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PREFACE

JPL Bibliography No. 39-3 is a compilation of official reports of the Jet Propulsion Laboratory released July 1, 1961 through June 30, 1962. Current security classifications are indicated; titles and abstracts given herein are unclassified.

Jet Propulsion Laboratory reports may be requested by the entry number or by the report number. When ordering classified reports, the government contract under which the report will be used should be indicated, and requests forwarded to JPL via the cognizant contracting officer for certification of security clearance and "need-to-know." Copies of unclassified reports are available upon direct request to the Jet Propulsion Laboratory.

The Bibliography has been divided as follows:

Author Index. Comprising the main portion of the Bibliography, this section is composed of the following types of reports: Technical Reports, Technical Memorandums, and Technical Releases.

Summary Publications. Quarterly Summary Reports, Bibliographies, Research and Space Programs Summaries and the Annual *Ranger* Report are included.

Astronautics Information. This series of publications is composed of Abstracts, Open Literature Surveys, Literature Searches, and Translations.

Numerical Index. The entry numbers for all reports in the Author Index, Summary Publications, and Astronautics Information sections are included in this index.

Subject Index. All reports in the Author Index and Summary Publications sections, as well as Literature Searches and Translations, are indexed.

CONTENTS

AUTHOR INDEX

Acord, J.

A01 *MARINER B* CAPSULE PROPULSION STUDY
Sehgal, R., Breashears, R., Acord J., Thompson, R., Pounder, E., Comuntzis, M.

Technical Memorandum 33-86, June 1, 1962
(Unclassified)

For abstract, see Entry S20.

Adamski, D. F.

A02 THE LUNAR SEISMOGRAPH EXPERIMENT: *RANGER 3, 4, 5*
Adamski, D. F.

Technical Report 32-272, June 1, 1962
(Unclassified)

A lunar seismograph experiment was carried aboard *Rangers* 3, 4, and 5—the first spacecraft capable of landing operating instrument packages on the Moon's surface. The seismometer (seismic transducer) is described, along with its environmental testing, its sterilization, and its integration in a lunar impact capsule. The data processing system used is discussed, as well as the form in which data will be presented to the seismologists.

Allen, L. S.

A03 A PARAMETRIC SURVEY OF CRITICALITY-LIMITED FAST REACTORS EMPLOYING URANIUM FLUORIDE FUELS
Allen, L. S.

Technical Report 32-198, March 15, 1962
(Unclassified)

Multigroup diffusion theory calculations are employed to estimate the size and weight of a uranium fluoride-fueled reactor. Beryllium, beryllium oxide, and graphite are investigated as possible reflector materials; diluents considered for the 93.5%-enriched fuel are the fluorides of sodium, lithium, beryllium, and zirconium. All survey calculations utilize the one-dimensional AIM-5 diffusion theory code and employ twelve energy groups.

It is estimated that for spacecraft reactors in the 10-Mw (th) class, the low fuel density of uranium fluoride results in reactors which are somewhat larger than comparable uranium carbide-fueled reactors. This assumes, however, that the solid fuel can achieve an average fuel burn-up of 30,000 Mwd/t, a performance which remains to be demonstrated for the 2000°F+ fuel-element surface temperatures that should characterize such reactors.

Alper, M. E.

A04 WEIGHT VS. RELIABILITY—A DESIGN CHOICE
Alper, M. E.

Technical Report 32-110, August 18, 1961
(Unclassified)

Several aspects of the problem of choosing a design reliability for a subsystem whose weight varies in a determinable manner with design reliability are discussed. The choice of design reliability is shown to depend on the other subsystems which make up the system and on the type of program in which the system is used. A design procedure and philosophy are proposed.

Apel, W. C.

A05 INSTRUMENTATION REQUIREMENTS FOR THE ENGINEERING EVALUATION OF NUCLEAR-ELECTRIC SPACECRAFT
Apel, W. C.

Technical Report 32-160, October 25, 1961
(Unclassified)

Spacecraft employing nuclear-electric propulsion are being proposed for missions to Venus and distances beyond. These spacecraft utilize a nuclear reactor to provide thermal energy to a turboalternator which generates electric power for an ion motor and the other spacecraft systems.

This report discusses the instrumentation and communications system needed to evaluate a nuclear-electric spacecraft in flight, along with the problems expected. A representative spacecraft design is presented, which leads to a discussion of the instrumentation needed to evaluate such a spacecraft. A basic communications system is considered for transmitting the spacecraft data to Earth.

The instrumentation and communications system, as well as all electronic systems on a nuclear-electric spacecraft, will be operating in high-temperature and nuclear-

radiation environments. The problems caused by these environments are discussed, and possible solutions are offered.

A06 TEST BED CONFIGURATIONS FOR THE FLIGHT TESTING OF *SNAP-8* POWERED ELECTRIC-PROPULSION SYSTEMS
Beale, R. J., Womack, J. R., Hirrel, P. J., Apel, W. C.

Technical Report 32-190, November 24, 1961 (Unclassified)

For abstract, see Entry B06.

Bank, H.

B01 APPLICATION OF THE *SURVEYOR* BUS AS A *CENTAUR* THIRD STAGE FOR *ADVENT*
Clarke, V. C., Jr., Eckman, P. K., Gordon, H. J., Bank, H., Blomeyer, L. S.

Technical Memorandum 33-82, February 23, 1962 (Confidential)

For abstract, see Entry C12.

Barrett, A. H.

B02 OBJECTIVES OF THE *MARINER* VENUS MICROWAVE RADIOMETER EXPERIMENT
Barrett, A. H., Copeland, J., Jones, D. E., Lilley, A. E.

Technical Report 32-156, August 22, 1961 (Unclassified)

At present there are several models involving the surface, atmosphere (and ionosphere), and cloud conditions of the planet Venus which attempt to account for the observed high brightness temperature of 600°K in the microwave temperature region. None of these models can be definitely accepted or rejected on the basis of presently available data, and it is the goal of the microwave radiometer experiment planned for the *Mariner* Venus mission to determine which of the proposed models most nearly approximates Venusian conditions. The disk of the planet will be scanned at four wavelengths (4, 8, 13.5 and 19 mm) to measure the temperature distribution across the planet. Measurement accuracy is expected to be to within 2%. In addition to the study of gross thermal characteristics of surface and atmosphere (or ionosphere), some information regarding the fine-scale thermal variations will be obtained.

B03 A SWEEP-FREQUENCY RADIOMETER FOR TERRESTRIAL AND PLANETARY ATMOSPHERES
Barrett, A. H.

Technical Memorandum 33-67, July 17, 1961 (Unclassified)

The feasibility and desirability of using microwave spectral lines of molecules to study the properties of planetary atmospheres will increase as the payload and power capabilities for deep-space exploration increase. Some of the scientific justifications for developing special microwave equipment and the requirements and/or specifications of this equipment are presented. The fundamental approaches to receiver development which must be explored are also discussed.

Batchelder, R. R.

B04 STIFFNESS MATRIX STRUCTURAL ANALYSIS
Batchelder, R. R., Wada, B. K.

Technical Memorandum 33-75, February 12, 1962 (Unclassified)

Four computer programs are presented for stiffness matrix analysis of structural frameworks, each program representing a different type of framework. The programs will compute the static loads, eigenvectors, eigenvalues, and dynamic stresses of the structure for various loadings. The programs are coded in FORTRAN language, and may be run at any IBM 704–7090 installation with a system compatible with that at the Jet Propulsion Laboratory. Since the programs are intended for use as a design tool, particular attention has been given to simplicity and flexibility of input and output. Discussion of the matrix equations and their application in analysis is supplemented by stiffness matrices and stresses for various member types; program input and output are given and illustrated by a sample problem.

Beale, R. J.

B05 SYSTEMS ENGINEERING OF A NUCLEAR-ELECTRIC SPACECRAFT
Beale, R. J.

Technical Report 32-158, October 31, 1961 (Unclassified)

Studies have shown that nuclear-electric propulsion systems will provide superior payload capability and unique advantages over chemical systems for high-energy deep-space missions.

Conceptual design studies of unmanned spacecraft employing nuclear-electric propulsion systems have been

undertaken to determine some of the major integration problems. Early recognition of these problems will help to stimulate the development effort that will be required to bring these systems into fruitful utilization.

Typical designs under consideration for interplanetary missions for the next decade employ a nuclear reactor providing thermal energy to a turbogeneration system which, in turn, supplies electrical power to an ion engine for primary propulsion and additional utility power for guidance and control, powered-flight radio transmission, instrumentation, etc.

The major systems and components which form a complete spacecraft are listed and the significant physical and operational characteristics of these various systems and components which affect spacecraft integration are reviewed. Conceptual configurations and detailed weight studies for a 60-kwe Venus-capture spacecraft and a 1-Mwe Jupiter-capture spacecraft are shown to illustrate typical physical arrangements based on the various hardware constraints. From these configurations, the major development goals are ascertained and summarized.

B06 TEST-BED CONFIGURATIONS FOR THE FLIGHT TESTING OF *SNAP-8* POWERED ELECTRIC-PROPULSION SYSTEMS

Beale, R. J., Womack, J. R., Hirrel, P. J., Apel, W. C.

Technical Report 32-190, November 24, 1961 (Unclassified)

A study was undertaken to determine, from a conceptual approach, a logical test-bed configuration to meet the following requirements: (1) flight test a 30-kwe *SNAP-8* power-generation system, (2) flight test a nominal 30-kwe ion motor and a nominal 30-kwe arc-jet motor, and (3) acquire useful spacecraft integration experience which could be directly applied to a 60- to 70-kwe mission spacecraft.

In the course of the study three distinct spacecraft concepts were reviewed: (1) a 70-kwe interplanetary mission spacecraft (representative of an ultimate utilization for *SNAP-8*), (2) a 30-kwe Earth-satellite test bed, and (3) a 30-kwe interplanetary test bed. The interplanetary mission spacecraft is described as a standard with which the two types of test beds can be compared. For each spacecraft concept several configurations are illustrated and described in detail. The descriptions include a discussion of the propulsion system, spacecraft mode of operation, guidance, control, power conditioning, instrumentation, and telecommunications. Preliminary weight and instrumentation parameters are summarized.

The technical advantages and disadvantages of the two test-bed concepts are surveyed in relation to the interplanetary mission spacecraft, and the recommendation to pursue the more sophisticated interplanetary test bed is made.

B07 A NUCLEAR-ELECTRIC SPACEBUS FOR PLANETARY LANDING MISSIONS

Beale, R. J., Speiser, E. W.

Technical Report 32-231, May 1, 1962 (Unclassified)

Studies have shown that a nominal 300-kwe nuclear-electric powered spacebus having a gross weight of 16,000 lb can perform significant planetary landing missions to the inner planets. The capabilities of such a spacecraft are discussed and a typical design approach for utilization of these capabilities is examined. The spacecraft considered employs a nuclear-turboelectric power system which supplies power to the primary propulsion device, an ion motor.

Representative missions which are considered include the delivery of landing capsules to the planets Mars, Venus, and Mercury. Scientific payload capabilities of the order of several thousand pounds allow the use of a spacebus/separable landing capsule technique, employing the parent spacebus as a communications relay to Earth. The spacebus, which remains in a planetary orbit, will utilize the nuclear-electric power supply to provide the high-powered relay communication capability for the landing capsule, as well as accomplishing valuable planetary mapping experiments extending over a period of several months. Realtime television transmission from the spacebus, and possibly from the landing capsule, can be provided with the power levels available.

A preliminary investigation of the adaptability of this system for more difficult deep-space missions indicates that the basic system has significant growth potential. Some of the more promising directions in which this potential may be explored are discussed.

B08 NUCLEAR-ELECTRIC SPACECRAFT CONCEPTS FOR UNMANNED PLANETARY EXPLORATION

Beale, R. J.

Technical Report 32-303 (Unclassified)
(Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 178-182, June 1962)

The utilization of advanced, high-powered nuclear-electric spacecraft in the near future for the unmanned

scientific exploration of space will provide significant weight allowances and power levels for scientific payloads and communication equipment. The electronic system designer, presently faced with minimum weight and power limitations imposed by today's chemically propelled spacecraft, must develop new techniques to take advantage of the greater capabilities promised by nuclear-electric spacecraft.

Power levels approaching 1 Mwe may be expected. Systems capable of employing this power must operate under an intense nuclear radiation flux at elevated temperatures for long time periods. It is suggested that development of such equipment be initiated at an early date.

Block, N.

B09 THE ASTRONOMICAL UNIT DETERMINED BY RADAR REFLECTIONS FROM VENUS
Muhleman, D. O., Holdridge, D. B., Block, N.

Technical Report 32-221, March 8, 1962 (Unclassified)

For abstract, see Entry M31.

Blomeyer, L. S.

B10 APPLICATION OF THE *SURVEYOR* BUS AS A *CENTAUR* THIRD STAGE FOR *ADVENT*
Clarke, V. C., Jr., Eckman, P. K., Gordon, H. J., Bank, H., Blomeyer, L. S.

Technical Memorandum 33-82, February 23, 1962 (Confidential)

For abstract, see Entry C12.

Boundy, R. A.

B11 TENSILE PROPERTIES OF FIVE LOW-ALLOY AND STAINLESS STEELS UNDER HIGH-HEATING-RATE AND CONSTANT-TEMPERATURE CONDITIONS
Gerberich, W. W., Martens, H. E., Boundy, R. A.

Technical Report 32-222, November 30, 1961 (Unclassified)

For abstract, see Entry G04.

Bourke, D. G.

B12 JPL CONTRIBUTIONS TO THE 1962 NATIONAL TELEMETERING CONFERENCE
Riddle, F. M., Mathison, R. P., Martin, B. D., Springett, J. C., Bourke, D. G.

Technical Memorandum 33-88, May 21, 1962 (Unclassified)

For abstract, see Entry R05.

Breshears, R. R.

B13 APPLICATIONS FOR MONOPROPELLANTS IN SPACE VEHICLES
Lee, D. H., Breshears, R. R., Harper, A. D., Wrobel, J. R.

Technical Report 32-174, October 5, 1961 (Confidential)

For abstract, see Entry L09.

B14 STUDIES OF CHEMICAL PROPULSION SYSTEMS FOR ORBITING OR LANDING ON THE MOON AND THE NEAR PLANETS
Harper, A. D., Breshears, R. R., Dipprey, D. F., Wrobel, J. R.

Technical Report 32-235, March 15, 1962 (Confidential)

For abstract, see Entry H04.

B15 *MARINER B* CAPSULE PROPULSION STUDY
Sehgal, R., Breshears, R., Acord, J., Thompson, R., Pounder, E., Comuntzis, M.

Technical Memorandum 33-86, June 1, 1962 (Unclassified)

For abstract, see Entry S20.

Bruns, R. A.

B16 COMPUTER INVESTIGATION OF TWO IMPORTANT CRITERIA FOR ADAPTIVE CONTROL SYSTEMS
Bruns, R. A.

Technical Report 32-191, November 21, 1961 (Unclassified)

Following a brief discussion of possible applications for adaptive control systems in space exploration, some

general descriptions of types of adaptive control systems are presented. Two criteria for such systems, IES (integral-error-squared) and IAE (integral-absolute-error), are discussed in detail, with emphasis on methods of utilizing computers rather than results obtained from the investigations. Finally, certain observations and conclusions are drawn from the analog and digital computer studies made on the attitude-control-system model.

Burt, P.

B17 SPIN AND EXCHANGE CORRECTIONS TO PLASMA DISPERSION RELATIONS
Burt, P., Wahlquist, H. D.

Technical Report 32-247 (Unclassified)
(Reprinted from *The Physical Review*, Vol. 125, No. 6, pp. 1785-1788, March 1962)

Longitudinal and transverse dispersion relations, including spin and exchange contributions, are derived for electromagnetic waves in a fully ionized plasma. The nonrelativistic Pauli description of the electrons is used, and the electron-density matrix is assumed to obey the quantum analog of the Vlasov equation. The electromagnetic fields satisfy Maxwell's equations with self-consistent source terms.

The dispersion relation for longitudinal modes is unaffected by spin, and the exchange correction derived agrees with that obtained by previous investigators. The transverse dispersion relation is evaluated in the long-wavelength limit for the completely degenerate plasma at 0°K. If the transverse frequency be written $\omega = \omega_0 + \omega_{sp} + \omega_{ex}$, where ω_0 is the frequency with spin and exchange effects omitted, our results for the corrections are $\omega_{sp} = (\omega_p^2/8\omega_0^3)(h^2/m^2)$, $\omega_{ex} = -3\omega_p^4\, q^2/80\omega_0^3\, K_F^2$, where $\mathbf{q}$ is the wave vector of a disturbance and $\hbar K_F$ is the momentum limit of the Fermi distribution.

Buwalda, P.

B18 MAN-TO-THE-MOON AND RETURN MISSION UTILIZING LUNAR-SURFACE RENDEZVOUS
Buwalda, P., Downhower, W. J., Eckman, P. K., Pounder, E., Rieder, R. A., Sola, F. L.

Technical Memorandum 33-53, August 3, 1961
(Confidential)

The use of rendezvous on the lunar surface as a method of carrying out the manned lunar-landing and return mission is described. This concept places a minimum requirement on the development of newer and larger launching-vehicle systems.

Campen, C. F., Jr.

C01 LUNAR REFERENCE COORDINATES
Campen, C. F., Jr.

Technical Memorandum 33-72, December 29, 1961
(Unclassified)

Two distinct sets of conventions regarding pictorial or chart representations of the Moon and planets are discussed. These are the Astronomical Convention and the Astronautical Convention as defined by the International Astronomical Union at its Eleventh General Assembly during August 1961.

C02 PHOTOGRAPHIC RESOLUTIONS AND COVERAGES OBTAINABLE WITH THE *RANGER* IMPACTING SPACECRAFT
Campen, C. F., Heftman, K., Willingham, D. E.

Technical Memorandum 33-78, April 6, 1962
(Unclassified)

The *Ranger* series of spacecraft have been designed to obtain, in part, relatively high-resolution photographs of limited areas of the front face of the Moon. Their camera designs were predicated on an essentially vertical descent and did not include allowances for possible effects due to angular separations of the optical axis and the direction of descent. Because of constraints set by other experiments and changes in mission concept, trajectories now being considered for the *Ranger* spacecraft may produce impact angles up to 60 deg from the vertical and rotations of the line of sight during descent photography of as much as 20 deg. Errors in the attitude-control system may contribute as much as 1.5 deg misalignment of the optical axis with respect to the desired direction. The effects of these factors on performance of the *Ranger* cameras are assessed.

Carr, R. E.

C03 FREE OSCILLATIONS OF A GRAVITATING SOLID SPHERE
Carr, R. E.

Technical Report 32-164, September 25, 1961
(Unclassified)

The problem of determining the free oscillations of a gravitating solid sphere is investigated. The problem

itself is formulated and, with the assumption of radial symmetry in the structure of the sphere, the numerical solution for the case of the toroidal oscillations is presented in detail. A formal description is given to indicate the numerical solution of the problem of the spheroidal oscillations.

C04 THE PROBLEM OF DESCRIBING PLANETARY AREAS OBSERVED FROM A PROBE WITH APPLICATION TO *MARINER* SPACECRAFT CONFIGURATIONS
Carr, R. E.

Technical Memorandum 33-73, January 10, 1962 (Unclassified)

Planetary areas being scanned from a probe are described in terms of planet-fixed coordinates. The manner of determining probe-oriented reference frameworks is illustrated, and the concept of equivalent cones for the scanning devices is introduced. In addition, a representation for a planet's terminator is given and a basis for a planetary latitude and longitude system is provided. As an example, a detailed algebraic formulation is given for obtaining the planetary latitude and longitude of one point on the terminator of Venus and one point of the periphery of an area which might be observed from two configurations of the *Mariner* spacecraft.

Childress, S.

C05 ON THE MOTION OF A CONDUCTING FLUID PAST A FINITE CYLINDRICAL BODY IN THE PRESENCE OF A STRONG MAGNETIC FIELD
Childress, S.

Technical Report 32-200, December 21, 1961 (Unclassified)

The flow of a conducting fluid past a finite and convex cylindrical body is investigated. The perturbation procedure employed is based on the assumption that the Hartmann number M is large in itself, as well as large compared to the Reynolds number Re. It is found that shear layers are developed fore and aft of the body, outside of which the disturbance of the free stream is $O(Re/M^2)$ in the velocity and $O(Re)$ in the dimensionless pressure. For a particular ordering of the parameters, the expansion of the drag to order $M^{1/2}$ inclusive is determined. The procedure also indicates that two distinct boundary layers are generally developed at the body.

The perturbation of the external flow field is obtained as a nominally second-order effect. However, the actual perturbation is, in the shear layers, larger by a factor log Re/M. The apparent trend toward abnormally large velocity and pressure in the shear layer is discussed.

Chilenski, J. J.

C06 AN EXPERIMENTAL INVESTIGATION OF THE PERFORMANCE OF THE NITROGEN TETROXIDE–HYDRAZINE SYSTEM IN THE OXIDIZER-RICH AND FUEL-RICH REGIONS
Chilenski, J. J., Lee, D. H.

Technical Report 32-212, March 12, 1962 (Unclassified)

The results of an experimental program directed toward determining some of the operational characteristics of the nitrogen tetroxide–hydrazine propellant system under oxidizer-rich and fuel-rich conditions are reported. Data are presented for the mixture-ratio ranges of 0 to 0.55 at a nominal chamber pressure of 300 psia and characteristic chamber length of 250 in., and at mixture ratios of 5.9 to 13.0 at nominal chamber pressures of 400 and 500 psia and characteristic chamber lengths of 100 and 3900 in.

Actual performance data obtained in each region are compared with data predicted from thermochemical performance calculations. From this comparison it is concluded that equilibrium conditions are obtained in neither region and that utilization of performance data obtained from assumptions of equilibrium will lead to serious errors. In the oxidizer-rich region examined, temperatures considerably below those predicted occur throughout the range of mixture ratios investigated because of the lack of exothermic dissociation of the nitrogen oxides. In the fuel-rich region, below a mixture ratio of 0.3, temperatures considerably higher than those predicted occur because of the lack of endothermic dissociation of ammonia.

Choate, R. L.

C07 DESIGN TECHNIQUES FOR LOW-POWER TELEMETRY
Choate, R. L.

Technical Report 32-153, March 5, 1962 (Unclassified)

A direct approach to the design of minimum-power telemetry systems utilizing a phase-locked PM demodulator is developed and illustrated for lunar missions requiring either narrow-bandwidth telemetry or voice

communications. It is shown that the transmitter power required for a lunar mission utilizing a properly designed PM system is 12.5 Mw for 5-cps bandwidth information, and 10.7 w for voice communications.

Two techniques of significance in telemetry system design are emphasized. First, the output S/N ratio is defined as the ratio of the mean information power output to the total mean-square closed-loop phase error, which includes the effect of signal distortion on the design. Second, the safety margin is defined as the ratio between the total mean-square phase error diminished by the mean-square phase error due to signal distortion and the quantity representing the nominal or expected mean-square phase error due to additive noise.

Clarke, V. C., Jr.

C08 DESIGN OF LUNAR AND INTERPLANETARY ASCENT TRAJECTORIES

Clarke, V. C., Jr.

Technical Report 32-30, Revision 1, March 15, 1962 (Unclassified)

The near-Earth or ascent portion of lunar and interplanetary trajectories is discussed. Of particular interest is the matching of the powered flight and coasting phases. To achieve a suitable match, consideration of vehicle-related engineering constraints, payload, and geometrical and energy requirements imposed by the extraterrestrial trajectory is essential. The geometrical constraints and trajectory shaping are treated in detail. To satisfy these constraints, direct ascent and parking-orbit types of trajectories are investigated and compared. Advantages and disadvantages of each are noted. The superiority of the parking-orbit type is illustrated. It is shown that this type has consistently greater payload capability and provides a convenient method of launch-time delay compensation. Finally, injection locations of Mars and Venus trajectories using parking orbits are mapped.

C09 A SUMMARY OF THE CHARACTERISTICS OF BALLISTIC INTERPLANETARY TRAJECTORIES, 1962–1977

Clarke, V. C., Jr.

Technical Report 32-209, January 15, 1962 (Unclassified)

Within the next decade considerable national effort will be expended in exploring neighboring planets. For the most part, this exploration will be accomplished with unmanned probes utilizing ballistic trajectories. Ultimately, electric propulsion systems will be used. In the interim, a knowledge of the characteristics of ballistic trajectories will be of considerable value in planning and designing interplanetary missions. These characteristics (flight times, launch dates, injection energy requirements, etc.) are presented for Mercury, Venus, Mars, and Jupiter trajectories as far ahead as 1977. Primary emphasis is placed on Venus and Mars trajectories, with only selected trajectories to Mercury and Jupiter given.

C10 CONSTANTS AND RELATED DATA USED IN TRAJECTORY CALCULATIONS AT THE JET PROPULSION LABORATORY

Clarke, V. C., Jr.

Technical Report 32-273, May 1, 1962 (Unclassified)

This report sets forth the list of constants and related data currently in use for space trajectory computation for the *Ranger*, *Mariner*, and *Surveyor* programs.

C11 INJECTION LOCATIONS OF LUNAR TRAJECTORIES FOR VARIOUS LAUNCH SITES

Clarke, V. C., Jr.

Technical Memorandum 33-48, July 12, 1961 (Unclassified)

This memorandum extends the study of lunar-ascent trajectories to the determination of injection locations from launch sites other than the Atlantic Missile Range. This extension appears desirable, because the Cape site is not well suited to some missions, such as the 24-hr equatorial satellite and the "out-of-the-ecliptic" shot. It may also be undesirable for manned space probes because of launch-azimuth limitations.

The additional launch sites studied are Christmas Island, Eniwetok Atoll, the southern point of the Island of Hawaii, and White Sands, New Mexico. A set of maps shows injection locations for various lunar declinations and launch azimuths from the four sites; the relation of launch azimuth and launch time is given in a series of plots.

C12 APPLICATION OF THE *SURVEYOR* BUS AS A *CENTAUR* THIRD STAGE FOR *ADVENT*

Clarke, V. C., Jr., Eckman, P. K., Gordon, H. J., Bank, H., Blomeyer, L. S.

