NASA SPECIAL PUBLICATIONS

SPRING 1966

Foreword

NASA's Special Publications, which comprise six wide-ranging series of titles, form an impressive collection of new scientific and technical information derived from or valuable to the manifold activities of the National Aeronautics and Space Administration.

These Special Publications include such significant sourcebooks as a three-volume set of *Ranger VII Photographs of the Moon* and a series of texts for upper-level engineering students on *Space Technology*. They also include many titles of particular interest to the technical community not involved in the Nation's space program. Representative of the latter category of Special Publications are *Plasma Jet Technology*, *Handling Hazardous Materials*, and *Selected Shop Techniques*.

The varieties of Special Publications include monographs, state-of-the-art summaries, conference proceedings, data compilations, handbooks, source books, histories, chronologies, charts, and selected bibliographies, as well as works directly resulting from NASA's Technology Utilization Program. The last group of publications reports innovations born of the needs of space exploration that are of potential worth to nonaerospace industry. It consists of Technology Utilization Notes, which are logical groupings of innovations in selected technical areas; Technology Utilization Reports, which are detailed descriptions of innovations of industrial promise; and Technology Surveys, state-of-the-art summaries identifying the more substantial contributions to technology being made by NASA or NASA contractors.

Bibliographies included in NASA's Special Publications are of two kinds. One consists of continuing bibliographies, which repackage in recurrent volumes for the specialist's benefit announcements of literature in certain scientific areas, such as aerospace medicine. These continuing bibliographies combine pertinent abstracts from both NASA's biweekly *Scientific and Technical Aerospace Reports* (*STAR*) and AIAA's biweekly *International Aerospace Abstracts* (*IAA*), and they are frequently updated. The other group is made up of bibliographies that cover specific time periods. Not limited to announcements from *STAR* and *IAA*, these special bibliographies reach back farther in time and provide a search of all pertinent available data from any known source of technical information, including newspaper and magazine references along with reports, journal articles, trade publications, meeting papers, and books. They were prepared by specially selected teams of scientists and engineers who are experts in the particular subject fields.

The present listing of NASA's unclassified Special Publications is the first to be published. Under six categories, its titles appear in reverse

chronological order: the newest publication first, the earliest last. The only exceptions to this order are titles, such as those of continuing bibliographies, that have bred supplements. In their case, the date of the latest supplement determines the place of the title in its particular list.

In every instance, the number of pages in a publication, its release date, its price, and the place where it may be obtained are given. Availability is indicated either by the initials CFSTI, meaning Clearinghouse for Federal Scientific and Technical Information, or by the initials GPO, which stand for Government Printing Office. The addresses of those two sources of publications are as follows:

Clearinghouse for Federal Scientific and Technical Information, Port Royal Road, Springfield, Va., 22151.

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

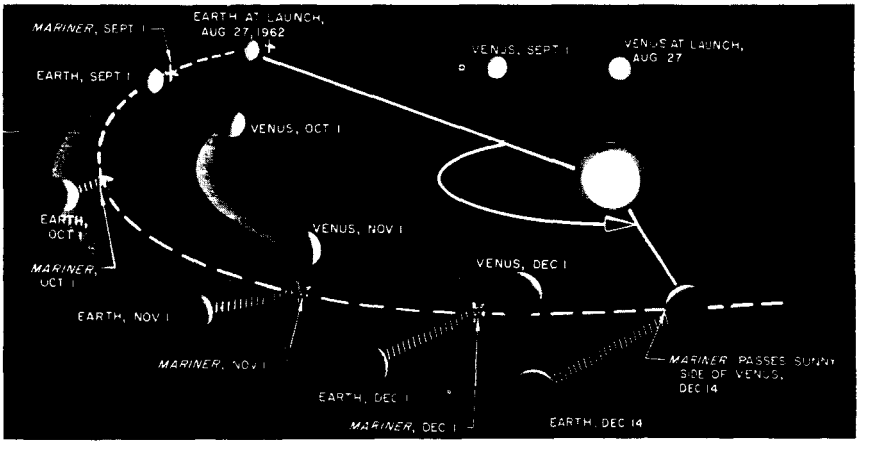
Contents

The Role of the Vestibular Organs in the Exploration of Space — NASA SP-77

A collection of 34 papers, presented at a conference in Pensacola, Fla., in January 1965, which comprises a state-of-the-art report on the experiments and observations of the effect space travel may have on the vestibular organs of man. The information includes animal studies, oscillation studies, use of drugs, and so forth. *Published January 1966.*

(392 pp.; GPO, $2.25)

Mariner-Venus 1962: Final Project Report — NASA SP-59



Prepared by the Jet Propulsion Laboratory, this report describes the history-making flight of the Mariner II spacecraft to the vicinity of Venus. The chronology begins with the activation of the project as a means for meeting the 1962 Venus launch opportunities. Chapters include historical background on Venus, project organization and management, and spacecraft system design and development. Other chapters cover operational events describing the Mariner II mission evaluation of the subsystems, tracking network, the data-recovery and processing system, and findings of the scientific experiments. *Published January 1966.* (344 pp.; GPO, $2.50)

NASA 1965 Summer Conference on Lunar Exploration and Science — NASA SP-88

Results of the conference on lunar exploration, held in Falmouth, Mass., in July 1965, including the conclusions and recommendations drawn from it. An overall lunar-mission summary is given, together with the working-group reports from which the summary was obtained, in the disciplines Geodesy/Cartography, Geology, Geophysics, Bioscience, Geochemistry (Mineralogy and Petrology), Particles and Fields, Lunar Atmosphere Measurements, and Astronomy. *Published January 1966.* (422 pp.; GPO, $1.50)

Observations From the Nimbus I Meteorological Satellite — NASA SP-89

Six papers presented by personnel of Goddard Space Flight Center at the Western Annual Meeting of the American Geophysical Union, held December 29, 1964, in Seattle. Early results obtained with the Nimbus I satellite are presented and discussed. *Published December 1965.* (90 pp.; CFSTI, $1.00)

The Meteoroid Environment and Its Effects on Materials and Equipment — NASA SP-78

Summary of a literature survey, prepared by the National Academy of Sciences, of publications appearing since 1960 on the meteoroid environment and its effects on materials and equipment. This detailed study is divided into sections: environment, hypervelocity-impact phenomena, and design considerations. *Published December 1965.* (116 pp.; GPO, $0.50)

Final Report on the Relay I Program — NASA SP-76

This report deals with (1) the design, development, and performance of the spacecraft hardware; (2) the various experiments performed (communications and radiation), plus a description of the Nutley, N.J., and the Andover, Maine, ground stations; and (3) information received from foreign governments participating in the Relay I project. *Published November 1965.* (767 pp.; GPO, $1.75)

NASA University Program Review Conference — NASA SP-85

A review conducted at a conference in Kansas City, Mo., March 1–3, 1965, by university professors and administrators of the programs sponsored by NASA through grants and research contracts with universities throughout the country. Included are papers on X-ray and gamma-ray astronomy and biological research, as well as on the effect the grants and contracts have had on research at particular universities. *Published November 1965.* (400 pp.; GPO, $1.50)

Dictionary of Technical Terms for Aerospace Use — NASA SP-7

This first edition of a dictionary for space scientists and technologists contains more than 6000 carefully chosen and precisely defined terms. It has not attempted, however, to include every aspect of space terminology. Compiled by William H. Allen. *Published November 1965.* (314 pp.; GPO, $3.00)

IEEE–NASA Symposium on the Definition and Measurement of Short-Term Frequency Stability — NASA SP-80

Papers and discussions presented at a symposium held at Goddard Space Flight Center, November 23–24, 1964, and sponsored jointly by NASA–GSFC and the Institute of Electrical & Electronic Engineers. The proceedings are arranged in four sessions, namely: I, Users' Viewpoint and Requirements; II, Theory; III, Devices; and IV, Measurement Techniques. *Published November 1965.* (317 pp.; GPO, $1.75)

Proceedings of the Apollo Unified S-Band Technical Conference — NASA SP-87

Papers presented at the conference held July 14–15, 1965, at Goddard Space Flight Center. The presentations made by persons directly involved in the Apollo program describe in some detail the ground systems that GSFC is now implementing for the complex support required for the Apollo Manned Space Flight Network. *Published October 1965.* (302 pp.; CFSTI, $3.00)

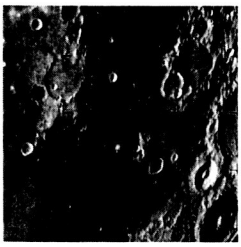
An Analysis of the Extraterrestrial Life Detection Problem — NASA SP–75

Guidelines and ground rules for a cohesive study of the solar system and beyond for evidences of life—past, present, or future. The study includes a section on "The Attributes of Life" and is mainly concerned with a discussion of conditions on Mars. *Published October 1965.* (33 pp.; CFSTI, $0.50)

Ranger VII Photographs of the Moon. Part I: Camera "A" Series — NASA SP–61

Reproductions of the 199 photographs taken by the "A" camera of Ranger VII at altitudes from 1300 miles to 3 miles above the surface of the Moon. Large format. *Published November 1964.* (226 pp.; GPO, $6.50)

