NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Memorandum 33-584

Volume I

Tracking and Data System Support for the Pioneer Project

Pioneer 10 – Prelaunch Planning Through Second Trajectory Correction December 4, 1969 to April 1, 1972

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PREFACE

This is Volume I of a series of documents describing and evaluating support of the Pioneer 10 Jupiter Mission, managed by Ames Research Center for the National Aeronautics and Space Administration. The work described in this volume was performed by the Tracking and Data Acquisition organization of the Jet Propulsion Laboratory, the Air Force Eastern Test Range, the Spaceflight Tracking and Data Network, and the NASA Communications Network of the Goddard Space Flight Center.

Volume I covers the Tracking and Data System support for the mission Dec. 4, 1969 to April 1, 1972, which is from the prelaunch planning phase through the second trajectory correction maneuver plus one week. The second trajectory correction maneuver was performed March 24, 1972.

Volume II will contain a description of the TDS flight support from the second trajectory correction maneuver through the cruise phase, including passage through the asteroid belt, which is from April 1, 1972 to Dec. 3, 1973.

Volume III will cover TDS flight support of the Jupiter flyby to end of nominal mission, which is from Dec. 4, 1973 to June 1, 1974.

Volume IV will cover TDS flight support of the first year of the extended mission which is from June 1, 1974 to June 1, 1975. The extended mission will henceforth be reported on an annual basis until the Pioneer 10 spacecraft is beyond the range of the Deep Space Network.

ACKNOWLEDGEMENT

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ABSTRACT

This report describes the Tracking and Data System support of the launch, near-Earth, and deep space phases of the Pioneer 10 mission, which sent a Pioneer spacecraft into a flyby of Jupiter that would eventually allow the spacecraft to escape the solar system. The support through the spacecraft's second trajectory correction is reported. During this period, scientific instruments aboard the spacecraft registered information relative to interplanetary particles and fields, and radio metric data generated by the network continued to improve our knowledge of the celestial mechanics of the solar system. In addition to network support activity detail, network performance and special support activities are covered.

I. INTRODUCTION

A. Mission Design and Objectives

The Pioneer 10 Mission was designed primarily to conduct exploratory investigations beyond the orbit of the planet Mars of the interplanetary medium, ascertaining the nature of the asteroid belt and probing the environmental and atmospheric characteristics of the planet Jupiter during a flyby on Dec. 4, 1973 after a journey of 992×10^6 km.

The secondary objective of this NASA mission was to advance technology and operational capability for long-duration flights to the outer planets, i.e., a Viking orbiter/lander, a Venus/Mercury, outer planet, and comet encounter probes. The spacecraft also was designed to eventually escape from the solar system.

Being the first material object of mankind likely to leave the solar system, it was deemed appropriate that the Pioneer 10 spacecraft carry "a message from Earth." This message was designed to indicate the locale, epoch, and nature of its builders to any advanced technological society that might intercept the spacecraft. Appendix A presents a sketch of the gold-anodized aluminum engraved plate, a key to the message, and the story of its conception.

Launched March 3, 1972 (GMT) within a period of best opportunity for near Jupiter flyby, which opportunity occurs every 13 months, Pioneer 10 spacecraft continued to be successfully supported at the end of the period covered by this document. On March 31, 1972, the spacecraft was 21,589,800 km from Earth and 161,806,350 km from the Sun.

B. Pioneer Project Background

Initiated in 1958 as part of the U.S. participation in the International Geophysical Year, the Pioneer Project evolved the following generations of missions:

(1) First Generation: Pioneers 1 through 5, 1958 to 1960 (approved March 27, 1958). These missions were lunar probes assigned to the National Aeronautics and Space Administration (NASA) by Executive Order on Oct. 1, 1958, the day that NASA became an independent agency. NASA delegated to the Air Force and the Army

the authority to direct these projects. The Jet Propulsion Laboratory was responsible for designing and building Pioneers 3 and 4. Pioneer 5 was developed by the Space Technology Laboratory (STL), now TRW. Pioneer 5, in closing out the first Pioneer generation, remained active in space more than 3 months and was not lost to Earth contact until it was 27.5 million km from Earth. This was a new record.

(2) Second Generation: Pioneers 6 through 9 and E, 1965 to 1969 (approved Nov. 9, 1962); managed by Ames Research Center (ARC) for NASA.

(3) Third Generation: Pioneer F (designated "10" after launch in 1972) and Pioneer G, to be launched in 1973 (approved Feb. 8, 1969); managed by Ames Research Center for NASA.

The second and third generation Pioneers were specified by ARC and designed and built by TRW.

1. Second-Generation Spacecraft. The second generation of spacecraft continued to furnish scientific and engineering data at the conclusion of the report period of this document. The assigned mission objectives and design life-time goals had been exceeded as a result of judicious redundancy in the design of the spacecraft and close monitoring of the spacecraft performance.

This longevity of the Pioneers 6 through 9 spacecraft extended the state-of-the-art for deep space mission planning, design, and operations, and enabled mission planners to realistically consider the extended probes of space and the planets. The primary objective of the Pioneer 6 through 9 missions was to accumulate scientific data from deep space, providing a study of the magnetic field, spatial plasma, cosmic rays, high-energy particles, electron density, electric fields, and cosmic dust within a region of 0.75 to 1.20 AU from the Sun. Near-real time data reduction and analysis was a part of a Pioneer space weather report teletyped regularly to the U.S. Space Disturbance Forecast Center.

Various specific engineering mission objectives were accomplished through use of the Pioneer signal from Pioneers 6 through 9. The effect of charged particles on the accuracy of the tracking doppler data was investigated. Pioneer data contributed to network corrections to doppler orbit determination data. Very accurate station location information was obtained not only for the NASA Space Network but also for large antennas owned by other governments. These results were valuable in support of the Apollo trajectory effort.

All the second-generation spacecraft were launched from Cape Kennedy Space Flight Center in Florida. Launch dates, heliocentric orbits, and number of scientific instruments carried were:

Pioneer 6: Dec. 16, 1965, inward orbit, six instruments.

Pioneer 7: Aug. 17, 1966, outward orbit, six instruments.

Pioneer 8: Dec. 13, 1967, outward orbit, 7 instruments.

Pioneer 9: Nov. 8, 1968, inward orbit, 7 instruments.

Pioneers 8 and 9 launch vehicles also carried "piggyback" an MFSN Test and Training Satellite (TETR-2), which was separated in Earth orbit and used in command simulation for Apollo station training.

A Pioneer E spacecraft in the same generation was launched on Aug. 27, 1969 but destructed after 438 sec of flight. A destruct signal was transmitted because of a loss of hydraulic pressure in the first stage.

2. Achievements. Achievements of the first- and second-generation Pioneer spacecraft are summarized in Table 1.

3. Pioneer G. The other spacecraft in the third generation, Pioneer G, was scheduled for launch toward Jupiter in April 1973. Trajectory and sequence of events up to Jupiter flyby were designed to be similar to those of Pioneer 10. However, Pioneer G's trajectory profile was such that the spacecraft would stay within the solar system as a solar orbiter after Jupiter flyby.

C. Pioneer Project Management

The management structure of the Pioneer 10 project is shown in Figure 1. The NASA Headquarters Office of Space Sciences was responsible for the planetary programs. The Pioneer Program Manager headed all activities of the Pioneer Project. NASA's Ames Research Center (ARC), located at Moffett Field, Calif., was in charge of all management coordination and control aspects for the Pioneer missions. The Pioneer Project Office was headed by the Pioneer Project Manager who was supported by a Project staff.

They assisted him in the areas of management control mission analysis, launch coordination, nuclear power, scientist coordination, contracts, magnetics, reliability, and quality assurance.

In addition, seven government-sponsored organizations supported the Pioneer 10 Mission with specific services. The Space Nuclear Systems Division of the Atomic Energy Commission controlled the development and production of the radioisotope thermoelectric generators (RTGs). Teledyne Isotopes was the prime contractor for these generators. The Experiment System, Spacecraft System, and Mission Operations System were supported by individual teams of the Ames Research Center. The spacecraft contractor was TRW Systems Group, TRW, Inc. The Bendix Field Engineering Corporation provided the electronic data processing support for the Mission Operations System. The Jet Propulsion Laboratory was the tracking and data acquisition center of the Pioneer missions and planned, managed, and controlled the support during the near-Earth and deep space phases of the missions. The Launch Vehicle System was managed by the Lewis Research Center, and the contractors were the Convair Division of General Dynamics and McDonnell Douglas Corp. The Unmanned Launch Operations of the Kennedy Space Center was supported by the Convair Division of General Dynamics.

Table 1. First- and second-generation Pioneers

Pioneer	Launched	Achievements
1	1958	Found extent of Earth's radiation bands
2	1958	Improved data on flux and energy levels of particles
3	1958	Discovered second radiation belt near Earth
4	1959	Extended measurements to within 37, 300 miles of the Moon
5	1960	Obtained solar flare and wind data
6	1965	Continued to report data after traveling 3. 3 billion miles
7	1966	Reported data during solar cycle from widely separated points within 1. 125 AU of the Sun
8	1967	Reported data during solar cycle from widely separated points within 1. 09 AU of the Sun
9	1968	First spacecraft to transmit at three frequencies through the solar corona to measure the electron concentration

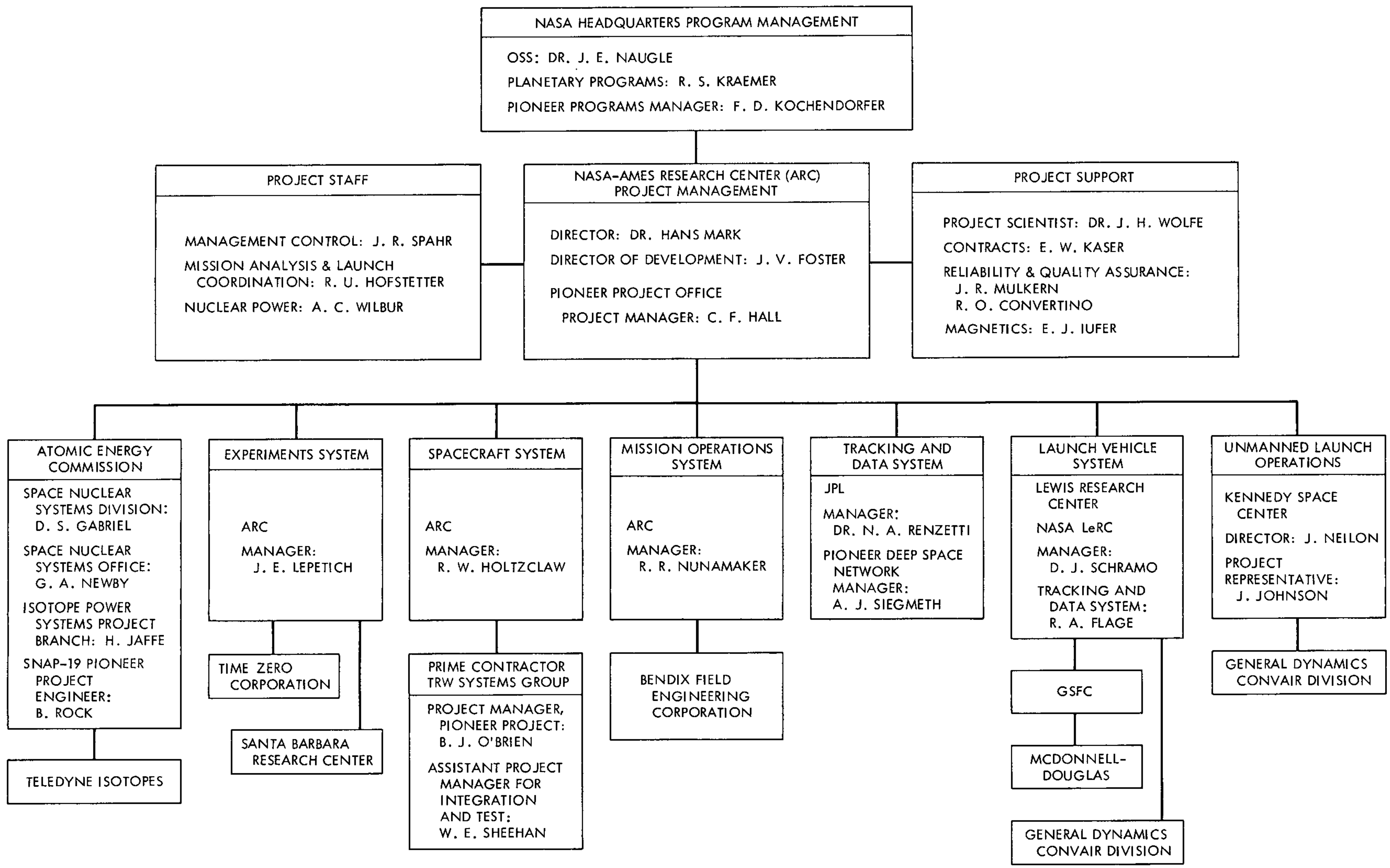


Fig. 1. Pioneer F and G Program Management Team

II. TRACKING AND DATA SYSTEM

A. TDS Organization

The Tracking and Data System (TDS) provided support to Pioneer 10 for all tracking and data acquisition (TDA) activities required to meet mission objectives. (The tracking and data function was defined as the acquisition and transmission of information that enabled the determination of space vehicle position, velocity, direction, system and subsystem performance, and experiment measurements, all with respect to a common time base.)

The TDS actually was an operationally unified collection of TDA resources. These required resources were provided by organizations under the Department of Defense (DOD), Goddard Space Flight Center (GSFC), and the Jet Propulsion Laboratory (JPL), referred to collectively as the TDA Support Agencies.

Four major organizations provided facilities and support for the TDS, with the Jet Propulsion Laboratory (JPL) designated as the TDA Support Center for the Pioneer 10 mission and, thereby, responsible for overall achievement of the tracking and data acquisition objectives and functions.

1. Air Force Eastern Test Range. The U. S. Air Force, through the Air Force Systems Command and the National Range Division, managed the Air Force Eastern Test Range (AFETR) for the DOD. As lead range for the Pioneer 10, the AFETR arranged the required support from DOD resources. The AFETR provided prelaunch and launch support and near-Earth TDS support for Pioneer 10.

2. Spaceflight Tracking and Data Network. Formerly the Manned Space Flight Network (MSFN) and the Space Tracking and Data Acquisition Network (STADAN), the Spaceflight Tracking and Data Network (STDN) was operated for NASA by the GSFC. The STDN provided near-Earth tracking and data acquisition support for Pioneer 10 spacecraft.

3. NASA Communications Network. The NASA Communications (NASCOM) network, operated for NASA by the GFSC, provided ground communications circuits required for support of Pioneer 10 mission.

4. Deep Space Network. The Deep Space Network (DSN), operated for NASA by JPL, provided support in the areas of deep space tracking,

radio metric, and telemetry data, and spacecraft command transmission. This support was provided by the DSN through three component facilities: (1) Deep Space Instrumentation Facility (DSIF), (2) Ground Communications Facility (GCF), and (3) Space Flight Operations Facility (SFOF). Data and information flowed among the three facilities within six basic DSN systems: telemetry, tracking, command, monitor, simulation, and operations control, all a part of the DSN Mark III System. Details of the DSN facilities and systems are given later in this document.

5. Tracking and Data System Manager. As required, the Director of the TDA Support Center designated a TDS Manager to be responsible for the TDA function. Basically, he acted as the interface between the Project and the TDS support agencies to match requirements with the capabilities of the support agencies to establish a compatible integrated system of TDA resources as the "Tracking and Data System."

The TDS Manager reviewed the NASA Support Instrumentation Requirements Document (SIRD), which was prepared by the Pioneer Project Manager and approved by NASA Headquarters, Office of Space Sciences, and Office of Tracking and Data Acquisition. It was also the TDS Manager's function to identify any inconsistencies and to ensure that all requirements were identified with the DOD or NASA organizations. He also assured the Pioneer Project that the NASA Network Support Plan (NSP) was prepared. He reviewed the NSP and DOD Program Support Plan (PSP) to identify any conflicts, duplications, and possible omissions. He also certified that all support planning was properly located and complete. The TDS Manager was accountable both to the Pioneer Project Manager to which he was assigned and to the assistant laboratory director for TDA at JPL.

6. TDS Support Configuration. Because of support agencies' responsibilities and capabilities, the nature of the project requirements, spacecraft performance characteristics, and flight profiles, a major change in the required support configuration occurs naturally as the spacecraft proceeds from the near-Earth phase to the deep-space phase of flight. Tracking and Data System preflight planning and flight operations support are oriented to coincide with these two phases. So, in effect, the TDS manager established one system configuration for the near-Earth phase and another for the deep-space phase.

a. Near-Earth phase. The near-Earth phase began with the launch countdown and ended when the spacecraft was in continuous view of the DSN stations. Normally, resources from all three support agencies comprised the configuration for the near-Earth phase. Data acquisition was provided by the AFETR land stations, ships, and aircraft; by STDN and by DSN stations in the near-Earth zone of operations. The John F. Kennedy Space Center (KSC), a field installation of NASA, managed certain instrumentation facilities available for TDA support. Support required from these sites was arranged through appropriate existing documentation. KSC was also the NASA single point-of-contact with the AFETR. Support required from the AFETR was contracted through the KSC.

For the near-Earth phase, the TDS made available for Pioneer 10 the resources of the AFETR, KSC, the Spaceflight Tracking and Data System, the DSN, and the NASA Communications System.

b. Deep-space phase. The deep-space phase began with deep-space station continuous view and continues until the end of mission. Normally, the three facilities of the DSN are the only resources used to support data acquisition and processing requirements during this phase. The NASCOM and GCF resources were employed for data transmission.

7. TDS Communication and Coordination. The complexity of the Project and TDS organization made it essential that a common means of communicating and coordinating tracking and data acquisition requirements, plans, procedures, reports, etc., existed between the Project and the TDS, and also between support agencies. In addition to the frequent contacts which were made through the day-to-day business, two basic established methods provided the required information flow: (1) via standing committees and scheduled meetings, and (2) via formal documentation systems. Specific items under each of these categories were as follows:

a. Committees and meetings

(1) Planetary and Interplanetary Projects Tracking, Telemetry, and Communications Panel. This panel, chaired by the Tracking and Data System Office, met approximately twice yearly, and its membership included representatives of the Pioneer and other unmanned planetary and interplanetary projects, support agencies, launch vehicle agencies, and NASA Headquarters.

(2) Project/Tracking and Data System Quarterly Reviews. Project and Tracking and Data System personnel met quarterly with NASA Headquarters representatives, reviewed progress, and resolved problem areas.

(3) Ad Hoc Committees. The representation and frequency of meetings varied as required for the stated purposes.

b. Applicable documents. Support Agency and Tracking Data System documents which were pertinent to the tracking and data acquisition function are only briefly discussed here.

As separate entities supporting the Tracking and Data System, each support agency maintained its own internal documentation system. Without altering or controlling these internal documentation systems (e.g., DSN Documentation System, National Range Universal Documentation System, and Goddard Space Flight Center Documentation), the Tracking and Data System Manager defined a Tracking and Data System documentation system which encompassed and supplemented the Support Agency documents. The Tracking and Data System Documentation System provided a comprehensive, unified description of the various documents produced in meeting the Project's tracking and data acquisition requirements. An outline of the documentation system is included here.

(1) Tracking and Data System Standard Practices. These were prepared by the Tracking and Data System Manager. Of particular importance to the Project was the Tracking and Data System/Project Standard Technical Interface Document.

(2) Tracking and Data System Estimated Capabilities for the Pioneer F and G Missions (Doc. 607-96, dated Dec. 15, 1969). This document was prepared by the Tracking and Data System Manager, based on inputs from the Near-Earth and Deep Space Support Agencies.

(3) Tracking and Data System Support Plan for the Pioneer F and G Missions. In actuality, this is comprised of the NASA Support Plan (NSP) and the Program Support Plan (PSP) for the Pioneer F and G Missions. It was prepared by the DSN Manager and by AFETR, respectively.

(4) Tracking and Data System Test Plan for the Pioneer F and G Missions. This document provided guidelines to and encompassed the near-Earth phase and the Deep Space Network test plans. It consisted of plans, procedures, and reports.

(5) Tracking and Data System Operation Plan for the Pioneer F and G Missions. This encompassed the near-Earth phase and Deep Space Network operations plans. Each plan contained numerous volumes regarding detailed commitments, interfaces, system descriptions, operational procedures, and directives. It included the Air Force Eastern Test Range Operations Directive and the Manned Space Flight Network Operations Plan.

(6) Tracking and Data System Support Reports for Pioneer F and G. These reports were to be comprised of Tracking and Data System periodic progress reports and a final report.

8. TDS/Pioneer Project Planning Organization. The Pioneer 10 premission planning period spanned from project inception through operational readiness testing prior to launch.

The JPL field station, AFETR (JPL/ETR) organization operated by JPL Section 293, had the responsibility to plan and coordinate the required support by agencies involved in the support of the near-Earth phase of the Pioneer 10 Mission. This organization advised the Pioneer Project on the long-term near-Earth TDS capabilities, and reviewed the TDA requirements and interface problems. Near-Earth phase assistance was provided on the SIRD, NSP, Program Requirement Document (PRD), PSP, Operations Directive (OD), OR, Operations Plan (OP), and Tracking Instruction Manual (TIM). This organization planned and conducted the preflight compatibility verification and operational tests of the near-Earth system. Support was provided for all interface reviews, analyzed plans and test results, including the required reports and documents. The near-Earth phase Project Engineer also acted collectively as an Assistant TDS Manager in matters related with the near-Earth function.

For the preparation and operation of the Deep Space Network a DSN/Pioneer F and G Operational Support and Planning Group was established. This organization consisted of a DSN Manager, a DSN Project Engineer and a team of systems and facility-oriented project engineers.

This organization was directly responsible to the Tracking and Data System Manager.

a. DSN Manager. The DSN Manager was responsible for the planning and implementation of DSN support for the Pioneer Project. He was appointed for the Pioneer Project. He was appointed for the Pioneer Project by JPL. The DSN Manager was responsible for developing the support necessary to meet all flight project tracking and data acquisition requirements and for the operational readiness of the DSN. In addition, his functions covered the flight operations to the end of the mission supported within the capabilities and resources of the DSN. The DSN Manager was responsible for the reviewing and clarification of the Pioneer F and G SIRD, for the preparation of the DSN portion of the NASA Network Support Plan, progress reports, and final report on implementation and readiness of the DSN for flight support. He conducted and documented pre- and post-flight operational readiness reviews and actual performance reviews of the network. He recommended changes to requirements and/or resources in order to meet mission objectives; observed and critiqued the qualitative and quantitative performance of the DSN during flight operations, and terminated DSN support with approval of the flight project in a manner appropriate to the original commitment. He certified to the TDS Manager the completion of task assignments and recommended actions in case of incomplete tasks; prepared recommendations for improvements in flight project support, and provided the necessary interfaces between the DSN and other elements of the TDS. The DSN Manager also functioned as assistant TDS Manager, when requested.

b. DSN Project Engineer. The DSN project engineer was responsible for planning and coordinating all interface engineering. His function was to bring the DSN to a state of readiness and thus fulfill commitments made by DSN management in response to the particular Pioneer Project requirements. He participated on the TDS planning team, under the TDS Manager and the DSN Manager during the early planning phases of the TDS DSN/Project activities. He assisted in the definition of the data flow interfaces between the DSN and the other elements of the TDS. The DSN Project Engineer participated on the DSN Capabilities Planning Team and assisted the DSN Manager in defining DSN Systems Functional Specifications. In response to the TDS and DSN milestone schedule, he produced and maintained a detailed implementation schedule reflecting the plan and status of DSN implementation, integration testing, training, documentation, and operations. He also coordinated the Interface Engineering Team; initiated actions necessary to complete events and tasks to meet the requirements of the NSP. He evaluated the DSN performance by comparing actual flight support with DSN commitments and Project requirements. The DSN Project Engineer was also responsible for assuring that scheduling inputs necessary for flight project support were submitted for the DSN Network Scheduling Office. He also participated in Mission Operations Working Group meetings established by the Pioneer Project. He was accountable to the DSN Manager and to the Chief of Pioneer Mission Operations during all flight support activities.

c. Interface Engineering Team. The membership of the Pioneer F and G Interface Engineering Team consisted of engineering representatives of DSIF Operations Engineering, DSIF Operations Planning, DSIF System Data Analysis, GCF Operations, SFOF/GCF Development, SFOF Data System, SFOF Data Processing, SFOF Support, DSN Simulation, and DSN System Engineering.

To assure that all Project/DSN interfaces were properly identified, the Pioneer Project was encouraged to participate in the team's activities. The Interface Team produced Volumes II through VIII of the DSN Operations Plan, DSN Test Plan, and Operations Reports. The team also performed detailed design functions pertaining to hardware/software and procedural interfaces, and team members performed advisory and operational roles during mission operations.

d. Other teams. The efforts of the systems- and facility-oriented Project Engineers were coordinated by the DSN Project Engineer. Through this organization, talents available in the DSN were applied to problems confronting the Pioneer planning organization. These people also supported mission design teams, as follows:

(1) A Capability Planning Team staffed by DSN design personnel with a spacecraft telecommunication design and a mission operations representative from ARC. This team developed functional block diagrams and mission control interfaces of the DSN.

(2) A Telecommunication Design Team chaired by ARC which consisted of spacecraft telecommunication engineers from ARC and TDS representatives from JPL.

(3) A Mission Operations Design Team chaired by ARC, with the DSN Project Engineer acting as a member of this team, for developing specific requirements for all elements of the ground system supporting the deep-space phase of these missions.

9. JPL Organizational Structure. Under the Director of the Jet Propulsion Laboratory, the Assistant Laboratory Director for Tracking and Data Acquisition headed the system- and project-oriented functional organizations responsible for the Deep Space Network. The Engineering and Operations Section provided the System and Project Engineering functions and the DSN Operations Organization. The DSN residents acted as liaison between the DSN and the Deep Space Stations. The Mission Support Office was headed by the TDS Manager. The DSN Managers provided the support for the specific current and future planetary and interplanetary missions. The DSN Systems Manager was responsible for the design of the DSN systems. The Tracking and Data Acquisition Program Control Office was engaged in the financial, budgeting, and control functions.

Under the Assistant Laboratory Director for Technical Divisions, the Telecommunications Division was responsible for research, design, and implementation of the Deep Space Stations. The Mission Analysis Division was in charge of the space navigation and orbit determination functions. It assisted DSN in the areas of research related to the radio metric tracking function. The Office of Computing and Information Systems headed the Data Systems Division which was responsible for the research, design, and implementation of the SFOF, and the Ground Communications Facility. The Facility System Engineers who handled the DSN Telemetry, Command, Tracking, Monitoring, Simulation, and Operations Control Systems were resident in the Telecommunications and Data Systems Divisions and interfaced with the corresponding DSN Systems engineers resident in the DSN Engineering and Operations Sections.

The JPL Systems Test and Launch Operations Section supported the JPL/ETR Station. This station was engaged in the Near-Earth Phase planning activities of the Pioneer 10 Mission.

Figure 2 shows the JPL divisions engaged in support of Pioneer 10 mission and Figure 3 shows the TDS support for Pioneer 10 mission. Figure 4 presents the DSN Project Engineering organization for Pioneer 10 support.

Table 2. DSN Instrumentation Facilities in Support of Pioneer 10 to April 1, 1972

Station number and name	Location	Year of initial operation	Antenna diameter, mount type	Pioneer 10 support function
11, Pioneer[a]	Goldstone DSCC, Calif.	1958	26 m, polar	Cruise
12, Echo	Goldstone DSCC	1962	26 m, polar	Cruise
14, Mars	Goldstone DSCC	1966	64 m, az-el	Mission enhancement and Jupiter encounter
41, Woomera	Tidbinbilla DSCC, Australia	1960	26 m, polar	Cruise
42, Weemala[a]	Tidbinbilla DSCC	1965	26 m, polar	Cruise
51, Johannesburg	Johannesburg, South Africa	1961	26 m, polar	Launch and cruise
61, Robledo[a]	Robledo DSS, Spain	1965	26 m, polar	Cruise
62, Cebreros	Cebreros DSS, Spain	1967	26 m, polar	Cruise
71, Cape Kennedy	Cape Kennedy, Fla.	1965	1.2 m, manual	Spacecraft/DSN compatibility verification
CTA 21 (JPL Compatibility Test Area)	Pasadena, Calif.	1968	None	Spacecraft/DSN compatibility testing

[a]Mutual stations; all other 26-m-diam antenna stations are DSN standard equipped.

B. DSN Facilities and Basic Systems

1. Station Support. The DSN instrumentation facilities that supported Pioneer 10 spacecraft from launch to April 1, 1972 are presented in Table 2.

The Venus Deep Space Station (DSS 13) at the Goldstone Deep Space Communications Complex (GDSCC) is not listed, however, because the DSN station was a research and development facility used to demonstrate the feasibility of new equipment and methods to be integrated into the operational network. Besides a 26-m-diam az-el mounted antenna, DSS 13 had a 9-m-diam az-el mounted antenna for testing the design of new equipment and support of ground-based radio science.

The Pioneer, Weemala, and Robledo Deep Space Stations (DSSs 11, 42, and 61) were "mutual" stations, while all other 26-m-diam stations supporting Pioneer 10 spacecraft had standard DSN facilities. Formerly, MSFN "wing" stations, DSSs 11, 42, and 61, differed from the DSN standard stations in that the STDN tracking data processor (TDP) was used instead of the DSN TDP; the STDN antenna position programmer also was added. The TDP, in conjunction with the antenna-pointing subsystem, provided the Mutual station with the necessary capability of transmitting radio metric data to the SFOF via high-speed data lines or teletype circuits. However, there was only one format from the Mutual stations for the teletype data in contrast to the multiple formats available from the DSN standard stations.

At the time of this report, two additional 64-m-diam antenna stations, Ballima Deep Space Station (DSS 43) in Australia and Rio Cofio (DSS 63) in Spain were under construction with completion expected in July 1973.

Overseas stations were normally staffed and operated by government agencies of the respective countries, except for a temporary staff of the Madrid DSCC, with some assistance from the U. S. support personnel.

2. DSN Mark III System. The DSN supported the Pioneer 10 flight project by tracking the spacecraft through the multimission DSN Mark III System. The actual planning and implementation of this complex system was directed and controlled by a program management structure. After the specific flight support requirements were established, these requirements were merged with the network's standardized multimission type capabilities to assure cost-effective capabilities compatible with both the Pioneer

third-generation missions and most of the future NASA planetary and interplanetary missions. Specific management controls were applied to assure that the DSN Mark III System, as planned for Pioneer 10, was ready for mission support, on time, within the budget, and with technical excellence.

The Mark I and Mark II Systems used in the 1960s for Pioneer missions were designed to meet the requirements of each particular flight project. They required many mission-dependent equipments and resources, resulting in a number of project independent/dependent interfaces. Then, because of changes in the state-of-the-art of deep space telecommunications, flight projects developed their own demodulation and command equipment with the DSN stations being constrained by the installation and operation of mission-dependent equipment at all deep space stations. With the network configured specifically for each project, the standardization and efficient use of the network's resources were not possible.

