino and Arthur Assadourian Washington, NASA, Feb. 1963 25 p 1 ref (NASA TN D-1591) OTS: $0.75

Simple optical projection equipment was used to determine the threshold of visual ability to detect quickly rates of change of visual angle. A brief analytical treatment shows the relationship of visual angular rate to closure speed or rate of vertical descent. Application of the data was made to the ranges of speed and distance that could, for example, be encountered under emergency conditions in a vertical landing from a straight-in lunar approach. The results indicate that a pilot has adequate visual ability to control a landing, even in this case of extreme closure velocity, if a reasonable braking thrust is available. Author

N63-13790 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PILOT-CONTROLLED SIMULATION OF RENDEZVOUS BETWEEN A SPACECRAFT AND A COMMANDED MODULE HAVING LOW THRUST

Gary P. Beasley Washington, NASA, Mar. 1963 17 p 4 refs (NASA TN D-1613) OTS: $0.50

A pilot's ability to control remotely the terminal phase of rendezvous between his orbiting spacecraft and an approaching commanded module which had relatively low thrust was studied by using a six-degree-of-freedom simulation. In this study, fixed-thrust engines were used and operated in an on-off manner. The thrust levels were adjusted to provide the commanded module with initial acceleration capabilities of 0.02g and 0.03g. For the initial rendezvous conditions assumed, these thrust accelerations were less than three times the sum of the apparent gravity differences between the vehicles and the maximum difference in centrifugal force. Results of this simulation study indicate that a human pilot, given visual information, range, and range rate, can control a low-thrust vehicle to effect terminal rendezvous under a variety of initial conditions. Author

N63-15241 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.

A SIMPLIFIED METHOD FOR MEASURING HUMAN TRANSFER FUNCTIONS

James J. Adams Apr. 1963 37 p 10 refs (NASA TN D-1782) OTS: $1.00

An investigation has been made with a nonmoving simulator to determine the effectiveness of a simplified method of measuring human transfer functions. The method is based on an adaptive autopilot scheme. In this method an analog pilot, which contains three variable gains, is automatically adjusted to match the human pilot. The gains are adjusted so as to minimize the root-mean-square difference between the analog pilot and the human pilot. The dynamics that the pilot controlled were varied. The tests demonstrated that stable determination of the transfer-function gains could be achieved. Tests in which the adjustable analog pilot was required to match a fixed-gain analog pilot resulted in accurate determination of the gains. Tests made with human subjects resulted in gains which are in general agreement with previous studies, in that the lead of the pilot is increased as the lag of the controlled dynamics is increased. Author

N63-15776 National Aeronautics and Space Administration, Washington, D.C.

EVALUATION OF A TECHNIQUE FOR DETERMINING TIME-INVARIANT AND TIME-VARIANT DYNAMIC CHARACTERISTICS OF HUMAN PILOTS

Jerome I. Elkind, Edward A. Starr, David M. Green and D. Lucille Darley (Bolt, Beranek and Newman, Inc.) May 1963 86 p 38 refs (NASA Contract NASw-185) (NASA-TN-D-1897) OTS: $2.25

A technique for determining the time-varying dynamic response characteristics of human pilots in tracking tasks is presented. The technique is based on a model adjustment or mimicking procedure in which a model composed of filters whose impulse responses are orthogonalized exponential functions is used. The filters are connected in parallel and their outputs are weighted and added together. The weights are determined so that the mean-square difference between the output of the model and the output of the pilot is minimum. Time-varying characteristics are measured by determining successively the model weights from short samples of the input and output signals of the human operator. The measurement technique has been implemented on a high-speed digital computer. Results obtained by applying the technique to measurement of a variety of digital filters, analog filters, and human-operator dynamic response characteristics are presented. It is shown that a model composed of five properly chosen filters can approximate a large variety of systems with an error of about one percent or less. Author

N63-18665 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ROUGH-AIR EFFECT ON CREW PERFORMANCE DURING A SIMULATED LOW-ALTITUDE HIGH-SPEED SURVEILLANCE MISSION

George J. Hurt, Jr., Washington, NASA, Aug. 1963 23 p 4 refs (NASA TN D-1924) OTS: $0.75

The NASA normal acceleration and pitch simulator, in conjunction with an analog computer, was used to simulate a vehicle flying through rough air at high subsonic Mach numbers. Vehicle response levels which were in excess of the accepted human comfort level were imposed on the test subjects. At the maximum levels investigated, it was found that the observer would be disrupted but not stopped in the performance of the assigned tasks. Author

N63-19176 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF DISPLAY NOISE ON PILOT CONTROL OF THE TERMINAL PHASE OF SPACE RENDEZVOUS

Jack E. Pennington Washington, NASA, Aug. 1963 17 p 4 refs

(NASA TN D-1619) OTS: $0.50

The series of tests described in the present paper was made to determine the pilot's ability to complete the rendezvous maneuver in the presence of display noise. The output of a random-noise generator was inserted into the instrument display to introduce an error signal similar to that which could be expected from a radar system. Runs were made first with perfect instruments and then with the noise error introduced into the data displays. Results show an increase in fuel consumption and time needed to complete the mission, and a decrease in pilot assurance, with the noise error in the instrument. Pilot proficiency increased with an increase in the accuracy of the display instruments and decreased with an increase in the amplitude of the error signal. Author

N63-22136 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASURED VARIATION IN THE TRANSFER FUNCTION OF A HUMAN PILOT IN SINGLE-AXIS TASKS

James J. Adams and Hugh P. Bergeron Washington, NASA, Oct. 1963 58 p

(NASA TN D-1952) OTS: $1.50

Measurements of the variations in the transfer function of a human pilot, relating visual stimuli to stick controller output, in a single-degree-of-freedom fixed-base simulator have been made by using an automatic model matching technique. Variations in subjects, controlled dynamics (from simple amplifiers to a double integration), display sensitivity, control sensitivity, and type of task (from compensatory tracking to pursuit tracking) were included in the tests. The results show that the pilot changes his transfer function whenever any element in the control loop is changed. Whereas wide variations in the transfer functions were measured, variations in the closed-loop characteristics were much more restricted. Author

15 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; sensors and transducers; and telescopes and cameras. *For related information see* 06 Auxiliary Systems, 08 Communications, 09 Electronics, and 22 Navigation and Guidance.

N63-10176 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

APPLICATION OF THE MODULARIZATION CONCEPT TO SATELLITE TAPE RECORDERS

P. T. Cole, H. J. Peake, and C. F. Rice Washington, NASA, Nov. 1962 15 p

(NASA TN D-1451) OTS: $0.50

A program is underway at Goddard Space Flight Center to adapt the widely accepted concept of modularization to magnetic tape recorders for satellite application. Prior to this program, special recorders were custom-designed for the particular requirements at hand. Even long lead times often were insufficient for development of good designs with assurance of reasonable reliability. Reduction of recorders to discrete mechanical modules offered an attractive solution to this problem. Slight design variations in modules would then make possible a series of recorders to operate at different speeds, operate over different frequency ranges, and perform different functions. This modularization concept is being applied in the design and development of the recorder for the United Kingdom No. 2 satellite with considerable success. Author

N63-10204 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SCANNING MECHANISM FOR A SATELLITE BORNE X-RAY SPECTROMETER

Gerald L. Hempfling Washington, NASA, Nov. 1962 17 p

(NASA TN D-1097) OTS: $0.50

The design and testing of a scanning mechanism of an X-ray spectrometer is documented. This device also maintains the detector perpendicular to the radiation beam incident from the grating, as the detector moves along the focal curve. The information presented in this report should be useful in the future designing of similar devices, particularly when the detector is required to remain perpendicular to the incident rays. Author

N63-11619 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE USE OF AN IONIZATION GAGE AS A QUANTITATIVE ANALYZER FOR BI-GASEOUS MIXTURES

Leonard T. Melfi, Jr., and George M. Wood, Jr. Washington, NASA, Dec. 1962 12 p 4 refs

(NASA TN D-1597) OTS: $0.50

The inherent difference in the relative ionization of helium and air has been utilized as a means of quantitatively measuring the percentage composition of helium-air mixtures. The technique will find application in facilities requiring multichannel analysis of any bigaseous mixtures which have sufficient differences in relative ionization. Upon the completion of laboratory testing, the gas analyzer was successfully field tested in conjunction with a project in which mixture compositions from 0- to 100-percent helium were measured from a number of survey points in a supersonic stream. Author

N63-12951 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

CALIBRATIONS AND COMPARISONS OF PRESSURE-TYPE AIRSPEED-ALTITUDE SYSTEMS OF THE X-15 AIRPLANE FROM SUBSONIC TO HIGH SUPERSONIC SPEEDS

Terry J. Larson and Lannie D. Webb Washington, NASA, Feb. 1963 37 p 28 refs

(NASA TN D-1724) OTS: $1.00

The X-15 flight calibration data to define static-pressure position errors are presented for two types of pressure-sensing configurations: a standard NACA pitot-static tube attached to a nose boom, and two manifolded flush static-pressure ports on the ogive nose. The position-error calibrations are presented up to M = 3.31 for the standard nose-boom installation and to M = 4 for the flush static

system. Presented also are stagnation-pressure errors sensed by a pitot probe ahead of the canopy. Methods used to determine the position errors are described. The nose-boom configuration is shown to be superior from the standpoint of position error and ease of calibration for the available data range. Author

N63-13220 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A VACUUM ULTRAVIOLET PHOTOIONIZATION DETECTOR

A. K. Stober, R. Scolnik, and J. P. Hennes Washington, NASA, Mar. 1963 11 p 15 refs

(NASA TN D-1715) OTS: $0.50

A small ceramic ion chamber has been developed for a rocket astronomy program in the vacuum ultraviolet. The chamber consists of a small metal plated ceramic shell incorporating a window of LiF, CaF_2 or BaF_2 and containing one of several fill gases such as nitric oxide, acetone, or carbon disulfide. Typical quantum efficiencies range from 8 to 10 percent for acetone with a CaF_2 window to 50 to 60 percent for carbon disulfide with a LiF window. Details of the chamber construction are given, and some recent applications of the detector are described. Author

N63-13303 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

PROPOSAL FOR DETERMINING THE MASS OF LIQUID PROPELLANT WITHIN A SPACE VEHICLE PROPELLANT TANK SUBJECTED TO A ZERO GRAVITY ENVIRONMENT

R. L. Evans and J. R. Olivier Washington, NASA, Mar. 1963 11 p (NASA TN D-1571) OTS: $0.50

A liquid-propellant mass-measurement system is proposed for the zero-gravity environment. The known thermodynamic relationships for the liquid propellant and an inert gas are used in conjunction with state-of-the-art instrumentation to provide a system comparable with terrestrial mass-measurement systems. In particular, the operation of the system is outlined for the propellant transfer method and for the determination of leaks and leakage rates. A second concept—a simplified version of the proposed mass-measurement system—is introduced and discussed. Author

N63-13795 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A DETECTOR FOR LOW ENERGY GAMMA-RAY ASTRONOMY EXPERIMENTS

K. J. Frost and E. D. Rothe Washington, NASA, Mar. 1963 10 p 12 refs

(NASA TN D-1693) OTS: $0.50

A detector has been developed specifically for rocket- and satellite-borne low-energy gamma-ray astronomy experiments. This detector consists of a CsI(Tl) crystal, 2 inches long by 1 inch in diameter, viewed by a single photomultiplier tube together with a CsI(Tl) crystal, 8.75 inches long by 5.75 inches in diameter, viewed by four photomultiplier tubes. The small crystal is inserted into a well of the larger crystal, their two outputs being run in anticoincidence. The output from the small crystal surviving the anticoincidence circuit is fed into a pulse-height analyzer. This detector and its mode of operation provide a gamma-ray spectrometer that has angular collimation, low background sensitivity, suppression of the Compton continuum, and relatively high photopeak efficiency. Data on the photopeak efficiency, angular response, and suppression of the Compton continuum at various energies are presented. Reasons for using anticoincidence shielding to contend with background problems, rather than bulk shielding with lead, are discussed. Author

N63-14026 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PERFORMANCE OF ELECTRICAL-RESISTANCE STRAIN GAGES AT CRYOGENIC TEMPERATURES

Albert Kaufman Washington, NASA, Mar. 1963 22 p 3 refs

(NASA TN D-1663) OTS: $0.75

Six types of commercial foil strain gages were investigated to determine whether they could be used in experimental stress analyses of space-vehicle structures at cryogenic temperatures. The effects of low temperatures on the gage factors were studied by mounting gages on constant-strain beams and loading them to strains of up to ±2000 microinches per inch with a strain-gage calibrator immersed in a cryogenic bath. These tests were conducted at room temperature and liquid-nitrogen (139° R) and liquid-hydrogen (36° R) temperatures. Hysteresis, creep, zero-drift effects, and linearity of the data were also studied in these tests. The more promising types of strain gages, as determined from the calibrator tests, were mounted on beta titanium tensile specimens and tested to higher strains of from 7500 to 13,000 microinches per inch in liquid hydrogen. Resistance measurements were made on the different gages at room temperature and dry-ice (350° R), liquid-nitrogen, liquid-hydrogen, and liquid-helium (7° R) temperatures. Author

N63-14276 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

APPARATUS FOR THE MEASUREMENT OF TRANSPORT PROPERTIES OF POLAR SEMICONDUCTORS

Martin M. Sokoloski and Felix E. Geiger Washington, NASA, Mar. 1963 14 p 21 refs

(NASA TN D-1695) OTS: $0.50

The existing theoretical and experimental data on the mobilities of polar semiconductors are reviewed briefly, with special emphasis on PbTe because of its technical importance in thermoelectric power generation. Theoretical calculations on optical and acoustical mode scattering are compared with experimental data. Experimental evidence indicates that the effects of changing statistics and possible changes in the effective mass as a function of temperature may hide the true dependence of the mobility on temperature. Therefore, a new series of measurements of transport properties, such as the Hall coefficient and resistivity, is suggested; and apparatus to measure these properties in the range from 80° to 850° K is described. The apparatus consists of a cryostat in which the sample can be cooled to liquid-nitrogen temperatures, and then heated and held at any desired intermediate temperature. A detailed description is given of the experimental apparatus: the cryostat, vacuum system, and sample holder assembly. The transport properties (Hall constant, resistivity, etc.) can be measured by the usual d.c. method; and, alternatively, an a.c. bridge can be used for direct resistance determination

Author

N63-14277 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A DYNAMIC THERMAL VACUUM TECHNIQUE FOR MEASURING THE SOLAR ABSORPTANCE AND THERMAL EMITTANCE OF SPACECRAFT COATINGS

W. B. Fussell, J. J. Triolo, and J. H. Henninger Washington, NASA, Mar. 1963 30 p 9 refs

(NASA TN D-1716) OTS: $1.00

The various optical and thermal methods of measuring solar absorptance and thermal emittance are discussed in some detail. The thermal vacuum technique used by Goddard Space Flight Center is described. The apparatus consists of: (1) a high vacuum chamber with inner walls cooled by liquid nitrogen, and (2) a powerful carbon arc lamp. In operation, a test sample coated with the material under investigation is suspended in the vacuum chamber facing a window in the chamber wall. A thermocouple in the test sample records its temperature. The sample is illuminated by the arc lamp, and its rise in temperature is recorded to above ambient temperature. While the arc lamp is on, its intensity of illumination is measured. The arc lamp is then turned off, and the sample's fall in temperature is recorded. From the sample's temperature-time data and the intensity of the arc lamp, the solar absorptance and thermal emittance can be computed to within ± 7 percent. Author

N63-15053 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PORTABLE INTEGRATING SPHERE FOR MONITORING REFLECTANCE OF SPACECRAFT COATINGS

F A. Jerozal (Continental Technical Service, Inc.), W B. Fussell, and J J Triolo Washington, NASA, Apr 1963 15 p 7 refs Previously announced as a preprint, see N62-17073 18-15
(NASA TN D-1714) OTS: $0.50

An integrating sphere is the most convenient device for measuring the total reflectance of opaque coatings of different degrees of curvature, specularity, and diffusivity A portable, 8-lb, single-beam, 6-inch-diameter integrating sphere reflectometer has been designed and fabricated at the GSFC, and has been used extensively to detect changes in the solar absorptivity of spaeecraft coatings due to environmental testing, ageing, or contamination Author

N63-15957 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A STEADY-STATE, STAGNATION-POINT, HEAT-TRANSFER-RATE MEASURING DEVICE

George E Glawe, Lloyd N Krause, and Robert C. Johnson Washington, NASA, May 1963 17 p 31 refs
(NASA TN D-1704) OTS: $0 50

A sensing device is described that is used to measure steady-state convective heat-transfer rate in high-temperature, high-velocity gas streams The device uses the measurement of axial heat conduction through a cylindrical plug, with one end of the plug at the stagnation point of a hemispherically shaped body exposed to the gas stream Experimental tests of three identical probes run through a subsonic Mach-number range from 0 2 to 0 8, and a supersonic Mach-number range of 2 8 to 3 5 established a correlation factor for the probes with a standard deviation of ±5 percent The heat input range was 0 7 to 70 $Btu/ft^{-2}/sec^{-1}$ Author

N63-16426 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md

EXPLORER XII SATELLITE INSTRUMENTATION FOR THE STUDY OF THE ENERGY SPECTRUM OF COSMIC RAYS

U D Desai, R L Van Allen, and G Porreca Washington, NASA, May 1963 19 p 3 refs
(NASA TN D-1698) OTS $0 50

This report describes the signal conditioning and programing processes required to digitize, store, and read-out the data from the various detectors used in cosmic-ray instrumentation aboard the Energetic Particles Satellite, Explorer XII Excitation of the sensors by particles produced signals which were subcommutated in a multiplexing system separate from the one used in the satellite telemetry system Two storage systems (15- and 512-bit capacities) and the programing method used to process the data from three separate detectors are described Author

N63-16989 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL EVALUATION OF LIQUID-FLUORINE SYSTEM COMPONENTS

Richard L De Witt and Harold W Schmidt Washington, NASA, June 1963 22 p 5 refs
(NASA TN D 1727) OTS $0 75

A prototype "quick-disconnect" coupling for ground-to-vehicle transfer of liquid fluorine was designed, developed, and successfully tested The coupling proved satisfactory at flow rates up to 2 5 lb sec and pressure differentials up to 23 lb/sq in One commercially available rotating-vane flowmeter was tested for liquid-fluorine compatibility A valve design employing a soft-seal material at the flow shutoff interface proved successful at flows of 2 0 lb sec and valve inlet pressures up to 97 lb/sq in. abs. In support of the valve design, dynamic liquid-fluorine compatibility testing was conducted on six soft-seal materials. Author

N63-18654 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ULTRAVIOLET PHOTODETECTORS

Lawrence Dunkelman Washington, NASA, Aug. 1963 19 p 50 refs Presented at the 1st Internatl. Conf. on Vacuum Ultraviolet Radiation Phys., U. of Southern Calif., Apr. 16–19, 1962 Previously processed as a reprint, See N63-13578 08-15
(NASA TN-D-1718) OTS: $0.50

This report reviews the characteristics of vacuum ultraviolet ion chambers having fill gases such as nitric oxide, acetone, carbon disulfide, or ethylene oxide with windows of lithium fluoride, cadmium fluoride, or barium fluoride. Their quantum efficiencies range from approximately 0.10 to 0.50 photoelectron/quantum, and the chambers may be operated in a gas multiplication mode with gains of 10^3 at 600 to 800 volts. The characteristics of photomultipliers and phototubes having alkali-tellurium, copper-iodine, or other cathodes with lithium fluoride, sapphire, quartz, or no windows are described. Some of the photomultipliers studied have quantum efficiencies as high as 0.20 photoelectron/quantum, and exhibit long-wavelength rejection ratios of many orders of magnitude over only several hundred angstroms. Author

N63-18669 National Aeronautics and Space Administration, Washington, D.C.

MEASUREMENT OF TORSIONAL RIGIDITY OF STIFFENED PLATES

Herbert Becker and George Gerard (New York U.) July 1963 39 p 12 refs
(NASA Grant NsG-17-59)
(NASA TN D-2007) OTS: $1.00

An instrument developed for measuring torsional rigidity of stiffened structures is described. Use of the instrument is discussed, and calibration procedures are explained. Perspective on the investigation is provided by the inclusion of pertinent theories for torsional rigidity with which the experimental measurements are compared. Author

N63-19074 National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

A SCINTILLATION COUNTER TELESCOPE FOR CHARGE AND MASS IDENTIFICATION OF PRIMARY COSMIC RAYS

D A. Bryant, G. H. Ludwig, and F B Mc Donald Washington, NASA, Aug 1963 10 p 6 refs
(NASA TN D-1757) OTS: $0 50

Two major objectives of the experiment employing the scintillation counter telescope described are the determination of: (1) the amount of interstellar material through which primary cosmic rays pass between their source and the earth's vicinity, and (2) the rigidity dependence of the modulation mechanism of hydrogen and helium nuclei. The telescope is a combination of scintillators (CsI crystals) giving both the energy E of the charged particle and its rate of energy loss dE/dx The method is sensitive to particles whose energy is sufficient to penetrate the dE/dx scintillator, yet too low to pass through the E one. In satellite applications, both the dE/dx and E signals will be analyzed and sorted digitally into 256 channels. Two ranges of sensitivity will be required to detect heavy particles as well as protons and alpha particles. Data from a series of cosmic ray balloon flights made with a prototype of this detector are presented. Author

16 LIFE SCIENCES

Includes biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems; and space sickness. *For related information see*: 14 Human Behavior; and 28 Space Radiation.

N63-10793 National Aeronautics and Space Administration, Washington, D. C.

PROCEEDINGS OF CONFERENCE ON SPACECRAFT STERILIZATION Held Under the Auspices of the NASA Biosciences Programs, July 9, 1962

Freeman H. Quimby, ed. Dec. 1962 104 p
(NASA-TN-D-1357) OTS: $2.50

The proceedings of a conference on spacecraft sterilization are presented. The information presented is essentially a transcript of the discussions. Recommendations of the participants for research and development are appended. Author

N63-11508 National Aeronautics and Space Administration, Washington, D.C.

BIOASTRONAUTICS

George B. Smith, Jr., Siegfried J. Gerathewohl, Bo E. Gernandt, Richard S. Johnston, and Richard S. Young 1962 36 p 60 refs Papers presented at Session L of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962
(See N63-11501 03-29)
(NASA-SP-18) GPO: $0.30

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4. EXOBIOLOGY Richard S. Young (NASA. Ames Research Center) 7 p 16 refs

N63-11740 National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

DEVELOPMENT OF INFLATABLE COMPONENTS OF PERSONAL EQUIPMENT FOR ASTRONAUT BODY INSTRUMENTATION AND SURVIVAL AT SEA

Matthew I. Radnofsky and Joseph J. Kosmo Washington, NASA, Jan. 1963 37 p 6 refs
(NASA TN D-1083) OTS: $1.00

Five inflatable components were designed, developed, and fabricated for use in the Mercury spacecraft. The items developed were a blood-pressure cuff, lifevest, liferaft, water container, and a radar reflector. Each item is discussed fully in this paper. Also discussed are the fabrication procedures used for these items. Author

N63-13222 National Aeronautics and Space Administration, Washington, D.C.

POSTURAL REFLEXES IN INTACT ANIMALS UNDER CONDITIONS OF WEIGHTLESSNESS

V. I. Yazdovskiy, E. M. Yuganov, and I. I. Kas'yan (Acad. of Sci., USSR) Mar. 1963 9 p 11 refs Transl. by Scripta Technica, Inc. of "Ustanovichnyy refleks intaktnykh zhivotnykh v usloviyakh nevesomosti" from Izv. Akad. Nauk SSSR, Ser. Biol. (Moscow), no. 5, 1960 p 762-767
(NASA TT F-130) OTS: $0.50

Experiments were conducted on two albino rats and two albino mice to study their postural reflexes under conditions of alternately increased and decreased gravity and to determine the time required for development of adaptive reactions in the weightless state.

Author

N63-13223 National Aeronautics and Space Administration, Washington, D.C.

MUSCLE TONUS UNDER CONDITIONS OF WEIGHTLESSNESS (O MYSHECHNOM TONUSE V USLOVIYAKH NEVESOMOSTI)

E. M. Yuganov, I. I. Kas'yan, and V. I. Yazdovskiy Mar. 1963 10 p 5 refs Transl. by Scripta Technica, Inc. from Izv. Akad. Nauk SSSR, Ser. Biol. (Moscow) no. 4, 1960 p 601-606
(NASA TT F-131) OTS: $0.50

An experiment was carried out to study the nature and degree of change in tonus of a rabbit's eye muscles under conditions of the intermittent action of increased gravity and weightlessness. Author

N63-14248 National Aeronautics and Space Administration, Washington, D. C.

THE ACTION OF CERTAIN PHARMACOLOGICAL AGENTS ON INTRACRANIAL CIRCULATION (DEYSTVIYE NEKOTORYKH FARMAKOLOGICHESKIKH AGENTOV NA VNUTRICHEREPNOGO KROVOOBRASHCHENIYA)

A. A. Kedrov and A. I. Naumenko Apr. 1963 18 p 14 refs Transl. by Faraday Translations from Fiziol. Zh. SSSR (Moscow), v. 40, no. 3, 1954 p 280-288
(NASA TT F-160) OTS: $0.50

The intracranial arteries are constantly in a state of tonic constriction of considerable intensity. The chemical agent with the most powerful action on the tonus of the intracranial arteries (tending to reduce it) is carbon dioxide. Nitrates, caffeine (with the longest-lasting effect), and dibazol are pharmacological substances with a direct depressant action on the tonus of the intracranial arteries. Nicotinic acid and citrin have no marked effect. Citral has a weakly expressed effect on the tonus of the intracranial arteries, tending to reduce it slightly. Author

N63-14316 National Aeronautics and Space Administration, Washington, D.C.

THE MECHANISM OF INTRACRANIAL CIRCULATION (O MEKHANIZME VNUTRICHEREPNOGO KROVOOBRASHCHENIYA)

A. A. Kedrov and A. I. Naumenko [USSR] Apr. 1963 27 p 35 refs Transl. by Faraday Translations from Usp. Sovrem. Biol. (Moscow), v. 38, no. 2, 1954 p 183-198
(NASA TT F-159) OTS: $0.75

Short-term experiments on cats and dogs were carried out by making use of the method of electroplethysmography. Two small platinum electrodes were embedded in the cranial cavity of the animal, and a high-frequency alternating current was passed through the structures lying between the electrodes after hermetic conditions were restored. Author

N63-14364 National Aeronautics and Space Administration, Washington, D.C.

CEREBRAL PULSATION IN THE CLOSED CRANIAL CAVITY (O PUL'SATSII MOZGA V ZAKRYTOY POLOSTI CHEREPA)

Yu. Ye. Moskalenko (Acad. Sci., USSR) Apr. 1963 19 p 27 refs Transl. by Faraday Translations from Izv. Akad. Nauk SSSR, Ser. Biol. (Moscow), no. 4, 1961 p 620-629
(NASA TT F-158) OTS: $0.50

Cerebral pulsation does exist in the closed cranial cavity. This pulsation is expressed as periodic fluctuations of the cerebrospinal fluid pressure of the order of 1 cm H_2O and back-and-forth movements of cerebrospinal fluid between the cavities of the cranium and the spine. Cerebral pulsation cannot be detected by the method of contrast roentgenoscopy or by the "transparent skull" method on account of their low sensitivity. Transmission of the pulse wave from the cerebral arteries to the veins is accomplished by means of cerebrospinal fluid pressure, bypassing the capillary route, so that capillary circulation remains smooth and uniform. Author

N63-14431 National Aeronautics and Space Administration, Washington, D.C.

SOME CHARACTERISTICS OF THE REGULATION OF INTRACRANIAL CIRCULATION (O NEKOTORYKH OSOBENNOSTYAKH REGULATSII VNUTRICHERPNOGO KROVOOBRASHCHENIYA)

A. A. Kedrov and A. I. Naumenko Apr. 1963 16 p 14 refs Transl. by Faraday Translations from Fiziol. Zh. SSSR (Moscow), v. 37, no. 4, 1951 p 431-438

(NASA TT F-161) OTS: 0.50

A new technical approach was developed for studying the circulation in the cephalic tissues of animals and for investigating the basic regulatory mechanisms of intracranial circulation. To this end, observations on a total of 18 animals were made. By comparing the reactions of the extracranial and intracranial arteries of animals to different influences, the authors have attempted to determine the validity of clinical theories and methods aimed at deducing the conditions of intracranial circulation from a study of the behavior of extracranial vessels. Author

N63-14432 National Aeronautics and Space Administration, Washington, D. C.

PRESSURE FLUCTUATIONS IN THE HERMETIC CAVITY (O KOLEBANIYAKH DAVLENIYA V GERMETICHESKI ZAKRYTOY CHEREPA)

A. I. Naumenko Apr. 1963 16 p 11 refs Transl. by Faraday Translations from Fiziol. Zh. SSSR (Moscow), v. 42, no. 8, 1956 p 660-667

(NASA TT F-162) OTS: $0.50

In the closed cranial cavity, intracranial pressure is characterized by constant pulse and respiratory fluctuations. The pulse fluctuations are caused by rhythmical dilation of the intracranial arteries. When an animal is in repose, pulse fluctuations do not exceed 1 to 2 mm H_2O due to an increase in arterial pulsations associated with reduced tonus of the arterial wall influenced by increased carbon dioxide in the blood. The increase in the volume of the arteries during cardiac systole and the ensuing increase in intracranial pressure are easily compensated by periodic accelerations of the outflow of venous blood and corresponding decreases in the volume of the cerebral veins. Author

N63-15510 National Aeronautics and Space Administration, Washington, D C

ON THE THEORY OF ELECTROPLETHYSMOGRAPHY (K TEORII METODIKI ELEKTROPLETIZMOGRAFII)

Yu Ye Moskalenko and A I Naumenko (First Leningrad Med Inst and Leningrad Electrotech Inst) May 1963 13 p 10 refs Transl by Faraday Translations from Fiziol Zh SSSR (Moscow), v 42, no 3, 1956 p 312-316

(NASA TT F-157) OTS $0 50

The extent of the changes in the electrical conductivity of the brain, in response to changes in the tonus of the brain vessels, was estimated by means of calculations in which the brain and its vascular and arachnoid members are approximately represented in a geometrical form convenient for mathematical analysis On the basis of the computations, it was possible to estimate the relative changes in the amount of cerebrospinal fluid in the cranial cavity Author

N63-15511 National Aeronautics and Space Administration, Washington, D C

MECHANISM OF VENOUS OUTFLOW FROM THE CRANIUM (O MEKHANIZME VONOZNOGO OTTOKA KROVI IZ CHERPA)

A A Kedrov, A I Naumenko, and Z Ya Degtyareva (I L Pavolov First Leningrad Med. Inst) May 1962 9 p 10 refs Transl by Farady Translations from Byull Eksptl Biol i Med (Moscow), no 9, 1957 p 10-14

(NASA TT F-163) OTS $0 50

Data obtained from investigations on six canine subjects indicated that the registration of pulse acceleration in the outflow of blood from cranial sinuses can be used as a method of investigating intercranial circulation This method has the advantage that it does not require opening the cranial cavity, thus, hermetic conditions need not be disturbed Author

N63-20611 National Aeronautics and Space Administration, Washington, D.C.

EXOBIOLOGY – NEW AREA FOR SCIENTIFIC RESEARCH [EKZOBIOLOGIYA – NOVAYA OBLAST' NAUCHNYKH ISSLEDOVANIY]

A. A. Imshenetskiy Aug. 1963 10 p refs Transl. by John E. Holman & Co., Inc. into ENGLISH from Vestnik Akad. Nauk SSSR (Moscow), No. 11, 1962 p 58-63

(NASA TT F-166) OTS: $0.50

A new area for scientific research, exobiology, is discussed. This new discipline is concerned with the explanation of the existence and expansion of life in the cosmos on the one hand, and on the other, with investigations of the effect of cosmic conditions on living organisms. Author

N63-20613 National Aeronautics and Space Administration, Washington, D.C.

EXPERIMENTAL RESEARCH IN SPACE PHYSIOLOGY [EKSPERIMENTAL'NYYE ISSLEDOVANIYA V KOSMICHESKOY FIZIOLOGII]

P. V. Vasil'yev, A. D. Voskresenskiy, and O. G. Gazenko 1963 13 p 12 refs Transl. into ENGLISH by John F. Holman and Co., Inc. from Izv. Akad. Nauk SSSR (Moscow), no. 1, 1963 p 15-23

(NASA TT F-186) OTS: $0.50

Two types of experiments are possible: (1) those designed to study a relatively small number of standard physiological characteristics by reproducing the effect of certain factors operative under actual spaceflight conditions; (2) those designed to elucidate the physiological mechanisms of action of these factors on the organism. The need for and significance of experimental investigation of the physiological mechanisms were illustrated with examples derived from the phenomenon of lateral acceleration. The results of inquiry into the hemodynamics of the pulmonary circulation, oxygen utilization by the cardiac muscle, oxygen tention in brain tissues, and central-nervous-system functions combined with a study of the literature, made it possible to construct a diagram showing the principal physiological effects of lateral acceleration. Author

N63-20754 National Aeronautics and Space Administration, Washington, D.C.

SELECTION OF SPACE CABIN ATMOSPHERES. PART I: OXYGEN TOXICITY

Emanuel M. Roth Washington, NASA, Aug 1963 94 p 177 refs

(NASA Contract NASr-115)

(NASA TN-D-2008) OTS: $2.25

The pertinent molecular mechanisms of oxygen toxicity are discussed in light of current free-radical concepts Specific effects of high oxygen tension in both experimental animals and man are then reviewed for the range of 0.2 to 1.0 atm Effects of higher oxygen tensions are covered only where they shed light on the pathological mechanism expected in the space-cabin environment The associated oxygen problems of radiation pathology are then analyzed A final review is made of information gaps and areas for future study which will aid in selection of space cabin systems Author

N63-20892 National Aeronautics and Space Administration, Washington, D C

STUDY OF SENSORY DEPRIVATION, PAIN AND PERSONALITY RELATIONSHIPS FOR SPACE TRAVEL [Final Report, Nov. 1, 1961-Oct. 31, 1962]

J. Peters, F. B. Benjamin, W. M. Helvey and G. A. Albright (Republic Aviation Corp., Farmingdale, N.Y.) Sept. 1963 72 p 28 refs
(Contract NASr-74)
(NASA TN D-2113) OTS: $2.00

A study was conducted to determine the relationships between the ability to endure pain, performance on the personality scales of both the Minnesota Multiphasic Personality Inventory (MMPI) and the Edwards Personal Preference Schedule (EPPS), and the ability to endure reduced sensory-input conditions. The results of the study indicated that (1) there were no consistent or notable differences between the pain-endurance selected subjects on most of the personality scales of the MMPI and the EPPS; (2) the relationship between the ability to endure pain and the ability to endure reduced sensory-input conditions was not statistically significant. Author

N63-22863 National Aeronautics and Space Administration, Washington, D.C.
PROBLEMS IN THE PHYSIOLOGY OF INTRACRANIAL BLOOD CIRCULATION AND THEIR CLINICAL IMPLICATIONS [VOPROSY FIZIOLOGII VNUTRICHEREPNOGO KROVOOBRASHCHENIYA S KLINICHESKIM IKH OSVESHCHENIYEM]
A. A. Kedrov and A. I. Naumenko. Oct. 1963 136 p 188 refs
Transl. into ENGLISH of a monograph of the State Publishing House for Med. Lit., Leningrad, 1954
(NASA TT F-156) OTS: $2.75

This experimental investigation deals with circulation in the brain and its membranes in different animals. The work presented is based on experimental observations involving a method developed and first used by the authors to investigate intracranial circulation. Author

17 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; and materials fabrication, handling and inspection. *For related information see* 06 Auxiliary Systems

N63-11680 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
METHOD FOR DESIGN OF PUMP IMPELLERS USING A HIGH-SPEED DIGITAL COMPUTER
Norbert O. Stockman and John L. Kramer. Washington, NASA, Jan. 1963 36 p 9 refs
(NASA TN D-1562) OTS: $1.00

A method of designing pump impellers is derived from the equations of motion and continuity for incompressible nonviscous flow. The flow is assumed to follow a known stream surface (representing blade shape) that extends from hub to shroud. Equations are also derived for approximate blade-surface velocities and pressures. A detailed numerical procedure and block diagram are given for use on a digital computer. A numercial example that illustrates limited use of the method is presented and further uses are indicated. Author

N63-12591 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
BOUNDARY LUBRICATION CHARACTERISTICS OF A TYPICAL BEARING STEEL IN LIQUID OXYGEN
William F. Hady, Gordon P. Allen, and Robert L. Johnson. Washington, NASA, Feb. 1963 16 p 10 refs
(NASA TN D-1580) OTS: $0.50

Friction and wear data were obtained with a typical bearing steel (AISI 440-C) at conditions approximating those encountered by bearings and seals in rocket engines using liquid oxygen as the lubricant. A 3/16-in.-radius hemisphere was loaded against the flat surface of a rotating disk at sliding velocities from 250 to 8000 ft/min and loads from 200 to 1500 grams. Fundamental boundary lubrication characteristics of liquid oxygen show the importance of surface-reaction films. The experiments described herein demonstrate the validity of the adhesion concept of friction and wear. Author

N63-13539 National Aeronautics and Space Administration. Washington, D.C.
EXPLOSION WELDING (SVARKA VZRYVOM)
V. S. Sedykh, A. A. Deribas, Ye. I. Bichenkov, and Yu. A. Trishin. Mar. 1963 14 p 9 refs Transl. by Faraday Translations, from Svarochnoye Proizvodstvo (Moscow), no. 5, 3-6, 1962
(NASA TT F-140) OTS: $0.50

The possibility of welding metals of the same and different types, and also of obtaining welded joints of large area, by means of an explosion has been experimentally established. The experiments show that the types of explosives used are of major importance, the most suitable for this purpose being low-density explosives in granular form. Author

N63-15769 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
INFLUENCE OF MICROSTRUCTURAL INCLUSIONS ON FRICTION AND WEAR OF NICKEL AND IRON IN VACUUM TO 10^{-9} MILLIMETER OF MERCURY
Donald H. Buckley and Robert L. Johnson. Washington, NASA, May 1963 25 p 14 refs
(NASA TN D-1708) OTS: $0.75

Friction, wear, and welding characteristics of three binary alloy systems were studied at ambient pressures from 760 to 10^{-9} millimeter of mercury. Studies were conducted with nickel-oxygen, nickel-tin, and iron-sulfur alloys. Friction and wear studies were made with a hemispherical (3/16-in. rad.) rider, which slides in a circumferential path on the flat surface of a rotating metal disk of the same material. The specimens were tested at various ambient pressures with a load of 1000 grams (2.2 lb), a sliding velocity of 28 to 1800 feet per minute, and a temperature of 75° F. The incorporation of nickel oxide (1.35 to 7.50 percent) in electrolytic nickel resulted in friction and wear properties in vacuum for nickel, which were characteristic of that experienced for nickel-base alloys in air at atmospheric pressure. The addition of tin (optimum 20-percent tin) to electrolytic nickel reduced friction and wear of nickel in vacuum by a factor of 10. The fundamental lubrication mechanism, however, is not the same for the two alloy systems. The addition of various percentages of sulfur (present as ferrous sulfide) to electrolytic iron (0.01- to 0.45-percent sulfur) reduced friction, wear, and welding of electrolytic iron in vacuum (10^{-9} mm Hg). Author

N63-15862 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
APPLICATIONS NOTES: SELECTED WELDING TECHNIQUES
Washington, NASA, Apr. 1963 31 p
(NASA SP-501) GPO $0.30

Tools and techniques developed by the George C. Marshall Space Flight Center for the welding of aluminum plates and sheets are described. A seam tracker device and proximity control unit proved effective in welding heavy-gage aluminum. Two segmented backup bars provide most of the back-bar functions. A special vacuum-type backup bar facilitates repairs in normally inaccessible locations. Tape retains and shapes the molten underbead without

weld contamination and proves useful for backup tasks. Handy fitup tools for fusion welding hold workpieces in near-perfect alinement. Alinement of large-diameter cylinders is maintained by direct-current straight-polarity TIG tack welding. Guide tips are developed for feeding fiber wire when welding with inert gas processes. Improved method of electric-arc spot welding utilizes the sigma technique. NEA

N63-16669 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

CALIBRATION OF A THERMAL-CONDUCTIVITY VACUUM GAGE IN THE RANGE OF 10 ^{4} TO 1 TORR BY MEANS OF A VOLUME-RATIO CALIBRATION SYSTEM

Raymond Holanda. Washington, NASA, June 1963. 27 p. 9 refs.
(NASA TN D-1729) OTS: $0.75.

Pressure measurements obtained with the thermal-conductivity gage were reproducible to about 1 percent to the lower limit of 10^{-2} torr and to 2 percent to the lower limit of 10^{-4} torr. Calibration curves for several gases are presented. Pressures in the range of 10^{-4} to 1 torr were accurately created by the injection of a small volume of relatively high-pressure gas into a large chamber that was initially at substantially zero pressure. An error analysis showed that pressures as low as 2×10^{-4} torr could be produced with a maximum limit of error of 3 percent. below 2×10^{-4} torr, the limit of error increased linearly to 6 percent at 10^{-4} torr. Author

N63-18661 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ACHIEVING SATELLITE RELIABILITY THROUGH ENVIRONMENTAL TESTS

John C. New. Washington, NASA, July 1963. 29 p. 3 refs. Presented at Inst. of Environmental Sci., Los Angeles, Apr. 17-19, 1963.
(NASA TN D-1853) OTS: $0.75

The principles, policies, and procedures used by NASA in achieving satellite reliability by exploiting environmental-testing techniques are described. The formalized environmental-test plan for a typical satellite program is reviewed to illustrate these objectives. A discussion that highlights the reliability objectives of space missions as contrasted with military or industrial missions is given. Actual experience gained by utilization of this program is shown by results obtained with several scientific satellites that have been successfully orbited. Author

N63-20612 National Aeronautics and Space Administration. Washington, D.C.