Technical Memorandum 33-82, February 23, 1962 (Confidential)

Cocca, T.

C13 DATA FROM THE JPL VENUS RADAR EXPERIMENT, MARCH–MAY, 1961
Cocca, T., Editor

Technical Memorandum 33-59, October 16, 1961
(Unclassified)

This report is a representative sample record of certain types of data logged during the radar exploration of Venus performed at Goldstone, Calif., during the period of March 10 to May 10, 1961. The data presented include both performance information of the Goldstone station and incoming signal information regarding the planet Venus.

A complete description and summary of the results of the Venus radar experiment are given in JPL Technical Report No. 32-132, for which the present report serves as a supplement.

Comuntzis, M.

C14 *MARINER B* CAPSULE PROPULSION STUDY
Sehgal, R., Breshears, R., Acord, J., Thompson, R., Pounder, E., Comuntzis, M.

Technical Memorandum 33-86, June 1, 1962
(Unclassified)

For abstract, see Entry S20.

Copeland, J.

C15 OBJECTIVES OF THE *MARINER* VENUS MICROWAVE RADIOMETER EXPERIMENT
Barrett, A. H., Copeland, J., Jones, D. E., Lilley, A. E.

Technical Report 32-156, August 22, 1961
(Unclassified)

For abstract, see Entry B02.

Corcoran, T. F.

C16 QUALITY ASSURANCE DIODE EVALUATION
Corcoran, T. F., Flynn, R. W., Lockyear, W. H., Dawe, R. H.

Technical Memorandum 33-71, April 16, 1962
(Unclassified)

Glass-cased diodes were subjected to a series of environmental tests in an effort to learn why they develop cracks when in spacecraft modules. The tests produced no cracks. A proposal is made for further study, expanded environmental tests, and new mounting and inspection techniques.

Davis, J. P.

D01 OPTIMIZATION OF CONDENSING TEMPERATURE FOR NUCLEAR TURBOELECTRIC SPACE POWER PLANT
Davis, J. P.

Technical Report 32-133, August 1, 1961
(Unclassified)

In order to scope operating parameters for a nuclear-electric powerplant, a relatively simple scheme has been derived for selecting the ratio of radiator condensing temperature to turbine inlet temperature. The optimum condensing temperature satisfies a set of approximate relations which minimize over-all powerplant specific weight for any given electrical power output with respect to the fraction of plant weight which is the radiator. As with all such analytical attempts, the validity of the results are contingent on the accuracy of the simplifying assumptions necessary to mathematically formulate the problem. These assumptions are presented and discussed.

The analysis indicates that over the range of anticipated radiator weight fractions and deviations from Carnot cycle efficiency, a choice of condensing to saturated turbine inlet temperature ratio of 0.60 to 0.70 is warranted. The analysis does not consider any weight penalties associated with higher vapor specific volumes or condensate pumping problems at lower condensing temperatures.

Dawe, R. H.

D02 QUALITY ASSURANCE DIODE EVALUATION
Corcoran, T. F., Flynn, R. W., Lockyear, W. H., Dawe, R. H.

Technical Memorandum 33-71, April 16, 1962
(Unclassified)

For abstract, see Entry C16.

Dipprey, D. F.

D03 STUDIES OF CHEMICAL PROPULSION SYSTEMS FOR ORBITING OR LANDING ON THE MOON AND THE NEAR PLANETS
Harper, A. D., Breshears, R. R., Dipprey, D. F., Wrobel, J. R.

Technical Report 32-235, March 15, 1962 (Confidential)

For abstract, see Entry H04.

D04 HEAT AND MOMENTUM TRANSFER IN SMOOTH AND ROUGH TUBES AT VARIOUS PRANDTL NUMBERS
Dipprey, D. F., Sabersky, R. H.

Technical Report 32-269, June 6, 1962 (Unclassified)

Results are presented from an experimental investigation of the relation between heat transfer and friction in smooth and rough tubes. Three rough tubes and one smooth tube were formed from electroplated nickel. The rough tubes contained a close-packed, granular type of surface with roughness-height-to-diameter ratios ranging from 0.0024 to 0.049. Measurements of the heat transfer coefficients (C_H) and the friction coefficients (C_F) were obtained with distilled water flowing through the electrically heated tubes. A Prandtl number range of 1.20 to 5.94 was investigated by adjusting the bulk temperature of the water. Results were obtained for Reynolds numbers from 6×10^4 to 5×10^5 and from 1.4×10^4 to 1.2×10^5 at the lowest and highest Prandtl number, respectively.

A similarity rule for heat transfer was used to correlate, interpret, and extend the experimental results. The results were compared with previously existing results, both theoretical and experimental. Increases in C_H due to roughness of as high as 270% were obtained. These increases were, in general, accompanied by even larger increases in C_F. An exception to this general behavior occurs at high Prandtl number in the region of transition between the "smooth" and "fully rough" C_F characteristic.

Downhower, W. J.

D05 MAN-TO-THE-MOON AND RETURN MISSION UTILIZING LUNAR-SURFACE RENDEZVOUS
Buwalda, P., Downhower, W. J., Eckman, P. K., Pounder, E., Rieder, R. A., Sola F. L.

Technical Memorandum 33-53, August 3, 1961 (Confidential)

For abstract, see Entry B18.

Easterling, M.

E01 A LONG-RANGE PRECISION RANGING SYSTEM
Easterling, M.

Technical Report 32-80, July 10, 1961 (Unclassified)

A technique is presented that may be used for precision real-time continuous range measuring at long ranges. The technique uses a carrier that is phase modulated by a pseudo-random binary sequence. The characteristics of the sequence that make it acquirable are discussed. The general form of a receiver capable of tracking the carrier is shown to be a type of phase-locked loop. A two-loop system capable of tracking a pseudo-random sequence and its clock is given. The combination of the receiver and the sequence tracking system form a ranging receiver. The power division necessary between the carrier and the sidebands is demonstrated to be determined by the noise bandwidths of the two tracking systems. The bandwidths necessary for tracking space probes and Earth satellites are given and some experiments in radar-tracking Earth satellites are described. Based on these experiments, estimates are made of the useful range of such a system in tracking space probes.

Eckman, P. K.

E02 MAN-TO-THE-MOON AND RETURN MISSION UTILIZING LUNAR-SURFACE RENDEZVOUS
Buwalda, P., Downhower, W. J., Eckman, P. K. Pounder, E., Rieder, R. A., Sola, F. L.

Technical Memorandum 33-53, August 3, 1961 (Confidential)

For abstract, see Entry B18.

E03 APPLICATION OF THE *SURVEYOR* BUS AS A *CENTAUR* THIRD STAGE FOR *ADVENT*
Clarke, V. C., Jr., Eckman, P. K., Gordon, H. J., Bank, H., Blomeyer, L. S.

Technical Memorandum 33-82 February 23, 1962 (Confidential)

For abstract, see Entry C12.

Elleman, D. D.

E04 THE USE OF A PROTON-PROTON SPIN DECOUPLING METHOD FOR THE DETERMINATION OF NUCLEAR MAGNETIC RESONANCE CHEMICAL SHIFTS
Manatt, S. L., Elleman, D. D.

Technical Report 32-163 (Unclassified)
(Reprinted from *The Journal of the American Chemical Society*, Vol. 83, No. 19, pp. 4095-4096, October 1961)

For abstract, see Entry M04.

E05 A DOUBLE RESONANCE STUDY OF THE NMR SPECTRUM OF 1-CHLOROBUTADIENE-1, 2 AND THE DETERMINATION OF THE RELATIVE SIGNS OF THE COUPLING CONSTANTS
Manatt, S. L., Elleman, D. D.

Technical Report 32-187 (Unclassified)
(Reprinted from *The Journal of the American Chemical Society*, Vol. 84, No. 9, pp. 1579-1582, May 1962)

For abstract, see Entry M05.

E06 CONFIGURATIONS OF SUPERCONDUCTING SHELLS REQUIRED FOR NEAR CRITICAL UNIFORM MAGNETIC FIELDS
Hildebrandt, A. F., Wahlquist, H., Elleman, D. D.

Technical Report 32-192 (Unclassified)
(Reprinted from *Journal of Applied Physics*, Vol. 33, No. 5, pp. 1798-1800, May 1962)

For abstract, see Entry H10.

E07 OPPOSITE RELATIVE SIGNS OF GEMINAL AND VICINAL FLUORINE-FLUORINE NMR COUPLING CONSTANTS IN A SATURATED FLUOROCARBON BY DOUBLE RESONANCE
Manatt, S. L., Elleman, D. D.

Technical Report 32-237 (Unclassified)
(Reprinted from *The Journal of the American Chemical Society*, Vol. 84, No. 7, p. 1305, April 1962)

For abstract, see Entry M06.

E08 FLUORINE-FLUORINE NUCLEAR SPIN-SPIN DECOUPLING
Elleman, D. D., Manatt, S. L.

Technical Report 32-262 (Unclassified)
(Reprinted from *The Journal of Chemical Physics*, Vol. 36, No. 7, pp. 1945-1946, April 1962)

A report on the successful application of the double resonance technique to the decoupling of sets of spin-coupled fluorine nuclei is given.

E09 AN NMR STUDY OF INDENE USING A PROTON-PROTON DECOUPLING TECHNIQUE
Elleman, D. D., Manatt, S. L.

Technical Report 32-265 (Unclassified)
(Reprinted from *The Journal of Chemical Physics*, Vol. 36, No. 9, pp. 2346-2352, May 1962)

The 60-Mc high resolution NMR spectrum of the protons of the five-membered ring of indene has been studied with the aid of the audio sideband phase detection proton–proton spin decoupling technique. The chemical shifts and the spin–spin coupling constants have been measured. The relative sign of the spin coupling constant J_{AX} was determined to be different than that of J_{AK} and J_{KX} by double irradiation experiments. Certain long-range couplings of the aromatic protons with the five-membered ring protons were detected.

Evans, D. D.

E10 ROCKET MOTOR STUDIES WITH CAVEA-B MONOPROPELLANT
Evans, D. D.

Technical Memorandum 33-64, October 6, 1961
(Confidential)

The introduction of a new monopropellant is normally followed by extensive engineering investigations to determine proper operating procedures and required rocket motor configurations in order to provide a basis for the design of flight-type hardware. This report describes an experimental investigation of the combustion characteristics of Cavea-B monopropellant at the 100-lb-thrust level. Several injection techniques and rocket motor configurations were studied. Experimental characteristic exhaust velocity and thrust data are presented as a function of characteristic chamber length for propellants with certain acid-to-salt ratios at chamber pressures of 150 and 300 psia. High percentages of theoretical combustion efficiency and theoretical specific impulse were obtained.

E11 IGNITION STUDIES OF CAVEA-B MONOPROPELLANT
Evans, D. D.

Technical Memorandum 33-65, October 6, 1961 (Confidential)

Hypergolic ignition of monopropellant systems is desirable in many potential applications. In order to design practical combustion devices properly, it is necessary that a knowledge of the relative ignition delays of various hypergols be available. This report summarizes the results of an experimental investigation of the ignition delay of a Cavea-B monopropellant system when reacted with various hypergolic amines. The experimental apparatus consisted of a 50-lb-thrust rocket motor utilizing a one-on-one impinging stream injector. Ignition delay was determined as the time interval between propellant impingement on a conductivity probe and the measurement of pressure rise as determined from a pressure transducer. The effect of various ignition-aid additives and various Cavea-B–amine mixture ratios was also evaluated.

Fearey, J. P.

F01 EVALUATION OF GOLDSTONE POLAR-MOUNT ANTENNA SYSTEMATIC ERRORS FROM STAR TRACKS
Ulery, D. L., Fearey, J. P.

Technical Memorandum 33-45, May 5, 1962 (Unclassified)

For abstract, see Entry U01.

Fehlner, F. P.

F02 INHIBITION OF A LOW-PRESSURE FLAME BY HALOGEN ATOMS
Fehlner, F. P.

Technical Report 32-122, August 14, 1961 (Unclassified)

An attempt was made to introduce chlorine atoms directly into a low-pressure acetylene-oxygen flame. The atoms were formed by flash photolysis of molecular chlorine contained in the reactant gases. Momentary inhibition of the acetylene flame was observed. The phenomenon was studied by means of high-speed photography, spectroscopy, and hot-wire anemometry. It was concluded that the cause of inhibition was chlorinated acetylene rather than chlorine atoms. Recommendations for improving the experimental setup are presented.

Fischbach, D. B.

F03 DIAMAGNETIC SUSCEPTIBILITY OF PYROLYTIC GRAPHITE
Fischbach, D. B.

Technical Release 34-219 (Unclassified) (Reprinted from *The Physical Review*, Vol. 123, No. 5, pp. 1613-1614, September 1, 1961)

The diamagnetic susceptibility of some pyrolytic graphites deposited at 2100 to 2300°C have been measured at room temperature. As-deposited samples had significantly larger susceptibilities than those of well-graphitized carbons or single-crystal graphite. Heat treatment at temperatures above 2300°C caused the total susceptibility to decrease to a minimum value, then rise and level out at a value characteristic of graphite, as a function of treatment temperature. The relationship of the susceptibility behavior to the structure of the pyrolytic graphite is discussed.

F04 THE ZENER RELAXATION AND A NEW MAGNETIC RELAXATION EFFECT IN Fe-RICH Fe-Al ALLOYS
Fischbach, D. B.

Technical Report 32-130, Revision (Unclassified) (Presented at Conference on Internal Friction, July 10-12, 1961, Cornell University, N. Y. Reprinted from *Acta Metallurgical*, Vol. 10, pp. 319-326, April 1962)

The damping behavior of Fe-Al alloys containing 8- to 36-at.% Al has been investigated in the temperature range 350–750°C using a torsion pendulum. Special care was taken to separate magnetic and non-magnetic damping effects. A new magnetoelastic damping peak has been observed near 600°C in alloys containing less than 22% Al. This peak, which apparently has not previously been observed, has the characteristics of a relaxation phenomenon. A mechanism is proposed involving the diffusion-limited, stress-induced oscillation of magnetic domain walls anchored by magnetic directional ordering. In addition, the temperature and composition dependence of the Zener relaxation (which occurs near 500°C) has been measured in the absence of magnetoelastic effects. Previous reports that the relaxation strength increases more slowly than the square of the solute content at low Al contents are confirmed and possible explanations are discussed. Effects of long range ordering are apparent in alloys containing more than 21% Al. The activation energy for the Zener relaxation is appropriate for self-diffusion, but the pre-exponential factor is unusually

small. At 17% Al, the activation energy is 56 kcal/mole and $\tau_0 = 8 \times 10^{-17}$.

F05 THE MAGNETIC SUSCEPTIBILITY OF PYROLYTIC CARBONS
Fischbach, D. B.

Technical Report 32-165 (Unclassified)
(Presented at 5th Conference on Carbon, Penn State University, June 1961. Reprinted from "Proceedings of the Fifth Conference on Carbon," Pergamon Press, New York, N. Y., 1962)

After heat treatment at temperatures up to 3600°C the magnetic susceptibility of several oriented pyrolytic carbons (pyrolptic graphites) has been measured in the as-deposited condition. For pyrolytic carbons deposited at temperatures above 2000°C the susceptibility is substantially larger than that of single-crystal graphite. However, it obeys the electron gas temperature dependence equation of Pacault and Marchand. Heat treatment at temperatures above the deposition temperature causes the anisotropic part of the susceptibility (measured at room temperature) to decrease to a minimum value after treatments near 2900°C before leveling out at the plateau value characteristic of graphite for heat treatment temperatures above 3100°C. The enhanced as-deposited susceptibility is attributed to the combination of large crystallite diameter and turbostratic structure observed in these materials. Possible causes of the susceptibility minimum are suggested. There is some evidence that the susceptibility behavior of pyrolytic carbons deposited at temperatures below 2000°C is similar to that usually observed in other pre-graphitic carbons.

Flynn, R. W.

F06 QUALITY ASSURANCE DIODE EVALUATION
Corcoran, T. F., Flynn, R. W., Lockyear, W. H., Dawe, R. H.

Technical Memorandum 33-71, April 16, 1962 (Unclassified)

For abstract, see Entry C16.

Focas, J. H.

F07 OBSERVATIONS OF MARS MADE IN 1961 AT THE PIC DU MIDI OBSERVATORY
Focas, J. H.

Technical Report 32-151, January 30, 1962 (Unclassified)

Results are presented of observations of Mars made in 1961 through the 24-in. refractor of the Pic du Midi Observatory. Measurements included in the observation program were: (1) polarimetric measurements of the proportion of polarized light coming from various regions of the planet; (2) photometric measurements, using photographic negatives, of the contrast between areas; and (3) photographic and visual observations of the upper atmosphere of Mars (in ultraviolet and blue light) and of the fine surface markings of the planet.

Gardner, R. E.

G01 EFFECTS OF IONIZING RADIATION ON SOLID ROCKET MOTOR COMPONENTS
Gardner, R. E.

Technical Report 32-234, December 21, 1961 (Unclassified)

Problems which the solid-propellant rocket engineer will encounter in designing for long-term storage in a radiation environment are discussed. Present knowledge of the radiation environment is summarized. Mechanisms of radiation degradation and its effects on tensile properties of propellant binders are discussed qualitatively. Data from a program of irradiation of several propellants are presented. Properties of two of the propellants were changed significantly by doses of the order of 4×10^6 rad.

Gates, C. R.

G02 SPACE GUIDANCE
Gates, C. R., Scull, J. R., Watkins, K. S.

Technical Report 32-162 (Unclassified)
(Reprinted from *Astronautics*, Vol. 6, No. 11, pp. 24-28, November 1961)

Partial answers can now be given to some of the questions raised in the past few years concerning guidance, control, and navigation in coming lunar and interplanetary flights.

Among the questions discussed are the following: (1) Can the boost vehicle be guided with sufficient accuracy so that no guidance is required after injection? (2) Is some form of midcourse guidance required, and, if so, should the midcourse-guidance system be located in the spacecraft or on Earth? (3) What new components are required for space guidance and to what extent can currently available components be utilized? (4) How

does one accomplish a soft-landing on the lunar surface? (5) Is a space navigator, measuring the angles between observable bodies and located in the spacecraft, needed for interplanetary flight?

Gerberich, W. W.

G03 STRESS DISTRIBUTION ABOUT A SLOWLY GROWING CRACK DETERMINED BY THE PHOTOELASTIC COATING METHOD

Gerberich, W. W.

Technical Report 32-208, April 4, 1962
(Unclassified)
(Presented at Spring Meeting of the Society for Experimental Stress Analysis, Dallas, Texas, May 16-18, 1962)

An experimental stress analysis technique is reported in which a birefringent coating is used to determine the stress distribution about a slowly growing crack. The maximum error of the test method for a large strain gradient is found to be less than 10%. For a plate with an internal crack, the experimentally determined stress distribution compares favorably with two numerical solutions. Comparison of stresses about an internal or double-edge crack with those about a single-edge crack indicates that the isochromatics bend over to about 45 deg with the plane of the crack in the former and are inclined at about 60 deg in the latter. Also, the stresses for a single-crack tip vary as the inverse square root of the radius, while the stresses for a double-crack tip follow an $r^{-1/4}$ law more closely.

G04 TENSILE PROPERTIES OF FIVE LOW-ALLOY AND STAINLESS STEELS UNDER HIGH-HEATING-RATE AND CONSTANT-TEMPERATURE CONDITIONS

Gerberich, W. W., Martens, H. E., Boundy, R. A.

Technical Report 32-222, November 30, 1961
(Unclassified)

The purpose of this investigation was to fill several gaps in the literature on high-heating-rate properties of several commonly used aerospace, structural materials. High-heating-rate results were obtained for three low-alloy steels: 4340 (400°F temper), 4130 (800°F temper), and 4130 (1050°F temper) and two stainless steels: 71-7 PH (TH 1050) and 410 (700°F temper). Stress levels ranging from 10 to 125 ksi and heating rates varying from 40 to 2000°F/sec were the testing parameters. A method was devised to compare yield temperature data of high-heating-rate test to tensile yield data of steady-state elevated temperature tests.

Results indicate that high-heating-rate properties of all the materials are superior to steady-state elevated temperature properties for heating rates of 40 to 2000°F/sec. For the low alloy steels, the higher the tempering temperature, the better the high-heating-rate properties. Properties of 410 stainless steel are superior to those of all other materials investigated.

Gier, H. L.

G05 EXPERIMENTAL INVESTIGATION OF EXHAUST DIFFUSERS FOR ROCKET ENGINES

Roschke, E. J., Massier, P. F., Gier, H. L.

Technical Report 32-210, March 15, 1962
(Unclassified)

For abstract, see Entry R11.

Glatts, G. S.

G06 STABILITY TESTS OF MONOPROPELLANTS EXPOSED TO FLAMES AND RIFLE FIRE

Glatts, G. S.

Technical Report 32-172, February 26, 1962
(Unclassified)

Tests of the stability of several monopropellants under the effects of impact and heat were conducted in order to assess the potential hazard from major fires and enemy attack in a propellant storage area. Hydrazine, hydrazine nitrate solution, *n*-propyl nitrate, and ethylene oxide were all tested in one-gallon aluminum containers (half of them filled to 25% and half to 95% capacity) by being subjected to oil bonfires and wood bonfires, and 20-mm incendiary, 20-mm high-explosive incendiary, and 30 caliber rifle fire. Aviation gasoline was tested in the same manner for comparison.

In the bonfire tests all four monopropellants generally gave explosion intensities equivalent to one another regardless of the type of bonfire (oil or wood) or the amount of liquid in the test container. Occasionally, however, with hydrazine, hydrazine nitrate solution, and *n*-propyl nitrate, anomalous results occurred: there was either no explosion or an explosion of above average intensity. Ethylene oxide more nearly approximated the behavior of aviation gasoline than did the other monopropellants.

In the rifle-fire tests *n*-propyl nitrate appeared to be most shock-sensitive, since it was exploded by all three types of ammunition. Hydrazine and hydrazine nitrate solution were exploded by the high-explosive ammunition, but not by the incendiary or 30 caliber ammunition. Ethylene oxide was not exploded by any of the gunfire, but the liquid was ignited by both incendiary and high-explosive incendiary ammunition.

Goggia, R. J.

G07 USE OF CARBON-ARC LAMPS AS SOLAR SIMULATION IN ENVIRONMENTAL TESTING
Maclay, J. E., Goggia, R. J.

Technical Report 32-271, June 4, 1962 (Unclassified)

For abstract, see Entry M03.

Golomb, S. W.

G08 SECURE COMMUNICATIONS
Lorens, C. S., Titsworth, R. C., Welch, L. R., Viterbi, A. J., Golomb, S. W.

Technical Report 32-65, August 30, 1961 (Secret)

For abstract, see Entry L20.

Gordon, H. J.

G09 APPLICATION OF THE *SURVEYOR* BUS AS A *CENTAUR* THIRD STAGE FOR *ADVENT*
Clark, V. C., Jr., Eckman, P. K., Gordon, H. J., Bank, H., Blomeyer, L. S.

Technical Memorandum 33-82, February 23, 1962 (Confidential)

For abstract, see Entry C12.

Hales, A. W.

H01 REGULARITY AND POSITIONAL GAMES
Hales, A. W., Jewett, R. I.

Technical Report 32-134, January 31, 1962 (Unclassified)

The concept of regularity is presented and several general results are proved. The results, in turn, are applied to the analysis of certain types of games.

Hanna, O. T.

H02 LAMINAR BOUNDARY LAYER DIFFUSION IN LIQUIDS WITH A VARIABLE DIFFUSIVITY
Hanna, O. T.

Technical Report 32-204, December 28, 1961 (Unclassified)

Laminar-boundary-layer diffusion is considered in liquids having a constant density and a Schmidt number greater than 30. An integral solution is obtained for flow past arbitrary geometries with finite normal velocities at the surface. The effect of a composition-dependent diffusivity is included. For the case of constant properties the integral results are shown to agree well with the exact solution.

Harper, A. D.

H03 APPLICATIONS FOR MONOPROPELLANTS IN SPACE VEHICLES
Lee, D. H., Breshears, R. R., Harper, A. D., Wrobel, J. R.

Technical Report 32-174, October 5, 1961 (Confidential)

For abstract, see Entry L09.

H04 STUDIES OF CHEMICAL PROPULSION SYSTEMS FOR ORBITING OR LANDING ON THE MOON AND THE NEAR PLANETS
Harper, A. D., Breshears, R. R., Dipprey, D. F., Wrobel, J. R.

Technical Report 32-235, March 15, 1962 (Confidential)

A study is presented of four spacecraft propulsion systems for use in conjunction with the currently proposed NASA vehicles, including the *Saturn* booster. Because of the implied time scale, no consideration is given to advanced systems utilizing nuclear systems for accelerating mass electrostatically, electromagnetically, or by direct heating. The systems considered represent the general classes of units suitable for spacecraft propulsion and are analyzed with emphasis on such aspects as over-all performance, configuration, operational reliability, and suitability for the space environment. A discussion is presented of the velocity requirements for orbiting and landing missions on the Moon and the near planets. The various systems are compared on the basis of payload performance capabilities for several selected missions.

Havlik, A. J.

H05 CROSSLINKED AND NON-CROSSLINKED DIISOCYANATE-LINKED ELASTOMERS CONTAINING SUBSTITUTED UREA GROUPS

Havlik, A. J., Smith, T. L.