Ranger VII Photographs of the Moon. Part II: Camera "B" Series — NASA SP–62



Reproductions of the 200 photos from the "B" camera, taken over same altitude range as in Part I. Large format. *Published March 1965.* (217 pp.; GPO, $6.50)

Ranger VII Photographs of the Moon. Part III: Camera "P" Series — NASA SP–63

Third and last volume in the series presenting Ranger VII photographs of the Moon, taken over the same altitude range. Part III includes 758 of the more than 3900 photographs taken with the 4 partial-scan P cameras. Large format. *Published October 1965.* (200 pp.; GPO, $6.50)

Proceedings of Second Symposium on Protection Against Radiations in Space — NASA SP–71

Papers of a conference held at Gatlinburg, Tenn., in October 1964, and sponsored by AEC, NASA, and USAF. Four disciplines are represented: The Radiation Environment, Biological Effects, Effects on Materials, and Shielding. *Published October 1965.* (551 pp.; GPO, $3.25)

Conference on Aircraft Operating Problems — NASA SP–83

Papers presented at the NASA Conference on Aircraft Operating Problems held at Langley Research Center, May 10–12, 1965. Contributions were made by representatives of NASA's Ames Research Center, Flight Research Center, and Langley Research Center, as well as by representatives of the Federal Aviation Agency. *Published August 1965.* (327 pp.; CFSTI, $3.00)

Summary Report on the NASA University Program Review Conference — NASA SP–81

Summary of the NASA University Program Review Conference held in Kansas City, Mo., March 1–3, 1965, including a discussion of background objectives, and policies of the NASA University Program from the point of view of a university professor. *Published July 1965.* (37 pp.; CFSTI, $1.00)

Electrical Power Generation Systems for Space Applications — NASA SP–79

State-of-the-art summary of several papers and committee reports on electric-power systems for space use, prepared by the Department of Defense and NASA for the supporting Research and Technical Panel of the Aeronautics and Astronautics Coordinating Board. *Published July 1965.* (40 pp.; CFSTI, $1.00)

Symposium on the Analysis of Central Nervous System and Cardiovascular Data Using Computer Methods — NASA SP–72

Proceedings of a conference held in Washington, D.C., October 29–30, 1964, at which Government and university authorities discussed use of computer techniques in collecting and analyzing data on the central nervous and cardiovascular systems. *Published July 1965.* (600 pp.; CFSTI, $4.50)

The Nature and Scope of the NASA University Program — NASA SP–73

Description and discussion of university research and training programs sponsored by NASA. Background and philosophy are given. *Published July 1965.* (39 pp.; GPO, $0.25)

Space Technology. Vol. I, Spacecraft Systems — NASA SP–65

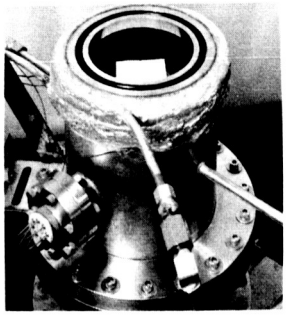
Basic text for the upper-level college engineering student on methods and processes of planning spacecraft systems so that the relationships of various parts and the utilization of various subsystems are fully established before designs are committed. *Published June 1965.* (85 pp.; GPO, $0.35)

Space Technology. Vol. II, Spacecraft Mechanical Engineering — NASA SP–66

Spacecraft Mechanical Engineering for the engineering student in terms of structures, temperature control, mechanisms, and electronic packaging. Some basic theory is presented, application of the theory and experiment to spacecraft examined, and actual examples of spacecraft hardware discussed. *Published June 1965.* (166 pp.; GPO, $0.60)

Symposium on Thermal Radiation of Solids — NASA SP–55

Symposium held in San Francisco, March 4–6, 1964, sponsored by NASA, the National Bureau of Standards, and the USAF's Aeronautical Systems Division. Papers constitute the sharing of research ideas and experiences by engineers, physicists, and representatives of other disciplines for the advancement of the science of thermal radiation of solids. Discussion sessions included in the book relate to the practical solution of space-age problems involving thermal radiative phenomena. The document also carries Air Force No. ML–TDR–64–159. Author and subject indexes. *Published June 1965.* (620 pp.; GPO, $3.75)



Survey of the Literature on the Solar Constant and the Spectral Distribution of Solar Radiant Flux — NASA SP–74

Survey of currently available data on this subject, including a discussion of relevant theoretical considerations concerning radiation, solar physics, scales of radiometry, and the thermal balance of spacecraft. *Published May 1965.* (43 pp.; CFSTI, $2.00)

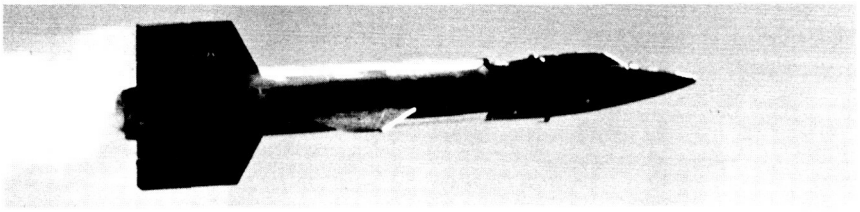
Aerodynamic Design of Axial-Flow Compressors — NASA SP–36

Results of the extensive research on the design of axial-flow compressors have been assimilated and correlated in this volume. Attention has been focused primarily on the problems pertinent to the axial-flow compressor of turbojet or turboprop engines, but the results should be applicable to any class of axial-flow compressors. Revised edition. *Published May 1965.* (508 pp.; GPO, $3.00)

Scientific Findings From Explorer VI — NASA SP–54

Selected papers and reports on data collected by Explorer VI, designed to provide a coordinated, comprehensive group of measurements of scientific interest over as large a region of the magnetosphere as possible. Simultaneous studies were made of the trapped radiation in the Van Allen region, galactic cosmic rays, geomagnetism, radio propagation in the upper atmosphere, and the flux of micrometeorites, or cosmic dust. *Published April 1965.* (381 pp.; GPO, $2.25)

X–15 Research Results, With a Selected Bibliography — NASA SP–60



Semitechnical summary of the X–15 program, directed toward achievements in scientific research rather than the better publicized and spectacular milestones of flight in the near-space environment. Index. *Published April 1965.* (128 pp.; GPO, $0.55)

Proceedings of the Conference on Space Nutrition and Related Waste Problems — NASA SP–70

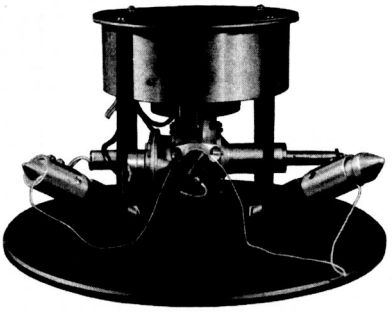
Proceedings of a conference held at the University of South Florida in Tampa, April 27–30, 1964, at which Government, industry, and university scientists considered the nutrition and waste problems associated with maintaining astronauts in space, especially over extended periods of time. Approximately 60 papers with discussions by conferees. *Published March 1965.* (400 pp.; GPO, $2.75)

Physics of Nonthermal Radio Sources — NASA SP–46

Proceedings of a conference for an international group of astronomers and physicists, held December 3–4, 1962, at the NASA Goddard Institute for Space Studies. The papers cover radio observations, optical observations, and theory of nonthermal radio sources outside the solar system. Index. *Published January 1965.* (171 pp.; GPO, $0.75)

Concepts for Detection of Extraterrestrial Life

NASA SP–56



The devices and instruments described in this illustrated booklet are among those planned for inclusion in vehicles designed to land on planets such as Mars. They constitute techniques for detecting growth and metabolism, for determining the presence of biologically significant molecules, and for actual visual observation of microorganisms and the planetary terrain. *Published December 1964.* (53 pp.; GPO, $0.50)

Effect of Ionizing Radiation on a Series of Saturated Polyesters

NASA SP–58

The polyesters of dihydric alcohols, HO–R_1–OH, and dicarboxylic acids, HOOC–R_2–COOH, were prepared autocatalytically and underwent ionizing radiation. The observed radiation effects were correlated to the molecular weights of the respective polymers. It was shown that the structural features of the polyester segment derived from the polyesterification of specific diols and specific diacids influenced greatly the direction and magnitude of the radiation effects. *Published November 1964.* (63 pp.; CFSTI, $1.75)

Quasi-Global Presentation of Tiros III Radiation Data

NASA SP–53

Worldwide radiation map in the 8- to 12-micron atmospheric "window," as derived from Tiros III's Channel 2 measurements for July 16, 1961. The map, covering the globe between 55° N and 55° S, is superimposed on various conventional synoptic analyses to study the utility of satellite radiation data for meteorological-analysis purposes. Extra-large format. *Published November 1964.* (23 pp.; GPO, $2.00)