The DSN started the detailed system design of the Mark III System in 1968, and began implementation of this third-generation system in 1969. The phase-over between the Mark II and Mark III Systems occurred during the 1971 calendar year. The network's configuration for the Pioneer 10 Mission at launch resembled the major features of the Mark III System, which included the basic support systems, for the first time.

The DSN Mark III system provided the following functions:

a. Acquisition of spacecraft telemetry data using standardized techniques. The network operated at higher and more valuable telemetry rates, for longer periods of time, covering longer distances and supporting multiple spacecraft simultaneously. The capability also existed to interact efficiently with larger and more complex spacecraft and science packages.

b. Positive control of spacecraft using standardized commanding techniques. The capabilities accommodated higher command bit rates covering longer deep space distances when operating directly from the control center by the flight project mission operations team. The advanced command capabilities made possible simultaneous control of multiple spacecraft and control of a variety of spacecraft types and scientific experiments.

c. Highly accurate radio navigation from Earth-based stations. The improved radio metric tracking system furnished precise range and range rate data at longer distances and made simultaneous tracking and guidance of multiple spacecraft possible. A more accurate orbit computation capability permitted the accommodation of more precise planetary ephemerides and astrodynamical constants.

d. Support of complex mission operations requirements. It was possible to operate independently and simultaneously multiple-flight missions with some mission support areas at remote locations. The real-time evaluation capability to monitor the network's qualitative and quantitative performance assured minimization of loss of data and permitted the identification of ground versus spacecraft failures.

e. Simulation of complex space flight operations. An extensive simulation capability permitted spacecraft and ground network failure mode testing for flight operations training, and could also be used as a diagnostic tool for ground network testing and fault isolation.

3. Systems-Facilities Relationship. Figure 5 depicts the functional relationship between the six DSN systems and the three DSN facilities. The tracking, telemetry, and command systems performed the basic functions of the mission support. The simulation, monitoring, and operations control systems were necessary to test the facilities, to train the operations teams, to monitor all DSN systems, and to control the operations of the DSN systems.

Block diagrams of the DSN systems illustrating the planned functions of each DSN system are presented in Appendix B.

4. Facilities. The facilities needed to carry out the basic functions evolved in three technical areas.

a. Deep Space Instrumentation Facility. The interface was through the RF link of the deep space stations (Table 2) and the telecommunications with the spacecraft.

To enable continuous radio contact with the spacecraft, the deep space stations were located approximately 120 deg apart in longitude; thus, a spacecraft in deep space flight was always within the field-of-view of at least one station, and for several hours each day might be seen by two stations. Since most spacecraft on deep space missions traveled within 30 deg of the equatorial plane, the deep space stations were located within latitudes of 45 deg north or south of the equator. All deep space stations operated at S-band frequencies: 2110 to 2120 MHz for Earth-to-spacecraft transmission and 2290 to 2300 MHz for spacecraft-to-Earth transmission.

To provide sufficient tracking capability to enable useful data returns from around the planets and from the edge of the solar system, two additional 64-m-diam antenna stations were under construction at Madrid, Spain, and Tidbinbilla, Australia, to operate in conjunction with the Mars Deep Space Station (DSS 14 in the Goldstone DSCC) by the middle of 1973.

b. Ground Communications Facility. Earth-based point-to-point voice and data communications from stations to control center was provided. In providing these capabilities, the GCF used the facilities of the worldwide NASA Communications Network (NASCOM) for all long distance circuits except those between the SFOF and the Goldstone Deep Space Communications Complex. Communications between the Goldstone DSCC and the SFOF were provided by a microwave link directly leased by the DSN from a common carrier.

c. Space Flight Operations Facility. This served as the control center for both network control function and mission control support.

Network and mission control functions were performed at the SFOF at JPL. The SFOF received data from all deep space stations and processed that information required by the flight project to conduct mission operations.

These functions were carried out: (1) real-time processing and display of radio metric data; (2) real-time and nonreal-time processing and display of telemetry data; (3) simulation of flight operations; (4) near real-time evaluation of DSN performance; (5) operations control and status and operational data display; and (6) general support such as internal communications by telephone, intercom, public address, closed-circuit TV, documentation, and reproduction of data packages. Master data records of science data received from spacecraft also were generated. Technical areas were provided for flight project personnel who analyzed spacecraft performance, trajectories, and generation of commands.

5. Systems

a. Telemetry. The DSN Telemetry System provided the capability for acquisition, conversion, handling, display, distribution, processing, and selection of telemetry data. Telemetry data are defined as the engineering and science information, including video, received from flight spacecraft via the telecommunications links.

The basic characteristics of the DSN Telemetry System are:

(1) Centralized control from the SFOF of the DSN Telemetry System configuration. This included the automatic execution by the deep space stations of configuration and telemetry standards and limits messages compiled by the DSN Telemetry Analysis Group, centrally located in the SFOF.

(2) Real-time reporting of DSN Telemetry System status to DSN Operations Control with digital television (DTV) displays through the Monitor System.

(3) Ability to handle a wide range of spacecraft data rates while simultaneously supporting multiple-project and multiple-data streams.

(4) Capability in the SFOF to process data in real time from one or more deep space stations and missions simultaneously without interference; capability to support missions in both test and flight operations phases.

(5) Capability at each deep space station for subcarrier demodulation, bit detection, and data decoding, preparation of a digital Original Data Record (ODR); and formatting for a high-speed transmission to the SFOF.

b. Command. The DSN Command System provided the means to generate and transmit commands to appropriate spacecraft-related verification, display, and control functions which were incorporated within the system to ensure the success of command operations. The DSN Command System provided a project with the means to command the spacecraft from the SFOF. The project could enter commands by input/output devices in the SFOF, or by high-speed data lines into SFOF from a remote location.

c. Tracking. The DSN Tracking System provided validated, precision radio metric data to flight project users by performing the tasks of data acquisition, handling, editing, calibration, display, distribution, validation, and prediction. In addition, a tracking data selection process was made available to the project users.

DSN metric data were defined as angle and doppler data generated by the DSIF and associated data such as lock status, time, frequency, data condition, and calibration.

The key characteristics of the DSN Tracking System were:

(1) Processing of DSN metric data in any standard DSN Tracking System format.

(2) Multimission capability to perform:

  (a) Simultaneous tracking and data acquisition of several spacecraft within the DSIF by the use of multiple DSSs.

  (b) Data handling at DSSs and transmission of data to the SFOF.

d. Simulation. The purpose of the DSN Simulation System was to create realistic simulation of expected operational environments for testing and training to prepare the DSN and its users for support of planned missions. This system also provided a capability for DSN and spacecraft failure mode isolation.

e. Monitor. This system provided the capability for sensing strategic characteristics of the various elements of the DSN, processing, displaying the data for use by DSN operations personnel, and for storing data for later analysis or reference. Monitor data were used for determining DSN status and configurations, for guidance in the direction of operations, for furnishing alarms of nonstandard conditions, and for analysis of the quantity and quality of data provided to the flight project.

f. Operations control. This system was the mechanism necessary for directing the operations of the DSN facilities and systems in support of flight projects. The functions of operations control were affected by both the DSN operations chief and the facility chiefs. Plans and procedures assured coordination and provided real-time direction in the event of anomalous conditions so that optimum support to flight projects was provided. The operations control functions were operating the network, scheduling, discrepancy reporting, sequence-of-events generation, master data records production, and operational document control.

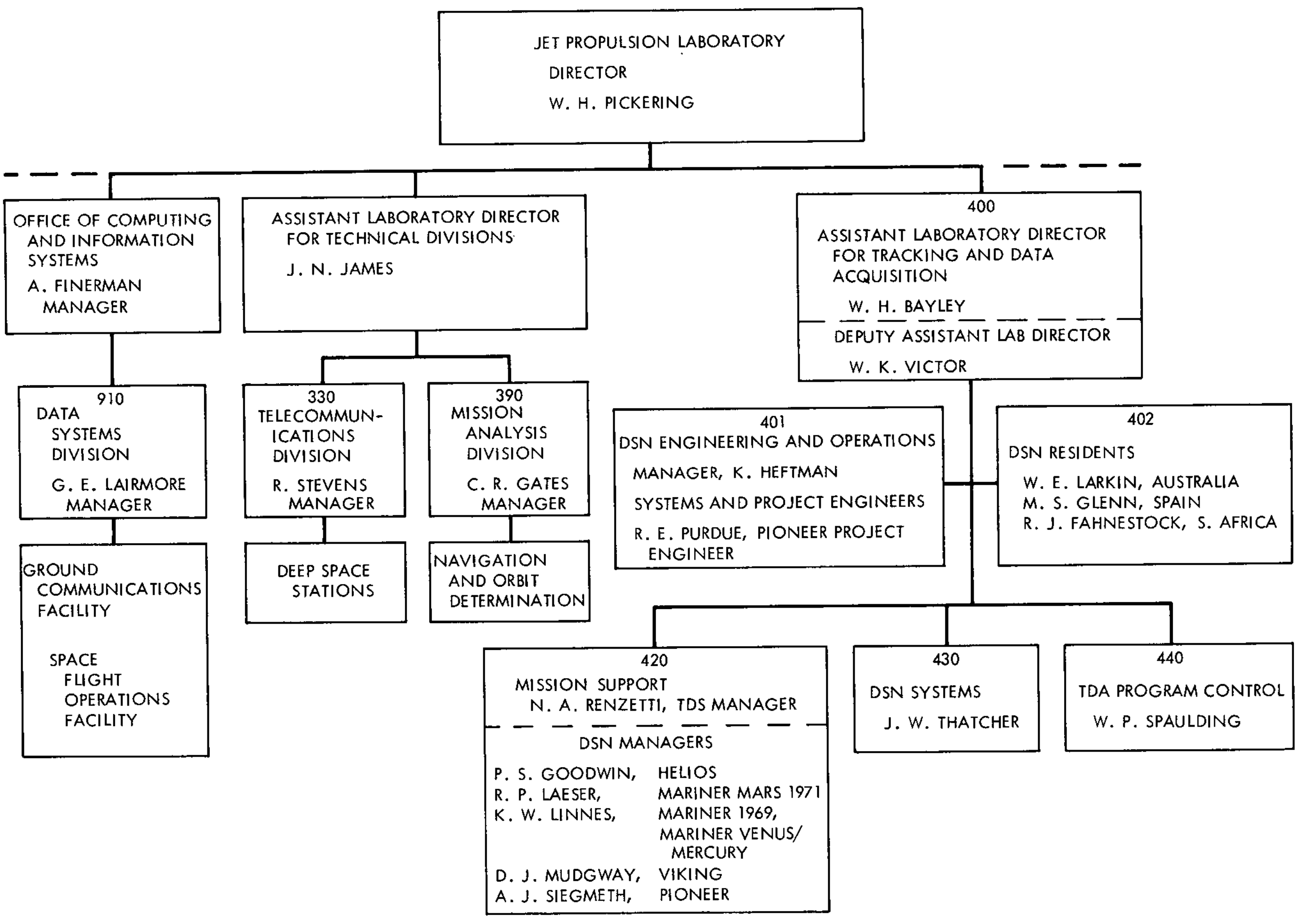


Fig. 2. JPL divisions engaged in TDA support of Pioneer 10 Mission

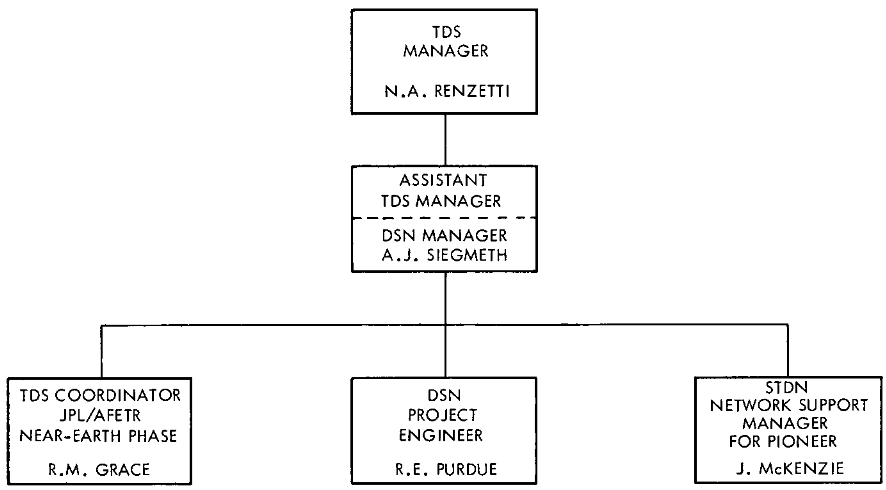


Fig. 3. TDS organization for Pioneer 10 Mission

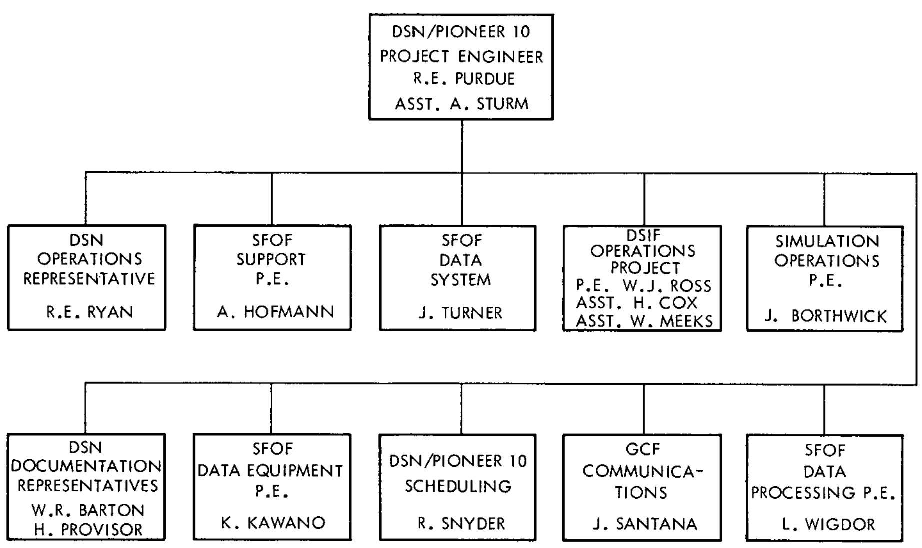


Fig. 4. DSN project engineering organization for Pioneer 10 Mission

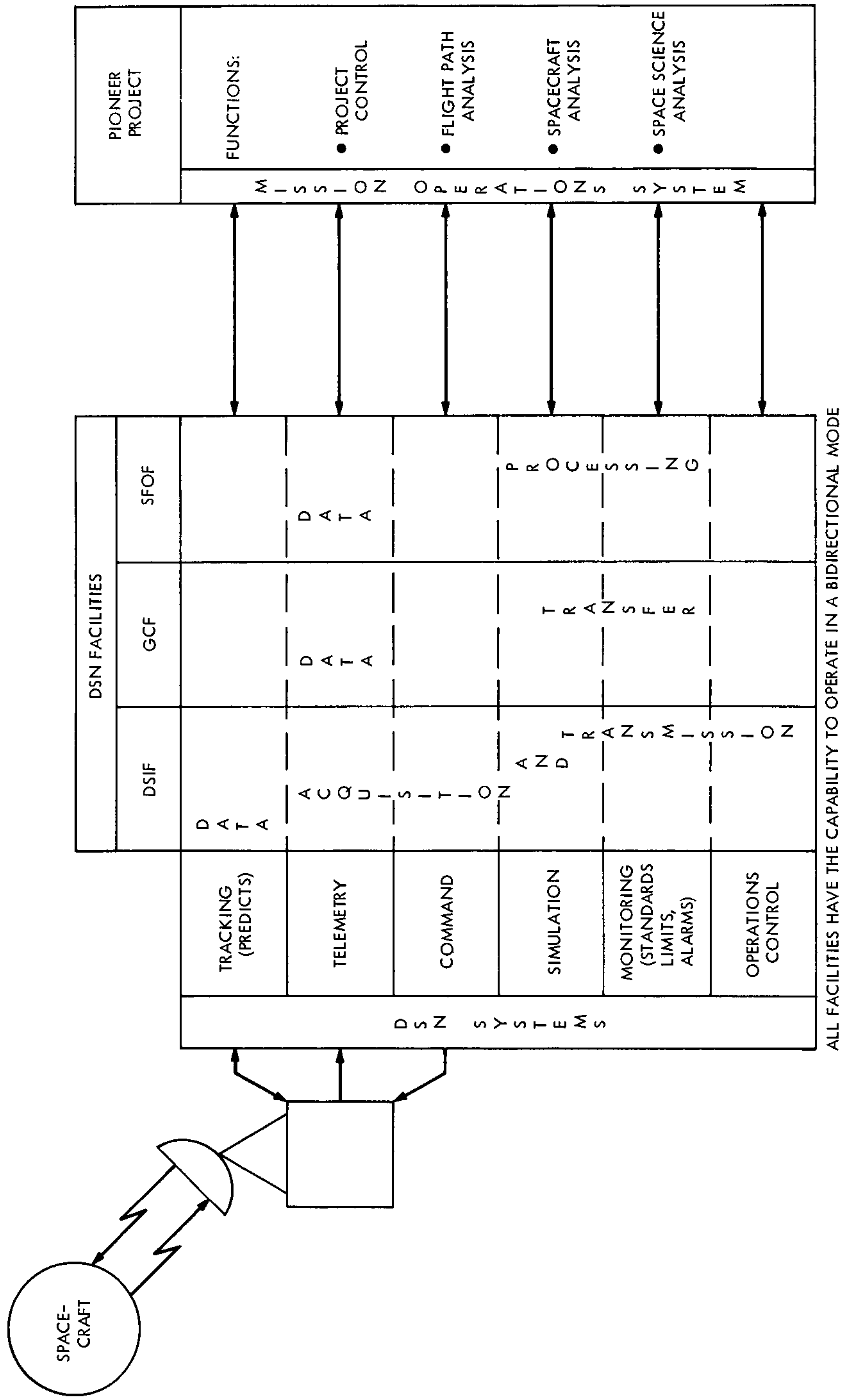


Fig. 5. Deep Space Network Systems

III. MISSION PROFILE

A. Flight Description

1. Over-all Trajectory. The powered flight trajectory for Pioneer 10 spacecraft was direct ascent; the interplanetary trajectory is near the ecliptic plane.

After passage through the Asteroid Belt, the spacecraft will fly by Jupiter near that planet's equatorial plane at about three Jupiter radii from the planet center at periapsis. The spacecraft will be four days in the vicinity of Jupiter, and less than two hours behind it; optimumly the spacecraft will pass behind Jupiter moon Io, the most reflective object in the solar system. The trajectory then continues away from the Sun; finally, with impetus from Jupiter, the spacecraft will escape from the solar system.

a. Corrections. Trajectory corrections were made March 7, and March 24, 1972, compensating for launch vehicle injection velocity vector errors.

b. Trajectory illustrations. General relationship of the Pioneer 10 trajectory to the sun, Earth, Asteroid Belt, and Jupiter is depicted in Figure 6. Figure 7 is a simplified mission profile.

2. Flyby Trajectory. Pioneer 10 spacecraft trajectory was designed to approach Jupiter in a counterclockwise direction, as viewed from the celestial north pole, meeting the planet slightly south of the ecliptic, passing around the planet in a counterclockwise direction to an altitude between 1-1/2 and 2 Jupiter radii above the surface of the planet, and exiting slightly north of the planet. The post-flyby trajectory was an inclination to an ecliptic of less than 5 deg with the spacecraft slowly escaping the solar system. An additional three years were to be required to cross Saturn's solar orbit.

Objectives of the flyby trajectory were: (1) to penetrate the Jupiter radiation belt; (2) to provide good viewing conditions for Jupiter before periapsis; (3) to obtain a short occultation for the spacecraft by Jupiter (less than 1 hour); and (4) to provide a radius of closest approach to the center of Jupiter between 2 and 3 Jupiter radii.

3. Injection Velocities. The relative position of Earth and Jupiter as they orbit the Sun permits a spacecraft to be launched only every 13

months into a Jupiter-bound trajectory with a minimum of launch energy. The 1972 launch period was 16 days; the daily launch window averaged 30 min. This was a limitation associated with the direct-ascent powered-flight profile.

Under optimum conditions, injection velocities of approximately 14 km/sec sufficed during this launch period. Velocity requirements were prohibitive throughout the remainder of the 13 months.

(The third stage, used with the Atlas/Centaur/TE 364 launch vehicle for the first time, made Pioneer 10 the speediest spacecraft. Its peak velocity was 51,800 km/h (32,000 mph), traveling 800,000 km (1/2 million miles) a day.)

4. Environments. Equipped with field-and-particles and optical-type instruments, the spacecraft travel between Earth and Jupiter was to be mostly in the interplanetary solar-wind environment. Influences of the Earth's atmosphere ceased several hours after launch. The spacecraft was also designed to fly through the Asteroid Belt and the high-density Jupiter magnetosphere where it was to explore the planet's trapped radiation particles.

5. Superior Conjunction. The relative position of the Earth and spacecraft will place the spacecraft in a superior conjunction configuration versus the sun and the Earth approximately 315 days after launch. Because the spacecraft was somewhat out of the ecliptic plane, the spacecraft/Earth line will not intercept the sun, but will come within a few solar radii. In this configuration, the radio beam will be intercepted through the high-density part of the solar corona and will be influenced significantly by the plasma. Because of the closeness of the spacecraft to the sun, DSN antennas will pick up, together with the spacecraft signal, solar high-frequency noise, which will degrade the received signal-to-noise ratio and can cut down considerably the quality and usefulness of the spacecraft-Earth telecommunication link. This condition will exist for approximately one or two weeks.

6. Challenges and Hazards

a. Asteroid belt. Pioneer 10 spacecraft, crossing Mars' orbit in June, was to reach the Asteroid Belt in July 1972 and remain in the belt for more than six months. With some 75,000 bodies larger than magnitude 20 in the belt, there is some possibility (considered slight) that the spacecraft could collide with one of the asteroids or meteoroids -- the largest of which is Ceres with a diameter of 768 km. Onboard sensors were designed to detect these bodies, which travel 48, 000 km/h relative to the spacecraft. This hazard could result in a loss of the spacecraft high-gain antenna radio link. Should this occur, the DSN would attempt to acquire spacecraft signals radiated by the medium-gain or omnidirectional antenna.

b. Jupiter radiation belts. The electrons, protons, and magnetic field in the Jupiter radiation belts have a much higher intensity and flux density than the Van Allen Belt through which the spacecraft passed the first day of flight. Possibility has been noted that the crystal oscillators of the spacecraft transponder will slightly detune as the spacecraft traverses the Jupiter radiation belt. The high-intensity Jupiter magnetosphere can also change the polarization ellipicity of the spacecraft signal radiated toward Earth. In addition, the spacecraft flying in the close vicinity of Jupiter undergoes an abrupt velocity change which causes, within 2 or 3 hours, a considerable change in the doppler shift. This shift has to be tracked by the spacecraft receiver and by the DSN.

c. Jupiter flyby. The physical nature of Jupiter creates many challenges. Jupiter's average distance from the sun is 5 AU, equivalent to approximately 75×10^7 km. Its mass is equivalent to 318 times the Earth's mass and comprises 70 percent of all planetary mass. Jupiter's diameter (approximately 71, 387 km) is 11 times the Earth's diameter, although density is approximately one-fourth of the Earth's density and its fastest rotation is 9 hours and 50 minutes. Assumption is that Jupiter's upper atmosphere is composed of hydrogen, helium, ammonia, and methane, and it is an intense radio noise source at decametric frequencies. However, the noise drops considerably toward the S-band frequency range. The typical cold sky system noise temperature of the Goldstone DSCC 64-m antenna station is 25 K. Movement of the antenna in the direction of Jupiter increases the system noise temperature approximately 5 K. This increase can cause a telemetry signal-to-noise degradation of around 0. 5 dB. The dense magnetosphere of the planet is caused by an extremely high magnetic field, which can be as high as 5×10^{-4} T (5 G).

7. Mission Firsts. With the success of Pioneer 10 mission, NASA will achieve the following space milestones:

(a) First use of a third stage on Atlas-Centaur launch vehicle.

(b) First NASA spacecraft to use nuclear energy as its primary power source.

(c) Speediest spacecraft: peak velocity of 51, 800 km/h (32, 000 mph), traveling 800, 000 km (1/2 million miles) a day.

(d) First spacecraft to pass through Asteroid Belt.

(e) First spacecraft to investigate Jupiter; roundtrip communications will be 90 min near Jupiter.

(f) First test of harnessing Jupiter's gravity and orbit to decrease travel time to orbits of outer planets.

(g) First man-made object to leave the solar system.

(h) Longest communication distance, 2. 4 billion km (1. 5 billion miles); roundtrip communications to take about 5 h, using new concepts in command and control.

B. Scientific Objectives and Experiments

1. Program Emphases. Designed to obtain precursory scientific information beyond the orbit of Mars, the Pioneer 10 mission program emphases were:

(a) Investigation of the interplanetary medium.

(b) Determination of the nature of the Asteroid Belt (both scientifically and as a hazard of space flight).

(c) Exploration of Jupiter and its environment.

2. Specific Efforts. Thirteen experiments were scheduled to produce findings about Jupiter, the Asteroid Belt, and the heliosphere. There were 11 special scientific instruments aboard the spacecraft: helium vector magnetometer, plasma analyzer, charged-particle instrument, geiger tube telescope, cosmic ray telescope, trapped radiation detector, ultraviolet photometer, imaging photopolarimeter, infrared radiometer, asteroid-meteoroid detector, and meteoroid detector. The 11 instruments weigh

approximately 30 kg (65 lb). With the exception of the infrared radiometer, all the instruments had been turned on by the end of the reporting period of this document.

Specific mission objectives of the 13 experiments in the three areas of exploration are listed by area here.

a. Interplanetary space

(1) Map the interplanetary magnetic field.

(2) Study the radial gradient of the solar wind and its fluctuations and structure.

(3) Study the radial and transverse gradients and arrival directions of high energy charged particles (solar and galactic cosmic rays).

(4) Investigate the relationships between the solar wind, magnetic field, and cosmic rays.

(5) Search for the boundary and shape of the heliosphere.

(6) Determine the density of neutral hydrogen.

(7) Determine the properties of interplanetary dust.

b. Asteroid belt

(1) Determine the size, mass, flux, velocity, and orbital characteristics of the smaller particles in the Asteroid Belt.

(2) Determine Asteroid Belt hazard to spacecraft.

c. Jupiter

(1) Map the magnetic field.

(2) Measure distributions of high energy electrons and protons in the radiation belts, and look for auroras.

(3) Find a basis for interpreting the decimetric and decametric radio emission from Jupiter.

(4) Detect and measure the bow shock and magnetospheric boundary and their interactions with the solar wind.

(5) Verify the thermal balance and determine temperature distribution of the outer atmosphere.

(6) Measure the hydrogen/helium ratio in the atmosphere.

(7) Measure the structure of the ionosphere and atmosphere.

(8) Measure the brightness, color, and polarization of Jupiter's reflected light.

(9) Perform two-color visible light imaging.

(10) Increase the accuracy of orbit predictions and masses of Jupiter and its moons.

3. Individual Experiments

a. Trapped radiation experiments

Instrument: trapped radiation detector (turned on 02:15, GMT, March 3 1972)

Principal investigator: R. Walker Fillius, University of California at San Diego

Co-investigator: Carl E. McIlwain, University of California at San Diego

This instrument was designed to determine the nature of particles trapped by Jupiter, particle species, angular distributions, and intensities. It has a very broad range of energies from 0.01 to 100 meV for electrons and from 0.15 to 350 meV for protons (hydrogen nuclei).

Experimenters are attempting to correlate particle data with Jupiter's mysterious radio signals, using five detectors to cover the planned energy range. An unfocused Cerenkov counter, measuring direction of particle travel by light emitted in a particular direction, detects electrons of energy above 1 meV and protons above 450 meV. A second detector measures electrons at 100, 200, and 400 thousand electron volts (eV).

An omnidirectional counter is a solid-state diode, which discriminates minimum ionizing particles at 400,000 eV, and high energy protons at 1.8 meV.

Twin dc scintillation detectors for low-energy particles distinguish roughly between protons and electrons because of different scintillation material in each. Their energy thresholds are about 10, 000 eV for electrons and 150, 000 eV for protons.

The instrument weighs 1. 7 kg (3. 9 lb) and uses 2. 9 W of power.

b. Charged particles experiment

Instrument: geiger tube telescope (turned on 0233, GMT, March 3, 1972)

Principal investigator: James A. Van Allen, University of Iowa, Iowa City

This experiment will attempt to characterize Jupiter's radiation belts, employing seven Geiger - Müller tubes to survey the intensities, energy spectra, and angular distributions of electrons and protons along Pioneer's path through the magnetosphere of Jupiter. The tubes are small cylinders containing gas that generates electrical signals from charged particles. Three tubes (considered a telescope) are parallel. Three others are in a triangular array to measure the number of multiparticle events (showers) occurring. The combination of a telescope and shower detector enables experimenters to compare primary with secondary events in the Jupiter radiation belts.

Another telescope was designed to detect low-energy electrons (those above 40, 000 eV), and help shed light on Jupiter's shock front in the solar wind and the tail of its magnetosphere.

The instrument can count protons with energies above 5 meV and electrons with energies between 2 and 50 meV.

The instrument weighs 1. 6 kg (3. 6 lb) and uses 0. 7 W of power.

c. Charged particle composition experiment

Instrument: charged particle instrument (turned on 02:34 GMT, March 3, 1972)

Principal investigator: John A. Simpson, University of Chicago

Co-investigators: Joseph J. O'Gallagher, University of Maryland, College Park, and Anthony J. Tuzzolino, University of Chicago.

This instrument has a family of four measuring systems. Two systems are particle telescopes operating primarily in interplanetary space between Earth and Jupiter and beyond Jupiter to the limit of spacecraft communications. The other two systems were designed to measure trapped electrons and protons inside the Jupiter magnetic field.

During the interplanetary phase of the mission (before and after Jupiter encounter) two telescopes will identify the nuclei of all eight chemical elements from hydrogen to oxygen and separate the isotopes hydrogen, deuterium, helium-3 and helium-4. Because of differences in isotopic and chemical composition and spectra it is possible to separate galactic from solar radiation as the spacecraft moves outward from under the influence of the Sun toward the nearby interstellar space. The instrument also measures how streams of high energy particles escape from the Sun and travel through interplanetary space. A main telescope of seven solid-state detectors measures the composition from 1 to 500 meV particles and a 3-element telescope measures 0.4 to 10 meV protons, and helium nuclei. If a key detector element should be destroyed in space, there exist diagnostic procedures and commands from Earth which will remove the defective element from the telescope operation.

For the magnetosphere of Jupiter, two new types of sensors were developed to cope with the extremely high intensities of trapped radiations. A solid-state ion chamber operating below -40° C measures only those electrons that generate the radio waves which reach Earth. The trapped proton detector contains a foil of thorium which undergoes nuclear fission from protons above 30 meV, but is not sensitive to the presence of the intense electron radiation. The instrument weighs 3 kg (7.3 lb) and uses 2.4 W of power.

d. Magnetic fields experiment

Instrument: helium vector magnetometer (turned on 02:48 GMT, March 3, 1972)

Principal investigator: Edward J. Smith, Jet Propulsion Laboratory, Pasadena, Calif.