Technical Report 32-180, May 31, 1962 (Unclassified)

A study was made of the preparation and properties of diisocyanate-linked elastomers prepared from polyoxypropylene glycol (POPG), toluene-2, 4-diisocyanate (TDI), and toluene-2, 4-diamine (TDA). The chemical structure and gelation of a series of prepolymers were investigated. Many series of elastomers were prepared at 60°C in open molds and at 110°C in closed molds from mixtures in which values of the ratio of isocyanate groups to the sum of the hydroxyl groups and amino groups (R_1) and the ratio of the amino groups to hydroxyl groups (R_2) were systematically varied. Cure at 60°C gave tough non-crosslinked elastomers, the properties apparently resulting from interchain attractive forces, while cure at 110°C gave covalently crosslinked elastomers having rather similar properties. Glass-transition temperatures increased linearly with the concentration of substituted urethane groups but were independent of the concentration of substituted urea groups. An explanation for this surprising behavior is presented. The non-crosslinked elastomers were soluble in N, N-dimethylacetamide (DMA) and similar solvents. Intrinsic viscosities in DMA were found to increase with R_1 at constant R_2. Young's modulus, tensile strength, and ultimate elongation were determined between −23 and 82°C. At elevated temperatures, the crosslinked elastomers showed near-equilibrium moduli, while the non-crosslinked ones did not. The number of chains per milliliter for the crosslinked elastomers was calculated from the quantities of excess isocyanate and urea hydrogens, along with an assumed topology for the network. The moduli for both types of elastomers were related to chemical composition. Various relationships between the ultimate properties and equilibrium moduli were evaluated. Extensions up to 5000% with elastic recoveries of better than 90% were noted.

Heftman, K.

H06 PHOTOGRAPHIC RESOLUTIONS AND COVERAGES OBTAINABLE WITH THE RANGER IMPACTING SPACECRAFT

Campen, C. F., Jr., Heftman, K., Willingham, D. E.

Technical Memorandum 33-78, April 6, 1962 (Unclassified)

For abstract, see Entry C02.

Heindl, C. J.

H07 COMPARISON OF FISSION ELECTRIC CELL GEOMETRIES

Heindl, C. J.

Technical Report 32-101, September 1, 1961 (Unclassified)

Comparison has been made of the relative power-to-weight ratios calculated for fission-electric cell reactor power systems based upon cells of plane, cylindrical, and spherical geometry. It is demonstrated that for systems of equal power output, the choice of cell geometry does not greatly affect the total weight of the system.

Hickman, R. S.

H08 DETERMINATION OF RADIATION CONFIGURATION FACTORS

Hickman, R. S.

Technical Report 32-154, December 21, 1961 (Unclassified)

Available techniques for the determination of configuration factors are reviewed and the mathematical definitions for these factors are presented. The relative merits of the Eckert sphere, mechanical integrator, and reflecting parabola experimental techniques are discussed. Finally, a graphical technique due to Zijl is presented. Of all methods discussed, the parabolic mirror method is easiest to use on complicated spacecraft shapes.

H09 TRANSIENT RESPONSE AND STEADY-STATE TEMPERATURE DISTRIBUTION IN A HEATED, RADIATING, CIRCULAR PLATE

Hickman, R. S.

Technical Report 32-169, November 22, 1961 (Unclassified)

The steady-state and transient temperature solutions for a heated, radiating, circular plate are presented. Two different approaches are used. The first nondimensionalizes all variables with respect to the edge temperature. Nondimensional centerline-edge temperature ratios and transient times are then presented as functions of the nondimensional heat input and plate radius. In the second

approach the variables are nondimensionalized with respect to the plate centerline temperature. Universal temperature profiles and temperature gradients are then presented as functions of the nondimensional heat input and plate radius.

Hildebrandt, A. F.

H10 CONFIGURATIONS OF SUPERCONDUCTING SHELLS REQUIRED FOR NEAR CRITICAL UNIFORM MAGNETIC FIELDS
Hildebrandt, A. F., Wahlquist, H., Elleman, D. D.

Technical Report 32-192 (Unclassified)
(Reprinted from *Journal of Applied Physics*, Vol. 33, No. 5, pp. 1798-1800, May 1962)

The boundary value problem for a superconductor has been solved for specific axially symmetric geometries. The interior field of a right circular shell is found to be quite uniform. Also it is found that the ends of the shell can be shaped to overcome a singularity at the end. This permits a near critical and uniform field to be obtained over a very large volume of the central region. Experimentally it was found that in agreement with calculation, a simple geometric shape electrolytically coated with lead would trap a field of 630 gauss with homogeneity.

Hiroshige, Y.

H11 FLUID ISSUING FROM THE CENTER OF A MAGNETIC DIPOLE
Hiroshige, Y., Yagi, F.

Technical Memorandum 33-63, October 30, 1961 (Unclassified)

This report is the first in a series of papers discussing the interaction of a magnetic field and a conducting fluid. The object of this study is to arrive at a better understanding of the distortions of the solar magnetic field caused by the flow of plasma away from the Sun. In particular, the simplified case of an incompressible, inviscid, infinitely conducting fluid in axisymmetric flow under steady conditions is treated; if the fluid flow is irrotational on an inner spherical boundary (the surface of the Sun) on which the magnetic field is a dipole centered at the origin, it is irrotational everywhere outside this boundary, and the magnitude of the velocity vector must be a constant multiple of the magnitude of the magnetic-field strength vector. The streamlines and magnetic-field lines are determined for this special case.

Hirrel, P. J.

H12 CONTROL AND GUIDANCE OF ELECTRICALLY PROPELLED SPACECRAFT
Hirrel, P. J.

Technical Report 32-166, September 15, 1961 (Unclassified)

Some of the conditions and methods of control and guidance for a nuclear-electric spacecraft are discussed in general terms. The type of spacecraft considered is one which is propelled by an ion motor. The broad aspects of the flight trajectory peculiar to this type of propulsion are examined. Some equipment limitations are reviewed.

H13 TEST-BED CONFIGURATIONS FOR THE FLIGHT TESTING OF *SNAP-8* POWERED ELECTRIC-PROPULSION SYSTEMS
Beale, R. J., Womack, J. R., Hirrel, P. J., Apel, W. C.

Technical Report 32-190, November 24, 1961 (Unclassified)

For abstract, see Entry B06.

Holdridge, D. B.

H14 THE ASTRONOMICAL UNIT DETERMINED BY RADAR REFLECTIONS FROM VENUS
Muhleman, D. O., Holdridge, D. B., Block, N.

Technical Report 32-221, March 8, 1962 (Unclassified)

For abstract, see Entry M31.

H15 SPACE TRAJECTORIES PROGRAM FOR THE IBM 7090 COMPUTER
Holdridge, D. B.

Technical Report 32-223, March 2, 1962 (Unclassified)

The space trajectories program for the IBM 7090 computer is described comprehensively, with emphasis on the development of the equations. Equations of motion for both the Cowell and Encke methods are given. Numerical experience with the class of trajectories encountered in practice is included to compare the Cowell and Encke methods, and to obtain an estimate of the over-all accuracy of the program. Sources of error are pointed out which are consistent with the precision of the numerical

methods. Operating instructions and descriptions of input and output are provided for the successful running of trajectories. Flow charts presented serve as a guide to the understanding of the internal sequence of events and control methods. Major subroutines used in the program are included. The program is written in the FORTRAN assembly program language.

Inskeep, J.

I01 DYNAMIC TESTING OF PRESSURE TRANSDUCERS —A PROGRESS REPORT

Inskeep, J.

Technical Report 32-268, December 6, 1961
(Unclassified)

Testing methods and results are described for frequency response testing of pressure transducers and associated coupling tubing as part of a current program of dynamic testing of pressure measurement systems. A shock tube, low frequency tank, acoustic siren, and commercial testing equipment are used to excite pressure transducers. Results are analyzed either graphically or with a flying spot scanner/wave analyzer. Types of equipment are described in detail as well as advantages of their use and problems encountered in their development and operation.

Results of a test program to obtain maximum frequency response from a commonly used strain-gauge pressure transducer are given in addition to general rules for selection of transducer types and coupling configurations.

Jaffe, L. D.

J01 BEHAVIOR OF MATERIALS IN SPACE ENVIRONMENTS

Jaffe, L. D., Rittenhouse, J. B.

Technical Report 32-150, November 1, 1961
(Unclassified)
(Presented at the ARS Space Flight Report to the Nation, New York, N. Y., October 9-15, 1961. Published in *ARS Journal*, Vol. 32, No. 3, pp. 320-346, March 1962)

Special problems relating to the behavior of materials in outer space arise from both the absence and the presence of surrounding matter, i.e., from vacuum and from particles in space. An attempt has been made to synthesize the best of current information on the nature of these particles and the effect that they have on materials. The materials considered are those likely to be used in space vehicles, spacecraft and space experiments: metals, ceramics, semiconductors, plastics, elastomers, paints, greases, and oils. The region of space considered extends from the minimum altitude for an Earth satellite to the orbits of Venus and Mars and close to the plane of the ecliptic.

J02 EVAPORATION EFFECTS ON MATERIALS IN SPACE

Jaffe, L. D., Rittenhouse, J. B.

Technical Report 32-161, October 30, 1961
(Unclassified)

Sublimation of inorganic materials in the vacuum of space can be predicted accurately from knowledge of their vapor pressures and, for compounds, of their free energies. Among the elements, cadmium, zinc, and selenium are readily lost near room temperature and magnesium at elevated temperatures. Selective loss at individual grains and at grain boundaries can produce some surface roughening. Evaporation rates of low-molecular-weight single-component oils can also be calculated from vapor pressures; most are rather high. Polymers lose weight in vacuum by decomposition; nylon, acrylics, polysulfides, and neoprene show high decomposition rates near room temperature. Many other polymers, including polyethylene and isoprene, are stable to high temperatures in vacuum. Engineering properties are, in general, little affected in vacuum unless appreciable loss of mass occurs.

J03 EFFECTS OF SPACE ENVIRONMENT UPON PLASTICS AND ELASTOMERS

Jaffe, L. D.

Technical Report 32-176, November 16, 1961
(Unclassified)

Exposed polymer surfaces will experience rapid deterioration in the Earth's radiation belts. Tetrafluoroethylene, nylon, acrylics, polysulfides, butyl rubber, and the like will have flexibility, strength, and electrical characteristics detrimentally affected in the radiation belts even through heavy shielding. On the other hand, such polymers as styrene, epoxies, filled resins (glass or asbestos-reinforced plastics), natural rubber, polyurethane and butadienestyrene will probably not be affected away from the surface. Electrons from solar flare emissions will probably damage the more sensitive materials to a shallow depth.

Polymers will suffer occasional perforation by meteoroids; inner surfaces of structural laminates may also undergo severe spalling when struck. Near Earth, roughening by meteoric dust will affect exposed optical surfaces of polymeric materials.

J04 FEASIBILITY OF INTERSTELLAR TRAVEL
Spencer, D. F., Jaffe, L. D.
Technical Report 32-233, March 15, 1962
(Unclassified)

For abstract, see Entry S34.

J05 NUCLEAR-ELECTRIC SPACECRAFT FOR UNMANNED PLANETARY AND INTERPLANETARY MISSIONS
Spencer, D. F., Jaffe, L. D., Lucas, J. W., Merrill, O. S., Shafer, J. I.

Technical Report 32-281, April 25, 1962
(Unclassified)

For abstract, see Entry S35.

Jet Propulsion Laboratory

J06 THE *RANGER* PROGRAM
Jet Propulsion Laboratory

Technical Report 32-141 (Unclassified)
(Reprinted from *Astronautics*, Vol. 6, No. 9, September 1961)

This report is comprised of seven papers: "*Ranger* in the Lunar Program," C. I. Cummings; "The *Ranger* Spacecraft," J. D. Burke; "Early *Ranger* Experiments," A. R. Hibbs, M. Eimer, M. Neugebauer; "Preparing *Ranger* for Operations," F. Duerr; "The *Ranger* Booster," H. T. Luskin; "The *Ranger* Lunar Capsule," F. G. Denison; "DSIF in the *Ranger* Project," N. A. Renzetti.

J07 SCIENTIFIC EXPERIMENTS FOR *RANGER 3, 4,* AND *5*
Jet Propulsion Laboratory

Technical Report 32-199, December 5, 1961
(Unclassified)

This report presents descriptions of the scientific experiments to be carried on *Ranger 3, 4* and *5* spacecraft—the first spacecraft designed to land operating instrument packages on the Moon's surface. The instruments for these experiments are a vidicon camera (for close-up pictures of the Moon's surface), a gamma-ray detector (for determination of the approximate concentration of the different radioactive materials present in the surface of the Moon), a radar altimeter (for obtaining radar reflectivity data), and a seismometer (for obtaining data regarding the inner structure of the Moon and the magnitude and depth of any thermal activity).

J08 THE *RANGER* PROJECT: ANNUAL REPORT FOR 1961
Jet Propulsion Laboratory

Technical Report 32-241, June 15, 1962
(Confidential)

The activities undertaken in the *Ranger* project are recorded as a phase of the unmanned lunar exploration program of the Jet Propulsion Laboratory. The reporting period is retroactive to the inception of the project early in 1960, and extends through the 1961 calendar year. Following issues of this report will cover the subsequent calendar years.

Major sections of the report include (1) historical background, (2) preliminary design and planning, (3) project management, (4) design and development, (5) assembly and test operations, and (6) project continuation planning.

The report covers the *Ranger 1* and *2* missions, assembly and test of *RA-3* and others of the lunar capsule series, and early efforts of the TV subsystem group of spacecraft, *Rangers 6, 7, 8* and *9*.

J09 SYSTEM CONSIDERATIONS FOR THE MANNED LUNAR-LANDING PROGRAM
Jet Propulsion Laboratory

Technical Memorandum 33-52, August 3, 1961
(Confidential)

In response to an invitation from NASA, two preliminary design studies of alternate system concepts of the manned lunar-landing and return mission have been prepared: (1) the use of solid-propellant rockets in launching-vehicle systems, and (2) the use of rendezvous on the lunar surface as a method for carrying out the complete mission.

J10 A SOLID-PROPELLANT *NOVA* INJECTION VEHICLE SYSTEM
Jet Propulsion Laboratory

Technical Memorandum 33-52, Addendum A, August 3, 1961 (Confidential)

This addendum contains technical discussions supporting a feasibility study of a large solid-propellant injection vehicle system. A summary of the study containing the guidelines and ground rules which governed the generation of this information is presented in JPL Technical Memorandum 33-52.

J11 SOME INTERRELATIONSHIPS AND LONG-RANGE IMPLICATIONS OF THE C-3 LUNAR RENDEZVOUS AND SOLID *NOVA* VEHICLE CONCEPTS
Jet Propulsion Laboratory

Technical Memorandum 33-52, Addendum B, October 2, 1961 (Confidential)

This addendum examines some interesting interrelationships between the *Saturn* C-3 lunar-rendezvous technique and the all-solid-propellant *Nova* direct approach to the Moon documented in the original Technical Memorandum 33-52 and Addendum A. Of necessity, this addendum contains areas of conjecture and judgment rather than technical facts exclusively.

A skeleton plan is presented for parts of NASA's manned programs using both the direct and indirect approaches and some of the reasons for arriving at this particular plan are explained. Several significant advantages of the plan are mentioned, as well as some disadvantages and interesting implications.

J12 A SUMMARY OF THE ALL-SOLID-PROPELLANT *NOVA* VEHICLE STUDIES AND A COMPARISON WITH THE LIQUID-PROPELLANT *NOVA* VEHICLE
Jet Propulsion Laboratory

Technical Memorandum 33-52, Addendum C, May 9, 1962 (Confidential)

This addendum is intended to summarize in a single document, all information pertinent to the all-solid *Nova* vehicle studies. Earlier related reports (TM 33-52, TM 33-52, Addendum A and TM 33-52, Addendum B) make possible a full understanding of the solid *Nova* concept.

Background information and the status of applicable solid work have been incorporated in an appendix as a convenient reference; in addition, several JPL development programs are discussed in relation to the strong bearing they have on the proposed solid *Nova* program.

J13 SUMMARY OF THE *SURVEYOR* SPACECRAFT SYSTEM
Jet Propulsion Laboratory

Technical Memorandum 33-54, September 1, 1961 (Confidential)

Results are summarized of the Hughes Aircraft Company study conducted on the feasibility, preliminary design, and performance of the *Surveyor* spacecraft.

J14 *TITAN* STUDY REPORT
Jet Propulsion Laboratory

Technical Memorandum 33-79, February 1, 1962 (Secret)

An investigation undertaken to determine the applicability of *Titan*-based boosters to the JPL space programs is discussed.

J15 SYSTEM CAPABILITIES AND DEVELOPMENT SCHEDULE OF THE DEEP SPACE INSTRUMENTATION FACILITY 1963–1967
Jet Propulsion Laboratory

Technical Memorandum 33-83, March 2, 1962 (Unclassified)

The planned capability of the Deep Space Instrumentation Facility for the 1963–1967 period is discussed in terms of station geometry and coverage, system capabilities, and spaceflight operations facility. Development schedules are presented, and the relationship of the DSIF to foreign governments and operating agencies is considered.

Jewett, R. I.

J16 REGULARITY AND POSITIONAL GAMES
Hales, A. W., Jewett, R. I.

Technical Report 32-134, January 31, 1962 (Unclassified)

For abstract, see Entry H01.

Johnston, A. R.

J17 INVESTIGATION OF A PULSE-TORQUED SYSTEM
Johnston, A. R., Szirmay, S.

Technical Report 32-136, April 19, 1961 (Unclassified)

An application of the pulse-torquing principle to acceleration measurement is investigated. The circuitry is

evaluated while functioning in an acceleration-measuring system. The dynamics of the digital force-rebalance loop, which includes the accelerometer pendulum, is investigated. The use of derived-rate feedback is found to provide stable operation over the complete input range, even though the pickoff response time might be several times the pulse repetition period.

Although tested primarily with an accelerometer, the electronics could also be used to pulse-torque a gyro. An analog-digital converter using the pulse-torquing circuitry and exhibiting accuracy similar to that of the accelerometer is demonstrated.

Jones, D. E.

J18 OBJECTIVES OF THE *MARINER* VENUS MICROWAVE RADIOMETER EXPERIMENT
Barrett, A. H., Copeland, J., Jones, D. E., Lilley, A. E.

Technical Report 32-156, August 22, 1961 (Unclassified)

For abstract, see Entry B02.

Kailath, T.

K01 MEASUREMENTS ON TIME-VARIANT COMMUNICATION CHANNELS
Kailath, T.

Technical Report 32-267, May 21, 1962 (Unclassified)

The problems are discussed of making detailed measurements of instantaneous values and the statistical parameters of time-variant filters when observations are permitted at the filter terminals only. It appears that the product of the maximum time and frequency spreadings produced by the time-variant filter sets a limit on the ability to determine the instantaneous values unambiguously, even in the absence of additive noise. This limit can be relaxed when average or statistical parameters of the filter are determined. For the determination of second-order filter statistics, a fourth-movement method is presented which exhibits some novel aspects.

Kamke, D.

K02 TRANSIENT TIMES IN FISSION-ELECTRIC POWER ELEMENTS
Kamke, D.

Technical Report 32-254, May 10, 1962 (Unclassified)

Since fission-electric cells are, in effect, condensers which are charged by means of internal fission fragment currents, they can be expected to show similar time variation of charge and voltage. The time variation and ultimate expected voltage are determined for cylindrical cells as functions of cell size and the parameters of the circuits in which the cells operate.

Kaskel, A.

K03 EXPERIMENTAL STUDY OF THE STABILITY OF A PIPE FLOW II. DEVELOPMENT OF DISTURBANCE GENERATOR
Kaskel, A.

Technical Report 32-138, August 23, 1961 (Unclassified)

The second phase has been completed in an investigation of the stability of pipe flow with respect to disturbances of different frequencies and amplitudes. A disturbance generator capable of producing a symmetrical disturbance has been developed and preliminary measurements, at a nominal $Re = 7600$ in air, indicate that small-amplitude disturbances do decay as they propagate down the pipe. Wavelength measurements of these disturbances have also been made and show good agreement with theoretically predicted values.

Kaus, P. E.

K04 NOTE ON THE ION BEAM NEUTRALIZATION PROBLEM IN THREE DIMENSIONS
Kaus, P. E., Levine, P. H.

Technical Report 32-294, June 7, 1962 (Unclassified)

The thrust of an ion engine is deteriorated by space-charge effects resulting from incomplete neutralization of the ion beam. This incomplete neutralization can occur by virtue of a velocity mismatch between the ions and the electrons used for neutralization, and/or a difference in the spatial distribution of the emitters of both species. The steady-state space-charge distribution around a spherical uncharged conductor is considered. Monoenergetic streams of ions and electrons are normally emitted from the surface of this conductor in a spherically symmetric fashion. Measures are derived to determine the drag/thrust ratio for small velocity mismatch and small deviation from spherical symmetry, as well as the characteristic dimensionless parameters of the problem.

Kendall, J. M., Jr.

K05 EXPERIMENTAL STUDY OF A COMPRESSIBLE VISCOUS VORTEX
Kendall, J. M., Jr.

Technical Report 32-290, June 5, 1962 (Unclassified)

Revolving fluid flows are of particular interest in connection with a number of technical applications. Experiments by others have shown that the tangential velocity distribution of a vortex flow confined within a chamber is much different than that predicted by two-dimensional laminar flow theory. Some of the reasons for this anomaly are studied. The experiments consist of visualization studies, boundary layer velocity measurements, and hot-wire anemometer measurements of flow fluctuations and of the turbulent shearing stress. The experiments reveal a highly three-dimensional behavior of the flow, and indicate that fluid turbulence is strongly dependent on the manner in which angular velocity is imparted to the flow.

Kerrisk, D. J.

K06 POTENTIALITIES OF ELECTRON BOMBARDMENT ION ENGINES FOR ELECTRIC PROPULSION
Kerrisk, D. J.

Technical Report 32-301 (Unclassified) (Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 188-193, June 1962)

The expected performance of electron bombardment ion sources when used for electrostatic propulsion is discussed. Two particular sources, the Duoplasmatron and the Penning Ion source, are examined in some detail and suggestions are made for improving their performance for application to electric thrust devices. It is concluded that electron bombardment sources may offer some advantages over surface contact engines if means can be found to significantly improve their propellant utilization.

Kopal, Z.

K07 THERMAL HISTORY OF THE MOON AND OF THE TERRESTRIAL PLANETS: NUMERICAL RESULTS
Kopal, Z.

Technical Report 32-225, January 9, 1962 (Unclassified)

The quantitative aspects of the thermal and stress history of the Moon, Mercury, and Mars are investigated. Sufficient detail provides an adequate basis for studies of their present structure as well as expected evolution. Equations are derived based on the assumption that planetary matter, radioactively heated from within, transports heat by conduction and responds to a thermal stress as a rigid body. Numerical results of their application to the cases of the Moon, Mercury, and Mars are included as a major part of the report.

Kotlensky, W. V.

K08 STRUCTURAL AND HIGH-TEMPERATURE TENSILE PROPERTIES OF SPECIAL PITCH-COKE GRAPHITES
Martens, H. E., Kotlensky, W. V.

Technical Report 32-181, November 30, 1961 (Unclassified)

For abstract, see Entry M11.

Krasinsky, J. B.

K09 A METHOD FOR DETERMINING RELATIVE HUMIDITY IN STERILIZING GAS MIXTURE CONTAINING ETHYLENE OXIDE, FREON 12, AND AIR
Vango, S. P., Krasinsky, J. B.

Technical Report 32-218, March 1, 1962 (Unclassified)

For abstract, see Entry V01.

Landel, R. F.

L01 VOLUME CHANGES AND POISSON'S RATIO OF POLYURETHANE PROPELLANTS UNDER TENSILE DEFORMATIONS
Stedry, P. J., Landel, R. F., Shelton, H. T.

Technical Report 32-168, September 25, 1961 (Confidential)

For abstract, see Entry S39.

L02 THE TENSILE BEHAVIOR OF COMPOSITE PROPELLANTS
Landel, R. F.

Technical Memorandum 33-62, September 25, 1961 (Unclassified)

The three-dimensional stress-strain-time surface generated in uniaxial tensile testing at constant strain rates is discussed. Implications for constant stress-rate, creep, and stress-relaxation experiments are indicated. The generated failure surface and interrelations to be expected for failure under a given set of test conditions are discussed in qualitative terms.

Landsbaum, E. M.

L03 EXPERIMENTAL STUDIES OF UNSTABLE COMBUSTION IN SOLID-PROPELLANT ROCKET MOTORS

Landsbaum, E. M., Spaid, F. W.

Technical Report 32-146, August 4, 1961
(Unclassified)

Observations of continued studies of combustion instability in tubular, case-bonded, solid-propellant rocket motors using polysulfide-ammonium perchlorate propellants are presented. Although early studies showed a correlation between the delay time from ignition to onset of instability and initial chamber pressure at high initial grain temperature, the lower-temperature data reported here showed an unexplained poor correlation. The trends of instability intensity, for a given motor geometry and grain temperature, are shown to apply to a wider range of grain dimensions and temperatures than that of initial chamber pressure alone. Regions of strong instability, weak instability, and stable operation have been mapped out in the pressure-grain temperature plane for various motor configurations.

The results are presented of several experiments in which hollow chambers were attached at either the head or nozzle end of the propellant grains. Increases in burning rate have been correlated with high-frequency pressure oscillation amplitudes, and the data appear to be in agreement with an erosive-burning mechanism.

L04 SOLID PROPELLANT COMBUSTION INSTABILITY: EXPERIMENTS WITH STAR GRAINS

Landsbaum, E. M., Spaid, F. W.

Technical Report 32-227, July 31, 1961
(Confidential)

Scale and full-size motors have shown different stability behavior. The results of tubular motor firings divided the pressure-frequency plane into regions of stability and instability and suggested a possible explanation for the results.

Lang, T. E.

L05 THE STRUCTURAL DYNAMIC BEHAVIOR OF A TANK-MOUNTED LIQUID-PROPELLANT ROCKET ENGINE

Lang, T. E.

Technical Report 32-194, December 8, 1961
(Unclassified)

Results are presented of a series of tests performed to evaluate the structural dynamic properties of a 6,000-lb-thrust liquid-propellant propulsion system developed by the Jet Propulsion Laboratory. The component parts of the structure tested include the engine chamber and valve body, gimbal, engine support cone, propellant tank, and engine directional control actuators. Information derived from these tests includes natural frequencies, damping coefficients, and mode shapes for vibration of the structure in bending, torsional, and longitudinal modes; axial attenuation curves for excitation of the structure with random time-varying forces; and component flexibilities from associated static tests.

Lass, H.

L06 A STATISTICAL PROBLEM RELATED TO THE LAUNCHING OF A MISSILE

Lass, H., Solloway, C. B.