Space-Cabin Atmospheres: Part I, Oxygen Toxicity

NASA SP–47

Review of the literature on toxicity of oxygen at pressures of less than 1 atmosphere, and the relation of oxygen to other factors of concern in space cabins, such as radiation effects and lung blast. *Published October 1964.* (51 pp.; GPO, $0.40)

Space-Cabin Atmospheres: Part II, Fire and Blast Hazards

NASA SP–48

Summary of the open literature on this subject, intended primarily for biomedical scientists and design engineers. *Published May 1964.* (119 pp.; GPO, $1.00)

Fourth National Conference on the Peaceful Uses of Space

NASA SP–51

Thirty papers delivered at a conference held in Boston, April 29–May 1, 1964. Eight sessions: Space and the Nation, Congress and Science, Men in Space, the Future, Machines in Space, Practical Uses of Satellites, Living in Space, and Working for Space. *Published October 1964.* (225 pp.; GPO, $1.50)

AAS–NASA Symposium on the Physics of Solar Flares

NASA SP–50

Proceedings of a conference at Goddard Space Flight Center, October 28–30, 1963, of American, European, Asian, and Australian scientists reporting on research progress in the field of solar-flare activity. Papers cover both observations and theory. Among the topics discussed are the origin, structure, motion, and development of flares; spectrographic observations; X-ray, gamma-ray, and radio emission; and energetic particles. *Published October 1964.* (465 pp.; GPO, $3.25)

Meteorological Observations Above 30 Kilometers

NASA SP–49

Three papers on meteorological rockets, network data, and rocket soundings, comprising one session of a conference on Meteorological Support for Aerospace Testing and Operation, held at Colorado State University, Fort Collins, July 11–12, 1963. *Published June 1964.* (57 pp.; GPO, $0.40)

Conference on the Law of Space and of Satellite Communications

NASA SP–44

Proceedings of a conference organized by Northwestern University School of Law, Evanston, Ill., May 1–2, 1963, as part of the Third National Conference on the Peaceful Uses of Space. The formal papers and comments in the first part of the volume represent an attempt to provide a broad perspective of the legal problems that have arisen and will emerge in the space age, and to indicate to what degree informal legal thought has reached a consensus or formulated tentative conclusions as to their resolution. The second part of the volume is concerned with monopoly and antitrust aspects, administrative aspects, and international aspects of communications satellite operations. *Published May 1964.* (205 pp.; GPO, $1.50)

Proceedings of NASA–AEC Liquid Metals Corrosion Meeting, Vol. I

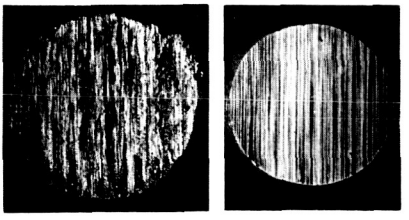
NASA SP–41

Proceedings of the unclassified portions of a meeting, held at NASA's Lewis Research Center, October 2–3, 1963, on mechanisms of liquid-metal corrosion, the results of compatibility tests with alkali metals, and the problems related to compatibility testing with alkali metals. *Published May 1964.* (316 pp.; CFSTI, $5.00)

Advanced Bearing Technology

NASA SP–38

Exposition of the fundamentals of friction and wear, fluid-film bearings, and rolling-element bearings, plus demonstrations of how fundamental principles can be applied to the solution of unique and advanced bearing problems. *Published February 1964.* (511 pp.; GPO, $1.75)



Results of the Project Mercury Ballistic and Orbital Chimpanzee Flights — NASA SP-39

This publication presents a full account of the flights of the Project Mercury chimpanzees, from program-planning through launch and recovery operations. It gives a detailed account of training techniques, in-flight measurements, and post-flight evaluation procedures. These flights verified the feasibility of manned space flight. The suborbital ballistic flight of "Ham," on January 31, 1961, was the prelude to Astronaut Alan B. Shepard's suborbital space flight, while the orbital flight of "Enos," on November 29, 1961, preceded the comparable flight of Astronaut John H. Glenn, Jr. *Published January 1964.* (71 pp.; GPO, $0.45)

Conference on Space, Science, and Urban Life — NASA SP-37

Proceedings of a conference held at Oakland, Calif., in March 1963, on the applicability of the national space program, and the knowledge resulting from aerospace research, to the problems of urban growth. *Published January 1964.* (254 pp.; GPO, $1.75)

Measurement of Thermal Radiation Properties of Solids — NASA SP-31

Proceedings of a symposium held at Dayton, Ohio, September 1962, and sponsored by NASA, the Air Force, and the National Bureau of Standards. *Published December 1963.* (587 pp.; GPO, $3.50)

Telstar I: Vols. 1, 2, and 3 — NASA SP-32

Compilation of papers written by employees of Bell Telephone Laboratories who were involved in the Telstar project. Volume 3 also contains an index to all three volumes. *Published November 1963.* (1940 pp.; CFSTI, $10.00 for set of 3; volumes not sold individually)

Ariel I: The First International Satellite — NASA SP-43

Project summary of the satellite launched April 26, 1962, in a cooperative effort by the United Kingdom and the United States. *Published November 1963.* (76 pp.; GPO, $0.70)

Mercury Project Summary, Including Results of the Fourth Manned Orbital Flight, May 15–16, 1963 — NASA SP-45

Review of the planning, preparation, experiences, and results of Project Mercury, including the results of the fourth U.S. manned orbital space flight—the final 34-hour mission of Astronaut L. Gordon Cooper. *Published September 1963.* (444 pp.; GPO, $2.75)

Conference on Space-Age Planning — NASA SP-40

Proceedings of the general sessions of the Third National Conference on the Peaceful Uses of Space, held in Chicago, May 1963. Participants included representatives of NASA, industry, and universities. Twenty-nine papers are presented under these broad headings: National Space Program, University-Industry Partnership in Space Projects, How Space Activities Are Changing the Economy, Consumer Goods Opportunities From Space Research, Placement and Management of Research and Development Projects, and Opportunities and Challenges in Space Procurement. *Published August 1963.* (301 pp.; GPO, $2.00)

The Observatory Generation of Satellites — NASA SP–30

Discussion of the missions and engineering designs of the Orbiting Geophysical Observatories, the Advanced Orbiting Solar Observatory, and the Orbiting Astronomical Observatory. *Published April 1963.* (62 pp.; GPO, $0.50)

NASA-Industry Program Plans Conference — NASA SP–29

Speeches and statements describing NASA's organization, present plans, and possible future projects, presented at a conference in Washington, D.C., February 11–12, 1963, for the information of industrial management as a partner in the national space program. *Published March 1963.* (231 pp.; GPO, $1.25)

Results of the Third U.S. Manned Orbital Space Flight, October 3, 1962 — NASA SP–12

Results of the MA–8 flight by Astronaut Walter Schirra, October 1962, including spacecraft and launch-vehicle performance, mission operations, aeromedical analysis of pilot performance, and pilot's flight report. *Published January 1963.* (120 pp.; GPO, $0.70)

Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration (Vols. 1 and 2) — NASA SP–11

State-of-the-art papers on NASA programs presented to the scientific and technical community at a conference held in Chicago, November 1–3, 1962. *Published December 1962.* (Vol. 1, 429 pp.; GPO, $2.50. Vol. 2, 532 pp.; GPO, $3.00)

These papers have also been individually published as follows:

Geophysics and Astronomy in Space Exploration	**NASA SP–13** (43 pp.; GPO, $0.35)
Lunar and Planetary Sciences in Space Exploration	**NASA SP–14** (85 pp.; GPO, $0.55)
Celestial Mechanics and Space Flight Analysis	**NASA SP–15** (41 pp.; GPO, $0.35)
Data Acquisition From Spacecraft	**NASA SP–16** (59 pp.; GPO, $0.40)
Control, Guidance, and Navigation of Spacecraft	**NASA SP–17** (54 pp.; GPO, $0.40)
Bioastronautics	**NASA SP–18** (35 pp.; GPO, $0.30)
Chemical Rocket Propulsion	**NASA SP–19** (55 pp.; GPO, $0.40)
Nuclear Rocket Propulsion	**NASA SP–20** (62 pp.; GPO, $0.45)
Power for Spacecraft	**NASA SP–21** (26 pp.; GPO, $0.25)
Electric Propulsion for Spacecraft	**NASA SP–22** (37 pp.; GPO, $0.35)
Aerodynamics of Space Vehicles	**NASA SP–23** (56 pp.; GPO, $0.40)

208–373 O—66——2

Gas Dynamics in Space Exploration — NASA SP-24
(51 pp.; GPO, $0.40)

Plasma Physics and Magnetohydrodynamics in Space Exploration — NASA SP-25
(77 pp.; GPO, $0.50)

Laboratory Techniques in Space Environment Research — NASA SP-26
(51 pp.; GPO, $0.40)

Materials for Space Operations — NASA SP-27
(46 pp.; GPO, $0.35)

Structures for Space Operations — NASA SP-28
(46 pp.; GPO, $0.35)