Co-investigators: Palmer Dyal, David S. Colburn, and Charles P. Sonett, NASA-Ames Research Center, Mountain View, Calif., Douglas E. Jones, Brigham Young University, Provo, Utah; Paul J. Coleman, Jr., University of California at Los Angeles; Leverett Davis, Jr., California Institute of Technology, Pasadena.

The magnetometer was designed to:

(1) Measure the interplanetary field in three axes from the orbit of the Earth out to the limits of spacecraft communication.

(2) Study solar wind interaction with Jupiter.

(3) Map Jupiter's strong magnetic fields at all longitudes and many latitudes.

(4) Study the relationship of the fields to Jupiter's moons.

(5) Seek the heliosphere boundary.

A helium vector magnetometer similar to that flown on Mariners 4 and 5, the instrument has a sensor mounted on a lightweight mast extending 6.5 m from the center of the spacecraft to minimize interference of spacecraft fields. The sensor is a cell filled with helium, excited by radio frequencies and infrared optical pumping.

The magnetometer was designed to operate in any one of eight different ranges: the lowest covering magnetic fields up to 2.5 gamma; the highest covering fields up to 1.4 G. Range selection is ground command or automatically selected by the instrument. Fields as weak as 0.01 gamma can be measured.

The instrument weight is 2.6 kg (5.7 lb); power used is up to 5 W.

e. <u>Meteoroid detection experiment</u>

Instrument: meteoroid detector (turned on 03:26 GMT, March 3, 1972)

Principal investigator: William H. Kinard, NASA-Langley Research Center, Hampton, Va.

Co-investigators: Robert L. O'Neal, Jose M. Alvarez, Donald H. Humes, and Richard E. Turner, NASA-Langley Research Center.

A system of 234 pressure cells mounted on the back of the spacecraft dish antenna is used to detect the distribution in space of tiny particles (masses of greater than one millionth of a gram). The pressure cells are in thirteen 20 by 30 cm (8 by 12 in.) panels, 18 to a panel.

When a particle penetrates a cell -- each of which is filled with a gas mixture of 75 percent argon and 25 percent nitrogen -- it is counted by a transducer as the gas escapes the cell. The average mass and energy of particles (with a mass of one billionth of a gram or more) penetrating the cells are calculated using laboratory impact test data. These data show the combined mass and velocity required for a particle to penetrate a cell. By combining these data with trajectory information, spatial distribution of the tiny meteoroids can be calculated.

The total weight of the instrument (panels and electronics) is 1.7 kg (3.7 lb), and it uses 0.7 W of power.

f. Cosmic ray energy spectra experiment

Instrument: cosmic ray telescope (turned on 18:49 GMT, March 5, 1972)

Principal investigator: Frank B. McDonald, NASA-Goddard Space Flight Center, Greenbelt, Md.

Co-investigators: Kenneth G. McCracken, Minerals Research Laboratory, North Ryde, Australia; William R. Webber and Edmond C. Roelof, University of New Hampshire, Durham; Bonnard J. Teegarden and James H. Trainor, NASA-Goddard Space Flight Center

The cosmic ray telescope also monitors solar and galactic cosmic ray particles. It tracks the twisting paths of high energy particles from the Sun and measures bending effects of the solar magnetic field on particles from the Galaxy, some traveling at near light speeds. The instrument can distinguish which of the ten lightest elements make up these particles. It also will measure high energy particles in Jupiter's radiation belts.

The instrument consists of three three-element, solid-state telescopes. A high energy telescope measures the flux of protons between 56 and 800 meV. A medium-energy telescope measures protons with energies between three and 22 meV, and identifies the ten elements from hydrogen to oxygen. The low-energy telescope will study the flux of electrons between 50, 000 eV and 1 meV and protons between 50, 000 eV and 20 meV.

The instrument weighs 3. 2 kg (7 lb) and uses 2. 2 W of power.

g. Ultraviolet Photometry Experiment

Instrument: ultraviolet photometer (turned on 21:20 GMT, March 6, 1972)

Principal investigator: Darrell L. Judge, University of Southern California, Los Angeles

Co-investigator: Robert W. Carlson, University of Southern California

This instrument addresses some basic questions about interplanetary and interstellar space as well as about Jupiter. During the planet flyby, the ultraviolet photometer instrument will measure the scattering by Jupiter's atmosphere of ultraviolet light from the sun in two wavelengths, one for hydrogen and one for helium. These data will be used to find the amount of atomic hydrogen in Jupiter's upper atmosphere, the mixing rate of Jupiter's atmosphere, the amount of helium in its atmosphere, and the ratio of helium (if any) to molecular hydrogen. By measuring changes in intensity of ultraviolet light glow as it scans across the planet, the instrument may identify Jupiter auroras, if they exist.

The instrument has two photocathodes, one of which measures ultraviolet radiation at 1216 Å, the other at 584 Å, the wavelengths at which hydrogen and helium scatter solar ultraviolet rays. With a fixed viewing angle, the instrument will use the spacecraft spin to scan Jupiter. It weighs 0.7 kg (1. 5 lb) and uses 0. 7 W of power.

h. Asteroid-meteoroid astronomy experiment

Instrument: asteroid-meteoroid detector (turned on 05:13 GMT, March 9, 1972)

Principal investigator: Robert K. Soberman, General Electric Company, Drexel University, Philadelphia, Pa.

Co-investigator: Herbert A. Zook, NASA-Manned Spacecraft Center, Houston, Tex.

This experiment is surveying the solid material between the Earth's orbit and 2.4 billion km (1.5 billion miles). By measuring the orbits of the material in the vicinity of the spacecraft, experimenters seek the origins of meteoroids, asteroids, and comets and the distribution of these bodies in the solar system.

Four nonimaging telescopes were designed to characterize objects, ranging from several hundred miles in diameter (asteroids) down to particles with a mass of one millionth of a gram, by measuring sunlight reflected from them. The telescopes measure numbers of solid particles, and individual particle size, velocity, and direction of travel.

This experiment (as does the photopolarimeter) periodically measures zodiacal light (sunlight scattered by the total mass of meteoroids and dust in deep space). Comparisons of zodiacal light measurements with particle measurements allow conclusions about the relationship of the zodiacal cloud brightness with size distribution of particles. Effects of secondary forces such as solar radiation and planetary gravity on orbits of small particles in the solar system also are studied. These data will be fundamental to design of all future outer planet spacecraft. They will allow estimates to be made of chances of penetration and spacecraft failure by impact of larger particles, and of surface erosion from bombardment by smaller particles.

Each of four telescopes consists of 20-cm (8-in.) mirror, an 8.4-cm (3.3-in.) secondary mirror, coupling optics, and a photomultiplier tube. Each telescope has an 8-deg view cone. The four cones overlap in part, and particle distance and speed is measured by timing entry and exit of view cones. Photomultiplied pulses are counted to find particle numbers.

The instrument weighs 3.3 kg (7.2 lb) and uses 2.2 W of power.

i. Imaging photopolarimetry experiment

Instrument: imaging photopolarimeter (turned on 21:31, GMT, March 10, 1972)

Principal investigator: Tom Gehrels, University of Arizona, Tucson

Co-investigators: David L. Coffeen, William Swindell, Jyrki Hameen-Anttila, and Charles E. KenKnight, University of Arizona; Robert F. Hummer, Santa Barbara Research Center; Jerry Weinberg, Dudley Observatory, Albany, N. Y.

This instrument provides data in a number of areas, using photometry (measurement of light intensity) and polarimetry (photometry measurements of the linear polarization of light), and imaging. Enroute to Jupiter, the instrument was measuring brightness and polarization of zodiacal light (sunlight scattered by interplanetary dust and solid matter) several times a month to determine the amount and character of interplanetary solid material. The instrument will take about ten images of Jupiter in the last 20 h before closest approach to the planet (periapsis).

The instrument uses a photoelectric sensor that measures changes in light intensity, employing the rpm spin of the spacecraft to electronically scan the planet, in narrow strips 0.03 deg wide. Controllers can vary the viewing angle of the instrument's 8.64-cm (3.4-in.) focal length telescope by about 150 deg relative to the spacecraft's spin axis, which is fixed on the Earth-spacecraft line. The telescope can see to within 10 deg of the spin axis, looking away from Earth.

The instrument includes a 2.5-cm (1-in.) aperture, 8.6-cm (3.4-in.) focal length telescope which can be moved 150 deg in the plane of the spacecraft spin axis by ground command or automatically. Incoming light is split by a prism according to polarization into two separate beams. Each beam is further split by going through a red filter (5800 to 7000 Å), and through a blue filter (3900 to 4900 Å). Channeltron detectors turn the light into electrical impulses, which are telemetered to Earth.

The instrument uses three viewing apertures: one 40 by 40 mrad for zodiacal light measurements, a second 8 by 8 mrad for nonimaging light measurements of Jupiter, and a third 0.5 by 0.5 mrad for scans of the planet from which pictures will be reconstructed.

The instrument weighs 4.3 kg (9.5 lb) and uses 2.2 W of power.

j. Plasma Analyzer Experiment

Instrument: plasma analyzer (turned on 21:20, GMT, March 13, 1972)

Principal investigator: John H. Wolfe, NASA-Ames Research Center

Co-investigators: Louis A. Frank, University of Iowa, Iowa City; Reimar Lust, Max-Planck-Institute fur Physik und Astrophysik, Institute fur Extraterrestrische Physik, Munchen, Germany; Devrie Intriligator, University of California at Los Angeles; William C. Feldman, Los Alamos, Los Alamos Scientific Laboratory, New Mexico

The plasma or solar wind instrument was designed to:

(1) Map the density and energy of the solar wind (ions and electrons flowing out from the sun)

(2) Determine solar wind interactions with Jupiter, including the planet's bow shock wave, and will look for the boundary of the heliosphere.

The instrument consists of a high resolution and medium resolution analyzer. It looks toward the sun through an opening in the spacecraft dish antenna, and the solar wind enters like the electron beam in a TV tube. The instrument measures direction of travel, energy (speed), and numbers of ions and electrons.

In the high resolution analyzer, the targets are 26 continuous-channel multipliers, which measure the ion flux in energy ranges from 000 to 18,000 eV. Detectors in the medium resolution detector are five electrometers, which measure ions only in ranges from 100 to 8,000 eV and electrons from one to 500 eV.

The plasma analyzer weighs 5.5 kg (12.1 lb) and uses 4 W of power.

k. Infrared Thermal Structure Experiment

Instrument: infrared radiometer

Principal investigator: Guido Munch, California Institute of Technology; Gerry Neugebauer, California Institute of

Technology; Stillman C. Chase, Santa Barbara Research Center; and Laurence M. Trafton, University of Texas, Austin.

The infrared radiometer was designed to measure Jupiter's net heat energy output. The two-channel radiometer, used successfully on two Mariner Mars spacecraft, will make measurements in the 14 to 25 and 29 to 56 micron wavelengths to study the net energy flux, its distribution over the Jupiter disk, and the thermal structure and chemical composition of Jupiter's atmosphere.

The instrument has a 7.2-cm (3-in.) Cassegrain telescope, and the detectors in its two channels are 88-element, thin-film, bimetallic thermopiles. Its field of view is about 2,400 by 700 km on Jupiter's cloud surface at closest approach of one Jupiter diameter. At this distance, it has a resolution of about 2,400 km (1,500 miles).

The instrument weighs 2 kg (4.4 lb) and uses 1.3 W of power.

1. Celestial mechanics experiment

Instrument: Pioneer 10 and the DSN

Principal investigator: John D. Anderson, Jet Propulsion Laboratory

Coinvestigator: George W. Null, Jet Propulsion Laboratory

This experiment uses the spacecraft itself as a sensitive instrument to better determine the mass of Jupiter and its satellites and to determine the harmonics and possible anomalies in Jupiter's gravity field. Experimenters measure the gravity effects of Jupiter and its satellites on the spacecraft flight trajectory.

Deep Space Network doppler tracking of the spacecraft determines its velocity along the Earth-spacecraft line down to a fraction of a millimeter per second, once per minute. These data are further augmented by optical and radar position measurements of the planets. Computer calculations using the spacecraft trajectory and known planet and satellite orbital characteristics should allow a five-fold improvement in the accuracy of current calculations of Jupiter's mass. Masses of Jupiter's four large (Galilean) moons will be determined to an accuracy of about one percent.

Experimenters expect to find the planet's dynamical polar flattening to within one-half mile, and to make estimates of the mass of the planet's surface layers.

m. S-band occultation experiment

Instrument: Pioneer 10 radio transmitter and the DSN.

Principal investigator: Arvydas J. Kliore, Jet Propulsion Laboratory.

Co-investigators: Gunnar Fjeldbo, Dan L. Cain, and Boris L. Seidel, Jet Propulsion Laboratory, and S. Ichtiaque Rasool, NASA-Headquarters, Washington, D. C.

Passage of the spacecraft radio signal through Jupiter's atmosphere as Pioneer 10 swings behind the planet for an hour will be used to measure Jupiter's ionosphere and density of the planet's atmosphere down to a pressure level of about one Earth atmosphere. Experimenters will use computer analysis of the incoming radio signals recorded on tape to determine the refractive index profile of Jupiter's atmosphere.

This sort of analysis has been done with stars passing behind the planet, but Pioneer S-band telemetry is a precisely known signal source. These refraction data should allow measurements of the electron density of Jupiter's ionosphere and, used with temperature measurements, will allow inferences about the hydrogen/helium ratio in the atmosphere. Experimenters also will measure the absorption profile of the atmosphere, which should allow calculation of ammonia abundance.

If the spacecraft trajectory allows, the experimenters also will look for an atmosphere on the Jupiter satellite, Io.

C. Engineering Objectives

There was a necessity to design and develop organizations, equipment, software, and procedures for Pioneer 10 Mission to advance technological and operational capability for missions to the outer planets and the limits of the heliosphere. Results of various phases of the Pioneer 10 Mission would have a direct bearing on the Pioneer G Jupiter Mission planning.

The engineering objectives and tests that were a part of the Pioneer 10 Mission design included:

(1) Added stress and strain of a launch in which the spacecraft was driven from Earth initially at 51, 800 km/h, faster than any man-made object hitherto had flown.

(2) First space tracking through a newly developed DSN multimission Mark III System.

(3) First use of nuclear-fueled electric power (4 radioisotope thermoelectric generators aboard the spacecraft) on an interplanetary mission.

(4) Test of hazards of the Asteroid Belt on hardware and tracking and data acquisition functions.

(5) Test of exact effect of solar radiation pressure on trajectory.

(6) First use of Jupiter's gravity and orbital motion to increase velocity of a spacecraft.

(7) Test of effects of Jupiter's radiation belts (an estimated million times those of Earth) on spacecraft and tracking and data acquisition.

(8) Continuous challenge to DSN to acquire and collect data stream despite variations of solar activities and lengthening of communication distances to the limit near the orbit of Uranus (about 2. 9 billion km from the sun which was to be reached in 7. 5 years).

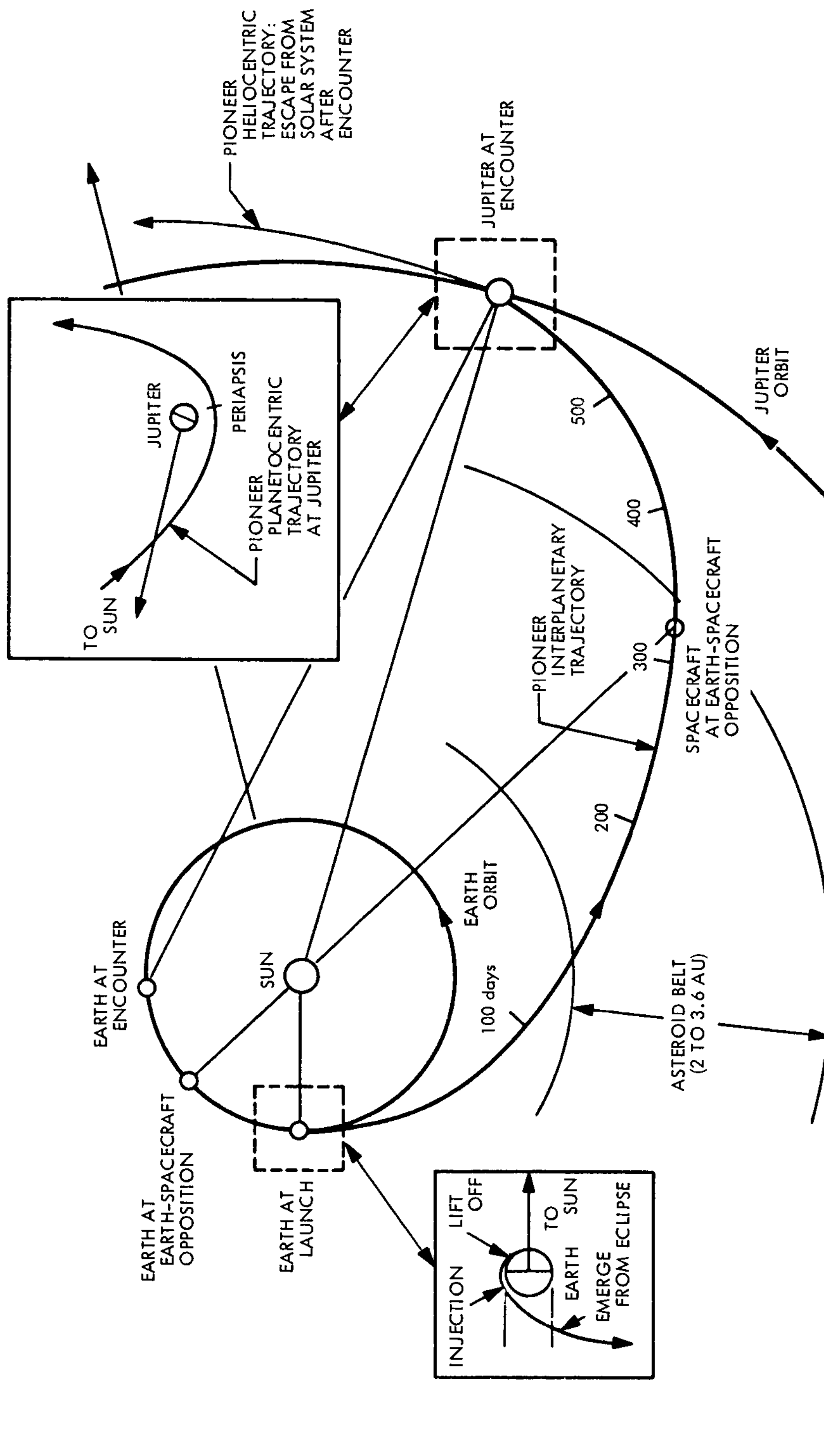


Fig. 6. Ecliptic project of typical Pioneer 10 trajectory

F.

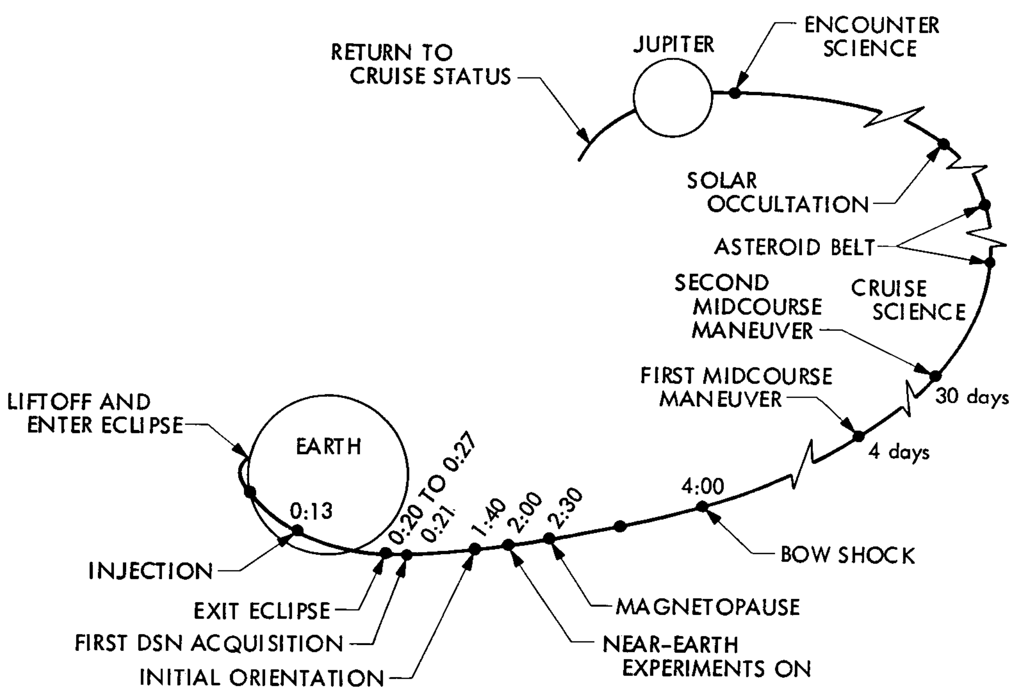


Fig. 7. Pioneer 10 Mission profile

IV. LAUNCH VEHICLE AND SPACECRAFT CONFIGURATIONS

A. Launch Configuration

Pioneer 10 Mission marked the first combining of an Atlas-Centaur vehicle and a Pioneer spacecraft for launch. The Atlas-Centaur launch vehicle also included for the first time a third stage: the 66,750-N (15,000-lb)-thrust, solid-fuel TE-M-364-4 engine.

Liftoff height of the over-all launch configuration was 40.3 m (132 ft); weight was 146,673 kg (323,415 lb), including the instrument-loaded spacecraft of 258 kg (570 lb). Both the third stage and the spacecraft were enclosed in an 8.7-m (29-ft)-long, 3-m (10-ft)-diam fiberglass shroud, which was jettisoned after leaving the atmosphere.

Table 3 and Figure 8 detail the overall Pioneer 10 Mission launch vehicle-spacecraft configuration and major assemblies, including all airborne RF systems (telemetry, tracking, and command).

B. Launch Vehicle

A three-stage Atlas SLV-3C/Centaur D/TE-364-4 vehicle, designated as AC-27, was used to launch the spacecraft. Prime contractor for the first two stages (Atlas SLV-3C and Centaur D-IA, respectively) was General Dynamics-Convair Division. McDonnell Douglas Astronautics Company was prime contractor for the third stage (TE-364-4).

Table 4 summarizes launch vehicle characteristics.

1. First Stage. The jettisonable booster, the sustainer/propellant, and the interstage adapter sections made up the first stage. A Rocketdyne MA-5 system of two booster engines, a sustainer engine, and two small vernier engines provided power. All engines were gimbaled to provide pitch, yaw, and roll control with power for gimbaling the engines provided by hydraulic systems.

During the booster phase of propulsion, guidance signals were provided by the Atlas flight control system: flight programmer, displacement gyro, rate gyro, and servo-amplifier packages. After jettison of the booster section, the Centaur inertial guidance system controlled gimbaling of the sustainer engine for pitch and yaw control and the vernier engine for roll control.

2. Second Stage. The Centaur D employed liquid hydrogen and liquid oxygen as propellants. Primary thrust was provided by two Pratt and Whitney RL 10A3-3 engines, which gimbaled for pitch, yaw, and roll control, and had a hard restart capability. Centaur guidance was performed by a Honeywell all-inertial system capable of accommodating a wide variety of steering programs.

During flight, the guidance system determined vehicle position and velocity, and initiated commands to guide the vehicle to preselected conditions. An autopilot acted on steering commands and controlled separate hydraulic systems that gimbaled each main engine. Vehicle orientation during coast periods was provided by small monopropellant engines.

3. Third Stage. The final stage of propulsion by the launch vehicle was provided by the Thiokol TE-364-4 solid propellant motor, which was attached to the Centaur through a spin table. At completion of Centaur burn, a spin rate of about 60 rpm was imparted to the third stage by small solid propellant rockets for spin stabilization during firing of the third-stage motor. The major portion of the attach fitting between the third-stage motor and spacecraft remained with the motor after injection into interplanetary flight and final separation of the spacecraft.

The aerodynamic shroud for the third-stage/spacecraft combination was a fiberglass fairing consisting of a 5.74-m (226.18-in.) long cylindrical afterbody and a 4.94-m (194.59-in.) long conical forebody. After leaving the atmosphere, the shroud was jettisoned in halves by the firing of explosive bolts and springs.

C. Spacecraft

Except for the electrical power supply, the spacecraft was provided by the TRW Systems Group on contract to NASA/Ames Research Center. The electrical power, supplied by radioisotope thermoelectric generators, was provided by Teledyne Isotopes on contract to the Atomic Energy Commission.

1. System Requirements and Constraints. General requirements upon the design of the Pioneer 10 spacecraft were:

(1) Compatibility with the Atlas SLV3C/Centaur/TE-364-4 launch vehicle.

(2) Compatibility with the Deep Space Network.

(3) A thermally controlled compartment in which to mount scientific instruments.

(4) A data system to sample readings from the instrumentation and transmit the information to Earth.

(5) A system to permit changes in operating modes of onboard equipment on command from Earth.

(6) A magnetically clean and an electromagnetic-interference-free spacecraft.

(7) Operation in space for more than two years and for distances beyond the orbit of Jupiter.

The launch vehicle imposed these three constraints upon the spacecraft: (1) weight of spacecraft, scientific instruments, and spacecraft-launch vehicle adapter fitting to be less than 265 kg; (2) usable volume of launch vehicle shroud limited the spacecraft size; and (3) vibration, acceleration, and shock loads induced by launch vehicle placed requirements on mechanical integrity of spacecraft and scientific instruments.

Compatibility with the DSN required that the communication system operate at S-band frequencies. In addition, capability was required for the downlink frequency to operate at a fixed ratio of the uplink frequency so that accurate doppler measurements could be made and the spacecraft velocity relative to Earth measured for trajectory determination. The downlink also was required to operate at a frequency governed by an onboard oscillator to provide for occasions when the ground stations were not transmitting to the spacecraft.

2. Configuration. Figures 9, 10, 11, and 12 display various views of the Pioneer 10 spacecraft configuration.

The spacecraft essentially consists of two thermally controlled equipment compartments, one hexagonally shaped and containing spacecraft equipment and the other an appendage containing scientific instruments. Forward of the equipment compartments is a 2.75-m (9-ft)-diam, parabolic reflector for the high-gain antenna. Mounted on struts forward of the reflector are the medium-gain antenna and the feed for the high-gain reflector.

The four radioisotope thermoelectric generators (RTGs) that supply power are mounted in pairs on two radially deployable trusses. For launch, the generators were in a stowed position next to the equipment compartment and under the reflector of the high-gain antenna. The angle between the support trusses for the generators is 120 deg. In the deployed position, the generators extend well beyond the perimeter of the reflector to reduce the radiation environment within the equipment compartments and reduce their magnetic influence at the magnetometer. The magnetometer is located on the end of a long folding boom that, when deployed, extends radially from the instrument side of the equipment compartment.

Viewing aperatures are provided in the equipment compartments as required by the scientific instruments. Mounts, external to the equipment compartment, are provided for the meteoroid and asteroid instrumentation.

The spacecraft is spin-stabilized with a spin rate somewhat below 5 rpm. The launch vehicle's spin-up system brought the spacecraft, together with the third stage of the launch vehicle, up to a rotational speed of around 60 rpm. After the third-stage burnout and separation, the spin rate was slowed down from 60 to 20 rpm by the use of automatically fired thrusters. Finally, deployment of the RTGs and the magnetometer further despun the spacecraft to a nominal spin rate of 4.8 rpm. The objective of this spin stabilization was to stabilize spacecraft attitude. Spin-axis precession maneuvers will be applied during the mission to orient the spin axis of the spacecraft to the Earth and thus illuminate the Earth with the directional beams of the medium-gain and high-gain antennas.

Because the geocentric longitude of the spacecraft varies over a wide range during the mission, the spacecraft has a monopropellant attitude-control system capable of precessing the spin axis and maintaining the Earth-pointing attitude on command. The initial reorientation to point the spacecraft spin axis toward the Earth occurred within a few hours after launch. The spacecraft is equipped with a complete telemetry and data handling system which generates a data stream containing the output of the scientific instruments and spacecraft equipment measurements. A system for receiving the modulating and distributing command instructions received from Earth provides flexibility in operation of the scientific instruments and the spacecraft. Spacecraft equipment delivers conditioned power to the scientific instruments and also supplies the instruments with appropriate timing and orientation indexing signals for control of measurements and data accumulation.

3. Subsystems

a. Electrical power supply. Each of the four SNAP 19 type RTG units was designed to provide almost 40 W of electrical power during the early part of the mission and about 30 W five years after launch. Expectation at launch was for continuing adequate power as the requirements of the spacecraft and scientific instruments would not exceed the capability of three of the RTG units at the time of Jupiter flyby.

Each RTS was fueled with plutonium-238 dioxide that produced up to 625 W of thermal energy at initial loading. The thermoelectric converter consists of six thermoelectric modules containing a total of 90 thermoelectric couples. Pairs of couples are connected in parallel and the resulting 45 pairs are connected in series. The thermoelectric couples consist of lead telluride n-elements and an alloy of tellurium, silver, germanium, and antimony for the p-elements.

In external appearance, each RTG consists of an outer housing in the form of a cylinder, end covers for the cylinder and six radial fins equally spaced around the cylinder and extending its length. The diameter and length of the cylinder are about 16.4 cm (6.5 in.) and 31.9 cm (11 in.), respectively. The radial dimension of each fin is about 15.2 cm (6 in.). Each RTG, independent of its support structure, weighs about 13.6 kg (30 lb).

4. Electrical Power Conditioning. The objective of the electrical power subsystem is to distribute and condition the power received from the RTGs to the spacecraft equipment and the scientific instruments. To meet the requirements of the power loads, the dc output of each RTG goes into a separate inverter. The 2.5-kHz squarewave output of the four inverters is fed into an ac bus. Most of the ac power is rectified and filtered to supply the main dc bus, which is shunt-regulated to 28 V ±1% by dumping excess power through an external shunt radiator. The regulation of the 28-Vdc bus is reflected back through the ac bus and through the fixed-ratio inverters, fixing the RTG's operating voltage at 4.2 V. A battery automatically carries any temporary overloads and is recharged automatically when excess power

is available. The scientific instruments and the traveling-wave-tube power amplifier of the transmitter section of the transponder receive power from the main dc bus. Most of the other spacecraft loads are supplied from the central transformer-rectifier-filter unit, which receives power from the ac bus and provides various dc output voltages.

5. Structure. The hexagonal equipment compartment as the basic structural element of the spacecraft supports the high-gain antenna on its forward end, attaches the launch vehicle by the launch-vehicle mating ring at its aft end, supports the scientific instrument compartment, accommodates the major portion of other subsystem assemblies, and provides for mounting of various external components, including the RTGs and the magnetometer boom. Rigid tubular truss work attached to the framework of the equipment compartment supports the parabolic reflector of the high-gain antenna, the high-gain antenna feed, the medium-gain antenna, the three thruster clusters, the attachment for the deployable booms for the RTGs, and the launch-vehicle mating ring. The reflector of the high-gain antenna was made from an aluminum honeycomb sandwich.