Technical Report 32-124, July 20, 1961
(Unclassified)

A statistical model of the delays encountered in the countdown of a missile launch is formulated. Both exact and approximate results are derived for the probability distribution of the number of days elapsed until two firings are accomplished. For a specific set of parameter values, the approximate and exact results are compared.

Laub, J. H.

L07 RECIRCULATION OF A TWO-PHASE FLUID BY THERMAL AND CAPILLARY PUMPING

Laub, J. H., McGinness, H. D.

Technical Report 32-196, December 8, 1961
(Unclassified)

A closed-cycle gas-supply system for gas bearings and gas-floated devices is described which eliminates mechanical pumps or compressors and uses, instead, thermal and capillary pumping action. A small quantity of a two-

phase fluid of suitable thermodynamic characteristics, such as Freon, is recirculated in a closed system. The fluid is thermally vaporized in an evaporator, and the superheated vapor, after passing through the gas bearing, is condensed and returned to the evaporator by capillary action. The system is of special interest to space application because it can operate in a zero-*g* environment from solar or nuclear power sources, without conversion to electrical energy.

Laufer, J.

L08 SOUND RADIATION FROM A TURBULENT BOUNDARY LAYER
Laufer, J.

Technical Report 32-119, November 1, 1961 (Unclassified)

If the restriction of incompressibility in the turbulence problem is relaxed, the phenomenon of energy radiation arises in the form of sound from the turbulent zone. In order to calculate this radiated energy, it is shown that, in addition to the conventional quantities, new statistical quantities, such as time-space correlation tensors, have to be known within the turbulent zone. For the particular case of the turbulent boundary layer, indications are that the intensity of radiation becomes significant only in supersonic flows. Under these conditions, the recent work of Phillips is examined, together wih some experimental findings of the author. It is shown that the qualitative features of the radiation field (intensity, directionality), as predicted by the theory, are consistent with the measurements; however, even for the highest Mach number flow, some of the assumptions of the asymptotic theory are not yet satisfied in the experiments. Finally, the question of turbulence damping due to radiation is discussed, with the result that in the Mach number range covered by the experiments, the energy lost from the boundary layer due to radiation is a small percentage of the work done by the wall shearing stresses.

Lee, D. H.

L09 APPLICATIONS FOR MONOPROPELLANTS IN SPACE VEHICLES
Lee, D. H., Breshears, R. R., Harper, A. D., Wrobel, J. R.

Technical Report 32-174, October 5, 1961 (Confidential)

The requirements of current and anticipated unmanned lunar and planetary spacecraft are discussed from the standpoint of the use of propulsion devices in guidance correction maneuvers (post-injection maneuvers, specifically). The unique qualifications of monopropellants for these applications are discussed. As examples, the use of monopropellants in the *Ranger* and *Mariner* spacecraft is described, and possible future applications for monopropellants are outlined.

L10 AN EXPERIMENTAL INVESTIGATION OF THE PERFORMANCE OF THE NITROGEN TETROXIDE–HYDRAZINE SYSTEM IN THE OXIDIZER-RICH AND FUEL-RICH REGIONS
Chilenski, J. J., Lee, D. H.

Technical Report 32-212, March 12, 1962 (Unclassified)

For abstract, see Entry C06.

Levine, P. H.

L11 PLASMA THEORY OF THE MANY-ELECTRON ATOM
Levine, P. H., von Roos, O.

Technical Report 32-135 (Unclassified) (Reprinted from *The Physical Review*, Vol. 125, No. 1, pp. 207, 213, January 1962)

A new approach to the many-electron atom, based on the formal equivalence between the Hartree-Fock equations and a quantum-mechanical generalization of the collisionless Boltzmann (Vlasov) equation, is presented. This equivalence casts the problem into the framework of conventional plasma theory, the Vlasov equation being merely replaced by its quantum-mechanical analog. The quantum Vlasov equation permits a straightforward expansion of the quantum-mechanical phase space distribution function in powers of $\hbar$. The first step of this expansion, corresponding physically to a classical correlationless plasma obeying Fermi statistics, leads to the Thomas-Fermi model. Successive steps generate quantum and exchange corrections. The method is applied to the case of the "statistical" correlationless atom (or ion), generalized for the first time to arbitrary temperature and nonzero total orbital angular momentum, with quantum and exchange effects being included to order $\hbar^2$.

L12 NOTE ON THE ION BEAM NEUTRALIZATION PROBLEM IN THREE DIMENSIONS
Kaus, P. E., Levine, P. H.

Technical Report 32-294, June 7, 1962 (Unclassified)

For abstract, see Entry K04.

Levy, G. S.

L13 THE DETERMINATION OF NOISE TEMPERATURES OF LARGE PARABOLOIDAL ANTENNAS
Schuster, D., Stelzried, C. T., Levy, G. S.

Technical Report 32-97, Revision (Unclassified)
(Reprinted from *IRE Transactions on Antennas and Propagation*, Vol. AP-10, No. 3, pp. 286-292, May 1962)

For abstract, see Entry S11.

L14 VENUSIAN AND LUNAR RADAR DEPOLARIZATION EXPERIMENTS
Levy, G. S., Schuster, D.

Technical Report 32-245 (Unclassified)
(Reprinted from *The Astronomical Journal*, Vol. 67, No. 5, pp. 320-326, June 1962)

From March 10 to May 10, 1961, a series of Venusian and lunar radar measurements were made at the Goldstone Tracking Station of the Deep Space Instrumentation Facility. These experiments were performed as a portion of an interplanetary communications research program. Depolarization phenomena were investigated at an operating frequency of 2388 Mc. A circular polarizer unit for the transmitter and receiver antenna feeds was employed. The normal mode of operation was to transmit righthand secondary circular polarization (RCP) and receive lefthand secondary circular polarization (LCP); the procedure was reversed for comparative results. Mismatched polarization echo signal strengths (RCP to RCP and LCP to LCP) were compared with matched strengths (RCP to LCP and LCP to RCP). The results indicated that Venusian depolarized signal strengths were down 10.7 $\pm$ 2 db to 13.4 $\pm$ 2 db from the matched strengths; the Moon's signal strength was down 11 $\pm$ 2 db.

If the depolarized component of about 12 db was produced by a reflection in which the transmitting and receiving circularly polarized antennas as well as the reflector remain fixed with respect to each other, the axial ratio of the elliptical polarization should be 4.5 db. The axial ratio was measured by installing a linear rotatable feed system in the receiving antenna. The axial ratio of the received signal from Venus was of the order of 1 db, but the signal was extremely noisy. The lunar axial ratio was about 0.5 db.

The over-all results of the depolarization experiments indicated that the Venusian data was similar to that of the Moon (lunar depolarization can be attributed to surface roughness); however, there was insufficient data to support firm conclusions.

Lewis, C. H., Jr.

L15 A DEVICE TO MEASURE THE CHANGE IN WIDTH CONTINUOUSLY DURING UNIAXIAL TESTS
Lewis, C. H., Jr.

Technical Memorandum 33-60, September 22, 1961 (Unclassified)

A brief description is given of a device which measures the change in width of an elastomeric tensile specimen continuously during testing. It can operate at temperatures of -65 to 160°F and with specimen widths of 1.000 to 0.375 in. It is actuated by the moving crosshead of the testing machine and returns to its starting point when the crosshead is returned. Width is measured at the center point of the specimen to an accuracy of ± 0.0005 in.

L16 MOTOR STRAIN TESTING
Lewis, C. H., Jr.

Technical Memorandum 33-61, September 22, 1961 (Unclassified)

A Jet Propulsion Laboratory study on the deflections of the inner surface of an internally pressurized tubular-port propellant grain, case-bonded in a thin-walled chamber is discussed. The effects of the $(b/a)^2$ ratio, pressurization rate, and pressure level under investigation are yet to be determined. The results of tests to date are presented and compared with a theoretical analysis based on small deformation elastic theory. The test apparatus is also described.

Lewis, G. W.

L17 CURRENT STATUS OF FAILURE CRITERIA STUDIES
Lewis, G. W.

Technical Memorandum 33-69, December 4, 1961 (Confidential)

A survey of failure studies associated with propellant and grain integrity in solid-propellant research is reported. Discussion centers around the development of the failure surface, dewetting, and grain slump. The survey concludes with a presentation of studies of defect-induced

failures and the correlation between critical defect size and motor acceptance.

Lilley, A. E.

L18 OBJECTIVES OF THE *MARINER* VENUS MICROWAVE RADIOMETER EXPERIMENT
Barrett, A. H., Copeland, J., Jones, D. E., Lilley, A. E.

Technical Report 32-156, August 22, 1961 (Unclassified)

For abstract, see Entry B02.

Lockyear, W. H.

L19 QUALITY ASSURANCE DIODE EVALUATION
Corcoran, T. F., Flynn, R. W., Lockyear, W. H., Dawe, R. H.

Technical Memorandum 33-71, April 16, 1962 (Unclassified)

For abstract, see Entry C16.

Lorens, C. S.

L20 SECURE COMMUNICATIONS
Lorens, C. S., Titsworth, R. C., Welch, L. R., Viterbi, A. J., Golomb, S. W.

Technical Report 32-65, August 30, 1961 (Secret)

Work in secure communications, conducted at the Jet Propulsion Laboratory over the last few years is summarized. The scope, philosophy, techniques, and mathematical results which have evolved over this period are presented. Three broad areas are treated: codes, systems, and security.

Lucas, J. W.

L21 NUCLEAR-ELECTRIC SPACECRAFT FOR UNMANNED PLANETARY AND INTERPLANETARY MISSIONS
Spencer, D. F., Jaffe, L. D., Lucas, J. W., Merrill, O. S., Shafer, J. I.

Technical Report 32-281, April 25, 1962 (Unclassified)

For abstract, see Entry S39.

MacFarland, R. K., Jr.

M01 A LIMIT ANALYSIS OF THE COLLAPSE OF HEXAGONAL CELL STRUCTURES UNDER AXIAL LOAD
McFarland, R. K., Jr.

Technical Report 32-186, December 1, 1961 (Unclassified)

A method for determining the approximate crushing stress of hexagonal cell structures subjected to axial loading is studied in order to ascertain an approximate analytical relation which can be used to compute the crushing stress of a given hexagonal cell structure. Of additional importance was the determination of the parameters that control the crushing stress to variations in these parameters. Experimental verification which was obtained for the resulting relations indicates that this method of analysis provides very effective upper and lower limits on the mean crushing stress of hexagonal cell structures.

Mack, L. M.

M02 THE LAMINAR BOUNDARY LAYER ON A DISK OF FINITE RADIUS IN A ROTATING FLOW. PART I: NUMERICAL INTEGRATION OF THE MOMENTUM-INTEGRAL EQUATIONS AND APPLICATION OF THE RESULTS TO THE FLOW IN A VORTEX CHAMBER
Mack, L. M.

MacFarland, R. K., Jr.
Technical Report 32-224, May 20, 1962 (Unclassified)

The laminar boundary layer on a stationary disk of finite radius in a rotating flow has been investigated by means of the momentum-integral method. The version of the momentum-integral method used in this study was originally developed by von Karman for the turbulent boundary layer on a rotating disk and applied by Schultz-Grunow and Taylor to problems of the present type for a laminar boundary layer. The tangential velocity distribution of the rotating outer flow was represented by a power law, as suggested by several experiments in vortex chambers, and the radial velocity of the outer flow was taken to be zero. For the boundary-layer velocity profiles, both polynominals and the similarity solution obtained by Stewartson for the flow near the edge of a finite-radius disk were used. The flow quantities computed by numerical integration were the radial mass flow in the boundary layer, the axial outflow velocity, the boundary-layer thickness, the amplitude of the radial velocity, the torque, and the direction of the surface streamline. For all outer

flows in which the circulation decreases with decreasing radius, the inward radial mass flow was found to have a maximum at some radius greater than zero and to be zero at the center of the disk. The solution near the center of the disk for an outer flow in solid-body rotation was also investigated, using Bödewadt's exact solution for the infinite-radius disk. The results for the radial mass flow were applied to the end-wall boundary layers in a vortex chamber, and a significant portion of the total mass flow through a vortex chamber of ordinary dimensions was found to appear as secondary flow in the end-wall boundary layers.

Maclay, J. E.

M03 USE OF CARBON-ARC LAMPS AS SOLAR SIMULATION IN ENVIRONMENTAL TESTING

Maclay, J. E., Goggia, R. J.

Technical Report 32-271, June 4, 1962 (Unclassified)

A description is given of the work performed in 1959 and 1960 on the solar simulator for the 6- × 7-ft space simulator presently located at the Jet Propulsion Laboratory. The space simulator was made by modifying an existent vacuum chamber and using carbon-arc lamps for solar simulation. All *Ranger* vehicles flown to date have been tested in this facility.

A series of appendixes cover various aspects of space-simulation design and use. Some of these appendixes give detailed analyses of space-simulator design criteria; others cover the techniques used in studying carbon-arc lamps and in applying them as solar simulation.

Manatt, S. L.

M04 THE USE OF A PROTON-PROTON SPIN DECOUPLING METHOD FOR THE DETERMINATION OF NUCLEAR MAGNETIC RESONANCE CHEMICAL SHIFTS

Manatt, S. L., Elleman, D. D.

Technical Report 32-163 (Unclassified) (Reprinted from *The Journal of the American Chemical Society*, Vol. 83, No. 19, pp. 4095-4096, October 1961)

The complexities of high-resolution NMR spectra of molecules can, in many cases, be simplified drastically by the use of double resonance spin decoupling techniques. Until recently the application of spin decoupling techniques to proton-proton systems was limited by the complexity of the required instrumentation. A new technique for accomplishing proton-proton spin decoupling with relatively simple instrumentation has been described recently; this is the audio sideband phase detection technique. A new application of this technique is described for the determination of certain proton chemical shifts which, heretofore, could not be unambiguously or accurately measured.

M05 A DOUBLE RESONANCE STUDY OF THE NMR SPECTRUM OF 1-CHLORORBUTADIENE-1, 2 AND THE DETERMINATION OF THE RELATIVE SIGNS OF THE COUPLING CONSTANTS

Manatt, S. L., Elleman, D. D.

Technical Report 32-187 (Unclassified) (Reprinted from *The Journal of the American Chemical Society*, Vol. 84, No. 9, pp. 1579-1582, May 1962)

The 60-Mc proton NMR spectrum of 1-chlorobutadiene-1, 2 has been studied by the audio sideband phase detection proton-proton decoupling method. Selective irradiation of certain of the spectral lines of one set of equivalent nuclei with a $\gamma H_1/2\pi$ of the order of the J's was carried out while simultaneously recording the transitions of the other nuclei. From interpretation of the changes in the decoupled regions of the spectrum, the relative signs of J_{AB} and J_{BX} were determined to be different. Reasons why it is impossible to determine the relative signs between J_{AB} and J_{AX} by this double resonance technique are discussed. An assignment of the absolute signs with J_{BX} and J_{AX} positive and J_{AB} negative has been made on the basis of the present work, the theoretical work of Karplus, and the high-resolution work of Snyder and Roberts.

M06 OPPOSITE RELATIVE SIGNS OF GEMINAL AND VICINAL FLUORINE–FLUORINE NMR COUPLING CONSTANTS IN A SATURATED FLUOROCARBON BY DOUBLE RESONANCE

Manatt, S. L., Elleman, D. D.

Technical Report 32-237 (Unclassified) (Reprinted from *The Journal of the American Chemical Society*, Vol. 84, No. 7, p. 1305, April 1962)

The determination is reported of the relative signs of the geminal and vicinal F^{19}–F^{19} NMR coupling constants in a saturated fluorocarbon by use of the audio sideband phase detection decoupling technique.

M07 FLUORINE-FLUORINE NUCLEAR SPIN-SPIN DECOUPLING
Elleman, D. D., Manatt, S. L.

Technical Report 32-262 (Unclassified)
(Reprinted from *The Journal of Chemical Physics*, Vol. 36, No. 7, pp. 1945-1946, April 1962)

For abstract, see Entry E08.

M08 AN NMR STUDY OF INDENE USING A PROTON-PROTON DECOUPLING TECHNIQUE
Elleman, D. D., Manatt, S. L.

Technical Report 32-265 (Unclassified)
(Reprinted from *The Journal of Chemical Physics*, Vol. 36, No. 9, pp. 2346-2352, May 1962)

For abstract, see Entry E09.

Marshall, R. R.

M09 COSMIC RADIATION AND THE K^{40}–A^{40} "AGES" OF IRON METEORITES
Marshall, R. R.

Technical Report 32-147, August 10, 1961
(Unclassified)

The potassium-argon data of Stoenner and Zähringer are consistent with an age for the iron meteorites of 5.0 ± 0.5 aeons. For iron meteorites with moderate to high concentrations of He^3, the A^{40} which has been produced by nuclear spallation and the A^{40} produced by the decay of primordial K^{40} can be calculated accurately (provided that the radiation age of the meteorite is known) and their sum compared to the measured A^{40}. Cosmogenic neon and argon predominate in inclusions of troilite and schreibersite in large iron meteorites. The enhanced yield of these elements seems to be due to the interaction of cosmic rays with elements below iron in atomic mass, such as chlorine, sulfur, and phosphorus.

The K^{39}/K^{41} ratio of some potassium recovered from the Canyon Diablo iron meteorite differed by less than 2% from the ratio in terrestrial potassium, but was consistent with the low radiation age of 0.145 aeon calculated by Fisher and Schaeffer for this meteorite.

M10 MASS SPECTROMETRIC STUDY OF THE LEAD IN CARBONACEOUS CHONDRITES
Marshall, R. R.

Technical Report 32-216, March 19, 1962
(Unclassified)

Measurements of the isotopic ratios of lead from the Indarch, Murray, Mokoia, and Orgueil carbonaceous chondrites show that their leads differ only slightly from the primordial type of lead which Patterson found in the Canyon Diablo iron meteorite. Formal calculation of the lead–lead ages of Murray and Mokoia yields 4.7 and 4.6 aeons, respectively. Empirical justification for these lead–lead ages comes from the agreement of similarly calculated ages for ordinary chondrites with those obtained by completely independent methods. There seems to be an additional small component of the radiogenic lead isotopes. The amount of this excess is comparable to that which has been observed in the Holbrook chondrite.

Indarch contains an excess of Pb^{207}. Either this meteorite is older (about 5.1 aeons), or some variations in isotopic composition were present at the beginning of the solar system.

Carbonaceous chondrites seem to have originated from chondritic material by the addition of certain elements and the loss of others. They acquired on the order of 1–4 ppm of primordial lead of the Canyon Diablo type.

Martens, H. E.

M11 STRUCTURAL AND HIGH-TEMPERATURE TENSILE PROPERTIES OF SPECIAL PITCH-COKE GRAPHITES
Martens, H. E., Kotlensky, W. V.

Technical Report 32-181, November 30, 1961
(Unclassified)

The room-temperature structural properties and the tensile properties up to 5000°F (2750°C) were determined for ten grades of specially prepared petroleum-coke coal-tar pitch graphites which were graphitized at 5430°F (3000°C). One impregnation with coal-tar pitch increased the bulk density from 1.41 to 1.57 g/cm³ and the maximum strength at 4500°F (2500°C) from 4000 to 5700 psi. None of the processing parameters studied had a marked effect on the closed porosity or the X-ray structure or the percent graphitization. The coarse-particle filler resulted in the lowest coefficient of thermal expansion and the fine-particle filler in the highest coefficient. A marked improvement in uniformity of tensile strength was observed. A standard-deviation analysis gave a one-sigma value of approximately 150 psi for one of these special grades and values of 340 to 420 psi for three commercial grades.

M12 TENSILE PROPERTIES OF FIVE LOW-ALLOY AND STAINLESS STEELS UNDER HIGH-HEATING-RATE AND CONSTANT-TEMPERATURE CONDITIONS
Gerberich, W. W., Martens, H. E., Boundy, R. A.

Technical Report 32-222, November 30, 1961 (Unclassified)

For abstract, see Entry G04.

Martin, B. D.

M13 THE *PIONEER IV* LUNAR PROBE: A MINIMUM-POWER FM/PM SYSTEM DESIGN
Martin, B. D.

Technical Report 32-215, March 15, 1962 (Unclassified)

The *Pioneer IV* lunar probe telemetry system was, of necessity, an efficient minimum-power FM/PM system design. Use of phase-coherent techniques in both the carrier and subcarrier channels produced a system capable of threshold performance at two Moon distances, one-half million miles, with only 180 mw of transmitted power. The design of the *Pioneer IV* telemetry system is described and a summary of the system performance during the mission is given.

The phase-coherent (phase-lock) technique is discussed, with emphasis on its application to the FM/PM system. The use of a carrier-tracking loop as a phase demodulator is examined, and expressions for the usable carrier and subcarrier sideband power are developed. A useful channel design equation is then described, and two typical FM/PM system design calculations are presented to illustrate the application of the previously derived techniques.

M14 JPL CONTRIBUTIONS TO THE 1962 NATIONAL TELEMETERING CONFERENCE
Riddle, F. M., Mathison, R. P., Martin, B. D., Springett, J. C., Bourke, D. G.

Technical Memorandum 33-88, May 21, 1962 (Unclassified)

For abstract, see Entry R05.

Massier, P. F.

M15 EXPERIMENTAL INVESTIGATION OF EXHAUST DIFFUSERS FOR ROCKET ENGINES
Roschke, E. J., Massier, P. F., Gier, H. L.

Technical Report 32-210, March 15, 1962 (Unclassified)

For abstract, see Entry R11.

M16 DEVELOPMENT OF A LIGHT-WEIGHT REGENERATIVELY COOLED THRUST CHAMBER WITH BRAZED RIBS AND BRAZED OUTER WIRE WRAP
Noel, M. B., Massier, P. F.

Technical Report 32-219, May 15, 1962 (Unclassified)

For abstract, see Entry N09.

Mathison, R. P.

M17 CONSTRAINTS IN SPACE TELECOMMUNICATION SYSTEMS
Mathison, R. P.

Technical Report 32-260 (Unclassified) (Reprinted from *Astronautics*, Vol. 7, No. 5, pp. 38-41, 46-50, 52, May 1962)

Engineering constraints affecting design of spacecraft telecommunications are described. Better known constraints include spacecraft power, size and weight limitations, space environmental considerations, operational and ground station requirements and inflexible schedules. Underlying the better-known constraints are the economics affecting design.

M18 JPL CONTRIBUTIONS TO THE 1962 NATIONAL TELEMETERING CONFERENCE
Riddle, F. M., Mathison, R. P., Martin, B. D., Springett, J. C., Bourke, D. G.

Technical Memorandum 33-88, May 21, 1962 (Unclassified)

For abstract, see Entry R05.

Maxworthy, T.

M19 MEASUREMENTS OF DRAG AND WAKE STRUCTURE IN MAGNETO-FLUID DYNAMIC FLOW ABOUT A SPHERE
Maxworthy, T.

Technical Report 32-236 (Unclassified) (Presented at Heat Transfer and Fluid Mechanics Institute, University of Washington, Seattle,

June 13-15, 1962. Reprinted from "Heat Transfer and Fluid Mechanics Institute Proceedings, 1962", Stanford University Press, Calif.,1962)

The drag experienced by metal spheres of several different diameters has been measured by determining their terminal velocities as they fall vertically through an electrically conducting fluid and an axial magnetic field. Induction coils were used to detect the moving, perturbed magnetic field associated with the sphere, allowing accurate determination of the latter's position in space and time and the gross nature of the perturbed field.

For the range of parameters considered (Reynolds numbers from 2000 to 11,000 and Hartmann numbers from 0 to 150) the drag coefficient scales with *Ha/Re* only. It is expected that, as the Reynolds number range is extended, it too will become an important parameter.

Analysis of the induction coil outputs shows that in a certain region of the *Ha/Re–Re* plane, turbulent fluctuations behind the spheres are suppressed. At the same time, a disturbance ahead of the spheres becomes increasingly apparent and has been observed 20 sphere diameters ahead of the body. The nature of the law of growth and decay of disturbances ahead of and behind the body has been determined in one case. The observations tend to confirm much of the recent theoretical work on the existence and structure of such disturbances.

McGinness, H. D.

M20 SOLUTION OF A CIRCULAR RING STRUCTURAL PROBLEM

McGinness, H. D.

Technical Report 32-178, November 1, 1961 (Unclassified)

Formulas for calculating the vertical shear, bending moment, torsion, and deflection at midspan are presented for the case of an endless circular ring of constant cross section which is held by N frictionless supports and symmetrically loaded by N concentrated forces and/or a uniformly distributed load, both of which act normal to the plane of the ring.

M21 RECIRCULATION OF A TWO PHASE FLUID BY THERMAL AND CAPILLARY PUMPING

Laub, J. H., McGinness, H. D.

Technical Report 32-196, December 8, 1961 (Unclassified)

For abstract, see Entry L07.

Meghreblian, R. V.

M22 THERMAL RADIATION IN GASEOUS FISSION REACTORS FOR PROPULSION

Meghreblian, R. V.

Technical Report 32-139, July 24, 1961 (Unclassified)

The influence of thermal radiation, produced by the fuel-propellant mixture in the cavities of a gaseous fission reactor, on the specific impulse, engine specific weight, and solid-fuel loading requirements is examined. An attempt is made to bracket the actual radiative properties of the mixture by considering two limiting cases, an opaque and a transparent gas. In obtaining the total power balance in the engine, an enthalpy-temperature relation is selected which is appropriate for hydrogen propellant. The analysis indicates that in the booster application of gaseous reactors, the choice between an opaque and a transparent gas is not critical to the determination of engine performance. The choice is critical, however, in systems of low thrust and very high specific impulse, and the opaque gas yields lower specific engine weights.

M23 RADIATION EXCHANGE BETWEEN TWO FLAT SURFACES SEPARATED BY AN ABSORBING GAS

Meghreblian, R. V.

Technical Report 32-197, April 6, 1962 (Unclassified)

An approximate analytical solution is obtained for the temperature distribution in an absorbing gas layer bounded by two flat surfaces radiating at different temperatures. The corresponding expression for the net radiation exchange between the two surfaces is derived and numerical solutions are obtained for gas layers up to ten optical thicknesses in depth. Similar results are derived for the special case of a gas layer at uniform temperature, and the net radiation exchange in this system is found to agree well with that in the previous system for gas layers less than two optical thicknesses in depth.