Proceedings of the Second National Conference on the Peaceful Uses of Space — NASA SP-8

Principal addresses, scientific papers, and panel discussions of a conference held in May 1962. *Published December 1962.* (282 pp.; GPO, $1.50)

Image Intensifier Symposium — NASA SP-2

Proceedings of the symposium held at Fort Belvoir, Va. October 24–26, 1961, under the joint sponsorship of NASA and the U.S. Army Engineer Research and Development Laboratories. *Published November 1962.* (252 pp.; GPO, $1.50)

U.S. Standard Atmosphere, 1962 — (No Number)

Updated tables of atmospheric parameters to 700 kilometers, incorporating results of rocket and satellite research through mid-1962. *Published September 1962.*
(278 pp.; GPO, $3.50)

Results of the Second United States Manned Orbital Space Flight, May 24, 1962 — NASA SP-6

Results of the MA–7 flight by Astronaut M. Scott Carpenter. *Published August 1962.*
(107 pp.; GPO, $0.65)

List of Selected References on NASA Programs — NASA SP-3

List of the selected NASA publications and releases issued during the 3 years following the agency's establishment, in October 1958. *Published July 1962.* (236 pp.; GPO, $1.25)

NASA Day, April 27, 1962: Western Space Age Industries and Engineering Exposition and Conference — NASA SP-4

Published record of NASA participation in the conference held in Washington, D.C., in April 1962. NASA speakers provided industrial management with information on NASA's programs and procedures. *Published July 1962.* (66 pp.; GPO, $0.45)

Results of the First United States Manned Orbital Space Flight, February 20, 1962 — (No Number)

Results of the MA–6 flight by Astronaut John H. Glenn, Jr. *Published April 1962.*
(204 pp.; GPO, $1.25)

Proceedings of the International Meteorological Satellite Workshop (No Number)

Report of the workshop held in Washington, D.C., November 13–22, 1961, on the results of the meteorological-satellite program of the United States and the possibilities for the future. The workshop was sponsored by NASA and the Weather Bureau. *Published January 1962.* (226 pp.; GPO, $1.75)

Results of the Second U.S. Manned Suborbital Space Flight, July 21, 1961 (No Number)

Report of the second (MR–4) manned suborbital space flight, on July 21, 1961, in which Astronaut Virgil I. Grissom was the pilot. *Published September 1961.* (58 pp.; GPO, $0.45)

Proceedings of a Conference on Results of the First U.S. Manned Suborbital Space Flight (No Number)

Report of the early results from the MR–3 flight, on May 5, 1961, of Astronaut Alan B. Shepard, Jr., with primary emphasis on the medical results. The conference, held in Washington, D.C., June 6, 1961, was sponsored by NASA in cooperation with the National Institutes of Health and National Academy of Sciences. *Published July 1961.* (76 pp.; GPO, $0.50)

Proceedings of the First National Conference on the Peaceful Uses of Space (No Number)

Proceedings of the conference held at Tulsa, May 26–27, 1961, describing the NASA program and its potential applications. *Published July 1961.* (184 pp.; GPO, $1.25)

NASA-Industry Program Plans Conference (No Number)

Proceedings of a conference held in Washington, D.C., July 28–29, 1960, whose purpose was to provide industrial management with an overall picture of the NASA program and to establish an adequate basis for subsequent conferences at various NASA Centers. *Published September 1960.* (124 pp.; GPO, $0.75)

Handbooks, Data Compilations, Charts, and Tables

Magnetic Fields Due to Solid and Hollow Conical Conductors — NASA SP-3022

The axial and radial components of the magnetic field produced by a solid, finite-length conical conductor with a constant azimuthal current density were derived, and numerical results were computed for several values of the half-cone angle. The triple integrals giving the field values were integrated twice analytically; the third integration was done numerically on electronic computers using Gaussian integration. Axial and radial magnetic fields due to hollow conical coils or hollow frustum coils of finite thickness can be obtained from these solid-cone fields by superposition. *Published December 1965.* (132 pp.; CFSTI, $1.00)

Equilibrium Thermodynamic Properties of Three Engineering Models of the Martian Atmosphere — NASA SP-3021

Entropy, enthalpy, pressure, and sound speed of three carbon dioxide-nitrogen mixtures are presented graphically for wide ranges of temperature and density. The temperature range is $250° \text{ K} \leq T \leq 25\,000° \text{ K}$ ($\Delta T = 250° \text{ K}$). The density range is $-7.0 \leq \log \rho/\rho_0 \leq 3.0$ ($\Delta \log \rho/\rho_0 = 0.2$). The chemical compositions of the three mixtures correspond to those selected as engineering models of the Mars atmosphere in NASA TN D-2525. *Published November 1965.* (162 pp.; CFSTI, $2.50)

Charts of Isentropic Exponent as a Function of Enthalpy for Various Gases in Equilibrium — NASA SP-3020

For enthalpies to 28 000 Btu/lb and pressures from 10^{-3} to 10^{2} atmospheres, curves of isentropic exponent as a function of enthalpy and speed are presented for equilibrium air, nitrogen carbon dioxide, and a composition of 20% CO_2 and 80% N_2 (by volume). For a pressure of 1 atmosphere, curves are also presented for compositions of 10% CO_2–90% N_2 and for 50% CO_2–50% N_2. *Published October 1965.* (10 pp.; CFSTI, $0.50)

Charts for Equilibrium and Frozen Nozzle Flows of Carbon Dioxide — NASA SP-3019

Results are presented for total pressures ranging to 1000 atmospheres and total enthalpies ranging to 55 kilojoules per gram. The properties of temperature, pressure, density, velocity dynamic pressure, Mach number, Reynolds number, molecular-weight ratio, and species concentrations are presented in charts. Temperature, pressure ratio, and density ratio across normal shock waves in a nozzle are also included. *Published August 1965.* (78 pp.; CFSTI, $0.75)

Charts for Equilibrium and Frozen Flows Across Plane Shock Waves in Carbon Dioxide — NASA SP-3018

In this work, the flow was assumed to be in equilibrium and the chemistry to be frozen with molecular vibrations either not excited or fully excited. Results are presented in graphical form for ambient pressures ranging from 10^{-7} to 10 atmospheres, and for speeds ranging from 1 to 16 km/sec. *Published July 1965.* (129 pp.; CFSTI, $1.00)

Charts for Approximate Thermodynamic Properties of Nitrogen-Oxygen Mixtures — NASA SP-3017

The purpose of this publication is to present data, determined by one consistent approach, on the thermodynamic properties of nitrogen and three nitrogen-oxygen compositions and the dimensionless speed-of-sound parameter for each. These properties have been calculated over a temperature range from 200° to 15 000° K for a pressure range from 10^{-4} to 10^{2} atmospheres. The data are presented in a combination of Mollier charts and tables, so that aerodynamic expansions can be performed. The results, which agree closely with more rigorous calculations, are considered suitable for engineering purposes. *Published June 1965.* (116 pp.; CFSTI, $1.25)

Venus and Mars Nominal Natural Environment for Advanced Manned Planetary Mission Programs — NASA SP-3016

Numerical values for a nominal natural environment for application in studies of advanced planetary missions to Venus and Mars. The data compiled here provide a standard environment so that various mission and preliminary design studies will all be based on realistic data and have a common basis for comparison of end results. *Published May 1965.* (71 pp.; CFSTI, $3.00)

Charts for Equilibrium Flow Properties of Carbon Dioxide in Hypervelocity Nozzles — NASA SP-3015

Conjecture on the composition of the Venusian and Martian atmospheres, as well as interest in the problems of flight within these atmospheres, has prompted this investigation. For initial stagnation pressures from 1 to 1000 atm and stagnation enthalpies from 400 to 20 000 Btu/lb, nozzle-flow properties for equilibrium carbon dioxide have been computed and plotted. Properties charted as a function of Mach number are as follows: temperature, pressure, density, speed, area ratio, dynamic pressure, stagnation-point pressure coefficient, Reynolds number, isentropic exponent, and molecular-weight ratio. Temperatures, pressures, and densities across normal shock waves are also charted, and weight-flow rate is plotted as a function of stagnation enthalpy. *Published April 1965.* (71 pp.; CFSTI, $3.00)

Equilibrium Thermodynamic Properties of Carbon Dioxide — NASA SP-3014

Entropy, enthalpy, pressure, and speed of sound of carbon dioxide computed for wide ranges of temperature and density are presented graphically. The temperature range is $250° \text{ K} \leq T \leq 25\,000° \text{ K}$ ($\Delta T = 250°$ K). The density range is $-7.0 \leq \log \rho/\rho_0 \leq +3.0$ ($\Delta \log \rho/\rho_0 = 0.2$). *Published April 1965.* (66 pp.; CFSTI, $3.00)

Bioastronautics Data Book — NASA SP-3006

This publication is for designers of aerospace vehicles and equipment. It contains carefully selected applied research data from the life sciences in consistent engineering units, accompanied by metric scales. Index. *Published February 1965.* (400 pp.; GPO, $2.25)