THE DEPOSITION OF VACUUM COATINGS BY MEANS OF ELECTRON BOMBARDMENT [PROTESS NANESENIYA POKRYTIY V VAKUUME S PRIMENENIYEM ELEKTRONNOY BOMBARDIROVKI]

V. K. Pereverzevv. Sept. 1963. 24 p. 11 refs. Transl. by Faraday Translations into ENGLISH from Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR (Moscow), no. 11, 1962. p 209-220
(NASA TT F-185) OTS: $0.75

A special vacuum sphere has been built in which it is possible to carry out the process of depositing thin films by the method of evaporating and condensing very high-melting substances in a high or superhigh vacuum, using electron bombardment, together with control of the quality of the coating and the conditions of deposition. Several different forms of the deposition process have been investigated in relation to a series of metals. Methods of studying the process of deposition of films of complex composition have been developed. Author

N63-22713 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

MINIMUM-OIL-FLOW REQUIREMENTS OF HIGH-SPEED BALL BEARINGS AT TEMPERATURES TO 800° F

Dean C. Glenn and William J. Anderson. Washington, NASA, Oct. 1963. 23 p. 15 refs.
(NASA TN D-1994) OTS: $0.75

A total of 58 minimum-oil-flow tests were performed on eight pairs of deep-groove ball bearings at DN values (product of bearing bore and speed) of 0.45×10^{6} to 1.2×10^{6}, thrust loads of 1000, 2000, and 3000 pounds, and bearing temperatures to 800° F with air-oil-mist lubrication. Minimum required oil flows (of the order of 10^{-4} to 10^{-2} lb/min) increased with increasing DN, load, and temperature to 500° F. At 600° F, varnish deposits formed that apparently aided lubrication and reduced the flow required below that at 500° F. Bearing temperature and torque generally decreased with decreasing oil flow down to the minimum-oil-flow conditions. Author

18 MATERIALS, METALLIC

Includes cermets; mechanical and physical properties of alloys and metals; and metallurgy. *For related information see*: 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Nonmetallic; 33 Stresses and Loads; and 34 Structural Design.

N63-10986 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DETERIORATION OF CALCIA-STABILIZED ZIRCONIA

John D. Buckley (M.S. Thesis - Clemson Agr. Coll., June 1961). Washington, NASA, Dec. 1962. 23 p. 6 refs.
(NASA TN D-1595) OTS: $0.75

The possible causes of the physical breakdown and friability exhibited by fused stabilized zirconia refractories when subjected to severe cyclic heat treatment in the heat exchangers of ceramic-heated blowdown jets were investigated. The crystal structure and the calcia content of unused stabilized zirconia refractory and of the deteriorated material were analyzed by X-radiation. Results of the analysis showed that the deteriorated material was definitely less stable (contained less cubic zirconia) than unused stabilized zirconia. Author

N63-12926 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

OBSERVATIONS OF PROPERTIES OF SINTERED WROUGHT TUNGSTEN SHEET AT VERY HIGH TEMPERATURES

E. C. Sutherland and William D. Klopp. Washington, NASA, Feb. 1963. 41 p. 9 refs.
(NASA TN D-1310) OTS: $1.00

The mechanical properties of five typical lots of commercial tungsten sheet were examined at temperatures from 3650° to 5200° F. The ductile-to-brittle transition temperature in bending was also determined. Results showed that the properties varied widely with the material lot. The greatest variation in mechanical properties occurred at maximum temperatures. Trace elements and grain size appear to affect high-temperature properties and the transition temperature significantly. Author

N63-13183 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TENSILE PROPERTIES AND SHEET-BENDING FATIGUE PROPERTIES OF SOME REFRACTORY METALS AT ROOM TEMPERATURE

Lee R. Foster, Jr., and Bland A. Stein. Washington, NASA, Jan. 1963. 32 p. 5 refs.
(NASA TN D-1592) OTS: $1.00

Results of tensile stress-strain tests and completely reversed sheet-bending fatigue tests conducted at room temperature on unnotched sheet specimens of Ta-10W tantalum alloy, D-31 niobium alloy, pure tungsten, and Mo-0.5Ti molybdenum alloy are presented. Fatigue data from tests on similar specimens of 2024-T3 aluminum alloy and 17-7 PH stainless steel are compared with previous data

from axial-load tests on larger specimens of these materials to determine whether the small size of the specimens used in this investigation produces representative results. Comparisons of the various materials on the basis of applied-stress—ultimate-strength and strength-density ratio also are presented. Author

N63-14402 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

CONTINUED INVESTIGATION OF AN ADVANCED-TEMPERATURE, TANTALUM-MODIFIED, NICKEL-BASE ALLOY

John C. Freche and William J. Waters Washington, NASA, Apr. 1963 31 p 17 refs
(NASA TN D-1531) OTS: $0.75

The investigation of an advanced-temperature, NASA nickel-base alloy having a nominal composition in weight percent of 8 tantalum, 6 aluminum, 6 chromium, 4 molybdenum, 4 tungsten, 2.5 vanadium, 1 zirconium, 0.125 carbon, and balance nickel was continued. This alloy appears to have considerable potential for various aerospace applications. The average ultimate tensile strength of the as-forged alloy ranged from 158,000 psi at room temperature to 18,000 psi at 2100° F. This compares with 135,000 and 34,000 psi, respectively, for the as-cast alloy. Stress-rupture data obtained up to 2100° F at 15,000 psi indicate average rupture lives for the as-cast alloy of 1000, 100, and 10 hours at 1817°, 1915°, and 2015° F, respectively. Impact tests provided evidence of alloy ductility. Additional evidence of workability was also obtained. Room-temperature forging, accomplished by unidirectional forging techniques, readily flattened ½-inch-diameter, as-cast bars, and thickness reductions of 50 percent were consistently obtained. In oxidation tests at 1900° F, relatively low oxidation rates were obtained, although spalling of the oxide scale was observed upon cooling through the 800° to 600° F range. The weight gain per unit surface area for the NASA alloy was 2.9 and 6.5 milligrams per square centimeter after 50 and 200 hours exposure, respectively. These are not excessive oxidation rates, particularly for short-time applications; however, spalling may pose a problem in applications where frequent temperature cycling occurs. Author

N63-14405 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

INFLUENCE OF FLUORINE ENVIRONMENT ON THE MECHANICAL PROPERTIES OF SEVERAL SHEET ALLOYS

Hadley T. Richards and Morgan P. Hanson Washington, NASA, Apr. 1963 15 p 8 refs
(NASA TN D-1706) OTS: $0.50

The effect of a liquid-fluorine environment on the mechanical properties of several sheet alloys was investigated. The smooth and notch tensile strengths and the elongation properties of steel, nickel, aluminum, and titanium alloys were determined in liquid-nitrogen and liquid-fluorine environments (-320° F). Possible deterioration in the presence of fluorine and high stresses was detected by comparing the properties of alloys exposed to the two fluids at -320° F. The commercial-quality fluorine used contained contaminants. The results of tests in liquid fluorine indicated possible degradation of the mechanical properties of the sheet alloys. Following 2-hour exposure, the decrease in tensile strength ranged from negligible to a maximum reduction of approximately 11 percent. Elongation showed similar trends. The sharp-notch strengths appeared to be unaffected by the liquid fluorine. Variations in test results and surface appearance could have been due to varying amounts of contaminants in the liquid fluorine. There was no evidence of ignition on any of the specimens that were fractured in the liquid-fluorine environment. Author

N63-15772 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTIVENESS OF SINGLE ALUMINUM METEOROID BUMPERS

Donald H. Humes Washington, NASA, May 1963 25 p 4 refs
(NASA TN D-1784) OTS: $0.75

An experimental investigation of the effectiveness of single aluminum meteoroid bumpers has been made. For impact velocities up to 15,000 ft/sec, the penetration of 0.062-inch-diameter copper spheres into aluminum targets can be greatly reduced by using a properly selected bumper placed an adequate distance from the main wall. In the velocity range of this investigation, there was a limit to the depth to which some bumper-protected targets were penetrated that occurred at a relatively low impact velocity, the lower velocity projectiles producing deeper penetrations than the higher velocity projectiles. The effectiveness of the bumper against the higher velocity projectiles was caused by the shattering of the projectiles as they penetrated the bumper at these velocities and by the dispersion of the resulting fragments over a large area of the main wall. The degree of fragmentation was a function of the impact velocity. The limit to which the aluminum bumper-protected targets were penetrated by copper spheres is a function of the bumper thickness. The optimum bumper thickness was between 0.5 and 2.0 times the diameter of the impacting projectile. At velocities great enough to cause fragmentation of the projectile, the penetration decreased with increased bumper standoff distance, up to a point, beyond which further increases in the bumper standoff distance had no effect on the penetration. A standoff distance greater than 8 projectile diameters was required to limit penetration in a bumper-protected target. Author

N63-16161 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PRELIMINARY INVESTIGATION OF MELTING, EXTRUDING, AND MECHANICAL PROPERTIES OF ELECTRON-BEAM-MELTED TUNGSTEN

Walter R. Witzke, Earl C. Sutherland and Gordon K. Watson Washington, NASA, May 1963 42 p 20 refs
(NASA-TN-D-1707) OTS: $1.25

Three tungsten ingots were prepared by the electron-beam-melting process. Billets machined from the ingots were successfully hot extruded in high- and low-velocity extrusion presses. The mechanical properties of the extruded electron-beam-melted tungsten were determined by tensile tests at temperatures from 70° to 3900° F. These data were compared to those of tungsten prepared by the powder-metallurgy process. Author

N63-16296 National Aeronautics and Space Administration, Washington, D.C.

PROGRESS REPORT OF THE NASA SPECIAL COMMITTEE ON MATERIALS RESEARCH FOR SUPERSONIC TRANSPORTS

Richard H. Raring, J. W. Freeman, J. W. Schultz, and V. R. Voorhees (Michigan U.) May 1963 191 p 3 refs
(NASA TN-D-1798) OTS: $3.50

Activities of the NASA Special Committee in Materials Research for Supersonic Transports during the first 19 months of its life are summarized. Detailed results from the several investigations of sheet materials for wings and fuselage made under the Committee cognizance are presented. Committee recommendations for further research are outlined. Author

N63-17340 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

INVESTIGATION OF MECHANICAL PROPERTIES AND METALLURGICAL CHARACTERISTICS OF A METALLIC CHROMIUM AND MAGNESIUM OXIDE COMPOSITE

Charles R. Manning, Jr., and Dick M. Royster Washington, NASA, June 1963 45 p 7 refs
(NASA TN D-1785) OTS: $1.25

An experimental investigation has been made to evaluate an uncoated, thin, composite sheet material, containing metallic chromium and magnesium oxide, for aerospace applications in the temperature range where coated refractory metals also

are being considered The evaluation consisted of mechanical-property tests, both at room and elevated temperatures up to 2600° F. The effect of preoxidation at various temperatures on the room-temperature properties is shown. Bend and tensile transition temperatures were also determined, and static oxidation tests were performed up to 2800° F. The metallurgical study included identification of the oxide films by X-ray analysis and also a study of the solid-state reactions taking place between the chromium and the ceramic material by the use of light and electron microscopy. Fabrication of the composite is discussed briefly. A description of the equipment and procedures utilized in performing the evaluation tests is included. Author

N63-18133 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN INVESTIGATION OF A NEW NICKEL ALLOY STRENGTHENED BY DISPERSED THORIA
Charles R. Manning, Jr., Dick M. Royster, and David N. Braski Washington, NASA, July 1963 39 p 13 refs
(NASA TN D-1944) OTS: $1.00

An experimental investigation was made to evaluate sheet material composed of a new nickel alloy strengthened by dispersed thoria, for aerospace applications in the temperature range from 1,800° F to 2,400° F. Mechanical-property tests were made at room and at elevated temperatures from 1,700° F to 2,570° F The effect of preoxidation at various temperatures on the room-temperature tensile properties is also shown. One diffusion coating was evaluated to determine its effectiveness in reducing oxidation. Fabrication studies included machining, diffusion-bond joining, and several different welding processes. A description of the equipment and procedures utilized in performing the evaluation tests is also included. The metallurgical study included X-ray analysis and a microstructural examination of uncoated and coated sheet material. Author

N63-18312 National Aeronautics and Space Administration, Washington, D.C.
TUNGSTEN AND MOLYBDENUM
Curt Agte and Jiri Vacek 1963 295 p 410 refs Transl. of the book "Wolfram a Molybden", State Publishing House of Tech. Lit., Prague, 1954
(NASA TT F-135) GPO: $1.00

The production of tungsten and molybdenum by powder metallurgy is considered. Discussed are: (1) tungsten and molybdenum occurrence; (2) extracting tungsten and molybdenum from ores, concentrates, and extraneous products; (3) refining tungstic and molybdic acids for production of ductile metal; (4) industrial methods of producing ductile semiproducts from tungsten and molybdenum; (5) working tunsten and molybdenum into ductile semiproducts; (6) production and working of highly sinterable tungsten; (7) properties of tungsten and molybdenum; (8) tungsten and molybdenum metallography; (9) alloys of tungsten and molybdenum; (10) technical uses of tungsten and molybdenum. N.E.A.

N63-18773 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A METHOD FOR PREDICTING THE STATIC STRENGTH OF A STIFFENED SHEET CONTAINING A SHARP CENTRAL NOTCH
Herbert A. Leybold Washington, NASA, Aug. 1963 24 p 8 refs
(NASA TN D-1943) OTS: $0.75

The structural configurations treated consist of a thin sheet with a notch, and a stiffener centrally located over the notch. Residual static strengths are predicted for three structural configurations having ratios of notch area to stiffener area equal to 0.2, 1.0, and 5.0. Two aluminum alloys, 2024-T3 and 7075-T6, were investigated. The predicted results are compared with a limited number of experimental results, and fair agreement is obtained. Author

N63-21894 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MOMENTUM ACCOMMODATION OF N^+, N_2^+, AND A^+ INCIDENT ON COPPER AND ALUMINUM FROM 0.5 TO 4 KEV
Howard F. Savage and Michel Bader Washington, NASA, Sept. 1963 24 p 10 refs
(NASA TN D-1976) OTS: $0.75

Momentum accommodation coefficients were determined with a two-component microbalance by measuring the normal and tangential components of the force imparted to a flat plate (Cu or Al) by the impinging ion beam (N^+, N_2^+, or A^+). Ion energies were varied between 0.5 and 4.0 kev, and the angles of incidence ranged from 0° to 50° from the normal. It is suggested that most of the reflected momentum is due to the ejection of target atoms (sputtering). Author

N63-22110 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
ALLOYING EFFECTS ON TUNGSTEN-FIBER-REINFORCED COPPER-ALLOY OR HIGH-TEMPERATURE-ALLOY MATRIX COMPOSITES
Donald W. Petrasek and John W. Weeton Washington, NASA, Oct. 1963 68 p 20 refs
(NASA TN D-1568) OTS $1.75

An investigation was conducted to determine the effect of alloying on the tensile properties and microstructure of tungsten-fiber reinforced composites Composites were made of tungsten fibers infiltrated with copper binary alloys that contain elements of varying solubility in tungsten Room temperature tensile tests were made on the composites, and a metallographic study of the microstructure of the fiber metal matrix interface was conducted In addition metallographic studies were made of tungsten fibers infiltrated with alloys, 70Ni-30Fe, S-816, and L-605 As the depth of penetration of the alloy into the fiber increased a decrease in both tensile strength and ductility of the composite resulted A notch embrittlement effect due to the formation of a brittle alloy zone with the tungsten fiber was observed and gave rise to greater reductions in tensile properties and ductility behavior than would be predicted by a law of mixture relation alone Author

N63-22112 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
STRESS-STRAIN BEHAVIOR OF TUNGSTEN-FIBER-REINFORCED COPPER COMPOSITES
David L. Mc Daniels, Robert W. Jech, and John W. Weeton Washington, NASA, Oct. 1963 45 p 36 refs
(NASA TN D-1881) OTS $1.55

An investigation was conducted to determine the stress strain behavior and tensile properties of metallic composites and to relate them to the properties of the base materials Room temperature tensile and dynamic modulus tests were used to determine these properties The composites were reinforced with either continuous or discontinuous fibers The tensile properties and stress strain behavior of composites reinforced with either type of fiber were similar, and, in both cases, the full strength of the fiber was utilized Author

19 MATERIALS, NONMETALLIC

Includes mechanical and physical properties of nonmetals (e.g., plastics). *For related information see*: 07 Chemistry; 17 Machine Elements and Processes; 18 Materials, Metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-10625 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

INITIAL WEIGHT LOSS OF PLASTICS IN A VACUUM AT TEMPERATURES FROM 80° TO 500° F

Hermilo R. Gloria, W. James Stewart, and Raymond C. Savin Washington, NASA, Dec. 1962 20 p 13 refs
(NASA-TN-D-1329) OTS: $0.50

Initial rates of weight loss are determined for five plastic materials at pressures from 3×10^{-7} to 3×10^{-6} mm Hg and at temperatures ranging from 80° to 500° F. The materials tested include two thermoplastics, polytetrafluoroethylene and polycarbonate; two types of reinforced phenolics; and a relatively pure epoxy resin. The effect of material thickness on initial rate of weight loss for all the test materials is also presented. Author

N63-11517 National Aeronautics and Space Administration, Washington, D.C.

MATERIALS FOR SPACE EXPLORATION

Don D. Davis, Jr., George F. Pezdirtz, Leonard Roberts, Richard H. Kemp, and Hubert B. Probst 1962 47 p 92 refs Papers presented at Session U of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)
(NASA-SP-27) GPO: $0.35

CONTENTS:

1. SPACE ENVIRONMENT AND ITS EFFECTS ON MATERIALS D. D. Davis, Jr. (NASA. Langley Research Center) 11 p 25 refs
2. NONMETALLIC MATERIALS FOR SPACECRAFT G. F. Pezdirtz (NASA. Langley Research Center) 10 p 16 refs
3. ABALATION MATERIALS FOR ATMOSPHERIC ENTRY L. Roberts (NASA. Langley Research Center) 8 p 30 refs
4. FLOW AND FRACTURE PROBLEMS IN AEROSPACE VEHICLES R. H. Kemp (NASA. Langley Research Center) 8 p 5 refs
5. HIGH-STRENGTH MATERIALS RESEARCH H. B. Probst (NASA. Langley Research Center) 8 p 16 refs

N63-12193 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

COMPATIBILITY OF MOLTEN URANIUM DIOXIDE WITH FIVE REFRACTORY MATERIALS

William A. Sanders and Isadore L. Drell Washington, NASA, Jan. 1963 33 p 16 refs
(NASA TN D-1442) OTS: $1.00

The compatibility of molten uranium dioxide with tungsten, tantalum, tantalum diboride, tantalum carbide, and hafnium carbide was determined at 5220° F for a test period of 15 minutes in a static argon atmosphere. Reactions occurred in all cases; however, the use of tungsten, tantalum, or hafnium carbide in contact with molten uranium dioxide appears possible for short time applications. Author

N63-18659 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXPERIMENTAL EVALUATION OF THREE TYPES OF THERMAL PROTECTION MATERIALS AT MODERATE HEATING RATES AND HIGH TOTAL HEAT LOADS

Andrew J. Chapman Washington, NASA, July 1963 22 p 8 refs
(NASA TN D-1814) OTS: $0.75

Three types of materials have been tested in an electric-arc-heated airstream to compare their performances as thermal-protection systems for reentry applications, involving long heating periods and high total-heat loads. Test-stream conditions and the specimen configuration were held constant for all tests. The quantity of heat dissipated by a specimen while its back-surface temperature was limited to a given value was used as a criterion for evaluating the materials. The tests indicated that charring composite materials were more effective than porous ceramic materials with an ablative filling or than low-temperature ablating materials. Author

N63-18776 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMIC EVIDENCE PERTAINING TO THE ENTRY OF TEKTITES INTO THE EARTH'S ATMOSPHERE

Dean R. Chapman, Howard K. Larson, and Lewis A. Anderson, Washington, U.S. Govt. Print. Off., 1962 26 p 32 refs
(NASA TR-R-134) GPO: $0.40

Evidence is presented which shows that the Australian and Java tektites entered the earth's atmosphere and experienced ablation by severe aerodynamic heating in hypervelocity flight. The laboratory experiments on hypervelocity ablation have reproduced ring-wave flow ridges and coiled circumferential flanges like those found on certain of these tektites. Systematic striae distortions exhibited in a thin layer beneath the front surface of australites also are reproduced in the laboratory ablation experiments, and are shown to correspond to the calculated distortions for aerodynamic ablation of a glass. About 98 percent of Australian tektites represent aerodynamically stable configurations during the ablative portion of an entry trajectory. Certain meteorites exhibit surface features similar to those on tektites Author

N63-21896 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CALCULATION OF ELECTRON ENERGY DEPOSITION IN THIN-FILM POLYMERIC MATERIALS

Louis A. Teichman and Ernest S. Armstrong Washington, NASA, Oct. 1963 11 p 6 refs
(NASA TN D-2010) OTS: $0.50

A procedure has been presented for approximating the energy deposited in shielded and unshielded polymer films by electrons entering the material normal to the surface. The analysis employs numerical methods to determine the average path length of an electron in a material for which the atomic density, atomic number, and mean excitation potential are known. It has been applied to three cases, including that of the inflated Echo II balloon, with incident electron kinetic energies up to 5 Mev. Characteristic variations of the deposited energy with incident electron kinetic energy have been derived. Author

20 MATHEMATICS

Includes calculation methods and theory; computers; data processing; and numerical analysis. *For related information see*: 08 Communications; 09 Electronics; 10 Facilities, Research and Support; and 22 Navigation and Guidance.

N63-10202 National Aeronautics and Space Administration, Washington, D. C.

MEASUREMENT OF THE STATE VECTOR

C. A. Harvey (Minneapolis-Honeywell Regulator Co.) Nov. 1962 23 p 3 refs Investigation conducted at Minneapolis-Honeywell Regulator Co. under sponsorship of NASA
(NASA Contract NASr-27)
(NASA TN D-1590) OTS: $0.75

Methods are described which may be used to transform the equations of motion of a vehicle to a standard form, measure the state of the system when described in this standard form, and remove first flexure mode effects from pitch-rate signals. Author

N63-10952 National Aeronautics and Space Administration, Washington, D.C.

A LOGICAL NET MECHANIZATION FOR TIME-OPTIMAL REGULATION

Fred B. Smith, Jr. (Minneapolis-Honeywell Regulator Co.) Dec. 1962 35 p 3 refs
(NASA Contract NASr-27)
(NASA TN D-1678) OTS: $1.00

A technique is described for mechanizing relay controllers. A quantized phase space for the plant is mapped into two or more points by a collection of logic elements whose Boolean inputs are the quantized variables. If the switching surfaces are known explicitly, the logic (the mapping function) of the controller may be computed in a straightforward manner. If the surfaces are known only implicitly, the logic may be adjusted on a representative collection of particular values of the desired mapping function. Experimental results are presented for time-optimal control of third-order and fourth-order plants. Author

N63-11506 National Aeronautics and Space Administration, Washington, D.C.

DATA ACQUISITION FROM SPACECRAFT

John T. Mengel, Joseph W. Siry, Albert G. Ferris, William R. Bandeen, and Charles D. Kirsten 1962 58 p 35 refs Papers presented at Session J of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11501 03-29)
(NASA-SP-16) GPO: $0.40

CONTENTS:

1. INTRODUCTION J. T. Mengel (NASA. Goddard Space Flight Center) 1 p
2. DATA PROCESSING FOR ORBIT DETERMINATION J. W. Siry (NASA. Goddard Space Flight Center) 13 p
3. DATA ACQUISITION AND PROCESSING FROM SCIENTIFIC SATELLITES A. G. Ferris (NASA. Goddard Space Flight Center) 6 p 1 ref
4. DATA PROCESSING FROM METEOROLOGICAL SATELLITES W. R. Bandeen (NASA. Goddard Space Flight Center) 19 p 13 refs
5. DATA ACQUISITION AT PLANETARY RANGES C. C. Kirsten (JPL) 17 p 21 refs

N63-11536 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

THE N-BODY CODE—A GENERAL FORTRAN CODE FOR SOLUTION OF PROBLEMS IN SPACE MECHANICS BY NUMERICAL METHODS

William C. Strack, Wilbur F. Dobson, and Vearl N. Huff Washington, NASA, Jan. 1963 94 p 11 refs
(NASA TN D-1455) OTS: $2.25

A general astronomical integration code designed for a large class of problems in space mechanics that may be solved by numerical integration is described. The equations of motion provide for the effects of up to eight gravitating celestial bodies, oblateness and aerodynamic forces from the celestial body at the problem origin, propulsion system thrust, and rotation of the body at the origin. Author

N63-11612 National Aeronautics and Space Administration, Washington, D.C.

AN EXPERIMENT IN THE USE OF PUNCHED CARDS IN THE STUDY OF PROBLEMS RELATING TO TEKTITES

G. G. Vorob'yev Dec. 1962 8 p 6 refs Transl. by John F. Holman & Co., Inc. of "Opyt ispol'zovaniya perfokart pri izuchenii problemy tektitov" from Meteoritika (USSR), Issue 22, 1962 p 157-161
(NASA TT F-114) OTS: $0.50

A manual system has been worked out for sorting 10,000 or more punched cards for classifying and systematizing tektite data. The system may be adapted to the field of meteoritics proper with no special changes. Author

N63-11620 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A METHOD FOR COMPUTING THE EFFECT OF AN ADDITIONAL OBSERVATION ON A PREVIOUS LEAST-SQUARES ESTIMATE

Patrick A. Gainer Washington, NASA, Jan. 1963 17 p 6 refs
(NASA TN D-1599) OTS: $0.50

Simple expressions are derived by which the effects of the new observation on the previously estimated regression coefficients and their covariance matrix may be computed without matrix inversion when observation errors are uncorrelated. The derivation is easily followed and produces an expression that is the same as that obtained from statistical filter theory for uncorrelated errors. Author

N63-12061 National Aeronautics and Space Administration, Washington, D.C.

APPROXIMATE SOLUTION TO A NONLINEAR DIFFERENTIAL EQUATION OF THE THIRD ORDER WITH THE N. N. BOGOLYUBOV ASYMPTOTIC METHOD

A. D. Maksimov Jan. 1963 11 p 5 refs Transl. of "Priblizhennoye Resheniye Nelineyogo Differentsial'nogo Uravneniya Tret'yego Poryadka Asimptoticheskim Metodom N. N. Bogolyubova." Izvest. Akad. Nauk SSSR, Otdel. Tekh. Nauk: Energetika i Avtomatika, (Moscow), 1962, no. 3 p 196-200 OTS: $0.50

The expressions developed have application to the investigation of rapidly damped oscillation processes in systems of the third order. Author

N63-12312 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A CENTRAL FACILITY FOR RECORDING AND PROCESSING TRANSIENT-TYPE DATA

Richard L. Smith, Charles W. Mealey, Jr., Charles F. Kadow, Arthur D. Brenza, Richard N. Bell, John C. Sturman, and Allen L. Perry Washington, NASA, Jan. 1963 81 p 1 ref
(NASA TN D-1320) OTS: $2.25

The data system described has the capacity of recording and automatically processing transient-type data in the frequency range of 0 to 10,000 cps. Data are recorded in both analog and digital form on magnetic tape and are processed by either an analog or a digital computer. Special shielded cable is used to transmit the data at low voltage levels from six test facilities over cable lengths up to 7,000 feet. Identification and search features are provided as well as a quick-look feature using a storage-type oscilloscope. The system has been in operation since March 1960. Author

N63-13283 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A NUMERICAL SOLUTION OF THE PROBLEM OF MIXING OF LAMINAR COAXIAL STREAMS OF GREATLY DIFFERENT DENSITIES—ISOTHERMAL CASE

Herbert Weinstein and Carroll A. Todd Washington, NASA, Feb. 1963 27 p 7 refs
(NASA TN D-1534) OTS: $0.75

The system under consideration is a slow-moving, heavy inner stream surrounded by a fast-moving, light outer stream infinite in extent. The flow region of interest lies between the inner jet entrance and the end of the potential core. The density ratio of the two streams may vary through several orders of magnitude, and no restrictions are placed on the velocities of the two components. The only information required is the initial velocity and concentration profiles and the physical properties of the fluids. An equation set is derived and solved numerically for several sets of input parameters. A system of equations that is not extremely sensitive to physical property variations results from the manner in which the variables are made dimensionless. A diffusion equation valid for high values of the density ratio is employed. No consideration is given to the hydrodynamic stability of the system. Results are calculated for a given set of

physical properties and a range of values of density and velocity ratio. These results include the following: (1) The potential core length is approximately 6 radii for fluids of the same density and a velocity ratio of 100. (2) For values of density ratio above 20, the effect of varying density ratio is small. (3) For Froude numbers of 10^2 or less, the mass and momentum transfer become second-order effects compared to the acceleration due to the force field. (4) Large changes in the values of physical properties of the two fluids cause relatively small changes in potential core length. Author

N63-13793 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A VARIATIONAL METHOD FOR THE OPTIMIZATION OF INTERPLANETARY ROUND-TRIP TRAJECTORIES

John S. Mac Kay and Leonard G. Rossa Washington, NASA, Mar. 1963 33 p 9 refs
(NASA TN D-1660) OTS: $1.00

The indirect method of the calculus of variations is used to optimize interplanetary round-trip trajectories for the case of a single, central, attracting body. The method of solution makes use of certain partial derivative properties of the Lagrangian multipliers associated with the Mayer formulation of the variational problem. This property of the multipliers allows the construction of mathematical expressions for certain other partial derivatives that must vanish when an optimum round trip has been found. These expressions are developed for the cases of propulsion systems using (1) fixed thrust and specific impulse or (2) variable thrust and constant exhaust-jet power. Two numerical examples demonstrate how the analytical results may be applied to the solution of round-trip problems including (1) actual three-dimensional planetary positions and (2) planetocentric maneuvers. Author

N63-14249 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

A RECURSION RELATION ASSOCIATED WITH A CERTAIN SPECIAL TYPE DETERMINANT

E. Baylis Shanks Washington, NASA, Apr. 1963 6 p
(NASA TN D-1112) OTS: $0.50

This paper is concerned with the development of formulas of a recursive nature from a certain special-type determinant. These formulas lead directly to computational routines that are effective in the evaluation of such determinants. Such computational routines are also applicable to a wide variety of recursion formulas, obtained by specialization of the parameters involved. Author

N63-15421 National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala

PERIODIC SOLUTIONS OF THE RESTRICTED THREE BODY PROBLEM REPRESENTING ANALYTIC CONTINUATIONS OF KEPLERIAN ELLIPTIC MOTIONS

Richard F. Arenstorf Washington, NASA, May 1963 18 p 10 refs
(NASA TN D-1859) OTS: $0.50

A detailed mathematical proof is given in this report for the following new result. In the restricted three-body problem with small mass ratio, there exist one-parametric analytic families of synodically closed solution curves, which are near rotating Keplerian ellipses with rational sidereal frequencies and appropriate positive eccentricities. Author

N63-17119 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md

SATELLITE OBSERVATIONS OF THE EQUATORIAL IONOSPHERE

L. J. Blumle Washington, NASA, June 1963 11 p 16 refs
(NASA TN D-1756) OTS: $0.50

A method is presented for measuring total electron content by observing the Faraday effect on satellite beacon transmitters at a station located on the magnetic equator. This method is applied to data observed at Huancayo, Peru, between September 1961 and February 1962. The total electron content at the magnetic equator was found to have nearly a 10 to 1 diurnal variation with a maximum of 4×10^{17} electrons/m^2 near 1500 hours. Values of the thickness parameter $(\int Ndh)/N_{max}$ for the observational period show an anomalous increase around layer sunrise which is attributed to a departure from thermal equilibrium. Author

N63-17143 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE EXCITATION OF ELECTROACOUSTIC WAVES BY ANTENNAS IN THE IONOSPHERE

H. A. Whale Washington, NASA, June 1963 18 p 13 refs
(NASA TN D-1760) OTS: $0.50

Measurements of the impedance of an electrically short 7.75-mc antenna in the ionosphere indicate that power is absorbed by some mechanism additional to electromagnetic radiation. The importance of the radiation of energy as an electron-pressure (electroacoustic) wave generated near the antenna is discussed, and it is shown that the calculated power radiated by this mechanism agrees well with the observations. Author

N63-17552 National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

EQUATIONS FOR THE NEWTONIAN STATIC AND DYNAMIC AERODYNAMIC COEFFICIENTS FOR A BODY OF REVOLUTION WITH AN OFFSET CENTER-OF-GRAVITY LOCATION

Robert C. Ried, Jr. and Edward E. Mayo Washington, NASA, June 1963 23 p 5 refs
(NASA TN D-1085) OTS: $0.75

Equations which are easily adaptable to machine computation are presented for the preliminary prediction of the supersonic and hypersonic stability characteristics of bodies of revolution with an arbitrary center-of-gravity location. The equations have been programed and an example of their application to a blunt reentry configuration is presented Author

N63-18130 National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala

ON THE ERROR PROPAGATION OF SOME INTERPOLATION FORMULAS FOR SECOND-ORDER DIFFERENTIAL EQUATIONS

Erwin Fehlberg Washington, NASA, July 1963 31 p refs
(NASA TN D-1834) OTS $1.00

Simple extrapolation formulas are presented for the propagation of the truncation error for interpolation formulas integrating $y'' = f(x,y)$. These error formulas are applied to the interpolation formulas of Milne and Gauss, and their accuracy is illustrated by examples. The error formulas are extended to cover the case of interpolation formulas for $y'' = f(x,y,y')$. The interpolation formulas of Milne and Gauss are supplemented by new formulas for y' in such a way that the combined formulas have the same small error parameter E as the original formulas of Milne or Gauss. Examples demonstrate the accuracy of the error formulas for these new interpolation formulas. Author

N63-18160 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TABLES FOR THE INTEGRAL OF THE CIRCULAR BIVARIATE NORMAL FREQUENCY FUNCTION

William L. Weaver and Kathleen C. Wicker Washington, NASA, July 1963 38 p 7 refs
(NASA TN D-1819) OTS: $1.00

Tables are presented for the integral of the offset circular bivariate normal (circular binormal) distribution function over two types of regions of the distribution: (1) circles centered at the origin of coordinate axes, and (2) infinite sectors bounded

on one side by an infinite radius vector passing through the origin. The tables can be used to determine the integral of the circular function over annular regions about the origin of coordinate axes, and the integral over regions bounded by two infinite radius vectors of arbitrary direction. The evaluation of the integral was performed numerically by using the quadrature formulas of Gauss. Author

N63-20889 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

TABLE OF $_2F_1$ (a,b;c;z) FOR a = 0(1/2)7, b = 0(1/2)7, AND c = 0(1/2)5/2 WITH COMMENTS ON CLOSED FORMS OF $_2F_1$ (a,b;c;z)

K. David Steidley Washington, NASA, Sept. 1963 28 p 12 refs
(NASA TN D-1735) OTS: $0.75

A table of Gauss' hypergeometric function $_2F_1$ (a,b;c;z) has been constructed that displays the analytic form for all integer and half-integer combinations from 0 to 7 of the parameters a and b, and 0 to 5/2 of c. In addition, a table is provided that gives the hypergeometric function in closed form for certain general relations among a, b, and c. Also shown is a simple function of $_2F_1$ (a,b;c;z) that yields all the classical orthogonal polynomials in algebraic form. Author

N63-21435 National Aeronautics and Space Administration, Washington, D.C.

QUALITY PROGRAM EVALUATION PROCEDURES

Sept. 1963 69 p
(NASA SP-6003) OTS: $1.75

Quality program evaluation procedures and related survey checklists are presented which are to be used in the evaluations of quality procedures and controls being applied to manned spaceflight programs. The program has three objectives: (1) to establish uniform standards for evaluating the degree and effectiveness of quality practices and controls, (2) to identify quality-type problems for evaluation and correction, and (3) to permit evaluation of various methods of controlling a specific quality area, leading to improved reliability and safety levels. The program is designed to identify problem and improvement areas consistent with the severe reliability and safety requirements of manned spaceflight systems. P.V.E.

N63-22162 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A GENERAL IBM 704 OR 7090 COMPUTER PROGRAM FOR COMPUTATION OF CHEMICAL EQUILIBRIUM COMPOSITIONS, ROCKET PERFORMANCE, AND CHAPMAN-JOUGUET DETONATIONS. SUPPLEMENT I – ASSIGNED AREA-RATIO PERFORMANCE

Sanford Gordon and Frank J. Zeleznik Washington, NASA, Oct. 1963 82 p 2 refs
(NASA TN D-1737) OTS: $2.00

An addition to the computer program is given that permits calculations of theoretical rocket performance for assigned area ratios. The use of thermodynamic derivatives to increase accuracy of interpolation in a specified range is discussed. A sample problem is included to illustrate the use of the program and to indicate the accuracy of the calculations.
Author

21 METEOROLOGY

Includes climatology, weather forecasting; and lower atmosphere studies. *For related information see*: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

N63-12003 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MONTHLY AND ANNUAL WIND DISTRIBUTIONS AS A FUNCTION OF ALTITUDE FOR SANTA MONICA, CALIFORNIA (PACIFIC MISSILE RANGE)

J. W. Smith Washington, NASA, Jan. 1963 157 p 16 refs
(NASA TN D-1569) OTS: $3.00

Statistical wind distributions for Santa Monica, California (Pacific Missile Range), are presented in tabular form as a function of altitude for monthly and annual periods. The data are tabulated at 1-km intervals from the surface to 27-km altitude and are based upon four observations daily for 5 years of serially completed upper-wind observations made between January 1, 1956, and December 31, 1960. The tabulations are arranged to show cumulative percentage frequencies of occurrence of: scalar winds; zonal and meridional wind components; semiplanar wind components from each of the four cardinal directions; and the vector, zonal, and meridional wind shears for 1000-m altitude layers. Time-altitude cross sections of the zonal and meridional wind components are presented, and a brief discussion of the wind data is given. Author

N63-12586 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE ATMOSPHERE AS A PART OF THE SPACE ENVIRONMENT

Richard A. Hord, Wilber B. Huston, and Harold B. Tolefson Washington, NASA, Jan. 1963 100 p 126 refs
(NASA TN D-1387) OTS: $2.25

CONTENTS:

1. COMPOSITION, TEMPERATURE, DENSITY, AND PRESSURE OF THE ATMOSPHERE Wilbur B. Huston 3-33 54 refs (See N63-12587 06-21)
2. RADIATION BALANCE OF THE EARTH'S ATMOSPHERE Richard A. Hord p 34-52 29 refs (See N63-12588 06-21)
3. WINDS AND MOTIONS IN THE ATMOSPHERE Harold B. Tolefson p 53-96 43 refs (See N63-12589 06-21)

N63-14586 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A RADIATION VIEW OF HURRICANE ANNA FORM THE TIROS III METEOROLOGICAL SATELLITE

W. R. Bandeen, B. J. Conrath, W. Nordberg, and H. P. Thompson Washington, NASA, Apr. 1963 18 p 7 refs Presented at the Intern. Symp. on Rocket and Satellite Meteorology, Washington, Apr. 23-25, 1962
(NASA TN D-1713) OTS: $0.50

The Tiros III meteorological satellite, containing two television cameras and a family of electromagnetic radiation experiments, was launched on July 12, 1961. Nine days later, the satellite passed directly over Hurricane Anna, the first hurricane of the 1961 Atlantic season. Data gathered by a five-channel medium resolution radiometer during one pass over the Hurricane are presented in the form of maps; and certain implications of the data are discussed. Supporting televison pictures are also given. The design and calibration of the medium resolution radiometer are briefly described. Author

N63-15346 National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala

CROSS SECTIONS OF TEMPERATURE, PRESSURE, AND DENSITY NEAR THE 80TH MERIDIAN WEST

Orvel E. Smith, William M. Mc Murray, and Harold L. Crutcher Washington, NASA, May 1963 159 p 21 refs
(NASA TN D-1641) OTS: $3.00

This report provides monthly and annual temperature, pressure, and density analyses along the 80th meridian west from the surface to 31 km. These parameters are furnished at constant altitudes and are based on 3 years of data, 1957 to 1960. The information is given in mean and standard deviation values for each element. Author

N63-18657 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SOME ASPECTS OF STRATOSPHERIC CIRCULATION DERIVED FROM METEOROLOGICAL ROCKET FIRINGS OVER THE UNITED STATES DURING THE WINTER OF 1961
Mohammad Rahmatullah (Pakistan Meteorol. Dept.) Washington, NASA, July 1963 15 p 10 refs
(NASA TN D-1755) OTS: $0.50

Data from six rocket-launching sites in North America obtained from a series of meteorological-rocket firings conducted between January 16 and February 23, 1961, were analyzed. Time cross sections of winds at Wallops Island, Virginia, and Cape Canaveral, Florida, are presented and discussed in the light of synoptically signigicant situations as determined by the 10-mb chart. Temperature soundings in the lower stratosphere relevant to the typical situations are also considered. TIROS II radiation data for orbits 827 and 957 have been analyzed in order that the effect of ozone on stratospheric disturbances might be studied. It was found that the penetration of the mesospheric westerly jet to lower levels was associated with the formation of a marked trough of low pressure over the eastern United States, and coincided with the occurrence of a severe cold period. No final stratospheric warming was observed, and by mid-February the westerlies were back to full strength. A microstructure of the mesodecline at 63 km was observed at Wallops Island and at White Sands, New Mexico. The analysis of TIROS II radiation data pointed out that the effect of changes in the ozone layer is completely masked by the varying cloud pattern. Author

N63-19370 National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md
ARCTIC METEOROLOGY PHOTO PROVE POLARIZED LIGHT EXPERIMENT (CONTINUATION OF PROJECT AMPP)
Gerald L. Hempfling, Harold E. Evans, Robert C. Baumann, and Richard J. Andryshak. Washington, NASA, Aug. 1963 20 p 1 ref
(NASA TN D-1449) OTS: $0.75

Two Aerobee-100 rockets were launched from Fort Churchill, Manitoba, Canada during May 1961. High-altitude pictures were obtained which illustrated the polarizing effects of ice crystals. At certain polarization angles, ice, snow, and clouds are clearly distinguishable. Ice, snow, and clouds also could be distinguished on properly exposed unpolarized black and white photographs, although the distinction was not as clear as on the polarized photographs. Author

N63-21392 National Aeronautics and Space Administration. Washington, D.C.
METEOROLOGICAL INVESTIGATIONS WITH ROCKETS AND SATELLITES (METEOROLOGICHESKIYE ISSLEDOVANIYA S POMOSHCH'YU RAKET I SPUTNIKOV)
K. Ya. Kondrat'yev. Sept. 1963 288 p 322 refs Transl. into ENGLISH from Hydromet. Press, Leningrad, 1962
(NASA TT F-115) OTS: $4.00

Methods for investigating the structure, composition, and dynamics of the upper atmosphere, and the possibility of utilizing artificial earth satellites for studying weather-forming processes in the troposphere and stratosphere are discussed. Modern information as to the composition, structure, and wind patterns of the upper atmospheric layers is given in detail, as are the results of investigations into solar and terrestrial radiation. Author

N63-23679 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE AUTOMATIC PICTURE TRANSMISSION (APT) TV CAMERA SYSTEM FOR METEOROLOGICAL SATELLITES
Rudolf A. Stampfl and William G. Stroud. Washington, NASA, Nov. 1963 16 p refs
(NASA TN D-1915) OTS: $0.50

This paper describes an additional camera system for the Nimbus satellite, designed for automatic and continuous real-time picture transmission during daylight. The camera uses an electrostatic storage vidicon which is exposed for 40 milliseconds, and read-out during the succeeding 200 seconds. The 800-line resolution and the 0.25-second scanning time per line are compatible with standard 240-rpm facsimile equipment which can be used for ground display. A 5-watt transmitter broadcasts the signal in the 136 Mc space telemetry band. FM is used and this makes a large variety of standard mobile communication equipment readily adaptable. On the ground, a manually tracked or even a fixed 10-db helix antenna, with a commercially available receiver and facsimile, is the only equipment required. Author

22 NAVIGATION AND GUIDANCE

Includes autopilots; star tracking; inertial platforms; and air traffic control. *For related information see*: 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities, Research and Support; 15 Instrumentation and Photography; 20 Mathematics; and 29 Space Sciences.