Melbourne, W. G.

M24 INTERPLANETARY TRAJECTORY OPTIMIZATION WITH POWER-LIMITED PROPULSION SYSTEMS

Melbourne, W. G., Richardson, D. E., Sauer, C. G.

Technical Report 32-173, February 26, 1962 (Unclassified)

A trajectory-optimization process is described in which the optimum-thrust equations are derived using the cal-

culus of variations. The magnitude of the thrust is constrained within an upper and a lower bound, but the thrust direction is arbitrary. This formulation allows both the constant- and the variable-thrust programs to be considered. For the constant-thrust program, certain propulsion-system parameters are optimized for maximum final vehicle mass. This theory has been used to study interplanetary missions to Venus and Mars using a power-limited propulsion system. Both one-way and round-trip rendezvous trajectories are considered. The analysis employs a two-body inverse-square force-field model of three dimensions. An iterative routine used to solve the two-point boundary-value problem is described.

M25 OPTIMUM INTERPLANETARY RENDEZVOUS TRAJECTORIES WITH POWER-LIMITED VEHICLES
Melbourne, W. G., Sauer, C. G., Jr.

Technical Report 32-226, March 5, 1962
(Unclassified)

The optimum-thrust equations for both variable and constant thrust are presented. These thrust programs are used to generate rendezvous trajectories from Earth to Mars for various flight times and launch dates during the years 1968–1971. The manner in which the propulsion requirements vary with flight time and launch date are considered, and a comparison of vehicle performance using the variable- and constant-thrust programs is presented. The optimization of the propulsion system parameters is discussed, and the existence of optimum launch dates is interpreted in terms of certain transversality conditions derivable from the calculus of variations. A brief comparison of the advanced propulsion vehicle and the ballistic vehicle propulsion requirements is made for Earth–Mars rendezvous trajectories. An appendix considering the analytical basis for this work is included.

M26 PAYLOAD OPTIMIZATION FOR POWER-LIMITED VEHICLES
Melbourne, W. G., Sauer, C. G., Jr.

Technical Report 32-250, April 9, 1962
(Unclassified)

An analysis is presented for maximizing the payload of a power-limited vehicle by optimizing the control variable of the propulsion system and the values of the propulsion system parameters. A constant-thrust program with coast capability is used. An exhaust velocity-dependent efficiency function for transmitting power from the vehicle powerplant to the exhaust beam is included in the optimization process. An approximate method of maximizing payload with respect to the propulsion system parameters is shown to yield very accurate results. These analyses have been applied to a series of theoretical Earth-Mars rendezvous missions.

Merrill, O. S.

M27 NUCLEAR-ELECTRIC SPACECRAFT FOR UNMANNED PLANETARY AND INTERPLANETARY MISSIONS
Spencer, D. F., Jaffe, L. D., Lucas, J. W., Merrill, O. S., Shafer, J. I.

Technical Report 32-281, April 25, 1962
(Unclassified)

For abstract, see Entry S35.

Milder, D. M.

M28 A STATISTICAL-MECHANICAL ESTIMATE OF ORBITAL COLLISION PROBABILITIES
Milder, D. M.

Technical Report 32-211, March 26, 1962
(Unclassified)

This report demonstrates how the ergodic theorem of statistical mechanics can be used to estimate the probability of certain celestial mechanical events, such as the lunar impact of a Moon-orbiter or the escape of a satellite from its parent. The restricted three-body configuration is used as a model to calculate the mean orbit lifetimes-between-collisions of a lunar satellite in bound orbits of various energies.

Mohl, C. F.

M29 *JUNO* FINAL REPORT. VOLUME III. *JUNO II*: EARTH SATELLITES
Mohl, C. F.

Technical Report 32-31, June 28, 1962
(Confidential)

This report is the last of a three-volume series covering the *Juno* program and the Jet Propulsion Laboratory's participation in early spacecraft activities. This volume covers the *Juno II* Earth satellite launchings that followed the *Juno II* space probes. This series of launchings involved eight very similar *Juno II* vehicles and six different types of payloads and covered the period from March 1959 to May 1961.

Morecroft, J.

M30 TELEMETRY SUPPORT EQUIPMENT (TSE) OPERATION AND MAINTENANCE MANUAL
Morecroft, J.

Technical Memorandum 33-66, October 16, 1961 (Unclassified)

The TSE (telemetry support equipment) operates as a data-processing device, or link, between the *Ranger 1* and *Ranger 2* telemetry receiving equipment and normal teletype facilities of the DSIF tracking stations. It operates on that scientific experiment data transmitted over telemetry channels 7.7, B10, B11, B12, and B13. This manual describes the operation and maintenance of the equipment.

Muhleman, D. O.

M31 THE ASTRONOMICAL UNIT DETERMINED BY RADAR REFLECTIONS FROM VENUS
Muhleman, D. O., Holdridge, D. B., Block, N.

Technical Report 32-221, March 8, 1962 (Unclassified)

Radar reflections from the surface of the planet Venus at a wavelength of 12.5 cm yielded a value of the Astronomical Unit of 149,598,845 $\pm$ 250 (p.e.) km, or a solar parallax of 8".7940976 $\pm$ 147 based on an Earth radius of 6,378,145 m. The computations were accomplished utilizing doppler-frequency-shift and time-of-flight observations (range measurements) in conjunction with the "best" available planetary ephemerides of the Earth and Venus. The investigations yielded proof of the transparency of the Venus atmosphere at 12.5 cm and some information on the radius of Venus. Systematic errors in the published ephemerides are also discussed.

Nagler, R. G.

N01 THE POSSIBILITY OF STRAIN DEPENDENCE IN THE THERMAL DEGRADATION PROCESSES OF VINYL POLYMERS
Nagler, R. G.

Technical Report 32-202, January 2, 1962 (Unclassified)

The plausibility of using induced steric strain energy as a control factor in the thermal degradation of vinyl polymers is viewed qualitatively. Polyethylene, the simplest vinyl polymer, is used as the primary example.

Nerheim, N. M.

N02 AN EXPERIMENTAL CORRELATION OF THE NONREACTIVE PROPERTIES OF INJECTION SCHEMES AND COMBUSTION EFFECTS IN A LIQUID-PROPELLANT ROCKET ENGINE (IN EIGHT PARTS).
PART VIII: ON THE EXPERIMENTAL PERFORMANCE OF THE PENTABORANE-HYDRAZINE PROPELLANT COMBINATION
Nerheim, N. M.

Technical Report 32-255, April 30, 1962 (Confidential)

An uncooled motor with unlike-impinging-streams injection at a thrust level of 20,000 lb was tested for short durations to evaluate the performance of the pentaborane-hydrazine propellant combination. The injection scheme was designed to produce near-uniform mass and mixture-ratio distribution at the mixture ratio used. In addition to the performance evaluation, which included the effect of continuous injection of small amounts of N_2O_4, the experiment determined combustion-product composition, solid-products size distribution, and the amount of heat transfer to the chamber.

Neugebauer, M.

N03 THE SPACE ENVIRONMENT, ADDENDUM NO. 1
Neugebauer, M.

Technical Release 34-229, Addendum 1, July 28, 1962 (Unclassified)

This addendum lists publications of, and briefly summarizes, any major advances made in our state of knowledge about the interplanetary environment during the eighteen months since the publication of JPL Technical Release 34-299, "The Space Environment".

N04 THE DETECTION OF THE PLASMA COMPONENT OF MAGNETOHYDRODYNAMIC WAVES IN SPACE
Neugebauer, M.

Technical Memorandum 33-93, June 12, 1962 (Unclassified)

The fundamental structure of low-frequency magnetohydrodynamic waves in interplanetary space is analyzed

with respect to variations of the magnetic field, the plasma velocity, and the plasma density. The analyses have been conducted in order to (1) determine the time profile of such waves as seen by the types of plasma detectors presently used or planned for use in the direct measurement of the properties of the interplanetary plasma, and (2) aid in the design of second-generation detectors specifically suited to the analysis of magneto-hydrodynamic waves in space. It is concluded that plasma detectors with flat resolution functions allow a reasonably faithful reproduction of the waveform of the plasma motion, but that this type of instrument suffers from blind spots for the detection of some transverse hydromagnetic waves. On the other hand, the type of instrument with a peaked resolution function is not troubled by blind spots, but creates a large amount of distortion of the plasma waveform. It is possible, however, to determine fluid velocity and density of the plasma by simultaneously monitoring each member of a group of at least four plasma detectors of conventional design.

Newton, J. F., Jr.

N05 EXPERIMENTS ON THE INTERACTION OF SECONDARY INJECTANTS AND ROCKET EXHAUST FOR THRUST VECTOR CONTROL

Newton, J. F., Jr., Spaid, F. W.

Technical Report 32-203, February 12, 1962
(Unclassified)

The specific area of interest for this program was the relatively low motor-chamber pressures and the high nozzle-expansion ratios associated with space-mission propulsion systems.

The tests were conducted with 1300- to 1500-lb-thrust solid-rocket motors. The nozzles were 15-deg conicals with a nominal expansion ratio of 25:1. All firings were conducted in zero-flow ejectors. Freon-12, water, and gaseous nitrogen were used as injectants. Nozzle-wall pressure profiles, side thrust, and the nozzle-wall shock interface were recorded.

The general character of the pressure disturbance was defined. The major portion of the side force was generated by the pressure disturbance downstream of the injector. The axial-thrust augmentation generated by the injectant was calculated. The effects of nozzle-expansion ratio and injector location on the side force were clearly illustrated.

Nicklas, J. C.

N06 DERIVED-RATE INCREMENT STABILIZATION: ITS APPLICATION TO THE ATTITUDE-CONTROL PROBLEM

Nicklas, J. C., Vivian, H. C.

Technical Report 32-69, July 31, 1961
(Unclassified)

An analysis is presented of a gyro-free nonlinear attitude-control system for a spacecraft. On-off jet actuators are used in the system, and hysteresis and a dead zone are intentionally included. Under certain conditions the feedback signal in the control system is proportional to an angular velocity increment of the system; this is termed the derived-rate increment feedback signal. The analysis for a single axis of the attitude-control system is given in two parts: the first is concerned with the performance of the system in a limit cycle; the second discusses the convergence to a limit cycle after a disturbance has occurred. Experimental results, showing performance of the system during convergence to and operation in a limit cycle, verify the results of the analysis. Although the technique is described for use in an attitude-control system, it can be successfully employed in other applications.

N07 ANALYSIS, DESIGN, AND TESTING OF A POSITION SERVO UTILIZING A STEPPER MOTOR

Nicklas, J. C.

Technical Report 32-206, January 25, 1962
(Unclassified)

The development of a position control system using a stepper or incremental motor is described. The advantages of this type of prime mover are discussed, and a technique of integrating the stepper motor into the system is analyzed. The output signal from the error detector used in the system comes from a sampler and zero-order hold circuit. This signal controls a gate which either allows or inhibits a pulse train to drive the stepper motor. The load on the motor is an under-damped second-order system. The stepper motor output position and the reference input determine the error. The analysis includes a stability investigation using the describing-function method and a computer simulation to determine the dynamic performance of the system. The effect of noise in the system is also the subject of a computer investigation. The equipment used to mechanize the control system is described, and the design considerations of the testing apparatus are discussed in detail. Results are presented of experimental work to determine the actual performance of the system.

Noel, M. B.

N08 EXPERIMENTAL INVESTIGATION OF THE FORCED-CONVECTION AND NUCLEATE-BOILING HEAT-TRANSFER CHARACTERISTICS OF LIQUID AMMONIA

Noel, M. B.

Technical Report 32-125, July 19, 1961
(Unclassified)

To achieve a safe and effective design for liquid-propellant rocket engines that are to be regeneratively cooled, knowledge of the heat-transfer characteristics of the propellant that is to be used as the coolant is essential. For many propellants, such as ammonia, the upper limit of nucleate boiling must be considered as the practical limit of the cooling capability of a propellant for rocket-engine application. The film-boiling region, which requires excessive surface temperatures to accommodate the characteristically low heat-transfer coefficients, lies at higher heat fluxes. The heat-transfer characteristics of commercial-grade anhydrous ammonia have been obtained experimentally by utilizing electrically heated tubes. A total of fifty-five tests were performed, including measurements in the forced-convection nonboiling and forced-convection nucleate-boiling regions. The upper limit of nucleate boiling q_{ul} has been determined for ranges of velocity, pressure, and liquid bulk temperature that include velocities between 0 and 156 ft/sec, pressures between 150 and 1820 psia, and liquid bulk temperatures between 23 and 158°F. The values of q_{ul} varied from 2 to 14 Btu/in.^{2} sec, depending upon the particular flow condition. An interpolation equation is presented that may be used to predict q_{ul} within the ranges of pressure, velocity, and liquid bulk temperature tested.

N09 DEVELOPMENT OF A LIGHT-WEIGHT REGENERATIVELY COOLED THRUST CHAMBER WITH BRAZED RIBS AND BRAZED OUTER WIRE WRAP

Noel, M. B., Massier, P. F.

Technical Report 32-219, May 15, 1962
(Unclassified)

Design and fabrication procedures are discussed of a brazed-rib-type thrust chamber fabricated from stainless steel or inconel for a 6000-lb thrust 20:1 expansion-area-ratio regeneratively cooled liquid-propellant rocket engine, designated as the JPL 6K Engine, which operates at a chamber pressure of 150 psia. Hydrazine is used as the fuel and regenerative coolant and nitrogen tetroxide as the oxidizer. The nozzle-throat diameter is 5.42 in. The thrust chamber consists of a sheet-metal gas-side liner with longitudinal ribs spot-welded and brazed to the outer surface. Wire is wrapped over the ribs circumferentially, spot-welded to the ribs, and brazed. The liner, ribs, and wire form the coolant-passage walls.

The three basic advantages of this type and size of thrust chamber are light weight, ease of fabrication, and comparatively low cost. The total dry weight of such a thrust chamber made of 347 stainless steel is 46.2 lb, and the net weight 56.3 lb.

A total of 87 static engine tests was made on 19 of 23 thrust chambers fabricated by this technique. Four of the chambers tested had an expansion-area ratio of 20:1; 15, which were shorter but had the same throat diameter, had an expansion-area ratio of 3.5:1. Accumulated test time was 1926 sec, including 558 sec regenerative cooling with hydrazine and 1368 sec cooling with water. One 20:1 thrust chamber was subjected to 16 separate engine tests, with an accumulated test time of 399 sec, and was still in very good operating condition after the tests were completed.

With water flowing through the coolant passages at 10 lb/sec, the measured nominal pressure drop between coolant manifolds of a 20:1 thrust chamber wrapped with flat wire was 17.2 psi.

Norman, R. M.

N10 TEST REPORT ON SLEEVE BEARINGS MADE OF DU MATERIAL

Norman, R. M.

Technical Memorandum 33-87, June 18, 1962
(Unclassified)

DU bearings were subjected to series of tests in which only the load was varied while the vacuum, shaft size and finish, and speed were held constant. It was found that load capability is markedly greater in normal atmosphere than in vacuum. It is thought that the mechanism of failure of heavily loaded DU bearings in vacuum is a combination of extreme local heating and bearing-bronze galling on the shaft. For a hardened ⅜-in.-D stainless steel shaft with 2.5 to 4.5-rms μ-in. finish, rotating continuously at 100 rpm in vacuum, the maximum desirable load is 700 psi, although 250 to 350 psi may be desirable for design objective.

Ostermier, B. J.

O01 COMMUNICATION WITH LUNAR PROBES
Renzetti, N. A., Ostermier, B. J.

Technical Report 32-148, August 23, 1961
(Unclassified)

For abstract, see Entry R03.

Pfeiffer, C. G.

P01 SIMPLE GUIDANCE FOR DEEP-SPACE BOOSTER VEHICLES
Pfeiffer, C.

Technical Report 32-128, November 1961
(Unclassified)
(Reprinted from *Astronautics*, Vol. 6, No. 11, pp. 30–31, 42, 44, November 1961)

A relatively simple injection-guidance system is described which is used in conjunction with post-injection midcourse correction adequate for lunar and interplanetary missions.

P02 THEORY AND APPLICATION OF THE CRITICAL DIRECTION METHOD OF TRAJECTORY OPTIMIZATION
Pfeiffer, C. G.

Technical Report 32-155, September 15, 1961
(Unclassified)

The theory and application are described of an optimization study that was conducted at the Jet Propulsion Laboratory during the early investigations of vehicle steering programs for lunar and interplanetary ascent trajectories with parking orbits. The study was performed to determine the form of the optimum steering program for the second stage of a booster vehicle designed to inject a payload into a nearly circular orbit, and to evaluate the efficacy of the "critical direction" technique for performing such trajectory optimization problems. It was concluded that the critical direction method is a very workable approach, but that sophisticated optimization procedures are really not warranted for this class of problems. Since future applications of the method might be of interest, the theoretical aspects of the study are emphasized.

Plamondon, J. A.

P03 THERMAL EFFICIENCY OF COATED FINS
Plamondon, J. A.

Technical Release 34-227, November 1961
(Unclassified)
(Reprinted from Paper 61-WA-168, presented at the Winter Annual Meeting of the Heat Transfer Division of the American Society of Mechanical Engineers, New York, N.Y., 1961)

The surfaces of a fin from which heat is rejected solely by radiation may have to be coated to obtain high values of thermal emissivity. An analysis was undertaken to determine the influence of the conductive resistance of a coating on the thermal performance of a fin. Two equations are derived to describe the heat-transfer characteristics of a coated fin: (1) a differential equation for the temperature profile on the radiating surfaces of the coating; and (2) an equation for the relative thermal performance of the fin in terms of fin efficiency. The equations are solved numerically, and the fin efficiencies are plotted as a function of two dimensionless parameters which appear in the differential equation. These efficiencies are compared with those for fins in which the conductive resistance of the coating is ignored.

P04 NUMERICAL DETERMINATION OF RADIATION CONFIGURATION FACTORS FOR SOME COMMON GEOMETRICAL SITUATIONS
Plamondon, J. A.

Technical Report 32-127, July 7, 1961
(Unclassified)

A derivation of the general integral for the determination of thermal-radiation configuration factors is presented, as well as a scheme for its solution using JPL's IBM 7090 computer. An analytical method is outlined for determining the rather complex analytical expression for the integrand and limits of integration between a particular pair of geometrical shapes. Two examples of the method's employment are presented. Finally a table of integrals for configuration factors between pairs of commonly encountered geometrical shapes is given. These integrals, with two exceptions, are completely general in regard to the relative orientation and size of the geometries.

Porter, R. N.

P05 ALPS: ADVANCED LIQUID PROPULSION SYSTEMS
Porter, R. N.

Technical Memorandum 33-58, October 2, 1961
(Unclassified)

The ALPS program was established to solve critical spacecraft propulsion problems created by the complexity of the missions planned for the near future (1965–1970). The basic ALPS system is a simple but extremely versatile bipropellant rocket. This system would be able to perform midcourse correction maneuvers, a final retro maneuver (into orbit or soft landing with hovering), and return launch. In addition, the basic system would be able to supply pressurized cold gas, hot gas, monopropellant, or a bipropellant combination for use in attitude control or propulsion system separation.

Potter, P. D.

P06 THE APERTURE EFFICIENCY OF LARGE PARABOLOIDAL ANTENNAS AS A FUNCTION OF THEIR FEED-SYSTEM RADIATION CHARACTERISTICS
Potter, P. D.

Technical Report 32-149, September 25, 1961 (Unclassified)

A simple graphical technique has been developed for the determination of paraboloidal antenna efficiency as a function of the feed-system radiation characteristics. The technique, based on graphical integration of the paraboloid surface current density, is applied in detail to the Cassegrainian feed system—a system which is used with low-noise antennas to maximize the ratio of antenna efficiency to system noise temperature. An analysis of errors involved in the calculation of antenna efficiency is discussed which includes polarization loss, aperature phase errors, azimuthal sampling errors, and aperture blockage.

P07 A SIMPLE BEAMSHAPING DEVICE FOR CASSEGRAINIAN ANTENNAS
Potter, P. D.

Technical Report 32-214, January 31, 1962 (Unclassified)

A simple beamshaping modification for Cassegrainian systems is described using a qualitative analysis. Such an analysis is also employed to explain the poor performance observed with an unmodified Cassegrainian system. Experimental data are presented on both the modified and unmodified systems. The modification reduces spillover by a factor of 2 to a value of only 1.3%. Simultaneously, the aperture efficiency is increased from 50% for the unmodified system to 60% for the modified system. Field measurements on an 85-ft modified Cassegrainian system are described which experimentally verify the applicability of the modified subreflector to low-noise antenna design. The measured zenith antenna temperature for this system is 9.5°K; measured aperture efficiency is 50%.

P08 THE APPLICATION OF THE CASSEGRAINIAN PRINCIPLE TO GROUND ANTENNAS FOR SPACE COMMUNICATIONS
Potter, P.

Technical Report 32-295 (Unclassified) (Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 154-158, June 1962)

In the last few years considerable interest has arisen in application of the Cassegrainian principle to paraboloidal antenna systems. In the case of large ground-based tracking antennas, it appears that this type of feed system can offer significant performance and operational advantages over conventional systems. However, for this application, special sidelobe requirements are imposed on the Cassegrainian system. The forward sidelobe distribution must be controlled to reduce the effect of solar noise interference, and the backlobe level must be controlled to reject blackbody radiation from the antenna environment. It is shown that these considerations are the major factor in choosing the feed system configuration. An experimental system utilizing an 85-ft antenna operating at 960 Mc is described. This system has an aperture efficiency of approximately 50% and a measured zenith noise temperature of 9.5°K.

Pounder, E.

P09 MAN-TO-THE-MOON AND RETURN MISSION UTILIZING LUNAR-SURFACE RENDEZVOUS
Buwalda, P., Downhower, W. J., Eckman, P. K., Pounder, E., Rieder, R. A., Sola, F. L.

Technical Memorandum 33-53, August 3, 1961 (Confidential)

For abstract, see Entry B18.

P10 *MARINER B* CAPSULE PROPULSION STUDY
Sehgal, R., Breshears, R., Acord J., Thompson, R., Pounder, E., Comuntzis, M.

Technical Memorandum 33-86, June 1, 1962 (Unclassified)

For abstract, see Entry S20.

Rechtin, E.

R01 LARGE GROUND ANTENNAS
Rechtin, E., Rule, B., Stevens, R.

Technical Report 32-213, March 20, 1962 (Unclassified)

This report consists of three talks given at the 1961 Annual Winter Meeting of the American Society of Mechanical Engineers. The first talk presents the 1961 capabilities and the needs anticipated by 1970. The critical parameters are listed and the difficulty of meeting the critical specifications treated. The second talk describes the Deep Space Instrumentation Facility advanced antenna system. The influence of the space program missions on the advanced antenna system and the critical technical and operational requirements of the system are discussed. The third talk consists of a discussion of the major design problems of current large radio antenna—their general requirements, sensitivity, frequency, and resolution. Types and combinations of antennas, axes, and antenna mounting designs are compared. Major problems of large radio antennas are summarized.

Rennilson, J. J.

R02 *SURVEYOR* ELEVATED TELEVISION EXPERIMENT
Rennilson, J. J.

Technical Memorandum 33-56, September 11, 1961 (Unclassified)

The television experiment of the *Surveyor* program is considered to be a very important part of the over-all scientific mission for lunar exploration. The instrumentation, as presently envisioned, consists of four fixed cameras, three of which are located around the spacecraft at intervals of approximately 120 deg. The fourth camera is positioned in a downward manner and is used mainly for approach pictures. An added optical system in conjunction with one of the three upper cameras forms high-resolution pictures of a 120-deg sector in the vicinity of the spacecraft. Since the position of the TV cameras restricts observation primarily to a small area of the lunar surface, the investigation of the feasibility of extending the TV system to greater heights (i.e., greater area) was initiated.

An engineering study of the feasibility of an elevated television system was done for the Jet Propulsion Laboratory by Hughes Aircraft Co. A summary of this study is included. A resultant configuration provides for two television cameras mounted one meter apart on a bar raised above the lunar surface by an extensible boom. The bar is rotatable in azimuth and elevation for accomplishing the scanning. One camera contains a zoom lens of the same type as in the first configuration (variable from 25- to 100-mm focal length) and the second contains a different zoom-type lens with a range of 100 to 400 mm.

Renzetti, N. A.

R03 COMMUNICATIONS WITH LUNAR PROBES
Renzetti, N. A., Ostermier, B. J.

Technical Report 32-148, August 23, 1961 (Unclassified)

The tracking and communication capabilities of the Deep Space Instrumentation Facility (DSIF)—a precision system capable of command, telemetering, and positional tracking of space probes for scientific investigations at lunar distances and beyond—are briefly described. The DSIF, controlled by the NASA-sponsored Jet Propulsion Laboratory of the California Institute of Technology, consists of a mobile station and three deep-space stations in California, Australia, and South Africa. The purpose of the *Ranger* project, the spacecraft, the communications equipment aboard the spacecraft, and the participation of the DSIF in this project are discussed.

Richardson, D. E.

R04 INTERPLANETARY TRAJECTORY OPTIMIZATION WITH POWER-LIMITED PROPULSION SYSTEMS
Melbourne, W. G., Richardson, D. E., Sauer, C. G.

Technical Report 32-173, February 26, 1962 (Unclassified)

For abstract, see Entry M24.

Riddle, F. M.

R05 JPL CONTRIBUTIONS TO THE 1962 NATIONAL TELEMETERING CONFERENCE
Riddle, F. M., Mathison, R. P., Martin, B. D., Springett, J. C., Bourke, D. G.

Technical Memorandum 33-88, May 21, 1962 (Unclassified)

The following topics are discussed: (1) communication with deep space vehicles, (2) tracking techniques for interplanetary spacecraft, (3) the *Mariner* planetary communication system design, (4) command techniques for the remote control of interplanetary spacecraft,

and (5) deep space exploration and the probability of success.

Rieder, R. A.

