

GUIDE TO NASA HISTORICAL OFFICE ARCHIVES COLLECTION

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· Apollo Terminology, (NASA SP-6001), prepared by the Office of Scientific and Technical Information, National Aeronautics and Space Administration, Washington, D.C., 1963

Technical Data and Standardization Glossary, (TD-2), prepared by the Office of the Assistant Secretary (Installations and Logistics), Department of Defense, Washington, D.C., 1965

Dictionary of Acronyms and Project Names, General Dynamics/Astronautics, a division of General Dynamics Corporation, San Diego, Calif., 1966

3. ABBREVIATIONS AND ACRONYMS

The abbreviations and acronyms listed alphabetically on the following pages are provided as an aid to understanding for readers of this Preliminary History. While by no means a complete listing --- for such is a near-impossibility in these days of proliferating alphabetical entities --- it should prove to be a considerable assistance to those less familiar with the language of technology.

The reader desiring an explanation in greater detail, or definitions of the more technical aerospace technology, is referred to the following sources:

Dictionary of Technical Terms for Aerospace Use, (NASA . SP-7), prepared by the Scientific and Technical Information Division, National Aeronautics and Space Administration, Washington, D.C., 1965

AGARD Aeronautical Multilingual Dictionary, G.H. Frenot (Paris) and A.H. Holloway (London), editors; The Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization; published by Pergamon Press, Oxford, London, New York, Paris; 1965

Aeronautical Dictionary, by Frank Davis Adams, National Aeronautics and Space Administration, Washington, D.C., 1965

The United States Air Force Dictionary, Woodford Agee Heflin, editor, Research Studies Institute, the Air University, USAF, 1956

In addition to the sources listed above, and the listings on the following pages, future historians will find that there are numerous other dictionaries, glossaries, and lists of abbreviations and acronyms available for their use. Prepared by many different individuals and organizations, federal and industrial, military and civilian, they are frequently limited in their separate coverages. However, serious scholars will find them valuable aids to understanding when performing research in depth on specific or closely-related subjects. While three typical examples are given below, there are many more:

ABBREVIATIONS AND ACRONYMS

A.

AA	Apollo Applications (see also AAP)
AAAS	American Association for the Advancement of Science
AACB	Aeronautics and Astronautics Coordinating Board
AAF	1. Army Air Field (current) 2. Army Air Forces (World War II)
AAFB	Auxilliary Air Force Base
AAP	Apollo Applications Program
AAS	American Aeronautical Society
ABC	American Broadcasting Company
ABL	Allegheny Ballistics Laboratory
ABMA	Army Ballistic Missile Agency
ABRES	Advanced Ballistic Reentry System
ACV	Air-Cushion Vehicle
ADAM	1. Air Deflection and Modulation (V/STOL aircraft) 2. Early man-in-space proposal
ADC	Air Defense Command
ADCSP	Advanced Defense Communications Satellite Project
AEC	Atomic Energy Commission
AEDC	Arnold Engineering Development Center, Tullahoma, Tenn.
AFA	1. Air Force Association 2. Air Force Academy
AFB	Air Force Base

AFCRL	Air Force Cambridge Research Laboratories, Mass.
AFFTC	Air Force Flight Test Center, Edwards AFB, Calif.
AFGE	American Federation of Goverment Employees
AFL-CIO	American Federation of Labor-Congress of Industrial Organizations
AFMTC	Air Force Missile Test Center, Patrick AFB, Fla.
AFSC	Air Force Systems Command
AGENA	Upper (second) stage of a launch vehicle
AGM	Air-to-ground Missile
AGU	American Geophysical Union
AIA	Aerospace Industries Association
AIAA	American Institute of Aeronautics and Astronautics
AID	Agency for International Development
AIMP	Anchored Interplanetary Monitoring Platform (see IMP)
ALARR	Air-launched-air-recoverable Rocket
ALOTS	Airborne Launch Optical Tracking System
ALOUETTE	Canadian Satellite Series (NASA-launched)
ALPA	Air Line Pilots Association
ALSEP	Apollo Lunar Surface Experiment Package
AMA	American Medical Association
AMSA	Advanced Manned Strategic Aircraft
AMTRAN	Automatic Mechanical Translator
AMU	Astronaut Maneuvering Unit
AMR	Atlantic Missile Range

AMS	American Meteorological Society
ANL	Argonne National Laboratory, Ill. (AEC)
ANNA	A Geodetic Satellite
AP	Associated Press
APE	Alfven Propulsion Engine
APGC	Air Proving Ground Center, Eglin AFB, Fla.
APL	Applied Physics Laboratory
APT	Automatic Picture Transmission
ARA	Amature Rocketeers of America
ARC	Ames Research Center, Calif. (NASA)
ARCAS	A class of sounding rockets
ARIA	Apollo Range Instrumentation Aircraft
ARIS	Advanced Range Instrumentation Ships
ARPA	Advanced Research Projects Agency
ARS	American Rocket Society
ASME	American Society of Mechanical Engineers
ASP	A Class of sounding rockets
ASPA	American Society for Public Administration
ASTIA	Armed Services Technical Information Agency
ASWA	Aviation and Space Writers Association
ATA	Air Transport Association
ATDA	Augmented Target Docking Adapter.
ATLAS	Missile used as first (booster) stage of launch vehicle

ATLAS-AGENA	Two-stage launch vehicle; Atlas first stage, Agena second stage
ATLAS-CENTAUR	Two-stage launch vehicle; Atlas first stage, Centaur second stage
ATM	Apollo Telescope Mount
ATS	Applications Technology Satellites
ATV	Agena Target Vehicle
AVCS	Advanced Vidicon Camera System
AVLABS	Army Aviation Material Laboratories
AWLS	All-Weather Landing System

B.

BBC	British Broadcasting System
BIOS	A class of Biology Satellites
BIS	British Interplanetary Society
BLUE STREAK	British launch vehicle
BMEWS	Ballistic Missile Early Warning System
BMWF	German Ministry of Scientific Research
BNS	Broadcasters Non-profit Satellite Service
BOAC	British Overseas Airways Corporation
BOB	Bureau of the Budget
BTL	Bell Telephone Laboratories

C.

CAB	Civil Aeronautic Board
CAJUN	A class of sounding rockets
CAT	Clear Air Turbulence

CBS	Columbia Broadcasting System
CCMTA	Cape Canaveral Missile Test Annex, Fla.
CDA	Command and Data Acquisition
CENTAUR	Upper (second) stage of a launch vehicle
CENTAURE	French sounding rocket
CERN	European Center for Nuclear Research
CKAFS	Cape Kennedy Air Force Station, Fla.
CM	Command Module (Apollo spacecraft)
CNAE	Brazilian Space Commission
CNES	Centre Nationale d'Etudes Spatiales (French)
CNIE	Argentine Space Commission
COE	Army Corps of Engineers
COESA	Committee on Extension to the Standard Atmosphere
C of F	Construction of Facilities (NASA budget item)
COMSAT	1. Class of Communication Satellites 2. Communications Satellite Corporation
CONIE	Spanish Space Commission
COSMOS	Class of Russian Satellites
COSPAR	Committee on Space Research
COST	Congressional Office of Science and Technology

D.

DAC	Douglas Aircraft Company
DAS	Data Automatic Subsystem
DASA	Defense Atomic Support Agency
DCA	Defense Communications Agency

DDC	Defense Documentation Center
DELTA	A class of launch vehicles
DIAMONTE	French launch vehicle
DME	Distance Measuring Equipment
DMU	Dual-purpose Maneuvering Unit
DOD	1. Department of Defense 2. Development Operations Division, ABMA
DSIF	Deep Space Information Facility
DSN	Deep Space Network

E.

ECS	Environmental Control System
ELDO	European Launcher Development Organization
ELECTRON	A class of Russian Satellites
ENEA	European Nuclear Energy Agency
ERC	Electronics Research Center (NASA)
EROS	Earth Resource Observation Satellite project
ESRO	European Space Research Organization
ESSA	1. Environmental Science Services Administration 2. Meteorological Satellites launched by NASA for (1.)
ETR	Eastern Test Range
EURATOM	European Atomic Energy Committee
EUROPA	Launch vehicle developed by ELDO
EVA	Extravehicular Activity
EXAMETNET	Inter-American Experimental Meteorological Rocket Network
EXPLORER	Class of NASA Satellites

F.

FAA	Federal Aviation Agency
FAI	Federation Aeronautique Internationale
FCC	Federal Communications Commission
FDL	1. Fast Deployment Logistic Fleet 2. Flight Dynamics Laboratory (AFSC)
FLOX	Flourine-Liquid Oxygen combination
FRC	Flight Research Center (NASA)

G.

GAO	General Accounting Office
GALCIT	Early rocket research projects named for Guggenheim Aeornautical Laboratory, California Institute of Technology
GATV	GEMI-Agena Target Vehicle
GCA	Ground Controlled Approach
GHOST	Global Horizontal Sounding Technique
GISS	Goddard Institute for Space Studies
GPO	Government Printing Office
GSFC	Goddard Space Flight Center (NASA)

H.

HEOS	Highly Eccentric Orbiting Satellite (interplanetary physics)
HERMES	Early rocket development project
HEW	Department of Health, Education, and Welfare
HIBEX	High-energy Boost Experiment
HITAB	High Altitude Background and Signal to Noise program

HRIR	High Resolution Infrared Radiometer
HST	Hypersonic Transport
HUD	Department of Housing and Urban Development

I.

IAF	International Astronautical Federation
IAM	International Association of Machinists
IALPA	International Airline Pilots Association
IATA	International Air Transport Association
IAU	International Astronomical Union
IBM	International Business Machines Corporation
ICAS	International Council of the Aeronautical Sciences
ICBM	Intercontinental Ballistic Missile
ICM	Improved Capability Missile
ICSU	International Council of Scientific Unions
IDA	Institute for Defense Analysis
IDB	Inter-American Development Bank
IDCSP	Initial Defense Communications Satellite Project (USAF)
IEEE	Institute of Electrical and Electronics Engineers
IGY	International Geophysical Year
INCOSPAR	Indian National Commission for Space Research
INTA	Instituto Nacional de Tecnica Aeroespacial (Spain)
INTELSAT	1. Class of Communications Satellites 2. International Telecommunications Satellite Consortium
IQSY	International Year of the Quiet Sun

IRBM	Intermediate Range Ballistic Missile
ITT	International Telephone and Telegraph Corporation
ITU	International Telecommunications Union
IUEW	International Union of Electrical Workers

J.

JAVELIN	Sounding Rocket
JCS	Joint Chiefs of Staff
JPL	Jet Propulsion Laboratory of California Institute of Technology (NASA)

K.

KAPUSTIN YAR	A Russian launching site
KSC	Kennedy Space Center (NASA)

L.

LAMDA	A Class of Russian Satellites
LaRC	Langley Research Center (NASA)
LC-	Launch Complex (LC-34, etc.)
LCC	Launch Control Center
LEM	Lunar Excursion Module (obsolete - see LM)
LeRC	Lewis Research Center (NASA)
LES	Launch Escape System.
LM	Lunar Module (Apollo spacecraft)
LRC	Lewis Research Center (obsolete see LeRC)
LUNA	Class of Russian Lunar probes
LUNAR ORBITER	Class of NASA lunar satellites

LURAIN	Lunar surface
LUT	Launcher-Umbilical Tower

M.

MAF	Michoud Assembly Facility (NASA)
MARINER	Class of NASA interplanetary spacecraft
MCC	Mission Control Center
MDTA	Modulation, Demodulation, Terminal and Associated Equipment
MIT	Massachusetts Institute of Technology
MOL	Manned Orbiting Laboratory (USAF)
MOLNIYA	Class of Russian communications satellites
MOOSE	Manned Orbital Operations Safety Equipment
MRBM	Medium Range Ballistic Missile
MRIR	Medium Resolution Infrared Radiometer
MSC	Manned Spacecraft Center (NASA)
MSFC	Marshall Space Flight Center (NASA)
MTF	Mississippi Test Facility (NASA)

N.

NAA	1. North American Aviation, Inc. 2. National Aeronautic Association
NAC	National Aviation Club
NACA	National Advisory Committee for Aeronautics
NAE	National Academy of Engineering
NAPO	NASA Pasadena Office
NAS	National Academy of Sciences

NASA	National Aeronautics and Space Administration
NASC	National Aeronautics and Space Council
NATO	North Atlantic Treaty Organization
NBC	National Broadcasting Company
NERO	Near Earth Rescue Operation
NERVA	Nuclear Engine for Rocket Vehicle Application
NICAP	National Investigations Committee on Aerial Phenomena
NIKE-	First (booster) stage for sounding rockets (Nike-Apache, Nike-Cajun, etc.)
NIKE-X	Antiballistic Missile System
NIMBUS	Class of NASA meteorological satellites
NOA	National Oceanography Association
NORAD	North American Air Defense Command
NRC	National Research Council
NRDS	Nuclear Rocket Development Station
NRL	Naval Research Laboratory
NSC	National Space Club
NSF	National Science Foundation

O.

· · · OAO	Orbiting Astronomical Observatory class of NASA satellites
OAR	Office of Aerospace Research
OART	Office of Advanced Research and Technology (NASA)
OECD	Organization for Economic Development
OGO	Orbiting Geophysical Observatory class of NASA satellites

OMSF	Office of Manned Space Flight (NASA)
ONERA	Office National d'Etudes Recherches Aerospatiales
ONR	Office of Naval Research
ORDS	Orbiting Data Relay System
OSO	Orbiting Solar Observatory class of NASA satellites
OSSA	Office of Space Science and Applications

P.

PAA	Pan American World Airways, Inc. (see PANAM)
PAGEOS	Passive Geodetic Earth-Orbiting Satellite (NASA)
Pan AM	Pan American World Airways, Inc. (see PAA)
PCS	Pointing-Control System
PEGASUS	Meteoroid Detection Satellite (NASA)
PERT	Program Evaluation Review Technique
PIONEER	Class of NASA interplanetary probes
PMR	Pacific Missile Range
PROTON	Class of Russian Space station
PSAC	President's Science Advisory Committee

Q.

QUASAR	Quasi-stellar object
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R.

RADAR	Radio Detection and Ranging
RAE	Royal Aircraft Establishment
RAES	Royal Aeronautical Society

RAF	Royal Air Force
RANGER	Class of NASA lunar probes
RCA	Radio Corporation of America
RCS	1. Reentry Control System 2. Reaction Control System
RMU	Remote Maneuvering Unit
RSA	Radar Signature Analysis
TRCC	Real Time Computer Complex

S.

SADL	Sterilization Assembly Development Laboratory
SAE	Society of Automotive Engineers
SATURN	Class of large space launch vehicles (NASA)
SBA	Small Business Administration
SCOUT	Class of small space launch vehicles (NASA & USAF)
SECOR	Class of Army Geodetic satellites
SEIT	Satellite Educational Informational Television
SEREB	Societe pour l'Etude et la Realisation d'Engins Balistiques
SERT	Space Electric Rocket Test
SETP	Society of Experimental Test Pilots
SLA	Spacecraft Lunar Module Adapter (Apollo)
SM	Service Module (Apollo spacecraft)
SNAP	Systems for Nuclear Auxiliary Power
SNPO	Space Nuclear Propulsion Office (NASA-AEC)
SOVCOMSAT	Russian Communication Satellite System

SRAM	Short Range Attack Missile
SSRC	Swedish Space Research Council
SST	Supersonic Transport Aircraft
STADAN	Space Tracking and Data Acquisition Network
STATALTEX	French missile program
STRAP	Star Tracking Rocket Attitude Positioning
SUPARCO	Pakistan Space and Upper Atmosphere Research Committee
SURVEYOR	Class of soft-landing lunar surface exploration spacecraft (NASA)
SYNCOM	Class of communications satellites (NASA)

T.

TAD	Thrust Augmented Delta space launch vehicle (NASA)
TAID	Thrust Augmented Improved Delta space launch vehicle (NASA)
TASS	Russian News Agency
TIROS	Class of meteorological Satellites (NASA)
TOS	Tiros Operational Satellites (ESSA)
TRANSIT	Class of Navigational Satellites (NAVY)
TRW	Thompson-Ramo-Woodridge Systems, Inc.
TWA	Trans World Airlines

V.

VANGUARD	First U. S. Satellite Launching Program
VELA	Nuclear detection satellites
VENUS	Russian interplanetary probes

VOSKHOD	Russian three-man spacecraft
VOSTOK	Russian named spacecraft
VOYAGER	NASA interplanetary program
V/STOL	Vertical and Short Takeoff and Landing aircraft
VTOL	Vertical Takeoff and Landing aircraft

W.

WALLOPS	Wallops Station Launch Site (NASA)
WASP	Weightless Analysis Sounding Probe
WMO	World Meteorological Organization
WOO	Western Operations Office (NASA)
WOOMERA	Australian Rocket Range
WSMR	White Sands Missile Range
WSO	Western Support Office (NASA)

Z.

ZELL	Zero Length Launch Platform
ZOND	Class of Russian Interplanetary probes

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C.(6) ORAL HISTORY

HISTORICAL NOTES
on
ORAL HISTORY IN NASA

HHN - 77

by

Eugene M. Emme
James M. Grimwood
William D. Putnam

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Historical Notes on Oral History in NASA

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HISTORICAL NOTES ON ORAL HISTORY IN NASA

Introduction

Contemporary history inevitably requires the careful use of interviews with their indispensable assets and inevitable hazards. NASA is a young Federal agency whose budget doubled each year of its first years, whose people and early programs were inherited from many other agencies, and 90% of whose dollars were expended outside of the agency proper with industrial and academic contractors. These dynamic factors illustrate the complexity of the historian's task in NASA even if novel, spectacular, and world-wide impact of space affairs were not intrinsic to the methodological problems of the historian. The history of science and technology in the twentieth century also is not a well-attended vineyard so that little help from academia is available.

Basically, our NASA historical program is divided into the following series of histories, each project in which helps provide a monographic "building block" for the overall agency history ultimately to be treated in volumes similar to The New World, Volume I of the AEC history.

- . Program Series, of which This New Ocean (SP-4201) by Swenson, Alexander, and Grimwood was the first published.
- . Center Series, of which Venture into Space (SP-4301), dealing with the Goddard Space Flight Center, will be the first published.
- . Management and Administrative Series, of which Rosholt's An Administrative History of NASA, 1958-63 (SP-4101) was the first published.

In addition, annual and other documented chronologies (Astronautics and Aeronautics), and special studies are also issued, such as The History of Rocketry (Wayne State Univ. Press, 1964), and Mae Link's Space Medicine in Project Mercury (SP-4002). A list of all NASA historical publications is attached. Beyond having less classified data than most R&D Agencies, NASA is also blessed in that the results of its activities, including history, can be easily published.

We have found oral history is best instituted in concert with a specific project, theme, or subject, and performed by the historian obligated to do the actual research and writing. Responsibility for the use of oral history interviews is, we believe, the indispensable feature of valid contributions to history.

Interviewing of key NASA officials and contractor personnel at all levels is compounded importantly by the fact that they remain extremely busy persons. Almost all become, as the depth of the historical research becomes evident, thoroughly dedicated to the documentation of the full story, no holds barred, while it is fresh and hot. The habit of news media to take statements out context provides the greatest handicap to overcome. Yet they find themselves fully committed to heavy current obligations and not eager to be interviewed without having some time for refreshing their memories. This is very different than interviewing "old timers" with little else to do but extoll the past, and their role in it. It should be noted that already the fatalities and passing of key persons in space affairs has raised the historical value greatly of interviews already performed, which only enhances the ultimate contribution of contemporary history. Among these should be mentioned the late John F. Kennedy, Hugh L. Dryden, Randolph Lovelace,

Gus Grissom, and Lloyd Berkner, important figures in the U. S. aerospace program. The dangers of the last survivors warping historical appreciation via oral history is, of course, generally recognized, and I shall not mention any names.