Tables of Energy Losses and Ranges of Electrons and Positrons — NASA SP-3012

Tables giving the mean energy loss of electrons by collisions with atomic electrons and by bremsstrahlung, the mean range, and the radiation yield (conversion of electron kinetic energy into bremsstrahlung energy) are presented for approximately 40 materials and 80 energies between 10 keV and 1000 MeV. Some comparisons are made between calculated and experimental values of the mean energy loss. *Published December 1964.* (127 pp.; CFSTI, $4.00)

Tables of Energy Losses and Ranges of Heavy Charged Particles — NASA SP-3013

Two-variable proton stopping-power and range tables are given as functions of the particle energy τ and of the mean excitation energy I_{adj} of the medium for 160 values of τ between 1 and 5000 MeV, and for 36 values of I_{adj}. These tables can be applied to any medium with specified mean excitation energy. Stopping-power and range tables that include the density-effect correction are given for protons, haons, pions, muons for 36 elements and compounds. *Published December 1964.* (131 pp.; CFSTI, $4.00)

Thermodynamic and Transport Properties for the Hydrogen-Oxygen System — NASA SP-3011

The properties calculated include enthalpy, entropy, molecular weight, heat capacity, isentropic exponent, composition, viscosity, thermal conductivity, and Prandtl number and Lewis number for chemical-equilibrium conditions. Also included are frozen heat capacity, frozen thermal conductivity, and frozen Prandtl number, all calculated with the equilibrium composition. Results are presented in tabular form and, in some cases, in graphical form. *Published August 1964.* (419 pp.; CFSTI, $6.00)

Tables of the Complex Fresnel Integral — NASA SP-3010

The complex Fresnel integral defined by

$$\int_0^{x+iy} \exp\frac{i\pi u^2}{2}\,du$$

is evaluated by means of Taylor's series expansions. The real and imaginary parts, accurate to five significant figures, are tabulated essentially throughout the complex plane, except in the regions $xy < -6.8$. Tabulation intervals in the x-direction are 0.02 for $0 \leq X \leq 10$, and 0.01 for $10 \leq X \leq 20$. Similar intervals apply in the y and $-y$ directions. An error analysis is presented of the methods used to evaluate the integrals. *Published July 1964.* (298 pp.; CFSTI, $4.00)

Tables for Supersonic Flow Around Right Circular Cones at Small Angle of Attack — NASA SP-3007

Results are presented for cone angles from 2.5° to 30° in regular increments of 2.5°. The calculations were performed using the theory of Stone, which yields results in a wind-fixed coordinate system. However, all results have been transformed into a body-fixed coordinate system. *Published June 1964.* (422 pp.; GPO, $2.25)

Tables of Flow Properties of Thermally Perfect Carbon Dioxide and Nitrogen Mixtures — NASA SP-3009

Equations, tables, and figures for use in the analysis of flow of carbon dioxide and mixtures of carbon dioxide and nitrogen. Tables of gas properties as functions of temperature and one-dimensional, normal, and oblique-shock parameters as functions of Mach number are presented for Mach numbers up to 12.7. The parameters dependent on Mach number are tabulated for stagnation temperatures from 1000° R to 3000° R. Condensation Mach numbers are also given. *Published May 1964.* (113 pp.; CFSTI, $2.50)

Thermodynamic Properties and Mollier Chart for Hydrogen From 300° K to 20 000° K — NASA SP-3002

The calculated properties for pressures from 10^4 to 10^3 atmospheres include energy, enthalpy, entropy, specific heats, and equilibrium constants for dissociation and ionization, chemical composition, density, compressibility, and speed of sound. Results are presented

in tabular form and in the form of a Mollier diagram, and are considered to be suitable for engineering purposes. *Published April 1964.* (63 pp.; CFSTI, $1.75)

Energy Spectra and Angular Distributions of Electrons Transmitted Through Sapphire (Al_2O_3) Foils — NASA SP–3008

Monte Carlo results are presented, in the form of 72 tables for the transmission of electrons with energies between 1 and 8 MeV through sapphire foils. Two types of beam geometry are treated for all source energies: (*a*) perpendicular incidence and (*b*) beams with an initial cosine-law angular distribution. For a source energy of 2 MeV, various incident beam obliquities are also treated. The physical factors taken into account include the energy losses due to collisions with atomic electrons, the mean energy loss due to bremsstrahlung, and the angular deflections and path detours due to multiple Coulomb scattering by atoms. *Published April 1964.* (107 pp.; CFSTI, $2.50)

Tables for Supersonic Flow Around Right Circular Cones at Zero Angle of Attack — NASA SP–3004

Results are presented for cone angles from 2.5° to 30° in regular increments of 2.5°. The calculations were performed using the Taylor and Maccoll theory. Numerical integrations were performed using the Runge-Kutta method for second-order differential equations. The desired free-stream Mach number was obtained to six or more significant figures in all calculations. The data listed in this report are essentially the same as those of Zdenk Kopal's Tables of Supersonic Flow Around Cones. *Published April 1964.* (421 pp.; GPO, $2.25)

Tables of the Composition, Opacity, and Thermodynamic Properties of Hydrogen at High Temperatures — NASA SP–3005

All data are tabulated for 14 total pressures between 1 and 1000 atmospheres and for 21 temperatures between 3000 and 200 000 R. Spectral-absorption coefficients are tabulated for 33 wave numbers between 1000 and 400 000 cm^{-1} at each pressure and temperature. The equations employed in making the theoretical calculations are listed, and typical examples of the tabulated data are presented in graphical form. *Published January 1964.* (185 pp.; CFSTI, $3.00)

Handbook of Space-Radiation Effects on Solar-Cell Power Systems — NASA SP–3003

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. *Published September 1963.* (120 pp.; CFSTI, $2.50)

Thermodynamic Properties to 6000° K for 210 Substances Involving the First 18 Elements — NASA SP–3001

Consistent tables for gaseous and condensed species give the following 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 enthalpy changes and logarithms of equilibrium constants. *Published September 1963.* (328 pp.; CFSTI, $5.00)

Histories and Chronologies

Space Medicine in Project Mercury — NASA SP–4003

This volume examines the development of NASA's fund of space-medicine information and experience. It also shows how NASA was able to draw upon the vast and rich resources of the Air Force, the Navy, other Government agencies, industry, and academic and private research institutions to develop life-support systems to protect man against the stresses of launch, orbit, reentry, and impact throughout the Mercury program. Index. *Published September 1965.* (198 pp.; GPO, $1.00)

Astronautics and Aeronautics, 1964: Chronology on Science, Technology, and Policy — NASA SP–4005

A chronology of events and statements of the seventh year of the space age, compiled from open public sources as ready reference for current use by space technologists, scholars, students, and writers, as well as for future analysts and historians. Index. *Published July 1965.* (527 pp.; GPO, $1.75)

Astronautics and Aeronautics, 1963: Chronology on Science, Technology, and Policy — NASA SP–4004

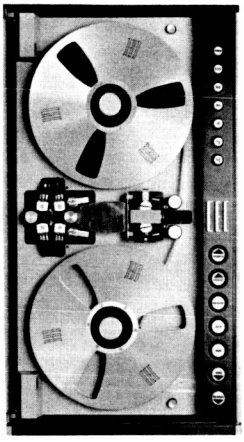
A chronology of events and statements of the sixth year of the space age, compiled from open public sources as ready reference for current use by space technologists, scholars, students, and writers, as well as for future analysts and historians. Index. *Published December 1964.* (610 pp.; GPO, $2.00)

Project Mercury: A Chronology — NASA SP–4001

A listing of major events in the first U.S. manned space-flight program, from preliminary discussions of Earth satellite vehicles through Astronaut Cooper's 22-orbit flight, in May 1963. Index. *Published September 1963.* (238 pp.; GPO, $1.50)

Magnetic Tape Recording Technology

NASA SP–5038



This Technology Survey discusses the entire range of recorder technology, but it emphasizes two aspects of development in which NASA has importantly participated. One is the area of miniature severe-environment tape recorders, for use in satellites and space probes. The other area particularly explored in this publication is that of commercial, ground-based tape recorders for acquiring telemetry data and for related purposes. It would be impossible to extract NASA's specific contributions to the technology of data acquisition and data reduction from the mass of application lore and know-how that has been generated, but NASA has had a strong indirect influence on this technology as a major customer for its products. Index. *Published January 1966.*

(326 pp.; GPO, $1.25)

The Electromagnetic Hammer

NASA SP–5034

Technology Utilization Report describing a method, under investigation at George C. Marshall Space Flight Center and by NASA contractors, of using electrodynamic forces for removing the distortion from welded components. The method consists of using a pancake electromagnetic coil driven by electric-discharge equipment to smooth out metal components such as welded rocket fuel tanks, gore segments, and bulkheads. The process is unusual in that no tooling other than the magnetic coil is required. In a typical application, the magnetic hammer has been used to remove distortions in fuel-tank domes for the giant Saturn V launch vehicle. This report covers the results of experimental work conducted for NASA by Republic Aviation, Inc., and Advanced Kinetics, Inc., on magnetic-coil design and development. *Published December 1965.* (22 pp.; GPO, $0.25)