N63-10201 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
SAMPLING STUDIES DOWNSTREAM OF HYDROGEN-NITROUS OXIDE-DILUENT FLAMES
Burton D. Fine. Washington, NASA, Nov. 1962 22 p 11 refs
(NASA TN D-1528) OTS: $0.75

Composition profiles were measured in the burned gas downstream of rich and lean hydrogen-nitrous oxide flat flames diluted with nitrogen, argon, and air. It was proposed that the nitric oxide found downstream of rich flames was formed by the reaction $N_2O + H \rightarrow NO + NH$ in the flame itself. Results for lean flames, based on the rates of decay of N_2O and the accumulation of NO, indicated that the reaction $N_2O + O \rightarrow 2NO$ is about 20 times slower than $N_2O + O \rightarrow N_2 + O_2$ and has an activation energy considerably less than 30 kcal. The effect of thermal decomposition of N_2O was negligible in the downstream zone but was important within the flame itself. Author

N63-10734 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
ANALYSIS OF GUIDANCE PERTURBATIONS FOR A LOW-THRUST MARS ORBITER MISSION USING SNAP-8
Alan L. Friedlander. Washington, NASA, Dec. 1962 83 p 5 refs
(NASA TN-D-1433) OTS: $2.25

A typical low-thrust Mars orbiter mission using the Snap-8 power-generating system is studied from a guidance viewpoint. For each of the three characteristic mission phases, the sensitivity of the final trajectory state (velocity, position, and mass) due to errors in the initial trajectory state and to thrust-vector errors is presented. The analysis is based on linear perturbation theory; however, it is augmented to account for the effects of large thrust-vector perturbations. In general, low-thrust trajectories are found to be highly sensitive to various sources of error. Author

N63-11507 National Aeronautics and Space Administration, Washington, D.C.
CONTROL, GUIDANCE, AND NAVIGATION OF SPACECRAFT
David H. Schmieder, John B. Winch, John D. McLean, John C. Houbolt, John D. Bird, Manuel J. Queijo, Rodney C. Wingrove, Brian F. Doolin, and John V. Foster. 1962 56 p 70 refs Papers presented at Session K of the NASA-University Conf. on the Science and

Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11501 03-29)
(NASA-SP-17) GPO: $0.40

CONTENTS:

1. ADAPTIVE GUIDANCE S. H. Schmieder and J. B. Winch (NASA. Marshall Space Flight Center) 8 p
2. A SURVEY OF MIDCOURSE GUIDANCE AND NAVIGATION TECHNIQUES FOR LUNAR AND INTERPLANETARY MISSIONS J. D. McLean (NASA. Ames Research Center) 6 p 4 refs
3. GUIDANCE AND NAVIGATION ASPECTS OF SPACE RENDEZVOUS J. C. Houbolt, J. D. Bird, and M. J. Queijo (NASA. Langley Research Center) 14 p 6 refs
4. ATMOSPHERE ENTRY GUIDANCE AND CONTROL R. C. Wingrove (NASA. Ames Research Center) 14 p 57 refs
5. SPACE VEHICLE ATTITUDE CONTROL B. F. Doolin (NASA. Ames Research Center) 6 p 3 refs
6. GUIDANCE AND CONTROL COMPONENTS RESEARCH J. V. Foster (NASA. Ames Research Center) 6 p

N63-11780 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STUDY OF AN AUTOMATIC SYSTEM FOR CONTROL OF THE TERMINAL PHASE OF SATELLITE RENDEZVOUS

Edgar C. Lineberry, Jr., and Edwin C. Foudriat Washington, NASA, 1962 19 p 5 refs
(NASA TR R-128) GPO: $0.30

An analytical and simulation study was conducted of an automatic system to control the terminal phase of rendezvous between two space vehicles. The system employs switching and thrust orientation criteria based upon relative-motion parameters, first to establish a collision course, and then to reduce the range and range rate to zero, simultaneously. Techniques are developed for employing either modulated thrust or on-off thrust at a constant level. Results of the study indicate that the automatic system can effectively control rendezvous over a wide range of initial conditions and can utilize the available fuel in a very efficient manner. Author

N63-12488 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PRELIMINARY REPORT ON THE SINGLE STATION DOPPLER-INTERFEROMETER ROCKET TRACKING TECHNIQUE

J. Carl Seddon Washington, NASA, Jan. 1963 33 p 5 refs
(NASA TN D-1344) OTS: $1.00

A portable trailer-housed system is described that provides range timing, range safety, telemetry, and rocket tracking services where normal rocket range facilities may not be available. Various methods of operating the station, with approximate cost estimates, are presented. Author

N63-12592 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STUDY OF THE EFFECT OF A DEADBAND ABOUT A DESIRED PERIGEE ON THE GUIDANCE OF A SPACE VEHICLE APPROACHING THE EARTH

Jack A. White Washington, NASA, Feb. 1963 23 p 7 refs
(NASA TN D-1607) OTS: $0.75

A study has been made to determine the effect of using a deadband to account for instrumentation inaccuracies on the guidance of a space vehicle to a desired perigee altitude. Corrective impulses were applied when the predicted perigee altitude of the vehicle exceeded a boundary of a deadband assumed to exist about the desired perigee altitude. Author

N63-13099 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EQUATIONS FOR DETERMINING VEHICLE POSITION IN EARTH-MOON SPACE FROM SIMULTANEOUS ONBOARD OPTICAL MEASUREMENTS

Alton P. Mayo, Harold A. Hamer, and Margery E. Hannah Washington, NASA, Feb. 1963 33 p 4 refs
(NASA TN D-1604) OTS: $1.00

Equations for 13 different combinations of sightings are presented for determining the position vector of a vehicle in earth-moon space from simultaneous onboard optical measurements. The methods for reducing the measurements for position determination are basically triangulation methods and incorporate combinations of measurements made on either one, two, or three bodies (earth, moon, and sun). Angular measurements made at the vehicle consist of declination of a body, right ascension of a body, body angular diameter, and include angles between a star and body center, star and horizon, moon center and earth horizon, landmark and star, landmark and body center, orbiting beacon and star, and orbiting beacon and body center. The methods presented apply to the determination of the total position vector (distance and direction from a reference body). With the exception of one method, the methods do not require the use of a stable platform. Author

N63-14028 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN EMERGENCY MIDCOURSE NAVIGATION PROCEDURE FOR A SPACE VEHICLE RETURNING FROM THE MOON

C. Dewey Havill Washington, NASA, Mar. 1963 31 p 3 refs
(NASA TN D-1765) OTS: $1.00

A manual emergency-navigation procedure for a vehicle returning from the moon is presented. The procedure involves photographing the earth from various positions along the trajectory returning from the moon, and deducing from image measurements the required midcourse corrections. Preliminary tests of the accuracy with which required image measurements can be obtained, together with machine computations of the overall accuracy of the guidance procedure, indicate the accuracy could be within the corridor depth of a lifting entry vehicle. Author

N63-14274 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ANALYSIS OF THE EFFECT OF ALTIMETER-SYSTEM ACCURACY ON COLLISION PROBABILITY

William Gracey Washington, NASA, Mar. 1963 10 p 2 refs
(NASA TN D-1627) OTS: $0.50

The probability of collision between two airplanes has been determined for their normal assignment to adjacent flight levels and for their very rare misassignment to the same flight level. Collision probabilities were computed for a flight-level separation minimum of 500 feet, airplane vertical dimensions of 20 and 40 feet, altitude-misassignment probabilities of 1/100,000 and 1/1,000,000, and altimeter-system errors (3σ valers) ranging from 0 to 2,000 feet. The results of the analysis showed that minimum collision probabilities occurred at altimeter-system errors of about 200 feet, and that for altimeter-system errors from 500 to 2,000 feet, the collision probability was several orders of magnitude greater than that for altimeter-system errors of 250 feet or less. Author

N63-14444 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

TWO SIGHTING PROBLEMS ASSOCIATED WITH SEXTANT TYPE MEASUREMENTS FOR SPACE NAVIGATION

Washington, NASA, Apr. 1963 9 p
(NASA TN D-1653) OTS: $0.50

CONTENTS:

1. THE EFFECT OF FIELD OF VIEW ON STAR FIELD IDENTIFICATION Daniel M. Hegarty p 2-3 (See N63-14445 10-22)
2. PRELIMINARY MEASUREMENTS OF THE ACCURACY OF MANUAL OPTICAL SIGHTING AT THE CENTER OF A PLANETARY DISK Marvin H. Thigpen p 5-6 (See N63-14446 10-22)

N63-15056 National Aeronautics and Space Administration Langley Research Center Langley Station, Va

AIRCRAFT VORTEX WAKES IN RELATION TO TERMINAL OPERATIONS

Joseph W Wetmore and John P Reeder Washington NASA, Apr 1963 24 p 5 refs Presented at the Symp on Development of Analytical Models for Estimating Airport Capacity, Calif U, Nov 29-30, 1962

(NASA TN D-1777) OTS $0 75

An analysis has been made on the basis of present understanding of trailing vortex characteristics, to provide an indication of the possible effects on aircraft encountering these vortices, the circumstances under which encounters might occur in terminal-area operations, and some means of dealing with the vortex problem in operations planning and traffic control Author

N63-18134 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va

RANDOM DEVIATIONS FROM STABILIZED CRUISE ALTITUDE OF COMMERCIAL TRANSPORTS AT ALTITUDES UP TO 40,000 FEET WITH AUTOPILOT IN ALTITUDE HOLD

Joseph J Kolnick and Barbara S Bentley Washington, NASA, July 1963 38 p 3 refs

(NASA TN D-1950) OTS $1 00

The random deviations from stabilized cruise altitudes of 19 commercial transports on scheduled, passenger-carrying flights, at altitudes up to 40,000 feet, have been evaluated from NASA VGH records The airplanes represented 10 aircraft types, of which 4 were turbojets, 3 were turboprops, and 3 were piston engines They were operated by nine United States airlines for a period of about 1 year over both land and ocean routes, covering 9,950 hours of cruise time The results of the evaluation showed that the airplanes flew within 200 feet of their stabilized cruise altitude for at least 99 5 percent of the cruise time for operation with autopilot in altitude-hold control, and for at least 94 5 percent of the cruise time for operation with manual control For 0 3 percent of the cruise time, the altitude deviations from stabilized cruise altitudes for operation with autopilot in altitude hold control did not exceed 250 feet for any of the airplanes over the altitude range up to 40,000 feet For 0 3 percent of the cruise time, the altitude deviations for manual control were about two to three times those for operation with autopilot in altitude-hold control No differences in altitude deviations due to altitude, airplane type, airline route, and season of the year were found Author

N63-18463 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va

TRAJECTORY ENTRY CONDITIONS AT THE LUNAR SPHERE OF INFLUENCE FOR APPLICATIONS TO DETAILED STUDIES OF NEAR-MOON TRAJECTORY AND IMPACT CONDITIONS

Harold A Hamer and Ward F Hodge Washington, NASA, July 1963 55 p 9 refs

(NASA TN D-1820) OTS $1 50

Flight conditions at the lunar sphere of influence have been compiled for use in conjunction with detailed studies of earth-moon trajectories The calculations were based on the assumption that the ascent portion of the trajectory is divided into two parts one part from earth injection to entry into the sphere of influence (earth-departure trajectory) and the other part lying within this sphere (near-moon trajectory) Each part is approximated by two-body solutions In the compilation, trajectory entry conditions at the lunar sphere of influence are presented in relation to earth injection conditions, and essentially describe the complete family of earth-departure trajectories that pass into the sphere of influence Extensive data pertaining to ballistic trajectories within the sphere of influence are also presented Author

N63-18469 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

A TRAJECTORY ANALYSIS OF A VARIABLE-DRAG PAYLOAD EJECTED FROM A VEHICLE IN A LOW EARTH ORBIT

Richard Reid and David B Middleton Washington, NASA, July 1963 29 p 3 refs

(NASA TN D-1938) OTS: $0.75

Useful trajectories are determined for dispatching the payload to desired regions for space experimentation Alteration of the basic trajectories is accomplished by means of the variable-drag feature The drag effects are studied in terms of changing the ballistic number of the payload at predetermined points along the basic trajectories The results of the study are presented as plots of distance and velocity relative to the orbiting vehicle Particular emphasis is given to the determination of parameter combinations which lead to conditions favorable for using the payload as a target for rendezvous practice The results of this study indicate that the scheme of ejecting a variable-drag payload from an orbiting vehicle can be developed into a useful method of space experimentation The trajectories obtainable are limited only by the ejection velocity and weight-area ratio of the payload Payload trajectories can be predetermined, within the accuracies of the parameters, for particular experiments by using the approach of this study Author

N63-22708 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

A STUDY OF SOME TRANSITION MATRIX ASSUMPTIONS IN CIRCUMLUNAR NAVIGATION THEORY

Ruben L Jones and Alton P Mayo Washington, NASA, Oct 1963 38 p

(NASA TN D-1812) OTS: $1 00

A study was made of the transition matrices utilized in midcourse navigation systems for circumlunar missions to compute future deviations from the reference trajectory The columns of the matrices were obtained by computing the effect on the individual components of the reference-trajectory position and velocity per unit change in the respective components of the insertion position and velocity The individual effects of excluding various masses from the trajectory computation scheme, the effect of increasing the disturbance, and the effect on the nominal partial derivatives of changing the reference trajectory were studied Author

N63-23685 National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

COMPARISON OF THE VON ZEIPEL AND MODIFIED HANSEN METHODS AS APPLIED TO ARTIFICIAL SATELLITES

David Fisher Washington, NASA, Nov 1963 18 p refs

(NASA TN D-2094) OTS: $0.50

The solutions to the problem of the near-earth satellite without drag, obtained by applying the von Zeipel method and the modified Hansen method, are compared Formulas are derived for osculating elements when the modified Hansen theory is expressed in terms of orbital true longitude Differences in the arbitrary constants are tabulated Transformations that relate the time element of the two theories are also given Author

23 PHYSICS, GENERAL

Includes acoustics, cyrogenics, and optics *For astrophysics see* 05 Astronomy and Astrophysics *For related information see* 12 Geophysics, 29 Space Sciences, 24 Physics Plasma, and 25 Physics, Solid-State

N63-10802 National Aeronautics and Space Administration, Washington D. C.

THERMODYNAMIC CALCULATIONS OF CARBON MONOXIDE—AIR DETONATION PARAMETERS FOR INITIAL PRESSURES FROM 1 TO 100 ATMOSPHERES

Loren E. Bollinger and Rudolph Edse (Ohio State U. Rocket Research Lab.), 1962 30 p
(NASA Grant NsG-44-60)
(NASA TN D-1667) OTS: $0.75

The composition, temperature, pressure and density behind a stable detonation wave and its propagation rate have been calculated for five mixtures of carbon monoxide and air at 1, 5, 25, and 100 atmospheres initial pressure, and at an initial temperature of 313.16° K. The results of these calculations show that the detonation velocities of stoichiometric carbon monoxide—air mixtures increase with increasing initial pressure whereas those of very rich and very lean mixtures are independent of the initial pressure. Author

N63-11498 National Aeronautics and Space Administration, Washington, D.C.

MATHEMATICAL APPARATUS OF THE THEORY OF ANGULAR MOMENTUM

A. P. Yutsis, I. B. Levinson, and V. V. Vanagas (Inst. of Phys. and Math., Acad. of Sci., Lithuanian S.S.R.) 1962 168 p 73 refs Transl. by A. Sen and R. N. Sen of the book "Matematicheskii apparat teorii momenta kolichestva dvizheniya" State Publ. House of Pol. and Sci. Lit. of the Lithuanian S.S.R., Vilnius, 1960
(Published for NASA and NSF)
(NASA TT F-98; Inst. fiz. i mat. AN Litovskoi SSR, Publ. 3) OTS: $1.75

This book on the theory of angular momentum covers the following: addition of two angular momenta; addition of an arbitrary number of angular momenta; graphical methods for operations with sums of products of Wigner coefficients; j-coefficients and their properties; utilization of transformation matrices for obtaining sum rules and transformation formulas for jm-coefficients; examples of application of the graphical method; and irreducible tensor operators and expressions for their matrix elements. J.R.C.

N63-11516 National Aeronautics and Space Administration, Washington, D.C.

LABORATORY TECHNIQUES IN SPACE ENVIRONMENT RESEARCH

Howard E. Martens, Jack L. Taylor, Floyd B. Humphrey, and Daniel D. Elleman 1962 52 p 58 refs Papers presented at Session T of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)
(NASA-SP-26) GPO: $0.40

CONTENTS:

1. TECHNIQUES FOR ACHIEVING STEADY-STATE TEMPERATURES ABOVE 1500° C H. E. Martens (JPL) 6 p
2. HIGH-VACUUM TECHNIQUES FOR RESEARCH J. L. Taylor (JPL) 19 p 15 refs
3. TECHNIQUES FOR LABORATORY STUDIES OF MODERN MAGNETISM F. B. Humphrey (JPL) 18 p 30 refs
4. GENERATION OF MAGNETIC FIELDS BY FLUX COMPRESSION IN SUPERCONDUCTORS D. D. Elleman (JPL) 7 p 13 refs

N63-12194 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

IRRADIATION EFFECTS OF 40 AND 440 NEV PROTONS ON TRANSISTORS

William C. Honaker and Floyd R. Bryant Washington, NASA, Jan. 1963 43 p 10 refs
(NASA TN D-1490) OTS: $1.25

Experimental results present data collected before, during, and after the bombardment of several types of transistors with 40 and 440 Mev protons. The degradation of the measured parameters varied with proton energy and with the alpha cutoff frequency of the transistor. Figures are presented which show the degradation of the gain of the transistors as a function of integrated proton flux. Author

N63-12214 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECTS OF SPUTTERING WITH HYDROGEN IONS ON TOTAL HEMISPHERICAL EMITTANCE OF SEVERAL METALLIC SURFACES

Donald L. Anderson and George J. Nothwang Washington, NASA, Jan. 1963 37 p 17 refs
(NASA TN D-1646) OTS: $1.00

The test specimens were cylindrical and were constructed from pure titanium, a titanium alloy containing 6-percent aluminum and 4-percent vanadium, pure aluminum, 2024 aluminum alloy, and pure copper. The energy level of the incident ions was 1000 electron volts. The test specimens were subjected to ion bombardment by immersion in a hydrogen plasma. The total hemispherical emittance of each specimen was measured in a cold-wall, vacuum-type calorimeter. Photomicrographs of all test specimens before and after bombardment with 10^{21} ions/cm^2 are presented and discussed. In addition, the changes in weight resulting from ion bombardment of all specimens are presented. Author

N63-12244 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE EFFECT OF VACUUM ON THE PENETRATION CHARACTERISTICS OF PROJECTILES INTO FINE PARTICLES

Leonard V. Clark and John Locke McCarty Washington, NASA, Jan. 1963 27 p 11 refs
(NASA TN D-1519) OTS: $0.75

The penetration characteristics of various spherical projectiles impacting a test-bed material of fine particles were examined in a pressure environment which ranged from atmospheric to 1×10^{-5} mm. Hg. absolute to evaluate the effects of material particle size, variations in the testing technique, and several of the projectile variables. The results of this study indicate that the depth of penetration in a granular material is independent of environmental pressure and the particle size, whereas the penetration depth in a powdery material increases with decreasing particle size and is independent of the environmental pressure only for pressures less than 1 mm. Hg. Author

N63-13217 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THERMODYNAMIC PROPERTIES OF CARBON-DIOXIDE AND NITROGEN MIXTURES BEHIND A NORMAL SHOCK WAVE

Henry T. Woodward Washington, NASA, Mar. 1963 28 p 7 refs
(NASA TN D-1553) OTS: $0.75

Thermodynamic properties of the gas in equilibrium behind normal shock waves in mixtures of carbon dioxide and nitrogen are calculated for resulting temperatures from 3000° to 8000° K at intervals of 1000° K and pressures of 1, 10, and 100 atmospheres. Equilibrium temperature, pressure, density, and component mole fractions are presented as functions of shock velocity and ambient pressure for an initial temperature of 300° K. Mixtures of 25-, 50-, and 75-percent N_2 by volume are considered. The amounts of NO, C, and CN which are formed could make a significant contribution to the electron density and the radiative heat flux potential. Author

N63-14205 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

THERMOLUMINESCENT SPECTRA OF SODIUM CHLORIDE AND HYDROXIDE-FREE SODIUM CHLORIDE IRRADIATED WITH 40-MEV ALPHA PARTICLES

James A. Partridge Washington, NASA, Apr. 1963 16 p 15 refs
(NASA TN D-1662) OTS: $0.50

The thermoluminescent spectra of 40-Mev alpha-irradiated sodium chloride single crystals have been investigated through post-irradiation measurements. Both as-received and hydroxide-free sodium chloride were used. Graphs of the variation of emission band intensity and position as a function of temperature for various radiation fluxes are presented. Emission bands at 360 and 432 millimicrons were found in both crystal types; a new band at 572 millimicrons was also observed in the hydroxide-free crystals. The 432-millimicron band is suppressed in the high-temperature glows of the hydroxide-free crystals. In contrast to X-ray induced spectra, the effect of particle irradiation was to cause the 360- and 432-millimicron bands to appear together in the high-temperature glow peaks. Comparison of the glow curves of the two crystal types indicated that the hydroxide-free sodium chloride increased light output. An impurity or defect is thought to be responsible for the effects noted in the hydroxide-free crystals. Author

N63-14272 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

OPTICAL PROPERTIES OF SATELLITE MATERIALS—THE THEORY OF OPTICAL AND INFRARED PROPERTIES OF METALS

Washington, NASA, Mar. 1963 252 p 84 refs
(NASA TN D-1523) OTS: $4.00

The probable effects of solar radiation, primary cosmic rays, Van Allen radiation, and meteoric dust on the emissive properties of materials are reviewed in the light of recently published data. Experimental data on the spectral emittance (0.25 to 27 microns) of metals with polished and carefully abraded surfaces are presented. A quantum mechanical theory of optical and infrared dispersion in metals originally developed by T. Holstein and previously presented in unpublished Westinghouse Research Laboratories Research Reports 60-94698-3-R1 and 60-94698-3-R6 (1954 and 1955) is combined with other existing theories of Umklapp and impurity scattering processes and is shown to successfully account for the optical properties of metals in the entire free electron region at all temperatures of interest. Detailed calculations are presented for monovalent and some polyvalent metals for which assumption of a symmetric Fermi surface is valid. Polyvalent and transition metals for which interband transitions are important and the Fermi surface is not spherical are also considered. In all, more than a dozen metals, for which reliable experimental data are available, have been successfully treated. Calculations of the absorption properties of superconducting metals are also presented in an attempt to determine the extent to which bulk electron-phonon processes are responsible for infrared absorption by superconductors. Author

N63-14430 National Aeronautics and Space Administration, Washington, D.C.

SOME EFFECTS OF SPECTRAL CONTENT AND DURATION OF PERCEIVED NOISE LEVEL

Karl D. Kryter and Karl S. Pearsons (Bolt, Beranek, and Newman, Inc.) Apr. 1963 55 p 15 refs
(NASA Contract NASr-58)
(NASA TN D-1873) OTS: $1.50

A number of experiments were conducted in which listeners equated a wide variety of sounds with respect to noisiness (equal acceptability) and loudness. The principal findings are as follows: (1) On the basis of data obtained from approximately 250 subjects, new equal noisiness contours and tables for use in the calculation of perceived noise level were determined. (2) Over a range of durations from 1½ to 12 secs, sounds were judged equally acceptable when the sound pressure level was reduced by 4½ dB for each doubling of duration. Variations in rise and decay times from ½ to 4 secs did not significantly influence the judgments. (3) Combining a pure tone of sufficient intensity with a band of filtered white noise caused subjects to judge the sound as noisier than the same band of noise at the same overall sound pressure level as the tone-plus-noise. On the other hand, the judged loudness of the band of noise, keeping overall level constant, was not appreciably affected by the addition of the tone. (4) Calculated measures of perceived noise level (PNdb), loudness, and the readings on A, B, C, and "flat" scales on a sound level meter were determined for a variety of "real" and artificial sounds of equal duration when these sounds were judged to be equally noisy or acceptable. Considering both absolute values and variability in the results, the order of merit, from best to worst, of the various measures for predicting the judgment data was as follows: PNdb, phons Zwicker, phons Stevens, "flat," C, B, and A scale of a sound level meter. Author

N63-15238 National Aeronautics and Space Administration, Washington, D.C.

APPLICATION OF THE METHOD OF PARTIAL SEPARATION OF VARIABLES TO TWO EQUIVALENT *p*-ELECTRONS (PRIMENENIYE METODA NEPOLNOGO RAZDELENIYA PEREMENNYKH K DVUM EKVIVALENTNYM *p*-ELEKTRONAM)

A. P. Yutsis Apr. 1963 32 p 4 refs Transl. by Faraday Translations from Zh. Eksperim. i Teor. Fiz. (Moscow), v. 23, no. 4(10), 1952 p 357–370
(NASA TT F-152) OTS $1.00

A discussion is presented of the radial integrals that express the total energy of the atom, in the case of partial separation of the variables after integration with respect to the spin and angular variables. Means of evaluating the kinetic energy integrals and integrals of electrostatic energy of the exchange type are described. Results of calculations for He, Li^{+}, and Be^{++} in the $2p^2$ configuration, obtained by the method of partial separation of variables, are presented in tabular form. Author

N63-16290 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

FORMULATION AND DIGITAL CODING OF APPROXIMATE HYDROGEN PROPERTIES FOR APPLICATION TO HEAT-TRANSFER AND FLUID-FLOW COMPUTATIONS

David P. Harry, III Washington, NASA, May 1963 73 p 17 refs
(NASA TN-D-1664) OTS: $2.00

A description of FORTRAN language subroutine for computation of approximate state relations, thermodynamic properties, and transport properties of molecular hydrogen is presented over the range from melting to dissociation for pressures up to 340 atm (5000 lb/sq in. abs) with accuracy characterized by errors of "a few percent." The computation routine may be used in various British or metric units for any fixed ortho-para composition and requires about 2100 storages. Properties and relations used in heat-transfer and fluid-flow calculations may be obtained simultaneously with any two state variables, or enthalpy and either pressure or specific volume known. Author

N63-16988 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PRELIMINARY EXPERIMENTAL INVESTIGATION OF FREQUENCIES AND FORCES RESULTING FROM LIQUID SLOSHING IN TOROIDAL TANKS

Irving E. Sumner Washington, NASA, June 1963 18 p 8 refs
(NASA TN D-1709) OTS: $0.50

A preliminary experimental investigation was conducted to determine the natural mode frequencies and slosh forces resulting from liquid oscillation in three horizontally oriented toroidal tanks of constant minor radius and varied major radii. The excitation amplitude was held constant, and the excitation frequency was varied to encompass the first and second natural modes of the contained liquids over a range of liquid-depth ratios. Author

N63-17315 Geophysics Corp. of America, Bedford, Mass.

PLANETARY AERONOMY X: ATOMIC POLARIZABILITIES AND SHIELDING FACTORS

A. Dalgarno Feb. 1963 87 p 96 refs Submitted for Publication (NASA Contract NASw-395)
(NASA CR-6; GCA-TR-63-2-N) OTS: $8.10 ph, $2.81 mf

The changes in the charge distribution of an atom interacting with an electric field and the various shielding effects of the inner closed shells of electrons on the distribution of nuclear and electron charge are discussed. The definitions and quantal formulae are explained, the approximations for the perturbation theory are presented, and solutions via variational methods, the Hartree-Fock approximation, expansion methods, and statistical methods are given. Finally, numerical values for dipole and quadrupole polarizabilities and for the quadrupole and higher order shielding factors are presented in tabular form. D.E.R.

N63-18015 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NONADIABATIC THEORY OF ELECTRON-HYDROGEN SCATTERING, PART II
A. Temkin and E. Sullivan Washington, NASA July 1963 23 p 14 refs
(NASA TN D-1702) OTS: $0.75

The triplet S-wave electron-atomic hydrogen elastic scattering phase shifts are recalculated by a previously introduced nonadiabatic theory. The previous calculation has been improved in a number of respects, the most important of which is the use of a noniterative technique for numerically solving the partial differential equations. (This technique is expected to be useful for a large class of linear second-order elliptic partial differential equations.) Phase shifts are computed to better than four significant figures. The results are quite close to the variational results of Schwartz but are, on the whole, somewhat larger. The deviations are considered significant, and the various approaches are discussed; specifically, our triplet scattering length (in Bohr radii) is $a_t = 1.7683$. Author

N63-18209 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
LEAK-RATE TESTING OF THE NASA PLUM BROOK REACTOR CONTAINMENT VESSEL
Edward G. Keshock and Claude E. De Bogdan Washington, NASA, July 1963 34 p 10 refs
(NASA TN D-1731) OTS: $1.00

The leak rate of the 520,000-cubic-foot Plum Brook Reactor containment vessel has been measured by two methods, the absolute-temperature-pressure method and the reference-system method. Both methods are described, and the equations for leakage in each method are investigated in detail. It is analytically determined that thermal-time-lag effects in small diameter reference systems are negligible. The results of three tests in which both methods were employed simultaneously are presented. A distinctive feature of one of the tests was the verification of the accuracy of results by using a known leak rate. Various test experiences are also presented. Author

N63-18232 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
THEORETICAL ELASTIC STRESS DISTRIBUTIONS IN CASSINIAN DOMES
David A. Spera and Robert H. Johns Washington, NASA, July 1963 55 p 12 refs
(NASA TN D-1741) OTS: $1.50

The geometric properties and elastic stress distributions in a family of domes with constant thickness, temperature, internal pressure, and material properties are investigated, and results are presented in a form suitable for preliminary design. The governing differential equations are solved by a finite-difference technique, which is presented in detailed algebraic form for the shells investigated, and in matrix form for general shells of revolution. Meridians of the domes considered are modified curves of Cassini and contain two parameters that permit a wide range of shapes. Variations in dome curvature, height, area, and volume with these two parameters are calculated. Membrane stress distributions and significant bending stresses are given for a class of domes that close cylinders of equal thickness, and have zero curvature at the junction section. Complete stress distributions are found for several dome geometries. In addition, a dome was fabricated and tested, and good agreement between experimental and theoretical results was obtained. Author

N63-18466 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE INFLUENCE OF HEATING RATE AND TEST STREAM OXYGEN CONTENT ON THE INSULATION EFFICIENCY OF CHARRING MATERIALS
Nick S. Vojvodich and Ernest L. Winkler Washington, NASA, July 1963 34 p 19 refs
(NASA TN-D-1889) OTS: $1.00

The insulation behavior of thin sections (1/10 of an inch) of some typical charring materials was studied at cold-wall convective heating rates between 5 and 120 Btu/ft^{2}sec in both arc-heated nitrogen and air. The insulation efficiency (the total cold-wall heat input per initial pound of material for a back-face temperature rise of 300° R) was used as a figure of merit in this investigation. Test results indicate that in both nitrogen and air the insulation efficiency is reduced as the heating rate is reduced. Furthermore, at the same cold-wall heating rate, the insulation efficiency measured in air was always lower than in nitrogen, with the most pronounced reduction occurring at the lowest rates. Temperature measurements of the material surfaces were higher in air than in nitrogen, suggesting that the effect of air environment on material performance is a consequence of exothermic combustion reactions. Author

N63-18660 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
POSITRON-HYDROGEN SCATTERING
Aaron Temkin Washington, NASA, Aug. 1963 20 p 12 refs
(NASA TN D-1849) OTS: $0.75

The nonadiabatic theory of electron-hydrogen scattering is applied to s-wave scattering of positrons by atomic hydrogen. This zeroth-order problem is considerably more difficult than the corresponding one for electron-hydrogen scattering. If we assume that the most extensive of Rotenberg's calculation relating strictly to the zeroth-order problem is an adequate approximation, then the present calculations support the conclusion that his final phase shifts are more correct than those of Schwartz. The nonadiabatic theory is also developed for higher partial wave scattering. The portion of the coupled set of equations which gives the major contribution to the phase shifts can readily be isolated. A first approximation of the truncated p-wave equations is obtained; the corresponding phase shifts are found to be positive, but much smaller than those of Bransden. Author

N63-18887 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A TECHNIQUE FOR PREDICTING FAR-FIELD ACOUSTIC ENVIRONMENTS DUE TO A MOVING ROCKET SOUND SOURCE
G. A. Wilhold, S. H. Guest, and J. H. Jones Washington, NASA, Aug. 1963 46 p 11 refs
(NASA TN D-1832) OTS: $1.25

Presented is a technique for obtaining the far-field acoustic environments produced by the launch of a large rocket-powered vehicle. The resulting far-field acoustic environments can be given in spectral and/or time history form for present-day types of rocket engines. This estimation requires the knowledge of engine parameters and vehicle trajectory information in order to provide a space-time correlation of the sound source in the propagating medium. Author

N63-19157 National Aeronautics and Space Administration, Washington, D.C.
SOUND AND ULTRA SOUND WAVES IN AIR, WATER AND SOLID BODIES [ZVUKOVYE I UL'TRAZVUKOVYE V VOZDUKHE, VODE I TVERDYKL TELAKH]
R. Hardin, ed, and V. A. Krasil'nikov 1963 361 p 14 refs Transl. into ENGLISH State Publ. House of Phys.-Math. Lit., Moscow, 1960
(Published for NASA and NSF)
(NASA TT F-96, IPST Cat. 811) OTS: $3.50

The basic physical questions connected with the propagation of sound and ultrasound waves in air, water, and solids, as well as various applications of these waves, are presented. A large section has been allotted to ultrasound waves and their applications, as well as to the propagation of sound in the atmosphere (atmospheric acoustics), in the sea (hydroacoustics), and in the earth (seismology). The propagation of high-intensity sound and ultrasound waves in gases, and particularly, in liquids are discussed, as well as the more important problems of aerothermoacoustics (jet noise, generation of sound by turbulence). The question of the propagation of elastic waves in solids (particularly in metals) is considered, as well as the basic ultrasonic applications in examining the elastic properties of solids. Special attention is given to the physical significance of the various phenomena Author

N63-19652 National Aeronautics and Space Administration, Langley Station Va Langley Research Center
WIND-TUNNEL MEASUREMENT OF PROPELLER WHIRL-FLUTTER SPEEDS AND STATIC-STABILITY DERIVATIVES AND COMPARISON WITH THEORY
Samuel R. Bland and Robert M. Bennett Washington, NASA, Aug. 1963 56 p 7 refs
(NASA TN D-1807) OTS: $1.50

Results are presented for a model consisting of a system of propeller and simulated powerplant mounted with flexibility in pitch and yaw on a rigid sting. A range of propeller blade angles, restraint stiffnesses, and restraint damping coefficients was investigated for a system symmetrical in pitch and yaw with a windmilling propeller. The measured stability derivatives are compared with two sets of theoretical derivatives. Whirl-flutter calculations made with the theoretical and measured derivatives are presented. Some results for the model mounted on a cantilever semispan wing are also given Author

N63-19859 National Aeronautics and Space Administration, Washington, D.C.
THE ABSORPTION COEFFICIENT OF ATOMS IN THE REVERSE ZEEMAN EFFECT WITH ARBITRARY DIRECTION OF MAGNETIC FIELD [KOEFFITSIENT POGLOSHCHENIYA ATOMOV V OBRATNOM EFFEKTE ZEYEMANA PRI PROIZVOL'NOM, NAPRAVLENII MAGNITNOGO POLYA]
V. Ye. Stepanov Aug. 1963 23 p 12 refs Transl. from Izv. Krymsk. Astrofiz. Observ. (Moscow), v. 18, 1958 p 136-150
(NASA TT-F-110) OTS: $0.75

On the basis of the classical theory of magnetic effect, the absorption coefficient of atoms in the reverse Zeeman effect with arbitrarily oriented magnetic field and also the polarization absorbed by the atoms have been calculated. The effective absorption is reflected in the form of two absorption coefficients, s_+ and s_-, which correspond to two mutually orthogonal conditions of polarization of light. With adaptation to astrophysical phenomena for determining the contours of absorption lines, it is necessary to compile two equations for radiant energy which are mutually independent Author

N63-19861 National Aeronautics and Space Administration, Washington, D.C.
CONFIGURATION INTERACTION IN THE CARBON ATOM [VZAIMODEYSTVIYE KONFIGURATSIY V ATOME UGLERODA]
A. P. Yutsis July 1963 28 p 9 refs Transl. from Zh. Eksperim. i Teor. Fiz. (Moscow), v. 19, 1949 p 565-576
(NASA TT-F-154) OTS: $0.75

The interaction of the $1s^2 2s^2 2p^2$, $1s^2 2p^4$, $1s^2 2s^2 2p3p$, and $1s^2 2s 2p^2 3s$ configurations of the carbon atom is theoretically investigated. Overall wave functions are derived for these configurations. The energy matrix elements are expressed as single-electron wave functions. The single-electron wave functions, obtained by the self-consistent field method without quantum exchange, are used to compute the energy matrix elements, both the diagonal and those connecting different configurations of the same affinity; the secular equations for each kind of term in the abovementioned configurations are solved. Author

N63-20347 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio
RECIPROCITY IN QUANTUM MECHANICS
D. E. Bilhorn, L. L. Foldy, V. A. Madsen, R. M. Thaler, and W. Tobocman (Case Inst. of Tech.) Washington, NASA, Aug. 1963 24 p 5 refs
(NASA TN D-1985) OTS: $0.75

A new derivation of the reciprocity theorem is given. The general invariance property of the Hamiltonian that leads to symmetry of the Green's function for a quantum mechanical system is exhibited. It is found that reciprocity does not necessarily imply Hermiticity of the Hamiltonian; the so-called "optical model potential," for example, satifies the reciprocity relations. The concept of reciprocity is then generalized to include a somewhat wider class of symmetry properties. Some properties of antiunitary transformations are discussed. Author

N63-20428 National Aeronautics and Space Administration, Washington, D.C.
A TWO-PLATE CRYSTAL LIGHT MODULATOR [DVUKHPLASTINCHATYY KIRSTALLICHESKIY MODULYATOR SVETA]
G. S. Arushanov Aug. 1963 16 p 6 refs Transl. into ENGLISH from Tekhn. Kino i Televideniya, no. 12, 1958 p 32-38
(NASA TT F-101) $0.50