Another unique spin-off of our contemporary history interviews is that existent files are better treated for future historical purposes because key persons are reminded of the limitations of their recall without refreshment by the interviewer or by consulting desk calendars, chronologies, and office documents. We feel confident that by our efforts we may have encouraged key persons to keep personal diaries or consider assembling papers and letters for their memoirs or historical purpose. Official record keeping is one of the areas we monitor closely, but the early appearance of substantial histories has been the most effective guidance that we can provide. We are often pleasantly surprised to learn that diaries have been kept. In a notable case, a top figure dictated his thoughts at the end of each working day for the sake of acquainting his children with his Washington experiences. This is another possible use of the tape recorder which should be noted. In this case, the tape was taken home daily rather than retained in the office so that the hazard of second thoughts was avoided. How lucky can the historian be?

In brief, major areas of oral history in the NASA Historical Program have been associated with the following:

- . Support of the Kennedy Library project, phase one interviews performed in 1964 with most of those who had personal contact with the late President on space matters.
- . Exit interviews of retiring or otherwise departing NASA persons, mainly performed only with key people because of the lack of manpower.

- . Major program histories, such as the Mercury history, and now including Gemini, Apollo, Ranger, Vanguard, and others.
- . Numerous interviews of NASA personnel have also been performed by various academic students of management, political science, and history, generally not recorded, and, hence, not exploiting formal oral history methods. We also solicit and file all taped speeches, press conferences, and other live events for future historical purposes.

NASA historical interviews are normally transcribed, and edited and signed by the interviewee who often add additional thoughts and sometimes attach related documents. The original tapes are also retained, although we have not determined their actual lifetime without annual exercising. The final typed interview thus becomes a source document in its own right, and it is filed with other related materials. Access to them is only for NASA historical purposes without other use granted by the interviewee, which explains why we have not yet issued a catalog of our NASA historical interviews. It is often possible to obtain use of these interviews for direct citation, or for background without attribution, for outside scholars. The NASA Historical Archives, of course, are largely open for any serious scholar without axe to grind. We welcome your inquiries and appended is a list of NASA historians and monitors who may be of assistance. Our only preferred practice is that use of our materials best serves history when we can receive feedback by receipt of the actual use made of the material by outside scholars. In this manner, we can help later scholars avoid duplication of effort.

For purposes of discussion, James M. Grimwood, Historian of the Manned Spacecraft Center, Houston, Texas, and William D. Putnam, Assistant Historian for Manned Space Flight in Headquarters, have prepared thoughts on other aspects of our NASA experience.

by

James M. Grimwood

Manned space flight efforts are so national in scope that it would be utterly foolish to presume that a history of a particular program could be researched and written from documentation that might by chance be collected in one locality.

Although the documentary accumulation within the organization directing the program may seem to be quite formidable, they represent only "the cap of the iceberg." Also, the recurring progress reports emanating from the program-directing activity, while being quite helpful, create the impression that no human being had anything to do with their development. In addition, the steps leading to development of some new component more often than not are completely omitted, as the end result is only reported. Many of the major decisions, often made face-to-face or by telephone, are never phrased in any documentation--only in the minds of the principals and those who carried out the stipulations of the decision.

The historians that researched and wrote This New Ocean: A History of Project Mercury realized very quickly that this project could not be accomplished in a vacuum. Most of the NASA centers, the military services, industry, and the universities had been involved in Project Mercury. As an initial course of action, the three authors involved sought to talk with people who were specialists in particular areas. These efforts carried the historians almost the length and breadth of the nation. Besides interviewing the experts (over 200) the numerous "desk archives" were tapped as new and important sources of information. Unfortunately in the Mercury history program only one interview was taped and I suppose that many would say that is the only piece of oral history accumulated for Project Mercury. I would contend that this is paying too much attention to a rigid definition and not enough attention to the needed meaning.

To me, forms of oral history would be the extraction of knowledge from an individual or individuals about the circumstances of an event not recorded in formal documentation at the time of its happening by taking notes, tape recording, or receiving

a written answer to a specified request. This is not to say that I am against a tape recorder, I am in complete agreement; but at the later date, when history is usually written, are the actor's verbatim words so necessary or so deathless? What I am saying is do not strain so much over the precise definition of oral history. I would like to give an example of what I would think was oral history when only interview notes were taken.

In July, 1960, Mercury-Atlas I, launched at Cape Cavaneral into rainy, overcast weather, exploded less than a minute after lift-off. Extreme difficulty was experienced in gathering the remains from the beach and ocean floor in an attempt to try and piece together what went wrong. Since this was an election year and the failures of the program had been widely publicized, the fate of Project Mercury hung tenuously in the balance. Between August 1960 and February 1961, the Rhode-Worthman committee (a NASA-Air Force group designated to investigate the failure and propose a solution) conducted meetings and directed tests that almost spanned the country. Some of the decisions on solutions can be found in formal documentation, many cannot. Examples of the latter:

James A. Chamberlin and Scott Simpkinson--interview related that Chamberlin in a San Diego hotel had sketched on some stationery a "horse collar" to strengthen the upper section of the Atlas launch vehicle. Ben Hohmann and Ernst Letch of the Aerospace Corporation told how they had theorized that the spacecraft-launch vehicle adapter might be weak and how they had suggested adding strength.

Administrators James E. Webb and Robert C. Seamans, Jr., mentioned in interviews how other Atlas failures had decreased the chances of any immediate launch of Mercury-Atlas II; NASA would have to assume all responsibility for another failure. Webb, new to the office at that time, had to give clearance to the large Navy force to deploy to the recovery zone.

These are but few of the circumstances surrounding the decision to launch MA-2, but the narrative discussion on the subject in a book, would have been without validity

had not the authors sought and talked with the principal actors.

Brief examples in the Mercury history project, which can be noted in This New Ocean, wherein oral history provided the more complete story:

- . Hugh L. Dryden (only taped interview) transition from NACA to NASA.
How NASA got the manned space flight program (Killian's call to Dryden telling him to outline in a memorandum why NASA should have the program).
- . Edward C. Welsh, Robert R. Gilruth, Webb, Walter C. Williams, Paul E. Purser, et al--decision to fly Mercury-Redstone 3 (Shepard) in view of the substance of the Hornig committee report.
- . James L. Lewis and Wayne E. Koons--helicopter pilots in the recovery attempt of Mercury-Redstone 4 (Grissom). Lewis said that he did not think much about Grissom, he was trying to save the spacecraft. He said that he had been conditioned in this respect during the training months, as the astronauts had seemed to thoroughly enjoy the water during the many practice recovery exercises.
- . William J. Douglas, Donald K. Slayton, and Webb, circumstances causing the removal of Slayton from Mercury flight status.

The interviews for the Mercury history, plus some 150 written comments received from the circulation of a draft edition of that book, have prompted the expansion of the oral history effort for Projects Gemini and Apollo. Highly sensitive tape recorders were purchased and a four-month preparatory period was set aside to map out itineraries and phrase questions for tentative interviewees. When ready for one particular phase the contractor was called and told the type of people we were interested in interviewing. At McDonnell, the Gemini spacecraft contractor, we asked for the vice-president in charge of the program; his chief technical lieutenants in such areas in program management, design (aerodynamic and component) contracting,

testing, training, and manufacturing. Quite surprisedly, there have been few cases "mike flight," which I believe was caused by two reasons: many of these individuals had previous experience in making speeches to audiences of some size, and by our structuring the interviews from memory rather than the sheaf of papers with Question 1, Question 2, and so on. We have found that a good way to relax the interviewee is to ask an opening question about his background and how he came to occupy the position in the program of your particular interest. Usually this leads him into an introspective discussion almost chronological in nature. An occasional question is interjected to clear out some of the technical jargon that often permeates the engineer's discussions. If you feel that you are getting a little too much of the company "hard sell" on their success, ask the individual about one of the worst things that happened in their particular development program or purposely phrase a question that you yourself know is wrong. More often than not, the remainder of the interview will be as true to the circumstances that happened as that individual can remember. As you build your interview based on a particular subject, you can also mention during an interview that you have talked with several people on this subject and list their names. You do not really play one against the other, necessarily, openly, that is, but the factor is present, and the individual becomes a little wary of making claims that his colleagues might ridicule. Also they seem to talk in more depth. The interview tricks that you bring to bear depend on your homework and your judgement of the individual involved. Thus far, we have visited about 16 major Gemini contractors, which besides the interviews and extra documentation that you gather has a second net result as you view the areas in which the development programs were conducted--often holding a piece of hardware in your hand while the interview is in progress.

Besides the interviews at the various contractors, the same type of program has been conducted among NASA and military services personnel. We have been careful to find and search out the government counterparts for those interviews we have conducted in industry. The striking feature that has developed is the number of face-to-face

decisions that have been made without full documentary coverage. Perhaps the most interesting decision concerned the Gemini VII/VI flight. In three days and some hours' time a suggestion was made in the field, quickly worked out, submitted to the President, and announced to the Nation by the President's office committing this country to a goal.

On Monday, October 25, 1961, the Agena target vehicle failed to achieve orbit for the first rendezvous mission for Project Gemini. While still in a Cape Kennedy control center following this event, Walter Burke of McDonnell mentioned to his chief lieutenant, John Yardley, Why didn't they resurrect and adapt a Martin plan of some six months before for a rapid launch demonstration? Burke wanted to launch spacecraft VII to be used as a rendezvous target for spacecraft VI. That night they flew to Houston to convince Robert R. Gilruth, Manned Spacecraft Center director. On the 26th, Gilruth discussed the plan with his aides and called George E. Mueller in Washington who carried the plan to Webb, Dryden, and Seamans. On the 27th, Mueller called Houston and gave them 15 minutes to decide if the plan could be carried out, as Mr. Webb had taken the proposal to the President. Gilruth polled his staff and the answer was yes. Thursday, October 28, 1965, William Moyers, the President's press secretary, announced the plan at a news conference, answering on-the spot technical questions by being in telephone contact with Julian Scheer, NASA's Associate Administrator for Public Affairs, who was listening to the conference.

Most of the circumstances surrounding this event are in the minds of the principals involved. Many did take the time to make hurried notes on their desk calendars, and there are a few informal notes taken while the conferences were in progress. This event, however, seems almost indelibly imprinted in the minds of the individuals involved. There were fewer contradictory statements made by 15 or so people that touched on this subject than any other subject I have attacked. Almost hour-by-hour progress can be discerned. The first rendezvous was perhaps the high point of Project Gemini, certainly it was the most dramatic.

About 200 interviews have been conducted for the Gemini history writing project.

Seventy percent of these have been transcribed; the tapes have been maintained.

For the Apollo program, an oral history approach similar to the Gemini effort is underway. About 75 interviews have been conducted to date.

Reflections on NASA Oral History

by

William D. Putnam

Our NASA experience with historical interviews has seemed to reveal three basic categories of benefits deriving from this technique as a research tool for writing contemporary history.

First, the personal accounts of actual participants in the events tend to put people back into the picture. It is good conditioning for a researcher to be exposed to personalized accounts of the events on which he already has voluminous written reports. Reports in any large bureaucracy, government or business, tend to be depersonalized to the extent where one begins to feel that events took place "untouched by human hands." The verbal account of someone intimately involved re-introduces the important human factor which is, of course, the essence of history itself

Second, any bias brought to the project, or acquired in the process of research, tends to be offset after the researcher has heard two (or more) sides of the same story recounted in forceful fashion. A real feeling for the complexity of personal interactions surrounding significant events is acquired. Dissenting views which may have been under consideration, yet never reached paper, can only be revealed through the oral history process. Often these are on the pivotal aspects of the history project itself.

Third, obscure sources of primary documentation may be uncovered. The desk files, personal diaries, telephone logs, and memoranda for the record which often prove to be the heart and soul of contemporary history are often turned up while interviewing participants in major events. Conversely, interviews are a most efficient manner in determining the significance of what only appears to be a key document, and often is not.

One of the most important lessons emerging from our NASA experience is the caution with which interview evidence must be used. Even the most able and well-trained

professional historian is subject to being influenced by a detailed personal account of an important event, especially when this account is the first evidence uncovered. The temptation is especially strong when a recorded interview has been transcribed and the evidence is present in black and white. In truth, of course, the historian's professional task has just begun at this point, for he must find other evidence-- documents or interviews--against which to weigh the original interview. It is through this evaluation, testing, and judgment that the historian's professional ability is exercised and, indeed, it is what makes him more than a mere recorder of other people's views.

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HEADQUARTERS:

Dr. Eugene M. Emme, NASA Historian, (13-37371) or 202/96-37371
EH/Dr. Frank W. Anderson, Jr., Deputy NASA Historian, (13-35493) or 202/96-35493
MCS/Mr. Wm. D. Putnam: Assistant NASA Historian, (202/96-27461) or (13-27461)
MM/Dr. Mac M. Link: Office of Space Medicine, Monitor, (202/96-24571) or (13-24571)
RC/John Sloop: Office of Adv. Res. & Tech., Monitor, (202/96 or 13-20937)
SP-1: Jack Posner, Office of Space Science & Appl., Monitor, (202/96 or 13-24540)

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Electronics Research Center/Mr. Edward T. Martin (Monitor), NASA Electronics
Research Center, 575 Technology Square, Cambridge, Mass., 02139 (617/491-1370)

Flight Research Center/Mr. Ralph Jackson (Monitor), Public Information Officer,
Flight Research Center, NASA Box 273, Edwards, Calif., 93523 (805/258-3311)

GSFC/Mr. Alfred Rosenthal: Historian, GSFC, NASA Greenbelt, Md., 20771 (301/982-4555
or 134-4955)

GISS/Dr. Arthur Levine: (Monitor), Goddard Institute for Space Studies, 2880
Broadway, New York, New York 10025 (212/UN-6-3600)

JPL/Mr. R. Cargill Hall, Historian, Jet Propulsion Laboratory, 4800 Oak Grove
Drive, Pasadena, California, 91103 (213/354-7018)

KSC/Dr. Robert A. Lindemann and Mr. Frank Jarrett: Historians, John F. Kennedy
Space Center, NASA, Kennedy Space Center, Florida 32931 (305/867-3561)

LaRC/Mr. Robert Mulac: (Monitor), Langley Research Center, NASA Langley Station,
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D.(7) PUBLICATIONS OF
H. L. Dryden

Revised Edition

THE PUBLICATIONS
OF
HUGH L. DRYDEN

(HHN-59)

Compiled by
Helen T. Wells

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National Aeronautics and Space Administration
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Preface

This is a compilation of the publications of the first NASA Deputy Administrator, the late Dr. Hugh L. Dryden. It spans his eventful career from his Johns Hopkins Ph.D. dissertation in 1919 to a paper published within a week of his death in late 1965. The broad span of subjects--from basic contributions to physics to the social implications of science, engineering, and public policy--provides an inkling of his brilliant and remarkable contributions to the Twentieth Century. It also demonstrates the inevitable interest future historians and other scholars may have in the papers of Dr. Dryden.

This revised edition incorporates 14 entries not included in the previously issued comment edition. In addition, refinements were made in 70 entries, in the form of correction or supplementary data.

Considerable effort was made to identify and include published addresses, especially during the NASA time period (1958-1965). It was not feasible to cite Dr. Dryden's published testimony on Capitol Hill over many years. His numerous unpublished writings, including speeches (and sermons), will be listed in a future Historical Note.

Several people were extremely helpful in various stages of compiling this list: Miss Grace Bogart, NASA Headquarters Library; Miss Jo Dibella, NASA Headquarters--formerly secretary to Dr. Dryden; Arthur Renstrom and Miss Shirley Medley, Library of Congress' Science and Technology Division; Miss Bernice Usdane and Philip Eckert, NASA Scientific and Technical Information Facility; and especially Mrs. Helen Morehouse, NASA Headquarters--also formerly secretary to Dr. Dryden--who devoted a generous amount of her time to assisting me.

This listing is intended to serve working scholars and reference librarians, but it cannot be regarded as definitive. Comments and suggestions are invited to eliminate any omissions or correct inaccuracies.

HTW

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"Looking Toward Maturity in the Space Age" (keynote address), Proceedings, Fifth National Conference on the Peaceful Uses of Space (St. Louis, Missouri, May 26, 1965). Washington: NASA SP-82, 1966.

"How the U.S. Cooperates with Other Nations in Space," Air Force/Space Digest International, I (June 1965), pp. 34-36.

"New Developments in U.S. Space Programme" The Financial Times (London), Survey Issue (June 8, 1965), p. X.

"The Nation's Manned Space Flights" (presented at the Governor's Conference on Oceanography and Astronautics, Lihue, Kauai, Hawaii, October 1, 1965). NASA Technical Memorandum X-56879.

"The Role of the University in the Exploration of Space" (address at the Autumn Meeting of the National Academy of Sciences, Seattle, Washington, October 11, 1965), Science, CL (November 26, 1965), pp. 1129-1133.

E.(8) SPECIAL
PUBLICATIONS



NASA SPECIAL PUBLICATIONS

Currently Available

FALL

1968



Introduction

NASA Special Publications report advances in science, engineering, technology, and management that have been important factors in the exploration of space. These publications contain new photographic and other information regarding the Earth, its Moon, interstellar space, and other planets; histories of significant programs, experiments, and flights; descriptions of a great variety of systems and devices, and the proceedings of conferences and symposia participated in by leaders in many disciplines. Both the most recent of these publications and those in which time has not diminished interest are listed in these pages.

Many of the discoveries and innovations of NASA Research Centers, contractors, and subcontractors are being used now in medical, educational, and other research. The handbooks, bibliographies and guides prepared for aerospace workers are also serving scientists and engineers in other fields. The Technology Utilization Series (pages 19 to 31) of Special Publications especially emphasizes information, data, and ideas likely to be helpful to industry.

The initials GPO preceding the price of a publication indicate that it may be purchased from the *Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.*

The initials CFSTI preceding the price of a publication indicate that it may be purchased from the *Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151.*

All of the publications described in this catalog were issued before June 30, 1968. To order one, please identify it both by its title and the "NASA SP" number assigned to it.



Gemini Summary Conference

Participants summarize the major results of the 10 manned flights of the Gemini Program in this Special Publication. It contains 21 technical papers presented at a Gemini Summary Conference on February 1 and 2, 1967, at the NASA Manned Spacecraft Center in Houston, Tex.; an introduction by George E. Mueller, Associate Administrator for Manned Space Flight, and 44 color photographs taken by the astronauts.

Five papers describe the rendezvous, docking, and tethering of spacecraft and a target vehicle; five describe extravehicular activities, and five review the operational support of the missions. Additional papers deal with onboard experiments, including synoptic terrain and weather photography; compare simulated and actual flight experiences, and relate results of the Gemini flights to the Apollo lunar-landing program.

NASA SP-138 1967 345 pp. GPO \$2.75

Earth Photographs from Gemini III, IV, and V

This volume contains 244 full-page reproductions in color of photographs of the Earth taken from altitudes of 100 and more miles. Captions locate and point out significant details. These views intrigue artists and philosophers, and already are being put to practical use in geology, meteorology, oceanography, and other sciences.

NASA SP-129 1967 276 pp. GPO \$7.00

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Histories and Chronologies	32
Management, Evaluation, and Analysis Standards	33
Handbooks, Data Compilations, Charts, and Tables	35
Bibliographies and Other Reference Works	42
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Fuel Cells

By L. G. Austin

Hundreds of reports of investigations for U.S. Government agencies were the basis for this guide to the past and future of fuel-cell technology. Information no longer readily available is summarized here to facilitate work in this rapidly changing field. Research on hydrogen-oxygen, hydrocarbon, amalgam, thermally regenerative, thermogalvanic, redox, hydrazine, ammonia, and biochemical fuel cells is discussed. Construction and manufacturing techniques are covered. So, too, are both theories and the various potential uses for different types of fuel cells. Appendices include a glossary, tabulated data, and a list of contract reports.