R06 MAN-TO-THE-MOON AND RETURN MISSION UTILIZING LUNAR-SURFACE RENDEZVOUS
Buwalda, J., Downhower, W. J., Eckman, P. K., Pounder, E., Rieder, R. A., Sola, F. L.

Technical Memorandum 33-53, August 3, 1961 (Confidential)

For abstract, see Entry B18.

Rittenhouse, J. B.

R07 BEHAVIOR OF MATERIALS IN SPACE ENVIRONMENTS
Jaffe, L. D., Rittenhouse, J. B.

Technical Report 32-150, November 1, 1961 (Unclassified)

For abstract, see Entry J01.

R08 EVAPORATION EFFECTS ON MATERIALS IN SPACE
Jaffe, L. D., Rittenhouse, J. B.

Technical Report 32-161, October 30, 1961 (Unclassified)

For abstract, see Entry J02.

R09 DYNAMIC PENETRATION STUDIES IN CRUSHED ROCK UNDER ATMOSPHERIC AND VACUUM CONDITIONS
Roddy, D. J., Rittenhouse, J. B., Scott, R. F.

Technical Report 32-242, April 6, 1962 (Unclassified)

For abstract, see Entry R10.

Roddy, D. J.

R10 DYNAMIC PENETRATION STUDIES IN CRUSHED ROCK UNDER ATMOSPHERIC AND VACUUM CONDITIONS
Roddy, D. J., Rittenhouse, J. B., Scott, R. F.

Technical Report 32-242, April 6, 1962 (Unclassified)

A device was constructed to study dynamic penetration in crushed rock in high-vacuum (10^{-5} mm Hg) conditions. The apparatus was designed to drop cylindrical metal rods, pointed on one end, into cohesionless crushed rock material. Dynamic penetration was studied as a function of several particle sizes and mixtures of these particle sizes. Other factors considered were the density of packing, probe dimensions, vacuum pressure, and vacuum degassing rates.

Experimental results show that the density of packing of the crushed rock particles is the dominant factor affecting the dynamic penetration. The maximum penetration occurs in air in the crushed rock with low density packing. The minimum penetration occurs in air in densely packed material.

Dynamic penetration in vacuum for the low-density and high-density packing lies between the results of penetration in air for the same packing conditions. At vacuum pressures above approximately 0.1-mm Hg, all penetration values approach the air penetration measurements.

Roschke, E. J.

R11 EXPERIMENTAL INVESTIGATION OF EXHAUST DIFFUSERS FOR ROCKET ENGINES
Roschke, E. J., Massier, P. F., Gier, H. L.

Technical Report 32-210, March 15, 1962 (Unclassified)

Due to the combination of design chamber pressure and nozzle-expansion-area ratio inducing flow separation in the expansion portion of the nozzle, rocket engines sometimes cannot be successfully tested at ground level. The supersonic exhaust diffuser is one type of device with which ambient pressure can be reduced to such a degree that flow separation will not occur during ground-level test firings.

Rupe, J. H.

R12 ON THE DYNAMIC CHARACTERISTICS OF FREE-LIQUID JETS AND A PARTIAL CORRELATION WITH ORIFICE GEOMETRY
Rupe, J. H.

Technical Report 32-207, January 15, 1962 (Unclassified)

A technique for evaluating the dynamic characteristics of free-liquid jets on a comparative basis is presented. This

method consists of determining the pressure distribution produced by the perpendicular impingement of a jet upon a flat plate. These data are, in turn, used to compare and categorize jets with unkonwn properties in terms of similar data produced by jets having known characteristics—i.e., with jets produced by fully developed turbulent flow, fully developed laminar flow, and a jet having a near-uniform velocity profile.

The visual characteristics, as well as both the mean and the fluctuating pressure distributions, are presented for these three reference configurations and for a number of jets produced by orifices having varying length–diameter ratios, combined with varying degrees of surface roughness in the initial five diameters of straight bore.

Rusch, W. V. T.

R13 RADIATION FROM A PARABOLOID WITH AXIAL-DIPOLE FEED

Rusch, W. V. T.

Technical Report 32-170, October 31, 1961
(Unclassified)

The current-distribution integral of vector diffraction theory is used to compute the radiation field of a paraboloidal reflector with axial-dipole feed. This radiating system, possessing perfect axial symmetry, is well suited to an investigation of the usefulness of the theory in predicting wide-angle and backlobe behavior of antennas. However, an axial null is produced in the radiation pattern which limits the practical application of the configuration. Theoretical gain patterns are presented for the JPL Goldstone facility 85-ft antennas, revealing the high-gain region, the wide-angle spillover region, and the diffraction region behind the reflector.

Sabersky, R. H.

S01 HEAT AND MOMENTUM TRANSFER IN SMOOTH AND ROUGH TUBES AT VARIOUS PRANDTL NUMBERS

Dipprey, D. F., Sabersky, R. H.

Technical Report 32-269, June 6, 1962
(Unclassified)

For abstract, see Entry D04.

San Miguel, A.

S02 STRAIN MEASUREMENTS ON A PRESSURIZED SOLID PROPELLANT GRAIN

San Miguel, A.

Technical Report 32-182, March 15, 1962
(Unclassified)

Using the photoelastic coating technique, measurements of the principal strains existing on the end cross section of five different solid propellant grains were made for two loading conditions. Surface reinforcing effects were minimized by the application of a low-modulus (500 psi) birefringent resin at the coating medium. The principal stresses in the coating were separated by a graphical procedure. The results indicate that the coating technique gives a more realistic measurement of grain stress concentrations and surface strain magnitudes, and that stress measurements obtained from classical model theory are quite conservative.

S03 PROPELLANT STRAIN ANALYSIS BY THE PHOTOELASTIC COATING TECHNIQUE

San Miguel, A.

Technical Memorandum 33-57, December 15, 1961
(Unclassified)

The magnitude and direction of principal strains on the surface of propellants may be measured by using the photoelastic coating technique. Classical photoelasticity theory is found to define the stress-optic properties of a low-modulus birefringent resin used to coat propellant structures. A beam structure of propellant is examined. A method for separating the principal stresses in the resin coating is illustrated. The technique is then applied to four internally pressurized motors. Two six-pointed grains and two tubular grains are examined and found to exhibit smaller strains than would be predicted by contemporary theory.

Sato, T.

S04 AN EXPERIMENTAL 960-MASER AMPLIFIER SYSTEM APPLICABLE TO SPACE COMMUNICATIONS

Stelzried, C. T., Schuster, D., Sato, T.

Technical Report 32-179, November 15, 1961
(Unclassified)

For abstract, see Entry S41.

S05 AN OPERATIONAL 960-Mc MASER SYSTEM FOR DEEP SPACE TRACKING MISSIONS
Sato, T., Stelzried, C. T.

Technical Report 32-306 (Unclassified)
(Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 164-170, June 1962)

An operational 960-Mc low-noise receiving system for use in deep-space tracking missions is described. A ruby-cavity maser, low-noise antenna, low-loss transmission line connecting the antenna to the maser and associated instrumentation all combine to yield reliable and low-noise performance. Results of tests on this system in preparation for the *Ranger RA-3* lunar probe are presented. The system was successfully used during operations with *RA-3*. A minimum system temperature of 47°K has been achieved.

Sauer, C. G., Jr.

S06 THE PERTURBATIONS OF A HYPERBOLIC ORBIT BY AN OBLATE PLANET
Sauer, C. G., Jr.

Technical Report 32-131, Revision (Unclassified)
(Reprinted from *ARS Journal*, Vol. 32, No. 5, pp. 714-717, May 1962)

The perturbations of the hyperbolic orbital elements of a vehicle in the gravitational field of an oblate planet are derived as functions of the initial osculating elements. Assumptions are made that atmospheric drag is absent and that the gravitational potential of the planet may be adequately represented by the principal term and the second harmonic. An example of an Earth-escape mission is presented in which a comparison is made between calculated orbital perturbations and results from a numerical integration of the equations of motion.

S07 INTERPLANETARY TRAJECTORY OPTIMIZATION WITH POWER-LIMITED PROPULSION SYSTEMS
Melbourne, W. G., Richardson, D. E., Sauer, C. G., Jr.

Technical Report 32-173, February 26, 1962 (Unclassified)

For abstract, see Entry M24.

S08 OPTIMUM INTERPLANETARY RENDEZVOUS TRAJECTORIES WITH POWER-LIMITED VEHICLES
Melbourne, W. G., Sauer, C. G., Jr.

Technical Report 32-226, March 5, 1962 (Unclassified)

For abstract, see Entry M25.

S09 PAYLOAD OPTIMIZATION FOR POWER-LIMITED VEHICLES
Melbourne, W. G., Sauer, C. G., Jr.

Technical Report 32-250, April 9, 1962 (Unclassified)

For abstract, see Entry M26.

Schieler, L.

S10 KINETICS OF THE REACTION BETWEEN ALCOHOLS AND ISOCYANATES CATALYZED BY FERRIC ACETYLACETONATE
Schieler, L.

Technical Report 32-129, July 1, 1961 (Unclassified)

The rate and temperature dependence of reaction for the ferric acetylacetonate catalyzed reaction between α-naphthyl, *o*-tolyl, and *p*-tolyl isocyanates and *n*-butyl alcohol are investigated. The effect of substituents on the reactivity of isocyanate and hydroxyl group are reported and correlated for substituted isocyanates by means of the Hammett equation. Several metal chelates were studied and their catalytic activity was compared to that of ferric acetylacetonate. All rate data are interpreted in terms of a mechanism involving simultaneous second-order uncatalyzed and catalyzed reactions between alcohol and isocyanate.

Schuster, D.

S11 THE DETERMINATION OF NOISE TEMPERTURES OF LARGE PARABOLOIDAL ANTENNAS
Schuster, D., Stelzried, C. T., Levy, G. S.

Technical Report 32-97 Revision (Unclassified)
(Presented at URSI, Spring 1961. Reprinted from *IRE Transactions on Antennas and Propagation*, Vol. AP-10, No. 3, pp. 286-292, May 1962)

A maser receiving system may have higher noise contributions from the antenna and transmission line than from the amplifier. Therefore, to develop lower-noise receiving systems, it is important to know the antenna and transmission line noise temperature. Several techniques for the measurement of absolute antenna noise temperature have been tested at the Jet Propulsion Lab-

oratory. Experiments have been conducted at 960 and 2388 Mc using an 85-ft paraboloidal reflector with several antenna feed configurations. At 2388 Mc, an antenna noise temperature of 15°K has been attained with an efficient antenna feed.

S12 AN EXPERIMENTAL 960-MASER AMPLIFIER SYSTEM APPLICABLE TO SPACE COMMUNICATIONS
Stelzried, C. T., Schuster, D., Sato, T.

Technical Report 32-179, November 15, 1961 (Unclassified)

For abstract, see Entry S41.

S13 VENUSIAN AND LUNAR RADAR DEPOLARIZATION EXPERIMENTS
Levy, G. S., Schuster, D.

Technical Report 32-245 (Unclassified) (Reprinted from *The Astronomical Journal*, Vol. 67, No. 5, pp. 320-326, June 1962)

For abstract, see Entry L14.

Scott, R. F.

S14 DYNAMIC PENETRATION STUDIES IN CRUSHED ROCK UNDER ATMOSPHERIC AND VACUUM CONDITIONS
Roddy, D. J., Rittenhouse, J. B., Scott, R. F.

Technical Report 32-242, April 6, 1962 (Unclassified)

For abstract, see Entry R10.

Scull, J. R.

S15 GUIDANCE OF SPACE VEHICLES
Scull, J. R.

Technical Report 32-91 (Unclassified) (Reprinted from *Navigation*, Vol. 8, No. 1, pp. 24-23, Spring 1961)

The guidance of lunar and planetary spacecraft is discussed primarily, with less emphasis on satellites. The trade-offs between injection, midcourse, and terminal guidance are covered, as well as the means of mechanizing them with radio, inertial, or celestial techniques. Examples of these guidance systems are described as applied to some of the current lunar and planetary spacecraft developed by the Jet Propulsion Laboratory.

S16 SPACE GUIDANCE
Gates, C. R., Scull, J. R., Watkins, K. S.

Technical Report 32-162 (Unclassified) (Reprinted from *Astronautics*, Vol. 6, No. 11, pp. 24-28, November 1961)

For abstract, see Entry G02.

S17 THE APPLICATION OF OPTICAL SENSORS FOR LUNAR AND PLANETARY SPACE VEHICLES
Scull, J. R.

Technical Report 32-274, May 31, 1962 (Unclassified)

In order to carry out successful missions, the United States lunar and planetary program is critically dependent on optical sensors. The attitude of a typical spacecraft is determined by optically sensing the position of the Sun and a reference star or planet. Information for directing high-gain telemetering antennas toward the Earth is obtained from an optical transducer. Many of the scientific experiments derive their measurements from optical detectors.

There is a wide variety of optical transducers needed to cover the range of spacecraft requirements. Sensors for the extreme ultraviolet are used for space science measurements. The portion of the spectrum sensed by horizon scanners is in the far infrared. Sun, star, and planet sensors operate largely in the visible region. The over-all intensity range covered by the optical sensors in a spacecraft is greater than 12 orders of magnitude. To meet these requirements, some of the types of sensors employed include solid-state photoconductors, photomultipliers, vidicons, and thermistor bolometers.

Some examples of optical sensors used for lunar and planetary missions are presented. The results of trade-off studies on sensitivity, accuracy, and field of view are discussed. The ground testing and simulation techniques, unique for the interplanetary optical sensors, are described. Flight test results from the *Ranger* spacecraft are reported.

Sehgal, R.

S18 PAYLOAD SEPARATION AND THRUST TERMINATION IN A SOLID-PROPELLANT ROCKET MOTOR
Sehgal, R.

Technical Report 32-175 (Unclassified)

(Reprinted from *Aerospace Engineering*, Vol. 21, No. 5, May 1962)

An investigation is presented of the time-acceleration relationship of the payload after motor separation, as a function of the effective orifice opening of thrust termination and pressure variation with time. An analytical model is constructed, and equations are derived to predict these parameters. Capability for velocity control of the payload is outlined. Results are compared with available flight-test data on axial acceleration of payload during thrust termination of *Shavetail* system.

S19 AN EXPERIMENTAL INVESTIGATION OF A GAS-PARTICLE SYSTEM
Sehgal, R.

Technical Report 32-238, March 16, 1962 (Unclassified)

Particles present in the flow of gas through rocket nozzles are shown to cause appreciable performance degradation which tends to cancel the increased performance resulting from high combustion temperatures of propellants with metal additives. The higher the particle weight fraction, the lower the efficiency (delivered I_{sp}/theoretical I_{sp}). In addition, theoretical investigations indicate that performance losses increase appreciably with increased particle sizes. Very small particles are least detrimental as their presence causes the least reduction in performance because of their high aerodynamic drag-to-mass ratio and, thus, high acceleration and velocity. Small particles have velocities and temperatures throughout the nozzle that are almost equal to those of the gas; however, the gas velocity itself may be somewhat reduced by the small particles.

Extensive experimental investigations and the effect of pertinent parameters on particle size distribution, particle shape, and combustion efficiency. It is shown that, with aluminized propellants, particle size distribution is pressure-dependent. An empirical relationship, written as $\log P = a + bD$, is developed which gives the average particle diameter D on a volume basis as a function of the pressure P.

S20 *MARINER B* CAPSULE PROPULSION STUDY
Sehgal, R., Breshears, R., Acord, J., Thompson, R., Pounder, E., Comuntzis, M.

Technical Memorandum 33-86, June 1, 1962 (Unclassified)

A summary is presented of studies conducted to determine whether or not there is adequate justification for the propelled capsule approach for the *Mariner B*. These studies were based on specific trajectory data for the 1964 Mars opportunity only because these data were currently available. It is anticipated that the differences between the 1966 and later opportunities will not affect the conclusions reached in this investigation, although the approach geometry will be somewhat different. A feasibility study of the propelled capsule system, which propels the capsule from the spacecraft on a fly-by trajectory, indicated the advantages of this system as opposed to the passive capsule system, which drops the capsule from the spacecraft on an impact trajectory and then diverts the spacecraft bus. A reliability analysis was performed for both configurations to estimate the probabilities of success for the fly-by and capsule phases of the mission.

Shafer, J. I.

S21 NUCLEAR-ELECTRIC SPACECRAFT FOR UNMANNED PLANETARY AND INTERPLANETARY MISSIONS
Spencer, D. F., Jaffe, L. D., Lucas, J. W., Merrill, O. S., Shafer, J. I.

Technical Report 32-281, April 25, 1962 (Unclassified)

For abstract, see Entry S35.

Shelton, H. T.

S22 VOLUME CHANGES AND POISSON'S RATIO OF POLYURETHANE PROPELLANTS UNDER TENSILE DEFORMATIONS
Stedry, P. J., Landel, R. F., Shelton, H. T.

Technical Report 32-168, September 25, 1961 (Confidential)

For abstract, see Entry S39.

Smith, A. H.

S23 A 500-ELECTRICAL-WATT SOLAR ENERGY THERMIONIC CONVERSION SYSTEM FOR A MARS SPACECRAFT
Smith, A. H.

Technical Report 32-171, April 15, 1962 (Unclassified)

The conceptual design of a solar energy thermionic (SET) conversion system suitable for use as the prime

source of electrical power for a Mars spacecraft is described. Two designs of such a system are considered. The most promising design, designated SET (A), would employ an individual, 9.5-ft-D, rigid, parabolic mirror to intercept, reflect, and concentrate solar energy. A multidiode thermionic generator would convert the concentrated thermalized solar energy into electricity. SET (A) would utilize a 500-electrical-w thermionic generator incorporating a cavity-type absorber, cesium-vapor-filled thermionic, diodes, heat radiators, temperature-controlled cesium reservoirs, and a solar-flux control mechanism. An alternate design, designated SET (B), would incorporate a 5-ft-D mirror and a 135-w thermionic generator. Four such modules would be clustered to provide up to 540 w of electrical power at Mars (aphelion). The design features are presented of a 135-w flight prototype, which is currently under active development. It is concluded that potentially advantageous solar energy thermionic conversion systems are possible, provided that long life and adequate reliability can be achieved.

Smith, T. L.

S24 CROSSLINKED AND NON-CROSSLINKED DIISOCYANATE-LINKED ELASTOMERS CONTAINING SUBSTITUTED UREA GROUPS
Havlik, A. J., Smith, T. L.

Technical Report 32-180, May 31, 1962 (Unclassified)

For abstract, see Entry H05.

Smith, W. W.

S25 DEVELOPMENT OF A TRAJECTORY-CORRECTION PROPULSION SYSTEM FOR SPACECRAFT
Smith, W. W.

Technical Report 32-205, December 8, 1961 (Unclassified)

The development program and performance capabilities of the *Mariner A* midcourse and approach-correction propulsion system are discussed. The propulsion system, which was intended for use on the 1962 *Mariner A* Venus spacecraft, is a 50-lb-thrust monopropellant hydrazine propulsion system capable of up to five "space" starts and four-months storage in a space environment. At the time of the cancellation of the *Mariner A* program the propulsion system development program was essentially complete, and it was decided to complete the remaining significant milestones so that a fully developed spacecraft trajectory-correction propulsion system could be made available for other programs. Therefore, it is concluded that the *Mariner A* midcourse and approach-correction propulsion system can be regarded as a fully developed flight system ready for flight implemenation in lunar and planetary spacecraft requiring a 50-lb-thrust multiple-start trajectory-correction and/or spacecraft maneuver propulsion system.

Sola, F. L.

S26 MAN-TO-THE-MOON AND RETURN MISSION UTILIZING LUNAR-SURFACE RENDEZVOUS
Buwalda, P., Downhower, W. J., Eckman, P. K., Pounder, E., Rieder, R. A., Sola, F. L.

Technical Memorandum 33-53, August 3, 1961 (Confidential)

For abstract, see Entry B18.

Solloway, C. B.

S27 A STATISTICAL PROBLEM RELATED TO THE LAUNCHING OF A MISSILE
Lass, H., Solloway, C. B.

Technical Report 32-124, July 20, 1961 (Unclassified)

For abstract, See Entry L06.

Spaid, F. W.

S28 EXPERIMENTAL STUDIES OF UNSTABLE COMBUSTION IN SOLID-PROPELLANT ROCKET MOTORS
Landsbaum, E. M., Spaid, F. W.

Technical Report 32-146, August 4, 1961 (Unclassified)

For abstract, see Entry L03.

S29 EXPERIMENTS ON THE INTERACTION OF SECONDARY INJECTANTS AND ROCKET EXHAUST FOR THRUST VECTOR CONTROL
Newton, J. F., Jr., Spaid, F. W.

Technical Report 32-203, February 12, 1962 (Unclassified)

For abstract, see Entry N05.

S30 SOLID-PROPELLANT COMBUSTION INSTABILITY: EXPERIMENTS WITH STAR GRAINS
Landsbaum, E. M., Spaid, F. W.

Technical Report 32-227, July 31, 1961
(Confidential)

For abstract, see Entry L04.

Speiser, E. W.

S31 PERFORMANCE OF NUCLEAR-ELECTRIC PROPULSION SYSTEMS IN SPACE EXPLORATION
Speiser, E. W.

Technical Report 32-159, December 15, 1961
(Unclassified)

An analysis is presented of the payload capabilities of nuclear-electric spacecraft for interplanetary exploration. Results are given in terms of vehicle terminal mass at its destination as a function of flight time for the mission. The missions studied include probes and orbiters to most of the planets in the solar system, and solar probes and flights out of the plane of the ecliptic.

For a given mission, flight time is determined chiefly by the initial acceleration of the spacecraft, whereas terminal mass is determined chiefly by the specific impulse of the thrust device. Some generalized curves are presented which indicate the initial accelerations required for several missions. The specific impulses required for various ratios of terminal mass to initial mass are shown for the same missions.

Once a particular set of mission flight time and payload requirements has been established, the optimum combinations of ion engine characteristics, powerplant weight and power level, and launch vehicle can be specified to satisfy these requirements.

S32 A NUCLEAR-ELECTRIC SPACEBUS FOR PLANETARY LANDING MISSIONS
Beale, R. J., Speiser, E. W.

Technical Report 32-231, May 1, 1962
(Unclassified)

For abstract, see Entry B07.

Spencer, D. F.

S33 THERMAL AND CRITICALITY ANALYSIS OF THE PLASMA CORE REACTOR
Spencer, D. F.

Technical Report 32-189, January 1, 1962
(Unclassified)

Radiative heat transfer to the propellant and reactor criticality for a fissionable gaseous rocket engine are analyzed to determine their interdependence. The necessity for propellant thicknesses of approximately 1 to 3 m, due to poor thermal absorption properties of hydrogen, significantly affects reactor critical radius and mass. The two primary adverse effects are (1) increased absorption in the reflector–moderator for a given reflector thickness, and (2) poor utilization of thermal neutrons by the core due to the lower geometrical view factor of the core for the reflector walls. In fact, there is a minimum core radius at a particular propellant thickness which allows the system to "go" critical.

Engine performance is limited primarily to two regions of operation; namely, a specific impulse of approximately 1550 sec at a thrust level of 2×10^6 lb and, a specific impulse of approximately 2200 sec at a thrust level of 5.3×10^6 lb.

S34 FEASIBILITY OF INTERSTELLAR TRAVEL
Spencer, D. F., Jaffe, L. D.

Technical Report 32-233, March 15, 1962
(Unclassified)

Mathematical equations for single-stage and multistage rocket propulsion are developed; velocity data and transit times are presented. The conclusions indicate that interstellar travel is theoretically feasible by utilizing known staged nuclear-energy systems.

S35 NUCLEAR ELECTRIC SPACECRAFT FOR UNMANNED PLANETARY AND INTERPLANETARY MISSIONS
Spencer, D. F., Jaffe, L. D., Lucas, J. W., Merrill, O. S., Shafer, J. I.,

Technical Report 32-281, April 25, 1962
(Unclassified)

Advanced electric propulsion spacecraft are shown to exhibit unique capability in performing planetary and interplanetary missions. In particular, performance analyses indicate that an electric propulsion spacecraft of 45,000-lb initial weight can perform all fifteen high-energy missions which are of interest to space scientists. Comparable chemical and nuclear heat exchanger spacecraft can perform only seven and nine of these missions, respectively.

Based on what are believed to be realistic estimates of system weight, the two powerplant types considered, thermionic and turbogenerator, appear to have comparable specific weights (12 to 14 lb/kwe) at the 0.3- to 1.5-

Mwe power level. This provides a strong incentive to adequately support both concepts, at least in the early phases of research and development.

Systems considerations regarding the utilization of these powerplants indicate a preference for the static (thermionic) type. For example, attitude control requirements of the spacecraft are minimized with the thermionic system by (1) eliminating rotating mechanical devices, and (2) providing a smaller radiator area, thus a less severe dynamic stability problem at the same power level.

Probably the most important factor is the inherent reliability associated with a static system. Demonstration of this reliability is feasible in ground testing. Because low-thrust propulsion units must operate for unusually long times, this factor will be extremely important.

It is recognized that many problems exist in developing a flyable thermionic or turbogenerator powerplant; however, based on the preceding arguments, a highly accelerated research and development program for both systems is warranted.

Spinrad, H.

S36 SPECTROSCOPIC TEMPERATURE AND PRESSURE MEASUREMENTS IN THE VENUS ATMOSPHERE
Spinrad, H.

Technical Report No. 32-251 (Unclassified)
(Reprinted from *Publications of the Astronomical Society of the Pacific*, Vol. 74, No. 438, pp. 187-201, June 1962)

Some physical properties of the atmosphere of Venus may be determined by analyzing the near-infrared bands of carbon dioxide which are visible at weak absorption features in the Cytherean spectrum.

This investigation was generated by interest in a possible variation of the CO_2 rotational temperature with Venus phase. The Chamberlain-Kuiper theory implies higher temperatures at small Venus phase angles when the CO_2 bands are strongest. It is pointed out that the theoretical predictions are not realized.

Springett, J. C.

S37 JPL CONTRIBUTIONS TO THE 1962 NATIONAL TELEMETERING CONFERENCE
Riddle, F. M., Mathison, R. P., Martin, B. D., Springett, J. C., Bourke, D. G.