This is a theoretical analysis of the operation of a two-plate crystal light modulator. The author found the modulator's optimum regime of operation, and the magnitudes of polarizing voltages and of harmonic distortions resulting from them Author

N63-20610 National Aeronautics and Space Administration, Washington, D.C.
GENERALIZATION OF THE THEORY OF PARTIAL SEPARATION OF VARIABLES TO INCLUDE THE CASE OF MULTIVALENT ATOMS [OBOBSHCHENIYE TEORII NEPOL'NOGO RAZDELENIYA PEREMENNYKH NA SLUCHAY MNOGOVALENTNYKH ATOMOV]
A. P. Yutsis Aug. 1963 24 p 6 refs Transl. by Faraday Translations into ENGLISH from Zh. Eksperim. i Teor. Fiz. (Moscow), v. 23, 1952 p 371-380
(NASA TT F-153) OTS: $0.75

With the aid of Laplace's theorem, a linear combination of determinants, expressing the wave function of the whole atom, is transformed in such a way that the quantum numbers of the inner electrons are found in minors of the determinants and the quantum numbers of the valence electrons in their cofactors. The total energy of the atom is expressed with the

aid of the wave function of the whole atom thus transformed. The general expression obtained is applicable to the case where the variables of the inner electrons are completely separated, and where the approximation of partial separation of variables applies to the valence electrons. This last expression for the total energy of the atom contains the spin-spin dependence in general form. Author

N63-22601 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
MAGNETIC FIELD OF A FINITE HELICAL SOLENOID
A. R. Sass and James C. Stoll Washington, NASA, Oct. 1963 46 p 4 refs
(NASA TN D-1993) OTS: $1.25

A superposition principle was utilized to calculate the magnetic field distribution of a solenoid of finite length, with infinitely thin walls, wound with a finite helical angle. This field distribution is the vector sum of the distributions due to the azimuthal and axial components of the current density. The magnetic fields are expressed in terms of tabulated solutions of complete elliptic integrals, and they are presented in graphical form for values of helical angles from 5° to 45°, and values of the ratio of solenoid length to radius from 1 to 20. Author

N63-22705 National Aeronautics and Space Administration, Washington, D.C.
DERIVATION AND TABULATION OF MOLECULAR INTEGRALS. SUPPLEMENT III(a) – TABLES FOR TWO-CENTER TWO-ELECTRON HYBRID INTEGRALS
Roop C. Sahni and James W. Cooley (N.Y.U.) Oct. 1963 854 p 8 refs
(NASA TN D-146-III(a))

A brief study of two-center, two-electron hybrid integrals that arise from Slater-type 1s, 2s, and 2p atomic orbitals is presented. The auxiliary functions for the integrals have been computed, and the results of the computation are presented in the form of tables. Author

N63-22706 National Aeronautics and Space Administration, Washington, D.C.
DERIVATION AND TABULATION OF MOLECULAR INTEGRALS. SUPPLEMENT III(b) – TABLES FOR TWO-CENTER TWO-ELECTRON HYBRID INTEGRALS
Roop C. Sahni and James W. Cooley (N.Y.U.) Oct. 1963 697 p For abstract see N63-22705 23-23
(NASA TN D-146-III(b))

N63-22707 National Aeronautics and Space Administration, Washington, D.C.
DERIVATION AND TABULATION OF MOLECULAR INTEGRALS. SUPPLEMENT III(c) – TABLES FOR TWO-CENTER TWO-ELECTRON HYBRID INTEGRALS
Roop C. Sahni and James W. Cooley (N.Y.U.) Oct. 1963 655 p For Abstract see N63-22705 23-23
(NASA TN D-146-III(c))

N63-22949 National Aeronautics and Space Administration, Washington, D.C.
SURVEY OF INVESTIGATIONS ON THE THEORY OF FLEXIBLE PLATES AND SHELLS, COVERING THE PERIOD FROM 1941 TO 1957 [OBZOR ISSLEDOVANIY PO TEORII GIBKIKH PLASTINOK I OBOLOCHEK ZA PERIOD S 1941 PO 1957 G.]
A. S. Vol'mir Oct. 1963 47 p 174 refs Transl. into ENGLISH from "Raschet Prostranstvennykh Konstruktsiy", v. 4 p 451–475 Moscow, State Pub. House of Lit. on Construct., Architecture and Construct. Mater., 1958
(NASA TT F-180) OTS: $1.25

Plates and shells, possessing finite bending stiffness, will be termed flexible if, within the limits of elastic deformation, they evidence deflections comparable to their thickness. An extensive literature has been devoted to the theory and design of such thin-walled structural elements during the last fifteen years in connection with aircraft design, marine engineering, instrument design, and numerous other branches of engineering. Author

N63-23676 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EFFECTS OF REGENERATIVE AND RADIATION COOLING ON PERFORMANCE OF ELECTROTHERMAL THRUSTORS
John W. Schaefer and John R. Jack Washington, NASA, Nov. 1963 13 p 3 refs
(NASA TN D-1738) OTS: $0.50

The effects of regenerative and radiation cooling on thrustor performance, as judged by the specific impulse, are presented for a frozen flow with a constant input power and propellant flow rate. In general, the performance gains to be achieved by regenerative cooling are strongly dependent on such operating parameters as gas enthalpy, wall temperature, and amount of regenerative cooling. When the frozen-flow efficiency decreases with increasing gas enthalpy, increased regenerative cooling results in a small gain or a loss in performance, depending on the wall temperature. When the frozen-flow efficiency increases with increased enthalpy, however, significant performance gains due to regenerative cooling can be anticipated, regardless of the assumed wall temperature. Author

N63-23680 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
ANGULAR DISTRIBUTION OF EMITTED AND REFLECTED RADIANT ENERGY FROM DIFFUSE GRAY ASYMMETRIC GROOVES
Morris Perlmutter and John R. Howell Washington, NASA, Oct. 1963 45 p refs
(NASA TN D-1987) OTS: $1.25

The directional emissivity and directional reflectivity of an infinitely long, isothermal, asymmetric groove with diffusely emitting and reflecting gray walls are analyzed, and numerical results are given. The directional emissivity is presented as a function of the groove parameters and material emissivity, while the directional reflectivity is presented as a function of these parameters and the angle of incident radiation. The directional reflectivity was found to be greatest at angles close to the angle of the incident beam, in sharp contrast to the commonly assumed diffuse or specular modes of reflection. The directional emissivity was greatest close to the angle bisecting the groove. The results thus indicate that the surface structure has a strong effect on the radiative properties. Author

N63-23683 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
A NUMERICAL ANALYSIS OF DIRECT NUCLEAR ELECTROGENERATOR CELLS THAT USE CERIUM 144 BETA-EMITTING RADIOISOTOPE SOURCES
Allen J. Cohen Washington, NASA, Nov. 1963 58 p refs
(NASA TN D-2070) OTS: $1.50

An analysis of a radioisotope electric cell that uses the beta emitter, cerium 144, was undertaken. The analysis, which relies on formats set forth for fission electric cells, takes into account the pertinent physical constraints in a more accurate manner than has been done previously. Results from the analysis are presented in tables and as representative plots. Comparisons between accurate and approximate solutions are also included. Author

24 PHYSICS, PLASMA

Includes fusion; and magnetohydrodynamics. *For related information see:* 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

N63-11124 National Aeronautics and Space Administration, Washington, D.C.

HYDROMAGNETIC WAVE PROPAGATION IN A CONSTANT DIPOLE MAGNETIC FIELD

John Carstoiu (Sylvania Electric Products, Inc.) Dec. 1962 37 p 24 refs

(NASA Contract NASr-18)

(NASA TN D-1689) OTS: $1.00

Basic concepts are first presented, and a theorem of decomposition for the rate of change of the magnetic field similar to the Cauchy-Stokes decomposition theorem in hydrodynamics is included. A theory of magnetohydrodynamic waves in the presence of a uniform magnetic field is presented, and some details on the geometry of dipole magnetic lines of force are discussed. Magnetohydrodynamic waves in a constant dipole magnetic field are described. Author

N63-11515 National Aeronautics and Space Administration, Washington, D.C

PLASMA PHYSICS AND MAGNETOHYDRODYNAMICS IN SPACE EXPLORATION

Adolf Busemann, Robert V. Hess, George P. Wood, Paul W. Huber, Clifford H. Nelson, and Macon C. Ellis, Jr. 1962 78 p 129 refs Papers presented at Session S of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962

(See N63-11502 03-29)

(NASA SP-25) GPO: $0.50

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N63-12949 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE MAGNETIC FIELD OF A LINE CURRENT IN A TRANSVERSE RAREFIED PLASMA STREAM

Albert G. Munson Washington, NASA, Feb. 1963 22 p 10 refs (NASA TN D-1551) OTS: $0.75

The steady-state flow of an infinitely conducting, rarefied, neutral plasma past a line current is considered. According to the Chapman-Ferraro theory, the plasma is confined to the exterior and the magnetic field to the interior of a cavity, the boundary of which is a thin current sheath. Within these restrictions the problem is solved exactly by a method similar to the hodograph method of incompressible fluid dynamics, and the magnetic field inside the cavity is presented. Results of approximate and exact solutions are compared. Author

N63-14805 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL EVALUATION OF A DIRECT-CURRENT LOW-PRESSURE PLASMA SOURCE

Stanley Domitz Washington, NASA, Apr. 1963 34 p 16 refs (NASA TN D-1659) OTS: $1.00

A plasma source, which consists of a hot-filament coaxial discharge in an axial magnetic field, was operated with argon gas. The quantities measured in the plasma beam were the magnitude plus spatial distribution of electron temperature, number density, and plasma potential. The plasma production efficiency is given as a function of the discharge parameters. The plasma beam was found to be up to 10 percent ionized with a minimum energy cost of 125 electron volts per ion, excluding filament and magnet power. Author

N63-14873 National Aeronautics and Space Administration. Langley Research Center, Langley Air Force Base, Va.

A THEORETICAL STUDY OF THE MOTION OF AN IDEALIZED PLASMA RING UNDER THE INFLUENCE OF VARIOUS COAXIAL MAGNETIC FIELDS

Clarence W. Matthew Washington, NASA, 1961 19 p 6 refs (NASA TR R-121) GPO: $0.30

The equations of motion of charged particles in a magnetic field have been applied to the problem of the motion of an idealized plasma ring in the magnetic fields arising from direct and/or alternating current flowing through a set of coaxial drive coils. The simplifications involved are such that the theory predicts the maximum velocities obtainable with the induced-electromotive-force plasma accelerator, the maximum axial velocities attained can be expressed by two simple empirical equations, one for small velocities and the other for large velocities, provided the constants are originally determined by applicable data. The results of a preliminary survey of multicoil traveling-wave accelerators indicate that such accelerators have very exacting design requirements if the plasma ring is to be contained within the accelerator throughout the entire process. Author

N63-15472 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A THEORETICAL STUDY OF THE MOTION OF AN IDEALIZED PLASMA RING THROUGH VARIOUS TRAVELING-MAGNETIC-WAVE PLASMA ACCELERATORS

Clarence W. Matthews Washington, NASA, May 1963 22 p 6 refs (NASA TN D-1636) OTS: $0.75

The results of several computations of the motion of idealized plasma rings, under the influence of several different traveling-magnetic-wave accelerators, are presented and analyzed to show some of the theoretical phenomena that can occur in such accelerators. The results indicated that only a narrow range of magnetic-field and plasma-ring characteristics existed in which the plasma ring was confined within the accelerator. Slippage of the ring with respect to the field was observed in all the computations made. Comparison with available experimental data showed almost an order-of-magnitude reduction in velocity resulted from experimental effects. Author

N63-15501 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DIRECT VELOCITY MEASUREMENTS IN LOW-DENSITY PLASMA FLOWS

W. D. Beasley, J. D. Brooks, and R. L. Barger Washington, NASA, May 1963 12 p 5 refs
(NASA TN D-1783) OTS: $0.50

The flow velocity is measured directly in a direct current arc jet by creating a luminous disturbance in the flow and measuring its time of flight over a known distance with photoelectric detectors. This technique is applicable to flows with high stagnation temperatures and low discharge pressures. Measurements made in supersonic flows without arc heating correlated well with velocities computed from pressure probe measurements. Measurements made in supersonic plasma flows exhibited good repeatability at static pressures well below 1 mm Hg. Author

N63-16291 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ELECTRON-HYDROGEN PHASE SHIFTS JUST BELOW THE INELASTIC THRESHOLD
Aaron Temkin Washington, NASA, May 1963 8 p 9 refs
(NASA TN-D-1720) OTS: $0.50

The singlet S-wave phase shifts for the scattering of electrons by atomic hydrogen just below the inelastic threshold (10.2 ev) are calculated by using a recently developed nonadiabatic theory. Previous calculations of Burke and Schey, based on the much more restricted close-coupling approximation, yielded a resonance characterized by the phase shift going through π radians. This result is indicative of a bound state of the compound system near the energy 9.4 ev. It is argued on the basis of a previous calculation that this resonance must be distinct from another resonance near 10.1 ev. On this basis it is concluded that this partial cross section must exhibit two resonances below threshold. Author

N63-16391 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
VARIATIONAL APPROACH TO THE CALCULATION OF CHARGE EXCHANGE CROSS SECTIONS FOR ADIABATIC COLLISIONS
Frederick E. Alzofon and Fred C. Witteborn Washington, NASA, May 1963 11 p 6 refs
(NASA TN-D-1654) OTS: $0.50

Cross sections for the reaction $H^+ + H(1s) \rightarrow H(1s) + H^+$ are calculated for incident particle energies between 10 ev and 2250 ev using an impact parameter method. The required electronic energy levels were found by varying one parameter in the molecular ion wave function at every value of proton separation. The resulting cross sections are compared with those obtained using more accurate wave functions and with experimental data. Author

N63-16711 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
DISPERSION AND DAMPING OF LONGITUDINAL ELECTRON OSCILLATIONS IN THERMAL PLASMAS
James F. Morris Washington, NASA, June 1963 58 p 25 refs
(NASA TN-D-1734) OTS: $1.50

Approximate frequencies and damping factors computed for longitudinal electron oscillations in classical and quantum thermal plasmas are presented; effects of some major assumptions on the values of dispersion variables are discussed. These and some other simple, incidental characteristics of plasmas are tabulated for electron number densities from 10^3 to 10^{24} per cubic centimeter, temperatures from near the "degeneracy" level to $10^{7°}$ K, and wavelengths from about 1 to 10^5 times the Debye distance. Author

N63-18652 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
RESONANCE IN A COLD MULTICONSTITUENT PLASMA AT ARBITRARY ORIENTATION TO THE MAGNETIC FIELD
Eli Reshotko Washington, NASA, July 1963 26 p 12 refs
(NASA TN D-1875) OTS: $0.75

The sensitivity of resonant frequency to the orientation of the propagation vector has been examined for plasmas having both single and multiple ion species. For propagation at right angles to the magnetic field, the hybrid resonances of Auer, Hurwitz, and Miller and of Buchsbaum are obtained. However, at high plasma density, if the direction of the propagation vector departs even slightly from 90°, each of these resonances shifts quickly to a higher frequency approaching the next single-species cyclotron frequency, and an additional resonance appears at a frequency below the lowest single-species cyclotron frequency. In the limit of high plasma density, all the aforementioned resonances have the common property that there is no net current in the direction of the electric field. Author

N63-18770 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ESTIMATES OF ATTENUATION AND REFLECTION OF TELEMETERING SIGNALS BY IONIZED FLOW FIELDS SURROUNDING TYPICAL REENTRY BODIES
Anthony J. Russo, Jr. Washington, NASA, Aug. 1963 90 p 28 refs
(NASA TN D-1778) OTS: $2.25

Estimates of the degree of signal loss due to attenuation and reflection by the inviscid equilibrium plasma sheath were made for spherically blunted cones with half-angles of 30°, 9°, and 0°, at Mach numbers as high as 25, 20, and 19.25, respectively. The computations were made for transmitting frequencies of 30 mc, 240 mc, and 10,000 mc, and over the altitude range from 60,430 feet to 230,000 feet. Calculations, utilizing the simplest application of electromagnetic theory, were made by using normalized body-shape parameters, and methods for applying the resulting tabulated data to specific vehicle reentry problems are discussed. The possible significance of viscous interaction and nonequilibrium effects on the applicability of the results to a given problem is discussed briefly. Charts of the electromagnetic properties of equilibrium air for temperatures from 3,000° K to 7,000° K are presented, from which attenuation and reflection estimates can be made when the density and temperature distributions are known. Author

N63-20888 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
PRELIMINARY INVESTIGATION OF PARTICLE-SUBSTRATE BONDING OF PLASMA-SPRAYED MATERIALS
Salvatore J. Grisaffe and William A. Spitzig Washington, NASA, Sept. 1963 31 p 13 refs
(NASA TN D-1705) OTS: $0.75

An investigation was undertaken to evaluate the effects of two plasma-spray powders, tungsten and zirconia, and four substrate materials, glass, stainless steel, tungsten, and copper, on the particle-to-substrate bond. All substrates except glass were metallurgically polished; the glass had a sufficiently smooth surface so that mechanical interlocking would not contribute to the resultant bond. It was found that the thermal conductivity of the substrate greatly influences the particle-to-substrate bond, whereas, in general, the physical properties of the spray powder have only a slight influence on the bond. Author

N63-20891 National Aeronautics and Space Administration, Washington, D.C.
AN ANALYSIS OF A VORTEX TYPE MAGNETOHYDRODYNAMIC INDUCTION GENERATOR
L. L. Lengyel and Simon Ostrach (Case Inst. of Tech.) 136 p 24 refs
(NASA Grant NsG-198-62)
(NASA TN D-2006) OTS: $2.75

Consideration is given to the performance characteristics of an a.c. magnetohydrodynamic power generator. A rotating magnetic field is imposed on the vortex flow of an electrically conducting fluid, which is injected tangentially into an annulus formed by two nonconducting concentric cylinders and two nonconducting end plates. A perturbation technique is used to determine the two-dimensional velocity and three-dimensional electromagnetic field and current distributions. Finally, the generated power, the ohmic losses, the effective power, and the electrical efficiency of the converter system are calculated. Author

N63-23122 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A MATHEMATICAL TREATMENT OF THE PROBLEM OF DETERMINING THE EIGENVALUES ASSOCIATED WITH A PARTITION FUNCTION OF AN ATOM IN THE INTERIOR OF A PLASMA
E. Baylis Shanks Washington, NASA, Oct. 1963 11 p 1 ref (NASA TN D-1111) OTS: $0.50

This paper is concerned with the determination of the numerical values of some of the eigenvalues and the total number of eigenvalues of the differential equation $x^2p'' + [2dxe^{-x} - k(k+1) - u^2d^2x^2]P = 0$. The problem arises in treating the effective ionization potential of an atom in the interior of a plasma, but is essentially a mathematical problem. Tabular data are shown listing a total of 55 of these eigenvalues for nine different cases. Author

N63-23653 National Aeronautics and Space Administration, Washington, D.C.
INVESTIGATION OF PLASMA AFTERGLOWS WITH APPLICATION IN NITROGEN
K. C. Stotz (Rensselaer Polytechnic Inst.) Nov. 1963 100 p refs
(NASA Grant NsG-48-60)
(NASA TN D-2226) OTS: $2.25

A discussion of electron loss mechanisms in low-density, low-temperature plasmas is presented. A method of measuring the radiation temperature employing a gated microwave radiometer is discussed. Measurements of the ambipolar diffusion coefficient and recombination coefficient in a room-temperature nitrogen plasma are obtained using the microwave transmission technique as a basic diagnostic tool. Previous results obtained by using the microwave transmission method are shown to be in error, and results of the present experiment are shown to be in agreement with microwave cavity measurements. The recombination is attributed to the dissociative recombination of the N_4^+ ion, although the three-body recombination of the N_2^+ ion may play a significant role. The temperature measurements have indicated a source of hot electrons in the early afterglow which is attributed to the presence of metastable molecules. Author

25 PHYSICS, SOLID-STATE

Includes semiconductor theory, and masers. *For related information see*: 09 Electronics, 23 Physics, General; and 24 Physics, Plasma.

N63-10174 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EFFECT OF OXIDIZER PARTICLE SIZE ON ADDITIVE AGGLOMERATION
Louis A. Povinelli Washington, NASA, Nov. 62 31 p 12 refs (NASA TN D-1438) OTS: $1.00

Oxidizer particle size was found to influence aluminum agglomeration during combustion, at atmospheric pressure, of propellant samples composed of ammonium perchlorate, polybutadiene acrylic acid, and aluminum. The results obtained were in agreement with a quantitative model presented for the additive growth process. Emission spectra were obtained for aluminized and nonaluminized propellants and interpreted in terms of the agglomeration process. Film supplement available on request. Author

26 PROPELLANTS AND COMBUSTION

Includes fuels; igniters; and oxidizers. *For related information see*: 07 Chemistry; and 27 Propulsion.

N63-10627 National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
EFFECT OF COMPOSITION ON COMBUSTION OF SOLID PROPELLANTS DURING A RAPID PRESSURE DECREASE
Carl C. Ciepluch Washington, NASA, Dec. 1962 14 p 8 refs (NASA TN D-1559) OTS: $0.50

The response of solid-propellant combustion to a pressure transient was studied in an apparatus that could be vented at a variable rate. The principal measurement was the time required for the pressure to decrease to one-half its initial value. The data are presented and discussed in terms of τ, the maximum value of the time required to extinguish combustion. The results indicate that the ease with which solid-propellant combustion may be extinguished is strongly dependent on physical factors such as the average size and the thermal conductivity of solid particles contained in the propellant. Analysis of the results suggested that hot-particle retention at the surface of the propellant was a major cause of the continuance of combustion in a rapidly decreasing pressure field. An examination of the data also indicated no correlation between τ and the propellant-strand burning rate. Author

N63-11616 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
RELATIVE IGNITABILITY OF TYPICAL SOLID PROPELLANTS WITH CHLORINE TRIFLUORIDE
Harrison Allen, Jr., and Murray L. Pinns Washington, NASA, Jan. 1963 24 p 2 refs
(NASA TN D-1533) OTS: $0.75

Ignition delays were measured after exposing samples of solid propellants and their components to the hypergolic fluid, chlorine trifluoride (ClF_3), in both the liquid and the gas phases. A comparison of these ignition-delay data serves as a measure of the relative reactivity of these propellant compositions with ClF_3. The gas-phase studies showed that the ignition delay varied exponentially with ClF_3 pressure and approached a limit of less than 50 milliseconds at 14 pounds per square inch absolute, the maximum pressure permitted by the experimental apparatus. The gas-phase studies also revealed that the reactivity of the propellant formulation was greatly affected by changes in concentrations of the dispersed solid components (ammonium perchlorate and aluminum) of the propellant. After reaching a minimum point, the ignition delay of the propellant increased with an increase in the concentration of the ammonium perchlorate component; with an increase in the concentration of the aluminum component, the ignition delay was decreased. All the propellant formulations were extremely reactive with liquid ClF_3 and had ignition delays of less than 3 milliseconds. Author

N63-11618 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECT OF THE ACCELERATION DISTURBANCES ENCOUNTERED IN THE MA-7 SPACECRAFT ON THE LIQUID-VAPOR INTERFACE IN A BAFFLED TANK DURING WEIGHTLESSNESS

Donald A. Petrash, Ralph C. Nussle, and Edward W. Otto Washington, NASA, Jan. 1963 15 p 2 refs
(NASA TN D-1577) OTS: $0.50

The acceleration disturbances imposed upon the experimental tank during spacecraft orientation maneuvers in orbit had no effect on the steady-state liquid-vapor interface configuration. The steady-state configuration is one in which the baffle is completely full, and the remaining liquid is uniformly distributed at the base of the standpipe. Control of the liquid-vapor interface was lost by the surface-tension baffle as the spacecraft passed through 0.30g during reentry into the earth's atmosphere. Author

N63-12160 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECT OF SURFACE ENERGY ON THE LIQUID-VAPOR INTERFACE CONFIGURATION DURING WEIGHTLESSNESS

Donald A. Petrash, Thomas M. Nelson, and Edward W. Otto Washington, NASA, Jan. 1963 33 p 4 refs
(NASA TN D-1582) OTS: $1.00

An investigation using capillary phenomena verified the contention that the liquid-vapor interface tends to assume a configuration corresponding to a condition in which the surface energies of the system are at a minimum and indicated that the phenomena can significantly alter the liquid-vapor interface depending on the geometry employed. The effect of using a capillary tube to alter the interface configuration in a spherical and a cylindrical tank was such that the liquid was positioned in the lower portion of the tank with the vapor located at the top of the tank. Author

N63-13951 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL EFFECT OF GAS FLOW TRANSIENTS ON THE HEAT RELEASE OF BURNING LIQUID DROPS IN A ROCKET COMBUSTOR

Marcus F. Heidmann Washington, NASA, Mar. 1963 20 p 12 refs
(NASA TN D-1576) OTS: $0.50

The change in heat release caused by drop shattering was qualitatively evaluated in a small-scale rocket combustor. A single 0.089-inch-diameter liquid-heptane jet was reacted with uniformly distributed gaseous oxygen in a 2-inch-diameter cylindrical combustor. Gas-flow transients were imposed on the burning drops produced by the jet when orifice-type area restrictors were inserted in the gas-flow path. The arrangement of components was coaxial. Restrictor size and position were varied for various combustor pressure levels. Combustor performance with and without restrictors was compared to evaluate the effect of the flow transients. The experimental study consisted of two parts: (1) exploratory tests to determine the region of sensitivity of the burning drops to flow transients and (2) systematic variations to obtain correlating gas-flow parameters. The exploratory tests showed that, with near sonic flow at the restrictor, the transient caused approximately 55 percent of the heptane entering the restrictor region to vaporize and burn. The change in heat release was at a maximum immediately following the restrictor and was complete in less than 6 inches. Drop breakup or shattering was the apparent cause of the increase in heat release. The systematic variation of restrictor size and pressure level showed no critical condition that divided transients with and without an increase in heat release. Rather, heat release increased uniformly with an increase in the severity of the transient. A correlation of the experimental data on the basis of aerodynamic forces alone could not be obtained. Results showed an empirical correlation with gas momentum at the minimum area of the restrictor. Author

N63-15773 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HELIUM CONCENTRATIONS DOWNSTREAM OF A VENT EXHAUSTING HELIUM AT SONIC VELOCITY INTO A SUPERSONIC STREAM OF AIR AT MACH NUMBERS OF 3.51 AND 4.50

Robert L. Stallings, Jr. and Paul W. Howard Washington, NASA, May 1963 21 p 3 refs
(NASA TN-D-1787) OTS: $0.50

Concentration profiles of helium have been measured at three axial stations downstream of a helium vent exhausting at sonic velocity into a supersonic stream of air. The sampling stations were located at 7.2, 14.4, and 21.7 vent diameters downstream of the vent. The tests were conducted at free-stream Mach numbers of 3.51 and 4.50, ratios of vent static pressure to free-stream static pressure from approximately 4 to 18, and helium stagnation temperatures of approximately 550° R and 260° R. Increasing the ratio of vent pressure to free-stream pressure resulted in a general increase in the concentration profiles at all three measuring stations and a decrease in the rate of decrease with distance of the maximum measured concentration through 21.7 vent diameters downstream of the vent. Increasing the vented-gas stagnation temperature resulted in an increase in the rate of mixing of the vented gas and the ambient air. Author

N63-15954 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

THE YIELD OF NITRIC OXIDE FROM PREMIXED FLAMES OF HYDROGEN AND HYDROCARBONS WITH NITROUS OXIDE

Burton D. Fine and Albert Evans Washington, NASA, May 1963 22 p 14 refs Presented at the Western States Combustion Inst., San Diego, Calif., Apr. 29-30, 1963
(NASA TN-D-1736) OTS: $0.75

The yield of nitric oxide (NO) from premixed flames containing nitrous oxide (N_2O) was measured on a cooled porous-plate burner. For rich hydrogen (H_2) - N_2O flames with an inert diluent, results indicated that NO was formed by reaction of N_2O with H_2. For rich ethylene- and acetylene-N_2O flames, results suggested that NO was formed from N_2O and oxygen (O). Results for lean H_2-N_2O-diluent flames showed that O is maintained by equilibrium with O_2, the contribution of thermal decomposition of N_2O being small. Author

N63-22598 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

COMBUSTION TESTS OF OXYGEN-HYDROGEN-HELIUM MIXTURES AT LOADING PRESSURES UP TO 8,000 POUNDS PER SQUARE INCH

Max E. Wilkins and Robert J. Carros Washington, NASA, Oct. 1963 34 p
(NASA TN D-1892) OTS: $1.00

Combustion tests have been made in a small chamber (1-1/2 in. inner diameter and 15-1/4 in. inside length) and in a shock-tube driver, 6-1/4 in. inner diameter by 40-ft long. Combustibles were principally stoichiometric oxygen–hydrogen–helium mixtures varying from 70- to 88-percent helium content and a few tests of oxygen–hydrogen mixtures varying from 76- to 90-percent hydrogen content. Initial loading pressures ranged from 300 up to 8,000 psi in the small chamber and up to 815 psi in the large chamber. Flamepath lengths were varied from 3/4 in. to 13-3/4 in. Different types of ignitors were used and compared. Author

N63-23677 National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala

THE EFFECT OF PROPELLANT SLOSHING ON THE STABILITY OF AN ACCELEROMETER CONTROLLED RIGID SPACE VEHICLE

Helmut F. Bauer Washington, NASA, Oct. 1963 92 p refs
(NASA TN D-1831) OTS: $2.25

Very useful results can be obtained from a simplified stability investigation of an accelerometer-controlled rigid space vehicle with respect to propellant sloshing. In this parametric study the liquid was simulated by an equivalent mechanical model consisting either of mass-spring-damper systems or pendulum-damper systems for each sloshing mode, and a non-sloshing mass with a moment of inertia. For simplification, only the propellant sloshing in one tank was considered. The influence of various parameters, such as ratio of sloshing propellant mass to total vehicle mass, natural slosh frequency, control frequency, control damping, gain factors of the attitude control system, accelerometer gain, its natural frequency, damping, and location was investigated. The potential hazard in control due to propellant sloshing in space vehicles can be eliminated by proper choice of tank form (slosh mass ratio decrease and slosh frequency increase), proper selection of characteristics, location and gain value of the accelerometer, and, as a last resort, by baffles in the propellant tanks. Author

27 PROPULSION

Includes airbreathing, electric, liquid, nuclear, and solid propulsion. *For related information see*: 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

N63-10327 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL PERFORMANCE OF AN ION ROCKET ENGINE USING A RECTANGULAR-SLAB POROUS-TUNGSTEN EMITTER

Ronald J. Cybulski, Joseph T. Kotnik, and David L. Lockwood Washington, NASA, Nov. 1962 27 p 8 refs
(NASA TN D-1321) OTS: $0.75

An ion rocket engine using a porous-tungsten ionizer has been operated for more than 50 hours. The techniques of electron-beam welding and high-temperature-furnace brazing were used to assemble the ionizer. Accelerator and power efficiencies of 90 and 70 percent, respectively, were obtained at a current density of 113 amp/sq m. The power efficiency was obtained at a specific impulse of 8680 seconds. Preliminary results indicate a propellant utilization efficiency of about 90 percent. Author

N63-10650 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE MEASUREMENTS DURING CAPTIVE AND LAUNCH FIRINGS OF A LARGE ROCKET-POWERED VEHICLE

William H. Mayes and Philip M. Edge, Jr. Washington, NASA, Nov. 1962 34 p 9 refs
(NASA TN D-1502) OTS: $1.00

Near- and far-field data were obtained while the exhuast was deflected 90° by a water-cooled turning bucket as well as when the exhaust was free of the bucket deflector. In addition, some measurements were made along and around the surface of the vehicle during captive firing. The data include overall sound pressure levels, spectra, time durations above a certain level, instantaneous pressures for transient and steady operating conditions, and pressure amplitude distributions. Author

N63-10735 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

SPACE-CHARGE-FLOW THEORY AND ELECTRODE DESIGN FOR ELECTROSTATIC ROCKET ENGINES

David L. Lockwood and Vladimir Hamza Washington, NASA, Dec. 1962 100 p 24 refs
(NASA TN D-1461) OTS: $2.25

The basic theory of space-charge flow is described, and three general methods of solution are discussed. Specific space-charge-flow geometries are described in detail. Included are the following: flow between coaxial cylinders, concentric spheres, coaxial cones, hyperbolic flow, flow between inclined planes, and circular flow. Since all the solutions discussed are for space-charge-limited flow, a discussion of partial space-charge flow is presented. The Pierce method of electrode design is described, and some practical limitations of this method are discussed. Electrode shapes for various space-charge flows are shown. Author

N63-10881 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

AN ELECTRON-BOMBARDMENT ION ROCKET OPERATED WITH ALTERNATING-CURRENT SUPPLIES

Paul D. Reader and Robert C. Finke Washington, NASA, Dec. 1962 34 p 3 refs
(NASA TN D-1457) OTS: $1.00

Power-supply weight savings and increases in reliability may result from the operation of an electron-bombardment ion rocket on alternating-current supplies instead of on the normal direct current. This approach was investigated with the alternating-current effects determined for 60-cycle sinusoidal wave forms. Results indicate that a compromise system, with three of the five necessary supplies operated with alternating current, was competitive with total direct-current operation. Author

N63-11509 National Aeronautics and Space Administration, Washington, D.C.

ROCKET PROPULSION

Walter T. Olson, Donald L. Nored, Edward W. Otto, Melvin J. Hartmann, Calvin L. Ball, Gerald Morrell, Richard J. Priem, Edmund R. Jonash, William A. Tomazic, John C. Sanders, and Leon M. Wenzel 1962 55 p 188 refs Papers presented at Session M of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)
(NASA-SP-19) GPO $0.40

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3. NEW PROBLEMS ENCOUNTERED WITH PUMPS AND TURBINES Melvin J. Hartmann and Calvin L. Ball (NASA. Lewis Research Center) 13 p 22 refs
4. RECENT ASPECTS OF ROCKET COMBUSTION RESEARCH Gerald Morrell and Richard J. Priem (NASA. Lewis Research Center) 6 p 14 refs
5. CURRENT RESEARCH AND DEVELOPMENT ON THRUST CHAMBERS Edmund R. Jonash and William A. Tomazic (NASA. Lewis Research Center) 10 p 23 refs
6. DYNAMICS AND CONTROL OF CHEMICAL ROCKETS John C. Sanders and Leon M. Wenzel (NASA. Lewis Research Center) 4 p 3 refs
7. CONCLUDING REMARKS Walter T. Olson (NASA. Lewis Research Center) 1 p

N63-11510 National Aeronautics and Space Administration, Washington, D. C.

NUCLEAR ROCKET PROPULSION

David S. Gabriel, Frank E. Rom, Robert G. Ragsdale, Donald Bogart, Edward Lantz, Herman H. Ellerbrock, John N. B. Livingood, David M. Straight, John C. Sanders, Herbert J. Heppler, Jr., and Clint E. Hart 1962 62 p 79 refs Papers presented at Session N of

the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29) (NASA-SP-20) GPO: $0.45

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3. NUCLEAR PHYSICS OF SOLID-CORE-GAS-COOLED ROCKET PROPULSION REACTORS D. Bogart and E. Lantz (NASA. Lewis Research Center) 9 p 3 refs
4. FLUID-FLOW AND HEAT-TRANSFER PROBLEMS IN NUCLEAR ROCKETS H. H. Ellerbrock, J. N. B. Livingood, and D. M. Straight (NASA. Lewis Research Center) 30 p 31 refs
5. PROBLEMS IN DYNAMICS AND CONTROL OF NUCLEAR ROCKETS J. C. Sanders, H. J. Heppler, Jr., and C. E. Hart (NASA. Lewis Research Center) 6 p 2 refs

N63-11512 National Aeronautics and Space Administration, Washington, D. C.

ELECTRIC PROPULSION FOR SPACECRAFT

Wolfgang E Moeckel, Seymour Lieblein, John R. Jack, George R. Seikel, Warren D. Rayle, and Edmund E. Callaghan 1962 37 p 49 refs Papers presented at Session P of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)

(NASA-SP-22) GPO: $0 35

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5. GENERATION OF THRUST—ELECTROSTATIC THRUSTORS W. D. Rayle (NASA. Lewis Research Center) 6 p 9 refs
6. ADVANCED CONCEPTS E. E. Callaghan (NASA. Lewis Research Center) 7 p 5 refs

N63-11781 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PERIGEE PROPULSION FOR ORBITAL LAUNCH OF NUCLEAR ROCKETS

Paul G. Johnson and Frank E. Rom Washington, NASA, 1962 26 p 11 refs

(NASA TR R-140) GPO: $0.40

A thrust program, called perigee propulsion, which minimizes gravity loss is analyzed. Thrust is applied intermittently in regions of high velocity (near successive perigees). The increased energy-addition efficiency yields mass ratios approaching those for impulsive velocity change. Corresponding times to reach desired energy are in days; but are still small relative to mission times. For specified orbital-launch missions, perigee-propulsion nuclear rocket systems are shown to equal continuous-thrust performance, with reactor powers an order of magnitude less than those of continuous-thrust systems. Application and operational aspects of perigee propulsion are discussed. Author

N63-12640 National Aeronautics and Space Administration, Washington, D.C.