NASA SP-120 1967 439 pp. GPO \$2.75

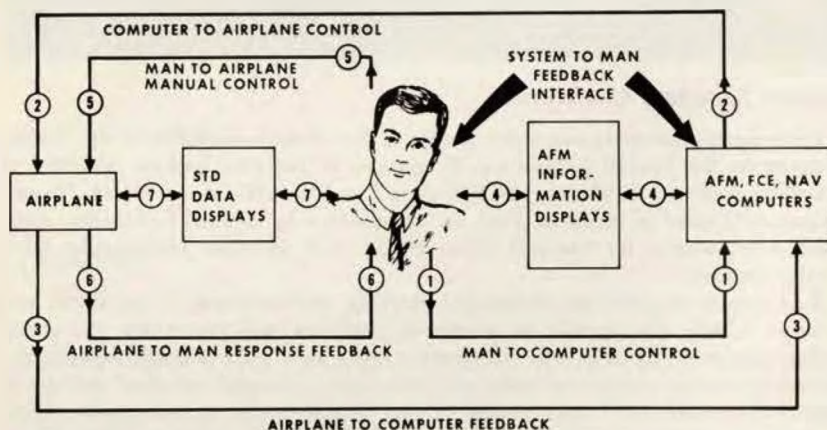
Sonic Boom Research

A. R. Seebass, Ed.

Possible means of reducing sonic boom overpressures, and the adequacy of current research, were discussed at NASA headquarters April 12, 1967. This volume contains five invited papers presented at that conference on basic theory, the effects of airplane operations and the atmosphere on sonic booms, and the effects of sonic booms on people and structures. A problem that has threatened to restrict commercial supersonic transport operations is further clarified in a preface by the editor and contributed remarks of participants from university and other laboratories.

NASA SP-147 1968 118 pp. GPO 50 cents

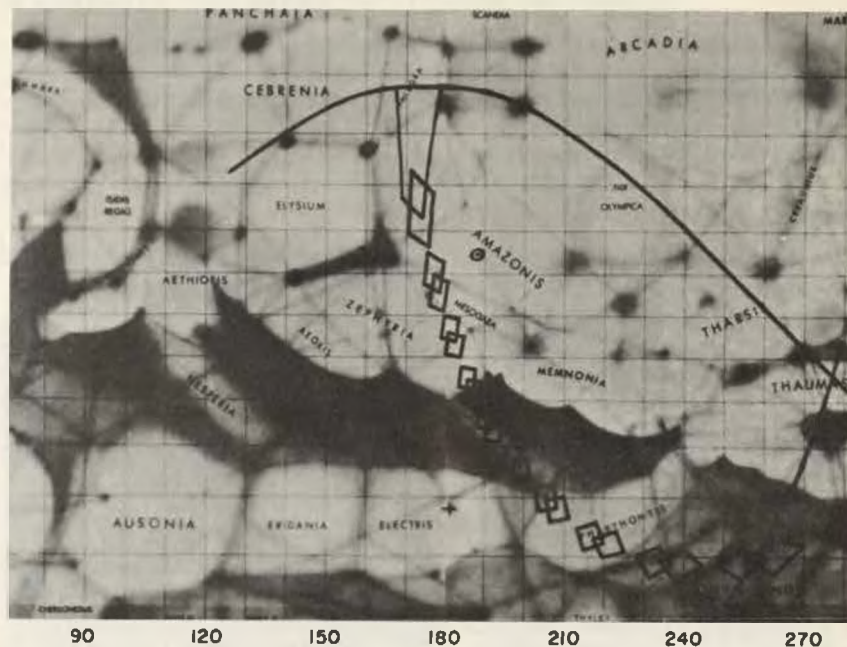
Recent Advances in Display Media



How can computer-generated information best be displayed in advanced aircraft and spacecraft? Fifteen papers given at a symposium sponsored by the Electronics Research Center in Cambridge, Mass., September 19 and 20, 1967, deal with aspects of this art. Thermochromic, fluidic, magnetic, electrostatic, laser and other display devices are among those considered. Technology applicable to nonaerospace systems as well as to cockpit displays is reviewed and current challenges to it are considered.

NASA SP-159 1968 146 pp. GPO \$1.00

Mariner-Mars 1964: Final Project Report



EAST LONGITUDE, deg

This is a technical history of the first man-made probe to travel to Mars, from the inception of the project in 1962 until two-way communication with the spacecraft was interrupted October 1, 1965. Prepared by Jet Propulsion Laboratory, the report describes the trajectory, the vehicle, testing operations, the flight, the tracking and data acquisition, and the engineering and scientific results. An appendix shows the project organization, and a bibliography lists 101 sources of further information.

NASA SP-139 1968 346 pp. GPO \$2.50

Summary of Gemini Extravehicular Activity

Reginald M. Machell, Ed.

The NASA Manned Spacecraft Center staff reviews the lessons of 12 hours and 25 minutes of extravehicular activity in this report, which includes recommendations regarding restraints, space suits, training, and other requirements. The development of life support systems, umbilical and tether combinations, and maneuvering equipment is recalled. So, too, are the training methods, and operational and medical aspects of the capabilities that men demonstrated during the Gemini flights.

NASA SP-149 1968 336 pp. CFSTI \$3.00

Conference on the Closed Life Support System

Findings in a program to develop a closed ecological system, reported at Ames Research Center in April 1966, are made available in this volume of proceedings.

NASA SP-134 1967 227 pp. CFSTI \$3.00

SURVEYOR FLIGHT FINDINGS

Historic additions to scientific knowledge of the Moon have been recorded in a series of preliminary reports compiled by the Lunar and Planetary Programs Division of the NASA Office of Space Science and Applications. Surveyors I, III, V, and VI were assigned to examine possible lunar landing sites for men. Each one distinguished itself in a new way.

Surveyor I, A Preliminary Report

This monograph describes the vehicle, the trajectory, tracking and data acquisition, photography, and scientific results of the first American soft landing on the Moon.

NASA SP-126 1966 40 pp. CFSTI \$3.00

Surveyor III, A Preliminary Report

A surface sampling arm dug trenches and made bearing and impact tests after this vehicle came to rest. This and other achievements such as photographing a solar eclipse and photographing the Earth in color are reviewed in this report of a 1967 flight.

NASA SP-146 1967 159 pp. CFSTI \$3.00

Surveyor V, A Preliminary Report

An alpha-scattering device disclosed the chemical composition of lunar material and a bar magnet experiment showed its magnetic characteristics. Surface temperatures and thermal characteristics also are discussed in the report of this flight.

NASA SP-163 1967 161 pp. CFSTI \$3.00

Surveyor VI, A Preliminary Report

Numerical values for physical and chemical properties of the lunar surface were refined and new information on the grain-size distribution became available. All Surveyor program requirements relative to the Apollo landing-site section were completed on the mission reviewed in detail in this volume. Photos and tables enhance the text.

NASA SP-166 1968 165 pp. CFSTI \$3.00



Aerospace Electronic Systems Technology: A Briefing for Industry

NASA spokesmen explained current and upcoming mission goals and demands upon aerospace technology at a briefing for industry sponsored by the Electronics Industries Association, May 3 and 4, 1967, at the Massachusetts Institute of Technology. The proceedings recorded in this volume delineate the role of the Electronics Research Center in Cambridge, Mass., and include discussions of the state of Earth orbital technology, lunar and planetary technology, and avionics.

NASA SP-154 1968 290 pp. GPO \$1.25



Geological analysis of Gemini photo of the Arabian Peninsula.

Scientific Satellites

By William R. Corliss

This is a comprehensive study of unmanned scientific satellites by an engineer noted for his skill in technical reporting. It covers the period from 1957, when a Russian satellite first beeped its greetings, through 1966. One major section deals with missions and spacecraft, and another with scientific instruments. Designs, experiments, capabilities, and orbits are recorded. A general bibliography and an appendix giving specifications of scientific satellites enhance the value of the work to students.

NASA SP-133 1968 822 pp. GPO \$3.00

Third Annual NASA-University Conference on Manual Control

This volume contains 34 papers presented at the University of Southern California, March 1 to 3, 1967. Discrete and decision processes in human actions are emphasized. The topics discussed included display systems, function models, computer processing of manual control records, psychological monitoring, advanced modeling techniques, and applications of manual control theory to problems involving simulators and both aircraft and spacecraft.

NASA SP-144 1968 459 pp. CFSTI \$3.00

Interstellar Grains

J. Mayo Greenberg and T. P. Roark, Eds.

Assembled here for reference use are the reports and remarks of several nations' scientists at a colloquium on interstellar grains at the Rensselaer Polytechnic Institute, August 24 to 26, 1965. The topics discussed included the formation, growth, scattering properties, and interactions of grains with the interstellar medium, polarization and its dependence on wavelength and spatial distribution, and granular extinction. The conference was under the auspices of the National Science Foundation and supported by NASA and the New York State Atmospheric Sciences Research Center
NASA SP-140 1967 269 pp. GPO \$1.25

1967 Summer Study of Lunar Science and Exploration

Prominent scientists recommend manned and unmanned lunar exploration efforts that exceed NASA's present capabilities, in this report of a summer study directed by Wilmot N. Hess of the NASA Manned Spacecraft Center. It contains the views of eight panels concerned with geology, geophysics, geochemistry, geodesy and cartography, lunar atmospheres, particles and fields, and astronomy, that met from July 31 to August 13, 1967, at the University of California at Santa Cruz. Although not an official NASA program, the recommendations of these scientists have been made available to others to stimulate the generation of further helpful ideas.
NASA SP-157 1967 398 pp. CFSTI \$3.00

Symposium on Computer Simulation of Plasma and Many-Body Problems

Techniques, philosophies, and potentialities of computer simulation of classical many-body problems were discussed at a symposium sponsored by the NASA Langley Research Center and the College of William and Mary, April 19 to 21, 1967, in Williamsburg, Va. Most of the proceedings in this volume deal with long-range forces and collective effects such as those that occur in plasmas and astrophysical systems, but several neutral-gas problems also were considered.

NASA SP-153 1967 440 pp. CFSTI \$3.00

A Survey of Attitude Sensors for Spacecraft

By Norman M. Hatcher

The fundamental principles of operation of horizon scanners, solar sensors, star trackers, space sextants, map matchers, and other sensors are set forth in this monograph to facilitate understanding of their use. The performance of many sensors in space is mentioned, and current research and problem areas are indicated.

NASA SP-145 1967 18 pp. CFSTI \$3.00

Protection Against Space Radiation

Special sessions of the American Nuclear Society's 13th annual meeting, at San Diego, Calif., in June 1967, dealt with this topic. This volume records the proceedings.

NASA SP-169 1968 600 pp. CFSTI \$3.00

Proceedings of a conference in 1964, sponsored by AEC, USAF, and NASA, on the same topic are also available: Second Symposium on Protection Against Radiations in Space.

NASA SP-71 1965 551 pp. GPO \$3.00

BENCHMARKS IN SPACE SCIENCE

Significant Achievements in Space Science 1966

This volume describes the many achievements in 1966 that were both significant steps toward the goals of scientific research and exciting news for lay readers. In it, authorities on space astronomy, space bioscience, ionospheres and radio physics, particles and fields, and solar physics summarize and relate discoveries and technological advances that promise to be of especial importance in their disciplines.

NASA SP-155 1968 419 pp. GPO \$1.50

Significant Achievements in Space Applications 1966

Satellites supported global programs in communications, meteorology, and geodesy in 1966, and indicated their potential usefulness in navigation, traffic control, agriculture, forestry, transportation, geology, hydrology, oceanography, and geography. Robert H. McQuain of the NASA Office of Space Science and Applications describes the progress made in deriving social and economic benefits from satellites.

NASA SP-156 1968 91 pp. GPO 50 cents

Significant Achievements in Space Science 1965

Twenty-one Mariner IV pictures of Mars revised men's knowledge of that planet in 1965. This and other advances in scientific knowledge are summarized in this volume.

NASA SP-136 1967 218 pp. GPO \$1.00

Significant Achievements in Space Applications 1965

This companion volume to NASA SP-136 (described above) covers noteworthy accomplishments in such fields as communications, geodesy, and meteorology.

NASA SP-137 1967 85 pp. GPO 45 cents

For the convenience of readers, advances in 10 scientific disciplines during the 1958-to-1964 period have been summarized in separate volumes:

Significant Achievements in Space Astronomy 1958-1964, NASA SP-91 1966 73 pp. GPO 45 cents; Significant Achievements in Space Bioscience 1958-1964, NASA SP-92 1966 128 pp. GPO 55 cents; Significant Achievements in Space Communications and Navigation 1958-1964, NASA SP-93 1966 68 pp. GPO 45 cents; Significant Achievements in Satellite Geodesy 1958-1964, NASA SP-94 1966 174 pp. GPO 60 cents; Significant Achievements in Ionospheres and Radio Physics 1958-1964, NASA SP-95 1966 60 pp. GPO 45 cents; Significant Achievements in Satellite Meteorology 1958-1964, NASA SP-96 1966 141 pp. GPO 60 cents; Significant Achievements in Particles and Fields 1958-1964, NASA SP-97 1966 94 pp. GPO 50 cents; Significant Achievements in Planetary Atmospheres 1958-1964, NASA SP-98 1966 59 pp. GPO 45 cents; Significant Achievements in Planetology 1958-1964, NASA SP-99 1966 71 pp. GPO 45 cents; Significant Achievements in Solar Physics 1958-1964, NASA SP-100 1966 96 pp. GPO 50 cents

Meteor Orbits and Dust: Proceedings of a Symposium

Gerald S. Hawkins, Ed.

Published simultaneously by NASA and as Volume II of the "Smithsonian Contributions to Astrophysics," this volume contains 20 papers prepared for a symposium sponsored by NASA and the Smithsonian Institution Astrophysical Observatory, August 8 to 13, 1965, in Cambridge, Mass. It includes flight data on meteoroid penetration hazards obtained by Pegasus I and II and smaller Explorer satellites.

NASA SP-135 1967 412 pp. GPO \$2.50

Oxide Dispersion Strengthened Alloys

By Nicholas J. Grant, Howard J. Siegel, and Robert W. Hall

In this report, prepared for the NASA Research Advisory Committee on Materials, the authors sought to explain why oxide dispersion strengthened alloys have not achieved greater commercial success. Their report points to major gaps in knowledge of these alloys and recommends expanded support of studies of them.

NASA SP-143 1967 25 pp. GPO 15 cents

Second Symposium on the Role of the Vestibular Organs in Space Exploration

Twenty-three papers presented at an Ames Research Center symposium in January 1966, under the auspices of the National Academy of Sciences-National Research Council Committee on Hearing, Bioacoustics, and Biomechanics. Practical problems posed by weightlessness and subgravity, and findings in current work with both animal and human subjects are among the topics discussed.

NASA SP-115 1967 312 pp. GPO \$2.00

Papers presented at a similar conference at Pensacola, Fla., in January 1965, have also been published under the title "The Role of the Vestibular Organs in the Exploration of Space."

NASA SP-77 1965 392 pp. GPO \$2.50

The Dynamic Behavior of Liquids in Moving Containers

Applications to space technology are stressed in this Southwest Research Institute review of problems posed by the sloshing and other motions of liquids and the effects on a vehicle's stability and control.

NASA SP-106 1967 467 pp. GPO \$2.70

First Compilation of Papers on Trajectory Analysis and Guidance Theory

Seven technical papers prepared by contractors for the NASA Electronics Research Center Guidance Laboratory on celestial mechanics, impulse transfers, functional models, and calculus of variation.

NASA SP-141 1967 215 pp. CFSTI \$3.00

Involuntary Hypohydration in Man and Animals: A Review

By John E. Greenleaf

This review summarizes the literature pertaining to delay in rehydration following water loss and associated factors influencing water intake by man and animals.

NASA SP-110 1966 34 pp. GPO 30 cents

SPACE TECHNOLOGY TEXTS

NASA Special Publications include a series of short basic texts for upper-level college engineering students. These were based on notes prepared for summer courses, the first five of which were given by the California Institute of Technology and the sixth at the University of California at Los Angeles. The staff of the Jet Propulsion Laboratory and many academic and industrial authorities helped plan these courses and publications.

Space Technology Vol. I: Spacecraft Systems

By L. H. Abraham

Method of planning spacecraft and relating and utilizing various subsystems are described. The author shows how to establish relationships of various parts and the utilization of various subsystems before designs are committed.

NASA SP-65 1965 85 pp.
GPO 35 cents

Space Technology Vol. II: Spacecraft Mechanical Engineering

By James L. Adams

Structural, temperature-control, and electronic-packaging methods and basic theory are included.

NASA SP-66 1965 166 pp.
GPO 60 cents

Space Technology Vol. III: Spacecraft Propulsion

By F. E. Marble

To be published as NASA SP-67.

Space Technology Vol. IV: Spacecraft Guidance and Control

By J. R. Scull

Tradeoffs among injection, midcourse, and terminal guidance, and ways of mechanizing systems, are covered.

NASA SP-68 1967 143 pp.
GPO 55 cents

Space Technology Vol. V: Telecommunications

By J. J. Stiffler

Fundamentals, modulation, data compression, and systems in use and planned are described.

NASA SP-69 1967 142 pp.
GPO 55 cents

Space Technology Vol. VI: Space Sciences

By T. A. Farley

A discussion of the geomagnetic field, Van Allen belt, galactic and solar cosmic rays, comets, and dust.

NASA SP-114 1967 84 pp.
GPO 35 cents

Bioenergetics of Space Suits for Lunar Exploration

A Literature Review by Emanuel M. Roth

This report discusses the new problems in optimal space-suit system design presented by the potential for severe physical exertion outside the spacecraft and on the surface of the Moon and other celestial bodies. Subjects covered include the metabolic load imposed on humans by exertion, the mechanics of locomotion under varied terrain and gravity conditions, mobility restriction in space suits, and problems of thermal control.

NASA SP-84 1966 140 pp. GPO \$1.00

Fifth National Conference on the Peaceful Uses of Space

Proceedings of a 1965 meeting in St. Louis of representatives of industry, the scientific community, and government to review accomplishments, goals, future programs, and the impact of space exploration on industry, communication, education, philosophy, and society. This volume includes "Looking Toward Maturity in the Space Age," by Dr. Hugh L. Dryden, NASA Deputy Administrator, who died in December 1965.

NASA SP-82 1966 200 pp. GPO \$1.50

The first National Conference on Peaceful Uses of Space was held in Tulsa in 1961, the second at Seattle in 1962, the third in Chicago in 1963, and the fourth at Boston in 1964. Proceedings of these conferences have also been published by NASA:

No number 1961 184 pp. GPO \$1.25

NASA SP-8 1962 282 pp. GPO \$1.50

NASA SP-40 1963 301 pp. GPO \$2.00

NASA SP-51 1964 226 pp. GPO \$1.50

Orbiting Solar Observatory Satellite OSO I: The Project Summary

A description of the work performed in connection with the Orbiting Solar Observatory, launched March 7, 1962, including details on spacecraft dynamics, structural design and fabrication, control systems, data acquisition and command systems, power supply, thermal control, testing, and experiments carried out with the OSO I.

NASA SP-57 1966 306 pp. GPO \$2.00

Medical Aspects of an Orbiting Research Laboratory

A report by the Space Medicine Advisory Group (SPAMAG), a group of consultants representing varied disciplines in the life sciences. Recommendations fall in three broad categories: (1) life support; (2) experiments to test the response in the space environment; and (3) research laboratory design and operation.

NASA SP-86 1966 144 pp. GPO \$1.00

Vacuum Technology and Space Simulation

By Donald J. Santeler, David H. Holkeboer,
Donald W. Jones, and Frank Pagano

A single source handbook which consolidates the numerous interacting vacuum techniques required for space simulation and which is specifically designed for the engineer who needs to purchase, operate, maintain, or otherwise use vacuum space simulation equipment.

NASA SP-105 1966 306 pp. GPO \$1.00

Development of a Small Animal Payload and Integration with a Sounding Rocket

Larry J. Early, Ed.

A report on the results of Phase I of the Bio-Space Technology Program, describing the design, development, and integration with a modified Arcas launch vehicle of a small-animal payload. Included are discussions of trajectory and performance, vehicle aerodynamic analysis, payload and recovery systems design, biological bench tests, payload flight-qualification testing, and flight tests and results.

NASA SP-109 1966 98 pp. GPO 60 cents

Human Response to Sustained Acceleration

A Literature Review by T. M. Fraser

A critical review of the open literature in the field, this report deals with the natural history and physiological effects of sustained acceleration and with human tolerance and performance.