6. Thermal Control. The thermal control subsystem provides the required thermal environment for the spacecraft components and scientific instruments during all phases of the flight. The objective of the thermal control subsystem is to maintain, in the vicinity of the scientific instruments, temperatures between -18 and +38°C and to keep the spacecraft equipment at temperatures required for satisfactory operation. Heating effects caused by the RTGs (stowed within the nose fairing), the third-stage motor casing, and the jet plume must be accommodated. The large variations in solar intensity and relative direction during interplanetary flight, and the loss of heat from the equipment compartments through sensor apertures, are compensated through louvers and special installation.

7. Propulsion and Attitude Control. During the major portion of the flight, Earth-pointing attitude is necessary for the narrow beam of the high-gain antenna of the spacecraft to illuminate the Earth and to maintain effective communications. Figure 13 depicts the relative position of the spacecraft's spin and antenna axis versus the Earth. With the geocentric longitude of the spacecraft varying continuously throughout the mission, it is necessary to

make numerous attitude adjustments. Since the spacecraft high-gain antenna has a half-power beamwidth of approximately 3.5 deg, it is anticipated that more than 200 spin-axis orientation maneuvers will be necessary to compensate for the relative movement of the spacecraft versus Earth, and also for the precession caused by solar pressure, which is 0.2 deg per day during the early part of the mission. In addition, to provide the planned encounter trajectory at Jupiter, some adjustments of the velocity vector may be required during the interplanetary flight. To make the velocity vector adjustments possible, thrust must be generated in a particular direction; therefore, with thrusters in a fixed relationship to the spacecraft, there is need for reorientations of the spacecraft.

Changes in the spin rate were also required. After injection, the rate was on the order of 60 rpm and had to be reduced to about 20 rpm before the deployment of the magnetometer and RTGs. As a result of the deployment, the spin rate was reduced to between 4 and 5 rpm (nominal: 4.8 rpm). In addition, to make possible attitude and velocity changes, small changes in the spin rate had to be corrected to maintain the rate of spin within the required limits.

Changes in attitude, velocity, and spin rate during the interplanetary flight will be accomplished by monopropellant hydrazine thrusters. Thrust will be provided by exothermic decomposition of the hydrazine in a catalyst bed and extension of the gas through a nozzle. Figure 14 depicts the location of the attitude-control spin control, velocity, and precession thrusters at the edge of the parabolic high-gain antenna structure. These thrusters can be operated in pairs. Each cluster contains a forward-facing nozzle and a rearward-facing nozzle. Two forward or two rearward nozzles will be used for velocity adjustment and opposite-facing nozzles will be fired for attitude changes, causing precession of the spin axis. Spin-rate changes will be accomplished by tangentially aligned nozzles thrusting with and against the spin.

A Sun or star sensor (Figure 15) provides reference signals necessary to time the thrust pulses for precession of the spin axis in a desired direction (Figure 16). Attitude changes can be accomplished "open loop" by ground command, or "closed loop" by homing the spacecraft on the S-band uplink signal radiated by a deep space station toward the spacecraft. The duration of thrust for velocity and spin-rate changes is established by ground calculations. This information is transmitted to the spacecraft, where it is stored for execution on command. Similarly, for an "open loop" reorientation, the direction and amount of precession desired can be transmitted to the spacecraft via the command link and stored for execution on command. This storage information can be combined to perform a precession-velocity change-precession sequence with suitable time intervals in the sequence and to provide a completely automated velocity vector adjustment with return to a selected spacecraft orientation.

A closed-loop precision maneuver will be used regularly for accurate realignment of the spin axis of the spacecraft toward Earth. A medium-gain and a high-gain spacecraft antenna will be used, respectively, for course and fine homing on the uplink and telecommunications signal. For the closed-loop maneuver, the axis of the medium-gain antenna and the feed of the high-gain antenna are offset from the spin axis and provide an amplitude-modulated signal when the spin axis is not aligned with the Earth. The CONSCAN subsystem processes this signal and fires the precession thrusters to establish the required precession and orient the spin axis toward Earth.

The hydrazine will be supplied to the thrusters through appropriate lines and valves from a single spherical pressurized bladder-tank, which is located in the center of the spacecraft equipment compartment. Electrical and small radioisotope heaters will be used to keep the plumbing of the hydrazine system above 2°C, which temperature keeps the fuel in a liquid state.

8. Communications. The communications subsystem provides for uplink and downlink communications, doppler coherence of the downlink carrier signal with the uplink carrier signal and generation of the conical span signal for closed-loop precession of the spacecraft spin axis toward Earth. S-band carrier frequencies are used in conjunction with a PCM/FSK/PM modulation format of the uplink carrier and PCM/PSK/PM modulation of the downlink using a single subcarrier.

A high-gain antenna is provided for communications at maximum data rates and extreme ranges. The high-gain antenna has a 2.75-m-diam parabolic reflector (the maximum diameter that can be accommodated within the shroud of the launch vehicle) and produces a maximum gain of about 3 dB and a beam width of about 3 deg at the half-power points. A coupled medium/low gain antenna with fore and aft elements, respectively, is provided for broad angle communications at intermediate and close ranges. The forward facing medium-gain horn provides a maximum effective gain of about 12 dB and a beam width of about 32 deg at the half-power points. The rearward facing low-gain antenna is a logarithmic conical spiral providing an effective gain greater than -5 dB over the rear hemisphere except for interference near the normal to the spin axis.

The signal for closed-loop precession of the spin axis toward Earth is obtained by tilting the beam of the receiving antenna with respect to the spin axis. The feed of the high-gain antenna can be offset by ground command to provide the tilt, and the beam of the medium-gain antenna has a permanent tilt. A signal processor conditions the amplitude-modulated RF signal produced by the scanning motion of the offset pattern and extracts a phase reference and timing signal for generation of the signal for firing the thrusters.

A frequency addressable receiver is always connected to each of the two antenna systems. The receivers and antennas are interchangeable through coaxial RF switches by ground command or automatically after a certain period of inactivity. Either receiver is capable of automatically providing a phase coherent signal to either of two transmitter drivers whenever a receiver is locked to an uplink signal. This coherent mode can be inhibited by command. The transmitter frequency is controlled by an auxiliary oscillator whenever the receiver is not locked to an uplink signal. The redundant transmitter drivers are connected to redundant 8-W traveling-wave-tube (TWT) power amplifiers which are coupled through coaxial RF switches to both the high-gain and medium/low gain antennas. At Jupiter range, command capability can be maintained by the high-gain antenna with transmission from the DSN 26-m-diam antennas at 400 kW. The uplink data rate will be one bit per second.

At Jupiter range, the data transmission rate can be as high as 1024 bits per second, using the spacecraft high-gain antenna and the DSN 64-m-diam ground antenna. With the DSN 26-m-diam ground antenna, the highest data rate will be 64 bits per second. These data rates will be possible when using convolutional coding of the data on the spacecraft with sequential decoding on the ground.

9. Data Handling. The spacecraft's data handling subsystem processes data originating from two major data sources. The first group of data is obtained from the outputs of the eleven onboard scientific instruments which provide data on the scientific measurements, configuration status, and operational health. The second group of data is composed of engineering data collected from sensors and transducers furnishing information necessary to determine spacecraft configuration status, operational characteristics, and operational health.

The data-handling subsystem has special capabilities of formatting and time-division multiplexing the data into a coded or uncoded serial type of data stream suitable for modulating the spacecraft's telemetry transmitter. Timing and operational signals are also provided to be included in the science and engineering data blocks. The data-handling subsystem can store and provide time-delayed readout of formatted data upon command request. The data-handling subsystem consists of a digital telemetry unit, a data storage unit, and a convolutional coder which is an integral part of the digital telemetry unit (Figure 17). The data-handling subsystem has three operational modes, eight commandable bit rates from 16 to 2048 bits per second in binary increments and eleven data formats with 23 format combinations.

The three operational modes are: (1) real-time, (2) telemetry store, and (3) memory readout. In the real-time mode, the data are transmitted directly without interim storage. In the telemetry storage mode, the data are stored and transmitted simultaneously until the data storage unit is full. Then, at this time, the mode reverts automatically to a real-time mode at the last commanded format and bit rate. In this mode, it is possible to sample and store data at a more rapid rate than can be received on the ground. Then, the stored data can be transmitted later at the prevailing bit rate. The memory readout mode consists of transmitting the data stored in the memory at any selected bit rate. Figure 18 shows the interrelationship between the real-time and the telemetry storage modes and the flow of the controlling commands necessary to operate the spacecraft in these modes.

The data handling subsystem processes 88 analog, 76 digital, and 168 bilevel data input channels originating from science and engineering type data sources. The telemetry formats generated by the data-handling subsystem are divided into science and engineering groups.

The science group includes two basic science formats and three special-purpose science formats for science main frame data, and two science formats that are subcommutated in the main frame. The basic science format contains 192 bits including 144 bits assigned to the scientific instruments, 6 bits to subcommutate the engineering formats, 6 bits to subcommutate the science subframe, 18 bits for frame synchronization and the remainder for identification of subcommutated data, telemetry mode, bit rate, and format.

The basic science format word length is three bits. If higher resolution is required, two or three of these words are assigned. All of the basic science formats are arranged for use primarily during interplanetary flight and the other during Jupiter flyby. In addition, three special-purpose science formats each contain 192 bits of digital data from only one or two scientific instruments, and are transmitted only in conjunction with one of the basic science formats alternating every 192 bits. These special formats provide the capability to sample data from certain scientific instruments at the high rate at the expense of reducing the amount of data from other instruments by one half. This feature will be particularly useful when the spacecraft is in the vicinity of Jupiter.

The typical Pioneer 10 formats are: A, B, C-1 through 4, A/D-1 through 8, B/D-1 through 8.

Telemetry Format A is the first science format that is arranged to meet the scientific requirements during interplanetary cruising. Figure 19 describes briefly these typical formats. All forty-three 3-bit words available are assigned to the scientific instruments for the Pioneer 10 mission. Seven scientific experiments share this format. The first 3 bits of each main frame contain the mode identification information. These words indicate whether the spacecraft is operating in the real-time, memory readout, or telemetry store modes. Bits 4 to 6 identify the spacecraft bit rate of 16 to 2048 bits per second in binary increments. Bits 8 through 24 comprise an 18-bit-long frame synchronization word. This word is standard in all Pioneer telemetry frames and is used by the ground data processing equipment to synchronize the received telemetry frames and words. Bits 97 through 101 are used for format identification. The subcommutation identification is represented by a 7 bit-word, bits 102 through 108 of each main frame. Bit 102 is the most significant bit for the 128-word engineering subcommutator with the most significant bit first. The subcommutated engineering words are contained in bits 109 through 114.

These 6-bit words appear in 128 successive formats and are obtained from various spacecraft engineering instrumentation such as voltage and current monitors, and switch positions. Analog, digital, and status information is also included in the engineering subcommutator words. The same engineering subcommutator is also used to telemeter the time necessary for correlating the attitude of the roll index reference line with science and engineering data. The command number and the stored execute delay time of five stored commands are also made available for ground validation and analysis purposes. The sequence status of the spacecraft's attitude-control system and the roll reference source and scientific instruments roll index pulse are also identified and telemetered. Additional engineering subcommutator words are available to transmit information on the star location, on the pulse length of the hydrazine thruster impulses, on the spin period sector generator modes, and on the power status of the control electronics assembly. The science subcommutator is also provided in each main frame consisting of sixty-four 6-bit words. The science subcommutator appears in bits 115 through 120 of the main frame. Analog, digital, and status information is accepted by the digital telemetry unit (DTU) from the scientific instruments for telemetering in the science subcommutator.

The format B is a second science format and is arranged to meet the scientific requirements during Jupiter flyby. It consists of an engineering subcommutator accelerated at the main frame-rate, resulting in a 32:1 sampling increase of the measurements. This high-time resolution engineering format will be used to investigate the engineering performance of the spacecraft or determine the source and cause of any detected anomaly. Format C has four basic types providing information on the four major engineering subsystems. C-1 is used for power, C-2 for the communications, C-3 for the electrical distribution/propulsion and C-4 for the attitude control subsystems. Formats D-1 and D-8 are special formats with the main frame of 192 bits. These main frames are assigned to a single instrument with the exception of format D-2, in which two instruments share the format. A format D can be telemetered only by alternating it with the frame of formats A or B.

The digital telemetry unit is the heart of the data-handling system and converts the time-multiplexed science and engineering data into a single data stream which modulates the spacecraft's transmitter. Nearly all elements of this unit are redundant. A stable crystal-controlled 65.536-kHz clock and countdown chain will generate the timing signals needed throughout the spacecraft, and will transfer data to the digital telemetry unit. The roll index pulse generated by the attitude-control system referenced to the timing signals is used to produce accurate roll position signals. This determines the roll position of the on-board instruments in relation to both the data and the spin rate. The digital telemetry unit drives the transmitter with a serial bit stream in the NRZ-L form. This is biphase modulated on a 32.768-kHz squarewave subcarrier.

The data storage unit (DSU) of the data-handling subsystem consists of a core stack containing 49,152 bits (or 256 streams of data) and associated logic. This unit, which is not redundant, has a read/restore type memory making possible the retransmission of stored spacecraft generated data. It is not necessary to clear the unit before starting a recording cycle. The storage and readout of data need not be continuous, since they may be interrupted and continued later by command, if required.

The convolutional coder unit codes the format of the data from the digital telemetry unit or the data storage unit to increase the overall efficiency of the telemetry system. The telemetry data can be either coded or uncoded by command. Figure 20 shows the functional configuration of the coder. The main element of this device is a multiple-bit shift register in which the data are shifted in and out of the register at the data bit rate. The encoder replaces each data bit generated by the digital telemetry unit by two symbols, P and Q. The value of each symbol is based on the values of 32 selected data bits previously generated. Each PQ is a logical "1" if there are an odd number of "1's" in the selected data bits; otherwise it is a logical "0". The encoding cycle begins at the end of the last bit of each frame synchronization word at which time each stage of the shift register containing the value of the previously transmitted 32 data bits and the 33rd flip-flop used to generate the code are reset to a logical "0". The output symbol rate of the encoder is double that of the input data rate. In error-free data, the bits of a pair provide an unambiguous representation of the original data bit. With errors in the data, the decoding process performed at the deep space stations

F

utilizing the sequence of PQ will provide reconstructed error-free data for transmission conditions well beyond normal acceptable limits without the coding. An overall coding gain of between 3.5 to 4 dB is expected.

10. Command. The spacecraft's command subsystem provides the capability of controlling the operating modes of the spacecraft equipment and scientific instruments from information received from the RF transmissions of the deep space stations and from signals generated on board at discrete events. The command subsystem consists of two command decoders and a command distribution unit (Figure 21).

The commands are transmitted to the spacecraft by the DSN station having a PCM/FSK/PM modulation of the uplink S-band carrier signal and employing a rate of 1 bit/sec. Twenty-two bits are transmitted from the ground for a single command message. Table 5 illustrates the 22 command bits. After a 4-bit preamble and a 1-bit sync pulse, 2 bits are used for selecting a decoder, 3 bits are used for command routing within the spacecraft, and 8 bits contain the command information. The last 4 bits comprise a parity check word. The code used is an optimal Hamming-type linear block code capable of detecting all possible 1- and 2-bit error patterns. The modulo-2 summation of the selected routing and data bits results in even parity for each case. The bit error rate of the ground system is 10^{-5}. By applying the described command block code, the combined spacecraft/DSN system word error rate has been increased to 10^{-9}. The activated spacecraft receiver demodulates the S-band carrier and provides the frequency shift key tones (FSK) to the command decoders. The 128 Hz represents a "0" and 204.8 Hz represents a "1". The addressed decoder converts the FSK tones to digital data and performs a verification operation with the command message to reduce the probability of executing wrong commands. The decoder forwards the routing address, command message, and if the command is properly verified, an execute pulse to the command distribution unit. If the command is not properly verified by the decoder, the execute pulse is inhibited and the command distribution unit does not act upon the command message.

The command distribution unit processes and distributes all commands to the spacecraft equipment and scientific instruments. Two basic types of output are provided by the command distribution unit: The first is a serial data output to a specific user; the routing portion of the command message identifies the user, and the 8 bits of command information provide the serial data. The second output is a signal applied to any one of the 255 discrete lines for initiating specific functions. The routing portion of the message signifies this discrete type of output and the 8-bit command information identifies the particular one of the possible 255 discrete commands. The command distribution unit also has the capability of being programmed by the routing and command messages to store up to 5 discrete commands for sequential execution at a later time and to store the time delay between sequence enable and sequence execution, and between each command of the sequence. This feature permits the command to be sent and verified by telemetry before execution and will be particularly useful when the communication round-trip time is great. In addition, the command distribution unit will provide a sequence of commands that will be activated at preset intervals by a sequencer which will be initiated automatically by separation of the spacecraft from the launch vehicle.

For redundancy, two decoders are provided for selective operation by an address in the transmitted command message. Redundant paths are provided throughout the logic of the command distribution unit. The discrete outputs are wired to prevent single-part failures from activating other outputs.

The spacecraft is capable of receiving continuous strings of commands by receiving one or more zeros between each adjacent command. Thus, it is possible to reduce the command word lengths to 19 bits for all except the first command.

Table 3. Atlas/Centaur third-stage Pioneer 10 RF systems summary

Vehicle stage	Vehicle-borne system	Subsystem or link	Type of modulation	Transmitter power, W	Carrier frequency, mHz
Atlas	Telemetry (S-band	RF No. 1	PAM/FM/FM	6 (Nominal)	2215.5
	Range safety command	Command Receivers (2)	FM	—	414
Centaur	Telemetry (S-band)	RF No. 1	PAM/FM/FM	6 (Nominal)	2202.5
	Range safety command	Command Receivers (2)	FM	—	414
	Tracking	C-Band transponder			
		ground-to-airborne	Pulsed	—	5690
		airborne-to-ground	Pulsed	1 (Average) ≥400 (Peak)	5765
Third stage	Telemetry (P-band)		FM/PM	3 (Average)	256.2
	Tracking	C-Band transponder			
		ground-to-airborne	Pulsed	—	5690
		airborne-to-ground	Pulsed	1 (Average) ≥400 (Peak)	5765
Pioneer 10	Telecommunications (S-band)	Telemetry link	PCM/PSK/PM	8 (max)	2292±1
		Tracking link			
		ground-to-airborne	PCM/PM (coherent or non-coherent)	—	2110±1
		airborne-to-ground		8	2292±1
		Command Link	PCM/PSK/PM	—	2110±1

Table 4. Launch vehicle characteristics

	SLV-3C booster	Centaur stage	TE-M-364-4
Weight	128, 920 kg (284, 269 lb)	17, 734 kg (39, 104 lb)	1142 kg (2510 lb)
Height	22.9 m (75 ft) (including interstage adapter)	14.6 m (48 ft) (with payload fairing)	2.1 m (6.75 ft) to top interstage ring
Thrust	1, 830, 520 N (411, 353 lb) sea level	130, 000 N (29, 200 lb) vacuum	65, 860 N (14, 800 lb)
Propellants	Liquid oxygen and RP-1	Liquid hydrogen and liquid oxygen	Solid chemical fuel TP-H 3062
Propulsion	MA-5 system two 778, 042-N (174, 841-lb)-thrust engines: one 268, 410-N (60, 317-lb)-sustainer engine and two 3, 008-N (676-lb)-thrust vernier engines	Two 65, 000-N (14, 600-lb)-thrust RL-10 engines. Ten small hydrogen peroxide thrusters	One solid-fuel engine
Velocity	2, 534 m/s (5665 mph) at BECO. 3543 m/s (7926 mph) at SECO	10, 262 m/s (22, 948 mph) at MECO	13, 913 m/s (31, 122 mph) at spacecraft separation
Guidance	Pre-programmed pitch rates through BECO Switch to Centaur inertial guidance for sustainer phase	Inertial guidance	Spin (60 rpm) imparted by spin table on top of Centaur

Table 5. Pioneer F and G command word

Bit numbers	Bits	Function
1–4	0 0 0 0	Preamble
5	1	Sync
6, 7	A_1	Decoder address
	A_2	
8–10	R_1 R_2 R_3	Routing address
11–18	C_1 C_2 C_3 C_4	Command message
	C_5 C_6 C_7 C_8	
19–22	P_1 P_2 P_3 P_4	Parity checks

Decoder addresses are 01 or 10 only.

Parity bits are generated as follows:

$$P_1 = R_1 + R_2 + R_3 + C_1 + C_2 + C_3 + C_4$$

$$P_2 = R_1 + R_2 + R_3 + C_1 + C_6 + C_7 + C_8$$

$$P_3 = R_1 + R_2 + C_2 + C_3 + C_5 + C_6 + C_7$$

$$P_4 = R_1 + R_3 + C_2 + C_4 + C_5 + C_6 + C_8$$

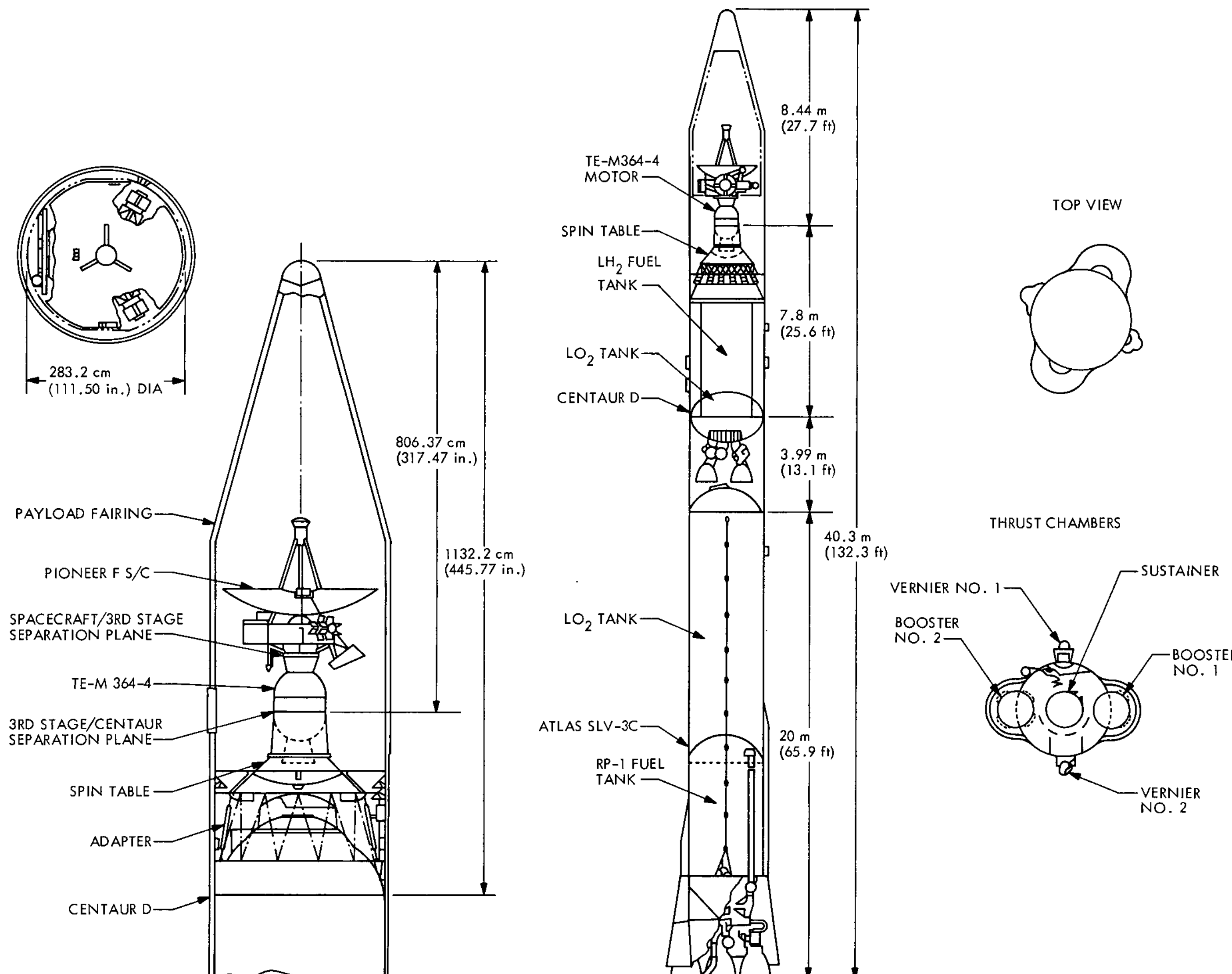


Fig. 8. Launch vehicle-spacecraft configuration

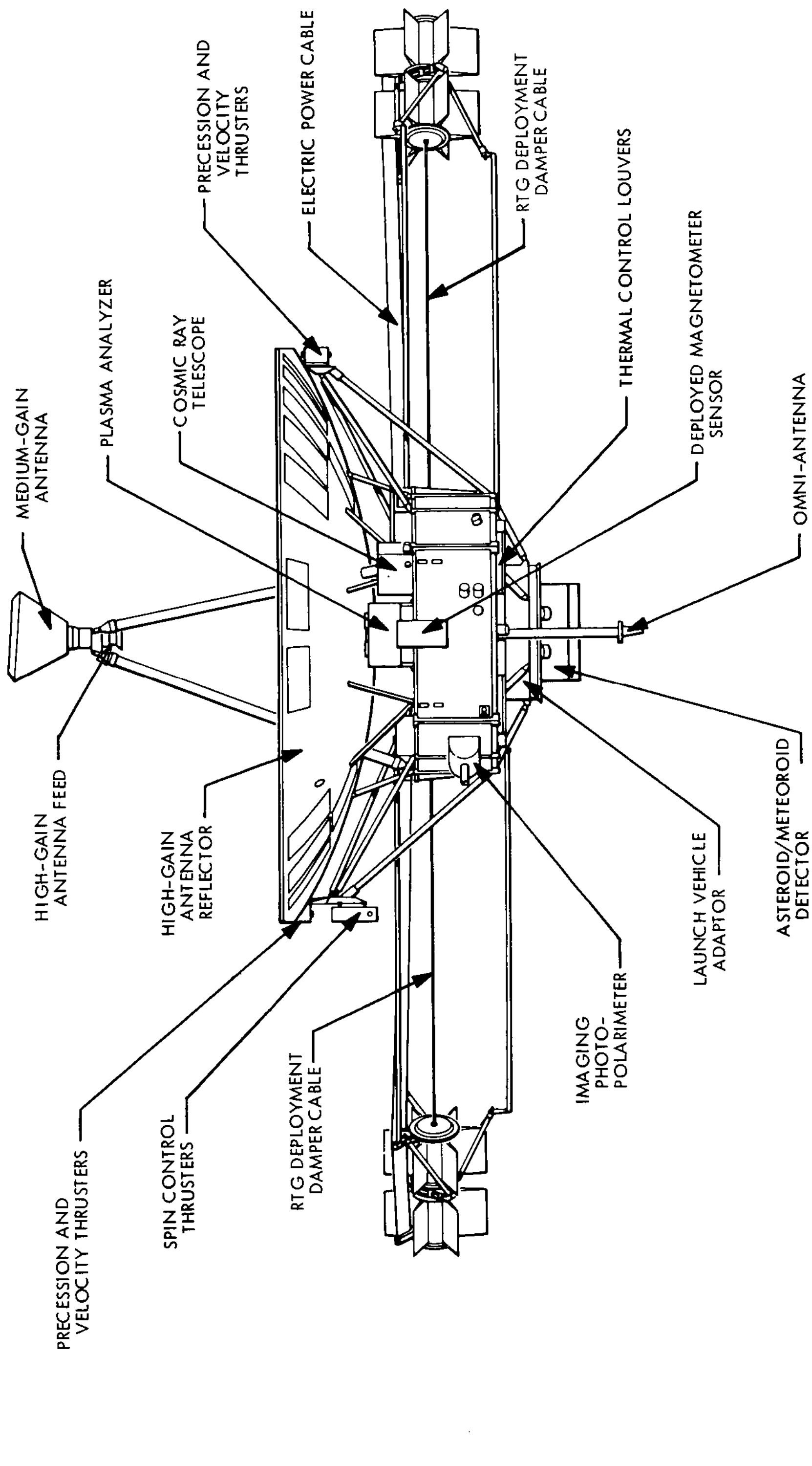


Fig. 9. Pioneer 10 spacecraft (side view)

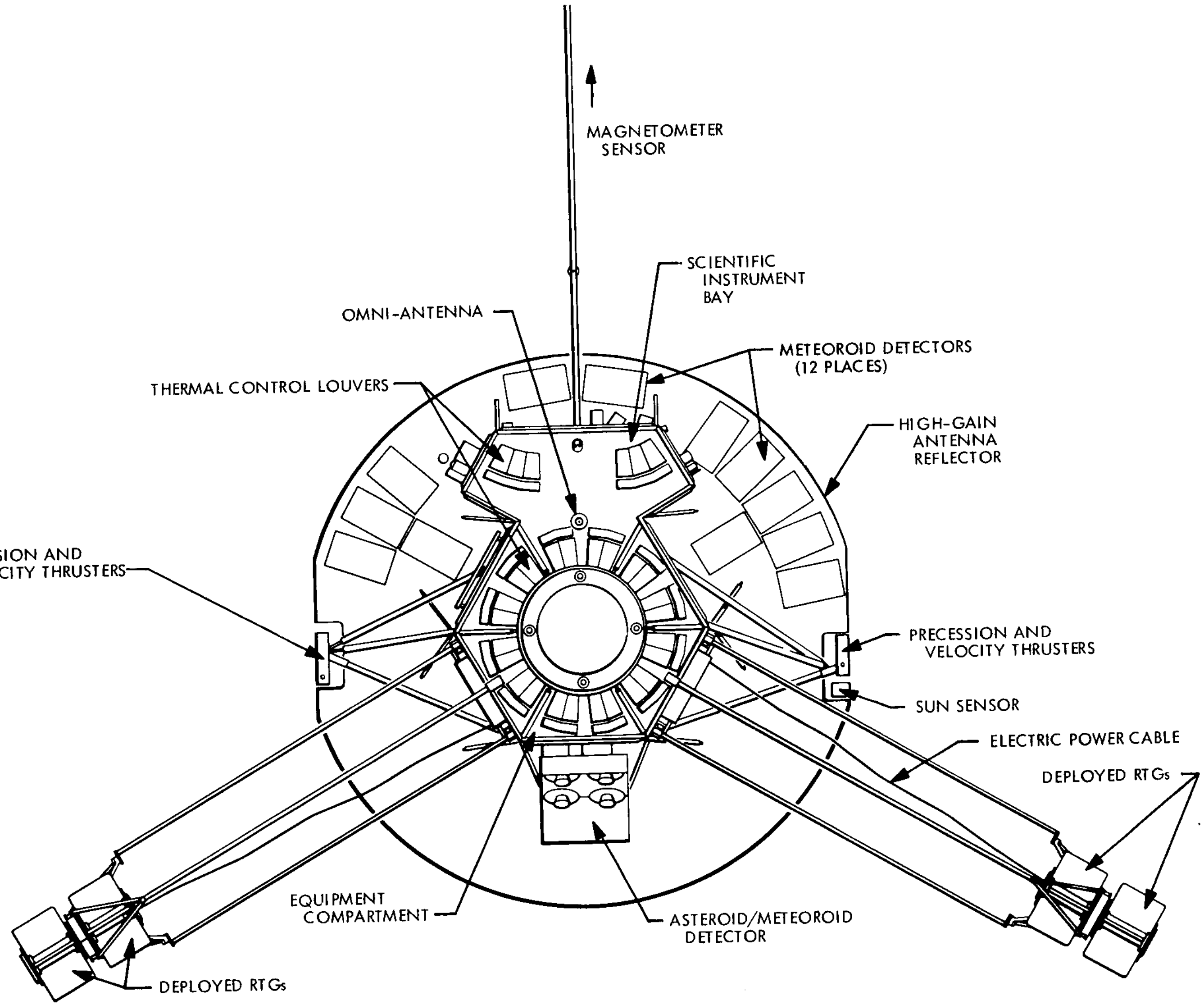


Fig. 10. Pioneer 10 spacecraft (bottom view)