LUNAR LANDING PROPULSION CONSIDERATIONS

K. R. Stehling Feb. 1963 23 p 3 refs

(NASA TN D-1723) OTS: $0.75

The propellant must have high density impulse, low ignition lag, and storability in space. The overall propulsion system must have operational reliability, simplicity, low weight, and throttling capacity. The four propellant combinations are rated in order of burnout velocities: F_2/N_2H_4, F_2/H_2, N_2O_2/N_2H_4, and H_2/O_2. The OF_2-diborane combination has interesting possibilities for further research. Author

N63-12931 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EROSION RESISTANCE AND FAILURE MECHANISMS OF SEVERAL NOZZLE MATERIALS IN A SMALL SOLID-PROPELLANT ROCKET ENGINE

Robert A. Signorelli and James R. Johnston Washington, NASA, 49 p 16 refs

(NASA TN D-1658) OTS: $1.25

A small-scale end-burning solid-propellant rocket-engine facility was constructed, and an investigation was conducted to study uncooled rocket-nozzle insert materials under carefully controlled test conditions. Relative performance and metallurgical failure mechanisms were determined for 12 nozzle materials, including refractory metals, graphites, cermets, reinforced plastics, and a ceramic. A nonaluminized propellant, Arcite 368, which has a theoretical flame temperature of 4700° F was used. The engine was designed to operate at a chamber pressure of 1000 pounds per square inch for 30 seconds with a nozzle-throat diameter of 0.289 inch. With the exception of molybdenum, all of the materials eroded to some degree. In general, the cermet and ceramic materials eroded very little (1 to 2 mils), tungsten and ZT graphite eroded moderately (5 to 9.5 mils), and the molded graphites and the 40-percent-resin phenolic-refrasil-composite material eroded extensively (up to 30.5 mils). The 20-percent-resin phenolic-refrasil and the phenolic-graphite materials eroded drastically (up to 54 mils), while complete failure occurred with phenolic-nylon material. The cermet and ceramic nozzles cracked extensively both radially and axially as a result of thermal stresses. Oxidation is believed to be the primary mechanism by which material was removed from the tungsten nozzle. Material removal from the graphite nozzles is attributed to oxidation coupled with mechanical erosion. Temperature measurements made with molybdenum and graphite nozzles indicated that the maximum throat-surface temperatures were slightly less than 3000° F, which is considerably below the 4700° F flame temperature. A technique for propellant burning-surface modification was developed involving internal ballistic formulas, which permits the systematic variation of engine chamber pressure. Author

N63-13218 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

TWO-DIMENSIONAL CRITICALITY CALCULATIONS OF GASEOUS-CORE CYLINDRICAL-CAVITY REACTORS

Robert E. Hyland, Robert G. Ragsdale, and Eugene J. Gunn Washington, NASA, Mar. 1963 29 p 10 refs

(NASA TN D-1575) OTS: $0.75

The critical mass of a cylindrical, gaseous-core cavity reactor system was computed with a four-group, two-dimensional diffusion code. Uranium 235 and plutonium 239 were considered as fuels. Moderator materials investigated were deuterium oxide (at 70° F) and graphite (at 70° and 5300° F). The study was conducted in two parts; the first part considered the effect on critical mass of variable fuel-region radius in a fixed-size cavity, and the second part pertained to specific effects for one particular configuration. The fuel region can be reduced to a radius of 0.20 to 0.33 of the cavity radius with little or no increase in critical mass. For fuel- to cavity-radius ratios from 0.20 to 1.0 and a graphite moderator at 5300° F, plutonium 239 requires about one-third of the critical mass of a uranium 235 fueled system. A hole (simulating an exhaust nozzle) through one end of the reflector-moderator region resulted in an increase in critical

mass of 5 percent. The hydrogen gas, which in nuclear-rocket application would exist between the fuel and moderator regions, was found to have a negligible effect on critical mass. The critical mass is relatively independent of fuel-region temperature and can be computed by evaluating all thermal values at the moderator temperature. Author

N63-15695 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

DESIGN AND OPERATIONAL PERFORMANCE OF A 150-KILOWATT SODIUM FLASH-VAPORIZATION FACILITY

Landon R. Nichols, Charles H. Winzig, Stanley M. Nosek, and Louis J. Goldman. Washington, NASA, May 1963. 52 p. 5 refs
(NASA TN D-1661) OTS: $1.50

The mechanical, electrical, and process design, and the operational performance of a 150-kilowatt sodium flash-vaporization facility are presented. Saturated liquid sodium at temperatures to 1600° F was circulated at flow rates to 19,000 pounds per hour through an electric-resistance heater. A maximum heater-outlet temperature of 1700° F is attained prior to decompression of the liquid to allow fractional flash vaporization. The liquid-vapor mixture is separated centrifugally, the saturated liquid is recirculated, and the saturated vapor is passed through a convergent nozzle, which simulates a turbine. Stable system operation is realized throughout the range of design parameters. No process instabilities occurred in the flashing process during either transient or steady-state operation. Tentative restricted and critical-flow data of sodium vapors through a convergent nozzle are presented and are compared with theoretically predicted flow for supersaturated and equilibrium expansions. An account of the operational problems, process characteristics, and process interruptions encountered during the 800-hour performance run are presented. Author

N63-15766 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

CHARGE-EXCHANGE EFFECTS ON THE ACCELERATOR IMPINGEMENT OF AN ELECTRON-BOMBARDMENT ION ROCKET

William R. Kerslake. Washington, NASA, May 1963. 45 p. 10 refs
(NASA TN-D-1657) OTS: $1.25

A systematic investigation of accelerator-grid-ion impingement was made with electron-bombardment ion rockets operated over a range of propellant utilization efficiencies from 0.11 to 0.95. Three ion rockets of 5, 10, and 20 centimeters in diameter were used to produce mercury-ion beams of 0.01 to 0.55 amperes at net accelerating potentials of 600 to 7000 volts. Trends of experimental impingement values were predicted by ion charge-exchange equations, particularly below propellant utilization efficiencies of 0.6. Discrepancies between experimental and predicted values were probably caused by direct impingement ions. Calculations were made to estimate the maximum lifetime of a molybdenum accelerator grid based upon the rocket operation parameters, charge-exchange equations, and the measured erosion rate of an endurance run. The experimental work was conducted in a 5-foot-diameter, 16-foot-long vacuum tank. Author

N63-15767 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

NUMERICAL EVALUATION OF ION-THRUSTER OPTICS

Vladimir Hamza and Edward A. Richley. Washington, NASA, May 1963. 42 p. 11 refs
(NASA TN-D-1665) OTS: $1.25

A numerical solution of the two-dimensional Poisson equation with mixed boundary conditions is presented. Examples of analysis of four variations in an electrostatic thrustor configuration are included, and results are compared. Solution of the matrix equation (obtained from finite difference equations) by the Cyclic Chebyshev Semi-Iterative method is described along with the effect of the relaxation factor on the rate of convergence. An estimate of the space-charge-density function is first obtained from the Laplacian potential distribution and the equations-of-motion. The solution of the Poisson equation is then accomplished by a method of successive approximations. A suppression-factor method of dealing with the typical problem of overestimation of the first-order space-charge-density function is discussed. Of particular interest is the space-charge-limited current calculation. This calculation is discussed in detail, and the accuracy of the solution is compared with analytical results for flow between concentric cylinders. The results of the analysis are compared with data obtained from an experimental thrustor. Author

N63-16995 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

POSSIBLE EFFECTS OF NONUNIFORM FLOWS ON PERFORMANCE OF ELECTROTHERMAL THRUSTORS

John R. Jack and John W. Schaefer. Washington, NASA, June 1963. 17 p. 5 refs
(NASA TN D-1732) OTS: $0.50

The effects of a nonuniform enthalpy profile on the performance of an electrothermal thrust generator are evaluated analytically. Performance characteristics are presented for uniform specific impulses ranging from 1000 to 2000 seconds, pressures of 0.01 to 100 atmospheres, and engine wall temperatures of 500° and 3000° K. The nonuniform profile changes the uniform specific impulse by 10 percent at most (except for simulated starting conditions), and the change can either be helpful or detrimental, depending upon the specific operating conditions. In general, an increase in the engine wall temperature causes the specific impulse to approach the uniform flow value. A very special nonuniform profile was also considered, one that may represent the startup of a cold engine. The magnitude of its effect on engine performance may be quite large, the variance depending on the operating conditions. Author

N63-17549 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MECHANICAL IMPEDANCE STUDY OF THE X-259 ROCKET MOTOR

Raymond G. Hartenstein and William G. Elsen. Washington, NASA, June 1963. 24 p. 1 ref
(NASA TN D-1681) OTS: $0.75

The impedance analysis of the X-259 rocket motor and roll-rig firing assembly indicates that the roll rig gives a soft spring effect to the rocket motor which, if unaccounted for, could lead to the misinterpretation of vibration levels especially in the higher frequency range. The mechanical impedance concept has proved to be a straightforward and plausible method of analyzing this phenomenon and, at the same time, increases the general usefulness of static firing data. To define the static firing arrangement completely, a study of the thrust cell mounted against the firing bay wall was also made. This study revealed the dynamic character of the thrust cell and provided excellent correlation with the design parameters of the device. Author

N63-18161 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

THE SIGNIFICANCE OF ATMOSPHERIC BALLISTICS IN ROCKET TECHNOLOGY

**G. H. R. Reisig. Washington, NASA, July 1963. 101 p. 34 refs
(NASA TN D-1830) OTS: $2.50**

The physical properties of the atmosphere pertain to the basic elements of rocket ballistics. The influence of these atmospheric properties on both rocket design and performance is grouped under three topics, namely: (a) rocket design climatology, (b) atmospheric rocket physics, and (c) atmospheric environments for rocket firings. Author

N63-18653 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
ADDITIONAL STUDIES OF SCREEN AND ACCELERATOR GRIDS FOR ELECTRON-BOMBARDMENT ION THRUSTORS
William R. Kerslake and Eugene V. Pawlik Washington, NASA, Aug. 1963 32 p 12 refs
(NASA TN D-1411) OTS: $1.00

An investigation of accelerator-grid systems was made with three ion thrustors having 5-, 10-, and 20-centimeter-diameter electron-bombardment ion sources. Mercury ion beams of 0.01 to 0.7 ampere were generated at net accelerating voltages of 600 to 7000 volts. Grid geometry was studied to determine the effect of hole shape, spacing, and grid thickness upon the ion focusing of the accelerator system and the fraction of Child's law current passed. Geometric limits for acceptable thrustor performance values are discussed. Grid temperature profiles were obtained to evaluate accelerator warping problems. Graphite grids were tested and found to be a solution to these problems for laboratory testing. The method of calculating thrust from metered electrical parameters was verified with a pendulum-type thrust target. Author

N63-18655 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
NEUTRALIZER TESTS ON A FLIGHT-MODEL ELECTRON-BOMBARDMENT ION THRUSTOR
Robert F. Kemp, J. M. Sellen, Jr. (Space Tech. Labs., Inc.) and Eugene V. Pawlik Washington, NASA, July 1963 38 p 7 refs
(NASA TN D-1773) OTS: $1.00

A series of neutralizer tests on a flight-test-design electron-bombardment thrustor is described that uses a pulsed-beam technique and utilizes a floating beam collector. The thrustor was operated at approximately flight-test design-point power levels. Electric potentials were measured with an electron emissive probe within the plasma exhaust beam for several neutralizer configurations. Measurements were also made of beam current density and neutralizer lifetimes. With a net acceleration voltage of 2500 volts, a net- to total-voltage ratio of 0.56, and a beam current of 200 to 280 milliamperes, the plasma potential was 8 to 9 volts above that of the neutralizer for the original neutralizer configuration, and ranged from this value to 0.9 volt for a number of other configurations. No increase in beam divergence due to inadequate neutralization was detected. Neutralizer lifetimes of 2 to 3 hours were typical, and are adequate for a ballistic flight test. Shielded neutralizer configurations showed projected lifetimes greater than 50 hours. Author

N63-19275 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A METHOD FOR DETERMINING THE PROPELLANT REQUIRED TO MAINTAIN AN EARTH ORBITAL VEHICLE IN A USEFUL ORBIT BETWEEN TWO SPECIFIED ALTITUDE LIMITS
James J. Buglia and John F. Newcomb Washington, NASA, Aug. 1963 32 p 8 refs
(NASA TN D-1817) OTS: $1.00

A set of working charts is presented which allows rapid determination of the propellant requirements for maintaining an earth orbital vehicle in a permanent circular orbit in the altitude range of 160 to 300 nautical miles. The orbit is allowed to decay to a predetermined altitude below the original orbital altitude, and a Hohmann transfer maneuver is used to return the vehicle to a circular orbit at its original altitude. The number of such corrections required per year, and the velocity requirement to make a correction are combined to give the yearly propellant-consumption requirement. Two atmosphere models were used, the 1959 ARDC model atmosphere, and the 1962 U.S. standard atmosphere. The results indicate that at the higher altitudes, propellant mass fractions of the order of 1 percent are required to sustain the orbit if the orbit is permitted to decay only a small percentage of the original orbit altitude before a correction is made. At altitudes below 180 nautical miles, the propellant consumption required to maintain the orbit for a year exceeds 10 percent of the total station weight. Author

N63-21895 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
AN EXPERIMENTAL INVESTIGATION OF GASEOUS-FILM COOLING OF A ROCKET MOTOR
James G. Lucas and Richard L. Golladay Washington, NASA, Oct. 1963 32 p 12 refs
(NASA TN D-1988) OTS: $0.75

Data indicate that the Hatch–Papell gaseous-film-cooling correlation may be used in rocket combustion chambers with purely convective heating and nonreactive, nondecomposable coolants and in convergent and throat regions of the nozzle, if an increased heat-transfer coefficient is used. Reactive coolants may be used at the possible expense of a required flow somewhat higher than would be predicted for a nonreacting coolant with equivalent transport properties. The data indicate a possible large wall-temperature effect due to flame radiation, and an approximate method is presented for inclusion of this effect in the correlation. Author

28 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. *For related information see* 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.

N63-10369 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE MAGNETIC FIELD OF A MODEL RADIATION BELT NUMERICALLY COMPUTED
Joseph C. Cain, Syun-Ichi Akasofu, and Sydney Chapman (Alaska, U.) Washington, NASA, Nov. 1962 22 p 18 refs Previously processed as reprint; for abstract see N62-11139 04-12
(NASA TN D-1447) OTS: $0.75

The magnetic field of a ring-current belt symmetrically encircling the earth is calculated numerically, to a first approximation, for a particular model belt. The whole distribution of the field is discussed, and, for a particular intensity of the belt, the calculation is carried to a second approximation. The field of the ring current is shown to be nearly uniform over the earth's surface, although the diamagnetism of the belt produces an insignificant irregularity in the field disturbance in auroral latitudes. In the model belt considered, the center line is connected with the auroral zone by the dipole field lines of force. Although its particles have not yet been observed directly, its existence is suggested by the quiet day anomaly of the satellite-observed magnetic field at six earth radii. Author

N63-11121 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THERMAL RADIATION INCIDENT ON AN EARTH SATELLITE
Frank W. Swalley Washington, NASA, Dec. 1962 73 p 8 refs
(NASA TN D-1524) OTS: $2.00

Equations have been derived, using vector analysis, which predict the incident energy at any given point on an earth satellite. The derivation is based on a nonspinning satellite and extended to include spinning vehicles. The satellite was assumed to be oriented in any one of three ways—toward the sun, toward the earth, and tangent to

the flight path at perigee. The amount of energy received depends upon the intensity of the radiation and the view factor between the object and source. The view factor equations are applicable to any mathematically describable shape. To determine the length of exposure to the sun, simple relations have been developed which predict the ingress and egress points of the earth's shadow. The solution to the equations was programed in a general manner on an IBM 7090. The input data required consisted of parameters to specify the orbit and an equation to describe the surface of the satellite. As an illustration, a cylindrical satellite with hemispherical ends was chosen. The view factor equations were derived and numerically integrated, and the incident energy was calculated for an arbitrarily selected orbit. The results indicated that spinning reduces the peak heat fluxes in all cases, and the minimum incident energy occurred when the vehicle was oriented toward the sun. The methods outlined in this report are applicable to satellites of other celestial bodies also. The only additional information required is a knowledge of the position of the sun and the orbital plane relative to the body. Author

N63-12064 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SEPTEMBER 26, 1960 SOLAR COSMIC RAY EVENT

C. E. Fichtel, D. A. Kniffen, and K. W. Ogilvie Washington, NASA, Jan. 1963 9 p 17 refs Previously published in J. Geophys. Res., v. 67, no. 10, Sept. 1962 p 3669-3672
(NASA TN D-1675) OTS: $0.50

Type IV radio emission is thought to be the most important observable characteristic of solar flares producing high-energy particles. It is shown that solar cosmic-ray particles arrived at the earth on September 27, 1960, following a small flare accompanied by a type IV burst of short duration. Apart from their magnitude, the characteristics of this event do not differ essentially from those of larger events. Author

N63-13096 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EARTH-REFLECTED SOLAR RADIATION INCIDENT UPON SPHERICAL SATELLITES IN GENERAL ELLIPTICAL ORBITS

F. G. Cunningham Washington, NASA, Feb. 1963 440 p 3 refs
(NASA TN D-1472) OTS: $6.00

A calculation is given for the earth-reflected solar radiation incident upon spherical satellites of unit cross-sectional area, in general elliptical orbits. The equations have been left in integral form, but have been machine integrated. The results are presented in tabular form for an extensive number of orbits, the incident energy P_{SE} (in milliwatts/cm^2) being given as a function of the azimuthal angle η of the satellite's position in orbit, measured from perigee. In addition, the orbital average of the incident radiation is calculated and entered at the bottom of each table. The model used assumes: (1) that the earth can be replaced by a sphere of radius equal to its mean radius, 6,367.5 km; (2) that the potential of the earth varies strictly as 1/r; (3) that the mean solar constant is equal to 1.395×10^6 erg/cm^2-sec; and (4) that the mean albedo of the earth is equal to 0.34. Author

N63-13102 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON THE ANOMALOUS COMPONENT OF LOW-ENERGY GEOMAGNETICALLY TRAPPED PROTONS

A. M. Lenchek Washington, NASA, Feb. 1963 25 p 27 refs Previously processed as reprint. For abstract see N62-14269 12-12
(NASA TN D-1679) OTS: $0.75

N63-13103 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NEUTRONS IN SPACE

Wilmot N. Hess Washington, NASA, Feb. 1963 11 p 14 refs
(NASA TN D-1696) OTS: $0.50

The various neutron sources in the solar system are discussed. Because of the neutrons' half-life, very few neutrons come into the solar system from outside. Cosmic rays interacting with the atmosphere or surface of the planets are the major neutron source near the planets. Studies of the neutron energy spectrum can give some information about the chemical composition of the planets. The sun is a source of neutrons from several processes. Thermonuclear burn in the corona and leakage from the burning cone do not seem to be important sources, but a significant number of neutrons may result from high-energy protons accelerated in flares on the sun. Author

N63-13722 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ENERGY SPECTRUM OF ELECTRONS IN THE OUTER RADIATION BELT

Wilmot N. Hess and John A. Poirier Washington, NASA, Mar. 1963 18 p 27 refs
(NASA TN D-1717) OTS: $0.50

The equilibrium energy spectrum of electrons in the outer radiation belt is determined by the injection spectrum and the loss processes that operate to remove the electrons or change their energy. The loss processes considered here are ionization energy loss, multiple scattering, and electron-electron scattering; the injection spectra considered are neutron β-decay electrons and monoenergetic electrons of 780 and 20 Kev. The problem is treated numerically. The results of the numerical calculation are compared with recent measurements of the outer-belt electron spectrum; it appears that neutron decays produce a reasonable fraction of the outer-belt electrons, but other processes such as acceleration may be important. Author

N63-14293 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PROTONS FROM 0.1 TO 5 MEV AND ELECTRONS OF 20 KEV AT 12 EARTH RADII DURING THE SUDDEN COMMENCEMENT ON SEPTEMBER 30, 1961

R. A. Hoffman, L. R. Davis, and J. M. Williamson Washington, NASA, Mar. 1963 10 p 3 refs
(NASA TN D-1700) OTS: $0.50

During the period around the sudden commencement of the magnetic storm on September 30, 1961, the ion-electron detector aboard Explorer XII observed fluxes of low energy protons and electrons while the satellite was at 12 earth radii and outside the magnetosphere. About 25 minutes before the sudden commencement, the proton intensity increased; and, 8 minutes before, the omnidirectional intensity suddenly jumped. The maximum flux of about 2×10^5 protons/cm^2-sec-ster above 140 Kev was attained ½ hour after the sudden commencement. Thereafter the intensities varied irregularly with time, and displayed fluctuations in anisotropy that were dependent on the direction of the local magnetic field. The energy spectrum was independent of both time and intensity. The energy density of the proton spectrum (1×10^{-9} erg/cm^3) was too small to account for the observed compression of the earth's field on the sunlit side during the magnetic storm. Time-coincident with the sudden jump in proton intensities, an electron flux first appeared and reached its peak value of 3×10^6 electrons/cm^2-sec-ster in the 10 to 35 Kev range about 1 minute before the observance of the sudden commencement on the earth's surface; it continued for about 10 minutes and then disappeared. The detection efficiency for electrons places an upper limit of 2×10^5 electrons/cm-sec-ster for the remainder of the storm. Author

N63-14426 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE LOW FREQUENCY POWER SPECTRUM OF COSMIC-RAY VARIATIONS DURING IGY

David Stern Washington, NASA, Mar. 1963 21 p 41 refs
(NASA TN D-1684) OTS: $0.75

The power spectra of cosmic-ray variations, as recorded by neutron monitors at various locations, is computed and analyzed. The frequency range of the variations covered (from 1/200 to 1/2 per day) is found to contain only one significant peak, contributed by the well-known 27-day variation. By use of the power spectrum, a quantitative estimate of the latitude dependence of the 27-day variation may be made. From this, the average rigidity dependence of the modulation amplitude is deduced, and is found to be essentially the same as that of Forbush decreases. The average was taken over the period July 1957 to December 1958, during which the peak decreased significantly. Irregular variations were also investigated, as was the correlation with magnetic activity. It is found that the irregular variations have approximately the same latitude dependence as the 27-day peak, decreasing roughly exponentially with increasing frequency. There was some correlation between magnetic activity and cosmic-ray variations, but it showed no clear recurrence tendencies. A general review of power spectral analysis, with emphasis on points relevant to this work, is included, and the conclusions, along with the connection between Forbush decreases and the 27-day variation, are discussed. Author

N63-14714 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE ARTIFICIAL RADIATION BELT MADE ON JULY 9, 1962

Wilmot N. Hess Washington, NASA, Apr. 1963 23 p 5 refs Previously processed as a reprint; see N63-10554 01-28
(NASA TN D-1687) OTS: $0.75

The available information on the artificial radiation belt formed by the July 9, 1962, high-altitude nuclear explosion is reviewed. Data from Injun-SR-3, Telstar I, Traac, and Ariel I are combined to form one picture of the artificial belt. The data are consistent to about a factor of 3. The flux map obtained in this way is used to calculate the flux encountered by several satellites. These show reasonable agreement with data on solar cell damage. Preliminary data on particle lifetimes are presented. Particles at $L > 1.30$ are expected to last several years on the basis of coulomb scattering. Crude calculations of shielding are made to indicate the doses received inside various vehicles. Author

N63-16293 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A STUDY OF THE HYDROGEN, HELIUM, AND HEAVY NUCLEI IN THE NOVEMBER 12, 1960, SOLAR COSMIC RAY EVENT

S. Biswas, C. E. Fichtel, and D. E. Guss Washington, NASA, May 1963 33 p 29 refs
(NASA TN-D-1764) OTS: $1.00

The composition and energy spectra of solar cosmic rays from the November 12, 1960, solar flare were studied by using rocket-borne nuclear emulsions. The abundances of hydrogen, helium, carbon, nitrogen, oxygen, neon, and larger nuclei were determined, and upper limits were set for light nuclei ($3 \leq Z \leq 5$) and fluorine nuclei. The relative numbers of helium, light, medium ($6 \leq Z \leq 9$), and large ($Z \leq 10$) nuclei in the solar beam were found to be 680 $\pm$110, $<$0.1, 10, and 1.0 $\pm$0.3, respectively. The composition was similar to that of the solar atmosphere, as determined by spectroscopic means, for those elements where a comparison could be made but was markedly different from that of galactic cosmic rays. Author

N63-17312 Geophysics Corp. of America, Bedford, Mass.

PLANETARY AERONOMY VII: THE SOLAR FLUX INCIDENT AT THE TOP OF THE ATMOSPHERES OF EARTH AND NEIGHBORING PLANETS FOR THE SPECTRAL REGION 50 A TO 3000 A

E. D. Schultz and A. C. Holland Nov. 1962 36 p 5 refs
(NASA Contract NASw-395)
NASA CR-11), (GCA-TR-62-14-N OTS: $3.60 ph, $1.28 mf

The solar flux incident at the top of the Earth's atmosphere has been compiled for the spectral region 50 A to 3000 A. Between 50 A and 1850 A, the major emission lines were distinguished from the continuum and are presented separately. The continuum and weak lines are lumped together. The pure experimental data are plotted in two clear and unambiguous presentations of the tabulation to provide a convenient comparison of the contribution of major emission lines with the contribution of the continuum and weak lines. To obtain the flux values at the top of the atmospheres of neighboring planets, intensity dilution factors are easily determined using an inverse square relation based on mean radius vector magnitudes. The tabulated data for Earth were used as a base to generate the entire model of the solar photon flux from 50 A to 3000 A for the top of the atmosphere of Venus and Mars. N E A

N63-18460 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

CERENKOV-SCINTILLATION COUNTER MEASUREMENTS OF THE LIGHT, MEDIUM, AND HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION FROM SUNSPOT MINIMUM TO SUNSPOT MAXIMUM

F. B. Mc Donald and W. R. Webber Washington, NASA, July 1963 21 p 31 refs Submitted for Publication
(NASA TN D-1754) OTS: $0.75

The intensity and rigidity spectra of Be, B, C, N, and O have been measured on a series of three Skyhook balloon flights using a Cerenkov-scintillation detector combination. The flights occurred at times close to solar minimum and maximum. The energy and charge resolution is comparable with that obtained by the latest emulsion techniques. It is observed that the light and medium nuclei display the same relative rigidity spectra throughout the solar cycle as the protons and α particles. This conclusion is valid only in the region studied ($E > 400$ Mev/nucleon), and striking variations may be expected for heavy primaries of low energy. The measured ratio of light to medium nuclei at the top of the atmosphere was 0.36 $\pm$ 0.06. This was not observed to vary appreciably over the solar cycle. Author

N63-19860 National Aeronautics and Space Administration. Washington, D C

A CONTRIBUTION TO THE SPECTRAL TYPE THEORY. IV. FORMATION OF LINES IN STELLAR SPECTRA [CONTRIBUTION A LA THEORIE DU TYPE SPECTRAL. IV. LA FORMATION DES RAIES DANS LES SPECTRES STELLAIRES]

Jean-Claude Pecker Aug 1963 56 p 43 refs Transl from Ann Astrophys., v. 14, no. 1, 1951 p 115-151
(NASA TT-F-116) OTS: $1.50

A method for computing the intensity of stellar spectral lines is presented in simple fashion by writing equivalent widths in a general form. The method is a generalization, extended to the "average" or "strong" absorption lines, of a method proposed by Unsold, and subsequently approached in a different manner by Minnaert, that made it possible to calculate the intensity in the "wings" of a line, or the equivalent width of "weak" lines. Author

29 SPACE SCIENCES

Includes space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories. *For space biology see*: 16 Life Sciences. *For related information see*: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

N63-10329 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE INFLUENCE OF PRECESSION OF EARTH RENDEZVOUS ORBITS ON LUNAR MISSION REQUIREMENTS

William R. Wells Washington, NASA, Nov. 1962 29 p 4 refs (NASA TN D-1512) OTS: $0.75

A study has been made to determine the influence of precession of an earth rendezvous orbit due to the earth's oblateness on lunar mission requirements. The nature of the regression along the earth-moon plane of the nodal line formed by the intersection of the earth rendezvous orbital and earth-moon planes is investigated. This investigation applies for the years 1964 to 1972. With this regression taken into account, two methods for correcting for more than anticipated delay times in earth orbit are considered. The two methods considered are a plane change and an increase in injection velocity. Results of the two methods indicate that the plane-change technique requires considerably less additional velocity. Based on the results of the analysis, launch windows corresponding to lunar positions or declinations throughout the month are presented. Author

N63-10868 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

DIFFERENTIAL CORRECTION FOR VINTI'S ACCURATE INTERMEDIARY ORBIT

N[ino] L. Bonavito Washington, NASA, Dec. 1962 18 p 3 refs (NASA TN D-1445) OTS: $0.50

This report presents an orbit-improvement method in which mean values of certain parameters characteristic of Vinti's kinetic equations are obtained for a series of observations in a predetermined time interval and are used to determine the corresponding set of Izsak elements which exactly factor Vinti's two quartic polynomials. As a consequence, predicted positions and velocities for an earth satellite at any time can be obtained. This report also includes a section on the partial derivatives resulting from the first order Taylor expansion of the conditional equations. Author

N63-11212 National Aeronautics and Space Administration, Washington, D.C.

RESULTS OF OBSERVATIONS OF MARS IN THE USSR DURING THE GREAT OPPOSITION OF 1956

G. A. Tikhov et al Dec. 1962 203 p 99 refs Transl. of articles from the book "Rezul'taty Nablyudeniy Marsa vo Vremya Velikogo Protivostoyaniya 1956 g v SSSR" Moscow, USSR Acad. of Sci. Pub. House, 1959 OTS $3.50

(NASA-TT-F-93)

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N63-11501 National Aeronautics and Space Administration, Washington, D.C.

PROCEEDINGS OF THE NASA-UNIVERSITY CONFERENCE ON THE SCIENCE AND TECHNOLOGY OF SPACE EXPLORATION, VOLUME I, CHICAGO, NOVEMBER 1-3, 1962

Homer E. Newell et al Dec. 1962 412 p 499 refs For Vol. II see N63-11502 03-29

(NASA-SP-11, Vol I) GPO: $2.50

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N63-11502 National Aeronautics and Space Administration, Washington, D.C.

PROCEEDINGS OF THE NASA-UNIVERSITY CONFERENCE ON THE SCIENCE AND TECHNOLOGY OF SPACE EXPLORATION, VOLUME 2, CHICAGO, NOVEMBER 1-3, 1962

Walter T. Olson et al Dec. 1962 522 p 805 refs For Vol. I see N63-11501 03-29 Cumulations of papers will be issued as indicated below

(NASA-SP-11, Vol. II) GPO: $3.00

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Geroge W. Brooks (NASA. Langley Res. Center) p 521-532 20 refs To be issued as part of NASA-SP-28 (See N63-11518 03-34)

N63-11504 National Aeronautics and Space Administration, Washington, D.C.

LUNAR AND PLANETARY SCIENCES IN SPACE EXPLORATION

Walter K. Victor, Manfred Eimer, Conway Snyder, Hugh R. Anderson, Marcia Neugebauer, Edward J. Smith, Ray L. Newburn, Jr., Robert C. Speed, James E. Conel, Robert L. Kovach, and Alden A. Loomis 1962 84 p 160 refs Papers presented at Sessions E. and H of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11501 03-29)
(NASA-SP-14) GPO: $0 55

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2. THE SCIENTIFIC EXPLORATION OF DEEP SPACE Eimer (JPL) 7 p 3 refs
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4. PLANETARY ASTROPHYSICS AND THE EXPLORATION OF THE SOLAR SYSTEM E. L. Newburn, Jr. (JPL) 9 p 30 refs
5. GEOLOGICAL EXPLORATION OF THE MOON AND PLANETS R. C. Speed, J. E. Conel, R. L. Kovach, and A. A. Loomis (JPL) 23 p 50 refs

N63-11609 National Aeronautics and Space Administration, Washington, D.C.

VELOCITY AND ENERGY OF THE TUNGUSK METEORITE

K. P. Stanyukovich and V. A. Bronshten Dec. 1962 8 p 13 refs Transl. of "O skorosti i energii Tungusskogo meteorita" from Doklady Akad. Nauk. SSSR, v. 140, no. 3, 1961 p 583-586
(NASA TT F-89) OTS: $0.50

On the basis of physical phenomena observed following the fall of the Tungusk meteorite, estimates are made of its energy and velocity. Possible explanations of the explosion that occurred during the fall of the meteorite are included. Author

N63-11611 National Aeronautics and Space Administration, Washington, D.C.

ON THE QUESTION OF THE ORIGIN OF TEKTITES

I. Ye. Starik, E. V. Sobotovich, M. M. Shats, and S. M. Grashchenko Dec. 1962 11 p 18 refs Transl. by John F. Holman and Co., Inc. of "K voprosu o proiskhozhdenii tektitov" from Meteoritika (USSR), issue. 22, 1962 p 97-102
(NASA TT F-113) OTS: $0.50

The question of the origin of tektites is approached through mathematical analysis of the data concerning the concentration of uranium and lead in samples and the isotopic composition of the lead. This type of analysis permits a closer approach to an understanding of the processes which occurred during the formation of tektites, and a fixing of the time at which they separated from their source material. Author

N63-11613 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

OPTIMUM LOW-ACCELERATION TRAJECTORIES FOR INTERPLANETARY TRANSFERS

Arthur V. Zimmerman, John S. Mackay, and Leonard G. Rossa Washington, NASA, Jan. 1963 41 p 8 refs
(NASA TN D-1456) OTS: $1.00

Methods of the calculus of variations are applied to the problem of minimizing propellant consumption for interplanetary transfers with a constant thrust and specific impulse, low-acceleration engine. On-off operation of the engine is permitted. The necessary conditions are developed and discussed for two-dimensional, planar transfer in an inverse-square gravitational field. Numerical results for Earth-Mars and Mars-Earth transfers are used to discuss the effects of initial thrust-to-weight ratio, specific impulse, travel time, and travel angle on the final mass. A performance map for one set of engine parameters is used to illustrate a graphical procedure for optimum-round-trip calculations. Author

N63-11614 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INTEGRAL EQUATION RELATING THE GENERAL TIME-DEPENDENT LIFT AND DOWNWASH DISTRIBUTIONS OF FINITE WINGS IN SUBSONIC FLOW

Joseph A. Drischler Washington, NASA, Jan. 1963 19 p 13 refs
(NASA TN D-1521) OTS: $0.50

The equation is applicable for any arbitrary time-dependent motion and can be utilized for flexible as well as rigid wings. The form of the equation is such that it should lend itself readily to modern high-speed computers for obtaining pressure distributions. Special cases of the integral equation are treated for two-dimensional incompressible flow and are presented in an appendix. The kernel function for oscillating finite wings in subsonic flow is obtained as a special case of the integral equation. Author

N63-11615 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ANALOG STUDY OF DESCENTS FROM LUNAR ORBIT

Joseph N. Sivo and Carl E. Campbell Washington, NASA, Dec. 1962 25 p 7 refs
(NASA TN D-1530) OTS: $0.75

An analog study of open-loop soft lunar landings from circular orbit was made to determine the effects of orbit altitude, retrothrust magnitude and direction, and techniques of retrothrust staging on propellant consumption, range, and velocity components near touchdown. Descents to the surface were investigated over a range of orbit altitudes to 300,000 feet and a range of thrust/earth-weight ratios to 1.5 for various thrust-vector directions relative to the velocity vector. Both continuous thrust and two-stage thrusting modes were used. Author

N63-12063 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MATHEMATICAL ANALYSIS FOR THE ORIENTATION AND CONTROL OF THE ORBITING ASTRONOMICAL OBSERVATORY SATELLITE

Paul B. Davenport Washington, NASA, Jan. 1963 19 p
(NASA TN D-1668) OTS: $0.50

A mathematical model is developed by which the following satellite orientation and control problems may be resolved: (1) determining attitude for maximum area of solar cells in sunlight; (2) generating slewing commands for a change in attitude; (3) computing star-tracker gimbal angles for maintaining proper orientation; and (4) determining when guide stars are occulted by the earth, sun, and moon. Author

N63-12075 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

AN ANALYTIC REPRESENTATION OF MUSEN'S THEORY OF ARTIFICIAL SATELLITES IN TERMS OF THE ORBITAL TRUE LONGITUDE

Ann E. Bailie and David Fisher Washington, NASA, Jan. 1963 23 p 4 refs
(NASA TN D-1468) OTS: $0.75

Analytic solutions to order k_2 of the differential equations of Musen's theory of artificial satellites are presented. These solutions include long-period terms and terms with small divisors derived from the k_2^2 approximation as well as from the third and fourth harmonics of the earth's potential. The results obtained herein may be used for computing orbits of artificial satellites to the first order, for

checking the machine programing of the numerical theory, and for comparing Musen's theory with other artificial satellite theories. In addition, these results may be incorporated into the numerical theory to broaden its applicability, particularly in the case of nearly circular orbits. Author

N63-12593 National Aeronautics and Space Adminsitration. Ames Research Center, Moffett Field, Calif.

A FLIGHT EVALUATION OF LUNAR LANDING TRAJECTORIES USING A JET VTOL TEST VEHICLE

L. Stewart Rolls and Fred J. Drinkwater III Washington, NASA, Feb. 1963 15 p 1 ref
(NASA TN D-1649) OTS: $0.50

The similarity of the lift and reaction-type controls in a jet-supported VTOL aircraft and a lunar landing craft made the X-14A aircraft useful for a preliminary study of problems associated with lunar landing trajectories. Flight paths investigated started at 1000 feet altitude and 1 mile from touchdown and required 1 to 2 minutes. The pilot could perform the mission easily when his field of view included both the prescribed touchdown point and the horizon. Author

N63-12594 National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.

THE COLLAPSE PHASE OF EARLY SOLAR EVOLUTION

A. G. W. Cameron Washington, NASA, Jan. 1963 14 p 2 refs
(NASA TN D-1682) OTS: $0.50

That phase of the contraction of a star in which H_2 molecules are being dissociated and H and He atoms are being ionized is examined, and it is found that a stellar configuration must be unstable against dynamical collapse during this phase. Quantitative calculations have been made with polytropes of indices 1.5 and 3. The gravitational instability sets in for stars of one solar mass at a radius of about 100 A.U. and ceases at about ⅓ A.U. If a star is rotating, having conserved angular momentum during its collapse, then it should flatten into a nebular disk without forming a central body in hydrostatic equilibrium. Some physical parameters of possible disks are given. Author

N63-12595 National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.

THE ORIGIN OF ATMOSPHERIC XENON

A. G. W. Cameron Washington, NASA, Feb. 1963 7 p 7 refs
(NASA TN D-1685) OTS: $0.50

Some of the differences in the isotopic composition of atmospheric and meteoritic xenon can be attributed to irradiation of solar xenon by neutrons during the deuterium burning phase of solar contraction, which was followed by accretion of the irradiated xenon into the atmosphere. This problem is examined here more carefully in view of a new measurement which has been made of the reaction rate for the capture of protons by deuterium. It is concluded that, apart from the xenon produced by the decay of extinct radioactivities, most of the atmospheric xenon was in the sun during the deuterium burning phase. Author

N63-12596 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A THEORETICAL STUDY OF THE TORQUES INDUCED BY A MAGNETIC FIELD ON ROTATING CYLINDERS AND SPINNING THIN-WALL CONES, CONE FRUSTUMS, AND GENERAL BODY OF REVOLUTION

G. Louis Smith Washington, GPO, 1962 17 p 7 refs
(NASA TR R-129) GPO: $0.30

The electromagnetic field equations are applied to nonferromagnetic conducting thin-wall cylinders, cones, and cone frustums. The equations are then applied to the general thin-wall body of revolution slowly spinning in a homogeneous magnetic field, in order to calculate the induced eddy currents and resulting torques. The solutions to these cases have direct application in calculating the magnetic torques tending to damp the rotation of spinning and tumbling satellites. Author

N63-12686 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

Z-FUNCTION SOLUTIONS FOR THE MOTION AND HEATING DURING ATMOSPHERE ENTRY FROM EQUATORIAL ORBITS OF A ROTATING PLANET

Frederick W. Boltz Washington, NASA, Feb. 1963 195 p 15 refs
(NASA TN D-1555) OTS: $3.00

The two-dimensional equations of motion for atmosphere entry have been transformed into a pair of first-order differential equations or a single second-order differential equation in generalized coordinates. The transformation is similar to that introduced by Chapman (NASA TR R-11) and is based on the assumption of an exponential atmosphere. However, no terms are deleted from the initial equations, and the solutions obtained for a ballistic or a roll-modulated lifting vehicle of arbitrary shape, size, and weight are valid for the entire atmosphere trajectory. A number of numerical machine-computed (IBM 704) solutions are tabulated for entries at circular and supercircular velocity into the atmospheres of Earth, Mars, and Venus from nearly equatorial orbits. Author

N63-12928 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A SATELLITE ORBIT COMPUTATION PROGRAM FOR IZSAK'S SECOND-ORDER SOLUTION OF VINTI'S DYNAMICAL PROBLEM

Raymond V. Borchers Washington, NASA, Feb. 1963 37 p 8 refs
(NASA TN D-1539) OTS: $1.00

This report extends the results of Vinti and Izsak and presents a computational procedure designed specifically for Izsak's second-order solution of Vinti's dynamical problem. With this procedure, the coordinates and velocity of an unretarded satellite can be obtained from a knowledge of its initial conditions r and v. In this procedure, the derivation is given for the complete set of six canonical constants from initial conditions. Three of these have been determined by Vinti and the remaining three by the author. All six of them are assumed known in Izsak's solution. This report includes an adaption of a Newton-Raphson iteration scheme specifically designed to solve a certain system of nonlinear equations introduced by Vinti for the purpose of numerically factoring a certain quartic equation. The solution by this method can be used instead of certain infinite series oxygen is estimated at 10^9 years. The mesopause is determined by CO_2 radiation. Near the mesopause, CO_2 should become dissociated and the free O atoms form a thin layer of O_2; this effect has no analogy on Earth. The model ionosphere has considerably smaller densities of ionization than comparable regions in the Earth's atmosphere. The *E* region is split into two distinct portions, with X-rays forming the higher one (E_2) and ultraviolet light ionizing O_2 near the mesopause (E_1). The Martian analog to the terrestrial F_2 region may not develop a very high electron density, and the entire ionosphere should be depleted at night. Author

N63-12929 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE LUNAR ORIGIN OF TEKTITES

Dean R. Chapman and Howard K. Larson Washington, NASA, Feb. 1963 66 p 92 refs Presented at the 13th International Astronautical Congress, Varna, Bulgaria, Sept. 23-29, 1962
(NASA TN D-1556) OTS: $1.75

Recent research results from the discipline of atmosphere entry aerodynamics have been applied to the study of tektites, especially those found in Australia. Hypervelocity ablation experiments with tektite glass have reproduced in the laboratory the same surface sculpture patterns, the same geometric relationships, the same systematic alteration in internal striae, and the same types of coiled circumferential flanges as those found on the Australian tektites. The

overall evidence establishes that the australites are objects which have entered the earth's atmosphere as individual pieces of rigid glass and and have been shaped by severe aerodynamic heating. Experiments have been conducted on molten glass ejected into the atmosphere with various viscosities and velocities. The results demonstrate that the configurations commonly formed by the action of aerodynamic pressures on fluid glass do not resemble the australite primary shapes. These experiments also show that the dominantly spheroidal forms of the primary australites were formed in an environment where the atmospheric density was many orders of magnitude less than that at the earth's surface. These results contradict the hypotheses that the australites originated from either the earth, or the other atmosphere-shrouded planets. Author

N63-12932 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PERIODIC ORBITS FOR MOON PROBES

Su-Shu Huang Washington, NASA, Feb. 1963 8 p 4 refs
(NASA TN D-1701) OTS: $0.50

A general discussion is presented on the broadening of scope, purpose, and, consequently, technique of celestial mechanics as a result of the space age. The discussion is focused on the time scale of the objects being studied. In order to differentiate from the more rigorous part of classical celestial mechanics, the name Space Mechanics is suggested to cover this field of study, which is empirical in purpose and numerical in approach. In the sense of Space Mechanics, some periodic orbits that enclose both the two finite bodies have been investigated within the framework of the restricted three-body problem. This represents only the first step in looking for orbits that will permit a moon-probing vehicle to make periodic encounters with the moon on its other side. Two families of periodic orbits have been found, one stable, one unstable, in the orbital plane of the hypothetical moon. Such periodic orbits also have been sought outside the orbital plane. Although a periodic orbit has been obtained numerically, it does not enclose the moon. Author

N63-13515 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

A CONSIDERATION OF LUNAR SURFACE BALLISTICS AND THE HAZARDS ASSOCIATED WITH SPACECRAFT LANDING OR LAUNCH OPERATIONS

D. C. Cramblit Washington, NASA, Mar. 1963 33 p 14 refs
(NASA TN D-1526) OTS: $1.00

This preliminary study was directed specifically toward determination of the trajectories or flight paths of lunar-surface particles accelerated by the jet blast from a lunar-landing or return vehicle. A range of particle velocities was assumed based on an anticipated effective exhaust gas velocity of 13,250 ft/sec for a LOX-LH_2 engine. Thus, velocities both above and below those required for escape or orbit from the lunar surface were considered. Data are presented in graph and chart form, along with a brief discussion. Sample calculations and basic data for the ballistics study are presented. Author

N63-13713 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

REMARKS ON HILL'S LUNAR THEORY. PART I

Karl Stumpff Washington, NASA, Mar. 1962 16 p 2 refs
(NASA TN D-1540) OTS: $0.50

In this paper, the Hill equation is modified to give a third-order differential equation for r(the planetocentric distance of the satellite). This equation can be solved by iteration (if the satellite orbit is considered to be a disturbed Kepler ellipse). This new solution is not only suitable for computer applications, but it is independent of the coordinate system and is valid for both a fixed and a rotating system, whereas Hill's solution was limited to simple-periodic orbits in a rotating system. The discussion of Hill's lunar problem provides a simple example of a method applicable also to more difficult problems, such as the restricted three-body problem, in which conic-section orbits can be considered good approximate solutions. Author

N63-13714 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

REMARKS ON HILL'S LUNAR THEORY. PART II

Karl Stumpff Washington, NASA, Mar. 1963 15 p 2 refs
(NASA TN D-1541) OTS: $0.50

In 1879, G. W. Hill, using his differential equation system, found a series of direct lunar orbits, which represent a simplification of the restricted three-body problem (neglecting solar parallax and eccentricity). In the present discussion, Hill's coefficients are successively determined from linear equations and are in the form of closed trigonometric expressions. Although this method, which does not extend beyond the third order, is only an interesting attempt at achieving the same goal via a different mathematical route, it does not extend as far as Hill's method (which may be carried out to the fifth or sixth order without difficulty). Author

N63-13715 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

DELINEATION OF TRACKS OF HEAVY COSMIC RAYS AND NUCLEAR PROCESSES WITHIN LARGE SILVER CHLORIDE CRYSTALS

Lawrence M. Slifkin (North Carolina U.) and Charles B. Childs
Washington, NASA, Mar. 1963 11 p 20 refs
(NASA TN D-1547) OTS: $0.50

Tracks of energetic charged particles, such as heavy primary cosmic rays and the products of nuclear collisions, have been made visible within the interior of large, transparent crystals of silver chloride. The tracks are delineated by photoelectric formation of metallic silver along them. This technique may be useful as a convenient and distortion-free method for the study of heavy primaries and fission fragments. Author

N63-13723 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE CRITICAL INCLINATION PROBLEM IN SATELLITE ORBIT THEORY

William A. Mersman Washington, NASA, 1962 32 p 11 refs
(NASA TR R-148) GPO: $0.40

Solutions of the satellite orbit problem are obtained that do not exhibit singularities at the critical inclination angle. Series representations are obtained, their regions of convergence are exhibited, and quantitative measures of their speeds of convergence are provided for use in numerical computations. Author

N63-14404 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ANALYTICAL THEORY OF THE STRETCH YO-YO FOR DE-SPIN OF SATELLITES

Joseph V. Fedor Washington, NASA, Apr. 1963 21 p 3 refs
(NASA TN D-1676) OTS: $0.75

An analysis of an advanced type of yo-yo for satellite de-spin is made. The analyzed stretch yo-yo consists of a weight, a spring, a wire, and end fittings, or simply a weight, a spring, and end fittings. Equations of motion are developed for the system but, because of the complex nature of the equations, they are not solved explicitly. By using a novel method of analysis, algebraic complexity is circumvented and simple design equations are derived. A straightforward step-by-step procedure is given for the design of the stretch yo-yo. The results calculated from the equations clearly indicate that the stretch yo-yo is less sensitive to satellite spin-up errors and uncertainty in the spin moment of inertia than is the conventional rigid yo-yo. Author

N63-14406 National Aeronautics and Space Administration, Washington, D.C.