Microelectronics in Space Research

NASA SP–5031

The primary purpose of this Technology Survey is to provide information on the contributions to the microelectronics field that have originated in NASA research programs. Also included is a review of the status of microelectronics, in which the limitations of the various technologies are highlighted. Considerable emphasis has been placed on silicon integrated-device technology, because of its importance. Microelectronics is defined here as those technologies by which circuit functions are realized in inseparable solid structures that duplicate the behavior of collections of conventional components. Microminiaturization aimed solely at reducing the size of components and circuits is not considered. *Published November 1965.* (130 pp.; GPO, $0.60)

Tungsten Powder Metallurgy

NASA SP–5035

This Technology Utilization Report, prepared for NASA under contract by Battelle Memorial Institute, summarizes recent developments in tungsten-powder metallurgy technology as related to space vehicles and the less traditional applications. The customary use of tungsten as a carbide or as a minor alloying element is not considered. *Published November 1965.* (40 pp.; GPO, $0.35)

Metal-Forming Techniques — NASA SP–5017

This Technology Utilization Report outlines recent metal-forming methods for sheet and plate materials used by the aircraft and aerospace industries, and describes particularly the techniques employed at present, some of which, like magnetic forming and hot-drape forming, are in experimental stages. *Published October 1965.* (52 pp.; GPO, $0.40)

Handling Hazardous Materials — NASA SP–5032

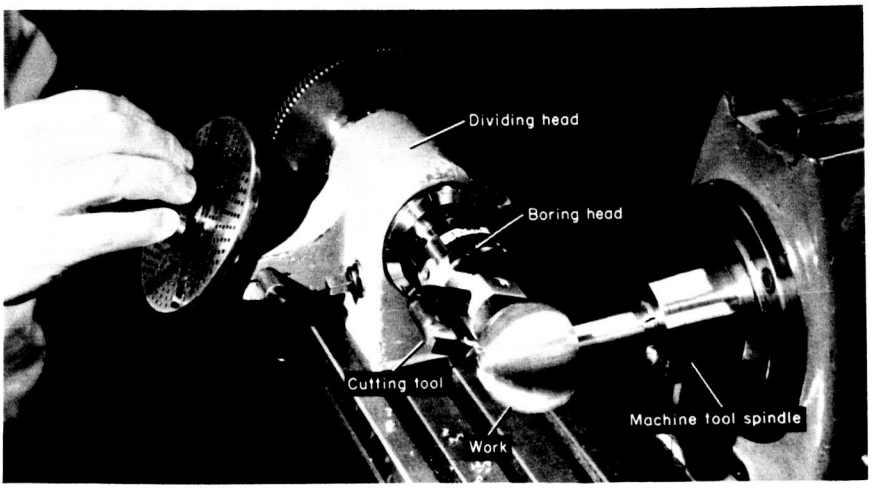
A Technology Survey on highly reactive materials (such as liquid hydrogen, pentaborane, fluorine, and hydrazine) studied in the search for fuels and oxidizers for spacework. Methods for safe handling of these and similar materials are discussed in relation to their hazardous properties. References are given to work done by NASA and other investigators. *Published October 1965.* (96 pp.; GPO, $0.45)

Plasma Jet Technology — NASA SP–5033

This Technology Survey of some of the present industrial applications of plasma-arc devices and of NASA work in this field was undertaken to stimulate the interest and imagination of readers concerned with technological progress. The publication emphasizes the industrial potential of plasma generators in the testing, coating, and spraying of materials, in chemical synthesis, and in other industrial operations. It includes accounts of NASA contributions to such technology and the instrumentation involved, and lists NASA plasma-arc facilities. Both arc-heater and propulsion work are noted, because both are of industrial interest. Work done on small thruster units may, for example, prove valuable in cutting, welding, etc., and that done on larger units may be adaptable to chemical and other procedures. The volume also includes a bibliography with selected abstracts for readers who may wish further information. Author index. *Published October 1965.*

(200 pp.; GPO, $1.00)

Selected Shop Techniques — NASA SP–5010



A Technology Handbook prepared especially for machinists, mechanics and those working in related crafts, on the premise that "although no two problems are identical, they may certainly be similar." It describes how fabrication obstacles were overcome by improvisation, by creating new tools, and sometimes by applying an old and maybe all-but-forgotten technique to a new field. *Published October 1965.* (105 pp.; GPO, $0.60)

Elastic Orifices for Gas Bearings — NASA SP-5029

Technology Utilization Report describing an elastic orifice for the control of fluid flow in a pressurized gas bearing. Test data indicate superiority of such a system over pressurized liquid and rolling-contact bearing systems. *Published October 1965.*

(11 pp.; GPO, $0.20)

Medical and Biological Applications of Space Telemetry — NASA SP-5023

Technology Utilization Report of the biotelemetry systems developed for or employed in the space effort and in civilian biomedical applications. It is directed toward expediting more widespread use of such devices and toward accumulation of information useful in further design and applications. Glossary. *Published September 1965.*

(66 pp.; GPO, $0.45)

Index to NASA Tech Briefs: Issue No. 1, January 1965 — NASA SP-5021

This index has been prepared as a guide to technological innovations derived from the NASA space program. The publication is arranged in two major sections: (1) a listing of the citations and abstracts of all NASA Tech Briefs published up to the latter part of 1964, arranged by subject category; (2) three indexes: Subject Index, Originator/Tech Brief Number Index, and Tech Brief/Originator Number Index. Supplements published semiannually. *Published February 1965.* (36 pp.; CFSTI, $1.00)

Index to NASA Tech Briefs: Issue No. 2, August 1965 — NASA SP-5021(01)

This index is the first semiannual supplement to NASA SP-5021. Subject and originator indexes. *Published August 1965.* (42 pp.; CFSTI, $1.00)

Technical and Economic Status of Magnesium-Lithium Alloys — NASA SP-5028

Technology Utilization Report on the magnesium-lithium alloys, their general characteristics, current applications, and economic considerations for their future use. One objective is to report on the progress being made in the application of the new ultralight magnesium-lithium alloys in the space industry and to disseminate this information to those organizations not acquainted with the alloys and their applications. The second objective is to speculate on possible future usefulness of the alloys in applications not oriented to space flight and to define technical and economic requirements for establishing such commercial use. *Published August 1965.* (45 pp.; GPO, $0.25)

Space Batteries — NASA SP-5004

Technology Handbook containing descriptions of three sealed battery systems for spacecraft, and a discussion of how test-data information may be shared among space contractors. *Published August 1965.* (53 pp.; GPO, $0.25)

Selected Welding Techniques — NASA SP-5003

Technology Utilization Notes containing descriptions and illustrations of tools and methods developed by NASA, and of potential value to industry, for welding aluminum sheet and plate. *Published in March 1964,* this work has been followed by a sequel, described below. (25 pp.; GPO, $0.30)

Selected Welding Techniques: Part II — NASA SP-5009.

Technology Utilization Notes outlining some of the more recent and interesting technological developments in welding. Welding tools and techniques described were selected from those used in welding aluminum sheet and plate at NASA's George C. Marshall Space Flight Center. *Published August 1965.* (34 pp.; GPO, $0.30)

A Technique for Joining and Sealing Dissimilar Materials — NASA SP-5016

This Technology Utilization Report describes a boltless attachment-and-sealing method used in cryogenic research at NASA's Lewis Research Center. The method features configured male and female members with a third material in the resulting cavity. Under the NASA Technology Utilization Program, this fastening method has been studied for potential use in industrial products and processes. The study suggests that the concept can provide the basis for a family of fastening and sealing methods. Representative areas of design use are presented. *Published June 1965.* (8 pp.; CFSTI, $0.25)

Conference on New Technology — NASA SP-5015

Proceedings of a conference on technology utilization held at Lewis Research Center, June 4–5, 1964, to discuss ways of transferring applicable space-research knowledge to the industrial community. *Published June 1965.* (156 pp.; GPO, $1.00)

Micropower Logic Circuits — NASA SP-5022

Technology Utilization Report containing illustrated descriptions of a number of digital logic circuits that were developed primarily to fill a need for very-low-power logic systems in space vehicles but which can easily be adapted for specific applications in nonspace computer systems. With relatively simple engineering modifications, applications of these circuits, as well as of three ancillary circuits described in this report, will be apparent for such equipment and products as automated production systems, numerically controlled machine tools, measuring instrumentation, remote controls and alarm systems, high-fidelity radio and recording systems, and television receivers. *Published May 1965.* (15 pp.; CFSTI, $0.75)

Reliable Electrical Connections — NASA SP-5002

Diagrams, photographs, and detailed instructions covering dependable techniques of different kinds of electrical connections. This Technology Handbook was originally published in *December 1963.* It has since been reprinted three times. The present reprint appeared in *April 1965.* Index. (67 pp.; CFSTI, $0.70)