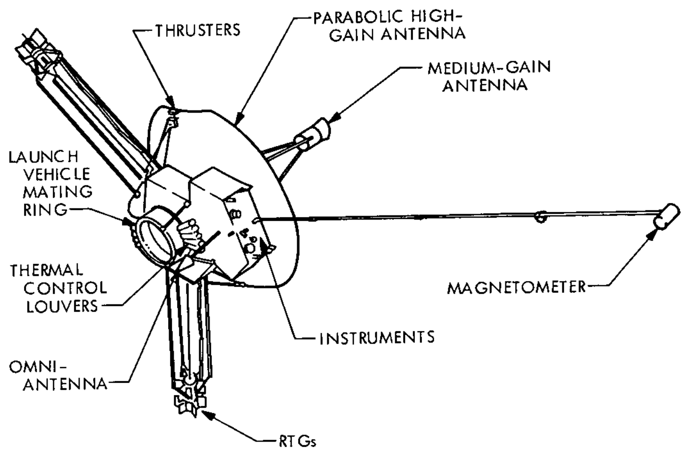


Fig. 11. Pioneer 10 spacecraft (perspective view)

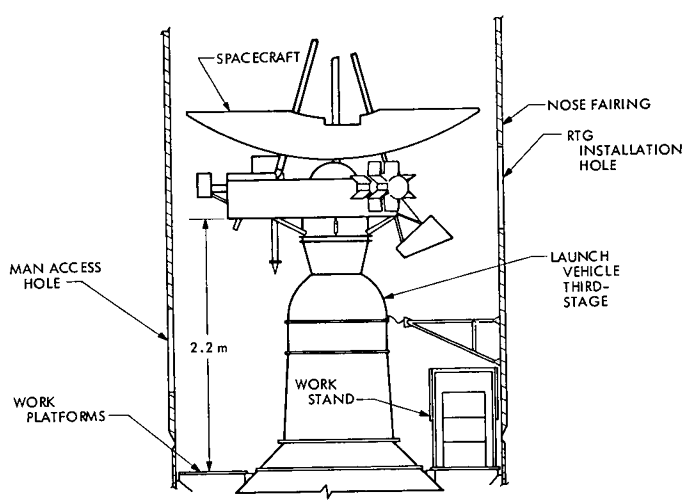


Fig. 12. Folded Pioneer 10 spacecraft mounted on launch vehicle within nose fairing

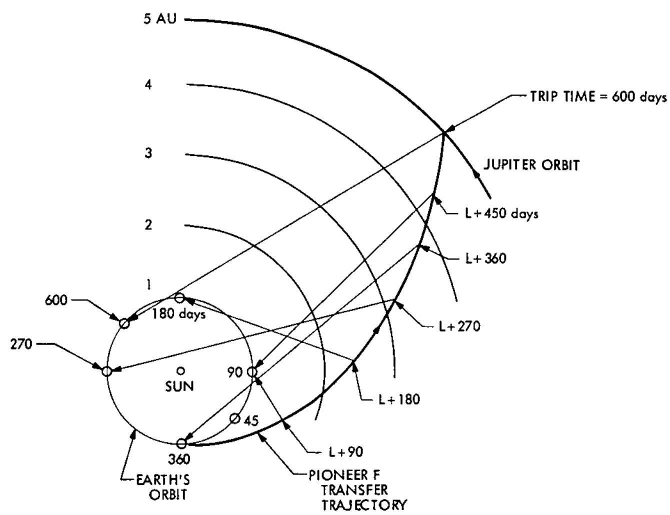


Fig. 13. Relative position of Pioneer 10 spacecraft spin and antenna axis toward Earth

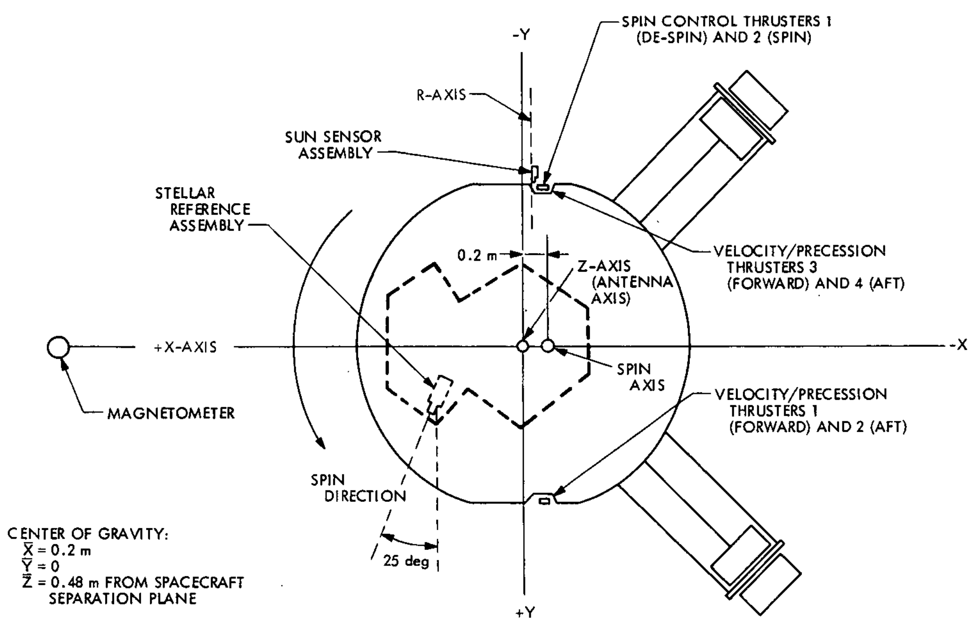


Fig. 14. Attitude-control equipment locations (view looking aft, from spacecraft to booster)

CHANNEL	FIELD OF VIEW FROM X-Z PLANE, deg	FIELD OF VIEW FROM Z-AXIS, deg
1	—	±12
2	0.5	12 - 90
3	0.5	90 - 170

FIELD OF VIEW, deg
30 × 0.2

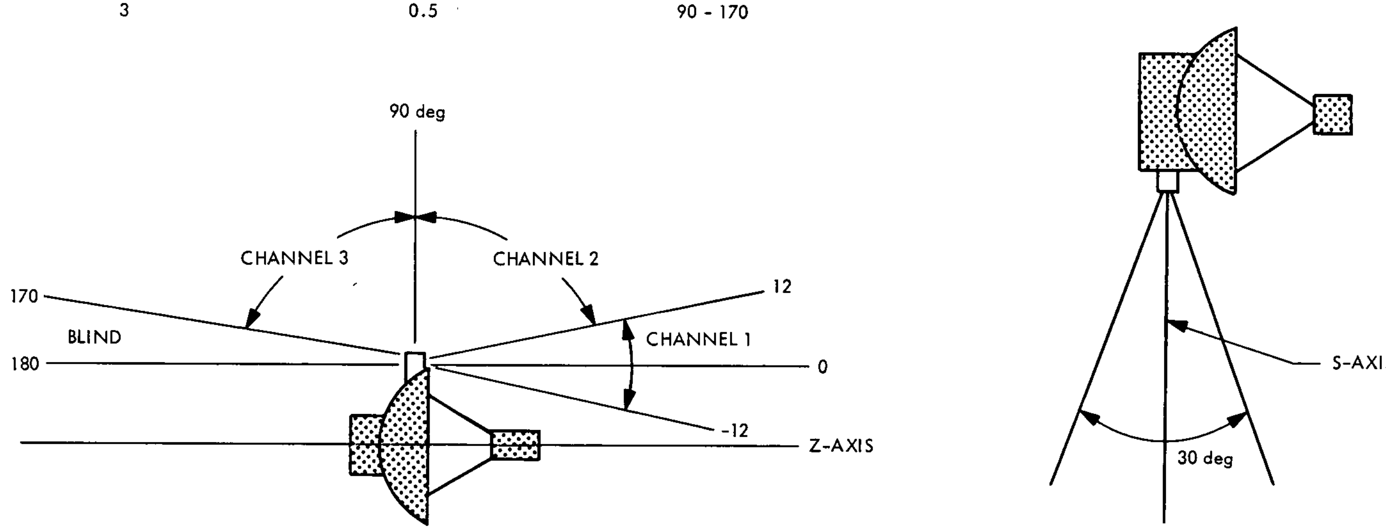


Fig. 15. Sun and star sensors

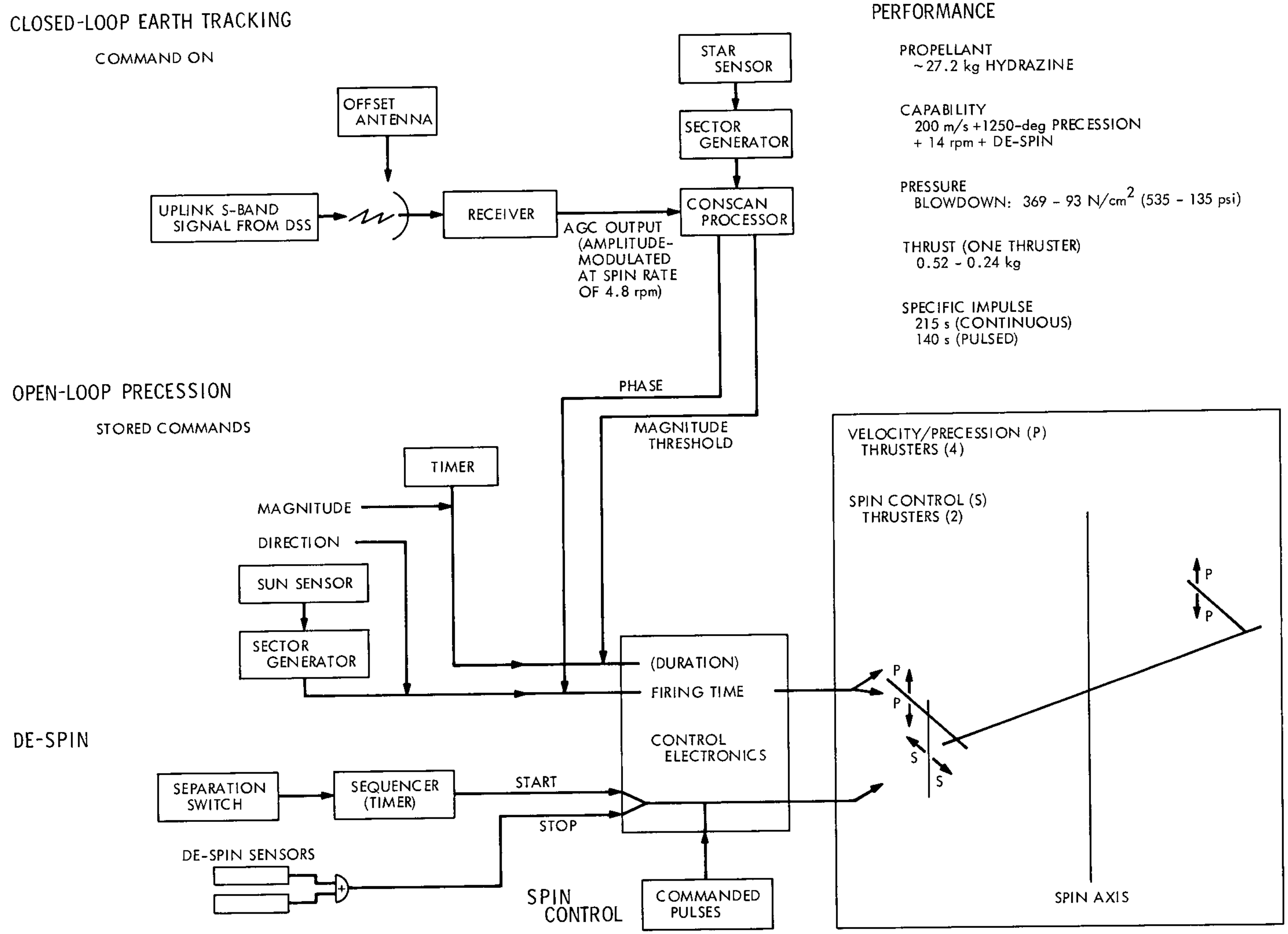


Fig. 16. Attitude, velocity, and spin control (altitude-control subsystem)

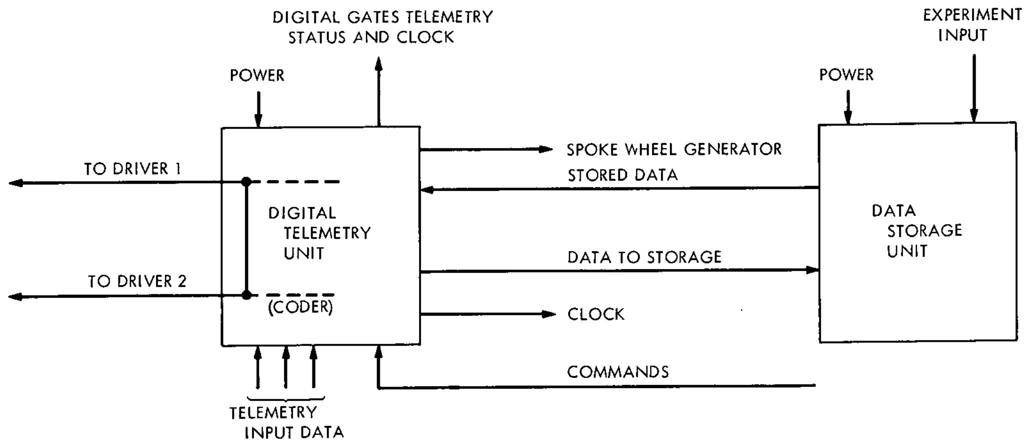


Fig. 17. Pioneer 10 data-handling subsystem

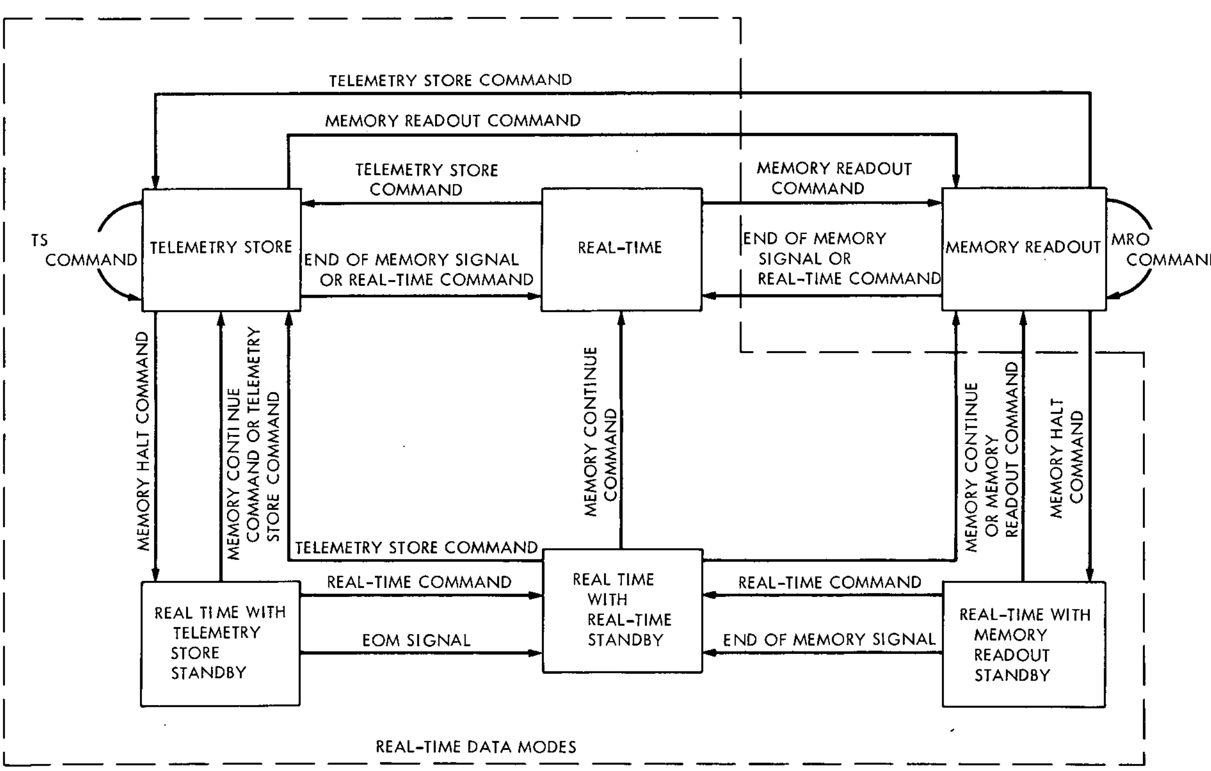


Fig. 18. Pioneer 10 spacecraft data system modes

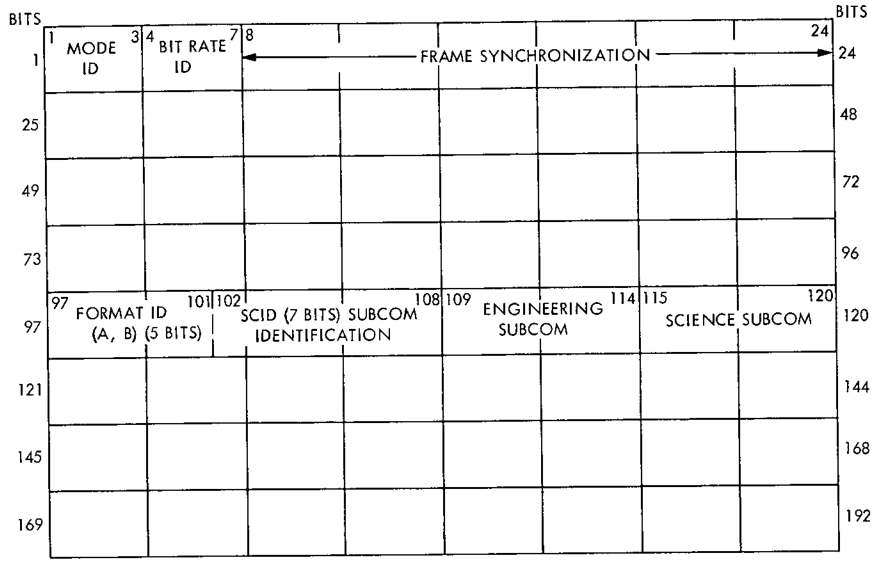


Fig. 19. Pioneer 10 telemetry Format A

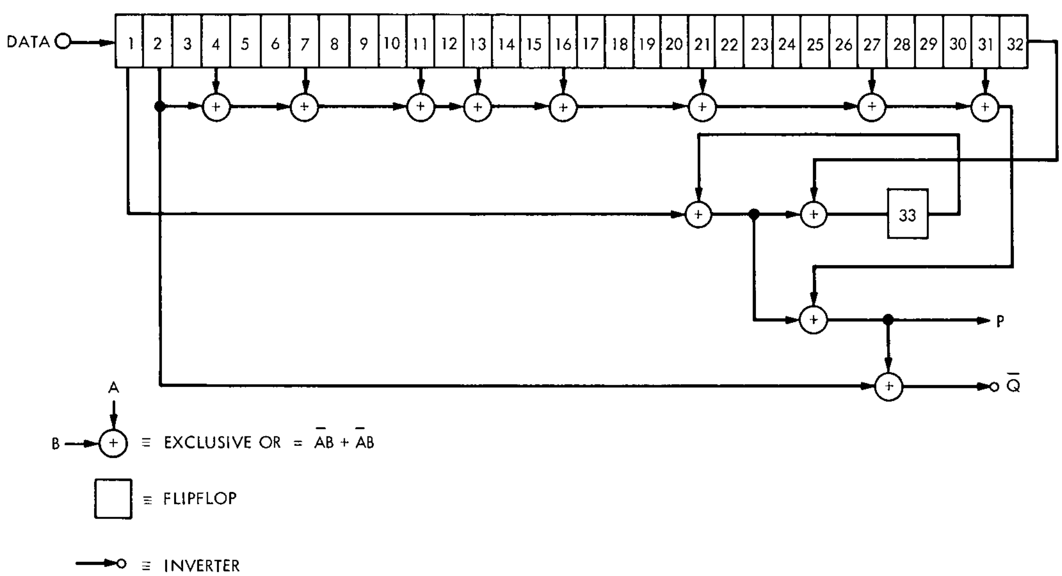


Fig. 20. Pioneer 10 convolutional coder

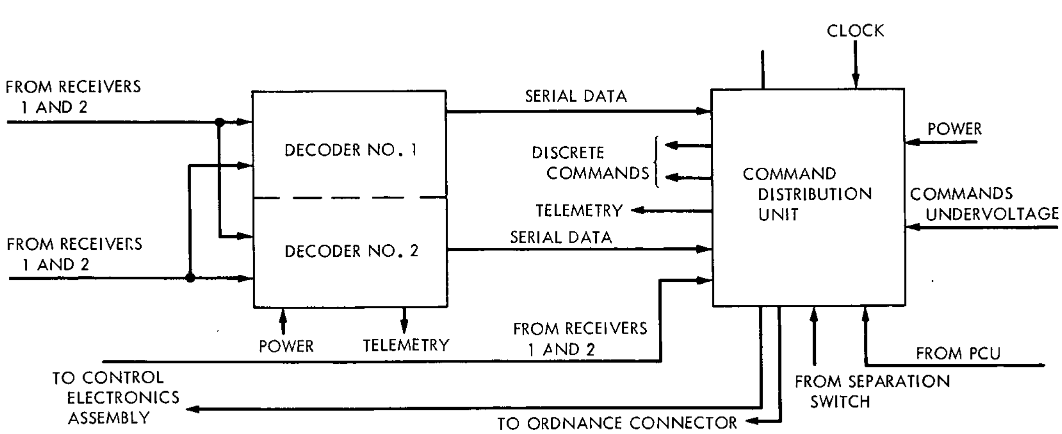


Fig. 21. Pioneer 10 command subsystem

V. TRACKING AND DATA ACQUISITION REQUIREMENTS AND TDS SUPPORT PLANNING

A. Control

Critical phases of the Pioneer 10 spacecraft flight — including launch, early flight, and midcourse maneuvers — were required to be operated from the Pioneer Mission Support Area (PMSA) at the Jet Propulsion Laboratory in Pasadena. Otherwise, mission control was to be maintained at the Pioneer Analysis Area (PMAA) at Ames Research Center.

B. Documentation

All project requirements on the tracking and data system were published in detail in the Support Instrumentation Requirements Document (SIRD) for Pioneers F and G in subsidiary documents called out in the SIRD. A NASA Support Plan (NSP) was prepared to respond to the SIRD.

Project requirements and TDS support plans are summarized for the near-Earth and deep-space phases in the remainder of this section.

C. Launch and Flight Constraints

The Project required TDS to plan support of a launch during the Jupiter opportunity from Feb. 24, 1972 through March 19, 1972. (Periods when the relative position of Earth and Jupiter permit a spacecraft to be launched into a Jupiter-bound trajectory with minimum energy occur at 13-month intervals.) The daily launch period was 30 min for the required direct-ascent mission.

Launch azimuths for the Pioneer 10 Mission varied from 98.95 to 110.0 deg (Table 6) with the azimuth progressively increasing, becoming more southerly for launches at a later time during the daily window. As pointed out in the following paragraphs, a number of factors were important in choosing the daily launch trajectories.

The launch azimuth constraint determined the boundaries of the near-Earth trajectories. The shorter Jupiter trip times were favored against the longer ones. Trajectories that were bringing the S-band radio beam too close to the solar corona were eliminated. This measure was necessary because of the degradation of the telecommunications link's signal-to-noise ratio caused by solar noise. In addition, efforts were made to share the available resources of the DSN between the Pioneer 10 Jupiter flyby and the

Mariner 1973 Venus and Mercury flybys. The view limitations of some onboard Pioneer 10 scientific instruments and the objective to have an S-band signal occultation by Jupiter were factors that determined the angle of the aiming point at Jupiter and its position in relationship to the planet's spin axis and equator. To reach the planned Jupiter flyby aiming point within a predetermined dispersion, two or possibly three midcourse or trim maneuvers were expected to be necessary to alleviate the aiming errors of the launch vehicle.

D. Near-Earth Phase

Near-Earth phase tracking and data acquisition required the participation of facilities of the AFETR, GSFC, Kennedy Space Center (KSC), DSN, and NASCOM. Required were the telemetry and radio metric tracking of the three stages of the launch vehicle and the collection of real-time telemetry from the spacecraft during powered flight.

Launch vehicle-generated information was necessary to monitor the performance of the launch vehicle system to determine any deviations from normal performance predictions and to generate a solar orbit injection velocity vector. This near-real-time orbit was necessary for the DSN to obtain antenna angle and frequency predictions for efficient first-signal acquisition. The real-time spacecraft telemetry to be furnished by the near-Earth phase tracking facilities was to be provided for the Project's Mission Operations Systems team to monitor the powered flight performance of the spacecraft to check for normalcy and prepare for the transmission of important commands after the first two-way signal acquisition by the DSN.

1. Data Types and Support Classifications. With data requirements separated for convenience into three types — metric data (C-band and S-band), launch vehicle telemetry, and spacecraft telemetry — there were five major uses for data required by Project. These were: (a) quick establishment of the mission's normalcy; (b) determination of minute by-minute status of the flight; (c) assistance of DSN, STDN, and AFETR in acquisition of vehicle and/or spacecraft; (d) assistance in Project decisions concerning a nonstandard mission; (e) and enabling of postlaunch analysis.

The requirements for metric and telemetry data support were classified according to their importance with respect to successful accomplishment of the mission. The three classes of requirements were defined by the Project Office as:

Class I: Reflection of minimum essential needs to ensure accomplishment of primary mission objectives, i.e., mandatory requirements that, if not met, might result in a decision not to launch.

Class II: Reflection of the needs to accomplish all stated mission objectives.

Class III: Reflection of the ultimate in desired support, i.e., support that would provide the capability to achieve the objectives at the earliest time in the mission program.

2. Data Requirements and Support Plans

a. Requirements. Tables 7 and 8 list Project data requirements of AFETR, STDN, Kennedy Space Center (KSC), and DSN resources. All Class I requirements (Table 9) for the near-Earth phase could be met by available resources. However there was potential constraint should any of the required stations in Table 9 not be available for launch. This especially held true for the Antigua supporting stations and the ship Vanguard, which were required to cover control vehicle events.

There was a special requirement for extended near-Earth phase in the event a highly nonstandard trajectory was experienced. The TDS facilities would be requested to extend their support over a period of time significantly greater than that planned. An example: if the spacecraft continued in a low Earth orbit. The purpose would be to obtain maximum data for analysis purposes.

b. Support plans. Thorough planning for optimum tracking and data acquisition support preceded the launch and flight of Pioneer 10 spacecraft. With JPL the tracking and data acquisition center, the facilities and resources of the DSN, NASCOM, GSFC, AFETR, KSC, and the JPL Scientific Computing Facility (SCF) were made available. Plans called for these to provide support as required.

The DSN was to provide capabilities for deep space tracking, telemetry data acquisition, and command, and also to provide operational facilities and some ground communications capabilities.

The NASCOM was to provide worldwide ground communications circuits and facilities.

The GSFC was to provide near-Earth tracking and data acquisition capabilities.

The AFETR was to provide tracking and data acquisition and some communications support during the near-Earth phase.

The KSC was to provide prelaunch and launch support.

SCF was to provide analysis program operations on one of two Univac 1108 computers.

Figures 22 through 24 show planned coverage for actual launch date, March 3, 1972. Tables 10 through 13 show the support planned to meet requirements.

Merritt Island radar, Grand Turk radar, Antigua radar and telemetry, and Ascension Island radar and telemetry were AFETR resources planned as support in the near-Earth phase. GSFC support was to be from Merritt Island USB station, Bermuda, Canary Islands, Ascension USB station, Tannarive, and the Apollo instrumentation ship, Vanguard.

During the launch operations, the telemetry bit rate to be used was set at 128 bits/s and the engineering telemetry was to be transmitted by the spacecraft in the real-time mode. Since the near-Earth phase support facilities would have no sequential decoding capabilities, the spacecraft's convolutional encoder was to be turned off. The traveling-wave tube amplifier of the spacecraft's telecommunications package would be turned on and would operate with the full power output, which would be radiated toward the ground by the omni/medium-gain antenna system. All experiments would be turned off during launch operations.

Figure 25 displays the typical Earth tracks planned for Pioneer 10 launches. Since the launch azimuth had to be changed for every day's launch opportunity to obtain the planned solar orbits, the Earth tracks of the planned launch trajectories covered a band approximately 2500 km wide. The locations of the launch vehicle's main engine cutoff (MECO), end of third stage burn, and Ascension Island and Johannesburg rise are indicated in the figure.

The launch sequence of events after the launch are displayed in Figure 26 with the key flight events given in Table 14. The signal visibility rise and set times at the corresponding near-Earth stations are given. This coverage chart shows that no data could be obtained from Antigua or Ascension Island on the third stage burnout and the subsequent 3 min of flight. To fill this gap it was planned to station the Apollo instrumentation ship, Vanguard, at a predetermined location to assure continuous spacecraft telemetry from launch up to the first DSN acquisition, and also obtain radio metric data on the injection.

The signal visibility rise times of the Ascension Island station (GSFC), DSS 51 in Johannesburg, and DSS 61 in Madrid are shown for four typical launch dates on Figure 27. The Ascension rise time is approximately 15 min and 45 seconds after launch. DSS 51 in Johannesburg would see the spacecraft starting at 21 min after launch. However, because of the low declination angles, DSS 61 in Madrid would see the spacecraft only between 29 and 63 min after launch. Since the Flight Project hoped to obtain a two-way telecommunications link lock not later than 26 min after launch, the decision was made to use DSS 51 as the prime first DSN signal acquisition station. The Goddard Space Flight Center's Ascension station would be used as a full backup of DSS 51. Both stations would see spacecraft events controlled by an onboard automatic sequencing system.

After the two-way lock was established with the spacecraft, the near-Earth phase of the mission would be completed and the deep space phase of the mission would begin. The deep-space phase of the mission would end when the mission would be terminated.