EVALUATION OF INFRARED SPECTROPHOTOMETRY FOR COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SOILS

R. J. P. Lyon (Stanford Res. Inst.) Apr. 1963 136 p 43 refs
(NASA Contract NASr-49(04))
(NASA TN D-1871) OTS: $2.75

A preliminary feasibility study of infrared analytical techniques for the study of the lunar surface has been made, including absorption studies of 370 rock and mineral samples, and reflection studies of 80 rocks. Spectral information was collected in the wavelength range 2.5 to 25 microns (4000 to 400 cm^{-1}). Emittance spectra have been calculated from the reflectance data for several of the most important rock types. Author

N63-14587 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SPRAY EJECTED FROM THE LUNAR SURFACE BY METEOROID IMPACT

Eugene M. Shoemaker, Henry J. Moore (Geol. Survey), and Donald E. Gault

(NASA TN D-1767) OTS: $1.00

Experimentally determined mass-size distributions of fragments ejected from craters formed in rock by hypervelocity impact have been combined with estimates of the rate of impact and mass distribution of interplanetary debris which strikes the lunar surface to find the rate and mass of fragments sprayed up from the lunar surface. It is shown that the flux of particles of a given mass ejected from the lunar surface will be at least three and probably four orders of magnitude greater than the flux of the impacting interplanetary debris of the same mass. Experimentally determined distributions of mass with velocity indicate that almost all of the debris is ejected at less than lunar escape velocity (2.4 km/sec) and contributes to secondary impact events. A small fraction of the ejecta, however, will leave the lunar surface at velocities greater than the escape speed. These results imply the presence of a lunar dust cloud of flying particles. The major fraction of the cloud is estimated to be a few kilometers deep with a spatial density at the lunar surface of the order of 10^5 to 10^7 times the spatial density of the interplanetary debris. These particles, together with the interplanetary debris, provide a powerful eroding agent that will continually abrade the lunar surface and reduce rubble to finer sizes. The inference to be drawn is that there must be at least a thin layer of dust-sized particles on the lunar surface—a layer which is being constantly agitated and stirred by the impacts to form a heterogeneous mixture of material from the entire surface of the moon. It is to be expected that lunar probes and vehicles will be subjected to higher rates of impact when immersed in the dust cloud than during the earth-moon voyage. Author

N63-14806 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SOME POSSIBILITIES FOR DETERMINING THE CHARACTERISTICS OF THE ATMOSPHERES OF MARS AND VENUS FROM GAS-DYNAMIC BEHAVIOR OF A PROBE VEHICLE

Alvin Seiff. Washington, NASA, Apr. 1963. 36 p. 12 refs.

(NASA TN D-1770) OTS: $1.00

One of the early objectives of space probes sent to Mars and Venus will be to determine the characteristics of the atmospheres on those planets for scientific purposes. Characteristics of interest include profiles of gas density, temperature, and pressure above the planet surface, and chemical composition of the atmosphere. It is found that the density, pressure, and RT product profiles in the atmosphere can be obtained from measurements of axial acceleration and the angle of entry into the atmosphere. For a certain class of entry body configurations, measurements of the static flight stability can be used to give information on the mean ratio of specific heats of the atmospheric gases. Measuring the ambient temperature so as to obtain the gas constant R from its product with temperature RT, and hence determine the mean molecular weight of the atmospheric gases is discussed. Luminosity detectors that view the excited high-temperature gases in the probe shock layer for evidence of composition are discussed, as well as the possibility of determining the kind of gases from measurements of stagnation temperatures. An important characteristic of this kind of probe experiment is that the definition of atmospheric properties begins as high in the atmosphere as any detectable effect on the probe occurs, in general, around 300,000 feet altitude. Author

N63-15052 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PREDICTION OF VELOCITY REQUIREMENTS FOR MINIMUM TIME ABORTS FROM THE MIDCOURSE REGION OF A LUNAR MISSION

Robert B. Merrick and George P. Callas. Washington, NASA, Apr. 1963. 40 p. 7 refs.

(NASA TN D-1655) OTS: $1.00

Problems associated with quick returns to the earth from the midcourse region of a lunar mission have been examined by relating errors in perigee height to some of the errors inherent in any abort maneuver. Four sources of error, other than the two-body approximation effects, were considered, and their influence upon the perigee height at return was examined statistically. These error sources are the inaccuracy in the knowledge of position and velocity at abort and the inaccuracies in the magnitude and aiming of the abort rocket. The aiming error in the thrust applied during abort was responsible for major perigee deviations. The velocity increments necessary to correct the errors incurred by the abort maneuver were computed at various points on the return trajectory. Less than 5 percent of the abort velocity increment is sufficient to correct these errors if the correction is applied at a range of 100,000 km from the earth. Author

N63-15236 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

GEOMETRICAL CHARACTERISTICS OF LUNAR ORBITS ESTABLISHED FROM EARTH-MOON TRAJECTORIES

Robert H. Tolson. Apr. 1963. 21 p. 6 refs.

(NASA TN D-1780) OTS: $0.50

An analysis has been made of the geometrical characteristics of lunar orbits which can be established from typical earth-moon transfer trajectories. An iterated two-body or patched-conic technique was used to relate the transfer-trajectory injection conditions to the selenocentric orbital parameters through a set of simultaneous transcendental equations. Solutions to these equations are presented for typical sets of injection conditions. These solutions suggest an additional simplification in the analysis which results in a simple physical understanding of the problem and also in some approximate, simple relationships between the lunar orbital parameters and the transfer-trajectory characteristics. In particular, it is shown that (unless changes in the orbital plane are instituted) there is a minimum-inclination lunar orbit which can be established. The value of this minimum inclination is given as a function of the injection conditions, and depends primarily on the injection flight-path angle and transfer-trajectory inclination to the earth-moon plane. In addition, an approximate equation is given which relates the lunar orbital inclination and nodal position to the injection conditions, hence, only one of these two lunar orbital parameters can be chosen arbitrarily. Author

N63-15304 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A PARAMETRIC INVESTIGATION OF THE LUNAR-ORBIT-RENDEZVOUS SCHEME

David F. Thomas and John D. Bird. Washington, NASA, Apr. 1963. 64 p. 2 refs.

(NASA TN D-1623) OTS: $1.75

A parametric study of lunar-mission vehicles designed for lunar-orbit-rendezvous and direct lunar missions was made for the purpose of determining the injected weight required for missions performed under various circumstances. Missions were considered which had crew sizes from 2 to 14 men, transported supplies to be deposited on the moon up to 40,000 pounds, circular and elliptic orbits at the moon with maximum altitudes from 50 to 8,000 international nautical miles, and points of entry into lunar orbit at both apolune and perilune. Three fuel combinations were considered. The results of this study indicate that the lunar-orbit-rendezvous mission requires much smaller weights injected to the moon than the direct lunar mission. For the lunar-orbit-rendezvous mission, the lowest lunar-mission-vehicle weights were generally

obtained for low-altitude orbits. In the case of elliptic lunar orbits entered at perilune, vehicle weight was relatively insensitive to lunar-orbit altitude. In the cases of circular lunar orbits and elliptic lunar orbits entered at apolune, vehicle weight increased markedly with lunar-orbit altitude. Author

N63-15306 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF LIFT ON SEPARATION DISTANCE AND LOADS FOR AN ABORTING VEHICLE AT MAXIMUM DYNAMIC PRESSURE OF A LUNAR MISSION

Joseph J. Janos and John R. Unangst. Washington, NASA, Apr. 1963. 26 p. 3 refs.
(NASA TN D-1775) OTS: $0.75

This investigation considers some of the effects of using lifting trajectories for abort of a lunar mission during the early part of the launch phase. Particular emphasis is placed on determining the effects of lifting abort trajectories on the possibility of a collision of the launch vehicle and spacecraft if abort is initiated at maximum dynamic pressure of the launch trajectory. Abort trajectories are computed with a range of constant values of lift-drag ratio from -1.0 to 1.0 and thrust levels of 83,450 and 151,300 pounds. The results indicate that a zero-lift abort at maximum dynamic pressure could result in a collision shortly after burnout of the abort motor. However, if the abort vehicle has a lift-drag ratio of ± 0.1, positive separation distance from the launch vehicle is maintained. The maximum loads encountered depend somewhat on the lift-drag ratio and are $-14.3g$ for the low-thrust level and $-18.6g$ for the high-thrust level. Author

N63-15322 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ORBITS RETURNING FROM THE MOON TO A SPECIFIED GEOGRAPHIC LANDING AREA

Luigi S. Cicolani. Washington, NASA, Apr. 1963. 47 p. 6 refs.
(NASA TN D-1652) OTS: $1.25

This paper develops a method of computing approximate trajectories returning from the moon to a fixed landing site. The gravitational field of a spherical earth is assumed to govern orbital motion, and the entry phase of the trajectories is described by a linear relation between entry range and flight time in the atmosphere. Data were computed for trajectories returning to Edwards Air Force Base during the month of February 1966, and an analysis of these data is presented. Author

N63-16258 National Aeronautics and Space Administration. Washington, D.C.

TABLES FOR ECCENTRIC AND TRUE ANOMALY IN ELLIPTIC ORBITS

Jack T. Kent, George B. Taack, Jr., and David C. Larson (Texas A and M. Coll.). 1963. 206 p.
(NASA TR-R-158) GPO $1.50

These tables have been compiled to facilitate the computation of orbits of spectroscopic and visual binaries and of small planetary objects such as asteroids and satellites. The eccentricity ranges from 0.01 to 1.00. The accuracy of the tables is eight digits. Author

N63-16429 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A REVIEW OF GEODETIC PARAMETERS

William M. Kaula. Washington, NASA, May 1963. 11 p. 28 refs.
(NASA TN D-1847) OTS: $0.50

It is recommended that the parametric values which are currently most used in orbital computation be adopted as provisional standards, rather than those which may be the best available, because the "most used" values differ only slightly from the "best" values, and further improvements in the values are expected within the next 4 years. Author

N63-16575 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON A MODIFICATION OF HANSEN'S LUNAR THEORY

Peter Musen. Washington, NASA, June 1963. 33 p. 9 refs.
(NASA TN D-1745) OTS: $1.00

A modification of Hansen's lunar theory is given in a form that permits a purely numerical treatment of solar perturbations of planetary satellites or of perturbations caused by the earth in the motion of hypothetical lunar satellites. The development of the coordinates and of the velocities of a satellite is obtained in the form of a trigonometric series in four arguments with numerical coefficients. At the earlier stages of the computation, it is not compulsory to use Hansen's basic W-function. Use is made of the fictitious mean anomaly and the replacement "bar" operation—two characteristic features of Hansen's theory—to set up a process of iteration in a convenient form, rather than to compute W. The preference given to the method of iteration was motivated by the circumstance that input information must not necessarily be limited to the choice of the rotating ellipse as an intermediary orbit. A systematic investigation of the orbital stability of lunar satellites can be based on the development given here. Author

N63-16985 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE LONG-PERIOD MOTION OF THE TROJANS, WITH SPECIAL ATTENTION TO THE THEORY OF THUERING

Karl Stumpff. Washington, NASA, June 1963. 17 p. 7 refs.
(NASA TN D-1416) OTS: $0.50

In 1930, B. Thuering published an approximative theory of long-period motion of the Trojans as a restricted three-body problem. With this theory the periodic orbits for all amplitudes can be approximated so that the remaining deviations are at most of the order of the mass of Jupiter ($<10^{-3}$). Thuering's solution provides a starting point for an exact theory of the plane long-period Trojan orbits according to the method of the variation of constants. Special attention is devoted to the borderline case, in which the periodic orbits around L_4 and L_5 overlap. This boundary orbit and its adjacent orbits run into the infinitesimal Charlier orbits around L_3—more specifically, into those of the hyperbola type. Author

N63-16987 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

ASCENT FROM THE LUNAR SURFACE

Rowland E. Burns and Larry G. Singleton. Washington, NASA, June 1963. 155 p. 5 refs.
(NASA TN D-1644) OTS: $3.00

The problem of three-dimensional optimal ascent from the lunar surface is discussed using the techniques of variational calculus. The moon is assumed to be spherical and rotating, perturbational effects from all other bodies are neglected. Final orbital inclination is calculated under the assumption that the angular displacement of the moon during ascent is negligible. Only single-stage vehicles are considered, and are subdivided into propellant and mass in orbit. Both thrust and mass-flow are assumed constant throughout the powered flight of a given vehicle. The technological range considered covers specific impulse values of 300 sec. to 450 sec (in steps of 50 sec), and lunar thrust-to-weight ratios of 1 to 7 (in steps of 1). Initial lift-off angles vary from 0° to 40° (in steps of 10°). Most results assume a launch site on the lunar equator at the lunar prime meridian, and a final orbital inclination of 5°. In each case, the thrust and velocity vectors are alined at cutoff. Sample cases deal with launch latitudes of 30° and 60°, while other calculations show the effects of varying final inclination from 0° to 180°. The results present mass fraction in orbit and final orbital altitudes as well as the initial values of certain mathematical functions (Lagrange multipliers) necessary to attain these end conditions. Optimum values of initial thrust-to-weight ratios and orbits of maximum mass fraction are described for each

combination of specific impulse and lift-off angle. These results are presented both tabularly and graphically; several examples illustrate applications to preliminary design studies. Author

N63-16993 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LUNAR FLIGHT STUDY SERIES: VOLUME 5. TRAJECTORIES IN THE EARTH-MOON SPACE WITH SYMMETRICAL FREE RETURN PROPERTIES
Arthur J. Schwaniger. Washington, NASA, June 1963. 29 p. 6 refs.
(NASA TN D-1833) OTS: $0.75

An extensive investigation has been made of the characteristics of so-called "free return" trajectories. For the purposes of the study, these trajectories are defined as having symmetric properties which afford flight to the vicinity of the moon and return to earth without need for propulsion after the initial boost phase. The restricted three-body model for the earth-moon probe system is used throughout. Two kinds of free return trajectories are shown to exist and are studied. Of particular interest is the fact that for one kind of free return path, the largest inclination which can be achieved between the flight plane at periselenum and the plane of the moon's orbit about earth is about 10.8°, whereas for the other kind of path, the largest possible inclination is dependent on the radius at periselenum. In this case the inclination is limited to about 14° or less for periselenum radius of 1938 km, but may be as great as 90° with periselenum radius of 21,150 km. Trajectories are also demonstrated which pass in front of the moon. These exhibit inclination behavior very much like that given by trajectories which go behind the moon. The injection velocity for these trajectories also changes only slightly from the circumlunar trajectories (less than 2 m/s for periselenum radius of 1938 km). However, the position of injection is changed considerably, and the flight time may be increased by as much as five times that for circumlunar flights. Author

N63-17105 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GODDARD SPACE FLIGHT CENTER CONTRIBUTIONS TO THE COSPAR MEETING, MAY 1962
Washington, NASA, May 1963. 231 p. 320 refs. A collection of papers presented at the COSPAR Third Intern. Space Sci. Symp., Washington, D.C.
(NASA TN D-1669) OTS: $3.50

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N63-17208 National Aeronautics and Space Administration, Washington, D.C.
PHOTOCHEMICAL PROBLEMS OF THE VENUS ATMOSPHERE
Paul Harteck, Robert R. Reeves, Jr., and Barbara A. Thompson. Washington, NASA, June 1963. 42 p. 46 refs.
(NASA Grant NsG-261-62)
(NASA TN D-1984) OTS: $1.25

In an experimental investigation of the possible chemical composition of the atmosphere of Venus, a series of conditions which may exist on Venus have been simulated. Experimental measurements were made of the absorption coefficients of carbon dioxide (CO_2), carbon monoxide (CO), oxygen (O_2), and other gases in the region from 1850 A to longer wavelengths. The behavior of CO_2 under the impact of ionizing radiation from pressures of 1 atmosphere down to a few hundred microns was studied, and extrapolation made to the region of chemosphere. Reaction mechanisms which may occur and be of major importance in the Venus atmosphere are discussed. As an alternate to the currently popular thermal origin of the observed microwave radiation emitted from Venus, a chemical source is suggested. Light-emitting chemical reactions of the type believed to occur on Venus are discussed. Preliminary results show that microwave radiation in the 3-cm wavelength region is emitted from the CO_2 discharge. Author

N63-19276 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ANALYSIS OF THE LUNAR RETURN MISSION
John P. Gapcynski and Robert H. Tolson. Washington, NASA, Aug. 1963. 30 p. 4 refs.
(NASA TN D-1939) OTS: $0.75

This report presents the results of an analysis of the lunar injection conditions which will ensure moon-to-earth return trajectories which satisfy specified reentry conditions. Consideration is first given to an overall discussion of the physical aspects of the return problem, and this discussion is then augmented with more quantitative results. Author

N63-19606 National Aeronautics and Space Administration, Edwards, Calif. Flight Research Center

HANDLING QUALITIES AND TRAJECTORY REQUIREMENTS FOR TERMINAL LUNAR LANDING, AS DETERMINED FROM ANALOG SIMULATION

Gene J. Matranga, Harold P. Washington, Paul L. Chenoweth, and William R. Young Washington, NASA, Aug. 1963 34 p 10 refs

(NASA TN D-1921) OTS: $1.00

A six-degree-of-freedom analog study was performed to aid in defining handling qualities and trajectory potential for terminal lunar landing. Results showed that, for a maneuvering task in the pitch mode and a random-motion-correction task in the roll and yaw modes, the pilots preferred rate or attitude command with control accelerations of about 10 deg/sec^2 and reasonable artificial damping. Also, to consistently perform successful landings, the pilots generally used thrust-to-weight ratios throttled between a minimum value of 0.8 lunar g and a maximum value of 1.8 lunar g. Author

N63-19734 National Aeronautics and Space Administration, Huntsville, Ala. Marshall Space Flight Center

TRAJECTORY SIMULATION APPLICABLE TO STABILITY AND CONTROL STUDIES OF LARGE MULTI-ENGINE VEHICLES

Ronald J. Harris Washington, NASA, Aug. 1963 98 p 22 refs

(NASA TN D-1838) OTS: $2.25

A three-dimensional six-degree-of-freedom trajectory simulation applicable to preliminary stability and control studies of vehicles having large multiengine boosters is formulated.

The simulation employs rigid-body equations-of-motion referenced to a special set of body axes known as Euler axes, an orthogonal right-handed triad having its origin at the instantaneous center of gravity of the vehicle. Fuel sloshing and elasticity effects are ignored. Simplifications are kept to a minimum in the derivation of the basic equations, consequently, the complexity of the simulation can be varied by assigning zero values to certain parameters. The aerodynamic characteristics of the vehicle are assumed to be a function of both Mach number and angle-of-attack. Vehicle mass and inertia characteristics are assumed to be time variant. Winds of arbitrary velocity and direction are incorporated into the simulation. Artificial stabilization is assumed to be provided by thrust-vector control and application of the drift-minimum or load-minimum principle, although other control modes can be applied. Thrust forces are resolved in a manner which allows arbitrary location of the engines, except for the restrictions that the engine array must be symmetrical with respect to the vehicle center line, and gimbal points must lie in a plane perpendicular to the center line. The simulation will provide basic systems design information concerning the dynamic behavior of specific configurations, with emphasis being placed primarily on the boost phase of flight. The basic information desired are the engine gimbal angles necessary for stabilization and the responsive motion of the vehicle to a specified disturbance. A numerical example is included which illustrates the application and flexibility of the simulation. Results are compared where possible with a typical two-dimensional simulation. Author

N63-19862 National Aeronautics and Space Administration, Washington, D.C.

PHYSICAL CONDITIONS ON MARS [FIZICHESKIYE USLOVIYA NA MARSE]

N. P. Barabashov Washington, NASA, Aug. 1963 13 p Transl. into ENGLISH from Vestnik Akad. Nauk SSSR (Moscow), no. 10, 1962 p 18-25

(NASA TT-F-165) OTS: $0.50

A discussion is presented in an effort to clarify what is reliably known about Mars, what is in the realm of more or less probable conjecture, and finally what is still completely unexplainable. Significant areas for future research toward determining the physical aspects of planets are indicated. Author

N63-19863 National Aeronautics and Space Administration, Washington, D.C.

COSMIC MINERALOGY – A NEW BRANCH OF SCIENCE [KOSMICHESKAYA MINERALOGIYA – NOVAYA VETV' NAUKI]

D. P. Grigor'yev Aug. 1963 7 p Transl. from Vestnik Akad. Nauk SSSR, no. 4, 1962 p 21-24

(NASA TT-F-170) OTS: $0.50

The conclusion is reached that out of a long-noted tendency to group mineralogical knowledge, there now emerges the important task of developing cosmic mineralogy as a special branch of the science of minerals. Author

N63-19864 National Aeronautics and Space Administration, Washington, D.C.

THE ORIGIN OF THE EARTH'S SHELLS [PROISKHOZHDENIYE OBOLOCHEK ZEMLI]

A. P. Vinogradov Aug. 1963 24 p Transl. from Vestnik Akad. Nauk SSSR, no. 9, 1962 p 16-29 Presented at the General Meeting of the USSR Acad. Sci., June 30, 1962

(NASA TT-F-171) OTS: $0.75

The questions considered include the methods of differentiating the terrestrial substance into shells of different physicochemical character, and the stages during which this differentiation took place. Answers are sought indirectly on the basis of cosmic data or on the basis of galactic distribution of the chemical elements. Author

N63-20609 National Aeronautics and Space Administration, Washington, D.C.

IONIZATION ASSOCIATED WITH HYPERVELOCITY IMPACT

J. F. Friichtenicht and J. C. Slattery Washington, NASA, Aug. 1963 21 p 3 refs

(NASA Contract NASw-561)

(NASA TN D-2091) OTS: $0.75

It has been found that electrically charged particles are emitted from the site of a hypervelocity impact. Presumably, the large energy release associated with the impact is sufficient to produce ionization, and the ions or electrons can be extracted by means of electrical collector systems. The quantity of charge emitted from semi-infinite targets as a function of target material, projectile material, and particle velocity and mass was measured. The experiments were conducted with micron-sized iron and carbon black (graphite) particles from the electrostatic hypervelocity accelerator. Data were collected for velocities up to 16 km/sec. All of the data fits the empirical relationship $Q_c = K E_p v/A$, where Q_c is the charge collected, K a constant, E_p the particle energy, A the atomic weight of the particle material, and v the particle velocity. The quantity K contains target material parameters and has not been evaluated, as yet. Qualitative observations of ionization produced from thin foil impacts have also been made. Author

N63-21344 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A CONTRIBUTION TO THE THEORY OF CRITICAL INCLINATION OF CLOSE EARTH SATELLITES

Shinko Aoki Sept. 1963 34 p 13 refs

(NASA TN D-1858) OTS: $1.00

A higher order theory of the motion of close satellites in the vicinity of the critical inclination is developed for the case of small eccentricity as well as moderate eccentricity. Terms up to the third order of magnitude are included for a potential which is plane symmetrical. It is shown that solutions up to this order can be obtained by using only Jacobian elliptic functions for the case of small eccentricity. For moderate eccentricity, elliptic integrals of the second kind or the Jacobian zeta-function are required. To obtain further approximations, elliptic integrals of the third kind are necessary for the case of

small eccentricity; but, for the case of moderate eccentricity, only the Jacobian elliptic functions and elliptic integrals of the second kind are required. The solutions are, in general, periodic functions, as is well known from the form of the equations of motion. Author

N63-21897 National Aeronautics and Space Administration. Washington, D.C.

RESEARCH STUDY ON THE ACCELERATION HODOGRAPH AND ITS APPLICATION TO SPACE TRAJECTORY ANALYSIS [Final Report]

Washington, NASA, Sept. 1963 90 p 31 refs
(NASA Contract NASw-565)
(NASA CR-19) OTS: $2.25

In this study, the acceleration hodograph was used to obtain transformed equations of motion for a propelled space vehicle subject to the gravitational attraction of one major celestial body in two-dimensional space. Basic definitive relations were determined, which are convenient for thrust program synthesis and trajectory analysis. Author

N63-22113 National Aeronautics and Space Administration. Washington, D.C.

THE PLASMA IN INTERPLANETARY SPACE

L. Biermann (Max-Planck-Inst. fur phys. und Astrophys.) Oct. 1963 20 p refs Presented at NASA Goddard Space Flight Center Colloq., Oct. 17, 1961, Greenbelt, Md. (NASA TN D-1901) OTS: $0.50

Interplanetary plasma, including the various lines of evidence for it, is described. This is followed by an account of the structure and composition of comets with emphasis on the ionized tails. The characteristics of these tails are explained by their interaction with a "solar wind" type plasma. Cometary phenomena bearing on the spatial and temporal distribution and dynamics of the plasma are discussed. A space experiment consisting of the formation of an artificial plasma cloud whereby these ideas could be tested and the plasma further investigated is described. Calculations indicate that the release of about 100 grams of barium at 200,000 km could be observed. Author

N63-23124 National Aeronautics and Space Administration. Washington, D.C.

METEOROID EFFECTS ON SPACE EXPLORATION

Maurice Dubin Oct. 1963 18 p 34 refs Presented at the IAS Natl. Meeting on Manned Space Flight, St. Louis, Mo., Apr. 30-May 2, 1962 Submitted for Publication
(NASA TN D-1839) OTS: $0.50

Available information concerning meteoroids and cosmic dust obtained from ground based observations and satellite measurements is reviewed. These data are presently limited to meteoroids and cosmic dust with heliocentric orbits intersecting the plane of the ecliptic at 1 au and interacting with the earth-moon system. From such information, the expectation of the number of impacts with interplanetary matter as a function of exposed spacecraft surface area exposure time, and meteoroid mass is presented. An estimate of the hazard has been made using appropriate hypervelocity cratering criteria. Author

N63-23708 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A THEORETICAL MODEL FOR SUNSPOT COOLNESS

R. K. Jaggi Washington, NASA, Oct. 1963 17 p refs
(NASA TN D-1906) OTS: $0.50

A theoretical model is developed for the behavior of sunspots as individuals. Two models, called the current sheath model and the snowplow model, known in the theory of the pinch effect, are worked out for the present problem of the sunspot expansion. Using the observational fact that the magnetic field of the sunspots grows to about 3,000 G in about ten days, numerical calculations based upon the current sheath model show that the sunspot area grows with the magnetic field and begins to pulsate when the magnetic field stops growing. The amplitude and frequency of oscillation depend upon the mass in the current sheath and the maximum magnetic field. The model suggests that the bright ring about the sunspots may exist at chromospheric height where the density of the material is about 10^9 particles/cm^3. Author

30 SPACE VEHICLES

Includes launch vehicle-spacecraft combinations; missile systems; operating problems; safety devices; and stability and control. *For boosters and launch vehicles see*: 31 Space Vehicles (Launch Vehicles). *For related information see*: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-10736 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

USE OF AN INERTIA SPHERE TO DAMP THE ANGULAR MOTIONS OF SPINNING SPACE VEHICLES

Jerrold H. Suddath Washington, NASA, 1962 14 p 6 refs
(NASA TR R-137) GPO: $0.30

The general moment equations for a spin-stabilized vehicle with an inertia-reaction angular rate damper were considered, and it was noted that simplification would result if the damper had a spherical inertia distribution. A control system incorporating such a damper was postulated. The resulting equations were linearized, and conditions for stability were obtained from an analysis of the cubic characteristic equation. Two numerical examples were included. Author

N63-10795 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYSIS OF THE CONING MOTIONS OF THE FINAL STAGES OF THREE NASA SCOUT DEVELOPMENT VEHICLES

George R. Young and James J. Buglia Washington, NASA, Dec. 1962 30 p 8 refs
(NASA-TN-D-1396) OTS: $0.75

A simplified analysis has been used to study the coning motions produced by separation disturbances of the final stages of three NASA Scout development vehicles. Normal, longitudinal, and transverse accelerometers, magnetometers, and antenna patterns, along with radar data, were utilized in the study. The results are given in terms of the calculated initial disturbing impulses required to give the stage a resultant flight-path deviation. The results indicated that Scout ST-2 received no discernible tipoff of the fourth stage, but Scouts ST-4 and ST-6 received initial disturbing impulses of at least 6.3 pound-seconds and 7.5 pound-seconds, respectively. Author

N63-10797 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LANDING CHARACTERISTICS OF A WINGED REENTRY VEHICLE WITH ALL-SKID LANDING GEAR HAVING YIELDING-METAL SHOCK ABSORBERS

Ulysse J. Blanchard Washington, NASA, Dec. 1962 45 p 5 refs
(NASA TN D-1496) OTS: $1.25

Landing-impact and slideout tests were made with a 1/10-scale dynamic model of a winged reentry vehicle landing on a hard-surface runway. An all-skid tricycle landing gear having yielding-metal energy straps was investigated. Results showed good landing characteristics over a wide range of landing conditions. Author

N63-11122 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SIMULATOR STUDY OF AN ACTIVE CONTROL SYSTEM FOR A SPINNING BODY

James J. Adams Washington, NASA, Dec. 1962 21 p 1 ref (NASA TN D-1515) OTS: $0.50

Model simulator tests of an automatic precession-wheel damping controller for a spinning vehicle have been made by using an inertial simulator mounted on an air bearing. The results show that this type of controller provides very good wobble damping and also provides the torque necessary to keep the vehicle spinning on its body axis of symmetry in the presence of a shift in the principal axes. The tests were made with the simulator in disk-, sphere-, and rod-shaped configurations. Author

N63-11986 National Aeronautics and Space Admininstration. Langley Research Center, Langley Station, Va.

ENVIRONMENTAL PROBLEMS OF SPACE FLIGHT STRUCTURES. II. METEOROID HAZARD

John R. Davidson and Paul E. Sandorff Washington, NASA, Jan. 1963 75 p 102 refs Prepared in collaboration with the NASA Research Advisory Comm. on Missile and Space Vehicle Structures For Part I., "Ionizing Radiation in Space and its Influence on Spacecraft Design", see N62-16103 16-28

(NASA TN D-1493) OTS: $2.00

The meteoroid environment and the effects of hypervelocity impact on space vehicles are described, and the effects of the incompleteness of present knowledge of each are discussed. The overall problem of the meteoroid hazard is evaluated and methods of eliminating the probability of meteoroid damage are given. A partial listing of typical research projects on meteoroid-environment and hypervelocity-impact problems is presented. Author

N63-12195 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

FEASIBILITY OF APPLYING FIELD-ION EMISSION TO ELECTROSTATIC ROCKET ENGINES

N. Stankiewicz Washington, NASA, Jan. 1963 22 p 8 refs (NASA TN D-1563) OTS: $0.75

The W.K.B. method was used to determine the ionization lifetimes of hydrogen, lithium, sodium, rubidium, cesium, and xenon in an applied electric field. These lifetimes were used in the analysis of a theoretical plane-diode engine consisting of a grid emitter that field-ionizes the impinging propellant. Results show that monatomic gaseous propellants are not suitable for field-ion emission engines of this design because of the excessively high voltage requirements for ionization. Author

N63-12246 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF THE LATERAL VIBRATION CHARACTERISTICS OF A 1/5-SCALE MODEL OF SATURN SA-1

John S. Mixson, John J. Catherine, and Ali Arman Washington, NASA, Jan. 1963 66 p 4 refs

(NASA TN D-1593) OTS: $1.75

Resonant frequencies and associated mode shapes, and damping of the model were determined at weight conditions simulating five points in the launch trajectory of the full-scale vehicle. The model was supported in a vertical position by a two-cable suspension system to simulate the free-free condition. The results show the unusual frequency spectrum and mode shapes associated with the clustered configuration of the Saturn SA-1 launch vehicle. In some modes, the booster tank deflections at a particular station are all approximately the same; these modes are similar to more conventional bending modes. In other modes, however, the booster outer tanks deflect in the opposite direction from the center tank; these unusual modes are termed cluster modes. Author

N63-13188 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STUDY OF THE EFFECTS OF BANK ANGLE, BANKING DURATION, AND TRAJECTORY POSITION OF INITIAL BANKING ON THE LATERAL AND LONGITUDINAL RANGES OF A HYPERSONIC GLOBAL REENTRY VEHICLE

Gene W. Sparrow Washington, NASA, Mar. 1963 25 p 2 refs (NASA TN D-1617) OTS: $0.75

An investigation has been made to determine the effect of banking position, bank angle, and banking duration on the lateral and longitudinal ranges of a hypersonic lifting reentry vehicle of global-range capability entering the atmosphere of a rotating oblate earth. Two schemes for controlling the angle of attack are used. Results indicate that banking the vehicle during the first half of a global-range reentry results in relatively large losses of longitudinal range without any appreciable gain in lateral range. In addition, it is found that lateral range can be obtained with less loss of longitudinal range if the scheme of using a small bank angle and an extended banking duration are used. A lift scheme which allows the angle of attack to increase during banking so that the vertical force does not decrease is not found to be as satisfactory as the constant angle-of-attack lift scheme because of relatively large losses of longitudinal range and reduced lateral-range capability. Author

N63-14626 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A SURVEY OF LARGE SPACE CHAMBERS

R. T. Hollingsworth Washington, NASA, Apr. 1963 15 p

(NASA TN D-1673) OTS: $0.50

Construction has been authorized for a number of large thermal-vacuum chambers to simulate orbital altitudes in the environmental testing of complete spacecraft. The proposed facilities shall be capable of simulating the low temperatures, solar and earth radiation, and vacuum of outer space. Outlined in this report are the individual specifications and capabilities of each of the proposed space-simulation facilities. Since the field of space simulation is growing rapidly, it is recognized that this survey will be out of date upon issue. Author

N63-15302 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.

THEORETICAL STABILITY ANALYSIS OF SKID-ROCKET LANDINGS OF SPACE VEHICLES

Robert W. Frahlich and Edwin T. Kruszewski Washington, NASA, Apr. 1963 19 p 2 refs

(NASA TN D-1625) OTS: $0.50

The governing equations for an arbitrary rigid body sliding on a landing surface are used to derive a stability criterion which relates the critical values of initial velocities to the coefficient of friction, center-of-gravity location, and initial angle-of-contact. A numerical application of the stability criterion is made for a vehicle used in an experimental investigation. Author

N63-15305 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.

INVESTIGATION OF THE SKID-ROCKER LANDING CHARACTERISTICS OF SPACECRAFT MODELS

Sandy M. Stubbs Washington, NASA, Apr. 1963 39 p 3 refs (NASA TN D-1624) OTS: $1.00

An experimental investigation was made of the skid-rocker landing characteristics of two dynamic models of proposed reentry vehicles. A "belly-landing" technique in which the vehicle was caused to skid and rock on its curved lower surface (heat shield) in order to convert sinking-speed energy into angular energy was investigated on a hard-surface runway for speed ranges that might be encountered with the use of a paraglider letdown system. Several landings were also made in calm water. Landing motions and acceleration data were obtained over a range of landing attitudes, horizontal velocities, and vertical velocities. Turnover stability limits for various center-of-gravity locations were determined for hard-surface landings. A brief experimental study was made of the effect of a small edge-mounted shock absorber on accelerations and rocking motions. Acceptable hard-surface landings could be made with all the configurations at landing attitudes between - 30° and 10°. For bodies of short length and high center of gravity, the possibility of converting sinking-speed energy into angular energy was substantially limited because of the instability (turnover) at landing attitudes greater than 10°. The landings resulted in maximum normal and angular accelerations of 15g and 70 radians per second^2, respectively, over a range of landing conditions. Water landings were satisfactory at horizontal landing velocities of 50 and 80 feet per second. Landings at 130 feet per second resulted in violent rebound at first impact followed by random impacts and high accelerations. Author

N63-15347 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

CALCULATED RESULTS FOR THE TRANSIENT HEATING AND MELTING PROCESS OF GLASS SHIELDS WITH VARIOUS MATERIAL PROPERTIES AT THE STAGNATION POINT OF A RE-ENTERING ICBM

John D. Warmbrod. Washington, NASA, May 1963. 28 p. 12 refs.
(NASA TN D-1643) OTS: $0.75

The transient performance in the vicinity of the stagnation point of ablation type glass heat-protection shields is presented for an ICBM that experienced high instantaneous ablation rates while reentering the atmosphere of the earth. The vehicle had a ballistic factor of 1000 lb ft^2 and reentered at a speed of 7226 m/sec. at an altitude of 150 km, and at an angle of 114° measured from the vertical. By the use of an exact numerical calculation method, transient ablation results for 26 hypothetical glass shields, each with a different set of thermal properties, are presented. The effect that the material properties of glass have on the performance parameters of the heat shields was investigated. It was found that the following trend of the glass thermal properties would tend to provide the lightest glass heat-protection shield for the vehicle: (1) a small thermal diffusivity $k/\gamma c_p$, (2) a high viscosity level, i.e., a large resistance to melting, and (3) a large emissivity constant of the supposedly opaque glass. It was found that the vaporization of the glass had very little effect on the necessary weight of the ablation-type shields. Author

N63-15473 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

STUDY OF INERTIAL NAVIGATION ERRORS DURING REENTRY TO THE EARTH'S ATMOSPHERE

Q. Marion Hansen, John S. White, and Albert Y. K. Pang. Washington, NASA, May 1963. 53 p. 8 refs.
(NASA TN D-1772) OTS: $1.50

The navigation errors in position and velocity which result from erroneous initial conditions and imperfect inertial navigation equipment have been analyzed for a space vehicle reentering the earth's atmosphere. The analysis has shown that, for realistic errors and reentry conditions, a linear error analysis will usually be valid; that is, the partial derivatives of final position and velocity with respect to initial conditions and equipment parameters may be treated as constants. Also, the analysis has demonstrated that these partial derivatives can be used to estimate the final errors which result from using various combinations of initial condition and equipment errors with the inertial navigation process started at various times before reentry. It was found that, when the inertial navigation process is started just prior to reentry, the final errors resulting from initial condition errors predominate, but, when started well before reentry, the final errors resulting from equipment errors predominate. Initial altitude error is the most significant initial-condition error, and accelerometer bias and gyro drift are the most significant equipment errors. The final errors due to accelerometer bias may be greatly reduced by treating the outputs of the accelerometers as zero above the atmosphere. Author

N63-15775 National Aeronautics and Space Administration, Washington, D.C.