Advanced Valve Technology — NASA SP-5019

Objectives of this Technology Survey are threefold: (1) to identify present limitations of commercially available valves; (2) to recognize current technological advancements beyond the general state of the art; and (3) to disseminate this advanced valve technology throughout industry. To fulfill these objectives present valve problem areas are recognized, research and development activities in these areas discussed, and the latest trends and techniques reported. Glossary. *Published April 1965.* (182 pp.; CFSTI, $1.50)

Transforming and Using Space-Research Knowledge (Ten Diversified Views) — NASA SP-5018

Ten papers selected from a symposium and workshop sponsored by NASA and the University of California, Los Angeles, June 2, 1964, to acquaint engineers, executives, and marketers in nonaerospace industries with new approaches, knowledge, and technology generated by Government-sponsored aerospace research. *Published March 1965.*

(110 pp.; GPO, $0.70)

NASA Contributions to the Technology of Inorganic Coatings — NASA SP-5014

Technology Survey of NASA's contributions in the areas of thermophototropic coatings, thermal control for space vehicles, solid-lubrication coatings, thermal-insulation coatings, application of coatings to substrates, measurement of coating optical properties, and refractory metal oxidation-resistant coatings. *Published February 1965.*

(268 pp.; GPO, $1.00)

Welding for Electronic Assemblies — NASA SP-5011

The second in a series of volumes on Reliable Electrical Connections. This Technology Handbook covers the theory requirements and fundamental techniques of interconnecting electronic components by resistance spot welding. A thorough understanding of the theory of resistance spot welding along with good workmanship and process control are the factors necessary to attain the required reliability. Glossary. *Published January 1965.*

(81 pp.; GPO, $0.40)

Effects of Low Temperatures on Structural Metals — NASA SP-5012

Testing procedures are described and test data tabulated in this Technology Utilization Report. Cryogenic properties are presented in graphic form and discussed for alloy steels and alloys of aluminum, nickel, titanium, and magnesium. *Published December 1964.*

(55 pp.; GPO, $0.40)

Precision Tooling Techniques — NASA SP-5013

Technology Utilization Notes describing novel tooling techniques and devices with possible industrial applications, developed at NASA's George C. Marshall Space Flight Center. Illustrated. *Published November 1964.* (25 pp.; GPO, $0.25)

The Retrometer: A Light-Beam Communications System — NASA SP-5005

A new system of voice communications transmitted on a beam of light is described in this Technology Utilization Report. It differs from prior systems in that the originating station requires no power other than that of the human voice. The advantages and limitations of the retrometer are briefly discussed, and some potential applications are analyzed. A detailed description of an experimental model is given. *Published April 1964.*

(19 pp.; CFSTI, $0.50)

The Measurement of Blood Pressure in the Human Body — NASA SP-5006

Technology Survey presenting a state-of-the-art summary prepared from the open literature for nonmedical scientists and engineers. *Published April 1964.*

(34 pp.; GPO, $0.30)

Measurement of the Heartbeat of Bird Embryos With a Micrometeorite Transducer — NASA SP-5007

Technology Utilization Report describing a new ultrasensitive momentum transducer that has been successfully adapted as a ballistocardiograph to measure the heartbeat of avian embryos. Experiments have demonstrated that life can be detected as early as 4 days in the incubation period. The technique appears to open new avenues of investigation in such areas as vaccine production and drug research. *Published April 1964.*

(10 pp.; CFSTI, $0.50)

An Improved Precision Height Gage — NASA SP-5001

Design and construction of this accurate, easy-to-use gage are described in a Technology Utilization Report. Possible variations and attachments to increase its utility are also suggested. *Published January 1964.* (13 pp.; CFSTI, $0.50)

Publications for Office of Manned Space Flight

Weight/Performance Management Survey Manual — NASA SP–6006

An Apollo Program Office Manual providing procedures for a management assessment of Apollo contractor activities, performance, and effectiveness of the management system. It also provides a tool for determining corrective action. *Published October 1965.*

(31 pp.; CFSTI, $2.00)

Electrical Power Management Survey Manual — NASA SP–6007

Procedures for a management audit of NASA Apollo Program contractor activities. It assesses performance toward objectives, evaluates effectiveness of the management system, and, where weaknesses exist, provides a tool for determining corrective action. This amplifies Electrical Power Management Standard CMO19–000–1, June 15, 1965. *Published September 1965.* (31 pp.; CFSTI, $2.00)

Electrical Power Management Standard — NASA SP–6005

This document is a standard for all Apollo procurement actions. It establishes a system for the management and reporting of electrical power source, load, and distribution properties of space vehicles. Its demand will probably be limited to OMSF centers and Headquarters offices. Its use is similar to that of SP–6004 noted below. *Published July 1965.*

(31 pp.; CFSTI, $2.00)

Mass Properties Standard — NASA SP–6004

This publication establishes a system for the management of mass properties during procurement and use of space vehicles, or portions thereof. It is designed to permit the acquisition of systematized, verifiable, and controllable mass properties of vehicle systems; to facilitate rapid establishment and reporting of inputs for the weight/performance relationship; and to enable parametric extrapolation from the reported systems to newly evolving systems. *Published June 1965.* (88 pp.; CFSTI, $3.00)

Reliability Program Evaluation Procedures — NASA SP–6002

The objectives of this document are threefold: (1) to establish uniform standards for evaluating the degree and effectiveness of reliability practices and controls; (2) to identify reliability 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. *Published September 1963.* (52 pp.; CFSTI, $1.50)

Quality Program Evaluation Procedures — NASA SP–6003

Procedures and related survey checklists to be used in evaluating quality procedures and controls being applied to manned space-flight 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 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 space-flight systems. *Published September 1963.* (69 pp.; CFSTI, $1.75)

Bibliographies and Other Reference Works

Extraterrestrial Life: A Bibliography. Part I, Report Literature — NASA SP-7015

Annotated bibliography of selected domestic and foreign reports prepared during the period 1952 through July 1964. Although primarily concerned with the general subjects of extraterrestrial life and exobiology, the bibliography includes references on such related topics as the origin of life on Earth and terrestrial contamination of spacecraft. Entries are indexed by subject, author, corporate source, and contract number. *Published November 1965.* (76 pp.; GPO, $0.45)

Ballistocardiography: A Bibliography — NASA SP-7021

Selected bibliography of reports and journal articles, of both domestic and foreign origin, published during the period 1877–1964. Prepared by staff members of the Federal Aviation Agency and published jointly by FAA and NASA. The document also carries the number FAA AM 65-15. *Published October 1965.* (46 pp.; GPO, $0.35)

Space Communications: Theory and Applications. A Bibliography. Vol. 1: Modulation and Channels — NASA SP-7022(01)

The first of a four-volume bibliography containing an extensive listing of references to reports, articles, and books on several subjects directly pertinent to the field of space communications. The compilers have endeavored to provide maximum coverage of the literature for the period 1958 through 1963. However, references to publications of unusual significance that appeared before 1958, as well as a limited number of 1964 references, have also been included. Subject index. *Published September 1965.* (474 pp.; GPO, $2.50)

The three other volumes of this bibliography follow:

Space Communications: Theory and Applications. A Bibliography. Vol. 2: Coding and Detection Theory — NASA SP-7022(02)

Subject index. (412 pp.; GPO, $2.25)

Space Communications: Theory and Applications. A Bibliography. Vol. 3: Information Processing and Advanced Techniques. — NASA SP-7022(03)

Subject index. (448 pp.; GPO, $2.50)

Space Communications: Theory and Applications. A Bibliography. Vol. 4: Satellite and Deep Space Applications. — NASA SP-7022(04)

Subject index. (290 pp.; GPO, $1.75)

The International System of Units—Physical Constants and Conversion Factors — NASA SP-7012

This document defines the basic units of the Système International, adopted officially by the 1960 Eleventh General Conference on Weights and Measures, and tables for converting from U.S. Customary Units. *Originally published October 1964; latest reprinting September 1965.* (20 pp.; GPO, $0.20)

Guide to the Subject Indexes for Scientific and Technical Aerospace Reports — NASA SP-7016 (Rev. 2)

Originally published April 1964, and revised twice since, this guide in its latest edition dates from mid-August 1965. (264 pp.; CFSTI, $2.75)

Lubrication, Corrosion, and Wear. A Continuing Bibliography — NASA SP-7020

Annotated bibliography of all references on this general subject that were stored in the NASA information system from January 1962 through March 1965. References pertaining to lubricating systems, lubricants, bearing design, machinery design, and heat transfer and lubricants for the special applications relating to space travel are included. Subject and author indexes. *Published August 1965.* (162 pp.; CFSTI, $1.75)

Aerospace Medicine and Biology. A Continuing Bibliography — NASA SP-7011

Monthly annotated bibliography concentrating on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life-support systems, exobiology, and personnel factors receive attention. Selected references acquired during the period January–March 1964. This first issue of this continuing bibliography dates from July 1964; the latest from September 1965. Successive issues of NASA SP-7011 are listed below. Subject, corporate source, and author indexes. (293 pp.; CFSTI, $2.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(01)**

Selected references acquired during the period April–June 1964. (186 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(02)**