NASA SP-103 1966 136 pp. GPO \$1.00

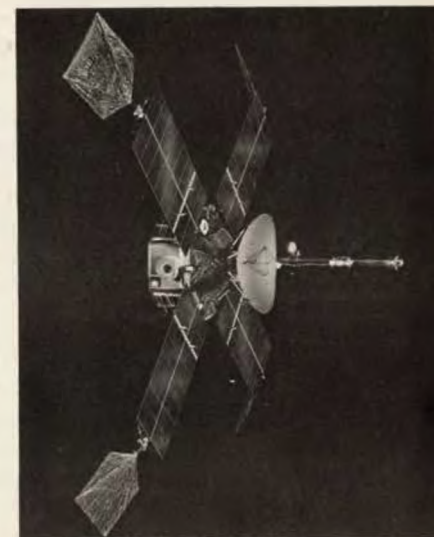
A Review of the Mariner IV Results

By Oran W. Nicks

Mariner IV revealed the thinness of the atmosphere, moon-like craters, and other features of Mars to men. In this paper the director of Lunar and Planetary Programs of the NASA Office of Space Science and Applications describes this historic spacecraft, its trajectory, and the experiments that it carried on its journey to within 9487 kilometers of Mars. Engineering advances, technological lessons learned, and findings regarding the interplanetary environment are summarized. A discussion of scientific highlights is illustrated with computer-enhanced pictures of portions of the Martian surface covered by the television system.

NASA SP-130 1967

39 pp. 25 cents



Spacecraft Sterilization Technology

This volume contains 36 papers prepared for a conference at the Jet Propulsion Laboratory in November 1965. Four of them explain NASA's efforts to facilitate the search for extraterrestrial life by preventing contamination of the findings.

NASA SP-108 1967 630 pp. GPO \$2.25

Aerospace Measurement Techniques

Gene G. Manella, Ed.

Possible bases for new instrumentation concepts were considered at a Massachusetts Institute of Technology symposium in July 1966, sponsored by the NASA Electronics Research Center.

NASA SP-132 1967 261 pp. GPO \$1.00

Astronomy in Space

Three papers presented at the 121st meeting of the American Astronomical Society in March 1966 by Homer E. Newell, Henry J. Smith, and Nancy G. Roman on, respectively, the NASA space astronomy program, solar astronomy, and stellar and galactic astronomy—plus an account of expanding vistas in astronomy by George E. Mueller noting opportunities opened by manned flight capability.

NASA SP-127 1967 67 pp. GPO 45 cents

A Survey of Space Applications

Real and feasible uses of space technology in communications, surveying the Earth's resources, geodesy, meteorology, and navigation are discussed. Prepared for a National Academy of Sciences summer study, with a foreword by James E. Webb.

NASA SP-142 1967 135 pp. GPO 70 cents

Space Cabin Atmospheres

Part I: Oxygen Toxicity

Part II: Fire and Blast Hazards

Part III: Physiological Factors of Inert Gases

Part IV: Engineering Tradeoffs of One- Versus Two-Gas Systems

These are open literature reviews by Emanuel M. Roth, relating oxygen to other factors of concern in space cabins, discussing environmental hazards, noting physiological effects of chemically inert gases, and engineering considerations.

NASA SP-47 Part I 1964 51 pp. GPO 40 cents

NASA SP-48 Part II 1964 119 pp. GPO \$1.00

NASA SP-117 Part III 1967 136 pp. GPO \$1.00

NASA SP-118 Part IV 1967 132 pp. GPO \$1.00

Dynamic Stability of Rotor-Bearing Systems

By Edgar J. Gunter, Jr.

The report of an investigation of the conditions in a rotor system which can lead to a type of a self-excited, unstable motion variously known as shaft whirling, oil film whirl, resonance whip, or half-frequency whirl, but referred to here as nonsynchronous precession. Theoretical results and experimental observations are compared.

NASA SP-113 1966 228 pp. GPO \$1.00

Conference on V/STOL and STOL Aircraft

Papers presented at a conference held at Ames Research Center, Moffett Field, Calif., April 4-5, 1966, summarizing recent NASA research results related to the aerodynamic, propulsion, and handling-quality aspects of V/STOL and STOL aircraft. Included are three NASA-supported feasibility studies of concepts for short-haul transports prepared by Boeing, Ling-Temco-Vought, and Lockheed.

NASA SP-116 1966 467 pp. CFSTI \$3.00

Space Power Systems Advanced Technology Conference

Proceedings of a conference held at Lewis Research Center, August 23-24, 1966, to review progress in space power systems technology. The information presented includes contributions by NASA contractors and by the Department of Defense and the Atomic Energy Commission and their contractors.

NASA SP-131 1966 285 pp. CFSTI \$3.00

Summary Report on the NASA-Western University Conference

A summary of NASA's first regional University Conference, November 8-9, 1965, at the Jet Propulsion Laboratory in Pasadena, Calif., with university participants drawn from the 13 Western States. NASA SP-122 1966 58 pp. CFSTI \$3.00

Progress in Development of Methods in Bone Densitometry

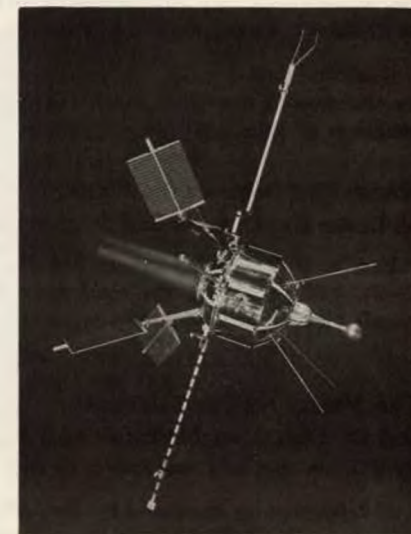
Proceedings of a conference held in Washington, D.C., March 25-27, 1965, under the joint sponsorship of NASA, the National Institute of Arthritis and Metabolic Diseases (NIH), and the American Institute of Biological Sciences.

NASA SP-64 1966 204 pp. GPO \$1.50

Ariel I: The First International Satellite

In Ariel I, a pilot project to establish a pattern of international cooperation, scientists and engineers of the United Kingdom and the United States studied the ionosphere and its relation to the Sun. This account covers the project's organization, the satellite's useful life (from April 1962 to November 1964), and the results. It describes the satellite's structure and major subsystems, and the tracking, data acquisition and data reduction operations. This is a summary document, prepared by Goddard Space Flight Center, in which readers will find guidance to further details of particular facets of a project which Sir Harrie Massey, Chairman of the British National Committee for Space Research, has acclaimed as "generally successful both technologically and scientifically."

NASA SP-119 1967 158 pp.
GPO \$1.50



Under the same title a project summary was published as NASA SP-43 (1963 76 pp. GPO 70 cents).

Philosophy of Simulation in a Man-Machine Space Mission System

An examination of the philosophy of simulation as it pertains to manned space activities, with particular orientation to research in the life sciences.

NASA SP-102 1966 107 pp. GPO 50 cents

Proceedings of a Conference on Theoretical Biology

A series of discussions on de novo cell synthesis and population ecology held at Princeton, N.J., November 22-24, 1963, under the sponsorship of NASA and the American Institute of Biological Sciences.

NASA SP-104 1966 188 pp. GPO \$1.00

Proceedings of a Symposium on Passive Gravity-Gradient Stabilization

Proceedings of a symposium held at Ames Research Center, May 10-11, 1965, to document the current state of the art in hardware development for gravity-gradient control systems.

NASA SP-107 1966 269 pp. GPO \$1.75

Gemini Midprogram Conference

This report contains 46 papers presented at the Gemini Midprogram Conference held at the Manned Spacecraft Center, Houston, Texas, February 23-25, 1966. The first group of 30 papers describes the spacecraft and launch vehicle, flight operations, and mission results; the second group reports on in-flight experiments.

NASA SP-121 1966 444 pp. GPO \$2.75

An Analysis of the Extraterrestrial Life Detection Problem

By Richard S. Young, Robert B. Painter, and Richard D. Johnson

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."

NASA SP-75 1965 33 pp. CFSTI \$3.00

NASA 1965 Summer Conference on Lunar Exploration and Science

Results of the conference on lunar exploration, held in Falmouth, Mass., July 19-31, 1965, including the conclusions and recommendations drawn from it. An overall lunar-mission summary is given, together with the working-group reports.

NASA SP-88 1965 422 pp. GPO \$1.50

The Meteoroid Environment and Its Effects on Materials and Equipment

By William A. Cosby and Robert G. Lyle

A detailed study, prepared by the National Academy of Sciences, of publications appearing since 1960 on the meteoroid environment and its effects on materials and equipment. Divided into sections on: Environment, Hypervelocity Impact Phenomena, and Design Considerations.

NASA SP-78 1965 116 pp. GPO 50 cents

Bioregenerative Systems

Proceedings of a conference sponsored by the American Institute of Biological Sciences and NASA, at Washington, in November 1966, include papers on the chemosynthetic approach to a closed bioregenerative life-support system, and related matters including the multidisciplinary research program dealing with the organism *Hydrogenomonas*.

NASA SP-165 1968 153 pp. GPO \$1.50

Final Report on the Relay I Program

This report deals with (1) the design, development, and performance of the spacecraft hardware; (2) the various experiments performed (communications and radiation) at the Nutley, N.J., and the Andover, Maine, ground stations; and (3) information received from foreign participants in the Relay I project.

NASA SP-76 1965 767 pp. GPO \$1.75

Conference on Aircraft Operating Problems

Papers presented at a conference at Langley Research Center, May 10-12, 1965. Contributions were made by Ames Research Center, Flight Research Center, and Langley Research Center.

NASA SP-83 1965 327 pp. CFSTI \$3.00

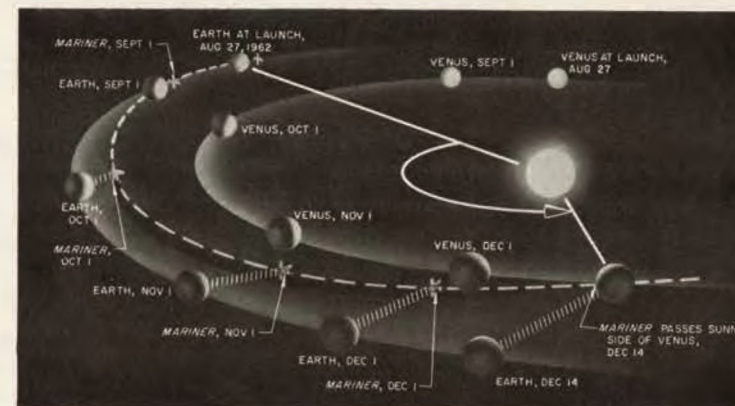
Symposium on Thermal Radiation of Solids

S. Katzoff, Ed.

Symposium held in San Francisco, Calif., March 4-6, 1964, sponsored by NASA, the National Bureau of Standards, and the USAF's Aeronautical Systems Division. The document also carries Air Force No. ML-TDR-64-159. Author and subject indexes.

NASA SP-55 1965 620 pp. GPO \$3.75

Mariner-Venus 1962: Final Project Report



Prepared by the Jet Propulsion Laboratory, this report describes the flight of the Mariner II spacecraft to the vicinity of Venus. The chronology begins with the activation of the project to meet the 1962 Venus launch opportunity. Chapters include project organization and management; spacecraft system design and development; operational events; evaluation of the subsystems, the tracking network, the data-recovery and processing system; and scientific findings.

NASA SP-59 1965 344 pp. GPO \$2.50

Concepts for Detection of Extraterrestrial Life

Freeman H. Quimby, Ed.

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.

NASA SP-56 1964 53 pp. GPO 50 cents

Scientific Findings From Explorer VI

Selected papers and reports on data collected by Explorer VI, designed to provide a coordinated, comprehensive group of measurements of scientific interest.

NASA SP-54 1965 381 pp. GPO \$2.25

Observations From the Nimbus I Meteorological Satellite

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, Wash.

NASA SP-89 1965 90 pp. CFSTI \$3.00

Proceedings of the Apollo United S-Band Technical Conference

Papers presented at the conference held July 14-15, 1965, at Goddard Space Flight Center. The presentations by persons directly involved in the Apollo program, describe the ground systems required. NASA SP-87 1965 302 pp. CFSTI \$3.00

Proceedings of the NASA-University Conference on Science and Technology of Space Exploration, Vols. 1 and 2

State-of-the-art papers on NASA programs presented to the scientific and technical community at a conference held in Chicago, Ill., November 1-3, 1962.

NASA SP-11 1962 Vol. 1 429 pp. GPO \$2.50
Vol. 2 532 pp. GPO \$3.00

NASA-University Program Review Conference

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.

NASA SP-85 1965 400 pp. GPO \$1.50

A "Summary Report on the NASA University Program Review Conference" described above is also available as NASA SP-81 (1965 37 pp. CFSTI \$3.00).

Electrical Power Generation Systems for Space Applications

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.

NASA SP-79 1965 40 pp. CFSTI \$3.00

Short-Term Frequency Stability

Proceedings of the IEEE-NASA Symposium on the Definition and Measurement of Short-Term Frequency Stability held at the Goddard Space Flight Center, Greenbelt, Md., November 23-24, 1964.

NASA SP-80 1965 317 pp. GPO \$1.75

Dictionary of Technical Terms for Aerospace Use

William H. Allen, Ed.

This first edition of a dictionary for space scientists and technologists contains more than 6000 carefully chosen and precisely defined terms. It does not attempt, however, to include every aspect of space terminology.

NASA SP-7 1965 314 pp. GPO \$3.00

Short Glossary of Space Terms

Brief definitions of frequently used space terms, selected from the *Dictionary of Technical Terms for Aerospace Use* (NASA SP-7). Second edition.

NASA SP-1 1966 52 pp. GPO 25 cents

X-15 Research Results, With a Selected Bibliography

By Wendell H. Stillwell

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.

NASA SP-60 1965 128 pp. GPO 55 cents

Conference on Nutrition in Space and Related Waste Problems

Proceedings of a conference at the University of South Florida in Tampa, April 27-30, 1964, on problems associated with maintaining astronauts in space.

NASA SP-70 1965 400 pp. GPO \$2.75

Ranger IX Photographs of the Moon:

Cameras "A," "B," and "P"

This is the fifth in a series of volumes of photographs of the Moon taken by the Rangers. It shows 170 selected Ranger IX frames.

NASA SP-112 1966 187 pp. GPO \$6.50

The other volumes in this series are: Ranger VIII Photographs of the Moon: Cameras "A," "B," and "P," NASA SP-111 (1966 187 pp. GPO \$6.50); Ranger VII Photographs of the Moon, Part I, Camera "A" Series, NASA SP-61 (1964 226 pp. GPO \$6.50); Part II, Camera "B" Series, NASA SP-62 (1965 217 pp. GPO \$6.50); and Part III, Camera "P" Series, NASA SP-63 (1965 200 pp. GPO \$6.50).

Survey of the Literature on the Solar Constant and the Special Distribution of Solar Radiant Flux

By M. P. Thekaekara

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.

NASA SP-74 1965 43 pp. CFSTI \$3.00

Aerodynamic Design of Axial-Flow Compressors

Irving A. Johnson and Robert O. Bullock, Eds.

Results of 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 turbojet or turboprop engines.

NASA SP-36 1965 508 pp. GPO \$3.00

Advanced Bearing Technology

By Edmond E. Bisson and William J. Anderson

Exposition of the fundamentals of friction and wear, fluid-film bearings, and rolling element bearings, with demonstrations of how fundamental principles can be applied to the solution of unique and advanced bearing problems.

NASA SP-38 1964 511 pp. GPO \$1.75

A Quasi-Global Presentation of Tiros III Radiation Data

By Lewis J. Allison, Thomas I. Gray, Jr., and Guenter Warnecke

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.

NASA SP-53 1964 23 pp. GPO \$2.00

Measurement of Thermal Radiation Properties of Solids

Joseph C. Richmond, Ed.

Proceedings of a symposium at Dayton, Ohio, September 5-7, 1962, sponsored by NASA, the Air Force, and the National Bureau of Standards. Index.

NASA SP-31 1963 587 pp. GPO \$3.50

Proceedings of the NASA-AEC

Liquid-Metals Corrosion Meetings, Vol. I

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.

NASA SP-41 1964 316 pp. CFSTI \$3.00

Results of the Project Mercury Ballistic and Orbital Chimpanzee Flights

James P. Henry and John D. Mosely, Eds.

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.

NASA SP-39 1963 71 pp. GPO 45 cents

Telstar I: Vols. 1, 2, and 3

Compilation of papers written by employees of Bell Telephone Laboratories who were involved in the Telstar project. Volume 3 contains an index to all three volumes.

NASA SP-32 1963 1940 pp. CFSTI \$3.00 per volume

U.S. Standard Atmosphere, 1962

Tables of atmospheric parameters to 700 kilometers, incorporating results of rocket and satellite research through mid-1962.

(No Number) 1962 278 pp. GPO \$3.50

List of Selected References on NASA Programs

List of the selected NASA publications and releases issued during the 3 years following the agency's establishment in October 1958.

NASA SP-3 1962 236 pp. GPO \$1.25

Technology Utilization Series

Teleoperators and Human Augmentation

By Edwin G. Johnsen and William R. Corliss

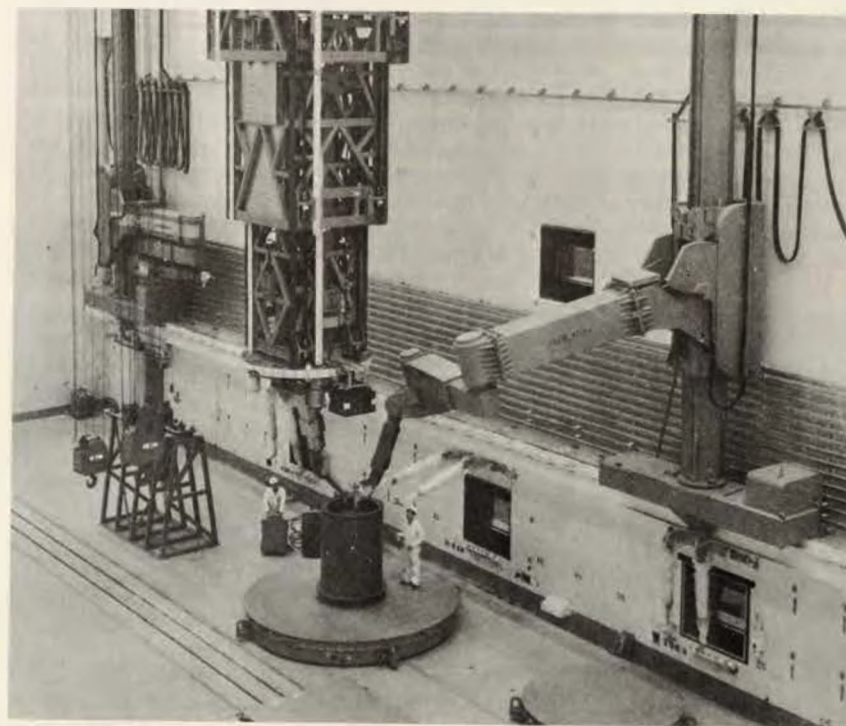
This AEC-NASA Survey describes dextrous, general-purpose, cybernetic machines that now enable men to operate tools in a hostile environment without personally entering it. Such machines are both extending and amplifying men's capabilities in space, the ocean depths, and industrial plants. They are also being adapted to help physically handicapped persons enjoy greater mobility.

Edwin G. Johnsen, Facilities Chief of the Joint AEC-NASA Space Nuclear Propulsion Office, and William R. Corliss, a professional technical writer, produced this generously illustrated study of the status and potentialities of teleoperators. After tracing the evolution of design principles embodied in current machines, they discuss the interfaces between men and these new machines.

Teleoperator technology has germinated and grown independently wherever men have tried to augment their hands, arms, and legs with machines. Most of the several thousand manipulator arms built in recent years have been used in atomic energy installations. Similar machines, the authors argue, can be used now increasingly to free men from dull, routine tasks.