AN APPLICATION OF TIME-OPTIMAL CONTROL THEORY TO LAUNCH VEHICLE REGULATION

F. B. Smith, Jr. and J. A. Lovingood (Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.). May 1963. 23 p. 9 refs.
(NASA Contract NASr-27)
(NASA TN-D-1895) OTS: $0.75

A minimum response-time criterion is used in the design of a pitch-attitude controller for a flexible launch vehicle. The criterion is applied to a fourth-order model containing the primary dynamics of the thirteenth-order vehicle. A collection of open-loop optimal trajectories is used to define a closed-loop control law. Results of an analog simulation are presented which show that this control law properly applied to the flexible vehicle results in good control. Author

N63-16159 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio

BASE HEAT TRANSFER, PRESSURE RATIOS, AND CONFIGURATION EFFECTS OBTAINED ON A 1/27 SCALE SATURN (C-1) MODEL AT MACH NUMBERS FROM 0.1 TO 2.0

John L. Allen and Robert A. Wasko. Washington, NASA, May 1963. 68 p. 10 refs.
(NASA TN-D-1566) OTS: $1.75

Heat fluxes at the nozzle-exit plane between the inboard engines varied from 40 to between 300 and 400 Btu/(sq ft)(sec) (for wall temperature of 100° F). On the base shield at the nozzle-throat plane, heat flux varied considerably with configuration, location, and operating conditions. In general, the heat flux was increased by discharging simulated turbopump gases through exhausterators around the outboard engines, and through stacks in the shroud surface that extended less than one-third of the local boundary-layer height. A recessed-base configuration having appreciable base bleed reduced heat fluxes over the Mach number range 0.8 to 2.0 from values between 80 and 20 to less than 5 Btu/(sq ft)(sec) (all at 100° F wall temperature). Author

N63-16294 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

HEAT-TRANSFER AND PRESSURE DISTRIBUTIONS AT MACH NUMBERS OF 6.0 AND 9.6 OVER TWO REENTRY CONFIGURATIONS FOR THE FIVE-STAGE SCOUT VEHICLE

Paul F. Holloway and James C. Dunavant. Washington, NASA, May 1963. 52 p. 11 refs.
(NASA TN-D-1790) OTS: $1.50

Wind-tunnel heat-transfer and pressure distributions have been obtained over two blunt-cone reentry configurations for an angle-of-attack range of 0° to 30° at a Mach number of 6.0, and 0° to 25° at a Mach number of 9.6. The pressure distributions have been compared with modified Newtonian theory for the full angle-of-attack range. The heat-transfer distributions at an angle-of-attack of 0° are compared with the theory of Lees. Some comments on heat-transfer distributions and the stagnation-point heating level are included. Author

N63-16298 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

THEORETICAL INVESTIGATION OF THE SLIDEOUT DYNAMICS OF A VEHICLE EQUIPPED WITH A TRICYCLE SKID-TYPE LANDING-GEAR SYSTEM

Richard B. Noll and Robert L. Halasey Washington, NASA, May 1963 32 p 14 refs

(NASA TN-D-1828) OTS: $1.00

The equations-of-motion for the slideout of a vehicle equipped with a tricycle skid-type landing-gear system are presented and reduced to three degrees of freedom. A comparison of the results of numerical calculations for the three-degree-of-freedom slideout of the X-15 research vehicle with flight-test results shows that the theoretical analysis of the slideout can adequately predict the slideout distance, the direction of lateral displacement, and the approximate lateral displacement. A numerical study of the slideout equations indicates that the velocity at which the aerodynamic influence on the vehicle becomes negligible can be predicted. Author

N63-16991 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LONGITUDINAL RANGE ATTAINABLE BY THE CONSTANT-ALTITUDE VARIABLE-PITCH REENTRY MANEUVER INITIATED AT VELOCITIES UP TO ESCAPE VELOCITY

E. Brian Pritchard Washington, NASA, June 1963 80 p 10 refs

(NASA TN D-1811) OTS: $2.00

The vehicles considered operate on Newtonian drag polars and vary in maximum lift-drag-ratio capability from 0 to 2, and vehicle ballistic parameter from 10 to 200 pounds per square foot. The maneuver altitude variation was 150,000 to 240,000 feet. Considerably longer ranges are shown to be available if the constant-altitude maneuver is controlled by pitch variation rather than by roll variation with the vehicle trimmed at maximum lift-drag ratio. The angle-of-attack rates required are defined. For a maximum lift-drag ratio less than 0.8, a good approximation to the attainable range is obtained by assuming an elliptic variation of drag coefficient with time. Author

N63-18132 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ARREST OF A MOVING MASS BY AN ATTACHED MEMBRANE

Manuel Stein Washington, NASA, July 1963 14 p

(NASA TN D-1928) OTS: $0.50

Large-deflection solutions are obtained for a fixed-end membrane strip and for a fixed circular membrane, each with a centrally located attached mass initially moving at a given speed. The solutions are given in the form of equations and curves for the deflections and stresses. Author

N63-18210 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLIGHT TEST OF A PITCH CONTROL FOR A SPINNING VEHICLE

H. D. Garner and H. J. E. Reid, Jr. Washington, NASA, July 1963 14 p refs

(NASA TN D-1922) OTS: $0.50

A flight test was made of a simple single-axis attitude-control system for the fourth stage of a spin-stabilized vehicle. The system utilized two body-fixed horizon detectors for attitude sensors, a single rate gyro for stability augmentation, and a single jet for control. It weighed less than 18 pounds, including batteries and control-jet gas. Flight results showed the attitude error to be less than $\pm 1/2°$, and the coning angle to be less than $\pm 2°$ throughout the test period. Very close correlation was obtained between actual flight-test results and preflight computer studies. Author

N63-18772 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF THE LANDING CHARACTERISTICS OF A REENTRY VEHICLE HAVING A CANTED MULTIPLE-AIR-BAG LOAD-ALLEVIATION SYSTEM

Sandy M. Stubbs and John R. Mc Gehee Washington, NASA, Aug. 1963 20 p 4 refs

(NASA TN-D-1934) OTS: $0.50

An investigation has been made to determine the landing-impact characteristics of a reentry vehicle having a multiple-air-bag load-alleviation system. A 1/16-scale dynamic model having four canted air bags was tested at flight-path angles of 90° (vertical), 45°, and 27° for a parachute or paraglider vertical letdown velocity of 30 feet per second (full scale). Landing for an attitude range between $-15°$ and 12° gave peak accelerations from 6g to 10.5g units, and maximum onset rates to peak accelerations of 66g per second or less. For landings made at high positive attitudes (15° and 20°), bottoming occurred, and peak normal accelerations were 12 to 15g units. Horizontal velocity had little effect on landing accelerations. The landing behavior was satisfactory for all conditions tested. The canted bags were effective in overcoming the effect of the friction forces resulting from horizontal velocity. Good agreement was obtained between experimental and computed time-history acceleration curves for the 90° flight path, 0° attitude test condition. Author

N63-19180 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STUDY OF A GUIDANCE SCHEME USING APPROXIMATE SOLUTIONS OF TRAJECTORY EQUATIONS TO CONTROL THE AERODYNAMIC SKIP FLIGHT OF A REENTRY VEHICLE

Robert S. Dunning Washington, NASA, Aug. 1963 34 p 4 refs

(NASA TN D-1923) OTS: $1.00))

Approximate closed-form solutions to the reentry equations are developed by assuming that the difference between the centrifugal and gravitational accelerations is negligible. The approximate solutions are valid in the exit-velocity range between approximately 23,000 and 26,000 feet per second. A numerical comparison is made between the approximate and exact solutions for six typical trajectories. The results indicate good agreement with complete convergence occurring at the skipout condition within a reasonable flight corridor. Approximate explicit equations governing coasting flight after a skip maneuver are also developed and compared with the exact solutions. A guidance scheme employing these equations is described, and results are presented from a two-dimensional digital-computer simulation of this scheme. Emphasis is placed on simplicity and speed of computation. The results indicate satisfactory control to exit from the atmosphere over ranges from approximately 70° to 200° about the center of the earth. Author

N63-19609 National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center

CONTROL OF A LARGE LAUNCH VEHICLE WITH LIMITED THRUST VECTORING IN THE PRESENCE OF WINDS

Dennis F. Collins, Jr. and Homer G. Morgan Washington, NASA, Aug 1963 27 p 7 refs

(NASA TN D-1951) OTS: $0.75

A large launch vehicle with limited thrust vectoring was analytically flown through two synthetic wind profiles to determine the vehicle's controllability when the aerodynamic upsetting moment temporarily exceeded the control moment. Results indicate that the vehicle is able to recover from the temporary instability resulting from large wind disturbances. Thus, an additional safety factor is present for a control system that has been designed with adequate thrust vectoring to maintain control for specified wind and payload conditions. It is shown that

for a given vehicle flying through a given wind profile, there is some minimum value of limit thrust-vector rotation angle, independent of control-system gains, below which the vehicle is always divergent. Author

N63-19735 National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center

THE EFFECT OF SOLAR RADIATION PRESSURE ON THE SPIN OF EXPLORER XII

F. V. Fedor Washington, NASA, Aug 1963 16 p 5 refs (NASA TN D-1855) OTS: $0.50

An equation-of-motion about a satellite spin axis is derived that includes solar-radiation torques produced by a solar-paddle array. The equation is applied to the Explorer XII and solved to explain the observed increase in the satellite spin. Also, an approximate equation is developed which permits rapid calculation of the effect of solar torques on satellite spin. Author

N63-23362 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

DYNAMIC RESPONSE OF RISING AND FALLING BALLOON WIND SENSORS WITH APPLICATION TO ESTIMATES OF WIND LOADS ON LAUNCH VEHICLES

Wilmer H. Reed, III Washington, NASA, Oct. 1963 33 p refs (NASA TN D-1821) OTS: $1.00

An analytical evaluation is made of the capabilities of balloon wind sensors to respond to detailed variations in the wind structure of the atmosphere, which can represent important load inputs for flexible launch vehicles. Both rising and falling spherical balloons are considered. It is found that for a balloon of given weight there is an optimum diameter for which the balloon response velocity is most sensitive to variations in the profile of horizontal winds. When the diameter of the balloon is larger than this optimum value, the advantages of reducing the balloon weight to improve its dynamic response become relatively insignificant. The apparent mass of ambient air surrounding the balloon is found to be of considerable importance at lower altitudes, where launch vehicles often encounter maximum aerodynamic loads. Author

N63-23652 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

FLIGHT TEST AND ANALYSIS OF THE ROLLING MOTIONS OF A 79° CLIPPED DELTA CONFIGURATION WITH WING-TIP FINS AT SUPERSONIC SPEEDS

James L. Raper Washington, NASA, Nov. 1963 56 p refs (NASA TN D-2017) OTS: $1.50

A free-flight investigation was conducted to determine the aerodynamic characteristics and motions of a rocket-boosted model of a simplified hypersonic glider configuration with wing-tip fins and a blunt base through a Mach number range extending up to 4.4. The model was statically and dynamically stable at small angles-of-attack, and experienced coupled motions when pitched to an angle-of-attack of about 12°. The addition of the wing-tip fins resulted in no improvement of the vehicle motions compared with the same vehicle with no fins. In general, the coupled motions experienced by the model were simulated by the use of the equations of motion for five degrees of freedom. Author

31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes boosters; clustered rockets; and multistage rockets. *For propulsion engines see*: 27 Propulsion. *For manned space capsules, satellites, and sounding rockets and space probes see*: 32 Space Vehicles (Spacecraft). *For launch vehicle-spacecraft combinations see*: 30 Space Vehicles. *For related information see*: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-10712 National Aeronautics and Space Administration, Washington, D. C.

LAUNCH VEHICLES OF THE NATIONAL LAUNCH VEHICLE PROGRAM

James E. Webb Nov. 1962 34 p

(NASA SP-10) Available from NASA. Office of Scientific and Technical Information, Washington, D. C.

The launch vehicles of the National Launch Vehicle Program are described. The information given for each vehicle includes: number of stages, propellants, thrust, maximum diameter, height, payload weight, first launch date, and vehicle use. The vehicles covered are: the Scout, Delta, Thor-Agena B, Atlas D, Atlas-Agena B, Titan II, Titan III, Centaur, Saturn, Advanced Saturn, and Nova. R.C.M.

N63-13548 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

PERFORMANCE AND SOME DESIGN ASPECTS OF THE FOUR-STAGE SOLID-PROPELLANT ROCKET VEHICLE USED IN THE RAM A1 FLIGHT TEST

Jack Levine Washington, NASA, Mar. 1963 50 p 10 refs (NASA TN D-1611) OTS: $1.25

A general description, some details of mechanical design and construction, and performance (including angle of attack of the rolling last stage) of a four-stage solid-propellant rocket system used in the RAM (Radio Attenuation Measurement) A1 flight test are presented. The fourth stage attained a maximum velocity of 17,800 feet per second at an altitude of 175,000 feet. Temperature data on the nose cone are also discussed. Author

N63-14025 National Aeronautics and Space Adminstration, Marshall Space Flight Center, Huntsville, Ala.

LAUNCH DEFLECTOR DESIGN CRITERIA AND THEIR APPLICATION TO THE SATURN C-1 DEFLECTOR

R. L. Evans and O. L. Sparks Washington, NASA, Mar. 1963 39 p 6 refs

(NASA TN D-1275) OTS: $1.00

Theoretical considerations pertinent to the successful design of dry-launch deflectors for super boosters are presented. Deflector configurations of many types, together with the particular configuration used in the launching of the C-1 Saturn booster, are described. It is concluded that the dry deflector can be successfully used to launch super boosters. In particular, it is predicted that the Saturn deflector may be used unlimitedly without the necessity of extensive overhaul and repairs. Author

N63-15694 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF SEVERAL FIFTH-STAGE SCOUT REENTRY VEHICLES FROM MACH NUMBER 0.60 TO 24.4 INCLUDING SOME REYNOLDS NUMBER EFFECTS ON STABILITY AT HYPERSONIC SPEEDS

Patrick J. Johnston. Washington, NASA, May 1963. 66 p. 8 refs. (NASA TN D-1638) OTS: $1.75

Longitudinal static stability investigations of several proposed configurations of the fifth-stage Scout reentry vehicle have been conducted in the the Mach number interval from 0.60 to 24.4. The results were summarized to show the effect of varying Mach number on the normal-force-curve slope and zero-lift center of pressure. The effect on longitudinal stability of limited variations in nose shape as well as afterbody geometry were determined at a Mach number of 6.8. The low-angle-of-attack stability of one configuration was examined to determine whether the test results obtained in helium were representative of those obtained in air at Mach numbers near 20. Of the three parameters investigated (Mach number, Reynolds number, and specific heat ratio of the test medium), it appeared that Reynolds numbers had the greatest effect on longitudinal stability at low angles-of-attack. Author

N63-15779 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ORBITAL ERROR ANALYSIS OF THE SCOUT RESEARCH VEHICLE

C. H. Woodling, Jarrell R. Elliott and Paul J. Stull. Washington, NASA, May 1963. 53 p. 1 ref.
(NASA TN-D-1639) OTS: $1.50

A statistical error analysis has been made of the orbital-accuracy capability of the Scout research vehicle. Twenty-six independent error sources were included in the analysis. Orbital-altitude error bands were determined for three nominal circular orbits at altitudes of 120, 300, and 600 nautical miles. In addition, for the 300-nautical-mile mission, a detailed examination was made of the effects of the separate errors; predominant error sources were determined, and an analysis was made of the effect on the orbital accuracy of injecting into the orbit with a velocity greater than that for circular. Also, a method for determining an enclosed area in apogee–perigee space (within which approximately 95 percent of all orbits will occur) is described and applied to the 300-nautical-mile mission. The results from this analysis indicate that the 95-percent-probability or 2σ error bands for the 120-, 300-, and 600-nautical-mile nominal circular orbits have maximum variations from the nominal altitudes of approximately ± 100, ± 110, and ± 150 nautical miles, respectively. It was found that these error bands are critically dependent upon the fourth-stage tip-off error, and will be appreciably less if the present fourth-stage separation system can be shown to have a 2σ value for tip-off of less than the 3.5° assumed in this analysis. For example, for the 300-nautical-mile mission, the maximum uncertainty in orbital altitude of a 95-percent basis is reduced to ± 85 nautical miles for a 2σ value of tip-off of about 2°. The results also indicate that the overall orbital accuracy of the Scout vehicle cannot be significantly improved, exclusive of tip-off, until the rocket parameters (specific impulse, propellant weight, and propellant burning rate) can be defined to within smaller variations than those assumed for this analysis. The effect of injecting into the orbit with a velocity greater than that for circular was found to reduce considerably the uncertainties about the minimum orbital altitude (the perigee of the orbit). Author

N63-19607 National Aeronautics and Space Administration. Langley Station, Va. Langley Research Center

FREE-FLIGHT INVESTIGATION OF THE DEPLOYMENT, DYNAMIC STABILITY, AND CONTROL CHARACTERISTICS OF A 1/2-SCALE DYNAMIC RADIO-CONTROLLED MODEL OF A LARGE BOOSTER AND PARAWING

Sanger M. Burk, Jr. Washington, NASA, Aug. 1963. 20 p. 7 refs.
(NASA TN D-1932) OTS: $0.50

Satisfactory deployment of a folding rigid member parawing from a parachute-stabilized rocket booster was shown. A center-of-gravity movement system was employed for control. Author

N63-21887 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ASYMMETRIC "PENSHAPE" NOZZLES IN JET-CANARD CONFIGURATIONS FOR ATTITUDE CONTROL

Robert W. Cubbison. Washington, NASA, Sept. 1963. 28 p. 3 refs.
(NASA TN D-1561) OTS: $0.75

For attitude control of all stages of a multistage vehicle a jet-canard configuration mounted on the uppermost stage with asymmetric external-expansion "penshape" nozzles may be considered. Such a nozzle has been investigated in the 2-ft by 2-ft supersonic wind tunnel. Data were obtained in quiescent air and at a Mach number of 3.88 for a nozzle pressure-ratio range of 10 to 1000 and simulated chamber pressures up to 600 psi absolute. Nozzle-flow-discharge angles ranging from 0° to 90° (relative to the body axis) were obtained by using different-angle nozzle units. The off-design thrust characteristics were essentially constant at 98 percent of ideal values for pressure ratios of 20 to the design value of 98. Body-surface pressure distributions indicated disturbances that extended 3 to 4 body diameters downstream of the nozzle throat when the exit flow was discharged parallel to the body axis. Flow-discharge angles of 13.5° or more produced little or no interaction with the body surface. With single-jet operation, the maximum steering moments (presented in parametric form) ranged from 0.2 to 0.73 as the flow-discharge angle was increased from 0° to 90°. Compared with single-jet operation, moments produced by differential fin rotation were about 25 percent less. Author

N63-21891 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE STATIC AERODYNAMIC CHARACTERISTICS OF SEVERAL CONFIGURATIONS OF THE BLUE SCOUT LAUNCH VEHICLE

Thomas C. Kelly and Robert J. Keynton. Washington, NASA, Sept. 1963. 43 p. 7 refs.
(NASA TN D-1958) OTS: $1.25

The investigation was conducted in the Langley 8-foot transonic pressure tunnel at Mach numbers from 0.60 to 1.03 and at a Reynolds number per foot of approximately 3.7×10^6. Results are presented showing the effects of fins, protuberances (antennas, wiring conduits, and launch fitting), first-stage base flare angle, and, for the basic configuration, fin-tip control deflection. Both longitudinal and lateral characteristics are presented. Author

N63-21892 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SURFACE PRESSURE DISTRIBUTIONS ON 0.0628-SCALE MODELS OF PROPOSED PROJECT FIRE SPACE VEHICLES AT MACH NUMBERS FROM 0.25 TO 4.63

Albin O. Pearson. Washington, NASA, Sept. 1963. 166 p.
(NASA TN D-1961) OTS: $3.00

Pressure distributions over the surface of 0.0628-scale models of a preliminary and a modified Project Fire space vehicle have been determined at Mach numbers from 0.25 to 4.63. Data are presented for the models at angles-of-attack from $-8°$ to 8°. Author

N63-23123 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

FLIGHT VIBRATION DATA FROM THE DELTA 9 LAUNCH VEHICLE

Lloyd A. Williams Washington, NASA, Oct. 1963 24 p 2 refs (NASA TN D-1683) OTS: $0.75

Vibration data for the three principle axes of the payload support structure were obtained from liftoff through third-stage motor burnout. Maximum vibration levels during first- and second-stage burning occurred at liftoff, staging, and fairing jettison with low levels between events. The maximum composite vibration levels for first- and second-stage burning were 2.5 g peak and 1.9 g peak for the thrust and lateral axes, respectively, and occurred at liftoff. The third-stage motor exhibited the normal resonant burning characteristics for this type of motor, that is, the tangential and longitudinal modes caused by acoustical cavity resonances. However, since this phenomenon is already well documented, the primary purpose of this vibration experiment was to record low-frequency high-stress amplitude vibration. Consequently, the measuring systems were set up to measure low-level first- and second-stage modal vibrations. Author

32 SPACE VEHICLES (SPACECRAFT)

Includes manned space capsules; satellites; and sounding rockets and space probes. *For boosters and launch vehicles see*: 31 Space Vehicles (Launch Vehicles). *For launch vehicle-spacecraft combinations see*: 30 Space Vehicles. *For related information see*: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-10328 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LATERAL RANGE CONTROL BY BANKING DURING INITIAL PHASES OF SUPERCIRCULAR REENTRIES

Donald L. Baradell (M.S. Thesis—V.P.I.) Washington, NASA, Nov. 1962 28 p 4 refs
(NASA TN D-1511) OTS: $0.75

The feasibility of increasing the lateral range capability of reentry vehicles having low-lift-drag ratios, by allowing the vehicle to reenter in a banked attitude, is investigated. The effects of such banked reentries on allowable reentry corridor width and on lateral range capability are discussed. Numerical results are used throughout the investigation to furnish accurate evaluations of the effects being studied and to check the validity of some approximate relations presented. The heading-angle change developed during the initial pullup by a vehicle reentering in a banked attitude is shown to produce significant increases in the lateral range achieved during reentry. Emphasis is placed on reentry at escape velocity, but the results also apply in character to reentry at other supercircular velocities. Author

N63-10536 National Aeronautics and Space Administration. Washington, D. C.

A RELIABILITY MODEL AND ANALYSIS FOR PROJECT MERCURY—3-ORBIT MANNED AND UNMANNED MISSION

William Wolman and Fred Okano Dec. 1962 29 p 2 refs
(NASA TN D-1558) OTS: $0.75

Based on test data of parts, components, and subsystems, the probability of successfully completing the mission and the probability of flight safety were desired for the Project Mercury 3-orbit mission. The purpose is to give the development of a mathematical model, data requirements, and other assumptions used in the Mercury reliability evaluation. Although the model was developed for the evaluation of the Mercury mission, the approach is general and can be modified for other space system applications. Author

N63-10904 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STUDY OF ABORT FROM A MANNED LUNAR LANDING AND RETURN TO RENDEZVOUS IN A 50-MILE ORBIT

Jack A. White Washington, NASA, Dec. 1962 14 p 2 refs
(NASA TN D-1514) OTS: $0.50

Analytical and simulation studies were made of some of the problems associated with abort from landing and return to an orbiting vehicle in a 50-mile lunar orbit. The present study was concentrated on abort from a hovering condition at the lunar surface, and the results are also applicable to lunar takeoff trajectories. Author

N63-11990 National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

RESULTS OF THE THIRD UNITED STATES MANNED ORBITAL SPACE FLIGHT, OCTOBER 3, 1962

Washington, NASA, Dec. 1962 122 p 13 refs
(Proj. Mercury)
(NASA SP-12) GPO: $0.70

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N63-12062 National Aeronautics and Space Administration, Washington, D. C.

DIRECT MEASUREMENTS OF COSMIC DUST SHOWERS

W. M. Alexander, O. E. Berg (NASA Goddard Space Flight Center), and M. Dubin Jan. 1963 12 p 14 refs Presented at the Symposium on the Astronomy and Physics of Meteors, Smithsonian Astrophysical Observatory, Cambridge, Mass., Aug. 28 - Sept. 1, 1961
(NASA TN D-1544) OTS: $0.50

The Explorer I interplanetary dust stream was detected for about a 10-hour period beginning on February 2, 1958. The peak impact rate was nearly 50 times the average rate over the remainder of the 12-day period of the experiment. From the limited data it may be shown that this stream was nearly in the ecliptic in a direct heliocentric orbit. This shower does not correspond to a known annually recurring meteor shower. A second stream of interplanetary dust has been detected with satellites and a sounding rocket. This stream appears to recur annually with a peak intensity on November 17. It was first detected in 1955 from the Aerobee rocket and was recognized in the November 1959 data from the Vanguard III satellite. Preliminary analysis of the Explorer VIII data indicates that it probably was also detected in 1960. The dust-stream characteristics correspond to those of the Leonids which have a heliocentric velocity of 72 km/sec. The data supporting the detection of these two interplanetary dust streams are presented and discussed, and the physical significance of these measurements reviewed. Although direct measurements from satellites have been made over a period of about 4 months and during the time of other known meteor streams, only these two interplanetary dust streams have been detected thus far by direct measurements. Author

N63-12125 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE NIMBUS SPACECRAFT AND ITS COMMUNICATION SYSTEM AS OF SEPTEMBER 1961

Rudolf A. Stampfl Washington, NASA, Jan. 1963 53 p 10 refs (NASA TN D-1422) OTS: $1.50

The major objective of the Nimbus project is to provide a capability for continuous satellite weather observation for application to weather analyses and forecasting. The spacecraft and associated ground systems have been designed to meet this objective and are now under construction. The basic measurements to be obtained include global television picture coverage of daytime cloud cover and measurements of infrared and reflected radiation, and the earth's heat balance. This paper describes the fundamental design criteria, and conditions governing this design. The characteristics of the Nimbus vehicle and its major systems are discussed and their performance is defined. Author

N63-12252 National Aeronautics and Space Administration. Marshall Space Flight, Center, Huntsville, Ala.

JUNO II SUMMARY PROJECT REPORT. VOLUME II. THE S-46 SATELLITE

Arthur W. Thompson Washington, NASA, Dec. 1962 305 p refs (NASA TN D-608) $4.00

This volume covers those phases of the Juno II program dealing with initiation, planning, design, and construction of the S-46 payload and the unsuccessful attempt to place it in orbit about the earth. Subjects covered include the objectives of the S-46 project, system parameters, special considerations for the launching, structure of the flight unit, performance of the booster and upper stages during and after the firing, and the tracking operations. Design and construction of the S-46 mechanical system, transmitter, telemetry, electrical networks, and battery and solar cell power system are covered. The thermal design is also treated. One chapter is devoted to testing of components, modules, assemblies, prototype payloads, and actual flight units; applicable test procedures and specifications are included. The last chapter covers the State University of Iowa radiation experiment in the areas of history, instrumentation, apparatus fabrication, instrument calibration, apparatus operation during flight, and the results of the flight. Author

N63-13104 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE SOUTHERN SKY SURVEY PAYLOAD

Richard M. Windsor Washington, NASA, Feb. 1963 17 p 7 refs (NASA TN D-1719) OTS: $0.50

Four Skylark rockets were fired from Woomera Missile Range, Australia, to measure stellar fluxes and nebulosities at energy bands between 1050A and 2800A. The payloads contained two basic types of detector systems: photomultipliers for the spectral region between 1900A and 2800A, and ionization chambers for the 1050A to 1500A range. Data acquisition was optimized by a spin control gas jet system. Also described are the vehicle, field operations, and performance. Author

N63-14428 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

RESULTS OF MICROMETEORITE PENETRATION EXPERIMENT ON THE EXPLORER VII SATELLITE (1959 IOTA)

H. E. La Gow and L. Secretan Washington, NASA, Apr. 1963 9 p 5 refs

(NASA TN D-1722) OTS: $0.50

The results of a micrometeoroid penetration experiment aboard satellite 1959 IOTA (Explorer VII) are presented. The sensors and their arrangement aboard the satellite are described, and the telemetry record obtained during flight is analyzed critically. It is concluded that one penetration through one cell occurred on the 16th day, and that it was caused by a particle approximately 10 microns in diameter. Author

N63-15055 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

VEHICLE TECHNOLOGY CONSIDERATIONS FOR A SOLAR PROBE

John A. Foschetti Washington, NASA, Apr. 1963 15 p 4 refs (NASA TN D-1747) OTS: $0.50

This report demonstrates that solar probes are feasible from the viewpoint of presently planned vehicle technology. For the early attempts, the Saturn C-1 is considered to be the most likely vehicle to place the final stage or stages into a circular orbit. If two slightly modified but identical Centaur Jr. vehicles are used for the upper stages, then this four stage configuration will be capable of placing from 400 to 2500 pounds at perihelion distances of 0.120 to 0.245 A.U. A more reliable three-stage configuration, using one Centaur Jr. for the upper stage but requiring greater modification in the original design of the vehicle, would place payloads of 400 to 2500 pounds at perihelion distances of 0.185 to 0.290 A. U. Analysis of the upper stages was based on the payload value obtained for the Saturn vehicle by using the "Generalized Powered Flight Trajectory Program." At burnout, there would be a payload of 24,612 pounds in a 100-nautical-mile parking orbit Author

N63-15166 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE OBSERVATORY GENERATION OF SATELLITES Session II of a Special Astronautics Symposium held at Franklin Institute, Philadelphia, Dec. 27, 1962, during the 129th Annual Meeting of the American Association for the Advancement of Science

Washington, NASA. Office of Sci. and Tech. Inform., Mar. 1963 62 p 15 refs

(NASA SP-30) GPO: $0.50

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1. THE MISSION OF THE ORBITING GEOPHYSICAL OBSERVATORIES Wilfred E. Scull (NASA. Goddard Space Flight Center) p 1–10 (See N63-15167 11-32)
2. THE ENGINEERING DESIGN OF THE ORBITING GEOPHYSICAL OBSERVATORIES George E. Gleghorn (Space Technol. Labs.) p 11–23 2 refs (See N63-15168 11-32)
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N63-16295 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.

A STUDY OF SEVERAL FACTORS AFFECTING THE FLUTTER CHARACTERISTICS CALCULATED FOR TWO SWEPT WINGS BY PISTON THEORY AND BY QUASI-STEADY SECOND-ORDER THEORY AND COMPARISON WITH EXPERIMENTS

Robert M. Bennett and E. Carson Yates, Jr. Washington, NASA, May 1963 42 p 16 refs

(NASA TN-D-1794) OTS: $1.25

Flutter characteristics of two homogeneous untapered wings, one having 15° sweep and aspect ratio 5.34 and the other having 30° sweep and aspect ratio 4.16, have been investigated analytically for Mach numbers up to 3.0. Calculations included variations in number and type of vibration modes employed (that is, measured

natural modes or uncoupled beam-type modes) and in the treatment of finite wing thickness and of loading in the tip region
Author

N63-16992 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMPARISON OF STEADY-STATE AND SIX-DEGREE-OF-FREEDOM ANALYSES OF PITCH-ROLL RESONANCE CONDITIONS FOR A LONG SLENDER SOUNDING ROCKET
Charles H. Whitlock Washington, NASA, June 1963 28 p 5 refs
(NASA TN D-1816) OTS: $0.75

The amplitude response of a long, slender sounding rocket under pitch-roll resonance conditions has been computed by two methods: a six-degree-of-freedom method of analysis and an approximate solution assuming steady-state flight conditions. Resultant flow-incidence angles and principal vehicle-structural loadings were calculated by both methods and compared throughout a typical flight. From this comparison, it is concluded that the steady-state method of analysis was useful in determining and understanding the loading conditions imposed by pitch-roll resonance for the model and trajectory in question.
Author

N63-17504 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif
SOME CONTROL PROBLEMS ASSOCIATED WITH EARTH-ORIENTED SATELLITES
Vernon K. Merrick Washington, NASA, June 1963 81 p 3 refs
(NASA TN D-1771) OTS $2.00

A stability and control analysis is made of a class of inertia-wheel-controlled earth satellites whose orientation is controlled relative to a set of orthogonal axes, two of which are the local earth vertical and the normal to the orbital plane. The NASA Nimbus meteorological satellite is a typical example. It is demonstrated for a restricted but nevertheless important subclass of these satellites, defined by a particular inertia distribution, that the stability about the local earth vertical (yaw) and the stability of the vehicle angular momentum are independent of each other. This fact is used to extract many fundamental dynamical properties of the system, in particular, the influence, on stability, of the orientation and time constant of the yaw-sensing gyro. Furthermore, the analysis gives some insight into the role of gravity torques and into the inherent difficulties involved in the removal of angular momentum from the vehicle. Performance data for a satellite similar to Nimbus, obtained from digital and analog studies, are used to supplement the stability analysis and to demonstrate transient responses following control commands.
Author

N63-17547 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE MOTION OF A 24-HOUR SATELLITE
Peter Musen and Ann E. Bailie Washington, NASA, June 1963 23 p 5 refs Previously announced as a preprint, see N62-11758 06-31
(NASA TN D-1750) OTS: $0.75

The theory and conditions for stability of a satellite with a 24-hour period are given. Bohlin's resonance theory was applied to obtain the solution. It is shown that the integrals of the problem can be represented in series form, with respect to the small parameter w, which is proportional to the mean motion of the critical argument in a nonresonance case. Expressions for the period of libration, and the mean motion of the critical argument in the unstable case are also given. A system of formulas is presented which can be used to compute any particular case.
Author

N63-18656 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EXPERIENCE IN THERMAL-VACUUM TESTING EARTH SATELLITES AT GODDARD SPACE FLIGHT CENTER
A. R. Timmins and K. L. Rosette Washington, NASA, Aug. 1963 15 p 2 refs
(NASA TN D-1748) OTS: $0.50

The philosophy used for conducting thermal-vacuum tests of unmanned earth satellites is presented. The application of the philosophy is examined through the results of the thermal-vacuum tests of three unmanned spacecraft. These results are summarized and discussed with respect to prototype and flight-unit spacecraft, hot and cold environments, and kinds and frequency of failures. Brief commentaries on the space performance of the spacecraft are included.
Author

N63-18664 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE PURPOSES OF ENVIRONMENTAL TESTING FOR SCIENTIFIC SATELLITES
John H. Boeckel Washington, NASA, July 1963 27 p 15 refs Presented to American Soc. for Quality Control (Washington Section) Reliability Training Program, Feb. 12, 1963
(NASA TN D-1900) OTS: $0.75

The economic necessity of high reliability dictates a major role for environmental testing in the exploration of space. High reliability in spacecraft can be achieved only through extensive environmental testing. Successful testing depends on a comprehensive test plan that is formulated from the requirements of specific programs. Successful satellites and space probes can be achieved most economically by full use of such test programs, and by timely application of object lessons learned from previous programs.
Author

N63-20601 National Aeronautics and Space Administration, Washington, D.C.
CHARACTERISTIC OF PASSIVE COMMUNICATION SATELLITES WITH LAMBERTIAN SURFACES
Herbert P. Raabe (General Mills) Sept. 1963 17 p 3 refs Presented at the XIII Intern. Cong., Varna, Bulgaria, Sept. 28, 1962
(NASA Contracts NAS5-890 and NAS5-1598)
(NASA TN D-1841) OTS: $0.50

Passive communication satellites with surfaces reflecting diffusely according to Lambert's law are particularly attractive, since they afford a directional pattern well matched to the optimum pattern of satellites in lower orbits, and since such surfaces are easily realized. The echo from diffuse reflectors varies statistically, and a combination diversity technique of frequency should be used to stabilize the signal. A spherical satellite is no longer required; and weight reduction and higher reliability can be gained from polyhedral structures. Compared with a rigidized specularly reflecting sphere, a Lambertian reflector affords a 7-db stronger echo for the same weight. Model tests of reflectivity agree well with the theory.
Author

N63-20605 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ARIEL I — EVOLUTION OF ITS STRUCTURE
Carl L. Wagner, Jr. Washington, NASA, Sept. 1963 45 p 6 refs
(NASA TN D-1903) OTS: $1.25

The world's first international satellite, Ariel I, was launced April 26, 1962, after almost two years of cooperative effort between the United Kingdom and the United States. The time scale from inception to launch of Ariel I required

overlapped scheduling of its design, fabrication, and testing. The extensive development program described culminated in a structure that successfully survived a rigorous and unscheduled injection sequence to become a successful and useful orbiting spacecraft. Author

N63-21056 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF PEAK DECELERATION ON RANGE SENSITIVITY FOR A MODULATED-LIFT REENTRY AT SUPER-CIRCULARS SPEEDS
Charlie M. Jackson, Jr., and Roy V. Harris, Jr. Washington, NASA, Sept. 1963 26 p 5 refs
(NASA TN D-1955) OTS: $0.75

Existing techniques were used to compute the flight path parameters for a maneuver which would define the undershoot boundary of the reentry corridor. Reentry conditions considered were velocities of 34,000, 36,000, and 38,000 fps and flightpath angles of $-6°$, $-7°$, $-8°$, $-10°$, and $-12°$. The effects of variation of peak deceleration on range and energy level of the vehicle at the end of the pullup maneuver were investigated, and the results indicated a high degree of sensitivity of these parameters to peak-deceleration variations when minimum peak deceleration was maintained. Author

N63-21101 National Aeronautics and Space Administration. Washington, D.C.
SPACE FLIGHT HANDBOOKS. VOLUME I: ORBITAL FLIGHT HANDBOOK; PART 1 – BASIC TECHNIQUES AND DATA
George Townsend and Donald Kraft et al Washington, NASA, Office of Sci. and Tech. Inform. 1963 323 p refs
(NASA Contract NAS8-5031)
(NASA-SP-33, Pt. 1) OTS: $5.00

A presentation is given of background data and material for developing basic techniques and data for earth orbital missions. Subjects discussed in this volume include: (1) physical data—presentation of a set of constants necessary in the computation of trajectories; (2) orbital mechanics—presentation of basic central motion trajectory equations; and (3) perturbations—special and general perturbation techniques. P.V.E.

N63-21102 National Aeronautics and Space Administration, Washington, D.C.
SPACE FLIGHT HANDBOOKS. VOLUME I: ORBITAL FLIGHT HANDBOOK; PART 2 – MISSION SEQUENCING PROBLEMS
George Townsend and Donald Kraft et al Washington, NASA, Office of Sci. and Tech. Inform., 1963 443 p refs
(NASA Contract NAS8-5031)
(NASA-SP-33, Pt. 2) OTS: $6.00

An orbital flight handbook is presented which is concerned with earth orbital missions. Included are some of the various calculations and corrections which are encountered in analyses of orbit maneuvers, rendezvous, orbital departure, and satellite reentry. C.L.W.

N63-21103 National Aeronautics and Space Administration, Washington, D.C.
SPACE FLIGHT HANDBOOKS. VOLUME I: ORBITAL FLIGHT HANDBOOK; PART 3 – REQUIREMENTS
George Townsend and Donald Kraft et al Washington, NASA, Office of Sci. and Tech. Inform., 1963 384 p refs
(NASA Contract NAS8-5031)
(NASA-SP-33, Pt. 3) OTS: $5.00

A presentation is given of background data and material to be used in determining the requirements for earth orbital missions. The following are discussed in this volume: (1) waiting-orbit criteria, (2) orbit computations, (3) guidance and control requirements, and (4) mission requirements. P.V.E.

N63-21104 National Aeronautics and Space Administration, Washington, D.C.
SPACE FLIGHT HANDBOOKS. VOLUME 2: LUNAR FLIGHT HANDBOOK; PART 1 – BACKGROUND MATERIAL
Fred Martikan and Frank Santora et al Washington, NASA, Office of Sci. and Tech. Inform., 1963 143 p refs
(NASA Contract NAS8-5031)
(NASA-SP-34, Pt. 1) OTS: $2.75

Background information on the flight mechanics aspects of lunar missions is presented. The astronautical constants describing the gravitational force acting on the space vehicle and the geometry of the celestial bodies are discussed, and the atmospheric, meteoric, radiative and thermal environment, and its effects on a space vehicle and its occupants are considered. The motion of a space vehicle in earth-moon space as interpreted in the three-body and restricted three-body problems of astronomy is discussed. The force models for trajectory calculation are described, and lunar trajectories and missions are classified. M.P.G.

N63-21105 National Aeronautics and Space Administration, Washington, D.C.
SPACE FLIGHT HANDBOOKS. VOLUME 2: LUNAR FLIGHT HANDBOOK; PART 2 – LUNAR MISSION PHASES
Fred Martikan and Frank Santora et al Washington, NASA, Office of Sci. and Tech. Inform., 1963 444 p refs
(NASA Contract NAS8-5031)
(NASA-SP-34, Pt. 2) OTS: $6.00

Detailed trajectory data for the various phases of a lunar mission are presented. Earth departure, earth-to-moon transfer, lunar orbit, descent to and ascent from the lunar surface, moon-to-earth transfer, and earth return trajectory techniques are discussed. A major portion of circumlunar and lunar approach and return trajectories are cataloged to a high degree of accuracy using the Voice (volume of influence calculated envelopes) technique. M.P.G.

N63-21106 National Aeronautics and Space Administration, Washington, D.C.
SPACE FLIGHT HANDBOOKS. VOLUME 2: LUNAR FLIGHT HANDBOOK; PART 3 – MISSION PLANNING
Fred Martikan and Frank Santora et al Washington, NASA, Office of Sci. and Tech. Inform., 1963 156 p refs
(NASA Contract NAS8-5031)
(NASA-SP-34, Pt. 3) OTS: $3.00

Methods of interpreting the general lunar trajectory data and using this data for specific mission dates are discussed. Equations for converting the selenographic coordinates of a particular lunar site or area relative to the moon's orbital plane (MOP) and the moon-earth line ($\overline{MEL}$) are presented. The lunar terminator is defined, and equations giving the orientation of the terminator in both the selenographic and MOP-$\overline{MEL}$ coordinate systems are presented. Declination, radial distance, and moon phase data for 1963 to 1971 are tabulated, and the conversion between generalized trajectory data and specific mission dates is demonstrated. Empirical equations that extend the cataloged data to other injection altitudes and flight path angles are included, as well as energy requirements for controlling return flight time and changing the trans-earth trajectory inclination. Mission planning envelopes

(generalized geometrical relationships for a given set of mission constraints) are charted for both the circumlunar and approach class trajectories. The procedures and steps to be followed in evaluating specific missions are demonstrated using a manned lunar landing and return mission, and an unmanned photoreconnaissance mission as examples.
M.P.G.