As planned, the typical Pioneer 10 launch vehicle/spacecraft altitude and velocity profiles during the power flight are given in Figure 28. The injection velocity of the spacecraft would be 14 km/s – the highest Earth-referenced velocity applied in NASA's planetary program. The planned Jupiter-bound mission trajectory was for the spacecraft to cross the Moon's orbit in 11 hours, Mars's orbit in 2-1/2 months, and fly by Jupiter in 650 days.

The corresponding uplink doppler shift and doppler rate of the S-band uplink carrier, as seen at DSS 51 after injection, would be as shown in

Figure 29. The uplink doppler shift, caused by the relative movement between spacecraft and DSS 51 antenna in Johannesburg at 22 min after launch, was plus 10 kHz. However, at 30 min, the doppler shift would be down to minus 60 kHz, and, later, below minus 70 kHz. The rate of this doppler shift at the time the uplink signal would first reach the spacecraft is around minus 220 Hz/s. This rate would drop to minus 50 Hz/s, around 30 min after launch. Because the spacecraft receiver had a maximum doppler rate capability of 150 Hz/s, it could only lock on the station's uplink S-band signal 25 min after launch, or later. After checking out the performance of the two-way links, the Projects could send the first command at 30 min after launch. Since the Project wanted the capability to change some of the flight sequences as early as possible, the DSN planned to attempt a two-way lock with a command capability as early as 26 min after launch on a best-effort basis.

E. Deep-Space Phase

1. Requirements

a. Tracking. Project tracking requirements of the DSN networks in brief were as follows here.

Two-way doppler data continuous from initial acquisition by the DSN to first midcourse maneuver or 5 days, whichever was first. At least one horizon-to-horizon pass per day thereafter through the remaining midcourse maneuvers (estimated to be 2) at 15- to 20-day intervals. After final maneuvers, one horizon-to-horizon pass per day for ten days followed with two such passes per week for three weeks.

Cruise phase requirements were for two horizon-to-horizon passes per two weeks — one on a day with a reorientation maneuver and one on a day without a reorientation maneuver. This last requirement was a minimum and assumed tracking data available during the reorientation maneuver and no significant perturbation of trajectory caused by the reorientation maneuver.

At least one horizon-to-horizon pass per day, signal-to-noise ratio permitting, was required between 30 days prior to and 30 days after solar conjunctions.

During the encounter or flyby phase, requirement was for two horizon-to-horizon passes per week from encounter minus 30 days to encounter plus 30 days, with continuous tracking from encounter minus 10 days to encounter plus 10 days.

The sample rate was required to be 1 point per 60 seconds except as follows:

(1) One point per second during midcourse maneuvers.

(2) One point per ten seconds from Ascension first acquisition to acquisition plus one hour.

(3) One point per ten seconds during DSS 51's first pass.

b. Telemetry. For the purpose of monitoring spacecraft performance, engineering evaluation, failure detection, and scientific data, the Project set forth requirements to support the primary mission objective.

Continuous coverage by the DSN 26-m-diam antenna network was required from initial acquisition to Jupiter encounter plus six months. The 64-m-diam antenna network was required to support at least one horizon-to-horizon tracking mission per week during the same period. And, during critical mission events, the 64-m network was to provide continuous coverage with suitable pre- and post-coverage.

Until Jupiter encounter plus six months to limit of receipt of downlink signal, the DSN was expected to give daily coverage as required.

2. Support Plans. The DSN planned to furnish almost 24-h/day continuous support from any three continuous-view combinations of the following 26-m-diam antenna stations: DSSs 11, 12, 41, 42, 51, 61, and 62. (Launch stations for Pioneer 10 were to be DSSs 11, 42, 51, and 61.) After July 1973 and during the Jupiter flyby phase, the 64-m-diam antenna subnet of DSSs 14, 43, and 63 was to provide the best assurance for near-optimum data return using the network's most advanced resources.

Because of Jupiter's position versus the inclination of the Earth's spin axis, the geocentric declination angle of the Pioneer 10 mission would be quite low, at least during the first part of the Jupiter transfer trajectory.

Figure 30 depicts the relationship between geocentric declination versus time after orbit injection. At injection, the geocentric declination angle is approximately minus 32-1/2 deg, and at Jupiter encounter the declination is minus 19 deg. Because of the low negative declination angles, the view of the spacecraft from the DSN stations located in the southern hemisphere is more favorable than the view from the northern hemisphere locations. Figure 31 shows the typical view periods for a Feb. 29, 1972 launch date (an example) versus the elevation angles of the corresponding antennas. The first acquisition station's (DSS 51) set time is approximately 2 h before the Ascension Island station loses view of the spacecraft. There is a small time gap between DSS 51 (Johannesburg DSCC) set and DSS 11 (Goldstone DSCC) rise. It was planned that during this gap the Ascension station would deliver the telemetry information. The view period of DSS 11 is in the vicinity of 7 h, but the view period of DSS 42 at Canberra, Australia, is more than 14 h long and there exists also a good overlap between DSS 51 (Johannesburg) rise and DSS 42 (Canberra) set.

The lengths of the view periods of the northern hemisphere stations increase gradually. One hundred days after launch the declination angle decreases from minus 33 deg to minus 24 deg. As shown in Figure 32, DSS 11 at Goldstone DSCC has at that time a maximum view period of almost 10 hours.

The low elevation angles of the northern hemisphere stations connected with short station overlaps, as shown between DSS 51 in Johannesburg or DSS 61 in Spain versus DSS 11 at Goldstone DSCC, can, during a few hours, cause a deterioration of the signal-to-noise ratio of the telemetry signal. The typical telemetry degradation factors versus 13- and 8-deg elevation angles are given. At Jupiter encounter the DSN plans to use the 64-m-diam antenna subnet: DSS 14, Goldstone DSCC; DSS 43, Canberra; and DSS 63, Madrid. The closest approach to Jupiter with a spacecraft/Jupiter center range of Jupiter radii equivalent of 210,000 km will be adjusted such that this periapsis point will be reached around the middle of the 5-h overlap between the Goldstone DSCC and Australian stations. Thus, the most important event of the missions will be supported by two 64-m-diam antenna stations. This configuration will enhance the reliability of data return.

Because of the large relative velocity changes between the Earth and the spacecraft, the uplink doppler shifts were much larger than ever experienced on previous planetary flights by the Deep Space Network. Figure 33 shows the relationship between the uplink doppler shift in kilohertz versus days after spacecraft injection. The doppler shift starts at minus 70 kHz and moves between two boundaries of minus 250 kHz and plus 130 kHz. The DSN planned to furnish additional crystal oscillators to all stations to handle these unusual doppler excursions. Because of the large gravitational forces of the Sun's biggest planet Jupiter, the doppler shift changes from minus 250 kHz down to minus 410 kHz; and, in a few hours, it will swing back around to minus 200 kHz (Figure 34). The DSN plans to equip DSSs 14 and 43 with special frequency synthesizers which will generate a linear frequency ramp at the predicted doppler rates. Using this equipment, the static phase error of the spacecraft receiver can be kept below 10 deg, and the static phase error of ground station receivers will be in the vicinity of zero. This capability will provide good assurance to sustain a continuous lock of the spacecraft and ground receivers and avoid doppler cycle slipping. The latter condition could dilute the precision of the two-way Jupiter flyby doppler information necessary for the success of the Celestial Dynamics equipment.

Figure 35 shows the spacecraft geocentric radius relationship versus time from injection in days. In addition, the threshold points of the corresponding telemetry bit rates are indicated. The 26-m-diam antenna stations will reach the 2048-bit/s telemetry rate under the most favorable conditions of the S-band telecommunications link at 140 days after launch with a geocentric range of 1.3 AU. At 230 days after launch, 512 bits will be obtained, and at Jupiter encounter the 26-m-diam antenna stations would be able to support a 128-bit/s telemetry rate. The 64-m-diam antenna stations will increase the data return considerably. If and when these facilities can be made available for tracking and data acquisition, telemetry bits rates of 1024 bits/s can be obtained after 280 days of flight and up to 700 days. This time frame will include the Jupiter encounter. The shown optimum-type telemetry bit rates can only be obtained when the spacecraft high-gain antenna points exactly to the Earth and the DSN antenna to the spacecraft.

F. Ground Communications

1. Requirements. Project communications requirements in the near-Earth phase were for data and voice channels within the elements of the TDS and among TDS facilities and the Project launch operations facilities adequate to conduct test and launch operations. Ground Communications Facility requirements as presented in the Support Instrumentation

Requirements Document for Pioneer 10 included voice nets, television, high-speed data (HSD), and teletype.

Location of NASCOM/GCF Operating Terminals for the near-Earth phase were required at:

(1) JPL-Space Flight Operations Facility, CTA 21, and Simulation Center

(2) Cape Kennedy Air Force Station — DSS 71, Real-Time Computing System, and Building AE

(3) Goddard Space Flight Center — Network Operations Control Center

(4) Kennedy Space Center — Central Instrumentation Facility for the AFETR

(5) Ames Research Center — Remote Information Center

Ground communications requirements are presented in Table 15.

2. Support. Except for the SFOF-Goldstone DSCC circuits, all circuits between the SFOF and DSSs, STDN stations, and other stations supporting Pioneer 10 were supplied to the DSN by NASCOM. The communications network shown in Figure 36 represents the types, quantities, and routing of circuits used in support of Pioneer 10's test and near-Earth phase. Figure 37 depicts the circuits used in support of Pioneer 10's deep-space phase up to the completion of the midcourse maneuver.

Existing GCF voice, teletype, and HSD systems as defined in GCF Functional Design for 1971-1972, Reference Number 3183-312-69, dated Dec. 1, 1969, were employed in the support of Pioneer 10. The voice and teletype systems were employed in the support of Pioneer 10 in basically the same manner in which prior Pioneer Project spacecraft were supported. The GCF HSD system, however, for the first time supported the Pioneer Project. The use of the NASCOM/GCF/HSD system was the prime means of transferring data between the SFOF and supporting stations.

a. High-speed data system. The NASCOM/GCF HSD system provided a 4800 bits/s synchronous high-speed data transfer capability. GCF HSD system acceptance tests were conducted with the Pioneer 10 prime support DSSs 11, 12, and 61 and with the ARC Remote Information Center (RIC).

The tests were successful in demonstrating that the tested stations could operationally support Pioneer 10 using the 4800 bits/s NASCOM/GCF HSD system.

b. Mission-dependent HSD system interface. One mission-dependent interface between the Pioneer Project and the GCF HSD system was required to support Pioneer 10. It was necessary to establish a NASCOM/GCF HSD capability between the SFOF and the ARC RIC. To expedite the operational HSD acceptance testing of circuits/equipments to be used for HSD flow between SFOF and the ARC RIC, the DSN responded to the Pioneer Project's request for the loan of HSD equipment. The DSN arranged for DSS 71 to ship their backup HSD encoder, decoder, and block multiplexer to ARC to be returned when ARC-procured equipment was delivered by the vendor. On August 4, 5, and 6, 1971, the GCF and ARC RIC successfully completed testing, and the HSD capability between ARC RIC and the SFOF were declared operational.

c. Support HSD configuration. The GCF, Pioneer Project, and NASCOM agreed on a HSD configuration and utilization plan to be used in support of Pioneer 10. The HSD configuration and utilization plan to be used in support Pioneer 10 launch phase is shown in Figure 38.

G. Testing Requirements

There was requirement for TDS facilities to design, plan, and conduct RF and data compatibility tests between the spacecraft and the TDS facilities during various phases of the mission performance. In particular, use of the DSN CTA 21 at JPL, Pasadena, was required to establish RF and data system compatibility between the spacecraft and DSN with microwave link between TRW, Redondo Beach, and CTA 21. For performance of software checkout and telecommunications subsystem tests, access to certain portions, e.g., receiver and TCP computer, was necessary. Detailed utilization planning for the CTA 21, determined by coordination with the Pioneer Integration and Test Manager, was to be provided in the DSN Utilization Schedules.

Varying levels of support by the TDS facilities of preflight operational tests and the training of project personnel also were required by Pioneer Project.

Table 6. Pioneer 10 launch days analysis

Launch date (GMT, 1972) month, day	Trip time, days	Range of launch azimuths, deg	Range of path angles at injection, deg
2/24	645	110.0 and yaw	4.95 - 9.45
2/25	655	110.0 and yaw	4.82 - 9.29
2/26	650	109.36 - 109.55	4.72 - 9.24
2/27	660	109.82 - 109.90	4.63 - 9.12
2/27	637	106.47 - 107.10	4.65 - 9.23
2/28	652	107.49 - 107.92	4.51 - 9.05
2/28	631	104.82 - 105.71	4.55 - 9.17
2/29	646	105.71 - 106.44	4.58 - 9.16
3/1	641	104.22 - 105.18	4.52 - 9.13
3/2	639	103.16 - 104.29	4.52 - 9.14
3/3	639	102.36 - 103.62	4.54 - 9.18
3/4	642	101.82 - 103.16	4.45 - 9.10
3/5	646	101.46 - 102.86	4.50 - 9.16
3/6	651	101.32 - 102.70	4.57 - 9.22
3/6	630	99.73 - 101.41	4.71 - 9.41
3/7	659	100.89 - 102.38	4.47 - 9.13
3/7	636	99.13 - 100.93	4.62 - 9.32
3/8	669	100.95 - 102.43	4.52 - 9.18
3/8	644	98.95 - 100.78	4.57 - 9.27
3/9	683	101.47 - 102.87	4.55 - 9.20
3/9	656	99.14 - 100.94	4.68 - 9.39
3/10	740	107.02 - 107.51	4.40 - 8.94
3/11	739	105.64 - 106.36	4.49 - 9.06
3/11	688	100.09 - 101.73	4.59 - 9.28
3/12	763	107.79 - 108.16	4.43 - 8.95
3/12	739	104.48 - 105.40	4.51 - 9.12
3/13	795	110.0 and yaw	4.61 - 9.05
3/13	738	103.26 - 104.39	4.59 - 9.23
3/14	737	102.12 - 103.44	4.66 - 9.33
3/15	763	103.94 - 104.97	4.65 - 9.28
3/16	800	107.78 - 108.22	4.74 - 9.30
3/17	840	110 and yaw	4.95 - 9.39
3/18	850	110 and yaw	5.09 - 9.54
3/19	860	110 and yaw	5.07 - 9.52

Table 7. Project requirements for C-band (radar) and S-band (radio) metric data for the near-Earth phase

Vehicle and System[a]	Class I	Class II
Centaur C-band	Launch to Centaur MECO + 60 sec	AOS[b] to LOS[c] for Cape Kennedy (1.16), Grand Turk (7.18), Antigua (91.18) and Tananarive
TE364-4 C-band	MECO through Yo deployment	AOS to LOS for Patrick (0.18), Bermuda (67.18), and Ascension (12.16)
Spacecraft S-band	1-hr interval starting at initial two-way acquisition[d]	

[a]All data transmitted to Real-Time Computer System.
[b]Acquisition of signal.
[c]Loss of signal.
[d]Either DSS 51 or Ascension (STDN) depending on initial acquisition station. This interval assumed to be a Class I interval even though not specified because of the importance of these data for validating two-way lock, initial spacecraft orbit, and commanding activities.

Table 8. Project requirements for launch vehicle and spacecraft telemetry data

Stage and Link (MHz)	Class I	Class II	Comments
Atlas (2215.5)	T-75 minutes to T+5 minutes		T-75 minutes to T-5 minutes during periods of radiation only
Centaur (2202.5)	T-75 minutes to Antigua LOS	AOS to LOS from stations at Bermuda, Vanguard and Tananarive	T-75 minutes to T-5 minutes during periods of radiation only
TE364-4 (256.2)	T-75 minutes to Yo deployment	AOS to LOS from stations at Bermuda, Ascension, ARIA[a] and Vanguard	T-75 minutes to T-5 minutes during periods of radiation only
Spacecraft (2292.0)	Start of spacecraft countdown to launch T-10 minutes (DSS 71 support)	T-10 minutes until initial two-way acquisition (See comments)	Class II requirement includes AOS to LOS from DSS 71, MIL[b], Bermuda, Antigua, Vanguard or ARIA, Canary Island, and Ascension (ACN)

[a] Apollo Range Instrumentation Aircraft.
[b] Merrit Island STDN station.

C2

Table 9. NETDS Class I requirements

Class I Requirement	Type of Data	Stations Required to Provide Support
T-75 Minutes to T-5 Minutes	Atlas Tlm (2215.5 MHz) Centaur Tlm (2202.5 MHz) TE364-4 Tlm (256.2 MHz)	AE and CIF
Start of spacecraft countdown to T-10 Minutes	Spacecraft Tlm (2292.0 MHz)	DSS 71
T-5 Minutes to T+5 Minutes	Atlas Tlm (2215.5 MHz)	AE/STS or CIF
T-5 Minutes to Antigua LOS	Centaur Tlm (2202.5 MHz)	AE/STS or CIF and Antigua
T-5 Minutes to Yo Deployment	TE364-4 Tlm (256.2 MHz)	AE/STS or CIF, Antigua and Vanguard or ARIA
One hour interval starting at initial two-way acquisition	Spacecraft data both metric and Tlm (2292.0 MHz)	ACN or DSS 51
Launch to Centaur MECO + 60 sec	Centaur C-band data	MIL (19.18) or Patrick (0.18), and Antigua
MECO through Yo Deployment	TE364-4 C-band Data	Vanguard

Table 10. Tracking resources for generation of C-band radio metric data

Station	Station symbol	System type	Comments
Merritt Island	MIL	TPQ-18	
Cape Kennedy	CKE	FPS-16	Range safety
Patrick AFB	PAT	FPQ-6	
Grand Turk	GTK	TPQ-18	
Bermuda	BDA	FPQ-6	
Antigua	ANT	FPQ-6	
Vanguard	VAN	FPS-16(V)	Apollo ship
Ascension Island (AFETR)	ASC	FPS-16	
Tananarive	TAN	FPS-16(V)	

Table 11. S-band tracking resources

Station	Station symbol	System type	Comments
Spacecraft Compatibility/ Monitor Station	DSS 71	DSN	Cape area
Central Instrumentation Facility	CIF[a]		Cape area
Building AE	AE	STS[b]	Cape area
Merritt Island	MIL	USB[c]	
Bermuda	BDA	USB	
Antigua	ANT	TAA-8	
Vanguard	VAN	USB	Apollo ship
Apollo aircraft	ARIA		
Canary Island	CYI	USB	
Ascension Island (AFETR)	ASC	TAA-3	
Ascension Island (STDN)	ACN	USB	
Johannesburg (DSN)	DSS 51	DSN	
Tananarive	TAN	STDN	

[a] Central Instrumentation Facility.

[b] Satellite Tracking Station.

[c] Unified S-band.

Table 12. Summary of expected metric data support

Station	C-Band Centaur (Class)	C-Band TE364-4 (Class)	S-Band Data After S/C Sep (Class)	Comments
Merritt Island	I			
Patrick AFB		II		
Cape Kennedy	II			Range Safety
Grand Turk	II			
Bermuda		II		
Antigua	I, II			
Vanguard		I		
Ascension (AFETR)		I, II		
Ascension (STDN)(USB)			I	
DSS 51 (DSN)			I	
Tananarive	II			Postretro of Centaur

Table 13. Summary of expected telemetry data support of S-Band telemetry requirements

Telemetry Site	Launch Vehicle Telemetry: Atlas (Class)	Launch Vehicle Telemetry: Centaur (Class)	Launch Vehicle Telemetry: TE634-4 (Class)	Spacecraft S-Band Telemetry (Class)
DSS 71 (DSN				I, II
AE/STS	I	I	I	
CIF	I	I	I	
Merritt Island (USB)				II
Bermuda (USB)		II	I	II
Antigua (AFETR)		I	I	II
Vanguard (Ship)		II	I	II
ARIA (Aircraft)		a	a	a
Canary Island (USB)				II
Ascension (AFETR)			I	
Ascension (STDN) (USB)				I, II
DSS 51 (DSN)				I
Tananarive (STDN)		II		

[a] The ARIA is a backup for the Vanguard and, if needed, would have the same class of requirement for Centaur, third stage, and spacecraft telemetry data as the Vanguard.

The real-time transmission of spacecraft telemetry data is desired (Class III) from MIL, Bermuda, Canary Island, Vanguard, Antigua, and ARIA.

Table 14. Key flight events

Mark Event No.	Event	Approximate Time From Launch (Sec)
1	Liftoff (5.08-cm or 2-in motion)	0
2	Booster engine cutoff (BECO)-Atlas	148
3	Jettison Atlas Booster Engine	151
4	Jettison Centaur insulation panels	193
5	Sustainer engine cutoff (SECO)-Atlas	243
6	Atlas/Centaur Separation	245
7	Main Engine Start (MES)-Centaur	255
8	Jettison nose fairing	267
9	Main engine cutoff - Centaur MECO	706 [a]
10	TE364-4 spinup rocket ignited (MECO+70 sec)	776
11	Centaur/TE364-4 separation (MECO+72 sec)	778
12	Start Centaur retrothrust	779
13	TE364-4 ignition (MECO+85 sec)	791
14	TE364-4 burnout (MECO+129 sec)	835
15	TE364-4/Pioneer F separation (MECO+229 sec)	935
16	Yo [b] - Deploy	938 [c]
17	Spacecraft Despin	1035
18	Radioisotope thermoelectric generator (RTG) turnon	1335

[a] MECO is variable from 705 to 712 sec.

[b] Despin counterweight.

[c] Estimated time for this event.

Table 15. Project requirements for ground communications

Type of Service	Location of Operating Terminals	Bandwidth	Channels	Data Rates	Purpose
I. Spacecraft/DSIF Compatibility Tests					
A. TRW - CTA 21					
1. High Speed Data (Via Microwave)	TRW-CTA 21	---	1	---	S/C Compatibility Tests
B. SFOF - CTA 21					
1. Voice	SFOF-CTA 21	3kHz	3	NA	Station Control, Status/Voice of Pioneer Loop, S/C Compability Tests
2. TTY	SFOF-CTA 21		2	100 wpm	Compatability Testing
3. High Speed Data	SFOF-CTA 21	3kHz	1	4800 BPS	Compatability Testing
II. Prelaunch Tests, Launch, and Near Earth Phase					
A. SFOF - Cape Kennedy - SFOF - ARC					
1. Voice					
a. Command Coordination Loop	AE-DSS 71 - SFOF - ARC	3kHz	1	NA	S/C Performance and Launch Operations Coordination
b. Status Loop	AE-DSS 71 - SFOF	3kHz	1	NA	Launch Status (AFETR Launch Minus Count)

Table 15 (contd)

Type of Service	Location of Operating Terminals	Bandwidth	Channels	Data Rates	Purpose
c. Navigation Loop	SFOF-AE-RTCS	3kHz	1	NA	Flight Navigation Analysis Coordination
d. Mission Decision Loop	SFOF-AE	3kHz	1	NA	Mission Decision Coordination
e. DSS 71 Station Voice	SFOF-DSS 71	3kHz	1	NA	Station Control
f. Status/Voice of Pioneer Loop	GSFC - DSS 51, 61, LeRC, NASA Hq, ARC	3kHz	1	NA	
g. DSN - ETR - NOCC Coordination Loop	SFOF - NOCC - AE	3kHz	1	NA	DSN - ETR - NOCC Launch Coordination
2. Teletype Circuits					
a. TTY	SFOF-AFETR RTCS	---	3	100 wpm	Metric Data Predicts Ops-X, Trajectory Data
b. TTY	SFOF-DSS 71	---	2	100 wpm	Ops Admin., TT Conf/360 Formatted Monitor Parameters
3. High Speed Data Circuits					
a. HSD	DSS 71-SFOF	3kHz	1	4800 BPS	Downrange Telemetry, Commands, Sim Telemetry Commands

Table 15 (contd)

Type of Service	Location of Operating Terminals	Bandwidth	Channels	Data Rates	Purpose
B. SFOF-DSN Deep Space Stations					
1. Station Voice Lines	SFOF-DSS 51 SFOF-DSS 11, 42, 61 (Test Phase Only)	3kHz	1 per DSS	NA	Station Control
2. High Speed Data	SFOF-DSS 51 SFOF-DSS 11, 42, 61 (Test Phase Only)	3kHz	1 per DSS	4800 BPS	S/C Telemetry Commands, Monitor, Ops Control
3. TTY	SFOF-DSS 51 SFOF-DSS 11, 42, 61 (Test Phase Only)	---	3 per DSS	100 wpm	Mission Support Ops Admin., Metric Data
C. SFOF-Ames Research Center					
1. Voice	SFOF - ARC RIC	3kHz	3	NA	CMD Coordination Loop, RIC-PMSA Loop, Status/Voice of Pioneer Loop
2. TTY	SFOF-ARC RIC		4 SPX 1 FDX	100 wpm	Ops Admin., 360 TTY Formatted Pioneer 10 Data
3. High Speed Data	SFOF-ARC RIC	3kHz	1	4800 BPS	S/C Telemetry
D. SFOF-GSFC-STDN Stations					
1. Voice					
a. DSN-NOCC-ETR Coordination Loop	SFOF-NOCC-ETR	3kHz	1	NA	DSN-ETR-NOCC Launch Coordination

Table 15 (contd)

Type of Service	Location of Operating Terminals	Bandwidth	Channels	Data Rates	Purpose
b. Project Operations Loop	SFOF-ACN-NOCC	3kHz	1	NA	Station Control
2. High Speed Data	SFOF-ACN SFOF-VAN/CYI	3kHz 3kHz	1 1	4800 BPS 4800 BPS	S/C Telemetry S/C Telemetry
3. TTY	SFOF-ACN	---	2	100 wpm	Predicts, Metric Data
E. DSN Simulation Center - SFOF, DSS's, STDN Stations					
1. Voice					
Simulation Co-ordination Loop	SFOF-Supporting DSS's	3kHz	1	NA	DSN Simcen Test Co-ordination
2. TTY	SFOF-DSN Simcen-DSS's	---	6	100 wpm	Simulation Tele-type Conference, Simulated Metric Data
3. High Speed Data	SFOF-DSN Simcen	3kHz	3	4800 BPS	Simulated Tel-emetry, Monitor Commands
III. Post Launch to Completion of Midcourse Maneuver					
A. SFOF to DSS's Sup-porting Pioneer 10					
1. Voice	SFOF-DSS 11, 12, 41, 42, 51, 61	3kHz	1 Per DSS	NA	Station Control
2. TTY	SFOF-DSS 11, 12, 41, 42, 51, 61		2 Per DSS	100 wpm	Metric Data, Ops Admin., TTY Conf.

Table 15 (contd)

Type of Service	Location of Operating Terminals	Bandwidth	Channels	Data Rates	Purpose
3. High Speed Data	SFOF-DSS 11, 12, 41, 42, 51, 61	3kHz	1 Per DSS	4800 BPS	Telemetry, Commands, Monitor, Ops Control
B. SFOF to ARC RIC					
1. Voice	SFOF-ARC RIC	3kHz	2	NA	RIC-PMSA Loop, Inter 4 Loop
2. TTY	SFOF-ARC/PMAA		4 SPX 1 FDX	100 wpm	Ops Admin., 360 TTY Formatted Pioneer 10 Data
3. High Speed Data	SFOF-ARC/PMAA	3kHz	2	4800 BPS	Telemetry, Commands Ops Control