Technical Memorandum 33-88, May 21, 1962 (Unclassified)

For abstract, see Entry R05.

Stearns, J. W.

S38 ELECTRO-PROPULSION SYSTEM APPLICATIONS
Stearns, J. W.

Technical Report 32-263 (Unclassified)
(Reprinted from *Astronautics*, Vol. 7, No. 3, pp. 22-23, 74, 76-77, March 1962)

The use of nuclear-electric propulsion for more difficult space missions is presented. It is pointed out that the prototype stage is approaching. Advantages of nuclear-electric propulsion over other systems are discussed in detail.

Stedry, P. J.

S39 VOLUME CHANGES AND POISSON'S RATIO OF POLYURETHANE PROPELLANTS UNDER TENSILE DEFORMATIONS
Stedry, P. J., Landel, R. F., Shelton, H. T.

Technical Report 32-168, September 25, 1961 (Confidential)

Volume changes accompanying tensile strain have been measured by hydrostatic weighing techniques. The inherent error of the method is analyzed and the limitations of the apparatus and the accuracy of the results are discussed. Four polyurethane propellants have been studied at 25°C, using strains from 2.5% to break, in 2.5% increments. The volume changes are interpreted in terms of a change in Poisson's ratio.

Stelzried, C. T.

S40 THE DETERMINATION OF NOISE TEMPERATURES OF LARGE PARABOLOIDAL ANTENNAS
Schuster, D., Stelzried, C. T., Levy, G. S.

Technical Report 32-97, Revision (Unclassified)
(Presented at URSI, Spring 1961. Reprinted from *IRE Transactions on Antennas and Propagation*, Vol. AP-10, No. 3, pp. 286-292, May 1962)

For abstract, see Entry S11.

S41 AN EXPERIMENTAL 960-MASER AMPLIFIER SYSTEM APPLICABLE TO SPACE COMMUNICATIONS
Stelzried, C., Schuster, D., Sato, T.

Technical Report 32-179, November 15, 1961 (Unclassified)

The application of a maser amplifier to deep space tracking and communications is discussed. A 960-Mc maser amplifier is described which is of the ruby cavity type and is designed specifically for use in the severe environment found at an operational deep space tracking station (JPL Goldstone DSIF); the microwave system components, dewar system, auxiliary components, and packaging are included. Maser performance is given in terms of techniques and results of amplifier gain and phase stabilities and noise-temperature measurements. Extensive tests made on the antenna feed system and microwave plumbing are examined, as well as antenna pattern and temper tests for two horn feeds with primary pattern tapers of 10 and 14 db. A figure of merit is given for a receiving system relating system noise temperature and antenna gain. The over-all system equivalent noise temperature (including the antenna, microwave plumbing, maser, and followup amplifier) was 75 $\pm$ 4°K.

S42 AN OPERATIONAL 960-Mc MASER SYSTEM FOR DEEP SPACE TRACKING MISSIONS
Sato, T., Stelzried, C. T.

Technical Report 32-306 (Unclassified) (Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 164-170, June 1962)

For abstract, see Entry S05.

Stevens, R.

S43 THE 1961 JPL VENUS RADAR EXPERIMENT
Victor, W. K., Stevens, R.

Technical Report 32-132, Revision 1 (Unclassified) (Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 84-97, June 1962)

For abstract, see Entry V03.

S44 LARGE GROUND ANTENNAS
Rechtin, E., Rule, B., Stevens, R.

Technical Report 32-213, March 20, 1962 (Unclassified)

For abstract, see Entry R01.

Stiffler, J. J.

S45 SYNCHRONIZATION OF TELEMETRY CODES
Stiffler, J. J.

Technical Report 32-304 (Unclassified) (Reprinted from *IRE Transactions on Space Electronics and Telemetry*, Vol. SET-8, No. 2, pp. 112-117, June 1962)

A well-known means of efficiently transmitting information over the continuous white gaussian channel involves the encoding of successive "blocks" of data into sequences of binary digits (called "code words"). Efficient decoding of these sequences, in turn, necessitates a knowledge of the instants in time at which one code word ends and the succeeding word begins.

A method for obtaining this synchronization is presented which neither decreases the channel capacity nor increases the complexity of the encoding equipment. The method is to select, from the many encodings which are equally good for purposes of synchronous operation, that encoding for which the maximum absolute value of the correlation ρ_0 between any code word and any sequence formed from the overlap of two code words is a minimum. Thus a large correlation is observed only in the synchronous phase position. This technique is applied to an important class of block codes, the "binary orthogonal codes." An alogorithm for constructing these codes with the desired self-synchronizing properties is presented, and upper bounds on the value of ρ_0 are thereby established.

Stoller, F. W.

S46 INVESTIGATION OF HAILSTORM DAMAGE TO DSIF ANTENNAS (PRELIMINARY REPORT)
Stoller, F. W.

Technical Memorandum 33-81, February 23, 1962 (Unclassified)

A study is being made of the probable frequency and severity of hailstorm damage to the ground antennas of the DSIF. The results will be applied in the design of the 1965 Advanced Antenna System (200 to 250-ft D) and in increased-accuracy resurfacing of the present 85-ft antennas.

From September 26 through November 6, 1961 extensive investigations were undertaken of the probable hailstorm conditions at the DSIF site in South Africa. On

completion of these investigations, tests were made of the effects of the resolved hailstorm conditions on the existing dish surface and on existing panel configurations which might be used as replacements. Many of the data available on hailstorm frequency and hailstone size are based on lay observer reports, and there are insufficient valid data to afford good statistical values.

Stumpf, H. J.

S47 FISSION-FRAGMENT ENERGY LOSS FROM VORTEX TUBES
Stumpf, H. J.

Technical Report 32-188, March 12, 1962 (Unclassified)

The heat load in the solid regions of the vortex-tube reactor due to fission fragments reaching the tube walls is calculated using a simplified model. Within the limits of the analysis, it can be seen that this heat load is reduced to a few percent of the total power if the diameter of the vortex tubes is greater than 20 cm at an exhaust pressure of 100 atm and greater than 8 cm at 300 atm. As the tube diameter is increased beyond these values, the effect on the fission-fragment heat load is small, and the dependence upon the specific impulse ratio I and the ratio of fuel to propellant density W becomes insignificant.

S48 VORTEX-TUBE AND REGENERATIVE-COOLING-TUBE PARAMETERS FOR GASEOUS FISSION REACTORS
Stumpf, H. J.

Technical Report 32-201, January 22, 1962 (Unclassified)

The performance of the vortex-tube reactor is governed primarily by the propellant mass flow rate, radius, and number of vortex tubes. A simple analysis is presented to define roughly the range of variables for which system performance is attractive. It is shown that the ratio of the radiation terms ϵ_c/β establishes the allowable range of values for the vortex-tube parameters. Whether or not the required values of ϵ_c/β can be obtained while maintaining adequate system capabilities depends upon the solution of the thermal radiation problem. The regenerative-cooling-tube parameters depend primarily upon the cooling-tube void fraction.

Szirmay, S.

S49 INVESTIGATION OF A PULSE-TORQUED SYSTEM
Johnston, A. R., Szirmay, S.

Technical Report 32-136, April 19, 1961 (Unclassified)

For abstract, see Entry J17.

Thompson, R.

T01 *MARINER B* CAPSULE PROPULSION STUDY
Sehgal, R., Breshears, R., Acord, J., Thompson, R., Pounder, E., Comuntzis, M.

Technical Memorandum 33-86, June 1, 1962 (Unclassified)

For abstract, see Entry S20.

Titsworth, R. C.

T02 SECURE COMMUNICATIONS
Lorens, C. S., Titsworth, R. C., Welch, L. R., Viterbi, A. J., Golomb, S. W.

Technical Report 32-65, August 30, 1961 (Secret)

For abstract, see Entry L20.

T03 POWER SPECTRA OF SIGNALS MODULATED BY RANDOM AND PSEUDORANDOM SEQUENCES
Titsworth, R. C., Welch, L. R.

Technical Report 32-140, October 10, 1961 (Unclassified)

This paper deals with the spectral distribution of signals coherently modulated by discrete random and randomlike sequences which change state only at integral multiples of some basic time division t_0. These signals may be modulated in many fashions, depending upon the types of sequences and signals available, the desired output phenomena, and the sequential rate. In general, a sequence may modulate signals randomly or in some fixed deterministic fashion. Furthermore, deterministic processes may be constructed to possess certain randomlike qualities. Special attention is directed to Markov chains and linear pseudorandom sequences; the signals

selected by the modulation process are not restricted to any one class, and examples are given for sinusoids and square waves.

Specifically, the effects of carrier-signal waveform and type of sequence upon the over-all power spectrum are considered. In the case of sinusoidal modulation, the effect of phase shift is investigated.

Trafton, L. M.

T04 THE JOVIAN ENVIRONMENT

Trafton, L. M.

Technical Memorandum 33-77, March 8, 1962
(Unclassified)

Quantitative knowledge of the Jovian atmosphere and the environment above the atmosphere is summarized. The summary is based upon review and interpretation of the professional literature and will be revised as new observational and theoretical work is carried out at JPL and elsewhere. Topics covered include composition and structure of the atmosphere, photometric properties of the atmosphere, period of rotation, magnetic field, and the Jovian radio-frequency spectrum.

Trummel, M.

T05 APPLICATION OF STATIC-TEST VIBRATION DATA

Trummel, M.

Technical Report 32-152, August 20, 1961
(Unclassified)

Vibration data taken during the static testing of solid-propellant rocket motors are significantly affected by factors peculiar to the test conditions. The results of a small test program are used to illustrate some of the problems involved in applying this data to (1) predict the flight vibration environment of a payload using the motors, and (2) detect the presence of "oscillatory" burning. It is shown that the greatest source of error is from vibration introduced by the intense acoustic field generated during the firing. The use of an acoustic enclosure to reduce this component of vibration and the use of a soft test stand to reduce the effect of test stand resonances are discussed. Methods of physical interpretation of the data for use in practical applications are presented.

Ulery, D.

U01 EVALUATION OF GOLDSTONE POLAR-MOUNT ANTENNA SYSTEMATIC ERRORS FROM STAR TRACKS

Ulery, D., Fearey, J.

Technical Memorandum 33-45, May 5, 1961
(Unclassified)

The reduction of the star-track data obtained from June 14 to December 12, 1960 yielded the following evaluation of the systematic pointing errors in the Goldstone Polar-Mount Antenna:

$$<LHA\,Error> = -0.1356\times10^{-1}+0.5772\times10^{-3}(DEC)+0.3136\times10^{-3}(LHA)+0.6973\times10^{-3}(LHA)(DEC)$$

$$<DEC\,Error> = 0.4580\times10^{-2}+0.5455\times10^{-3}(DEC)-0.8938\times10^{-3}(LHA)$$

The residuals from the fits were distributed approximately normally with mean zero. The standard deviation in local hour angle was 0.8613×10^{-2} deg and in declination it was 0.1038×10^{-1} deg. Correlated errors in hour angle of periods 1600 and 3200 sec were found to have been induced by the coarse resolver in the angular encoder.

Vango, S. P.

V01 A METHOD FOR DETERMINING RELATIVE HUMIDITY IN STERILIZING GAS MIXTURE CONTAINING ETHYLENE OXIDE, FREON 12, AND AIR

Vango, S. P., Krasinsky, J. B.

Technical Report 32-218, March 1, 1962
(Unclassified)

A method is presented for determining relative humidity in a sterilizing gas mixture containing ethylene oxide as the active ingredient. This method entails the use of a commercially available instrument for conveniently determining the dew-point temperature.

V02 DETERMINATION OF PERMEABILITY OF CAST TEFLON SHEET TO NITROGEN TETROXIDE AND HYDRAZINE

Vango, S. P.

Technical Memorandum 33-55, August 25, 1961
(Unclassified)

The apparatus and procedures used for determining permeability of N_2O_4 and N_2H_4 through so-called cast teflon sheet are described.

Victor, W. K.

V03 THE 1961 JPL VENUS RADAR EXPERIMENT
Victor, W. K., Stevens, R., Editors

Technical Report 32-132, Revision 1, April 11, 1962 (Unclassified)

The feasibility of exploring the solar system by radar was demonstrated on March 10, 1961, when a radio signal was beamed at the planet Venus, and, for the first time in history, the return echo was detected within a few minutes. The JPL Venus radar experiment has resulted in (1) an improvement of the accuracy of the Astronomical Unit by more than two orders of magnitude, (2) an indication of similarity between the dielectric constant and apparent roughness of Venus surface material and that commonly found on Earth, and (3) a determination of the rotation rate of Venus for its most probable axis of rotation. In addition, the experiment verified that reliable interplanetary UHF communication is possible over ranges of 50 to 75 million miles and that planetary radar observatories are both practical and useful. Many improvements in the state of the radar and communications art are noted.

V04 GROUND EQUIPMENT FOR SATELLITE COMMUNICATION
Victor, W. K.

Technical Report 32-137, Revision, October 30, 1961 (Unclassified)

The cost of a single operational satellite-communication ground station capable of handling television bandwidths is two- to four-million dollars. The station includes one 85-ft diameter Az-El antenna designed to operate both as a standard UHF monopulse tracking radar and as a microwave communications relay. It is capable of operating with both passive and active satellites, and this dual capability is included with very little increase in cost over that required for operating with either passive satellites only or active satellites only.

All significant items of ground equipment and their estimated cost have been listed; difficult-to-procure items which may require special development are identified, and the functional specifications for the critical items have been included. Illustrative designs showing the pertinent communication system parameters for both active and passive satellites have been included in order to define the performance requirements of the ground equipment. It is noted that another station of the type described may be required to reduce switch-over time between satellites, thereby approximately doubling the indicated cost.

Viterbi, A. J.

V05 SECURE COMMUNICATIONS
Lorens, C. S., Titsworth, R. C., Welch, L. R., Viterbi, A. J., Golomb, S. W.

Technical Report 32-65, August 30, 1961 (Secret)

For abstract, see Entry L20.

Vivian, H. C.

V06 DERIVED-RATE INCREMENT STABILIZATION: ITS APPLICATION TO THE ATTITUDE-CONTROL PROBLEM
Nicklas, J. C., Vivian, H. C.

Technical Report 32-69, July 31, 1961 (Unclassified)

For abstract, see Entry N06.

Volkoff, J. J.

V07 TEMPERATURE-CONTROL ENGINEERING OF A NUCLEAR-ELECTRIC SPACECRAFT
Volkoff, J. J.

Technical Report 32-232, May 15, 1962 (Unclassified)

A study is presented of the significance of system temperature in the design of spacecraft components and its effect on the over-all performance and operational range of a nuclear-electric ion-propelled spacecraft. The systems integration philosophy and system components of a typical nuclear-electric spacecraft are discussed.

A conceptual 70-kwe spacecraft configuration for an Earth-to-Venus deep-space mission is selected for this study. Operating steady-state temperatures expected of the spacecraft subsystems are examined. Environmental factors, including solar, nuclear, and planetary thermal energies, are shown to have considerable effects on component or system temperature. Spacecraft subsystems and components are briefly discussed with regard to system requirements, specifications, and configuration. The expected temperature gradients and proposed methods for temperature control are surveyed.

Major temperature-control problems of spacecraft subsystems and their interrelated effects are discussed. Methods are suggested to lessen the environmental and interrelated effects and to prevent a component from approaching a critical operating condition.

von Roos, O.

V08 ELECTRON-EXCHANGE CORRECTION TO THE PHONON DISPERSION RELATION IN METALS
von Roos, O.

Technical Release No. 34-104, Revision (Unclassified)
(Reprinted from *The Physical Review*, Vol. 124, No. 1, pp. 71-74, October 1, 1961)

The statistical theory recently developed is applied to an investigation of the dispersion relation of sound waves in metals with special regard to contributions due to electron exchange. Contrary to current belief, it is found that these contributions are by no means negligible in the long-wavelength limit. Furthermore, it is shown that the temperature dependence of the renormalized sound frequencies is solely mediated by the temperature dependence of the Fermi-Dirac distribution of the electrons.

V09 PLASMA THEORY OF THE MANY-ELECTRON ATOM
Levine, P. H., von Roos, O.

Technical Report 32-135, January 1, 1962 (Unclassified)

For abstract, see Entry L11.

Vrebalovich, T.

V10 APPLICATION OF HOT-WIRE TECHNIQUES IN UNSTEADY COMPRESSIBLE FLOWS,
Vrebalovich, T.

Technical Report No. 32-229, May 1962 (Unclassified)
(Presented at the ASME Hydraulic Division Conference, Worcester, Mass., May 21–23, 1962. Reprinted from "Symposium on Measurement in Unsteady Flow," American Society of Mechanical Engineers, New York, N.Y. 1962)

The interpretation of hot-wire voltage fluctuations induced by an unsteady compressible flow field is presented. The use of fluctuation mode diagrams to determine the type and amplitude of disturbances detected in an unsteady flow is illustrated. Examples cited are (1) unsteady flow in an oscillating compressible laminar boundary layer, (2) the potential field near such a boundary layer, and (3) the disturbances present in a supersonic wind tunnel. The results are compared with both theory and other measuring techniques. A practical computational scheme is given for the determination of unsteady flow quantities from hot-wire results.

Wada, B. K.

W01 STIFFNESS MATRIX STRUCTURAL ANALYSIS
Batchelder, R. R., Wada, B. K.

Technical Memorandum 33-75, February 12, 1962 (Unclassified)

For abstract, see Entry B04.

Wagner, H. E.

W02 SCIENTIFIC SUBSYSTEM OPERATION: *RANGER 3, 4, 5*
Wagner, H. E.

Technical Memorandum 33-80, February 2, 1962 (Unclassified)

Special flight and ground instrumentation developed to perform four scientific experiments on the *Ranger 3, 4,* and 5 missions is discussed. System test philosophy and procedures are outlined, and data reduction and presentation are given. The scientific instrumentation and GSE are described in some detail.

Wahlquist, H.

W03 MODULATION BROADENING OF UNSATURATED LORENTZIAN LINES
Wahlquist, H.

Technical Report 32-82 (Unclassified)
(Reprinted from *The Journal of Chemical Physics*, Vol. 35, No. 5, pp. 1708-1710, November 1961)

Closed, analytic expressions are obtained for the harmonic amplitudes which arise in the modulation of unsaturated Lorentzian absorption lines. Exact formulas are derived relating characteristics of the observed sig-

nals (amplitude, width, slope ratios, etc.) to the true half-width for arbitrary modulation amplitude. The results of greatest experimental interest are graphed.

W04 CONFIGURATIONS OF SUPERCONDUCTING SHELLS REQUIRED FOR NEAR CRITICAL UNIFORM MAGNETIC FIELDS
Hildebrandt, A. F., Wahlquist, H., Elleman, D. D.

Technical Report 32-192 (Unclassified)
(Reprinted from *The Journal of Applied Physics*, Vol. 33, No. 5. pp. 1798-1800, May 1962)

For abstract, see Entry H10.

W05 SPIN AND EXCHANGE CORRECTIONS TO PLASMA DISPERSION RELATIONS
Burt, P., Wahlquist, H.

Technical Report 32-247 (Unclassified)
(Reprinted from *The Physical Review*, Vol. 125, No. 6, pp. 1785-1788, March 1962)

For abstract, see Entry B17.

Walker, F. J.

W06 AN AUTOMATIC TEMPERATURE-CONTROL SYSTEM FOR WATER-COOLED STRAIN-GAGE WIND TUNNEL BALANCES
Walker, F. J.

Technical Report 32-228, April 27, 1962
(Unclassified)

The design and operation are described of the automatic system which controls the temperature of water-cooled strain-gage balances used in the continuous flow, 21-in. hypersonic wind tunnel at the Jet Propulsion Laboratory.

Watkins, K. S.

W07 SPACE GUIDANCE
Gates, C. R., Scull, J. R., Watkins, K. S.

Technical Report 32-162 (Unclassified)
(Reprinted from *Astronautics*, Vol. 6, No. 11, pp. 24-28, November 1961)

For abstract, see Entry G02.

Welch, L. R.

W08 SECURE COMMUNICATIONS
Lorens, C. S., Titsworth, R. C., Welch, L. R., Viterbi, A. J., Golomb, S. W.

Technical Report 32-65, August 30, 1961 (Secret)

For abstract, see Entry L20.

W09 POWER SPECTRA OF SIGNALS MODULATED BY RANDOM AND PSEUDORANDOM SEQUENCES
Titsworth, R. C., Welch, L. R.

Technical Report 32-140, October 10, 1961
(Unclassified)

For abstract, see Entry T03.

Wells, W. H.

W10 HETERODYNE PROPERTIES OF A THREE-LEVEL QUANTUM SYSTEM
Wells, W. H.

Technical Report 32-157 (Unclassified)
(Reprinted from *The Journal of Applied Physics*, Vol. 33, No. 5, pp. 1851-1861, May 1962)

It is well known that a three-level system functions as a mixer for radiation at its three resonant frequencies. This topic is treated in detail by analogy to a three-terminal-pair circuit element, one pair for each frequency. To one pair, fixed power is applied from a local oscillator, or "pump." Attention is then centered on the other two pairs to determine their small signal response and transfer characteristics. A slight generalization of the impedance concept takes account of the frequency changes and allows the results to be expressed as self impedance at each terminal pair, and a transfer impedance between pairs. The damping effect of molecular surroundings is taken into account. The three-level maser is a special case in which the terminal pair for the idle frequency is open and the self impedance at the signal terminals has a negative resistive part.

Quantization of the radiation field is included by expressing quantum uncertainties in the same form as classical noise, i.e., correlation functions and power spectra. The means for achieving this are derived from a formalism which connects noise theory to quantum theory

through the fact that the Wigner density of linear systems, such as modes of the radiation field, varies with time exactly like a classical probability density. The rules for using this technique are stated as needed without proof; the photon concept is not used. The method is extended to include a system pumped by broadband noise.

W11 DIFFRACTION TELESCOPE FOR ASTRONOMY IN SPACE
Wells, W. H.

Technical Report 32-230, April 15, 1962
(Unclassified)

Normally, the aperture of a telescope is limited by the need to hold optical tolerance over the face of the focusing element. This limitation may be removed by accepting two conditions: (1) diffraction focusing rather than refraction or reflection focusing; and (2) immense focal lengths, practical only in the force-free environment of outer space.

The properties of a diffraction telescope are derived assuming an aperture of 50 m and a focal length of 1000 km. The principal element is a 50-m Fresnel-zone plate, or diffraction lens, of 625 annuli. Tolerances are so lax that the lens may be fabricated from plastic and held flat by spinning. Angular resolution is 10^{-8} rad. The central peak of the image of a point source is 1-cm D. The power brought to focus in this central peak is equal to the power which is incident on a circle of 560-in. D. The undistorted field of view is about ½ deg. The detector is assumed to be in a separate vehicle, which guides on a reference image using the vernier thrust of an ion engine. Chromatic aberration becomes a serious problem in detecting weak sources. The pass band of the uncorrected lens is only 8 Å wide, but correction is feasible. The tolerance in finding the focal plane is 71 cm.

Williams, H. E.

W12 ANALYSIS OF A CIRCULAR, CYLINDRICAL SHELL LOADED AS SIMPLE CANTILEVER
Williams, H. E.

Technical Report 32-64, September 1, 1961
(Unclassified)

The stresses and deflections in a circular, cylindrical shell loaded at each end by a force and moment applied through rigid rings are presented. The shell may be stiffened by additional rings, and it is assumed that rapid changes in stress and deflection occur only in the axial direction in the immediate vicinity of a ring.

W13 THE FREE-SURFACE BOUNDARY CONDITIONS WITH SURFACE TENSION
Williams, H. E.

Technical Report 32-88, December 1, 1961
(Unclassified)

A derivation of the free-surface boundary conditions for a fluid is presented, in addition to the necessary relations for formulating these conditions in general coordinates.

W14 SHORT, TAPERED SHELLS OF REVOLUTION: I. AXISYMMETRIC EDGE LOADING II. UNIFORM PRESSURE LOADING
Williams, H. E.

Technical Report 32-92, July 10, 1961
(Unclassified)

An approximate solution is presented for the stresses and deflections in a short, linearly tapering shell acted upon by an axisymmetric set of horizontal shear forces and meridional bending moments applied on the edges. A solution for the shell acted upon by a uniform surface pressure is also given. The analysis is limited to shells which are quasi-cylindrical.

Willingham, D. E.

W15 PHOTOGRAPHIC RESOLUTIONS AND COVERAGES OBTAINABLE WITH THE *RANGER* IMPACTING SPACECRAFT
Campen, C. F., Jr., Heftman, K., Willingham, D. E.

Technical Memorandum 33-78, April 6, 1962
(Unclassified)

For abstract, see Entry C02.

Womack, J. R.

W16 TEST-BED CONFIGURATIONS FOR THE FLIGHT TESTING OF *SNAP-8* POWERED ELECTRIC-PROPULSION SYSTEMS
Beale, R. J., Womack, J. R., Hirrel, P. J., Apel, W. C.

Technical Report 32-190, November 24, 1961
(Unclassified)

For abstract, see Entry B06.

W17 A 35-KWE *SNAP-8* SATELLITE TESTCRAFT
Womack, J. R.

Technical Memorandum 33-84, May 7, 1962
(Unclassified)

A conceptual design is presented of a testcraft for evaluation of the performance in space of a 35-kwe *SNAP-8* turboelectric power generating system. Ground rules for the study (including booster requirements) are listed. The various systems of the testcraft are described and a typical mode of operation is presented. Boost and flight configurations of the testcraft are illustrated and preliminary weight estimates of the systems which comprise the testcraft are made. Changes in the initial ground rules and constraints which might permit a more optimum testcraft design are discussed.

Wrobel, J. R.

W18 APPLICATIONS FOR MONOPROPELLANTS IN SPACE VEHICLES
Lee, D. H., Breshears, R. R., Harper, A. D., Wrobel, J. R.

Technical Report 32-174, October 5, 1961
(Confidential)

For abstract, see Entry L09.

W19 STUDIES OF CHEMICAL PROPULSION SYSTEMS FOR ORBITING OR LANDING ON THE MOON AND THE NEAR PLANETS
Harper, A. D., Breshears, R. R., Dipprey, D. F., Wrobel, J. R.