N63-21345 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF THE DYNAMIC TESTS OF THE STRETCH YO-YO DE-SPIN SYSTEM
William R. Mentzer Washington, NASA, Sept. 1963 25 p, 3 refs
(NASA TN D-1902) OTS: $0.75

Results of the stretch yo-yo feasibility and flight qualification tests are presented. These tests were conducted to prove the concept that the stretch yo-yo is a more accurate despin device than the rigid yo-yo, and to verify the analytical development of the stretch yo-yo properties. Variations in the design parameters and their effects on the final spin rate of the payload are noted in the analysis of the test results. The variables include initial spin rate, moment of inertia, and spring properties. A computer solution of the test payload equations of motion is included for comparison with the experimental results to confirm the mathematical analysis of the stretch yo-yo system. As a result of the successful flight qualification tests, a stretch yo-yo was flown on Ariel I.
Author

N63-21848 National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
PROJECT MERCURY – A CHRONOLOGY
James M. Grimwood Washington, NASA, 1963 250 p refs
(NASA SP-4001; MSC-HR-1) GPO: $1.50

A brief but accurate chronology of important events throughout the Mercury program is presented, the rapid pace at which the Mercury development and operation were carried out is discussed. Three major divisions of the project are: (1) major events leading to Project Mercury, (2) research and development phase of Project Mercury, (3) operational phase of Project Mercury.
J.E.T.

N63-21893 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SIMULATOR STUDY OF A SATELLITE ATTITUDE CONTROL SYSTEM USING INERTIA WHEELS AND A MAGNET
James J. Adams, W. E. Howell, and Hugh P. Bergeron Washington, NASA, Oct. 1963 18 p 8 refs
(NASA TN D-1969) OTS: $0.50

Three degree-of-freedom tests of an automatic attitude control system for a satellite have been made by using an inertia simulator mounted on an air bearing. The control torques used in the system were the inertia reaction torques of three body-mounted flywheels, and the magnetic reaction torque of a permanent bar magnet. The control signals used for the wheel were an attitude input provided by light sensors and the wheel-angular-velocity input provided by the tachometer. The magnet was used for removing momentum from the system and was controlled by the wheel angular velocity. Tests were made to demonstrate the stability of the system, the sensitivity that could be obtained with the system, and the operation of the magnet system. The results show that attitude control that would be satisfactory for many missions can be achieved with this control system. Author

N63-21912 National Aeronautics and Space Administration, Washington, D.C.
RELIABILITY PROGRAM EVALUATION PROCEDURES
Sept. 1963 52 p
(NASA SP-6002) OTS: $1.50

The objectives are threefold: (1) to establish uniform standards for evaluating the degree and effectiveness of reliability practices and controls. (2) to identify reliability-type problems for evaluation and correction. (3) to permit evaluation of the various methods of controlling a specific area leading to improved reliability and safety levels. These standards may be used to survey contractual compliance to all reliability publications. They are designed to identify problem and improvement areas consistent with the severe reliability and safety requirements of Manned Space Flight Systems.
Author

N63-22806 Space Technology Labs., Inc., Redondo Beach, Calif.
EXPLORER VI AND PIONEER V DATA. VOLUME II: A COMPENDIUM OF EXPLORER VI DATA
Alan Rosen and Edward J. Smith Washington, NASA, Oct. 1963 170 p 14 refs
(NASA Contract NASw-270)
(NASA CR-4) OTS: $3.00

The data obtained from the scintillation-counter experiment and the search-coil magnetometer experiments on the Explorer VI satellite are presented graphically. A compendium of data on the field magnitude and phase angle is included.
Author

33 STRESSES AND LOADS

Includes fatigue; vibration; flutter; and structural tests. *For thermal stress see*: 13 Heat Transfer and Thermodynamics. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 34 Structural Design.

N63-10179 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
BUCKLING OF RING-STIFFENED CYLINDERS UNDER A PURE BENDING MOMENT AND A NONUNIFORM TEMPERATURE DISTRIBUTION
Melvin S. Anderson and Michael F. Card Washington, NASA, Nov. 1962 33 p 5 refs
(NASA TN D-1513) OTS: $1.00

Thirteen stainless-steel ring-stiffened cylinders were subjected to a pure bending load and heated rapidly until buckling occurred. For most of the cylinders the heating was not uniform around the circumference so that appreciable axial thermal stresses were present. Elementary thermal stress theory was found to be inadequate for the prediction of these thermal stresses, but a method was developed that would give satisfactory thermal stress results. By properly accounting for the thermal stress, the buckling load could be correlated with a theory for the buckling of an axially compressed ring-stiffened cylinder that is uniformly heated. Author

N63-10205 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION AT MACH NUMBER 3.0 OF EFFECTS OF THERMAL STRESS AND BUCKLING ON FLUTTER CHARACTERISTICS OF FLAT SINGLE-BAY PANELS OF LENGTH-WIDTH RATIO 0.96

Sidney C. Dixon. Washington, NASA, Nov. 1962 34 p 19 refs
(NASA TN D-1485) OTS: $1.00

Tests were conducted at dynamic pressures from 1,500 pounds per square foot to 5,000 pounds per square foot, and at stagnation temperatures from 300°F to 660°F. The panel supporting structure allowed partial thermal expansion of the skins. Panel skin material and skin thickness were varied. An overall flutter boundary is presented in terms of a modified temperature parameter, which approximately accounts for the effects of differential pressure and variations in panel skin material and skin thickness, and indicates the effects of thermal stress and buckling on the flutter characteristics of the panel. The experimental results are compared with theory for the condition of zero stress and for the onset of buckling.
Author

N63-10532 National Aeronautics and Space Administration, Washington, D. C.

STATISTICAL METHODS IN THE NONLINEAR THEORY OF ELASTIC SHELLS

V. V. Bolotin Dec. 1962 17 p 8 refs Translation of "Statisticheskiye metody v nelineynoy teorii uprugkih obolochek" from Izv. Akad. Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, 1958, no. 3, p. 33–46. Presented at a seminar in the Inst. of Mechanics of the Academy of Sciences USSR, Oct. 3, 1957
(NASA-TT-F-85) OTS: $0.50

A statistical method is presented for calculation of the mathematical expectation and dispersion of buckling loads of an arbitrary shell characterized by a finite number of parameters defining not only the loads but also initial deformations, defects in manufacture, and so forth. The method should be useful in design calculations and in interpreting experimental data for the buckling of elastic shells. Calculated values for a shallow cylindrical panel are in good agreement with the mean value of experimentally determined critical forces.
Author

N63-10799 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

VARIABLE-AMPLITUDE FATIGUE TESTS WITH PARTICULAR ATTENTION TO THE EFFECTS OF HIGH AND LOW LOADS

Eugene C. Naumann Washington, NASA, Dec. 1962 25 p 12 refs
(NASA TN D-1522) OTS: $0.75

Load schedules were designed to approximate gust load statistics for tests on 2024-T3 and 7075-T6 aluminum-alloy sheet specimens and maneuver load statistics for tests on 7075-T6 specimens. The test data were analyzed by assuming linear cumulative damage, and a limited statistical analysis was used to strengthen conclusions. The value of the summation of cycle ratios was found to vary with changes in frequency of application of the highest load level for eight-step tests and with the omission of the lowest load level for four-step tests. The variation in the summation of cycle ratios was not significant when the lowest load level for eight-step tests was omitted.
Author

N63-10801 National Aeronautics and Space Administration, Washington, D. C.

A GENERAL DIGITAL COMPUTER ANALYSIS OF STATICALLY INDETERMINATE STRUCTURES

Paul H. Denke (Douglas Aircraft Co.) Dec. 1962 72 p 14 refs Presented at a meeting of the Structures and Materials Panel of AGARD, Aachen, Germany, Sept. 17, 1959
(NASA TN D-1666; previously published as Douglas Aircraft Co. Engineering Paper 834) OTS: $1.75

A procedure for structural analysis, comprising a matrix formulation of the equilibrium and Maxwell-Mohr continuity equations, and an associated digital computer program, has been developed. This procedure is applicable, in its basic form, to any linear discrete structure. The method has been fully verified by comparison with test results, both in the laboratory and in proof test, and it has been shown to be a practical analysis tool in numerous applications.
Author

N63-10898 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PRELIMINARY INVESTIGATION OF EFFECT OF HYDROGEN ON STRESS-RUPTURE AND FATIGUE PROPERTIES OF AN IRON-, A NICKEL-, AND A COBALT-BASE-ALLOY

Stanley J. Klima, Alfred J. Nachtigall, and Charles A. Hoffman Washington, NASA, Dec. 1962 36 p 16 refs
(NASA-TN-D-1458) OTS: $1.00

Hollow specimens of A-286, Inconel 700, and S-816 alloys were tested in axial tensile fatigue and stress rupture while hydrogen gas was forced through them. The tests were repeated with air as the internal gas. In both types of tests, the specimen outer surface was exposed to a normal air atmosphere and a heat source. Test temperatures were 1200° F for A-286 and 1500° F for Inconel 700 and S-816. The average fatigue lives of all the alloys and the average stress-rupture lives of A-286 and Inconel 700 were neither significantly increased nor decreased due to the hydrogen environment compared with the average lives obtained with air tests. S-816 provided significantly lower average stress-rupture lives in hydrogen tests than in air tests.
Author

N63-10987 National Aeronautics and Space Administration, Washington, D. C.

ON SCALING LAWS FOR MATERIAL DAMPING

Stephen H. Crandall (MIT) Dec. 1962 25 p 8 refs
(NASA-TN-D-1467) OTS: $0.75

Similarity analyses are made to provide scaling laws which indicate the effects of amplitude, frequency, and material properties on the resonant damping experienced by structural elements when the damping is due to internal material properties. Two nonlinear damping "laws" are considered. Correlations provided by the scaling laws were performed on data from a large number of tests with steel, brass, and aluminum cantilever beams.
Author

N63-12004 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL PANEL FLUTTER RESULTS FOR SOME FLAT AND CURVED TITANIUM SKIN PANELS AT SUPERSONIC SPEEDS

John G. Presnell, Jr., and R. L. McKinney Washington, NASA, Jan. 1963 17 p 2 refs
(NASA TN D-1600) OTS: $0.50

The results of tests at Mach numbers from 1.72 to 2.62 on panels having a thickness from 0.015 to 0.045 inch, length-width ratio from 0.36 to 2.76, and radius-thickness ratio from 600 to infinity are presented. These results indicate a strong influence of differential pressure, which caused buckling, on the flutter mode and on the dynamic pressure at flutter for the curved panels. Results for both the flat and curved panels fall within an extrapolation of an existing experimental panel-flutter boundary.
Author

N63-12479 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL EVALUATION OF THEORETICAL ELASTIC

STRESS DISTRIBUTIONS FOR CYLINDER-TO-HEMISPHERE AND CONE-TO-SPHERE JUNCTIONS IN PRESSURIZED SHELL STRUCTURES

William C. Morgan and Peter T. Bizon Washington, NASA, Feb. 1963 28 p 8 refs
(NASA TN D-1565) OTS: $0.75

An experimental investigation was made of the stress state that exists in a toriconical structure of constant wall thickness. The data were compared with stress states determined analytically by methods published in a previous phase of the same general program. The results of the investigation proved the validity of the analyses. Correlation was within reasonable limits of experimental error. Author

N63-12590 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE IN-PLANE VIBRATIONS OF A FLAT SPINNING DISK

James G. Simmonds Washington, NASA, Dec. 1962 41 p 4 refs
(NASA TN D-521) OTS:$1.00

An analysis of the influence of spinning on the natural frequencies of vibration of a thin elastic disk is first made, and it is shown that this influence is negligible. Next, the natural frequencies for a stationary disk corresponding to the two extreme cases of clamping to a rigid hub and no clamping whatsoever are calculated. Approximate expressions for the two natural frequencies of a clamped disk which approach zero as the ratio of hub diameter to disk diameter approaches zero are given. Finally, there is presented an orthogonality relation between any two natural modes of vibration. Author

N63-13261 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASURED AND CALCULATED SUBSONIC AND TRANSONIC FLUTTER CHARACTERISTICS OF A 45° SWEPTBACK PLANFORM IN AIR AND IN FREON-12 IN THE LANGLEY TRANSONIC DYNAMICS TUNNEL

E. Carson Yates, Jr., Norman S. Land, and Jerome T. Foughner, Jr. Washington, NASA, Mar. 1963 44 p 12 refs
(NASA TN D-1616) OTS: $1.25

In order to investigate the reliability of flutter data measured in the Langley transonic dynamics tunnel, an experimental and theoretical subsonic and transonic flutter study has been conducted in air and in Freon-12 in this facility. The wing planform employed had an aspect ratio of 4.0, a taper ratio of 0.6, and 45° of quarter-chord sweepback. A sting-mounted full-span model was tested in addition to three sizes of wall-mounted semispan models. A wide range of mass ratio was covered by the tests in air and by flutter calculations made by the modified strip-analysis method of NACA Research Memorandum L57L10. A limited amount of data was obtained in Freon-12. Results of the tests in air and in Freon-12 are in good agreement with the flutter calculations at all Mach numbers. The test data compare favorably with previously published transonic flutter data for the same wing planform. The results indicate that flutter characteristics obtained in Freon-12 may be interpreted directly as equivalent flutter data in air at the same mass ratio and Mach number. Author

N63-13717 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

POSTBUCKLING EFFECTS ON THE FLUTTER OF SIMPLY SUPPORTED RECTANGULAR PANELS AT SUPERSONIC SPEEDS

Robert W. Fralich Washington, NASA, Mar. 1963 31 p 16 refs
(NASA TN D-1615) OTS: $0.75

A theoretical analysis is given for the flutter of simply supported rectangular panels subjected to supersonic flow over one surface. Postbuckling effects of in-plane edge loads and in-plane shortenings on the flutter speed are investigated. The von Kármán large-deflection plate theory is used in conjunction with linearized static aerodynamic strip theory. A Galerkin procedure using the first two static buckling modes is employed to find the flutter criterion for panels with ratios of length in the streamwise direction to half-wavelength in the cross-flow direction between 0 and 2. Author

N63-13789 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STRENGTH OF FILAMENTARY SHEETS WITH ONE OR MORE FIBERS BROKEN

George W. Zender and Jerry W. Deaton Washington, NASA, Mar. 1963 9 p 2 refs
(NASA TN D-1609) OTS: $0.50

Experimental static-stress-concentration factors at failure for a filamentary material containing unidirectional dacron fibers and subjected to tensile loads are presented and compared with previously published theoretical results. The favorable agreement of the theoretical and experimental results indicates the theory is valid for the static-load case. Author

N63-14250 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

FATIGUE BEHAVIOR OF MATERIALS UNDER STRAIN CYCLING IN LOW AND INTERMEDIATE LIFE RANGE

Robert W. Smith, Marvin H. Hirschberg, and S. S. Manson Washington, NASA, Apr. 1963 57 p 12 refs
(NASA TN D-1574) OTS: $1.50

A series of constant-strain range tests was made for a wide variety of materials producing fatigue lives varying from a few cycles to about one million cycles. The specimens were subjected to axial, compression-tension, low-frequency fatigue about a zero mean strain. Load range was measured periodically throughout each test, enabling an analysis of fatigue results in terms of elastic, plastic, and total strains. Materials tested were AISI 4130 (soft and hard), AISI 4340 (annealed and hard), AISI 52100, AISI 304 ELC (annealed and hard), AISI 310 (annealed), AM 350 (annealed and hard), Inconel X, titanium (6A1-4V), 2014-T6, 5456-H311, and 1100 aluminum, and beryllium. Fatigue-life relations between elastic, plastic, and total strain components were established. For metallurgically stable materials, straight-line fits of the logarithmic elastic strain-life and plastic strain-life data produce a relation that agrees well with the total strain life data. The strain-life data are also used to explain changes in susceptibility to stress concentrations over a large life span and to rate correctly the relative notch sensitivities of the four test materials that experienced nontest-section failures in comparison with the other materials. Author

N63-14271 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ROOM-TEMPERATURE SHEAR AND COMPRESSION TESTS OF STIFFENED PANELS WITH INTEGRAL OR ATTACHED COOLING CIRCUITS

Marvin B. Dow and Ralph O. Whitley Washington, NASA, Mar. 1963 44 p 3 refs
(NASA TN D-1499) OTS: $1.25

The results of tests on 22 Z-section-stiffened panels loaded in shear and compression are presented and discussed. The sheet used in the fabrication of 16 of the panels had cooling circuits attached to, or made an integral part of, the sheet. The panels were tested at room temperature with water flowing in the cooling circuits at the design values of inlet pressure and flow rate. The results indicated that the presence of the cooling circuits did not significantly penalize the load-carrying capability of the panels. Structural loads had little effect on the flow rate of water in the cooling circuits until severe

sheet buckling at high load levels had occurred. Water leaks developed in the cooling circuits of a few panels before gross panel failure, but in no cases were the leaks caused by rupturing of the cooling circuits due to load. Supplemental tests showed that turbulent flow existed in the cooling circuits at the design values of inlet pressure and flow rate. Author

N63-14279 National Aeronautics and Space Administration, Washington, D.C.

OBSERVATIONS ON THE ROLE OF NONLINEARITY IN RANDOM VIBRATION OF STRUCTURES

Richard H. Lyon (Bolt, Beranek and Newman, Inc.) Washington, NASA, Mar. 1963 47 p 17 refs

(NASA Contract NASr-47)

(NASA TN D-1872) OTS: $1.25

The effects of nonlinearity in several clamped-clamped beam vibration problems are reviewed. Possible effects are: jump or instability phenomena, amplitude limiting effects, and distortion of probability densities. Studies of prototype panel-frame structures show similar behavior. The necessity for extending these efforts to built-up structures is emphasized. Also, estimates for the onset on nonlinearity based on two simple models are made to show how one can be guided in experimental design by quantitative-empirical considerations. Some theoretical techniques are appraised for their applicability to the structures problem. In particular, two approximation methods are singled out for detailed comment. The possibilities of a more creative use of experimental analysis and a closer tie between theoretical and experimental effort in structures research are explored. Author

N63-15765 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

METHODS OF EXPRESSING MASS UNBALANCE

N. C. Schaller and J. M. Lewallen Washington, NASA, May 1963 12 p

(NASA TN-D-1446) OTS: $0.50

Three different methods of expressing mass unbalance are presented: (1) force vectors in two planes perpendicular to the axis, (2) principal axis shift and tilt, and (3) force and moment vectors relative to the center of gravity. Each method is discussed briefly. However, method (3) has been determined to be the more useful in expressing mass unbalance for spacecraft payloads, because (a) specific payload data, other than center of gravity location are not required, (b) static unbalance is separated from dynamic unbalance, and (c) convenient comparison to other payload configurations is possible. Since unbalance information is conventionally recorded in two planes perpendicular to the spin axis, a unique conversion operation is presented which allows method (1) to be expressed as method (3) Author

N63-15777 National Aeronautics and Space Administration, Washington, D. C.

A CONTRIBUTION TO THE THEORY OF PRESSURE STABILIZED STRUCTURES

A. C. Kyser (Astro Research Corp., Santa Barbara, Calif.) May 1963 42 p 3 refs

(NASA Contract NASr-8)

(NASA TN-D-1919) OTS: $1.25

A large-deformation analysis is presented for an element of a flexible inflatable plate consisting of an array of contiguous tubes. The element is represented by a transversely loaded, pressurized, cylindrical chamber of indefinite length having two flat sides connected by flexible but inextensible membranes. The behavior of the cylindrical element is described for the complete range of deformation for the case of lateral compression, shear, or rolling loads, and a method is described for obtaining a graphical solution for the shape of the cross section under any given combination of loads. It was found that, under certain conditions, large compressive deformations give rise to geometrical instabilities, or conditions of negative spring rate. Author

N63-16880 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PRELIMINARY INVESTIGATION OF CATASTROPHIC FRACTURE OF LIQUID-FILLED TANKS IMPACTED BY HIGH-VELOCITY PARTICLES

Francis S. Stepka and C. Robert Morse Washington, NASA May 1963 29 p 9 refs

(NASA TN-D-1537) OTS: $0.75

Metal test specimens, acting as a wall of a liquid-filled tank, were impacted by small, high-speed particles. The specimens were 1/32- and 1/16-inch-thick 2014-T6 and 7075-T6 aluminum and 1/32-inch-thick 60-percent-cold-reduced AISI 301 stainless steel. The liquids used were water, glycerin, and nitrogen. The impacts were made at velocities up to 7500 feet per second. The investigation showed that catastrophic fracturing rather than simple puncturing can occur as a result of impact. The importance of some of the primary variables contributing to the fracturing is discussed. Author

N63-18211 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOADS INDUCED ON A FLAT PLATE AT A MACH NUMBER OF 4.5 WITH A SONIC OR SUPERSONIC JET EXHAUSTING NORMAL TO THE SURFACE

William Letko Washington, NASA, July 1963 25 p 8 refs

(NASA TN D-1935) OTS: $0.75

An investigation was made to determine the pressure distributions on a flat plate with a sonic or a supersonic jet exhausting normal to the plate surface. Tests were made at a Mach number of 4.5 for a range of jet pressure ratios (that is ratio of stagnation pressure of secondary jet to free-stream static pressure), and for various free-stream Reynolds numbers. Based on a comparison of the ratio of the total reaction force of the test jet to the calculated reaction force of an isolated fully expanded jet (with mass flow equal to that of the test jet), the supersonic nozzle appears to be more effective for use as a control than the sonic nozzle. Total force as used herein is the calculated simple reaction force of an isolated nozzle, plus the induced force resulting from the secondary-jet interference with the stream flowing over the flat plate. The data also indicate that eliminating areas of negative pressure on the plate would cause an increase in effectiveness up to approximately 12 percent for either jet. Author

N63-18461 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STATISTICAL MODEL FOR SYNTHETIC WIND PROFILES FOR AEROSPACE VEHICLE DESIGN AND LAUNCHING CRITERIA

Robert M. Henry Washington, NASA, July 1963 36 p 24 refs

(NASA TN D-1813) $1.00

A model for extreme-value wind-velocity profiles, based on the multivariate gaussian (joint normal) distribution of the horizontal components of wind velocity, is presented. These profiles can be constructed rapidly and objectively wherever the parameters of the wind distribution are known, and they can be tailored to a specific location, season, launch azimuth, and critical altitude. Some examples of these profiles are shown and discussed. In addition to the usual design-criterion profile, methods of constructing extreme-value profiles for launching criteria are presented, and the application of these profiles

in aerospace-vehicle operations is indicated. Derivation of the equations used to construct the profiles, and derivation and discussion of confidence limits are presented in appendixes.
Author

N63-18668 National Aeronautics and Space Administration, Washington, D.C.
THE EFFECT OF INITIAL IMPERFECTIONS ON THE BUCKLING STRESS OF CYLINDRICAL SHELLS
C. D. Babcock and E. E. Sechler (Calif. Inst. of Tech.) July 1963 46 p 7 refs Previously processed; for abstract see N63-10817 02-33
(NASA Grant NsG-18-59)
(NASA TN-D-2005) OTS: $1.25

An experimental investigation is carried out to determine the effect of an axially symmetric initial imperfection on the buckling load of a circular cylindrical shell under axial compression loading. The imperfection studied has the form of a half sine wave in the length direction. The shells are formed by a copper electroforming process. The theoretical buckling loads are also computed for the imperfect shells, and show the same trend as the experimental study. Author

N63-18771 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE EFFECTS OF VARIABLE-AMPLITUDE LOADINGS ON FATIGUE CRACK PROPAGATION PATTERNS
C. Michael Hudson and Herbert F. Hadrath Washington, NASA, Aug. 1963 23 p 4 refs
(NASA TN D-1803) OTS: $0.75

Axial-load variable-amplitude fatigue tests were conducted on 2024-T4 aluminum-alloy specimens. Both gust and ground-air-ground cycles were simulated in these tests, and the resulting fracture patterns were carefully inspected to determine which loadings produced the various markings. The effects of loading order and load magnitude on the size and texture of the markings were also investigated. Author

N63-18888 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A THEORETICAL BASIS FOR MECHANICAL IMPEDANCE SIMULATION IN SHOCK AND VIBRATION TESTING OF ONE-DIMENSIONAL SYSTEMS
F. J. On and R. O. Belsheim Washington, NASA, Aug. 1963 28 p 5 refs
(NASA TN D-1854) OTS: $0.75

The feasibility of mechanical impedance control and simulation in environmental shock and vibration testing of mechanical structures was investigated theoretically. Fundamental and useful mathematical expressions for impedance are given for the analysis, control, and simulation in mechanical structures that can be considered as one-dimensional linear-passive systems. The validation of these expressions in the application to impedance control and simulation is approached primarily from analytical considerations. General theories of application are summarized, along with a few simple examples of specific cases. The overall results of the investigation, as well as certain conclusions that may be drawn, are discussed. Several recommendations are made in connection with the information obtained from this study. Author

N63-19279 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE COUPLED DYNAMIC RESPONSE OF A TANK PARTIALLY FILLED WITH A LIQUID AND UNDERGOING FREE AND FORCED PLANAR OSCILLATIONS
David G. Stephens and H. Wayne Leonard Washington, NASA, Aug. 1963 43 p 18 refs
(NASA TN D-1945) OTJ $1.25

The experimental portion of this investigation was conducted by using a partially filled cylindrical tank, fitted with baffles, and suspended to allow freedom in pitch and translation. An excitation force was provided by a small air jet coupled to the base of the tank. Experimental data are presented to show the effects of liquid damping, excitation force, and coupled natural frequency on the stability of the system. Analytical results, obtained by using the pendulum analogy to simulate the dynamic characteristics of the liquid, are also presented. Comparisons of the analytical results with those obtained experimentally are made to define the regions of applicability and limitations of the pendulum analogy for the dynamic simulation of the liquid in the stability analysis of the system. Author

N63-19733 National Aeronautics and Space Administration, Cleveland, Ohio Lewis Research Center
A SIMPLIFIED METHOD OF DETERMINING THE ELASTIC STATE OF THERMAL STRESS IN A THIN, FLAT PLATE OF FINITE DIMENSIONS
Ernest Roberts, Jr., and Alexander Mendelson Washington, NASA, Aug. 1963 24 p
(NASA TN D-1740) $0.75

An integrodifferential equation that defines the behavior of the shear stress in a thermally loaded, thin, flat plate of finite dimensions is derived. The equation is reduced to a system of linear algebraic equations by a method that employs polynomial approximations for the shear stresses. The boundary conditions are satisfied identically. Several examples of the method, presented in detail, show that solutions of high accuracy can be produced on a desk calculator with a minimum of labor. A calculation of the displacements shows that the strain compatibility conditions are closely satisfied everywhere. Author

N63-19858 National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center
CALIBRATIONS OF AIRCRAFT STATIC-PRESSURE SYSTEMS BY GROUND-CAMERA AND GROUND-RADAR METHODS
William Gracey and Joseph W. Stickle Washington, NASA Aug 1963 30 p 3 refs
(NASA TN D-2012) OTS: $0.75

This report presents the calibrations of two static-pressure systems (a fuselage vent system and a pitot-static tube mounted above and ahead of the pilot's compartment) as determined near sea level by a ground-camera technique, and at an altitude of 25,000 feet by a ground-radar method. The maximum probable error (3 standard deviations) for both the low- and high-altitude calibrations of the fuselage vent system was about 1 pound per square foot, or 12 feet, at sea level and 30 feet at 25,000 feet above sea level Author

N63-21055 National Aeronautics and Space Administration Langley Research Center, Langley Station, Va.
APPLICATION OF TRANSTABILITY CONCEPT TO FLUTTER OF FINITE PANELS AND EXPERIMENTAL RESULTS
Sidney C. Dixon (M.S. Thesis, Va. U.) Washington, NASA, Sept. 1963 36 p 21 refs
(NASA TN D-1948) OTS: $1.00

The governing differential equation was solved by the Galerkin method. Numerical results obtained from four-term solutions are presented for both clamped and simply supported panels with various length-width ratios and various ratios of lateral to longitudinal midplane stress. Experimental data are presented for essentially clamped panels with a

length-width ratio of 4. Tests were conducted at a Mach number of 3.0, at dynamic pressures from 1,600 to 5,000 lb/sq ft, and at stagnation temperatures from 300° to 650° F. The results revealed that the flutter characteristics are very sensitive to the panel buckling characteristics. Both theory and experiment indicated that existing experimental panel-flutter envelopes can be inadequate as flutter criteria for stressed panels. Author

N63-21065 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLUTTER OF FLAT RECTANGULAR ORTHOTROPIC PANELS WITH BIAXIAL LOADING AND ARBITRARY FLOW DIRECTION
Herman L. Bohon (M.S. Thesis, Va. Polytech. Inst.) Washington, NASA, Sept. 1963 35 p 18 refs
(NASA TN D-1949) OTS: $1.00

A theoretical analysis is presented on the flutter of simply supported orthotropic panels at supersonic speeds. Modified piston theory is employed for the lateral loading. Flutter boundaries show that orthotropic panels are highly sensitive to small changes in flow angularity. Rotation of the panel causes a change in the critical flutter mode which results in a stable region completely bounded by an unstable region. There are stress ratios for which very large thicknesses are required for prevention of flutter once the panel undergoes the mode change. Author

N63-21888 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SINSUSOIDAL VIBRATION TESTING OF NONLINEAR SPACECRAFT STRUCTURES
William F. Bangs Washington, NASA, Sept. 1963 14 p 3 refs
(NASA TN D-1763) OTS: $0.50

The purpose of this technical note is to discuss some of the shortcomings associated with the familiar sinsusoidal sweep test. Waveform distortion, being one of the more obvious problems, is discussed. An analytical model of a simplified structure undergoing vibration testing was studied with the aid of an analog computer. Solutions for a nonlinear model demonstrate distortion of the armature acceleration even though the applied force is sinusoidal. Filtering the control signal to eliminate distortion may unduly penalize the specimen, although this technique is acceptable where the distortion is the "random" type caused by the banging of parts. Author

N63-21889 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
TECHNIQUES FOR PREDICTING LOCALIZED VIBRATORY ENVIRONMENTS OF ROCKET VEHICLES
Robert E. Barrett Washington, NASA, Oct. 1963 65 p 4 refs
(NASA TN D-1836) OTS: $1.75

Factors such as combined random forcing functions, structural dissimilarities, nonlinearities, and multimodal responses generate vast amounts of computations and bookkeeping. The purpose of this report is to provide prediction techniques which meet the requirements of both simplicity and adequacy. All the necessary information, with the exception of the structural configuration, has been provided for the user. With these methods and a knowledge of the structural mass characteristics pertaining to a specific problem, the vibratory environment of a component at any location on the vehicle may be determined. Author

N63-22897 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE NATURAL FREQUENCIES OF UNIFORM RECTANGULAR-CROSS-SECTION FREE-FREE SANDWICH BEAMS
Robert R. Clary and Sumner A. Leadbetter Oct. 1963 20 p 14 refs
(NASA TN D-1967) OTS: $0.50

Natural frequencies of the first six lateral bending modes were measured. Correlation with values calculated from the Timoshenko beam theory was excellent when the secondary effect of transverse shear was included. The shear effect was increasingly important for the higher modes. For one beam the natural frequencies corresponding to the first five modes were measured and were found to increase as the density of the surrounding air was reduced from a sea-level value to that of a near vacuum. Author

34 STRUCTURAL DESIGN

Includes structural elements; and weight analysis. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 33 Stresses and Loads.

N63-10804 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COLLECTED PAPERS ON INSTABILITY OF SHELL STRUCTURES—1962
Washington, NASA, Dec. 1962 757 p 575 refs A collection of papers presented at the NASA SYMPOSIUM ON INSTABILITY OF SHELL STRUCTURES, Langley Research Center, Oct. 24-25, 1962
(NASA-TN-D-1510) OTS: $8.00

N63-11050 National Aeronautics and Space Administration, Washington, D.C.
STRUCTURAL SYNTHESIS OF SYMMETRIC WAFFLE PLATE
Lucien A. Schmit and Thomas P. Kicher (Case Inst. of Tech.) Dec. 1962 62 p 7 refs
(NASA Contract NsG-110-61)
(NASA TN D-1691) OTS: $1.75

This note reports the successful development of a synthesis capability for symmetric waffle plates. The structural configuration employed as an example in this study is an integrally stiffened waffle plate used primarily for aerospace structures. The criterion of design selection employed is the total weight of the waffle. Author

N63-11056 National Aeronautics and Space Administration, Washington, D.C.
A CONTRIBUTION TO THE THEORY OF FOLDING DEFORMATIONS IN EXPANDABLE STRUCTURES WITH A PARTICULAR APPLICATION TO TOROIDAL SHELLS
H. U. Schuerch and G. M. Schindler (Astro Research Corp.) Dec. 1962 29 p 5 refs
(NASA Contract NASr-8)
(NASA TN D-1690) OTS: $0.75

Outlines for a theory of large deformations, including folding, of arbitrary inextensible membranes are presented. The approach to the problem utilizes isometric mapping techniques complemented by the additional topological constraints of the folding problem in real membrane structures. The theory is applied to an inextensible membrane in the form of a torus. Rigorous solutions are found for a particular class of deformations. Theoretical results are verified, qualitatively, by realization of predicted folding patterns on two torus models. Author

N63-11057 National Aeronautics and Space Administration, Washington, D.C.

A THEORY AND APPLICATIONS OF FILAMENTARY STRUCTURES

H. U. Schuerch, O. R. Burggraf, and A. C. Kyser (Astro Research Corp.) Dec. 1962 84 p 20 refs

(NASA Contract NASr-8)

(NASA TN D-1692) OTS: $2.25

A theory of filamentary structures consisting of monotropic membranes is presented. Applications to isotensoid pressure vessels with rotational symmetry demonstrate the use of the theory. Particular attention is given to applications of filamentary design of variable-geometry expandable structures. Experimental data, obtained from filament-wound toroidal pressure vessels, confirm the validity of the theory and demonstrate application of the analytical design technique for filamentary structures. Author

N63-11518 National Aeronautics and Space Administration, Washington, D.C.

STRUCTURES FOR SPACE OPERATIONS

Harry L. Runyan, Robert W. Leonard, Eldon E. Mathauser, Roger A. Anderson, and George W. Brooks 1962 48 p 80 refs Papers presented at Session V of the NASA-University Conf. on the Science and Technol. of Space Exploration, Chicago, Nov. 1-3, 1962 (See N63-11502 03-29)

(NASA-SP-28) GPO: $0.35

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3. RESEARCH, DESIGN CONSIDERATIONS, AND TECHNOLOGICAL PROBLEMS OF STRUCTURES FOR PLANETARY ENTRY VEHICLES R. A. Anderson (NASA, Langley Research Center) 10 p 25 refs
4. RESEARCH, DESIGN CONSIDERATIONS, AND TECHNOLOGICAL PROBLEMS OF STRUCTURES FOR SPACECRAFT G. W. Brooks (NASA, Langley Research Center) 12 p 20 refs

N63-15351 National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

INFLUENCE OF WEIGHT PARAMETERS ON THE PROPULSION REQUIREMENTS OF ORBIT-LAUNCHED VEHICLES

Dietrich W. Fellenz and Ronald J. Harris Washington, NASA, May 1963 91 p 11 refs

(NASA TN D-1525) OTS: $2.25

The effects of thrust-to-weight ratio and structural-weight assumptions on payload performance have been investigated for orbit-launched vehicles with lunar or escape missions. The propulsion systems considered were high-energy chemical and nuclear heat-exchanger systems. It is shown that the assumption of structural weights as being composed of terms proportional to thrust level and propellant loading is necessary and practical for the discussion of the influence of thrust-to-weight ratio on payload performance. Results are given in parametric form showing payload ratio and related performance parameters as functions of thrust-to-weight ratio, representative engine and tankage specific weights for both propulsion systems, tangential and circumferential thrust orientations, and different altitudes. The curves permit the rapid determination of maximum payload conditions as well as the discussion of performance parameters of off-optimum configurations. Author

N63-15393 National Aeronautics and Space Administration, Washington, D.C.

ON ISOMETRIC DEFORMATION OF SCREW SURFACES

G. W. Schindler (Astro Research Corp.) Washington, NASA, May 1963 14 p 3 refs Previously processed as technical report ARC-R-72; see N63-12656 06-34

(NASA Contract NASr-8) Previously processed as technical report ARC-R-72; see N63-12656 06-34

(NASA TN D-1918) OTS: $0.50

A study of strain-free deformation mechanisms of surfaces that are capable of folding into a flat annular disk of vanishing engulfed volume is presented. The approach used follows a technique of isometric mapping. Author

N63-15778 National Aeronautics and Space Administration, Washington, D.C.

ANALYSIS OF AXISYMMETRIC, ROTATING PRESSURIZED FILAMENTARY STRUCTURES

O. R. Burggraf and H. U. Schuerch (Astro Research Corp., Santa Barbara, Calif.) May 1963 47 p 9 refs

(NASA Contract NASr-8)

(NASA TN-D-1920) OTS: $1.25

An analytic treatment of the equilibrium configurations for thin-walled, axisymmetric, rotating, filamentary pressure vessels is presented. Solutions in the form of tabulated elliptical integral functions are developed for the pertinent geometrical characteristics of the structural shapes and for their associated filamentary geometries. A morphological review of the corresponding structures is presented, based upon a discussion of the mathematical properties of the solutions. Experimental realization of the equilibrium configuration of a single filament subject to a centrifugal force field confirms the validity of analytic expressions. Applications of formulas to problems of external loadings and of the static stability of filamentary, pressure-stabilized structures demonstrate the utility of the analytical technique. Author

N63-16986 National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

ORBIT-LAUNCHED NUCLEAR VEHICLE DESIGN AND PERFORMANCE EVALUATION PROCEDURE FOR ESCAPE AND PLANETARY MISSIONS

Ronald J. Harris and Robert E. Austin Washington, NASA, June 1963 74 p 6 refs

(NASA TN D-1570) OTS: $2.00

A comprehensive procedure is described, and reference data presented, by which the effect of certain design parameters upon the basic performance of orbit-launched nuclear vehicles can be readily determined for escape and planetary missions. The performance parameters investigated are payload ratio, propellant ratio, characteristic velocity requirement, burning time, injection altitude, central angle and flight-path angle. The effects of initial thrust-to-weight ratio, initial altitude, specific impulse, specific weight factors and hyperbolic excess velocity are considered. The range of specific impulse assumed is restricted to that considered practical for nuclear-heat-exchanger propulsion systems. Numerical examples are included which illustrate the methodology and indicate the degree of accuracy that can be expected of the estimation procedure. The results of the numerical examples are compared with exact computer solutions, and are shown to be well within the accuracy usually required in preliminary design studies. Author

N63-19277 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

AN INVESTIGATION OF THE NATURAL FREQUENCIES AND MODE SHAPES OF DOUBLE CONICAL SANDWICH DISKS

William M. Thompson, Jr., and Robert R. Clary Washington, NASA, Aug. 1963 27 p 5 refs

(NASA TN D-1940) OTS: $0.75

Experimental data from vibration tests of some shallow sandwich disks, having a radially symmetric thickness linearly tapered from a maximum thickness at the center, are presented. The data show differences in response of disks containing aluminum honeycomb cores and styrofoam cores, with the disk center pinned in one case and suspended on soft supports in another case. Measured natural frequencies for the lower modes are compared with frequencies calculated by the Rayleigh energy method. Author

N63-19610 National Aeronautics and Space Administration, Washington, D. C.

IMPORTANT STRUCTURAL RESEARCH PROBLEMS FOR THE SUPPORT OF FUTURE SPACE MISSIONS

Lewis H. Abraham. Aug. 1963. 19 p. In Collaboration with the NASA Res. Advisory Comm. on Missile and Space Vehicle Structures

(NASA TN D-2059) OTS: $0.50

The purpose of this report is to delineate and predict the structural research problems which can be viewed as technically or economically of major significance to missile and space vehicles planned or envisioned for the time period of 1970 to 1980. This report suggests general areas of research and, where possible, specific areas in which research effort should be concentrated in order to provide necessary information and understanding for the design of missile and space vehicles and necessary support equipment for this era. Author

N63-23126 National Aeronautics and Space Administration, Washington, D. C.

RECOMMENDATIONS AND EVALUATIONS OF MATERIALS-RESEARCH AREAS OF IMPORTANCE TO MISSILE AND SPACE VEHICLE STRUCTURES

Jack B. Esgar, Norris F. Dow, and William R. Micks. Oct. 1963. 31 p. 8 refs. Prepared in collaboration with the NASA Res. Advisory Comm. on Missile and Space Vehicle Struct.

(NASA TN D-2125) OTS: $0.75

Several requirements for research on new and improved structural materials are reviewed and discussed. Information about these requirements in terms of the description of the applications and advantages for improved materials is reviewed for high-temperature materials with oxidation resistance and ductility, low-temperature materials with ductility and impermeability, pressure vessel materials, and shielding materials. Author

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