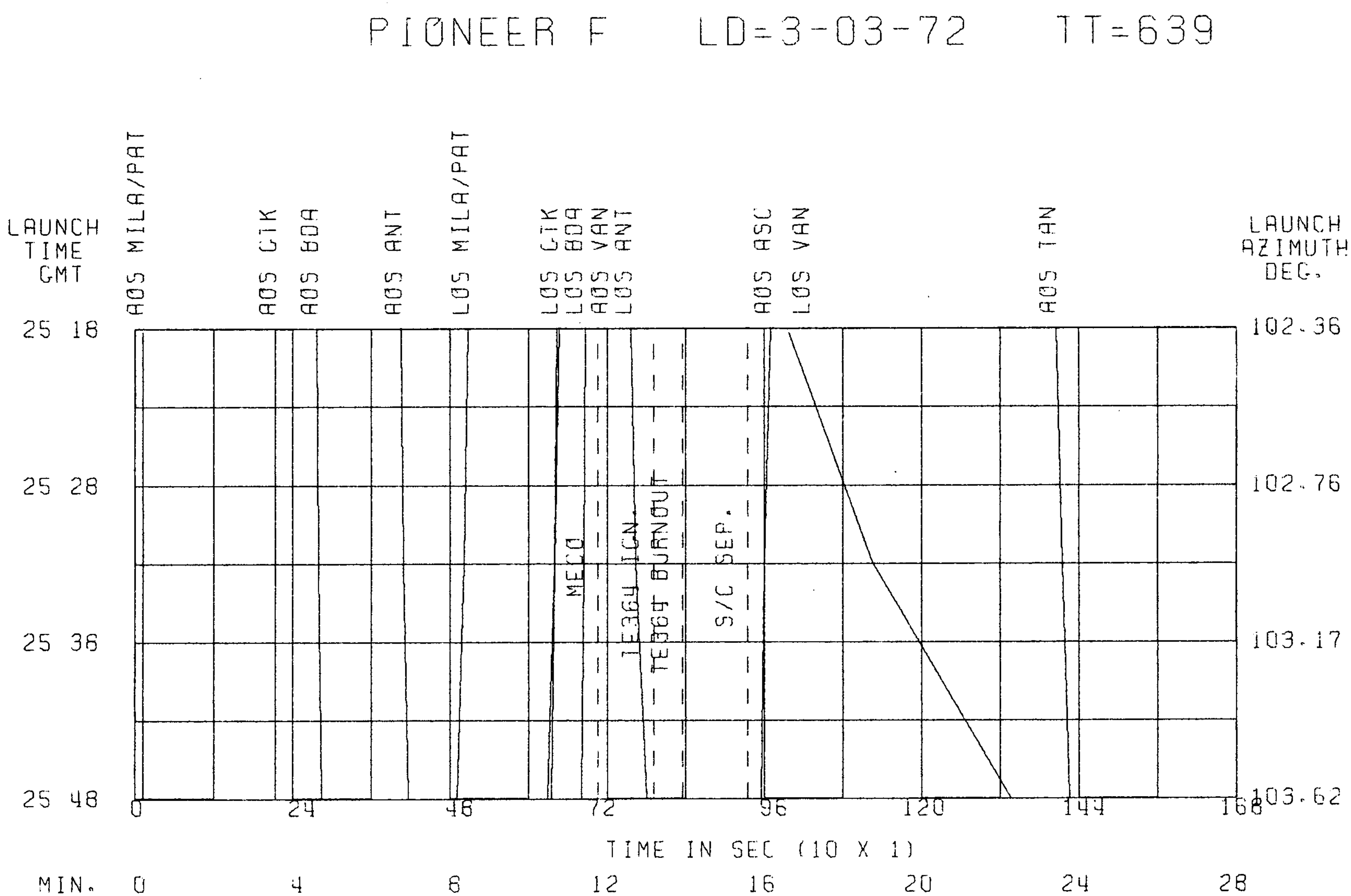


Fig. 22. Planned coverage, C-band metric data, March 3 launch date

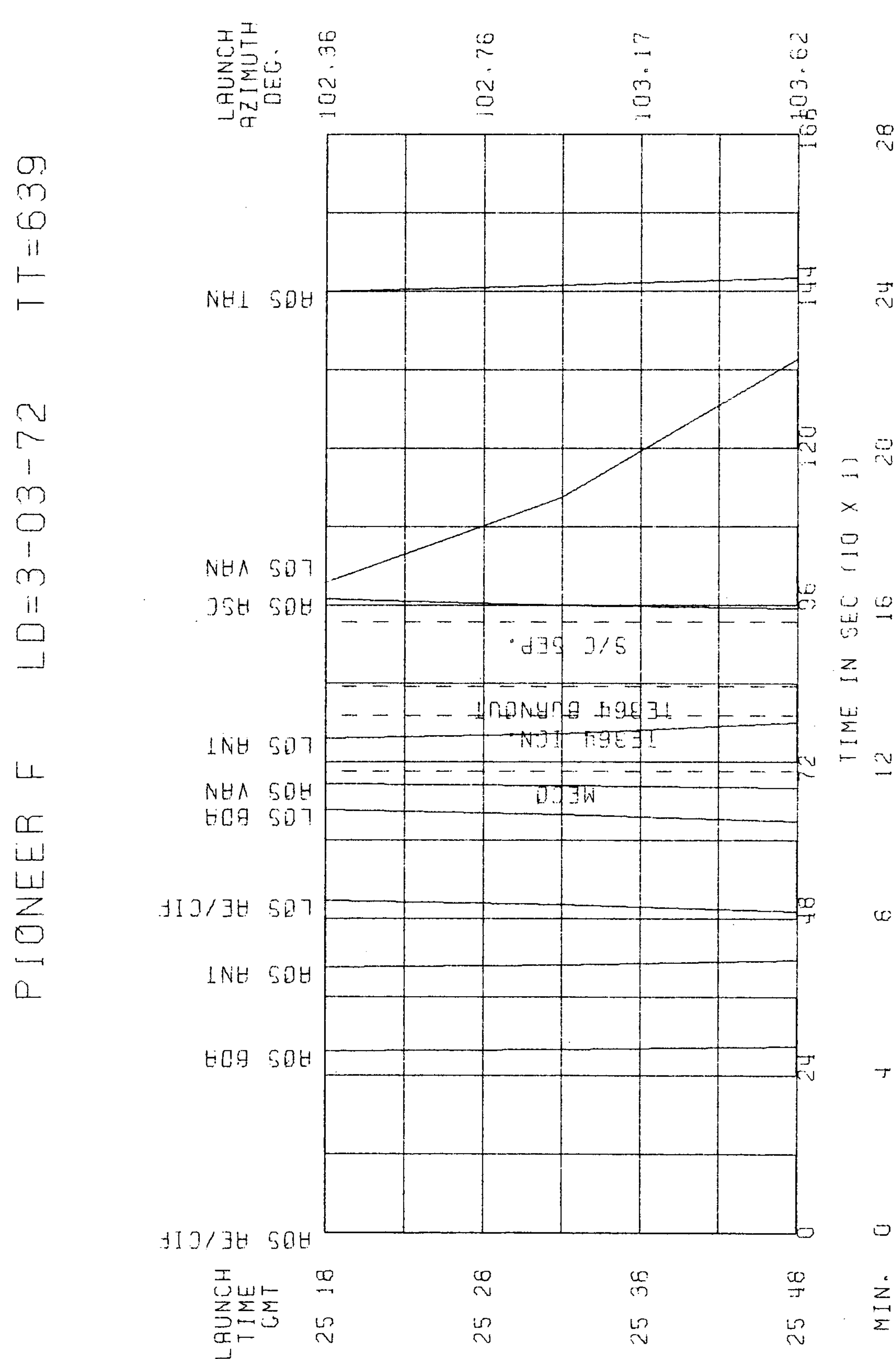


Fig. 23. Planned coverage, launch vehicle telemetry data, March launch date

B

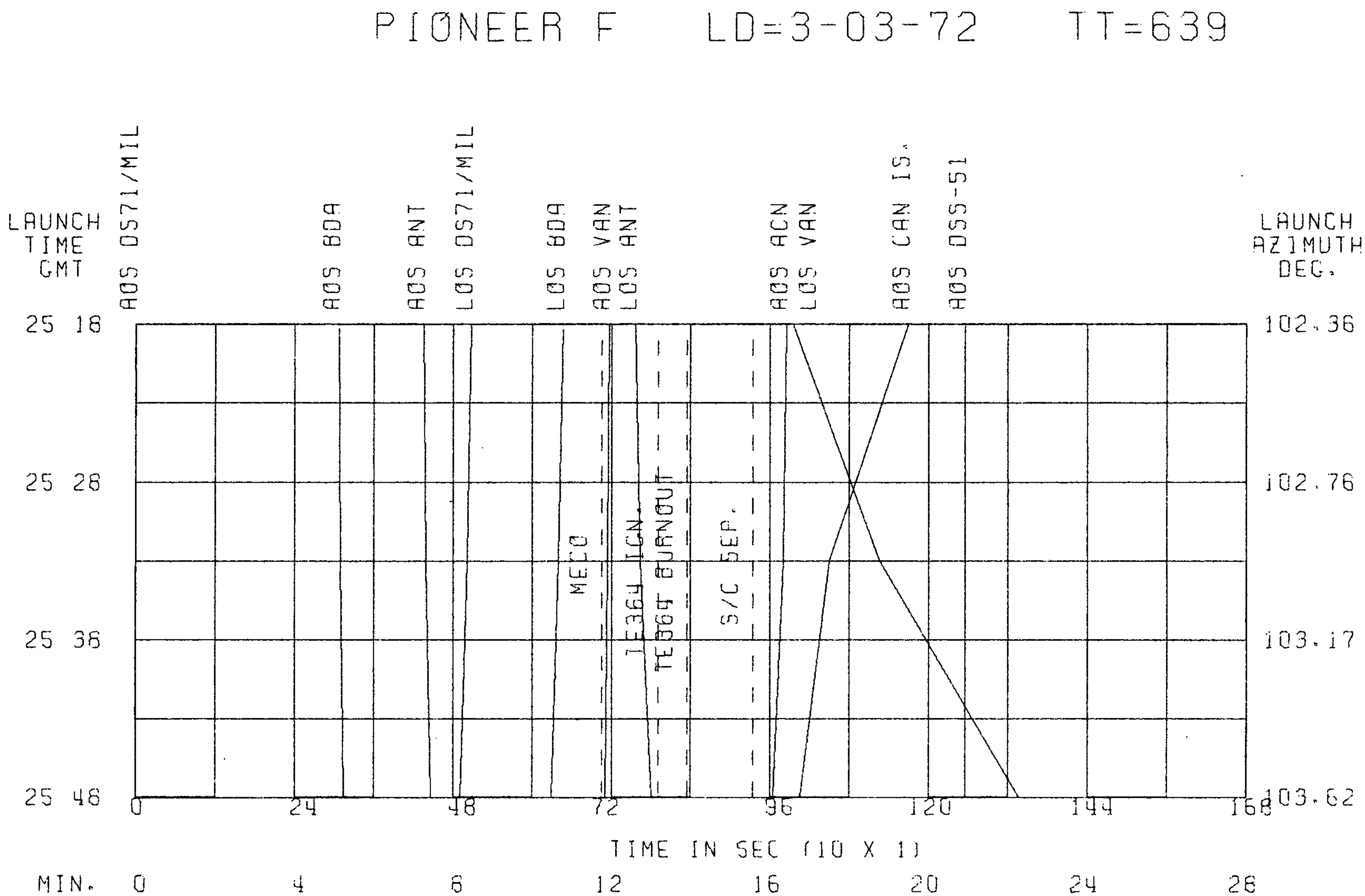


Fig. 24. Planned coverage, spacecraft telemetry data, March 3 launch date

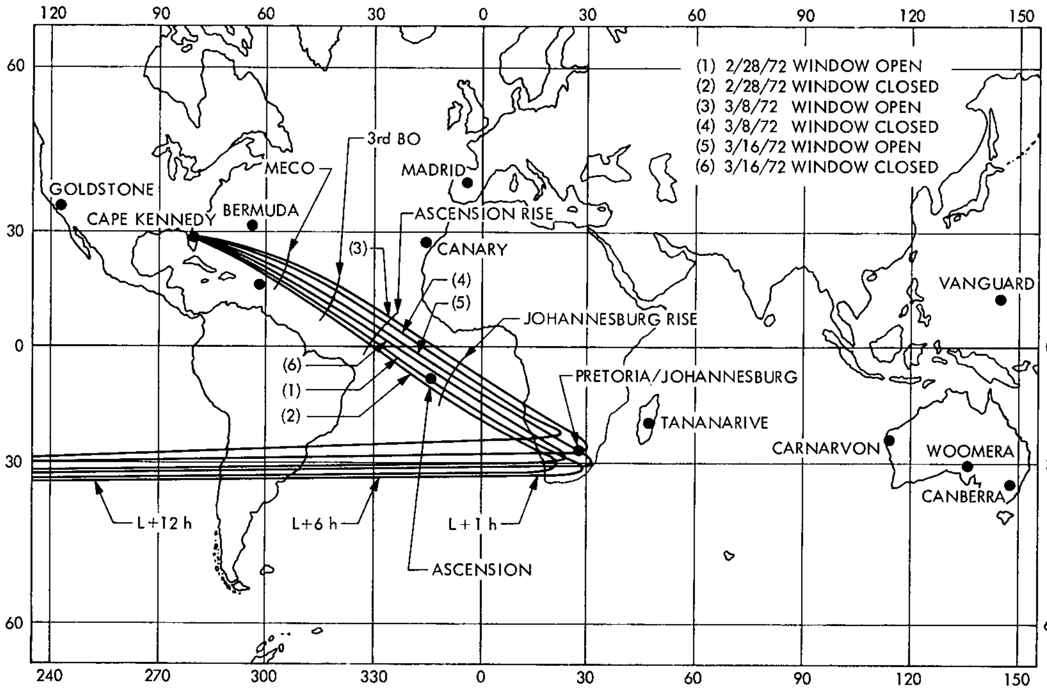


Fig. 25. Pioneer 10 Earth tracks

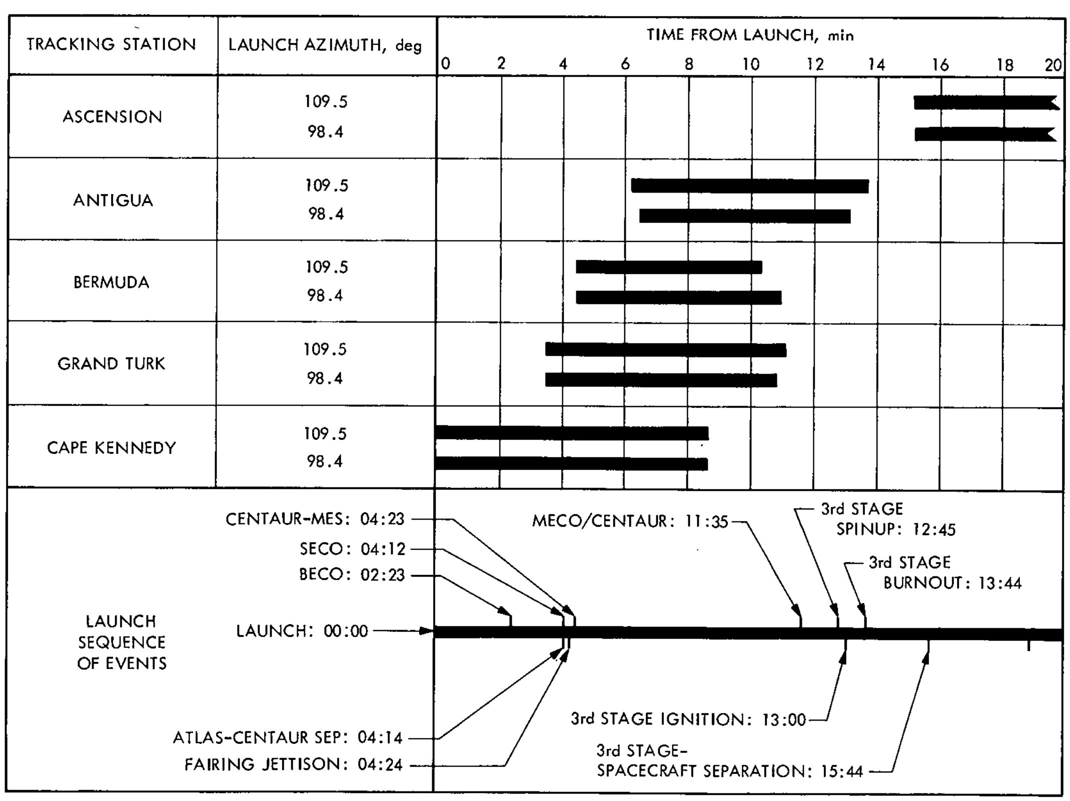


Fig. 26. Nominal tracking station coverage (1-deg elevation) during powered flight