The eight principal subsystems of today's outstanding teleoperators are described in detail, with particular emphasis on actuating, sensing, and terminal devices.

NASA SP-5047 1968 265 pp. GPO \$1.00



Wall-mounted, remotely controlled hands in a rocket development station.

Contamination Control Principles

By *H. D. Sivinski, W. J. Whitfield, and W. L. Clement*

In this well publicized report, Willis J. Whitfield (whom Time Magazine calls "Mr. Clean") and his colleagues at the Sandia Corporation in Albuquerque, N. Mex., present a basic model for contamination control in pharmaceutical, electronic, and other industries where ultracleanliness is important. This is a guidebook for managers, foremen, and technicians. It deals with particulate, gaseous, liquid, radiation, and microbial contamination, and describes both stationary and portable clean work stations. Laminar air flow systems are emphasized, and fundamental principles are explained.

NASA SP-5045 1967 55 pp. GPO 40 cents

Analytical Chemistry Instrumentation: A Survey

By *Julia S. Whitlock, R. F. Muraro, and Leonard A. Cavanagh*

The alpha-scattering device used on the Moon for chemical analysis of its surface is one of many intriguing instruments described in this survey by Stanford Research Institute scientists. NASA contributions to ultraviolet, infrared, and X-ray spectroscopy, neutron-activation analysis, mass spectroscopy, gas chromatography, specific gas analyzers, vacuum equipment, and life-detection techniques are reviewed. Much of the information may be helpful in medical, materials, and other research, and both students and users of modern instruments are finding this publication of interest.

NASA SP-5083 1967 134 pp. GPO 60 cents

Thermal Protection Systems: A Survey

By *Peter E. Glaser et al.*

Aerospace work helpful to designers of such varied things as natural gas pipelines and surgical tools is reviewed in this survey by an internationally noted authority on solar furnaces and his colleagues at Arthur D. Little, Inc. Fundamental principles and measurement methods are discussed, as well as placement of insulation materials, the structure of multi-layer systems, and supports for insulation. genic applications are stressed, but insulations for use at high temperatures also are described. "Southern Engineering" abstracted this work in its December 1967 issue.

NASA SP-5027 1967 148 pp. GPO 60 cents



Multi-layer insulation pinned on the wall of a tank.

Constructing Inexpensive Automatic Picture-Transmission Ground Stations

By *Charles H. Vermillion*



This report tells how to build a ground station to receive pictures from weather satellites. Such a station can be built from surplus parts costing less than \$500. Local weather services, radio and TV stations, scientists, farm cooperatives, and other interested persons are now receiving cloud-cover pictures several times a day via such stations in all parts of the world. The antenna, FM receiver, and other components are described and the operation of such a ground station is explained.

NASA SP-5079 1968 62 pp. CFSTI \$3.00

Structural Design Concepts: Some NASA Contributions

By *L. Albert Scipio*

Many aerospace contributions to structural design are applicable to buildings and other structures that need not fly. The author of this survey has summarized such advances in structural types, concepts, and design synthesis and optimization. He describes the development of materials associated with these advances, and gives examples of ways in which they may be used. This survey was written primarily for the designer and is being used as a college text. Eighty-one figures, scores of references, and a glossary are included.

NASA SP-5039 1967 174 pp. GPO 70 cents

Advanced Valve Technology

By *Louis C. Burmeister, John B. Loser, and Eldon Sneegas*

This is a second, greatly enlarged, and improved edition of a Midwest Research Institute survey of innovations that are helping to solve leakage, thermal, and reliability problems in a variety of fluid systems. It discusses materials compatibility, lubrication, and response time; valve actuators, position indicators, and computer control.

NASA SP-5019 1967 183 pp. GPO \$1.00

Commercial Potentials of Semipermeable Membranes

By Sidney B. Tuwiner, Ernest J. Henley, and H. Kenneth Staffin

A survey of spacecraft-stimulated progress in producing and using membranes, including advances which have varied but impressive economic potentialities. Presented are data on new techniques and principles, membrane applications in batteries, advances in material science, level control in batteries, fuel cells, and various separation processes. NASA SP-5061 1967 45 pp. GPO 35 cents

Magnetic Tape Recording Technology

By Skipwith W. Athey

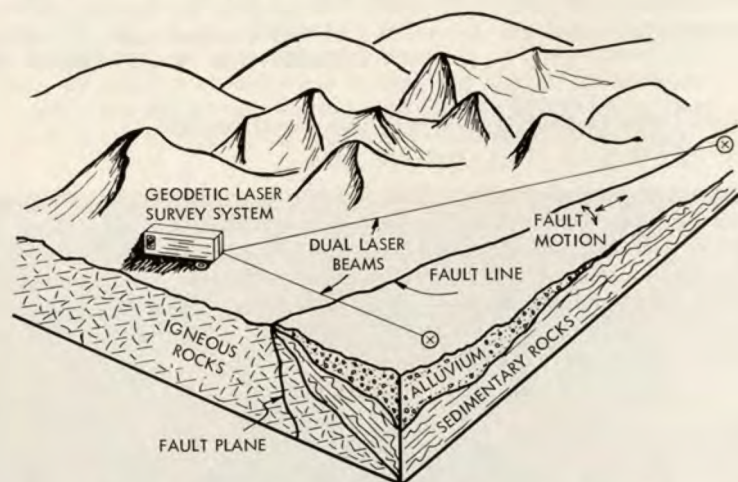
A survey of the entire range of recorder technology, with emphasis on two aspects of development in which NASA has played an important part. One is the area of miniature severe-environment tape recorders, for use in satellites and space probes. The other area is that of commercial, ground-based tape recorders.

NASA SP-5038 1966 326 pp. GPO \$1.25

Microelectronics in Space Research

Provides information on the contributions to the microelectronics field that have originated in NASA research programs. Also includes 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. NASA SP-5031 1965 130 pp. GPO 60 cents

Earthquake Prediction from Laser Surveying



This report by R. A. Fowler describes a dual-beam laser system developed by North American Aviation, Inc., subsequent to a Laser Space Communications Systems Study done under contract for NASA. The author discusses its use both to predict earthquakes and to measure the response of structures to earthquake activity.

NASA SP-5042 1968 32 pp. GPO 35 cents

Plasma Jet Technology

Compiled by P. R. Dennis, C. R. Smith, D. W. Gates, and J. B. Bond

This survey 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. NASA SP-5033 1965 200 pp. GPO \$1.00

The Electromagnetic Hammer

This report describes a method of using a pancake electromagnetic coil driven by electric-discharge equipment to smooth out nonferrous metal components such as welded rocket fuel tanks, gore segments, and bulkheads.

NASA SP-5034 1965 22 pp. GPO 25 cents

Cumulative Index to NASA Tech Briefs 1963-1967

Tech Briefs are short announcements of innovations and developments by NASA research centers, contractors, and subcontractors that are potentially applicable to problems arising outside as well as within the aerospace industry. A cumulative index containing abstracts of these briefs is published annually. This one lists more than 2000 Tech Briefs, any one of which may be purchased for 15 cents from the Clearinghouse for Federal Scientific and Technical Information. Subjects and the originating sources are indexed.

NASA SP-5021(06) 1967 140 pp. CFSTI \$1.00 (See Page 56)

Solid Lubricants

By M. E. Campbell, John B. Loser, and Eldon Sneegas

A survey of the state of development of solid lubricants, including types and specifications, commercial applicability, cost factors, theory, and new developments in the field. Methods of evaluating solid film lubricants and the test apparatus are also discussed. NASA SP-5059 1966 115 pp. GPO 50 cents

A "Bibliography on Solid Lubricants" also has been published as NASA SP-5037 (1966 14 pp. CFSTI \$3.00).

NASA Contributions to the Technology of Inorganic Coatings

By Jerry D. Plunkett

A 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, and measurement of coating optical properties, and refractory metal oxidation-resistant coatings.

NASA SP-5014 1964 268 pp. GPO \$1.00

Brazing and Brazing Alloys, a Bibliography

Identifies the current literature to provide industry with summaries of information obtainable in the aerospace field. NASA SP-5026 1967 52 pp. CFSTI \$1.00

Mathematical Computer Programs

Several mathematical programs and programing techniques for digital computers which are available through the NASA Technology Utilization program are outlined. Although the functions that the programs perform are not new, and similar programs are available in many large computer center libraries, the collection may be useful to centers with limited systems libraries for instructional purposes for new computer operators. NASA SP-5069 1967 26 pp. CFSTI \$1.00

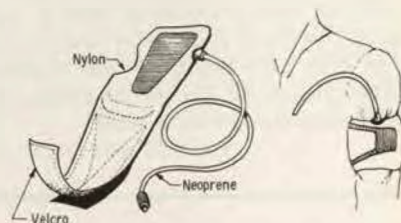
Nonglassy Inorganic Fibers and Composites

By Cameron G. Harman

This report presents information about non-metallic, inorganic whiskers and fibers, and composites that may be useful to industry. Emphasis is given to boron carbide whiskers, boron filaments, refractory ceramic fibers, and metal-fiber-reinforced metallic composites. This is a Southwest Research Institute report with 61 references. NASA SP-5055 1966 44 pp. GPO 35 cents

NASA Contributions to Cardiovascular Monitoring

This survey describes new aids to measuring blood pressure, sensing external manifestations of cardiovascular forces, and attaching electrodes to the human body. It emphasizes non-space uses of technology developed for manned space flights. NASA SP-5041 1966 43 pp. GPO 25 cents



Tungsten Powder Metallurgy

By V. D. Barth and H. O. McIntire

Prepared for NASA under contract by Battelle Memorial Institute, this report 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. NASA SP-5035 1965 40 pp. GPO 35 cents

Metal-Forming Techniques

By Ilia I. Islamoff

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. NASA SP-5017 1965 52 pp. GPO 40 cents

Some New Metal and Metal-Ceramic Composites

This report is designed to show industrial management the current state of development of some composite materials, including dispersion-strengthened composites, fiber composites, and reinforced ceramics.

NASA SP-5060 1966 26 pp. GPO 25 cents

PRECIPITATION-HARDENING STAINLESS STEELS

Steels that resist corrosion and have high strength at high temperatures have figured importantly in the work of both the Atomic Energy Commission and NASA. Information regarding their use is available now in a series of AEC/NASA Handbooks. These reports were originally prepared by the Battelle Memorial Institute for the Manufacturing and Engineering Laboratory of the George C. Marshall Space Flight Center. They have been revised and updated by the authors for the benefit of other potential users of these steels.

Machining and Grinding of Ultrahigh-Strength Steels and Stainless Steel Alloys

By C. T. Olofson, J. A. Gurklis, and F. W. Boulger

NASA SP-5084 1968 202 pp. CFSTI \$3.00

Shaping of Precipitation-Hardening Stainless Steels by Casting and Powder Metallurgy

By J. G. Kura, V. D. Barth, and H. O. McIntire

NASA SP-5086 1968 42 pp. CFSTI \$3.00

Thermal and Mechanical Treatment for Precipitation-Hardening Stainless Steels

By C. J. Slunder, A. F. Hoenie, and A. M. Hall

NASA SP-5089 1968 193 pp. CFSTI \$3.00

Welding of Precipitation-Hardening Stainless Steels

By J. J. Vagi, R. M. Evans, and D. C. Martin

NASA SP-5087 1968 181 pp. CFSTI \$3.00

Surface Treatments for Precipitation-Hardening Stainless Steels

By A. M. Hall

NASA SP-5090 1968 58 pp. CFSTI \$3.00

Adhesive Bonding of Stainless Steels

— Including Precipitation-Hardening Stainless Steels

By R. E. Keith, M. D. Randall, and D. C. Martin

NASA SP-5085 1968 115 pp. CFSTI \$3.00

Vacuum Switchgear

By W. S. Emmerich

Technological advances in space work have increased the possibility of operating electrical switches in vacuum, which would offer significant advantages. The manager of Westinghouse plasma programs has reviewed and evaluated this work.

NASA SP-5063 1964 36 pp. GPO 35 cents

Technical and Economic Status of Magnesium-Lithium Alloys

By Paul D. Frost

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 and to define technical and economic requirements for commercial use. NASA SP-5028 1965 45 pp. GPO 25 cents

Vibrating Diaphragm Pressure Transducer

This report, prepared under contract for NASA by Southwest Research Institute, describes the vibrating diaphragm pressure transducer developed at Ames Research Center for use in high-velocity wind tunnels. The instrument is used for sensing absolute gas pressures over the range of approximately 10^{-3} to 10^3 mm Hg. With little or no modification, the transducer can be used as a differential capacitor pressure transducer, an electrometer input device, a magnetic damping measuring device, and an accurate multiplier for use with electronic analog computers.

NASA SP-5020 1966 27 pp. GPO 30 cents

Selected Welding Techniques, Parts I and II

Descriptions and illustrations of tools and techniques used in welding aluminum sheet and plate at Marshall Space Flight Center.

Part I NASA SP-5003 1964 25 pp. GPO 30 cents

Part II NASA SP-5009 1964 34 pp. GPO 30 cents

A "Bibliography on Welding Methods" is also available as NASA SP-5024 (1966 28 pp. CFSTI \$3.00).

Selected Electronic Circuitry

Describes specific innovations derived from space programs that appear to be useful generally. Information is included on amplifier, oscillator, multi-vibrator, wave-shaping, temperature-compensation, and control circuits. Special computer circuits are also included.

NASA SP-5046 1967 100 pp. GPO 70 cents

Welding for Electronic Assemblies

This 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.

NASA SP-5011 1964 81 pp. GPO 40 cents

Bibliography on Electromechanical Transducers

Annotated bibliography of current literature on the applications and uses of electromechanical transducers, with subject and author indexes. Material selected by ASTRA, Midwest Research Institute.

NASA SP-5036 1966 20 pp. CFSTI \$3.00

High-Velocity Metalworking



This is a comprehensive survey by the Midwest Research Institute of the new state of the arts of electromagnetic, electrohydraulic, pneumatic-mechanical, and explosive metalworking. By these processes, complex, finished surfaces, and close-tolerance parts in a great range of sizes can now be produced with less waste than by more conventional methods. The authors explain the fundamentals, point out the limitations, and emphasize the varied potentialities of all four processes. Separate chapters cover die design and material behavior at high strain rates. There are 290 illustrations and 192 references. NASA SP-5062 1967 183 pp. GPO \$1.50

Properties and Current Applications of Magnesium-Lithium Alloys

By R. J. Jackson and P. D. Frost

This is a compilation of engineering information on magnesium-lithium alloys. The mechanical properties and metallurgical characteristics for standard and developmental alloys are included. Various processing techniques, including cleaning and finishing, fabrication, casting, and joining, are discussed.

NASA SP-5068 1967 54 pp. GPO 40 cents

NASA Contributions to Metals Joining

By W. J. Reichenecker and J. Heuschkel

This survey covers the many developments in joining metals by mechanical fasteners, soldering, brazing, welding, and plasma spray bonding, reported between 1962 and mid-1965.

NASA SP-5064 1967 141 pp. GPO 60 cents

Method of Brazing Aluminum to Stainless Steel for High-Stress-Fatigue Applications

This report describes a procedure developed for NASA by the Rocketdyne Division of North American Aviation, Inc., to minimize the formation of intermetallic compounds in aluminum-stainless-steel joints for valve assemblies in rocket motors. The author, D. C. Martin, of the Battelle Memorial Institute, believes the procedure also can be followed advantageously in meeting other challenges to materials engineers.

NASA SP-5040 1968 11 pp. GPO 15 cents

Reliable Electrical Connections, 4th Edition

Prepared under the direction of James A. Gay, Jr.

Diagrams, photographs, and detailed instructions covering dependable techniques of different kinds of electrical connections.

NASA SP-5002 1967 66 pp. GPO 30 cents

Effects of Low Temperatures on Structural Metals

Testing procedures are described and test data are tabulated in this report. Cryogenic properties are presented in graphic form and discussed for alloy steels and alloys of aluminum, nickel, titanium, and magnesium.

NASA SP-5012 1964 55 pp. GPO 40 cents

Elastic Orifices for Gas Bearings

Test data indicate superiority of such a system over pressurized liquid and rolling-contact bearing systems.

NASA SP-5029 1965 11 pp. GPO 20 cents

Precision Tooling Techniques

Describes devices with possible industrial applications, developed at NASA's Marshall Space Flight Center.

NASA SP-5013 1964 25 pp. GPO 25 cents

Conference on Selected Technology for the Petroleum Industry

A conference held at Lewis Research Center, December 8-9, 1965, to acquaint representatives of the petroleum industry with new technology resulting from the space effort. Choice of the topics was guided by a series of meetings between Lewis staff members and petroleum specialists.

NASA SP-5053 1966 169 pp. GPO \$1.25

Symposium on Technology Status and Trends

Proceedings of a conference at Huntsville, Ala., April 21-23, 1965, sponsored by the Technology Utilization Office of Marshall Space Flight Center for representatives of nonaerospace industry.

NASA SP-5030 1966 248 pp. GPO \$1.50

Conference on New Technology

Proceedings of a conference at Lewis Research Center, June 4-5, 1964, to discuss ways of transferring applicable space-research knowledge to the industrial community.

NASA SP-5015 1964 156 pp. GPO \$1.00

TECHNOLOGY UTILIZATION COMPILATIONS

Techniques and tools used in NASA research centers and industrial concerns serving them are tersely described in these compilations of ideas for technicians. Some will be new to many readers, others may be familiar but possibly used in novel ways. Specialists in the subject matter of each group have evaluated and chosen the items reported.

Electronic Circuits

Shows 22 amplifier, oscillator, power supply, and miscellaneous circuits.

NASA SP-5917(01)

1968 19 pp. CFSTI 30 cents

NASA SP-5917(02)

1968 15 pp. CFSTI 25 cents

Metal Fabrication

Contains a dozen tips on cutting, machining, shaping, and forming metal.

NASA SP-5915(01)

1968 8 pp. CFSTI 20 cents

Machine Shop Measurement Technology

Describes measuring tools, devices, systems, fixtures, aids, and accessories.

NASA SP-5912(01)

1968 11 pp. CFSTI 20 cents

Metallography and Metals Testing Techniques

Discusses preparation of samples, and stress-corrosion and tensile testing.

NASA SP-5911(01)

1968 9 pp. CFSTI 20 cents

Hand Tools

Two compilations of items about novel electronic tools, portable tools, assembly tools, and unusual modification and uses of standard tools.

NASA SP-5908(01)

1968 12 pp. CFSTI 25 cents

NASA SP-5908(02)

1968 8 pp. CFSTI 20 cents

Seals and Sealing Techniques

Shows special-purpose seals and gaskets and installation tools.

NASA SP-5905(01)

1967 14 pp. CFSTI 25 cents

Selected Fluid and Vacuum Technology

Systems, components, testing and maintenance items are covered.

NASA SP-5904(01)

1967 25 pp. CFSTI 35 cents

Piping and Tubing Technology

Special piping and tubing methods, including making joints and disconnects.

NASA C67-03

1967 17 pp. CFSTI \$3.00

Selected Shop Techniques

Inspection devices and machine tools, including fixtures and modifications.

NASA C67-02

1967 15 pp. CFSTI \$3.00

Selected Machining and Metal Fabricating Technology

Twenty-nine items selected because of widespread uses with machine tools.

NASA SP-5065

1967 26 pp. GPO 25 cents

Selected Electronic Circuitry

Amplifier and other common circuits and special computer circuits are shown.

NASA SP-5046

1967 100 pp. GPO 70 cents

Electronic Instrumentation Techniques and Equipment

Practical solutions to problems for which standard aids were not available.

NASA SP-5907(01)

1967 14 pp. CFSTI 25 cents

Fasteners and Fastening Techniques

Clamp, clip, and strap fasteners, and adjustable and protective fasteners.

NASA SP-5906(01)

1967 12 pp. CFSTI 20 cents

Synthesis of Fluorinated Hydrocarbons

Reports demonstrated reactions potentially useful in various industries.