Technical Report 32-235, March 15, 1962
(Confidential)

For abstract, see Entry H04.

Wu, C.-S.

W20 THE MOTION OF A PLASMA COLUMN IN A LONGITUDINAL MAGNETIC FIELD
Wu, C.-S.

Technical Report 32-126, June 30, 1961
(Unclassified)

The expansion of an infinitely long plasma column in a longitudinal magnetic field is considered. An initial equilibrium condition is postulated. The plasma is assumed to have finite conductivity. The analysis is based on the one-fluid hydrodynamic theory.

Yagi, F.

Y01 FLUID ISSUING FROM THE CENTER OF A MAGNETIC DIPOLE
Hiroshige, Y., Yagi, F.

Technical Memorandum 33-63, October 30, 1961
(Unclassified)

For abstract, see Entry H11.

Y02 ON THE SOLUTION OF A CERTAIN INTEGRAL EQUATION
Yagi, F.

Technical Memorandum 33-68, January 25, 1962
(Unclassified)

An equation arrived at by A. R. Hibbs (see "Exploration of the Moon and Planets," National Academy of Sciences, National Research Council, NAS/NRD Pub. 845, 1961), which describes the distribution of original and added material in impact craters, is treated. The existence of a solution is shown and a specific case solved. This analytic solution is compared with that obtained on the IBM 7090 computer.

Zoutendyk, J. A.

Z01 A METHOD FOR PREDICTING THE EFFICIENCY OF SOLAR CELL POWER SYSTEMS OUTSIDE THE EARTH'S ATMOSPHERE
Zoutendyk, J. A.

Technical Report 32-259, April 10, 1962
(Unclassified)

A method is presented for predicting both the short-circuit current of solar cells in space and the degradation of solar-cell efficiency in going from terrestrial to space conditions. The results of this method are compared with telemetry measurements from a spacecraft in flight. The consistency of the data from the two different sources is demonstrated.

SUMMARY PUBLICATIONS

AB01 QUARTERLY SUMMARY REPORT [APRIL 1 TO JUNE 31, 1961]

Quarterly Summary Report 38-4, July 15, 1961 (Confidential)

A quarterly summary is presented of the research activities conducted by the Jet Propulsion Laboratory in the field of nondestructive testing of solid-propellant rocket motors.

AB02 QUARTERLY SUMMARY REPORT [JULY 1 TO SEPTEMBER 31, 1961]

Quarterly Summary Report 38-5, October 1, 1961 (Confidential)

Research activities conducted by the Jet Propulsion Laboratory in the field of nondestructive testing of solid-propellant rocket motors are reported. Progress in the following areas of research is described in detail: (1) effects of moisture on mechanical properties, (2) volume changes under tensile deformations, and (3) the influence of strain upon burning rate.

AB03 QUARTERLY SUMMARY REPORT [OCTOBER 1, 1961 TO DECEMBER 31, 1961]

Quarterly Summary Report 38-6, February 1, 1962 (Confidential)

A quarterly summary is reported of the research activities conducted by the Jet Propulsion Laboratory in the field of nondestructive testing of solid-propellant rocket motors. Progress in specific areas of research is described in detail.

An introduction to the problems and objectives of the program is given in QSR 38-1; a bibliography of the subject is presented in QSR 38-1, -2, -3; Section I of QSR 38-4 presents a general description of the subject areas covered by the entire program.

AB04 QUARTERLY SUMMARY REPORT [JANUARY 1 TO MARCH 31, 1962]

Quarterly Summary Report 38-7, May 1, 1962 (Confidential)

For abstract, see Entry AB03.

AB05 RESEARCH SUMMARY, VOLUME I [APRIL 1 TO JUNE 1, 1961]

Research Summary 36-9, Volume I, July 1, 1961 (Unclassified)

A bimonthly report is presented of unclassified supporting research and development conducted at the Jet Propulsion Laboratory. Beginning with this issue, the Research Summary will be published in two volumes: Volume I is unclassified, and Volume II is classified Confidential.

AB06 RESEARCH SUMMARY, VOLUME II [APRIL 1 TO JUNE 1, 1961]

Research Summary 36-9, Volume II, July 1, 1961 (Confidential)

A bimonthly report is presented of classified supporting research and development conducted at the Jet Propulsion Laboratory.

AB07 RESEARCH SUMMARY, VOLUME I [JUNE 1 TO AUGUST 1, 1961]

Research Summary 36-10, Volume I, October 6, 1961 (Unclassified)

For abstract, see Entry AB05.

AB08 RESEARCH SUMMARY, VOLUME II [JUNE 1 TO AUGUST 1, 1961]

Research Summary 36-10, Volume II, October 4, 1961 (Confidential)

For abstract, see Entry AB06.

AB09 RESEARCH SUMMARY [AUGUST 1 TO OCTOBER 1, 1961]

Research Summary 36-11, November 1, 1961 (Unclassified)

For abstract, see Entry AB05.

AB10 RESEARCH SUMMARY, VOLUME I [OCTOBER 1 TO DECEMBER 1, 1961]

Research Summary 36-12, Volume I, January 2, 1962 (Unclassified)

For abstract, see Entry AB05.

AB11 RESEARCH SUMMARY, VOLUME II [OCTOBER 1 TO DECEMBER 1, 1961]

Research Summary 36-12, Volume II, January 2, 1962 (Confidential)

For abstract, see Entry AB06.

AB12 RESEARCH SUMMARY [DECEMBER 1, 1961 TO FEBRUARY 1, 1962]

Research Summary 36-13, March 1, 1962 (Unclassified)

For abstract, see Entry AB05.

AB13 RESEARCH SUMMARY [FEBRUARY 1 TO APRIL 1, 1962]

Research Summary 36-14, May 1, 1962 (Unclassified)

This is the final issue of the Research Summary. Future reports of JPL/NASA supporting research activities will be incorporated in the Space Programs Summary series of bimonthly periodicals. Effective July 1, 1962, material that would have appeared in Volumes I and II of Research Summary 36-15 will be found in Volumes IV and V of Space Programs Summary 37-15.

AB14 SPACE PROGRAMS SUMMARY, VOLUME II [MARCH 1 TO MAY 1, 1961]

Space Programs Summary 37-9, Volume II, June 1, 1961 (Confidential)

Classified JPL research and development activities having specific application to NASA sponsored space programs are compiled in a bimonthly report.

AB15 SPACE PROGRAMS SUMMARY, VOLUME I [MAY 1 TO JULY 1, 1961]

Space Programs Summary 37-10, Volume I, August 1, 1961 (Unclassified)

A bimonthly report is presented of the unclassified research and development activities conducted at the Jet Propulsion Laboratory having specific application to space programs under the sponsorship of the National Aeronautics and Space Administration.

AB16 SPACE PROGRAMS SUMMARY, VOLUME II [MAY 1 TO JULY 1, 1961]

Space Programs Summary, 37-10, Volume II, August 1, 1961 (Confidential)

For abstract, see Entry AB14.

AB17 SPACE PROGRAMS SUMMARY, VOLUME I [JULY 1 TO SEPTEMBER 1, 1961]

Space Programs Summary 37-11, Volume I, October 1, 1961 (Unclassified)

For abstract, see Entry AB15.

AB18 SPACE PROGRAMS SUMMARY, VOLUME II [JULY 1 TO SEPTEMBER 1, 1961]

Space Programs Summary 37-11, Volume II, October 1, 1961 (Confidential)

For abstract, see Entry AB14.

AB19 SPACE PROGRAMS SUMMARY, VOLUME I [SEPTEMBER 1 TO NOVEMBER 1, 1961]

Space Programs Summary 37-12, Volume I, December 1, 1961 (Unclassified)

For abstract, see Entry AB15.

AB20 SPACE PROGRAMS SUMMARY, VOLUME II [SEPTEMBER 1 TO NOVEMBER 1, 1961]

Space Programs Summary 37-12, Volume II, December 1, 1961 (Confidential)

For abstract, see Entry AB14.

AB21 SPACE PROGRAMS SUMMARY, VOLUME I [NOVEMBER 1, 1961 TO JANUARY 1, 1962]

Space Programs Summary 37-13, Volume I, February 1, 1962 (Unclassified)

For abstract, see Entry AB15.

AB22 SPACE PROGRAMS SUMMARY, VOLUME II [NOVEMBER 1, 1961 TO JANUARY 1, 1962]

Space Programs Summary 37-13, Volume II, February 1, 1962 (Confidential)

For abstract, see Entry AB14.

AB23 SPACE PROGRAMS SUMMARY, VOLUME I [JANUARY 1 TO MARCH 1, 1962]

Space Programs Summary 37-14, Volume I, April 1, 1962 (Unclassified)

For abstract, see Entry AB15.

AB24 SPACE PROGRAMS SUMMARY, VOLUME II [JANUARY 1 TO MARCH 1, 1962]

Space Programs Summary 37-14, Volume II, April 1, 1962 (Confidential)

For abstract, see Entry AB14.

AB25 SPACE PROGRAMS SUMMARY, VOLUME I [MARCH 1 TO MAY 1, 1962]

Space Programs Summary 37-15, Volume I, May 31, 1962 (Confidential)

The Space Programs Summary is a bimonthly publication which reports JPL space exploration programs and related supporting research and advanced development projects conducted under the sponsorship of the National Aeronautics and Space Administration. The subtitle and security classification of all volumes of the Space Programs Summary are:

Volume I, The Lunar Program (Confidential)

Volume II, The Planetary-Interplanetary Program (Confidential)

Volume III, The Deep Space Instrumentation Facility (Unclassified)

Volume IV, Supporting Research and Advanced Development (Unclassified)

Volume V, Supporting Research and Advanced Development (Confidential)

Volume VI, Space Exploration Programs and Space Sciences (Unclassified)

Volume VI is an unclassified digest of appropriate material from Volumes I through V, plus the reports of the JPL Sciences Division.

AB26 SPACE PROGRAMS SUMMARY, VOLUME II [MARCH 1 TO MAY 1, 1962]

Space Programs Summary 37-15, Volume II, May 31, 1962 (Confidential)

For abstract, see Entry AB25.

AB27 SPACE PROGRAMS SUMMARY, VOLUME III [MARCH 1 TO MAY 1, 1962]

Space Programs Summary 37-15, Volume III, May 31, 1962 (Unclassified)

For abstract, see Entry AB25.

AB28 SPACE PROGRAMS SUMMARY, VOLUME IV [MARCH 1 TO MAY 1, 1962]

Space Programs Summary 37-15, Volume IV, June 30, 1962 (Unclassified)

For abstract, see Entry AB25.

AB29 SPACE PROGRAMS SUMMARY, VOLUME V [MARCH 1 TO MAY 1, 1962]

Space Programs Summary 37-15, Volume V, June 30, 1962 (Confidential)

For abstract, see Entry AB25.

AB30 SPACE PROGRAMS SUMMARY, VOLUME VI [MARCH 1 TO JUNE 1, 1962]

Space Programs Summary 37-15, Volume VI, June 30, 1962 (Unclassified)

For abstract, see Entry AB25.

AB31 PUBLICATIONS OF THE JET PROPULSION LABORATORY [JANUARY 1938 THROUGH JUNE 1960]

Bibliography 39-1, December 29, 1961 (Unclassified)

Abstracts are compiled of official Jet Propulsion Laboratory reports released prior to July 1, 1960. The author

index comprises the main body of the Bibliography and numerical and subject indexes are also included.

AB32 PUBLICATIONS OF THE JET PROPULSION LABORATORY [JULY 1960 THROUGH JUNE 1961]

Bibliography 39-2, December 29, 1961
(Unclassified)

Abstracts are compiled of official Jet Propulsion Laboratory reports released July 1, 1960 through June 30, 1961. The author index comprises the main body of the Bibliography and numerical and subject indexes are also included.

AB33 THE *RANGER* PROJECT

Annual Report for 1961, June 15, 1962
(Confidential)

This report was released as JPL TR 32-241. For abstract, see Entry J08.

ASTRONAUTICS INFORMATION

ABSTRACTS

The Jet Propulsion Laboratory library prepares and distributes a series of abstracts of reports dealing with the subject of spaceflight and applicable data and techniques. Author, subject, and source indexes are included with each issue and are cumulative for the current year. The Astronautics Information Abstracts are published in two volumes of six monthly issues each year.

For preceding volumes and numbers, see Bibliography Nos. 39-1 and 39-2. Issues released July 1, 1961 through June 30, 1962 include the following:

AC01 **ABSTRACTS, VOL. IV, NO. 1**
Abstracts 4,001 through 4,100, July 1961
(Unclassified)

AC02 **ABSTRACTS, VOL. IV, NO. 2**
Abstracts 4,101 through 4,201, August 1961
(Unclassified)

AC03 **ABSTRACTS, VOL. IV, NO. 3**
Abstracts 4,202 through 4,321, September 1961
(Unclassified)

AC04 **ABSTRACTS, VOL. IV, NO. 4**
Abstracts 4,322 through 4,427, October 1961
(Unclassified)

AC05 **ABSTRACTS, VOL. IV, NO. 5**
Abstracts 4,428 through 4,521, November 1961
(Unclassified)

AC06 **ABSTRACTS, VOL. IV, NO. 6**
Abstracts 4,522 through 4,616, December 1961
(Unclassified)

AC07 **ABSTRACTS, VOL. V, NO. 1**
Abstracts 5,001 through 5,100, January 1962
(Unclassified)

AC08 **ABSTRACTS, VOL. V, NO. 2**
Abstracts 5,101 through 5,200, February 1962
(Unclassified)

AC09 **ABSTRACTS, VOL. V, NO. 3**
Abstracts 5,201 through 5,330, March 1962
(Unclassified)

AC10 **ABSTRACTS, VOL. V, NO. 4**
Abstracts 5,331 through 5,455, April 1962
(Unclassified)

AC11 **ABSTRACTS, VOL. V, NO. 5**
Abstracts 5,456 through 5,566, May 1962
(Unclassified)

AC12 **ABSTRACTS, VOL. V, NO. 6**
Abstracts 5,567 through 5,682, June 1962
(Unclassified)

OPEN LITERATURE SURVEYS

The Jet Propulsion Laboratory library prepares and distributes a series of open literature surveys dealing with the subject of spaceflight and applicable data and techniques. Author and subject indexes are included in each issue and are cumulative for the current year. An index of periodicals covered is included in each issue. A comprehensive list of periodicals scanned during the year is included in the first issue of each volume and is reviewed and revised from time to time.

The Astronautics Information Open Literature Survey is published in two volumes of six monthly issues each year. For preceding volumes and numbers, see Bibliography Nos. 39-1 and 39-2. Issues released July 1, 1961 through June 30, 1962 include the following:

AC13 OPEN LITERATURE SURVEY, VOL. IV, NO. 1
Entries 40,001 through 40,202, July 1961
(Unclassified)

AC14 OPEN LITERATURE SURVEY, VOL. IV, NO. 2
Entries 40,203 through 40,453, August 1961
(Unclassified)

AC15 OPEN LITERATURE SURVEY, VOL. IV, NO. 3
Entries 40,454 through 40,728, September 1961
(Unclassified)

AC16 OPEN LITERATURE SURVEY, VOL. IV, NO. 4
Entries 40,729 through 41,018, October 1961
(Unclassified)

AC17 OPEN LITERATURE SURVEY, VOL. IV, NO. 5
Entries 41,019 through 41,268, November 1961
(Unclassified)

AC18 OPEN LITERATURE SURVEY, VOL. IV, NO. 6
Entries 41,269 through 41,476, December 1961
(Unclassified)

AC19 OPEN LITERATURE SURVEY, VOL. V, NO. 1
Entries 50,001 through 50,205, January 1962
(Unclassified)

AC20 OPEN LITERATURE SURVEY, VOL. V, NO. 2
Entries 50,206 through 50,417, February 1962
(Unclassified)

AC21 OPEN LITERATURE SURVEY, VOL. V, NO. 3
Entries 50,418 through 50,669, March 1962
(Unclassified)

AC22 OPEN LITERATURE SURVEY, VOL. V, NO. 4
Entries 50,670 through 50,951, April 1962
(Unclassified)

AC23 OPEN LITERATURE SURVEY, VOL. V, NO. 5
Entries 50,952 through 51,270, May 1962
(Unclassified)

AC24 OPEN LITERATURE SURVEY, VOL. V, NO. 6
Entries 51,271 through 51,483, June 1962
(Unclassified)

LITERATURE SEARCHES

The technical staff of the Jet Propulsion Laboratory library conducts extensive literature searching programs covering subjects selected by the Laboratory engineers and designed to meet their individual research requirements. Searches considered to be of interest to persons working in the field of astronautics are published for distribution to interested organizations. The following searches have been published from July 1, 1961 through June 30, 1962.

AC25 EFFECTS OF STERILIZING AGENTS ON MICROORGANISMS

Barber, E., Flynn, P., Compilers

Literature Search 260, August 1961 (Unclassified)

Material has been collected on the effect of sterilizing agents on bacteria, spores, and viruses, and on the production and maintenance of sterile environments in the laboratory. There is a section for each type of sterilizing agent: radiation, temperature, ultrasonics, and vacuum. Radiation is divided into gamma-, ultraviolet-, and X-radiation, and the section on vacuum contains material on the effects of drying. An author index is included.

AC26 ORGANIC SEMICONDUCTORS: PROPERTIES AND APPLICATIONS

Sweitzer, D., Compiler

Literature Seach 341, September 1961 (Unclassified)

This compilation comprises references on conductive properties of organic materials, and a few applications of such compounds, several concerning synthesis. Subjects covered are: photoconductivity, conductivity and semiconductivity, excited states, dielectric effects, and applications.

AC27 RADIOMETRY AND PHOTOMETRY OF THE MOON AND PLANETS

Barber, E., Compiler

Literature Search 345, September 1961 (Unclassified)

Material has been collected on photometry, spectrophotometry, colorimetry, and other methods of studying the surfaces and atmospheres of the planets in the visual, ultraviolet, and infrared regions. The material is divided into nine sections covering the major planets, the Moon, and lunar eclipses. A general section contains survey articles and some selected references on instrumentation. An author index is included.

AC28 THERMIONIC AND THERMOELECTRIC CONVERSION SYSTEMS

Barber, E., Compiler

Literature Search 392, March 1962 (Unclassified)

This search is divided into three sections: Thermionic Conversion Systems, Thermoelectric Conversion Systems, and General Information. The last section contains articles of a more general nature, which discuss both thermionic and thermoelectric systems, and some selected references on magnetohydrodynamic converters. JPL Astronautics Information Literature Search No. 294, "Thermionics and Thermoelectricity," published in December 1960, contains earlier references and additional information on this subject.

AC29 ELECTRICALLY PROPELLED SPACECRAFT AND ASSOCIATED SUBJECTS

Hayes, J., Compiler

Literature Search 428, May 1962 (Unclassified)

This search includes sections on electrically propelled spacecraft, electric propulsion, and associated subjects. The last section contains a few references on basic research pertinent to electric propulsion. In each section the material is divided into the following categories: books, reports, and periodicals. An author index is included.

TRANSLATIONS

Relevant articles from foreign journals and news media are translated and published and are made available to interested organizations. The following translations have been published from July 1, 1961 through June 30, 1962:

AC30 THE FLIGHT OF *VOSTOK* 2
Zygielbaum, J. L., Translator

Translation 24, October 2, 1961 (Unclassified)

This translation describes the August 7, 1961 *Vostok* 2 flight and the spacecraft's radio communication instrumentation. A brief biography of Herman Titov is included, as well as excerpts from the press conference at the Academy of Sciences of the USSR.

AC31 THE LARGE RADIO TELESCOPE AT PULKOVO
Zygielbaum, J. L., Translator

Translation 25, January 30, 1962 (Unclassified)

The principle of investigation and the design of a new reflector microwave radio telescope with large aperture and high resolving power are given. Astronomical results obtained with this instrument are also presented. The axis of the radio telescope can be directed to any part of the sky by shifting the reflecting elements and the feed. The geometry of the reflecting surface, characteristics of the directional diagram, and kinematics of the adjusting mechanism of the reflecting elements are considered. The principal features of the radio telescope and some results of the astronomical observation are given.

AC32 RADIO LOCATION OF VENUS
Zygielbaum, J. L., Translator

Translation 26, March 6, 1962 (Unclassified)
(Translated from *Izvestia*, May 12, 1961)

In 1961 the Soviet Union claimed to have determined the radio location of the planet Venus. The purpose for this determination was to (1) investigate the physical properties of the planet's surface, (2) evaluate the period of its rotation, and (3) define the dimensions of the solar system more accurately. All three goals were purported to have been achieved. The processing of the results of the radio location is continuing and the results will be published in Soviet scientific journals.

AC33 RADIO FREQUENCY MASS SPECTROMETER
Zygielbaum, J. L., Translator

Translation 27, May 12, 1962 (Unclassified)
(Translated from *Iskustvennye Sputniki Zemli*, No. 3, 1959)

A radio-frequency mass spectrometer for the investigation of the ion composition of the Earth's upper atmosphere is examined. The construction of the instrument and its component parts are discussed. A method for using the mass spectrometer is presented, followed by a representational listing of the instrument's normal operational modes.

AC34 ON THE QUESTION OF CAPTURE IN A RESTRICTED CYCLICAL PROBLEM OF THREE BODIES
Zygielbaum, J. L., Translator

Translation 28, June 4, 1962 (Unclassified)
(Translated from *Iskustvennye Sputniki Zemli*, No. 3, 1959)

Lemma proof is presented for this problem, as well as proof of the inevitable departure of a particle from the sphere of gravitation. Five implications relating to the problem are also discussed. An approximate examination of the problem with respect to the possibility of capture of a missile, launched from the Earth, by the Moon and the planets is also presented. Perturbations from the Earth cannot noticeably change prominent hyperbolic motion inside the sphere of influence, and a missile, after entering this sphere of influence, should leave it during its first orbit around the Moon if it does not impact on the lunar surface. During an Earth missile's initial orbit around the Sun, capture by a planet appears impossible.

NUMERICAL INDEX

Technical Reports and Technical Releases

Technical Memorandums

Technical Memorandums	Entry No.
33-45	U01
33-48	C11
33-52	J09
33-52, Add. A	J10
33-52, Add. B	J11
33-52, Add. C	J12
33-53	B18
33-54	J13
33-55	V02
33-56	R02
33-57	S03
33-58	P05
33-59	C13
33-60	L15
33-61	L16
33-62	L02
33-63	H11
33-64	E10
33-65	E11
33-66	M30
33-67	B03
33-68	Y02
33-69	L17
33-71	C16
33-72	C01
33-73	C04
33-75	B04
33-77	T04
33-78	C02
33-79	J14
33-80	W02
33-81	S46
33-82	C12
33-83	J15
33-84	W17
33-86	S20
33-87	N10
33-88	R05
33-93	N04

Summary Publications

Research Summaries	Entry No.
36-9, Vol. I	AB05
36-9, Vol. II	AB06
36-10, Vol. I	AB07
36-10, Vol. II	AB08
36-11	AB09
36-12, Vol. I	AB10
36-12, Vol. II	AB11
36-13	AB12
36-14	AB13

Quarterly Summary Reports	Entry No.
38-4	AB01
38-5	AB02
38-6	AB03
38-7	AB04

Space Programs Summaries	Entry No.
37-9, Vol. II	AB14
37-10, Vol. I	AB15
37-10, Vol. II	AB16
37-11, Vol. I	AB17
37-11, Vol. II	AB18
37-12, Vol. I	AB19
37-12, Vol. II	AB20
37-13, Vol. I	AB21
37-13, Vol. II	AB22
37-14, Vol. I	AB23
37-14, Vol. II	AB24
37-15, Vol. I	AB25
37-15, Vol. II	AB26
37-15, Vol. III	AB27
37-15, Vol. IV	AB28
37-15, Vol. V	AB29
37-15, Vol. VI	AB30

Bibliographies	Entry No.
39-1	AB31
39-2	AB32

Annual Reports	Entry No.
Ranger	AB33
	J08

Astronautics Information

Abstracts	Entry No.
Vol. IV, No. 1 (Abstracts 4,001-4,100)	AC01
Vol. IV, No. 2 (Abstracts 4,101-4,201)	AC02
Vol. IV, No. 3 (Abstracts 4,202-4,321)	AC03
Vol. IV, No. 4 (Abstracts 4,322-4,427)	AC04
Vol. IV, No. 5 (Abstracts 4,428-4,521)	AC05
Vol. IV, No. 6 (Abstracts 4,522-4,616)	AC06
Vol. V, No. 1 (Abstracts 5,000-5,100)	AC07
Vol. V, No. 2 (Abstracts 5,101-5,200)	AC08
Vol. V, No. 3 (Abstracts 5,201-5,330)	AC09
Vol. V, No. 4 (Abstracts 5,331-5,455)	AC10
Vol. V, No. 5 (Abstracts 5,456-5,566)	AC11
Vol. V, No. 6 (Abstracts 5,567-5,682)	AC12

Open Literature Surveys	Entry No.
Vol. IV, No. 1 (Entries 40,001-40,202)	AC13
Vol. IV, No. 2 Entries 40,203-40,453)	AC14
Vol. IV, No. 3 (Entries 40,454-40,728)	AC15
Vol. IV, No. 4 (Entries 40,729-41,018)	AC16
Vol. IV, No. 5 (Entries 41,019-41,268)	AC17
Vol. IV, No. 6 (Entries 41,269-41,476)	AC18
Vol. V, No. 1 (Entries 50,001-50,205)	AC19
Vol. V, No. 2 (Entries 50,206-50,417)	AC20
Vol. V, No. 3 (Entries 50,418-50,669)	AC21
Vol. V, No. 4 (Entries 50,670-50,951)	AC22
Vol. V, No. 5 (Entries 50,952-51,270)	AC23
Vol. V, No. 6 (Entries 51,271-51,483)	AC24

Literature Searches	Entry No.
260	AC25
341	AC26
345	AC27
392	AC28
428	AC29

Translations	Entry No.
24	AC30
25	AC31
26	AC32
27	AC33
28	AC34

SUBJECT INDEX