Selected references acquired during the period June–July 1964. (136 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(03)**

Selected references acquired during the period August–September 1964. (146 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(04)**

Selected references acquired during October 1964. (126 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(05)**

Selected references acquired during November 1964. (146 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(06)**

Selected references acquired during December 1964. (180 pp.; CFSTI, $1.00)

A Cumulative Index to the 1964 Issues of a Continuing Bibliography on Aerospace Medicine and Biology — **NASA SP-7011(07)**

This cumulative index supersedes SP-7011 and the six supplements SP-7011(01) through SP-7011(06). (554 pp.; CFSTI, $5.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(08)**

Selected references acquired during January 1965. (138 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(09)**

Selected references acquired during February 1965. (138 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(10)**

Selected references acquired during March 1965. (118 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(11)**

Selected references acquired during April 1965. (174 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(12)**

Selected references acquired during May 1965. (106 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(13)**

Selected references acquired during June 1965. (124 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(14)**

Selected references acquired during July 1965. (140 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(15)**

Selected references acquired during August 1965. (150 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(16)**

Selected references acquired during September 1965. (130 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(17)**

Selected references acquired during October 1965. (140 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(18)**

Selected references acquired during November 1965. (130 pp.; CFSTI, $1.00)

Aerospace Medicine and Biology. A Continuing Bibliography — **NASA SP-7011(19)**

Selected references acquired during December 1965. (120 pp.; CFSTI, $1.00)

Preparing Contractor Reports for NASA: Technical Illustrating — NASA SP-7008

Guidelines to insure the proper selection of size, shape, and style of illustrations for use in printed technical publications for NASA. The following areas are covered in detail: (1) materials; (2) graphs; (3) line drawings; (4) perspective drawings; (5) typography and lettering; (6) photographs; (7) layouts; and (8) figuring reductions. *Published August 1965.* (27 pp.; GPO, $0.15)

Preparing Contractor Reports for NASA: Repro Typing and Layout — NASA SP-7007

Ground rules for the production of suitable reproducible copy with a minimum of effort. Topics discussed are: (1) the typewriter; (2) the reproducible layout sheet; (3) section headings; (4) spacing; (5) hyphenation; (6) error correction; (7) typing tables and figures; (8) the reproducible layout; (9) figuring reductions; and (10) typing equations. *Published August 1965.* (19 pp.; GPO, $0.15)

Planetary Atmospheres. A Continuing Bibliography — NASA SP-7017

Selection of annotated references to unclassified reports and journal articles announced in *Technical Publications Announcements* (*TPA*, Vol. 2), *Scientific and Technical Aerospace Reports* (*STAR*), and *International Aerospace Abstracts* (*IAA*). The majority of the references pertain to studies, measurements, and discussions concerning the atmospheres of Mars, Venus, and Jupiter, but a limited number of references to the atmospheres of Mercury and Saturn are also included. Subject and author indexes. *Published July 1965.* (142 pp.; CFSTI, $1.50)

Lasers and Masers. A Continuing Bibliography — NASA SP-7009

Bibliography of annotated references to the characteristics and applications of lasers and masers that were introduced into the NASA information system between January 1962 and February 1965. *Published June 1965.* (280 pp.; CFSTI, $2.50)

Bibliographies on Aerospace Sciences. A Continuing Bibliography — NASA SP-7006

Annotated references to unclassified bibliographies that have been announced either in *Technical Publications Announcements* (*TPA*, Vol. 2, 1962), or its successor, *Scientific and Technical Aerospace Reports* (*STAR*, Vol. 1, 1963, and Vol. 2, January–May 1964), or *International Aerospace Abstracts* (*IAA*, Vol. 3, 1963, and Vol. 4, January–May 1964). Each entry in the bibliography consists of a citation and, when available, an abstract. A subject index is included. *Published April 1965.* (52 pp.; CFSTI, $1.00)

Bibliographies on Aerospace Science. A Continuing Bibliography — NASA SP-7006(01)

This subsequent issue of NASA SP-7006 contains annotated references to unclassified bibliographies on aerospace science introduced into the NASA information system during the period June 1964–February 1965. *Published August 1965.* (68 pp.; CFSTI, $0.75)

Communications Satellites. A Continuing Bibliography — NASA SP-7004

Annotated references to unclassified reports and journal articles dealing with the development, operation, and problems of communications satellites, that were introduced into the NASA information system during the period January 1962–April 1964. Subject and author indexes. *Published July 1964.* (90 pp.; CFSTI, $1.00)

Communications Satellites. A Continuing Bibliography — NASA SP-7004(01)

Annotated references to unclassified reports and journal articles on this subject introduced into the NASA information system during the period May 1964–January 1965. *Published April 1965.* (56 pp.; CFSTI, $1.00)

A Selected Listing of NASA Scientific and Technical Reports for 1964 — NASA SP-7018

Annotated listing of NASA reports and journal articles announced during 1964 in *Scientific and Technical Aerospace Reports* (*STAR*). Included are Special Publications, Technical Reports, Technical Notes, Technical Memorandums, Technical Translations, Technical Reprints, and Contractor Reports. The arrangement of this publication is the same as that of *STAR*. Subject, corporate source, author, and report/accession indexes. *Published April 1965.* (1132 pp.; GPO, $5.25)

High Energy Propellants. A Continuing Bibliography — NASA SP-7002

Annotated references to unclassified reports and journal articles on this subject introduced into the NASA information system during the period January 1962–March 1964. Prime emphasis is given to references concerned with research-and-development studies on solid, liquid, and hybrid propellants and oxidizers, but the bibliography also provides extensive coverage of such related topics as propellant handling and storage, combustion characteristics, toxicity, and hazards and safety measures. A subject index is included. *Published June 1964.* (65 pp.; CFSTI, $1.75)

High Energy Propellants. A Continuing Bibliography — NASA SP-7002(01)

Annotated references to unclassified reports and journal articles on this subject introduced into the NASA information system during the period April 1964–December 1964. *Published April 1965.* (98 pp.; CFSTI, $1.75)

Contract Number Index to Reports Announced in STAR — NASA SP-7019

Cumulative index to scientific and technical reports produced under NASA contract, NASA grant, NASA order, or other Government agency contract, and announced in *Scientific and Technical Aerospace Reports* (*STAR*), Vol. 2, 1964. Contract number/accession number and corporate source/contract number indexes. *Published February 1965.* (156 pp.; CFSTI, $5.00)

Lunar Surface Studies. A Continuing Bibliography — NASA SP-7003

Annotated references to unclassified reports and journal articles on this subject introduced into the NASA information system during the period January 1962–March 1964. Contains references to a variety of specific topics, including the theory of lunar origin, the lunar atmosphere, and physical characteristics of the Moon. Techniques and instrumentation for lunar observation, measurement, and analysis are covered. Subject and author indexes. *Published June 1964.* (98 pp.; CFSTI, $2.25)

Lunar Surface Studies. A Continuing Bibliography — NASA SP-7003(01)

Annotated references to unclassified reports and journal articles on this subject introduced into the NASA information system during the period April 1964–January 1965. *Published February 1965.* (54 pp.; CFSTI, $1.00)

Clarity in Technical Reporting — NASA SP-7010

Commonsense suggestions for improving written technical reports. In particular, the booklet discusses basic attitudes, some elements of composition, the organization and contents of the report, and the editorial review. Since technical information is transmitted not only in written reports but also in talks and lectures, a section is devoted to the technical talk—the orally delivered technical report. In both written and oral reports, stress is placed on striving for clarity. *Published December 1964.* (25 pp.; GPO, $0.15)

Bibliography Related to Human Factors System Program, July 1962–February 1964 — NASA SP-7014

Bibliography divided into 18 categories covering the areas of human research and performance, man-systems integration, and life-support and protective systems. Also relevant listings under the categories of biology, physiology, and psychology. Each listing includes information for locating an abstract in either *Scientific and Technical Aerospace Reports* (*STAR*) or *International Aerospace Abstracts* (*IAA*). *Published September 1964.* (242 pp.; CFSTI, $3.50)

A Selected Listing of NASA Scientific and Technical Reports for 1963 — NASA SP-7005

Abstracts, a subject index, a corporate source index, and a personal author index for selected NASA formal reports. The abstracts are grouped and listed under 34 categories. The subject index is characterized by terms that identify the particular area of study. The reports are also listed in a report/accession number index and an accession/report number index. *Published May 1964.* (236 pp.; CFSTI, $3.50)

Contract Number Index to Reports Announced in STAR (Part 1) — NASA SP-7001

Guide to contract-generated scientific and technical reports for 1962–63 that were announced in *Scientific and Technical Aerospace Reports* (*STAR*), Vol. 1, and its predecessor *Technical Publications Announcements* (*TPA*), Vol. 2. Reports generated under Government contract, grant, or order are listed by accession number. *Published March 1964.* (197 pp.; CFSTI, $3.00)

Subject Index

T

U

V

W

X

U.S. GOVERNMENT PRINTING OFFICE : 1966 O—208-373