NASA SP-5901(01)

1968 18 pp. CFSTI 25 cents

Selected Photographic Techniques

Photographic identification methods, photocopy techniques, and photographic devices.

NASA SP-5914(01)

1968 7 pp. CFSTI 15 cents

Insulation Tools and Techniques

Suggests cryogenic, thermal, acoustical, and vibrational insulation techniques.

NASA SP-5909(01)

1968 10 pp. CFSTI 20 cents

Electrical Hand Tools and Techniques

Connectors, strippers, bending, and other special tools.

NASA SP-5916(01)

1968 8 pp. CFSTI 20 cents

NASA SP-5916(02)

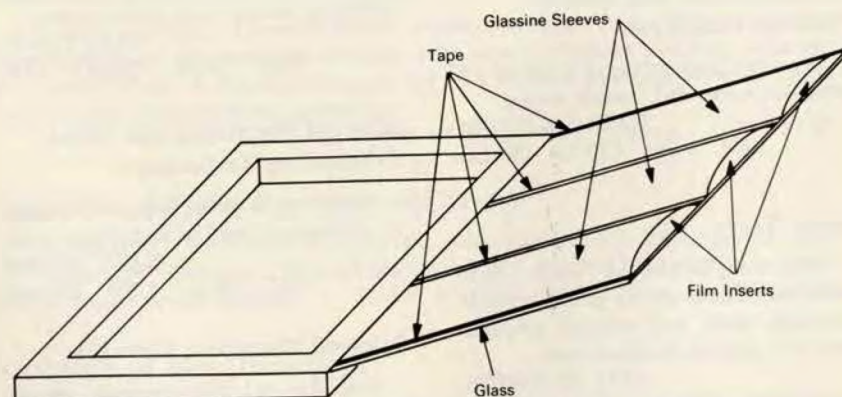
1968 10 pp. CFSTI 20 cents

Machine Tools and Fixtures

Devices for use with drilling and milling machines, lathes, and measurement and layout fixtures.

NASA SP-5910(01)

1968 9 pp. CFSTI 20 cents



Assessing Technology Transfer

By Richard L. Lesher and George J. Howick

An abridgement of a report prepared for the National Commission on Technology, Automation, and Economic Progress, which was established in August 1964. Considered are such questions as the value of technology transfer as a national goal, the sufficiency of sources for such transfer, incentives and barriers, transfer mechanisms or channels used to date, and elements essential to effective transfer. The authors conducted depth interviews with persons in Government agencies that have technology-transfer and information dissemination programs.

NASA SP-5067 1966 121 pp. GPO 50 cents

Adhesives, Sealants, and Gaskets

By R. B. Perkins and S. N. Glarum

A survey of adhesives, sealants, and gaskets developed to operate in the extreme environment of space that will interest specialists in the subject. The reliability of materials used in a liquid oxygen environment is emphasized. The following are described in detail: polymeric fillers in adhesives, elastomeric films in glue lines, epoxy ester adhesives, sealants for low-temperature service, gasket design, and measurement of stress in gaskets. NASA SP-5066 1967 63 pp. GPO 25 cents

Nondestructive Testing: Trends and Techniques

The proceedings of the Second Technology Status and Trends Symposium, in October 1966, at the Marshall Space Flight Center. Technical papers discuss the examination of multilayer printed wiring boards by laminography, evaluation of adhesive bonded composite materials, ultrasonic analysis of aluminum, and X-ray television techniques for nondestructive testing. The nine papers in this newsy publication are highly illustrated. NASA SP-5082 1967 123 pp. GPO 55 cents

Histories and Chronologies

This New Ocean: A History of the Project Mercury

By Loyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander

A highly readable, well-documented story of Project Mercury, the first U.S. manned space flight program, which spanned 55 months from authorization through Cooper's 22-orbit flight in May 1963 and which, at one time or another, involved more than 2 million people. A wealth of background information concerning the events and decisions that led up to manned space exploration is given, and each of the six Mercury flights is described in detail.

NASA SP-4201 1966 680 pp. GPO \$5.50

An Administrative History of NASA, 1958-1963

By Robert L. Rosholt, with a Foreword by James E. Webb

The first five chapters of this study cover the antecedents and first years of the National Aeronautics and Space Administration; the remaining four deal with the change in political administration and the acceleration of the space program in 1961, and with the organizational consequences through 1963. Emphasis is on organizational structure and administrative procedures, including intra-agency procedures, personnel, finance, and procurement.

NASA SP-4101 1966 381 pp. GPO \$4.00

Space Medicine in Project Mercury

By Mae Mills Link

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.

NASA SP-4003 1965 198 pp. GPO \$1.00

Astronautics and Aeronautics, 1966

Chronology on Science, Technology, and Policy

Events, statements, and other information pertinent to aeronautical and space affairs compiled for ready reference. Sources include newspapers, speeches, agency releases, magazine articles, and editorials. An extensive index.

NASA SP-4007 1967 479 pp. GPO \$1.50

Under the same title similar chronologies are available for three preceding years.

For 1965, NASA SP-4006 1966 681 pp. GPO \$2.25

For 1964, NASA SP-4005 1965 527 pp. GPO \$1.75

For 1963, NASA SP-4004 1964 610 pp. GPO \$2.00

Project Mercury: A Chronology

By James M. Grimwood

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.

NASA SP-4001 1963 238 pp. GPO \$1.50

Management, Evaluation, and Analysis Standards

An Introduction to the Evaluation of Reliability Programs

By D. S. Liberman and A. J. Slechter

A basic orientation to the task of evaluating the effectiveness of a reliability program is presented. Primary emphasis is devoted to discussing the assurance task as it relates to project requirements and resources, and to describing the factors which determine effectiveness in program implementation.

NASA SP-6501 1967 67 pp. CFSTI \$3.00

Elements of Design Review for Space Systems

To help technically trained personnel implement and evaluate a design review program, this publication discusses the objectives, elements, application, and costs. Functions the design review should serve at various levels of assembly, milestones in development, and on differing projects are set forth.

NASA SP-6502 1967 57 pp. CFSTI \$3.00

Introduction to the Derivation of Mission Requirements

Profiles for System Elements

From the mission requirements profile for an overall system, requirement profiles for subsystems can be derived by identifying the relating parameters and resolving their influence numerically. This document describes a 10-step process. Appendices illustrate its use to derive requirement profiles for six subsystems of spacecraft.

NASA SP-6503 1968 91 pp. CFSTI \$3.00

Failure Reporting and Management Techniques in the Surveyor Program

"Many of the innovations employed on Surveyor may prove useful in the management of other complex development programs," according to Benjamin Milwitzky, Surveyor Program Manager, NASA Headquarters. This document describes the rigorous, closed-loop failure reporting system that functioned as an effective mission-assurance tool.

NASA SP-6504 1967 46 pp. CFSTI \$3.00

Parts and Materials Application Review for Space Systems

Parts and materials application reviews attest to the adequacy of space system hardware. This is a guide for parts and materials specialists and design engineers. It describes NASA's parts and materials program, discusses the structuring of the application review, and gives examples of appropriate activities.

NASA SP-6505 1967 53 pp. CFSTI \$3.00

Introduction to the Assurance of Human Performance in Space Systems

For project engineering and management personnel, this is a guide to methods of detecting and eliminating human-induced failures. Design features, procedures, and work situations are considered.

NASA SP-6506 1968 42 pp. CFSTI \$3.00

Weight/Performance Management Survey Manual

An Apollo Program Office Manual providing procedures for a management assessment of contractor activities, performance, and effectiveness of the management system.
NASA SP-6006 1965 31 pp. CFSTI \$3.00

Electrical Power Management Survey Manual

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.
NASA SP-6007 1965 31 pp. CFSTI \$3.00

Electrical Power Management Standard

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.
NASA SP-6005 1965 31 pp. CFSTI \$3.00

Mass Properties Standard

This publication establishes a system for the management of mass properties during procurement and use of space vehicles, or portions thereof.
NASA SP-6004 1965 88 pp. CFSTI \$3.00

Reliability Program Evaluation Procedures

The objectives of this document are (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.
NASA SP-6002 1963 52 pp. CFSTI \$3.00

Quality Program Evaluation Procedures

Procedures and related survey checklists to be used in evaluating quality procedures and controls being applied to manned space-flight programs are set forth.
NASA SP-6003 1963 69 pp. CFSTI \$3.00

Structural Systems and Program Decisions

Two volumes written for decision-makers who must assimilate, validate, and interpret changes in baseline requirements on vehicle programs. This study presents a computer program designed to help management rapidly assess the impact of design criteria.
Vol. 1 NASA SP-6008 1966 214 pp. CFSTI \$3.00
Vol. 2 NASA SP-6008(01) 1966 386 pp. CFSTI \$3.00

Forecasts and Appraisals for Management Evaluation

Two volumes intended primarily for those responsible for the administration, design, development, manufacture, and test of the Apollo system.
Vol. 1 NASA SP-6009 1966 220 pp. CFSTI \$3.00
Vol. 2 NASA SP-6009(01) 1966 370 pp. CFSTI \$3.00

Handbooks, Data Compilations, Charts, and Tables

Models of the Trapped Radiation Environment

Vol. I: Inner Zone Protons and Electrons

By James I. Vette

Vol. II: Inner and Outer Zone Electrons

By James I. Vette, Antonio B. Lucero, and Jon A. Wright

Vol. III: Electrons at Synchronous Altitudes

By James I. Vette and Antonio B. Lucero

Vol. IV: Low Energy Protons

By Joseph H. King

These volumes are compilations of the results of a program sponsored by NASA and USAF for the purpose of defining a model of the radiation environment of the Earth. The first two volumes contain model environments for the lower altitude regions where trapping is relatively stable. The third volume presents a model of the Earth synchronous orbit at 19 300 nautical miles near the boundary of stable trapping where the particle fluxes vary through several orders of magnitude. The fourth volume contains a model of the energy proton flux for energies below 4 MeV.

Vol. I NASA SP-3024 1966 55 pp. CFSTI \$3.00

Vol. II NASA SP-3024 1966 88 pp. CFSTI \$3.00

Vol. III NASA SP-3024 1966 107 pp. CFSTI \$3.00

Vol. IV NASA SP-3024 1967 62 pp. CFSTI \$3.00

Electron Densities and Scale Heights in the Topside Ionosphere:

Alouette I Observations Over the American Continents

Vol. I: November, December 1962, and January 1963

Vol. II: March and May 1963

Vol. III: June, July, September, and October 1963

Vol. IV: Summary Graphs

By Kwok-Long Chan, Lawrence Colin, and John O. Thomas

Data on electron density and plasma at various heights and times obtained by the satellite. The measurements were made over the American continents at a sunspot minimum epoch of the solar cycle.

Vol. I NASA SP-3027 1966 504 pp. CFSTI \$3.00

Vol. II NASA SP-3032 1966 607 pp. CFSTI \$3.00

Vol. III NASA SP-3033 1967 584 pp. CFSTI \$6.25

Vol. IV NASA SP-3034 1967 321 pp. CFSTI \$3.00

An additional volume presents data obtained over Hawaii during the winter of 1962-1963 and the summer of 1963.

NASA SP-3038 1967 283 pp. CFSTI \$3.00

Electron Densities and Scale Heights in the Topside Ionosphere:

Alouette I Observations in Midlatitudes

By John O. Thomas, M. Rycroft, and L. Colin

The tabulated data were computed from ionograms recorded at Stanford University in the summer and winter of 1963-64.

NASA SP-3026 1966 614 pp. CFSTI \$3.00

Venus and Mars Nominal Natural Environment
for Advanced Manned Planetary Mission Programs, 2d Edition
By Dallas E. Evans, David E. Pitts, and Gary L. Kraus

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 be based on realistic data and have a common basis for comparison of end results. The data in this revised edition differ from those of the first edition mainly as a result of the Mariner IV Mars flyby experimental results.

NASA SP-3016 1967 52 pp. CFSTI \$3.00

Thermodynamic Equilibrium in Prebiological Atmospheres
of C, H, O, N, P, S, and Cl

By M. O. Dayhoff, E. R. Lippincott, R. V. Eck, and G. Nagarajan

The book presents the mathematical methods used and the computer program from which the tables were derived. Also, a survey of thermodynamic equilibrium states of ideal gas systems containing C, H, O, N, P, S, and Cl are discussed. Appendix I discusses applications with regard to the thermodynamic equilibria in planetary atmospheres. Appendix II discusses application with regard to the role of thermodynamic equilibrium in the inorganic origin of organic matter.

NASA SP-3040 1967 257 pp. CFSTI \$3.00

Handling and Use of Fluorine
and Fluorine-Oxygen Mixtures in Rocket Systems

By Harold W. Schmidt

Fluorine's reactivity and toxicity demand engineering perfection. The author, with the help of Jack T. Harper, has presented information now available about its properties, compatibility, and the requirements for its safe, intelligent use, for the guidance of designers, engineers, and scientists.

NASA SP-3037 1967 279 pp. GPO \$1.50

Tables of Interference Factors for Use in Correcting Data
from VTOL Models in Wind Tunnels with 7 by 10 Proportions

By Henry H. Heyson

The tables give interference factors for models whose span is parallel to either the long or the short side of the wind tunnel. Instructions for the use of these values for semispan models are included.

NASA SP-3039 1967 649 pp. CFSTI \$3.00

Space Measurement Survey: Instruments and Spacecraft,
October 1957-March 1965

Henry L. Richter, Jr., Ed.

This volume contains fact sheets on most of the satellites and probes launched, from Sputnik 1 through Gemini III. Information includes orbital parameters, instruments carried, and experimental objectives of each orbital or deep space probe.

NASA SP-3028 1966 1008 pp. CFSTI \$3.00

CURRENT KNOWLEDGE OF OTHER PLANETS

"Technological advances in the last decade have made it feasible to consider launching spacecraft to all the planets," according to Oran W. Nicks, Deputy Associate Administrator for Space Science and Applications, NASA. "To maximize the returns from ambitious planetary missions, however, it is important that we continually examine all information available. For this reason, the preparation of a series of handbooks was undertaken." Three are now available. Each one contains a glossary and gives scores of references in addition to new technical data.



Handbook of the Physical Properties of the Planet Venus

By L. R. Koenig, F. W. Murray, C. M. Michaux, and H. A. Hyatt

Radio and radar astronomy, and the flight of Mariner II, have added observational data to theoretical studies of Venus, the nearest planet to Earth. This volume reviews what is known of its surface, atmosphere, and other still bewildering properties.

NASA SP-3029 1967 132 pp. GPO 60 cents

Handbook of the Physical Properties of the Planet Mars

By C. M. Michaux

Although observed from Earth at every opportunity for many years, Mars remains an enigma. This volume summarizes both observational and theoretical conclusions regarding its surface, structure, and the possible presence of life there.

NASA SP-3030 1967 167 pp. GPO 70 cents

Handbook of the Physical Properties of the Planet Jupiter

By C. M. Michaux et al.

The largest planet in the solar system is especially intriguing because of such difficult-to-explain features as its wandering Great Red Spot and erratic decameter radio noise storms. This volume presents the astronomer's findings and recent conclusions.

NASA SP-3031 1967 142 pp. GPO 60 cents

**Charts for Equilibrium and Frozen
Nozzle Flows of Carbon Dioxide**
By George G. Mateer and Victor L. Peterson

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 charted.

NASA SP-3019 1965 78 pp. CFSTI \$3.00

**Charts for Equilibrium and Frozen Flows
Across Plane Shock Waves in Carbon Dioxide**
By Craig D. Simcox and Victor L. Peterson

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 at ambient pressures ranging from 10^{-7} to 10 atmospheres, and for speeds ranging from 1 to 16 km/sec.

NASA SP-3018 1965 129 pp. CFSTI \$3.00

Equilibrium Thermodynamic Properties of Carbon Dioxide
By Harry E. Bailey

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 $250^\circ \text{K} \leq T \leq 25\,000^\circ \text{K}$ ($\Delta T = 250^\circ \text{K}$). The density range is $-7.0 \leq \log \rho/\rho_0 \leq +3.0$ ($\Delta \log \rho/\rho_0 = 0.2$).

NASA SP-3014 1965 66 pp. CFSTI \$3.00

**Charts for Equilibrium Flow Properties
of Carbon Dioxide in Hypervelocity Nozzles**
By Leland H. Jorgensen and Robert J. Redmond

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 atmospheres 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.

NASA SP-3015 1965 71 pp. CFSTI \$3.00

**Charts for Approximate Thermodynamic
Properties of Nitrogen-Oxygen Mixtures**
By Bruce Fowler and Ronald Brown

The thermodynamic properties of nitrogen and three nitrogen-oxygen compositions and the dimensionless speed-of-sound parameter for each have been calculated over a temperature range from 200° to $15\,000^\circ \text{K}$ for a pressure range from 10^{-4} to 10^2 atmospheres.

NASA SP-3017 1965 116 pp. CFSTI \$3.00

**Tabulated Communication Characteristics
of a Steady-State Model of Interplanetary Space**
By R. J. Hruby, A. H. Somes, J. Dime, and H. Tashjian

The changes in an electromagnetic wave as it passes through interplanetary and coronal space depend on the intervening plasma and magnetic field. These changes are presented here as a function of the transmission range and the view angle relative to an Earth-Sun line in the ecliptic plane. This information can be used to determine the total change in an electromagnetic wave between any two points in the Earth-Sun volume excluding the magnetosphere.

NASA SP-3042 1967 524 pp. CFSTI \$3.00

**Tables of Flow Properties of Thermally Perfect Carbon Dioxide
and Nitrogen Mixtures**
By William Patrick Peterson

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° to 3000°R . Condensation Mach numbers are also given.

NASA SP-3009 1964 113 pp. CFSTI \$3.00

**Thermodynamic Properties and Mollier Chart
for Hydrogen From 300°K to $20\,000^\circ \text{K}$**
By Robert F. Kubin and Leroy L. Presley

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.

NASA SP-3002 1964 63 pp. CFSTI \$3.00

**Tables of the Composition, Opacity, and
Thermodynamic Properties of Hydrogen at High Temperatures**
By N. L. Krascella

All data are tabulated for 14 total pressures between 1 and 1000 atmospheres and for 21 temperatures between 3000° and $200\,000^\circ \text{R}$. Spectral-absorption coefficients are tabulated for 33 wave numbers between 1000 and $400\,000 \text{ cm}^{-1}$ at each pressure and temperature.

NASA SP-3005 1963 185 pp. CFSTI \$3.00

**Tables for Supersonic Flow Around Right
Circular Cones at Zero Angle of Attack**
By Joseph L. Sims

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.

NASA SP-3004 1964 421 pp. GPO \$2.25

Tables of Fe I Line Intensities

Vol. I: Temperatures from 1000° to 6500° K

Vol. II: Temperatures between 6500° and 20 000° K

By William J. Borucki

Tables of intensities for 2200 atomic lines are presented in tables intended for use in computing the absolute intensity and spectral distribution for Fe I line radiation from optically thin media, determining the temperature of an observed plasma, and indicating a non-Boltzmann distribution of excited electronic states when such conditions exist.

NASA SP-3041 1968 218 pp. CFSTI \$3.00

Properties of Magnetic Materials for Use in High-Temperature Space Power Systems

By P. E. Kueser, D. M. Pavlovic, D. H. Lane, J. J. Clark, and M. Spewock

Test data are given and evaluated for eight magnetic materials found suitable for high-temperature liquid alkali-metal system applications. Each one is discussed with respect to its use in equipment parts operating at two different temperature levels.

NASA SP-3043 1968 318 pp. GPO \$2.50

Equilibrium Thermodynamic Properties of Three Engineering Models of the Martian Atmosphere

By Harry E. Bailey

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 $250^\circ \text{K} \leq T \leq 25\,000^\circ \text{K}$ ($\Delta T = 250^\circ \text{K}$). The density range is $-7.0 \leq \log \rho/\rho^0 \leq 3.0$ ($\Delta \log \rho/\rho^0 = 0.2$).

NASA SP-3021 1965 162 pp. CFSTI \$3.00

Charts of Isentropic Exponent as a Function of Enthalpy for Various Gases in Equilibrium

By Leland H. Jorgensen

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 percent CO_2 and 80 percent N_2 (by volume). For a pressure of 1 atmosphere, curves are also presented for compositions of 10 percent CO_2 - 90 percent N_2 and for 50 percent CO_2 - 50 percent N_2 .

NASA SP-3020 1965 10 pp. CFSTI \$3.00

Energy Spectra and Angular Distributions of Electrons Transmitted Through Sapphire (Al_2O_3) Foils

By Martin J. Berger and Stephen M. Seltzer

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.

NASA SP-3008 1964 107 pp. CFSTI \$3.00

Additional Stopping Power and Range Tables for Protons, Mesons, and Electrons

By Martin J. Berger and Stephen M. Seltzer

This report is a supplement to earlier tabulations which it extends. Data are given for liquid H_2 , LiF, Si, Ge, propane and freon. It also corrects tables for electrons in muscle and bone in earlier volumes.

NASA SP-3036 1967 40 pp. CFSTI \$2.00

The previous reports cited above were: "Tables of Energy Losses and Ranges of Heavy Charged Particles," NASA SP-3013 (1964 131 pp. CFSTI \$3.00); and "Tables of Energy Losses and Range of Electrons and Positrons," NASA SP-3012 (1964 127 pp. CFSTI \$3.00), by the same authors and Walter H. Barkas.

Thermodynamic, Transport, and Flow Properties for the Products of Methane Burned in Oxygen-Enriched Air

By Bobby H. Croom and Edward W. Leybe

Results of calculations to determine the composition and the thermodynamic, transport, and flow properties of gas mixtures. Properties are computed for methane burned in air enriched with oxygen so as to maintain approximately 20 percent oxygen in the combustion products.

NASA SP-3035 1966 89 pp. CFSTI \$3.00

Calculations of Thermal Field Emission for a Terminated Image Potential

By James F. Morris

Computed properties are presented that characterize electron emission with a terminated image potential for fields from 10^4 to 10^8 volts per centimeter, temperatures from 0° to 3000°K , work functions from 1 to 8 volts, and Fermi levels from 1 to 15 electron volts.

NASA SP-3023 1966 610 pp. CFSTI \$3.00

Magnetic Fields Due to Solid and Hollow Conical Conductors

By James C. Stoll, Peggy L. Yohner, and James C. Laurence

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.

NASA SP-3022 1965 132 pp. CFSTI \$3.00

Thermodynamic and Transport Properties for the Hydrogen-Oxygen System

By Roger A. Svehla

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.

NASA SP-3011 1964 419 pp. CFSTI \$3.00

Bibliographies and Other Reference Works

An Annotated Bibliography of Computer-Aided Circuit Analysis and Design

By Charles W. Meissner, Jr.

This document presents an annotated bibliography of computer-aided circuit analysis, beginning with 1956 when the first serious attempts were made to use the computer as an aid to the analysis and design of electronic circuits, up to the middle of 1966. Emphasis has been placed on programs and their application rather than on related areas.

NASA SP-7023 1968 41 pp. CFSTI \$3.00

Management: A Continuing Literature Survey with Indexes

This is a selection of annotated references to unclassified reports and journal articles entering the NASA information system from 1962 through 1967.

NASA SP-7500 1968 55 pp. CFSTI \$3.00

Lasers and Masers: a Continuing Bibliography

A bibliography of annotated references on the characteristics and applications of lasers and masers that were introduced into the NASA information system between February 1966 and April 1967.

NASA SP-7009(02) 1967 441 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7009 containing references acquired between January 1962 and February 1965 (280 pp. CFSTI \$3.00), and NASA SP-7009(01) containing references acquired between February 1965 and April 1967 (465 pp. CFSTI \$3.00).

Lunar Surface Studies: a Continuing Bibliography

A selection of annotated references to reports and journal articles introduced into the NASA information system during the period February 1966–January 1967. Subjects include the theory of origin, atmosphere, and physical characteristics of the Moon. Techniques for lunar observation, measurement, and analysis are also covered. Subject and author indexes.

NASA SP-7003(03) 1966 71 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7003(02), reflecting NASA acquisitions February 1965–January 1966 (36 pp. CFSTI \$3.00); NASA SP-7003(01), April 1964–January 1965 (54 pp. CFSTI \$3.00); and NASA SP-7003, January 1962–March 1964 (98 pp. CFSTI \$3.00).

Lubrication, Corrosion, and Wear: a Continuing Bibliography

Annotated bibliography of references stored in the NASA information system from April 1965 to August 1966.

NASA SP-7020(01) 1966 296 pp. CFSTI \$3.00

Previously issued under the same title: SP-7020, containing references acquired from January 1962 through March 1965 (167 pp. CFSTI \$3.00).

Extraterrestrial Life: a Bibliography Part I, Report Literature Part II, Published Literature

A comprehensive collection of annotated references on the general subjects of extraterrestrial life and exobiology, including such related topics as the origin of life on Earth and terrestrial contamination of spacecraft. Part I consists of references to selected domestic and foreign reports prepared during the period 1962 through July 1964; Part II lists journal articles and books published in the period 1900–1964. A limited selection of 1965 sources is also included. The first volume is indexed by subject, author, corporate source, and contract number. The subject and author indexes of the second volume also cover information contained in Part I.

NASA SP-7015 Part I 80 pp. GPO 45 cents
NASA SP-7015 Part II 1965 345 pp. GPO \$2.00

Space Communications:

Theory and Applications, a Bibliography

Vol. 1: Modulation and Channels

Vol. 2: Coding and Detection Theory

Vol. 3: Information Processing and Advanced Techniques

Vol. 4: Satellite and Deep Space Applications

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. References to publications of unusual significance that appeared before 1958, as well as a limited number of 1964 sources, have also been included. Subject index.

NASA SP-7022(01) 1965 Vol. 1 486 pp. GPO \$2.50

NASA SP-7022(02) 1965 Vol. 2 426 pp. GPO \$2.25

NASA SP-7022(03) 1965 Vol. 3 463 pp. GPO \$2.50

NASA SP-7022(04) 1965 Vol. 4 303 pp. GPO \$1.75

Ballistocardiography: a Bibliography

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.

NASA SP-7021 1965 49 pp. GPO 35 cents

The International System of Units — Physical Constants and Conversion Factors Compiled by E. A. Mechtly

This document defines the basic units of Systeme International, adopted officially by the 1960 Eleventh General Conference on Weights and Measures, and tables for converting from U.S. customary units.

NASA SP-7012 1965 20 pp. GPO 20 cents

Particles and Fields Research: a Bibliography

An extensive list of references to journal articles, books, conference proceedings, and English translations of foreign journals published between January 1958 and May 1966. Particularly comprehensive with regard to space research on energetic particles and on magnetic and electric fields.

NASA SP-7026 1966 173 pp. CFSTI \$3.00

Aerospace Medicine and Biology: a Continuing Bibliography

Annotated bibliography concentrating on the biological, physiological, psychological, and environmental effects on man 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. Among related topics covered are sanitary problems, pharmacology, toxicology, safety and survival, life-support systems, exobiology, and personnel factors. This most recent supplement contains references to NASA acquisitions during May 1967.

NASA SP-7011(37) 1967 78 pp. CFSTI \$1.00

Previous 1967 issues under the same title: SP-7011(36), containing selected references acquired in April 1967 (69 pp. CFSTI \$3.00); SP-7011(35), March 1967 (70 pp. CFSTI \$3.00); SP-7011(34), February 1967 (101 pp. CFSTI \$3.00); and SP-7011(32), January 1967 (81 pp. CFSTI \$3.00).

Cumulative Indexes are available for previous years: "A Cumulative Index to the 1966 Issues of a Continuing Bibliography on Aerospace Medicine and Biology," NASA SP-7011(33); 556 pp. CFSTI \$3.00; "A Cumulative Index to the 1965 Issues of a Continuing Bibliography on Aerospace Medicine and Biology," NASA SP-7011(20), 721 pp. CFSTI \$3.00; and "A Cumulative Index to the 1964 Issues of a Continuing Bibliography on Aerospace Medicine and Biology," NASA SP-7011(07), 554 pp. CFSTI \$3.00. Supplements may also be purchased individually from CFSTI for \$3.00 per copy.

High Energy Propellants: a Continuing Bibliography

Annotated references to report and journal literature on the subject introduced into the NASA information system January–December 1966. Emphasis is on solid, liquid, and hybrid propellants and oxidizers, but the bibliography also covers such related topics as propellant handling and storage, combustion characteristics, toxicity, and safety measures. Subject and author indexes.

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NF-26 A Report from Mariner IV. — A final report on the results of Mariner fly-by of the planet Mars. 8 pages.

NF-27 Living in Space. — A description of the ingenious life support systems devised by science and industry to enable spacecraft crews to remain in space for extended periods of time in an earth-like environment. 12 pages.

NF-28 The Laser. — An illustrated summary, in layman terms, of the laser beam and the role it will play in NASA's exploration of space. Also described are uses to which laser has been applied in the fields of medicine, metallurgy and communications. 8 pages.

NF-29 Orbiting Solar Observatory. — The mission of OSO — obtaining understanding of the nature of the universe. 8 pages.

NF-30 Gemini Pictorial. — Color photographs of earth from Gemini spacecraft.

NF-31 Pioneer. — Describes the Pioneer program, in which spacecraft investigate and monitor interplanetary phenomena at widely separated points in space.

NF-32 Lunar Orbiter. — A description of the unmanned Lunar Orbiter spacecraft which have transmitted spectacular photographs of the moon taken from lunar orbits.

NF-33 Saturn V. — Color wall sheet depicting Saturn V, America's largest rocket vehicle, which will launch the Apollo spacecraft.

NF-34 Lifting Bodies. — Describes the design, testing and flying of powered and unpowered lifting bodies, including a brief technical and illustrated description of types of lifting bodies. 8 pages.

NF-35 Surveyor. — Discusses the Surveyor Program in which the Surveyor spacecraft makes soft landings on the moon and transmits photographs and data back to earth.

vistas of science SPACE SERIES

The following paperback books are published by and may be ordered from Scholastic Book Services, 904 Sylvan Avenue, Englewood Cliffs, N.J. 07632, or 5675 Sunol Boulevard, Pleasanton, Calif. 94566, at 50 cents each. The books are the result of a joint project: the National Science Teachers Association coordinates development of the manuscripts and establishes educational acceptability of the books, and NASA provides scientific and technical guidance.

Man's Conquest of Space, by James J. Haggerty, Jr. — Discusses various types of spacecraft and the national space program. Lists projects by which students can increase their understanding of gravity, velocity, navigation, and other space-related subjects. 128 pages. (Replaces SPACECRAFT.)

The Challenge of the Universe, by J. Allen Hynek and Norman Anderson. — Discusses the earth, the moon, the planets, gravity and light, the sun, stars, galaxies, and the universe. 148 pages. (Revised.)

Life Beyond the Earth, by Samuel Moffat and Elie Schneour, with an epilogue by Joshua Lederberg. — Discusses the biological aspects of space exploration and considers the possibilities of the existence of life on other planets.

nasa's motion pictures

The National Aeronautics and Space Administration produces films describing NASA research and development programs in space and aeronautics and documenting the results of this research. The publication "NASA Film List" describes those which are for general audience. A separate list of NASA technical films also is available. For copies of the lists, and for information, write to the Educational Office of the NASA Center which serves your state. (See page 8.)

Your request for publications may be mailed to the Educational Office at the NASA Center which is designated to serve your state, as indicated in the list below. (But a request to be entered on the regular mailing list for NASA FACTS may be sent direct to Headquarters in Washington. See page 11.)

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A single copy of any publication may be obtained by checking the box at the right of the publication number below, printing name and address in space provided on page 9, and mailing to the NASA Center Educational Office which serves your state. (See page 8).

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nasa facts

Each issue of NASA Facts describes a NASA program, such as Manned Space Flight Apollo, Surveyor, etc., or deals with a subject such as Living In Space, or The Laser.

The issues appear at irregular intervals.

Copies will be mailed on a continuing basis only to those who request listing in writing. Such a request may be made on the form on page 12

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NASA FILM LIST

NATIONAL
AERONAUTICS
AND
SPACE
ADMINISTRATION

January, 1968

An Adventure in Research

The following films, together with The Poetry of Polymers (HQ 143) and It's You Against the Problem (HQ 146), included previously in the NASA film list, comprise a series of films about basic research scientists and their space research projects. These films illustrate career opportunities for high school and college students interested in basic research, and were produced for NASA under supervision of the University Film Foundation.

Ceramics in Space. HQ 142--1968--Color, 20 min.

Shows the role of a graduate research assistant in the study of ceramic materials capable of meeting space requirements. Features Dr. James I. Mueller, University of Washington.

The Challenge of Unanswered Questions. HQ 148--1968--Color, 16 min.

Illustrates study of the Aurora Borealis or "northern lights," its cause and effects, by Dr. Sydney Chapman and his assistants at the Institute of Geophysics, University of Alaska.

Great is the House of the Sun. HQ 144--1968--Color, 21 min.

Atop Mount Haleakala, the "House of the Sun," Dr. Walter Steiger and his colleagues from the University of Hawaii study the effects of the airglow phenomena and solar radiation in space, while other scientists prepare experiments to be flown aboard space rockets to study ultra-violet radiation.

X-Ray Spectroscopy - The Inside Story. HQ 140--1968--Color, 26 min.

Dr. Robert J. Liefeld, New Mexico University, explains to a group of high school students how and why he uses the spectroscope to study X-ray beams. He describes how specially-grown crystals are used in a crystal X-ray spectrometer to diffuse an X-ray beam, isolate a single wavelength, scan the spectrum and record its characteristics.

September 1968

RECENT NASA FILM RELEASES

*Supplement to NASA Film List

Apollo Mission Highlights. AD-1--1968--Color, 12 min.

A new look at the plans and preparation for man's first journey to the moon. Through photography and animation, shows the techniques of launching, earth orbit, lunar landing, exploration of the moon, return and recovery of the astronauts. Explains briefly what the astronauts plan to do on the moon, and how scientists will evaluate the lunar rock samples which are brought back to earth.

The Apollo 4 Mission. HQa 181--1968--Color, 16 min.

Depicts the assembly and launching of the first Saturn V/Apollo space vehicle, the world's largest rocket. Shows detail of the stage separations, acceleration to an altitude of 11,232 miles above earth, and the effects of reentry of the unmanned spacecraft at a speed of 25,000 miles per hour.

Nuclear Propulsion in Space. HQ 152--1968--Color, 24 min.

Illustrates the principle of the nuclear rocket, and the possible future use of such a propulsion system as the third stage of a Saturn V rocket. Compares nuclear propulsion to chemical and electric propulsion for space vehicles; shows the development of the nuclear engine; and describes how such a rocket might one day be used in a manned flight to another planet.

Radio Astronomy Explorer. HQa 186--1968--Color, 30 min.

Against a background of research currently performed by optical and ground-based radio astronomy, this film describes the design and function of the new Radio Astronomy Explorer, a spacecraft with 1500 foot antennas which will detect and relay various types of radio waves emitted by the sun, earth and the planet Jupiter. Dr. John F. Clark, Director of the NASA Goddard Space Flight Center, and Dr. John Findlay, Chairman of the U. S. Lunar and Planetary Missions Board, discuss the significance of this new satellite.

*For information on borrowing or purchasing these films, see the NASA Film List or write NASA Headquarters, Code FAD, Washington, D. C. 20546.

HOW TO ORDER NASA MOTION PICTURES AND FILMSTRIPS

The National Aeronautics and Space Administration produces films describing NASA research and development programs in space and aeronautics and documenting the results of this research.

These films may be borrowed for showings to educational, civic, industrial, professional or youth organizations. They may also be shown on unsponsored public service television broadcasts, unless otherwise indicated. There is no rental charge, however, borrowers must pay return postage (fourth class rate) and insurance. A separate list of NASA technical films is available to those who request it.

When ordering a film, give the name and address, including zip code, of the person and organization assuming responsibility for the film. Specify the date on which the film will be shown and an alternative date, if possible. You may wish to indicate an alternative film in case the film requested is not available.

Residents of the United States should address requests for films to the appropriate NASA Regional Film Library listed below. Residents of Canada may obtain these films from the National Science Film Library, 1762 Carling Street, Ottawa 13, Ontario, Canada, for a small handling charge. All other foreign requests for films should be sent to NASA Headquarters, Code FAD-2, Washington, D.C. 20546.

Prints of most NASA films, filmstrips and other audiovisual aids may be purchased by schools and other organizations for non-profit showings. For information on purchase, please write to NASA Headquarters, Code FAD-2, Washington, D.C. 20546.

Films listed are 16mm, sound productions in color or black and white, as indicated. Each film is designated by a code letter as suitable for: (U) Upper Elementary Grades 7-8, (S) Secondary Grades 9-12, (A) Adult and College Level.

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Public Affairs Office
Moffett Field, California 94035

NASA Electronics Research Center
Educational Programs Office
Cambridge, Massachusetts 02139

NASA George C. Marshall Space
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Marshall Space Flight Center,
Alabama 35812

NASA Goddard Space Flight Center
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NASA John F. Kennedy Space Center
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Kennedy Space Center,
Florida 32899

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Nevada
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California
(San Luis Obispo,
Kings, Kern,
Tulare, Inyo
Counties, and
south)
Utah

NASA Langley Research Center
Langley Station
Public Affairs Office
Mail Stop 154
Hampton, Virginia 23365

NASA Lewis Research Center
Office of Educational Services
21000 Brookpark Road
Cleveland, Ohio 44135

NASA Manned Spacecraft Center
Public Affairs Office, AP-2
Houston, Texas 77058

NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103

*Alaska requesters may also obtain NASA films from Department of Audio-Visual Education, University of Alaska, College, Alaska 99701.

Requesters in Hawaii may obtain prints from State Department of Education, Audio-Visual Center, 4211 Wai'alae Avenue, Honolulu, Hawaii 96816.

GENERAL INTEREST FILMS

Please Note:

Because of continuing research and discovery in many areas of the aeronautics and space programs, the information in some NASA films may be dated; however, those films of continuing historical interest are listed. Note the production date following each title.

Alouette — Canada's First Satellite. HQa 94 — 1963 — B/W, 14 min. The design and operation of a satellite with a mission to investigate the ionosphere. (Not cleared for commercial TV) (S-A)

America in Space. HQ 103 — 1963 — Color, 14 min. Brief overview of NASA's first five years (1959-63) showing the growth of America's space program from Explorer I through early phases of the Apollo Program for manned exploration of the moon. (S-A)

Ariel — The First International Satellite. HQ 58 — 1963 — Color, 13 min. Describes the sun's effect on earth's ionosphere and how this in turn effects radio transmission. International cooperation in space investigation is illustrated. (S-A)

Ariel II. HQa 115 — 1963 — Color, 26½ min. The second international satellite and how it was developed and placed into orbit to gain new knowledge about the structure of the universe. Shows research and development, assembly, testing, evaluation and launching. (S-A)

Assignment: Shoot The Moon. HQ 167 — 1967 — Color, 28 min. Summarizes what we have learned about the moon through Ranger, Surveyor and Lunar Orbiter photography, and how this new knowledge contributes to manned flight to the moon. Unique views of craters and other lunar surface features, and of the earth seen from the moon, are included. (U-S-A)

Before Saturn. HQa 76 — 1962 — Color, 14½ min. The history of rockets from early Chinese up to and including the giant Saturn I launch vehicle. (S-A)

The Big Challenge. HQa 170 — 1967 — Color, 28 min. The story of the planning and construction of the Vehicle Assembly Building, crawler, mobile service structure, and the buildings and support facilities of the Kennedy Space Center, Merritt Island, Florida. Produced jointly by NASA and the Corps of Engineers, this film presents in detail the building of the "moonport". (S-A)

The Biosatellite Program — Between the Atom and the Star. HQ 107 — 1965 — Color, 28 min. Biological experiments in a zero gravity environment; types of experiments planned; how the experiments will contribute to knowledge of basic life processes and toward means for supporting life. (S-A)

Celestial Mechanics and The Lunar Probe. HQa 26 — 1958 — Color, 9½ min. Describes the orbital mechanics of guiding lunar probes. (S-A)

The Clouds of Venus. HQa 82 — 1963 — Color, 30 min. The planning, launching and results of the Mariner II voyage past Venus. (S-A)

Doorway to Tomorrow. HQa 171 — 1967 — Color, 28 min. A documentary portrait of the new John F. Kennedy Space Center with emphasis on the Complex 39 "moonport" from which the Apollo astronauts will be launched to the moon. Shows in detail the Vehicle Assembly Building, the assembly of a Saturn V-Apollo vehicle, the mission launch control center and the movement of the launch vehicle by crawler to the launch pad. (U-S-A)

The Dream That Wouldn't Down. HQk 125 — 1965 — B/W, 26:48 min. The dream of Dr. Robert Goddard, the father of rocketry, is explored and examined through reminiscences of Mrs. Goddard. Included is historic footage of Dr. Goddard's early experiments and the personal commentary of Mrs. Goddard. (U-S-A)

Echo in Space. HQ 37 — 1961 — Color, 14 min. The story of Thor-Delta II which placed Echo I, a 100 foot sphere, in orbit as a passive communications satellite. (S-A)

Electric Power Generation in Space. HQ 155 — 1967 — Color, 26:30 min. An educational film describing the problems and methods of generating sufficient power for various needs in space; includes the solar cell, fuel cell, Rankine cycle, Braeton cycle and other experimental systems. (S-A)

Electric Propulsion. HQ 96 — 1965 — Color, 24 min. Shows in nontechnical terms, what electric propulsion is, how it works, why it is needed, its present status and program for development, and how it may be used for both manned and unmanned missions. (S-A)

Father of The Space Age. HQa 54 — 1961 — B/W, 18½ min. Traces the development of Dr. Robert Goddard's rocket research from his early manhood through his final efforts in development of liquid fueled guided rockets. Includes commentaries by Mrs. Goddard, original motion picture coverage of Dr. Goddard's rocket tests, scenes of the dedication of the NASA Goddard Space Flight Center, and the posthumous presentation of the Langley Medal award in 1959. (Not cleared for commercial TV.) (S-A)

The First Soft Step. HQk-SR1 — 1966 — B/W, 28:38 min. A detailed look at the overall mission accomplishments of the Surveyor program to soft-land a picture taking craft on the surface of the moon. The program introduces the viewer to the spacecraft and to top scientists involved in its flight. It concludes with actual photos sent back to earth from Surveyor One. (S-A)

The Flight of Faith 7. HQa 101 — 1963 — Color, 28½ min. Astronaut Gordon Cooper's flight on August 15-16, 1963, is documented from preflight training and medical checkouts to launch, flight, and recovery. (S-A)

Flight to Tomorrow. HQ 168 — 1967 — Color, 28 min. By comparison with present-day jet travel, this film shows some of NASA's advanced aeronautical research to improve the aircraft of tomorrow; included are the supersonic transport, hypersonic aircraft, vertical take-off and landing aircraft, and research on problems of jet noise, sonic boom and stability of light aircraft. (S-A)

Food for Space Travelers. HQk-SR3 — 1966 — B/W, 28:31 min. A report on the progress and problems involved in developing, preparing and eating nutritious and tasteful foods during extended space journeys. Host John Fitch visits a space foods kitchen and samples food prepared for astronauts. (S-A)

The Four Days of Gemini 4. HQa 134 — 1965 — Color, 27½ min. The Gemini 4 mission of Astronauts James McDivitt and Edward White. Includes prelaunch and launch activities, Astronaut White's spectacular "space walk", photographs of the earth, and other experiments con-

ducted during the mission. Sound track includes narration and actual voice communications by the astronauts. Shows details of White's space suit and "space gun". (U-S-A)

Freedom 7. HQa 51 — 1961 — Color, 28½ min. Astronaut Alan B. Shepard's suborbital launch. Describes part of his training, his activities during the last few days before launch, his recovery and reception aboard the rescuing aircraft carrier. (S-A)

Friendship 7. HQa 59 — 1962 — Color, 58 min. Astronaut John H. Glenn's first American orbital space flight. Documents Project Mercury, including a close look at tracking stations around the world. (S-A)

The Guaymas Story. HQ 165 — 1967 — Color, 27:05 min. A visit to the NASA tracking station at Guaymas, Mexico, and a study of the relationship between the community and the space facility. (S-A)

The Hard Ones. HQ 120 — 1965 — Color, 15 min. The difficulties and problems encountered in designing, building, and operating unmanned satellites for scientific research and practical applications such as communications and weather forecasting. Features the Orbiting Geophysical Observatory, designed to gather knowledge about the earth and sun, and their inter-relationships. (S-A)

International Cooperation in Space. HQ 60 — 1965 — Color, 23 min. NASA's program of cooperation with many countries in launching international satellites, carrying of foreign experiments on U.S. spacecrafts, sounding rocket research, global tracking networks. (S-A)

It's You Against the Problem. HQ 146 — 1967 — Color, 26 min. One film in a series on science career guidance, this is a study of the research work of Dr. Simon Ostrach and his colleagues at Case Institute of Technology. (S-A)

The John Glenn Story. HQa 90 — 1963 — Color, 30 min. A biography of Astronaut John Glenn narrated by Jack Webb. Stresses American ideals as exemplified in the life of Astronaut Glenn; the importance of physical, mental and moral values. Portrays his youth in New Concord, Ohio, his service as a combat pilot in World War II and the Korean War, and his momentous adventure as the first American to orbit the earth. (U-S-A)

Landing on the Moon. HQk-SR2 — 1966 — B/W, 28:17 min. The Lunar Module is the topic of this film. The viewer is taken inside the module and is given a simulated ride to the surface of the moon. (S-A)

Living in Space. 1965 Part I, HQ 131-A. "A Case for Regeneration", Color 12 min.

Part II, HQ 131-B. "Regenerative Processes", Color, 20 min.

Part III, HQ 131-C. "A Technology for Spacecraft Design", Color, 12 min. A series of three films which depict various problems which man must solve as he makes extended journeys in space.

Part I illustrates the requirements for oxygen, water, food, and waste disposal which must be incorporated in a regenerative or recycling system.

Part II presents a more comprehensive view of the physics, chemistry and mechanics involved in a life support system, and the possible solutions to physical problems such as bathing, shaving, eating and sleeping in a weightless environment.

Part III shows the technology being developed for a regenerative system for long duration manned space flights. Part I and III, (S-A); Part II (U-S-A)

Legacy of Gemini. HQ 160 — 1967 — Color, 27:30 min. This film presents the major accomplishments of the Gemini two-man space flights and the relationship of these accomplishments to the Apollo three-man flights to the moon; outstanding photography of man in space and the earth seen from space are included. (U-S-A)

Log of Mariner IV. HQa 159 — 1966 — Color, 27 min. A documentary on the Mariner IV spacecraft which photographed the surface of Mars. The film describes the major problems of trajectory, mid-course maneuver, and translation of digital information into photographs; and includes the photographs of the Martian surface. (S-A)

Lunar Landing: The Mission of Surveyor I. HQa 173 — 1967 — Color, 15 min. A documentary account of the Surveyor I mission to land on the moon and send back close-up photographs of the lunar terrain; shows the launching and the method by which photographs were received. (S-A)

The Mastery of Space. HQ 9 — 1962 — Color, 58 min. Traces the development of Project Mercury and documents the sub-orbital flight of Freedom 7 as well as the orbital flight of Friendship 7 on February 20, 1962. Project Gemini, Apollo and the Saturn booster are also briefly discussed. (S-A)

Men Encounter Mars. HQ 149 — 1965 — B/W, 28½ min. A documentary about the engineers and scientists who planned and directed the complex mission of Mariner IV to photograph the Martian surface. (S-A)

A Moment in History. HQa 122 — 1964 — Color, 13½ min. The presentation of honorary U.S. citizenship to Winston Churchill by President Kennedy on April 6, 1963.

The live television transmission was sent via satellite from the White House to England. (S-A)

Orbiting Solar Observatory. HQa 95 — 1962 — Color, 25 min. Describes the Orbiting Solar Observatory spacecraft which is designed to gather information concerning the sun's effect on the earth. (S-A)

The Poetry of Polymers. HQ 143 — 1967 — Color, 19 min. The story of Dr. Frank d'Alelio, research scientist at the University of Notre Dame, and the role of basic research in the space program. This is one in a series of films for career guidance in science. (S-A)

Power for The Moonship. HQk-SR4 — 1966 — B/W 28:23 min. The fascinating new world of fuel cells is explored in this film. Viewers are shown working models of the fuel cell for the Apollo spacecraft, and are given a hint of possible future uses here on earth. (S-A)

Project Apollo — Manned Flight to the Moon. HQ 88 — 1963 — Color, 13 min. Major steps in the Apollo Program to place men on the moon and get them back to earth safely. Includes principal features of the preparatory Gemini spacecraft, the Titan booster and the kinds of operations carried out in the Gemini program. Covers the complete sequence of events for the manned lunar landing from earth launch to return. (S-A)

Project Echo. HQ 24 — 1960 — Color, 27 min. Tells the story of the Echo spacecraft and launch vehicles Thor-Delta I and Thor-Delta II which placed Echo 1, a 100-foot sphere in orbit as a passive communications satellite in August, 1960. (S-A)

Ranger VII Photographs of the Moon. HQa 118 — 1964 — B/W, 7 min. Photographs of the moon, taken by Ranger VII as it approached the moon on July 31, 1964. (S-A)

Ranger VIII Television Pictures of The Moon. HQa 132 — 1965 — B/W, 7½ min. A report on photographs taken of the moon by cameras onboard the Ranger VIII spacecraft. (S-A)

Ranger IX Television Pictures of The Moon. HQa 133 — 1965 — B/W, 6½ min. Short film of lunar photographs taken by the Ranger spacecraft in February and March 1965, with a narrative account of the missions. The photographs have been printed to provide continuous views as the spacecraft descends toward the moon until the moment of impact, and wide and narrow angles are included. (U-S-A)

Returns From Space. HQa 156 — 1966 — Color, 27 min. Some of the varied "spinoff" benefits and products of

space research and development are demonstrated. These include use of sensors for monitoring hospital patients, devices which aid the disabled, the uses of freeze-dried foods by campers, new technological tools, and materials, and microminiaturization of electronic components.

(U-S-A)

Research Project X-15. HQ 79 — 1966 — Color, 27 min. The story of the development of the X-15 research airplane as the latest in a series of experimental aircraft, and the results obtained from X-15 flights. Dramatic photography of the X-15 flights at the edge of space and landings on dry lake beds are included.

(S-A)

Returning from The Moon. HQk-SR 9 — 1966 — B/W, 28:21 min. This film explores the problem of getting the Apollo Command Module safely back through the atmosphere to earth. Explores the problems of guidance and heating and the manufacturing process for the ablative heat shield.

(S-A)

Room at The Top. HQk-SR7 — 1966 — B/W, 28:13 min. At the top of the giant Saturn-Apollo is the Command Module, the crew quarters, flight center and command post for the flight to the moon. This all-important room at the top of Saturn is examined in detail.

(S-A)

Saturn Launch Complex 34. HQa 70 — 1962 — Color, 16½ min. Dr. Kurt Debus, Director, NASA J. F. Kennedy Space Center, discusses with the help of models and diagrams, the complexities of the building and operation of Saturn Launch Complex 34. Dr. Debus also tells why a newer and larger complex than #34 was needed to launch the Saturn V vehicles which will carry man to the moon.

(S-A)

Saturn Propulsion Systems. HQa 77 — 1962 — Color, 14 min. The theory of reaction engines and the application of the theory in the Saturn propulsion system.

(S-A)

The Shape of Things To Come. HQ 106 — 1965 — Color, 21 min. Describes the need for advanced research and provides examples of promising research programs.

(S-A)

Skyward the Great Ships. HQ 166 — 1967 — B/W, 27:20 min. A report on the various types of propulsion being developed for space missions and the applications and advantages of each; illustrates research in chemical, nuclear and electrical propulsion systems.

(S-A)

Space Medicine. HQk-SR8 — 1962 — B/W, 28:31 min. Dr. Charles Berry discusses and shows the medical progress and problems of sending a human being into space and concludes that, so far, there are no serious problems. A fascinating look at the medical program for Manned space flight.

(S-A)

Space Navigation. HQ 116 — 1967 — Color, 21 min. An educational film illustrating with animation and live-action photography the equipment, techniques and mathematics of space navigation between the earth and moon and the earth and other planets.

(S-A)

Steps to Saturn. HQa 67 — 1962 — Color, 22 min. Depicts the background and development processes of the Saturn program. The film shows the flight of the first Saturn vehicle.

(S-A)

Suited For Space. HQk-SR5 — 1966 — B/W, 28:30 min. This history of space suits, from Mercury through Apollo to future concepts. Also included is a close-up look at the Portable Life Support System an astronaut will wear on the surface of the moon.

(S-A)

Ticket through The Sound Barrier. HQk-SR10 — 1966 — B/W, 28:07 min. The Supersonic Transport development program is explored in this film. The viewer is taken on a personal inspection trip of contending configurations and gets to examine each. Also included is a "ride" in a simulated SST.

(S-A)

TIROS, Experimental Weather Satellite. HQa 25 — 1960 — Color, 14 min. Depicts the preparation and launch of the weather satellite TIROS I, April 1, 1960. TIROS and future meteorological satellites are described.

(S-A)

TIROS II, Experimental Weather Satellite. HQa 31 — 1961 — Color, 6 min. Shows launch of TIROS II, November 23, 1960, and summarizes results of the three months of activity during which Tiros I transmitted TV pictures of the earth's cloud cover. Cloud cover pictures from TIROS I are shown, as well as the volume of taped data. Film describes the TV cameras used to photograph the earth's cloud cover and subsystems used to measure earth and atmospheric radiation.

(S-A)

Trial Balance. HQ 123 — 1965 — Color, 27 min. Presents recent knowledge in space science, particularly that gained through analysis of information acquired from spacecraft.

(S-A)

Universe. HQa 91 — 1960 — B/W, 28 min. Explores by animation and special effects the solar system, Moon, Mars, Venus, Mercury, Earth, Saturn and the Milky Way and galaxies beyond. (Not cleared for television)

(U-S-A)

Universe on a Scratchpad. HQ 164 — 1967 — B/W, 28:20 min. A candid study of the work of a modern day astrophysicist, and his method of studying the universe; features commentary by Dr. Robert Jastrow and Dr. Patrick Thaddeus of the NASA Goddard Institute for Space Studies, New York. A companion film to *A View of the Sky*, although each may be viewed separately.

(S-A)

A View of the Sky. HQ 163 — 1967 — Color, 27:40 min. An explanation through symbolic photography of the various historical theories of the universe from Copernicus through Einstein; with a brief look at present day space exploration. (S-A)

The Vital Link. HQa 174 — 1967 — Color, 28:20 min. The dramatic story of NASA's worldwide tracking networks for both manned and unmanned space flights, and how they permit communications between earth and spacecraft hundreds or millions of miles away, includes scenes of a simulated Apollo manned flight. (S-A)

A Voice for Mercury. HQa 66 — 1961 — Color, 14½ min. Describes the construction and equipping of NASA's world-wide Mercury Tracking network. (S-A)

The World Beyond Zero. HQa 121 — 1961 — Color, 28 min. The story of a satellite and the cooperative efforts of the world-wide network tracking stations linking the space scientists and engineers with their orbiting spacecraft through Cape Kennedy; Lima, Peru; Santiago, Chile; Johannesburg, South Africa; Anchorage, Alaska; Winkfield, England; and Woomera, Australia. The film stresses cooperation between nations engaged in the exploration of space. (U-S-A)

MANNED FLIGHT REPORT FILMS

Report films on each manned flight in the Gemini Program (Gemini III through XII) and current flights in the Apollo are available upon request. Each film is 16mm color, with sound; running times vary from 10 to 20 minutes. (S-A)

TECHNICAL FILMS

A list of technical films about NASA projects may be obtained by writing to: NASA Headquarters, Code FAD-2, Washington, D.C. 20546.

TECHNOLOGY UTILIZATION

These films would be of interest to scientists and engineers in Government and industry; science and engineering teachers; and, senior and graduate, university science and engineering students.

An Energy Absorption Process Employing Frangible Metal Tubing. HQa 150 — 1964 — Color, 8 min. Film shows a frangible tube shock absorber relying on the principle of fragmentation. The device provides extremely high energy absorption and was developed for use as a landing impact absorber for spacecraft. (S-A)

Hazards of Tire Hydroplaning to Aircraft Operation. HQa 112 — 1963 — Color, 15 min. This film explains the phenomena of tire hydroplaning, under what condition it occurs, and the resulting hazards to aircraft operations. Based upon tire studies at NASA's Langley Research Center, the film was produced to identify and draw particular attention to the wet runway hazard. The film can be used best as a training film for flight and flight safety personnel. (S-A)

Reduced Gravity Simulator for Study of Man's Self Locomotion. HQa 124 — 1964 — Color, 10 min. Shows an arrangement of cables and harnesses on an overhead track, which very simply duplicates the effects of reduced gravity such as occurs on the moon. The unit has been used in training astronauts to acquaint them with this low gravity effect. (S-A)

Automobile Tire Hydroplaning. "What Happens". HQa 162 — 1967 — Color, 12 min. Based on NASA research in aircraft safety, this film illustrates the effects of automobile tire hydroplaning, or loss of contact between tires and wet highways. Special photography reveals the dangers when hydroplaning occurs. The film was produced jointly by the Bureau of Public Roads and NASA.

(S-A)

By-Products of Space Research — Selected Examples. HQ 179 — 1967 — Color, 16:30 min. Recent industry applications of aeronautical and space technology and the resulting new or improved products on techniques are demonstrated in this film. Examples illustrated include the use of computers to improve X-ray photographs, application of tire hydroplaning studies to highway safety, new tools for diagnosing muscle disease, contributions to crystal growth technology, space telemetry applications for FM broadcasting, a new type of inorganic paint. (S-A)

NASA FILMSTRIPS

Don't Build That Rocket Alone! FS-1 — 1965 — Color, 64 frames; with record and script. Emphasizes the importance of safety precautions and for adult supervision in building and launching model rockets. The dangers of improper handling of such rockets are illustrated. (S-A)

Electric Propulsion. FS-4 — 1965 — Color, 110 frames; with script. Illustrates the techniques and advantages of electric propulsion and possible future uses for manned and unmanned space missions. Based on the NASA 16mm film of the same title. (S-A)

Geology from Space. FS-3 — 1967 — Color, 24 frames; with record and script. Using photographs of the earth taken by Gemini astronauts, this filmstrip shows various geological features around the world, and emphasizes how space photography can aid future geological study. (S-A)

In Sight of the Giant Steps. FS-4 — 1967 — Color, 40 frames; with record and teacher's guide. Through the paintings and sketches of leading contemporary American artists, this filmstrip tells the story of space exploration. Produced for art and social studies as well as science classes by the National Art Education Association, NEA, with assistance from the National Gallery of Art. (S-A)

Meteorology from Space. FS-5 — 1967 — Color, 22 frames; with record and script. Shows how Tiros photography of storm centers and cloud formations provides new knowledge about the weather. (S-A)

Project Apollo — Manned Flight to the Moon. FS-6 — 1963 — Color, 100 frames; with updated script. Presents the story of manned flight to the Moon, from the Mercury and Gemini programs through the first lunar mission and the return of the three-man Apollo program crew to earth; stylized animation, based on the NASA film of the same title. (S-A)

Reach for the Moon and Touch a Star. FS-7 — 1967 — Color, 40 frames; with record and teacher's guide. Produced in cooperation with the National Art Education Association; presents the story of space exploration through the paintings and sketches of leading American artists. (U)

Space Navigation. FS-8 — 1967 — Color, 69 frames; with script. Shows the method for planning trajectories and placing manned and unmanned spacecraft into the proper orbits for their space destinations. Based on the NASA film of the same title. (S-A)

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