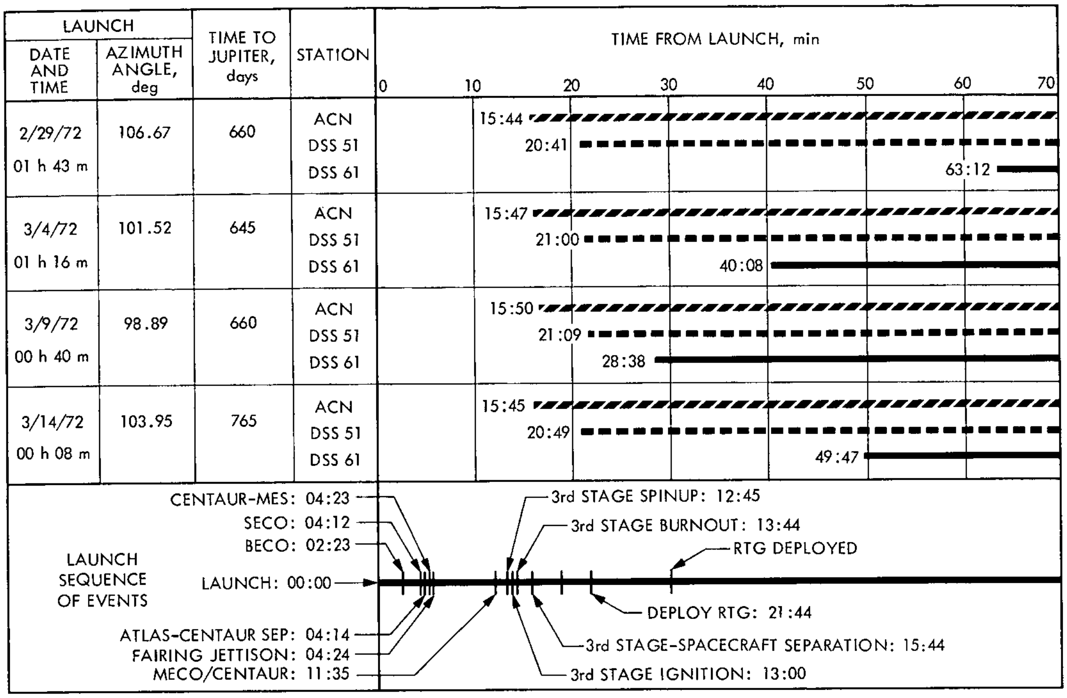


Fig. 27. Pioneer 10 first DSN acquisition typical station rise times

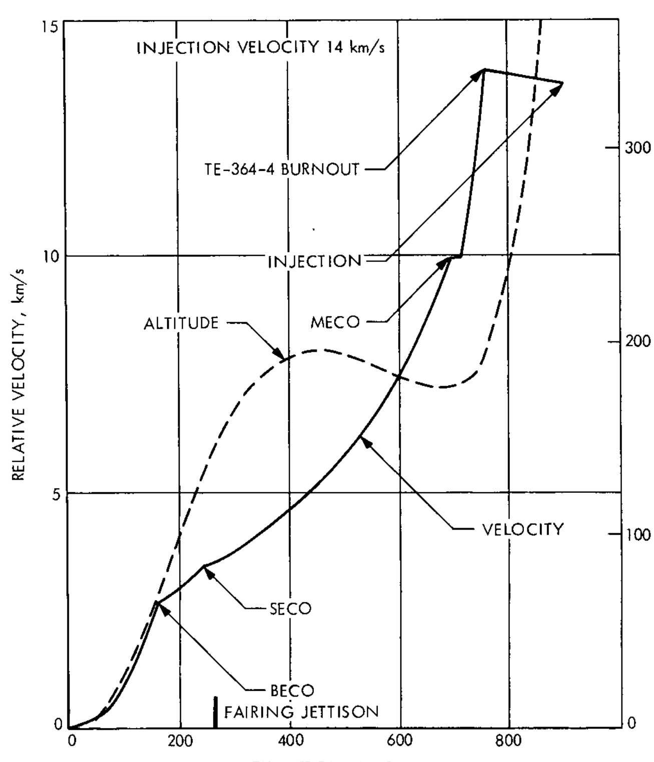


Fig. 28. Typical Pioneer 10 altitude and velocity profiles during powered flight

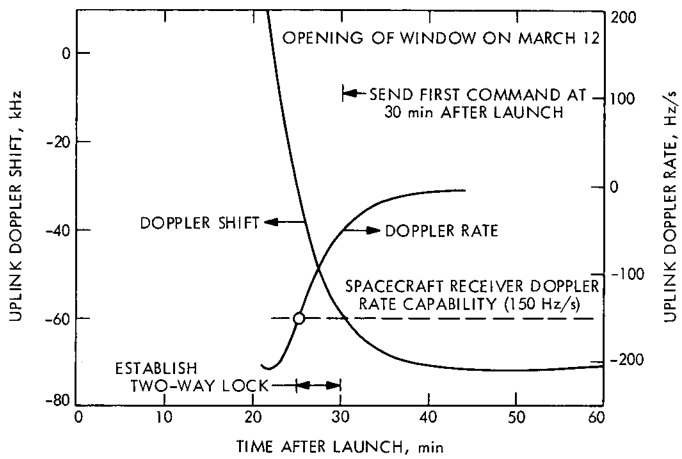


Fig. 29. Pioneer doppler rate at DSS 51

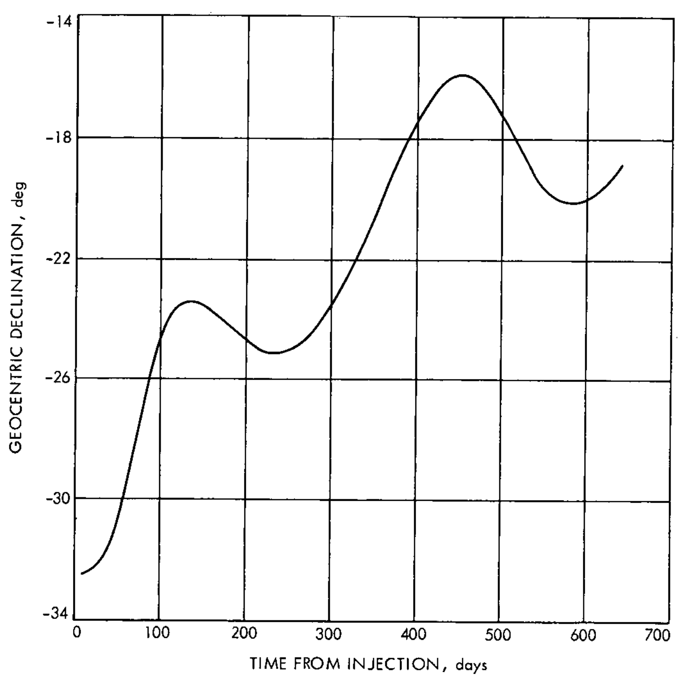


Fig. 30. Declination of Pioneer 10

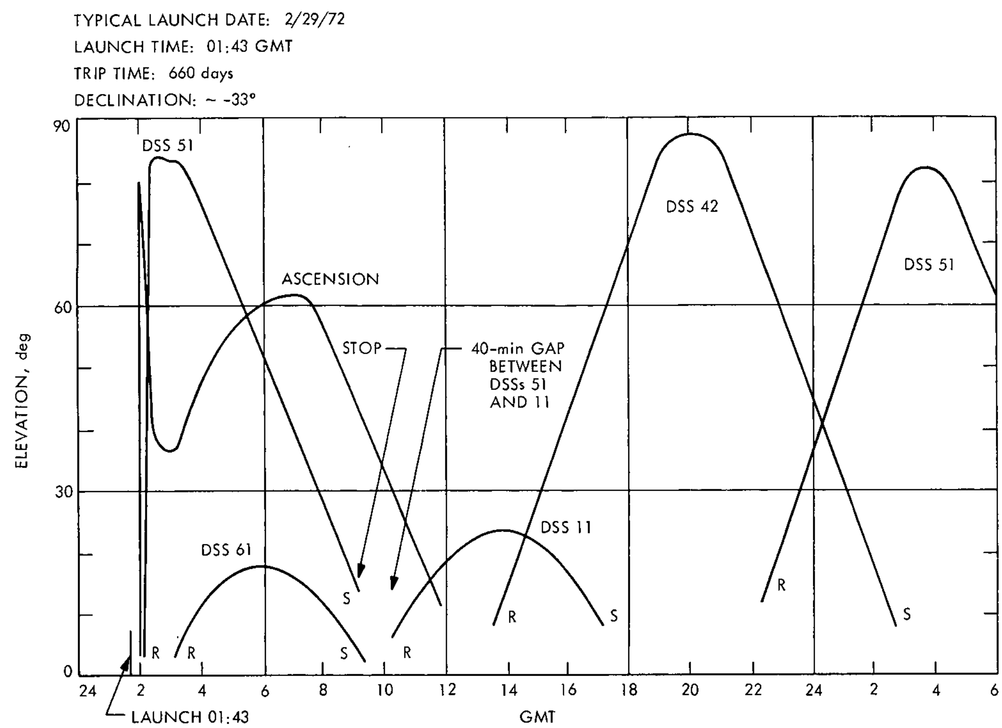


Fig. 31. Station view of Pioneer 10 on typical launch day

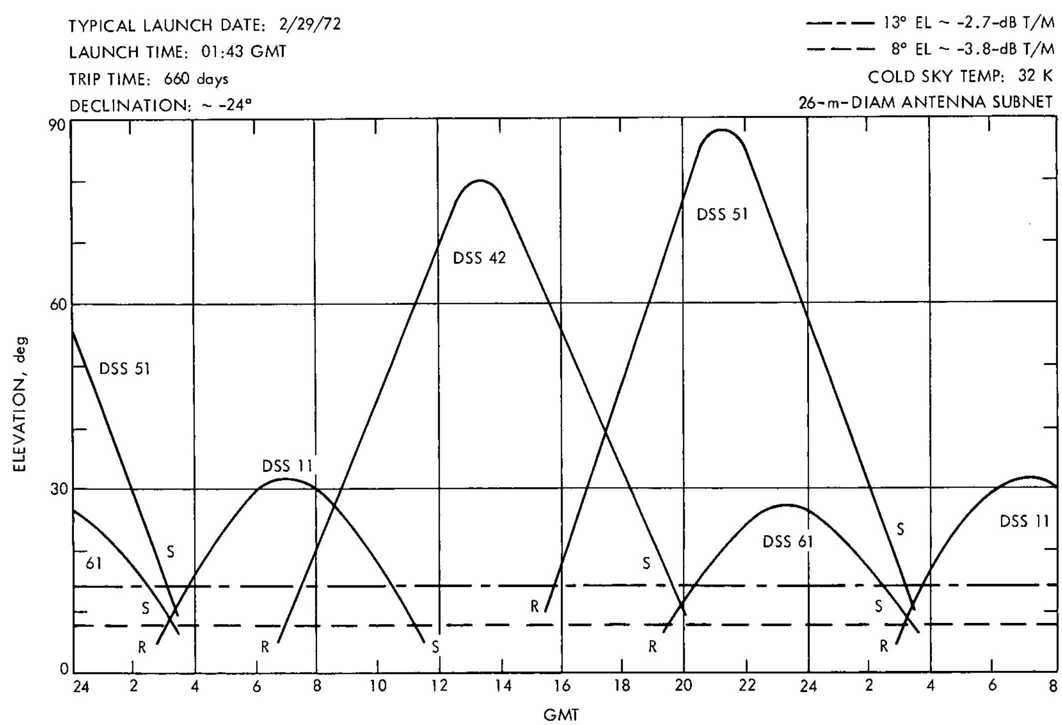


Fig. 32. Station view of Pioneer 10 100 days after launch

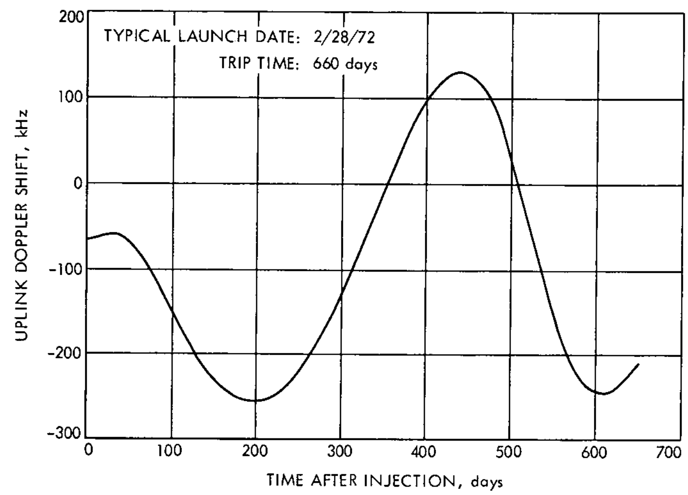


Fig. 33. Pioneer 10 uplink doppler shift between spacecraft and center of Earth

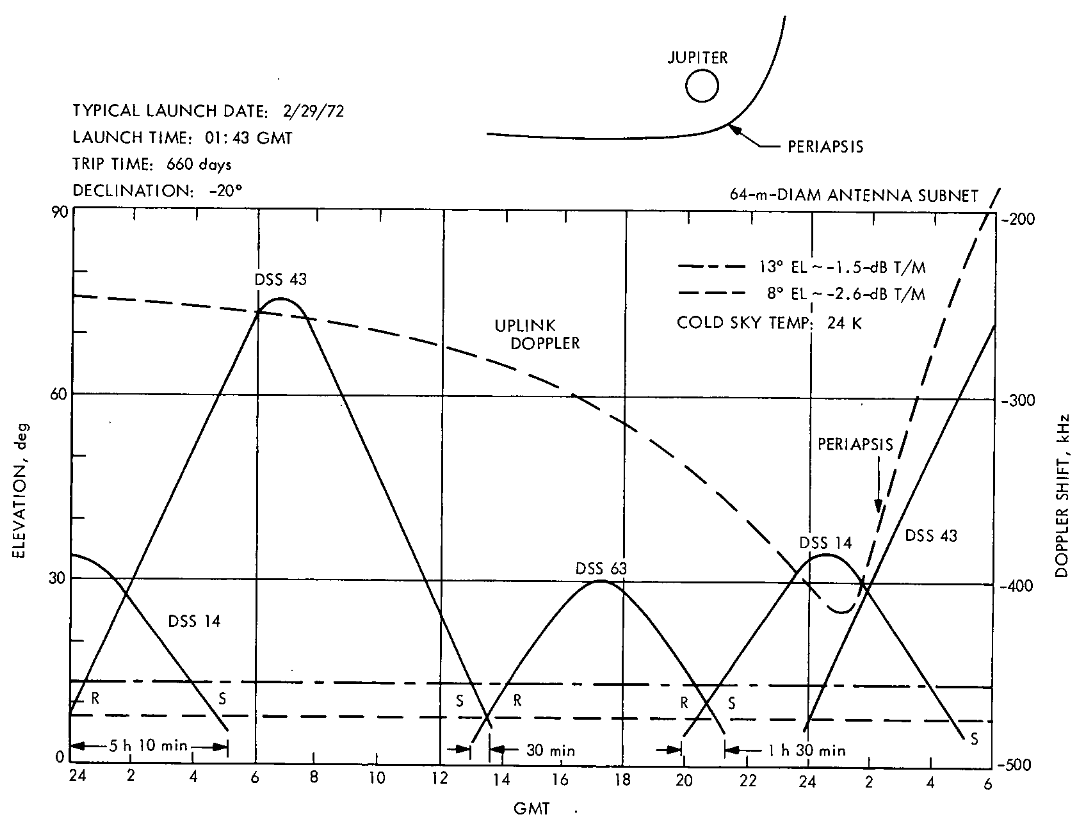


Fig. 34. Station view of Pioneer 10 at Jupiter encounter

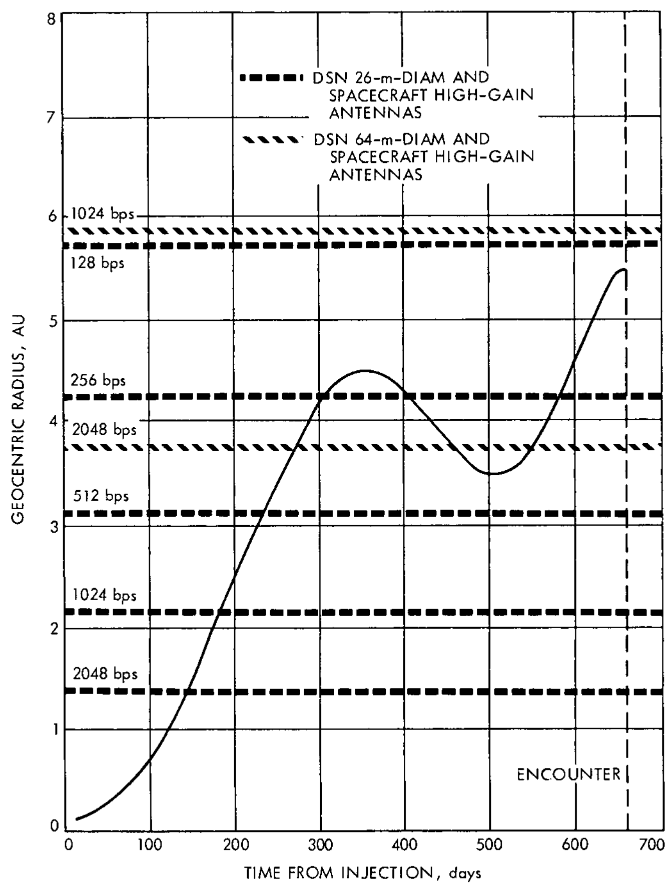


Fig. 35. Earth-Pioneer 10 distance and telemetry bit rates

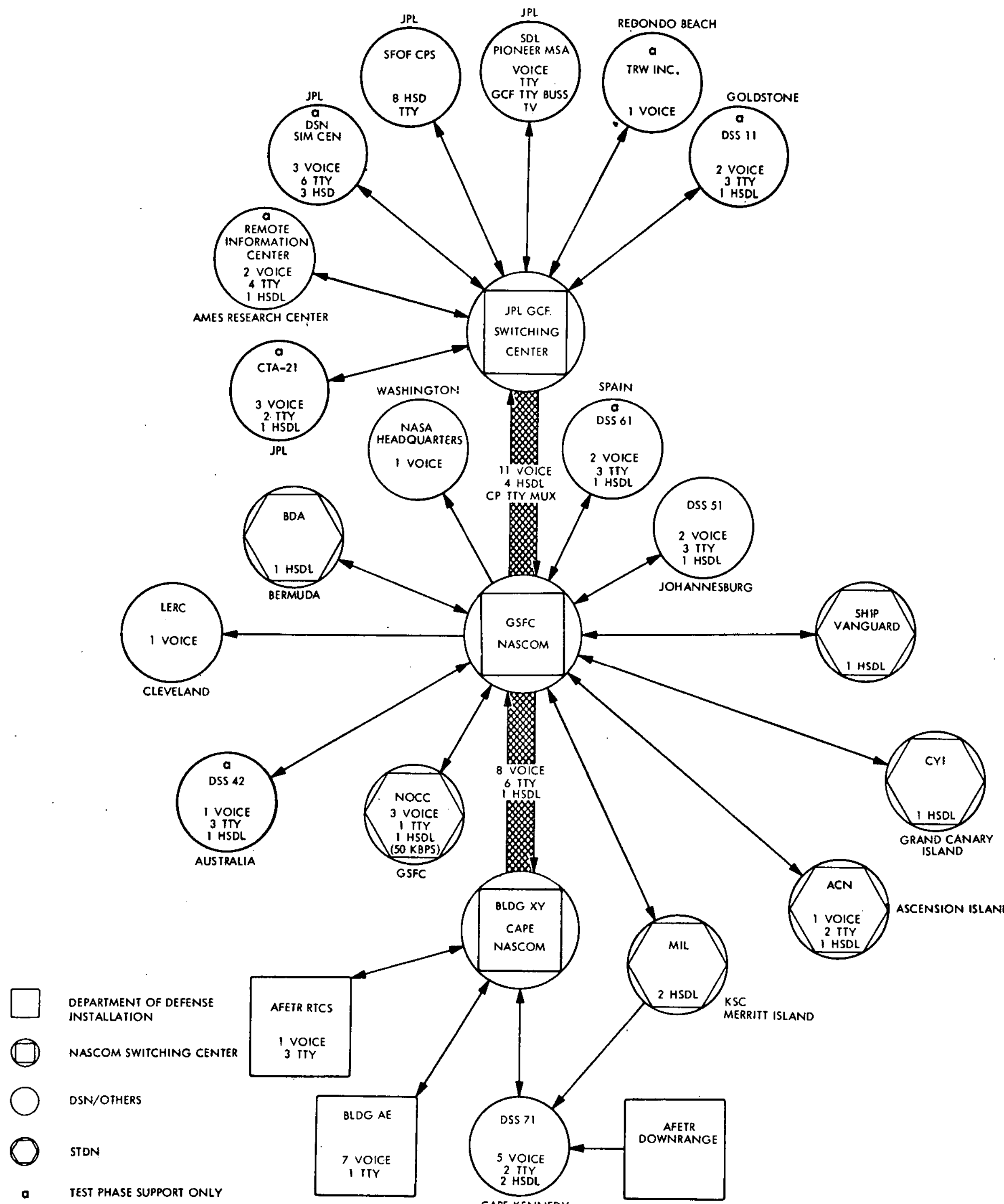
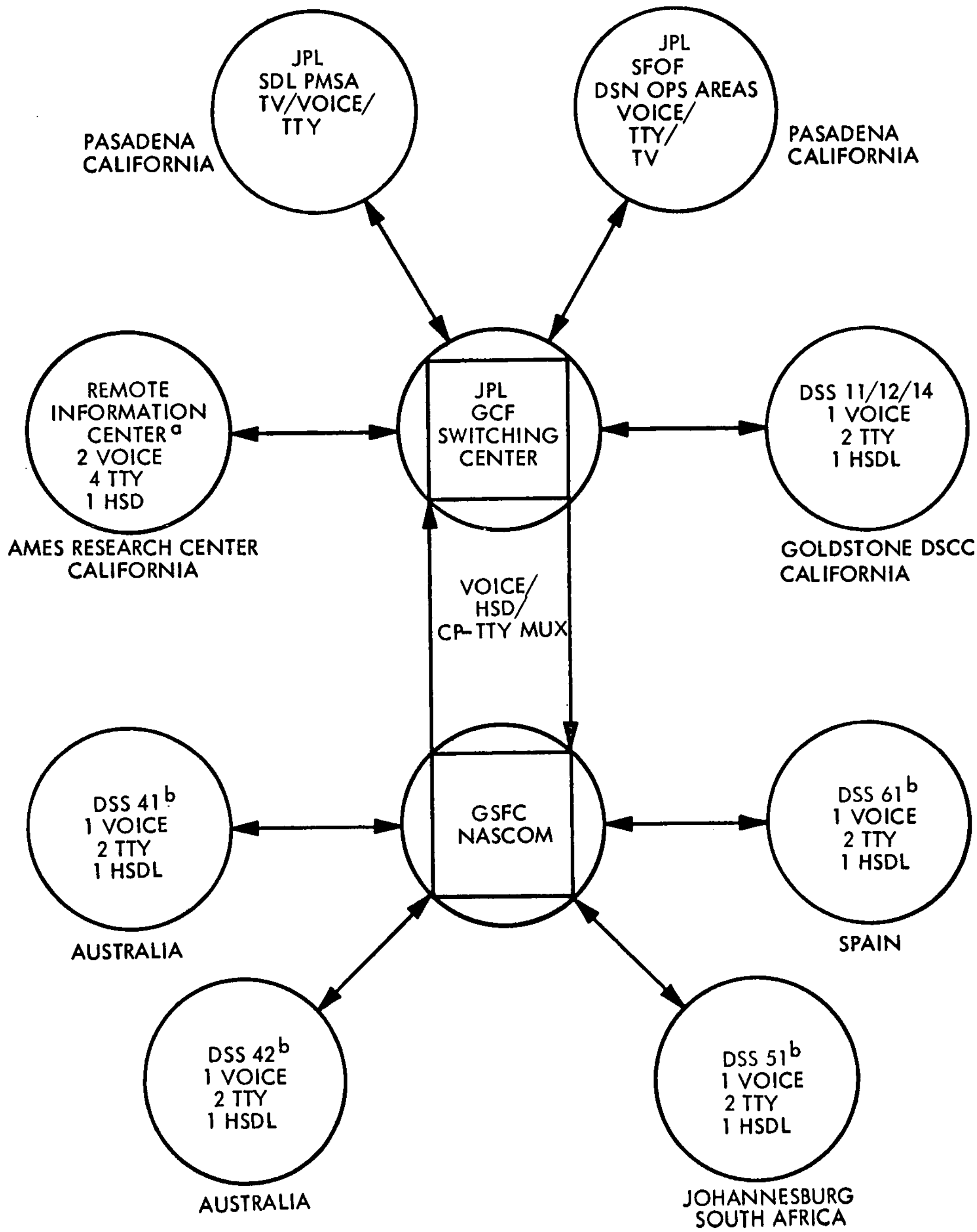


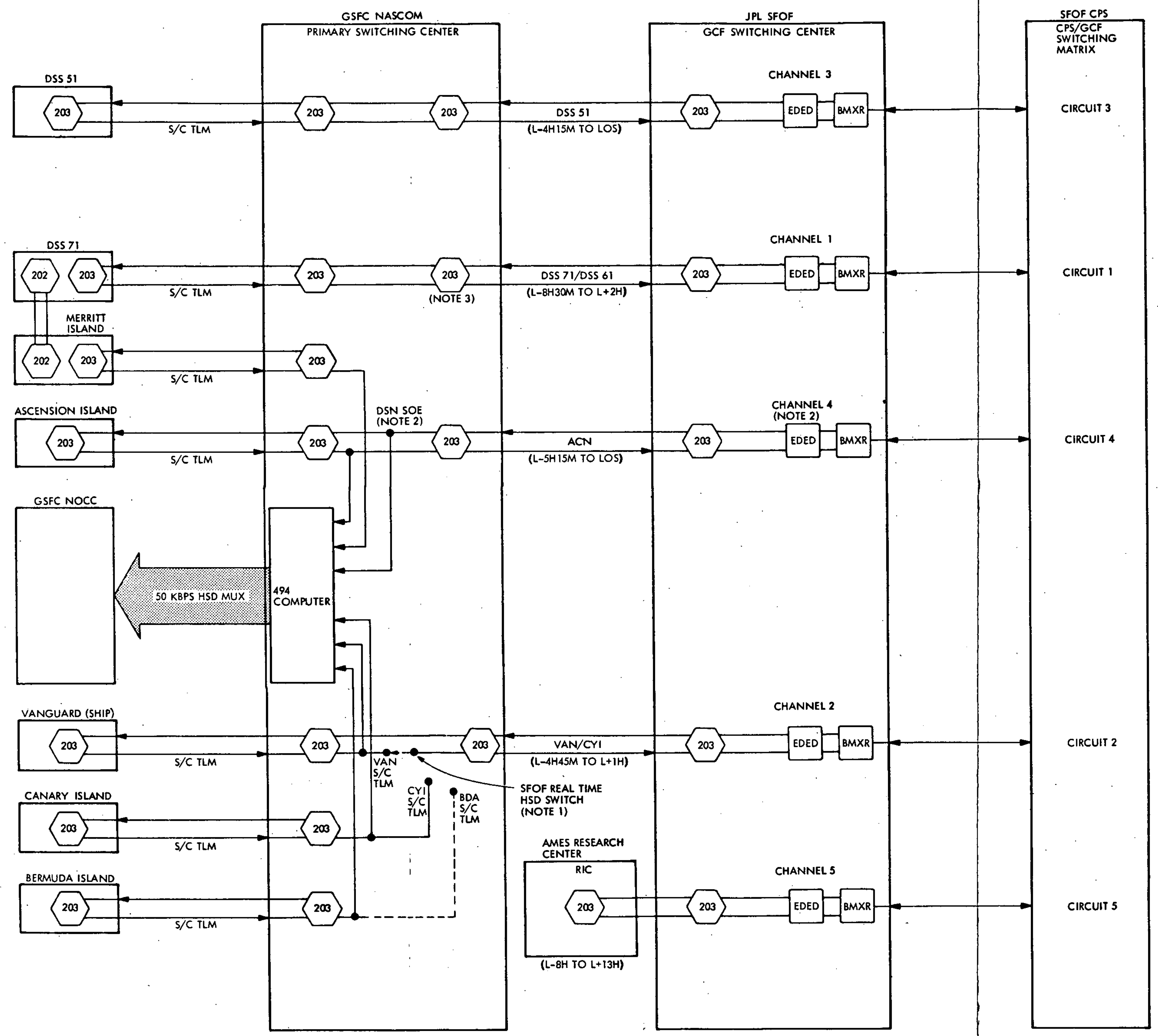
Fig. 36. DSN-NASCOM-STDN-AFETR support locations and circuit interfaces for Pioneer 10 near-Earth test and near-Earth phase



[a] CIRCUITS SHARED WITH PIONEERS 6-9

[b] VOICE CIRCUITS TO OVERSEAS DSSs
WILL BE CONFERENCED BY GSFC

Fig. 37. Pioneer 10 maneuver and cruise phase support locations and GCF-NASCOM circuit interfaces



GODDARD COMM MANAGER WILL SWITCH FROM VANGUARD S/C TLM TO CYI S/C TELEMETRY ON REAL-TIME REQUEST OF JPL COMM CHIEF. SWITCH TO CYI WILL BE REQUESTED AT VANGUARD LOSS OF SIGNAL (NOMINALLY L+26 min).

IF DSS 71 S/C TLM IS NOT AVAILABLE DURING BDA VIEW PERIOD (NOMINALLY L+5 min TO L+10 min), JPL COMM CHIEF WILL REQUEST A SWITCH FROM VANGUARD TO BDA S/C TELEMETRY.

CHANNEL 4 WILL BE USED IF SOE'S ARE TO BE TRANSMITTED TO NOCC VIA HIGH-SPEED DATA LINE.

Fig. 38. NASCOM-STDN-DSN HSD configuration and utilization plan for Pioneer F launch phase (L - 6h to L + 13 h)

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VI. PREFLIGHT TESTING

A. Test Plan

1. Approach. The TDS test program for the Pioneer F Mission, developed to be consistent with a Mission Operations Master Test Plan, was prepared jointly by the Spacecraft System, Mission Operations System (MOS), and TDS. Definition of the tests to be run and the cognizant organizations was given in a TDS test plan.

Compatibility tests were designed to demonstrate and verify compatibility between the Spacecraft System and Mission Operations. Software tests were designed to demonstrate correct functioning and operational readiness of the software system. Training tests were designed to train TDS personnel in correct operation of the software and data system. Training practice provided to MOS personnel under the Mission Operations Training Plan provided training and testing of TDS personnel and configurations in addition to that provided by the TDS test plan.

TDS testing was conducted under the DSN/Spacecraft Compatibility Test Plan, the DSN Test Plan, and the TDS Near-Earth Phase Test Plan. Although the TDS began support of Mission Operations tests some months prior to launch, the support of these tests was used for additional training and testing of the TDS, and supplementary operational verification tests were scheduled to gain more experience with, and correct, operational procedures.

2. DSN/Spacecraft Compatibility Test Plan. The approach to DSN/spacecraft compatibility testing on the Pioneer F Mission was to demonstrate first a compatible RF interface between the spacecraft and a DSS telecommunications system. Next, the compatibility of the spacecraft and DSN Telemetry and Command Data Systems was to be demonstrated by the proper processing of data. The tests were conducted between the spacecraft located at TRW, Redondo Beach, and CTA 21 at JPL, Pasadena, by use of microwave link. The second phase of compatibility testing verified the design compatibility established at JPL by RF verification tests conducted at Cape Kennedy between the spacecraft in Bldg AE and DSS 71.

3. DSN Test Plan. The objectives of the DSN Test Plan were to demonstrate: (1) the integrity and internal compatibility of the DSN Data System; (2) the correct functioning of the DSIF, GCF, and SFOF configurations committed to support the mission; and (3) DSN operational readiness to support the mission. The plan consisted of basically three types of tests: (1) subsystem integration, (2) system integration, and (3) operational verification. The integration tests were designed to demonstrate that the engineering features of the subsystem/system were met. The tests started at the facility level with testing of the mission-dependent equipment and software, in the multi-mission environment. The network system level integration test followed. Upon completion of these tests, the facilities were transferred from the developing to the operational organization, and operational verification tests (OVT) demonstrated the adequacy of operational procedures to conduct mission operations.

4. Pioneer F MOS Test Plan. TDS-supported tests were conducted by the MOS to demonstrate the capability to execute space flight operations in accordance with the Space Flight Operations Plan (SFOP). Such tests were under the direction of the Chief of Mission Operations (ARC-1), and carried out under the MOS Test Plan. All such tests were supported by the DSN Project Engineering Team, Operations Team, and Simulation Team. All tests were conducted in the SFOF with support as required from SFOF, GCF, DISF, MSFN, and AFETR. Although outside the DSN Test Plan, these tests afforded valuable training and test experience to the TDS.

B. Test Chronology

1. Readiness Review. Participated in by NASA Headquarters officials, a launch readiness review was held on Feb. 22 at Cape Kennedy to assess the state of readiness of all elements of the Pioneer Project in support of launch of the Pioneer F spacecraft. On the basis of the review, the decision was that the spacecraft system and the ground support system was ready for launch at Jupiter window opening on Feb. 27.

The review culminated months of planning and implementation work, extensive training of personnel, and exhaustive testing of facilities by the DSN. During the same period, the Pioneer Project Mission Operations Team had engaged in simulated mission operations activities to assure that the Project and Network teams obtained the training.

2. Readiness Testing. Two final Operational Readiness Tests (ORT) were conducted: one on Feb. 15, 16, and 17; the other on Feb. 21 and 22. The ORTs verified the actual launch and cruise configurations of the near-Earth and deep-space phases of the mission.

With the performance of the final ORT, the Mission Operations System and DSN testing program was completed. Involved in this testing was the coordinated participation of the deep space stations, the Ground Data System at JPL, and the Remote Information Center at NASA/ARC. The Center had been tested and was ready to perform instrument health analysis and to function as a backup for flight operations during the initial phase of the mission.

3. Compatibility. The DSN had also provided the resources of DSS 71 at Cape Kennedy for the Spacecraft/RF and Data System Compatibility Tests. The performed measurements verified that the flight equipment was compatible with the ground support and that the spacecraft could be operated and controlled as planned during launch and cruise operations (Paragraph C-5, this section).

4. Priorities. Priority agreements had been established between the Mariner Mars 1971 Project, the DSN, and the Pioneer Project for usage of the Ground Data System and, in particular, the IBM 360/75 computers.

5. Launch Vehicle and Spacecraft Testing. A launch vehicle Composite Readiness Test was performed on Feb. 22 also, demonstrating the readiness of the total launch vehicle in support of the mission.

The Atlas Centaur launch vehicle AC-27 had been erected on Launch Complex 36A on Dec. 22, 1971. The spacecraft, without radioisotope thermoelectric generators (RTGs) but equipped with a full complement of scientific instruments, had been airlifted from TRW, the spacecraft contractor, via a Mini-Guppy aircraft to the Cape Kennedy Air Force Station on Jan. 15, 1972.

A series of tests was performed in Building AD to assure that all elements of the spacecraft and scientific instruments were in operational readiness for launch. These tests consisted of a spacecraft leak test, a third-stage fit check, an integrated system test, detailed subsystem performance tests, and scientific instrument performance tests. Following these tests, a spacecraft/DSS interface performance test was conducted to verify the

c

compatibility of the communication system between the spacecraft and the DSN. The activities in Building AD were concluded with a practice countdown, final inspection, and biological sampling.

During this period, the RTGs were delivered to the Kennedy Space Center, performance tested, and stored under secure conditions where they awaited installation on the spacecraft at the launch pad one day before launch. A terminal countdown demonstration and flight acceptance composite test of the launch vehicle were also performed during this period.

Following the activities in Building AD, the spacecraft had been moved to the propellant loading building where it was loaded with propellant, pressurized, and weighed, and a thruster-cluster assembly firing test was performed to exercise the propulsion subsystem. The spacecraft was then mated to the launch vehicle third-stage followed by encapsulation of the spacecraft/third-stage combination. This assembly was moved to Launch Complex 36A where it was mated to the Atlas/Centaur launch vehicle. After installation of the third-stage thermal shield, an on-stand integrated system test was performed, followed by final spacecraft/DSS interface checks.

6. Support Summary. A summary of the DSN tests and test support is presented in Figure 39.

C. Test Reports

1. Testing Levels. There were three levels of testing established: (1) subsystem prerequisite tests, (2) systems integration and verification tests, and (3) combined systems and performance tests. With the summarization of systems integration and verification tests and the combined systems and performance test, this section presents the near-Earth TDS performance in the MOS training exercises.

The TDS Near-Earth Test Plan (JPL Document 616-21) was used as the criterion for developing test procedures and schedules for the Pioneer F Mission.

2. System Integration and Verification Tests. Results of these telemetry and tracking tests were nominal. Individual test objectives are reported here.

a. Telemetry

(1) DSN SIMCEN/DSS 71/SFOF software verification: to verify that simulated data from the DSN Simulation Data Conversion Center (SIMCEN), which was formatted into high-speed data blocks by DSS 71, was compatible with the SFOF 360/75 computer spacecraft data input program.

(2) RF readiness demonstration: to verify all launch area and AFETR RF loops and data transmission circuits.

(3) Live spacecraft data verification: to verify the near-Earth TDS software against the live spacecraft data subcarrier recorded on magnetic tape.

(4) Communications loop back to DSS 71: to evaluate the data communications circuits between DSS 71 and the AFETR receiving sites, which was accomplished by tying terminal communications modulator/demodulators (modem) at each site back-to-back and observing DSS 71 simulated data as it is looped back to DSS 71 from each receiving site.

(5) Receiving site RF loop back to DSS 71: to establish the nominal RF performance of AFETR receiving sites, which was accomplished by radiating simulated data from DSS 71 at each receiving site and looping it back to DSS 71 through the entire receiving system in the mission configuration.

(6) DSN SIMCEN/GSFC/SFOF compatibility: to demonstrate that GSFC 642B computer software is compatible with DSN SIMCEN and SFOF software, which was accomplished by tying the 642B computer output (simulated data from the SIMCEN) back-to-back with the computer input (spacecraft data) and observing the simulated data as they are looped back from GSFC.

(7) STDN RF readiness demonstration: to establish nominal RF performance of STDN receiving sites, which was accomplished by radiating simulated data from GSFC at each receiving site and looping them back to GSFC through the entire receiving system in the mission configuration.

(8) STDN computer/communication demonstration: to verify the high speed data format and 642B computer program compatibility at each STDN receiving site, which was accomplished by tying the computer output (simulated data) back-to-back with the computer input (spacecraft data) and observing the simulated data as they are looped back to GSFC from each receiving site.

b. Tracking

S-Band metric data and acquisition predicts test: to verify compatibility of DSN and GSFC formats with AFETR RTCS and to evaluate processing accuracy and capability of the RTCS. Also, to verify format and content of RTCS real-time predicts that have been planned for the Pioneer F Mission.

(2) Vanguard C-band test: to test the C-band metric data flow interface between Vanguard and the Real-Time Computer Systems (RTCS), verifying that the RTCS can accept and process Vanguard data to the accuracy required.

(3) Mapping to Jupiter Encounter Demonstration: to determine accuracy of RTCS mapping program output parameters as compared to SFOF mapping program output parameters.

3. Combined Systems Performance Test. Demonstrating that the near-Earth TDS was prepared to support Project operational readiness tests, a combined systems performance test on Feb. 10, 1972 proved successful. However, details of the subject test seemingly indicated otherwise. Problems were discussed during a telephone conference of involved groups on Feb. 11 when operational details were involved.

The spacecraft data identification was 23; the simulated spacecraft data identification was 33. This was a problem because STDN had no program for the use of the 33 identification. A work-around for this problem for launch and future ORTs was the performance of a data transfer with ACN and, time permitting, with Vanguard between launch minus 4 h and launch minus 3 h and 30 min.

STDN objected to the use of long-loop simulation center data in the plus count of ORTs 1 and 2 because this resulted in STDN operating in a non-mission configuration. STDN proposed to use tapes of spacecraft data prepared at the MSFN Merritt Island (MILA) unified S-band (USB) site.

The test was performed on Feb. 10, 1972. T - 0 was at 1700 GMT. Launch was simulated on March 9 at 0040:00 GMT with a launch azimuth of 100.95 deg.

The participating stations were:

<u>STDN</u>

BDA
VAN
ACN
CYI
TAN
NOCC
NTTF (standby)
GRTS

<u>KSC</u>

CIF
AE TLM LABS
AE MDC

<u>AFETR</u>

RTCS
ANTIGUA (telemetry only)
ASCENSION (telemetry only)
TEL-4

<u>DSN</u>

DSS 71
SIM CENTER
DSN OPS. CTL.
DSS 51

<u>PROJECT</u>

NAV Team

a. <u>Minus count</u>

(1) Communications: Communications circuits to Building AE and DSS 71 were established satisfactorily. However, as the count progressed, reception on certain nets to the Building AE Mission Director Center deteriorated. These items were covered with the center manager at Building AE.

It was necessary to reestablish the use of the satellite circuits between Ascension Island and Cape Kennedy. Originally it was planned for two NASCOM circuits, via the satellite, to be used for Centaur guidance (800 bits/s) and spacecraft (128 bits/s) data received at the AFETR telemetry station at Ascension. One of these circuits was needed for another test. To eliminate confusion and establish which circuits were available, the notification of communication circuits changes was reviewed with the GSFC communication manager in the debriefing. To work around this situation, it was decided that as soon as DSS 71 had performed its minus count checks with Ascension Island, the circuit would be used for the 800-bit data in the minus and plus counts.

(2) Tracking and computer support: Checkout of static points between AFETR, DSN, and GSFC progressed satisfactorily. The transmission of minus-count nominal predicts from AFETR at liftoff time (T) minus 40 min was hampered because, prior to transmission, a circuit test conducted by the AFETR on the lines to be used for transmitting the predicts had not been followed by an end of message (EOM) which interrupted the lines in the communications processor (CP). A second set of predicts was transmitted satisfactorily at T minus 20 min. Proper teletype procedures have been reviewed with AFETR personnel at RTCS. It should be pointed out that on non-JPL missions AFETR is not required to use these procedures.

At T minus 2 min the Goddard Real-Time System (GRTS) was not operationally ready, but the count proceeded to lift-off. The computers were back on-line at T plus 4 min. This would not be a hold item for launch.

(3) Telemetry: DSS 71's checkout with the AFETR was delayed because DSS 71 was in an interface configuration that is used in operations directive (OD) 3663 (engineering tests) rather than OD 3660. Once the proper configuration was established, it was discovered that the lines to Antigua and Ascension had unacceptable bit error rates; viz, 80 errors in 50 kbits and 90 errors in 50 kbits on the Antigua and Ascension Island lines, respectively. In previous tests these circuits exhibited no errors. Since there was some suspicion as to the exact configuration and the inability of AFETR to provide a comparable bit-error-rate test, no action was taken during the test to locate the source of the errors. For future tests the circuits were to be held up until the trouble was isolated.

Building AE telemetry lab checked out satisfactorily with AFETR and GSFC. At the start of the GSFC checkout, there was confusion over the use of the GSFC voice nets at Building AE, but this was resolved without too much delay.

DSN checkout of spacecraft telemetry data circuits from GSFC appeared to progress normally.

b. Plus count

(1) Communications: no troubles were observed.

(2) Tracking and computer support: All computations were processed satisfactorily. The simulated data from Vanguard appeared to be in error, inasmuch as when it was mapped out to Jupiter, the result was poor. This indicated that perhaps the wrong trajectory was used in preparing the simulated data. Subsequent to the test, Goddard checked the data and found it to be valid. Simulated data from ACN was unusable due to the absence of carriage returns and line feeds. The mode of entering the data on line at ACN was suspected. This mode was a simulated configuration not used for launch.

(3) Telemetry: AE telemetry lab had no problems with either the GSFC or AFETR data transmission.

DSS 71 maintained sync on the data played back from Antigua.

Due to problems, the Simulation Center data ceased to function in this test at T plus 25 min.

During the debriefing with STDN, it was revealed that the STDN was using a spacecraft identification of 23 instead of 33 (to indicate simulation) for the test.

4. MOS Training Exercises. Two simulated metric data packages were prepared by the AFETR/RTCS for use by the Mission Operations System (MOS) in tests at the SFOF. One package consisted of data for a nominal launch and the other for a launch emergency abort test. These data and associated sequences of events were used on three different occasions at the SFOF.

In addition, the near-Earth TDS participated in two operational readiness tests that are reported on here.

a. Pioneer F ORT 1, Feb. 15 and 16. The test was successfully completed with minor problems.

T minus 0: 0040 GMT, Feb. 16; simulating a March 9 launch at 0040:00 GMT with a launch azimuth of 100.95 deg.

The participating stations were:

STDN	AFETR
MIL	RTCS
BDA	ANTIGUA
VAN	ASCENSION
ACN	TEL-4
CYI	
TAN	DSN
NOCC	
NTTF (standby)	DSS 71
GRTS	DSS 51

KSC

CIF
AE TLM LABS
AE MDC

(1) Minus count

(a) Communications: there were no significant problems.

(b) Tracking and computer support: static point and tracking and data handling subsystem (TDH) punch tests performed satisfactorily. Due to procedural trouble, the RTCS 3100 computer was not operational until 2302 GMT. The RTCS 3600B was not operationally ready at 2254 GMT and was not operational at lift-off. This presented no problem, inasmuch as the trouble manifested itself only when the 3600 A and B were connected together — a configuration not required for Pioneer Mission support.

(c) Telemetry: no problems. Bit error checks between AFETR and DSS 71 on this test revealed no such errors as were present in the test of Feb. 10.

ACN reported that one of their 642B computers was not operationally ready at T minus 147 min, with an estimated time of return to operation of 1500 on Feb. 18. This left ACN with no back-up computer.

ACN/VAN data transfer tests with SFOF were performed satisfactorily.

Tests with AE telemetry were performed satisfactorily.

At liftoff all systems were green with the exception of the 3600B previously mentioned.

(2) Plus count

(a) Communications: there were no problems.

(b) Tracking and computer support: it was necessary to prepare a second set of AFETR predicts at T plus 40 min because the set transmitted at T plus 35 min did not contain the constants transmitted to RTCS at L minus 90 min. The transmission of the T plus 35 min set was interrupted when NAT Track pointed out the difficulty. It was determined that the L minus 90 min message was misplaced at RTCS. The mistake could have been caught with the minus count set of AFETR predicts transmitted at T minus 42 min that did not contain the L minus 90 min. corrections to the "constants." Procedures between NAT Track and ETR computer were to be revised to include a voice confirmation of the receipt of "constants" sent to teletype. Because ACN did not receive the set of retransmitted predicts, they were retransmitted.

All other support was satisfactory.

(c) Telemetry: no problems.

GSFC transmitted MIL prepared tapes of spacecraft telemetry data rather than use long-loop simulation center data.

b. Pioneer F ORT 2, Feb. 21 and 22. The test was successfully completed with minor problems detailed here.

T minus 0: 0154 GMT, Feb. 22; launch was simulated for March 1 at 0154 GMT with a launch azimuth of 106.00 deg.

The participating stations were:

STDN

MIL
BDA
VAN – at sea
ACN
CYI
TAN
NOCC
NTTF (standby)
GRTS

KSC

AE TLM LABS
AE MDC

AFETR

RTCS
ANTIGUA
ASCENSION
TEL-4

DSN

DSS 71
DSS 51

KSC/CIF did not participate because of the holiday.

(1) Minus count

(a) Communications: there were no significant problems.

(b) Tracking and computer support. The RTCS 3100 and 3600B computers were not operationally ready at 2230 GMT. At 2300 GMT, the RTCS 3100 was declared operational. At 2355 GMT, the 3600B was operational. Not able to duplicate the problem with the 3600B, Command and Data Handling Console (CDC) stood by.

(c) Telemetry: all checkouts were performed satisfactorily.

(d) Liftoff: after an unscheduled hold (part of the simulation), liftoff was simulated with all systems green.

(2) Plus count

(a) Communications: there were no problems.

(b) Tracking and computer support: AFETR retransmitted the predicts based on the third-stage orbit because the first set used the wrong epoch. The simulated DSS 51 data was rough, and as a result no good solutions were transmitted. Computer problems at simulation center were the cause.

(c) Telemetry. There were problems in the transmission of the launch vehicle data from Bermuda.

5. Spacecraft/DSN RF and Data System Compatibility Test Summary. The 112 h of tests performed included prototype spacecraft (Group A tests), flight spacecraft tests via microwave between JPL's CTA 21 and TRW (Group B tests), and flight spacecraft tests at DSS 71 at the launch site (Group C tests).

Group A strong signal tests were conducted for 4 h on Aug. 16 and 6 h on Nov. 22 in 1971. Group B strong signal tests were conducted for a total of 35 h on Dec. 3, 21, and 22, 1971. Group C verification weak signal tests were conducted a total of 35 h on Jan. 1 and Feb. 1, 2, in 1972, 8 h on Feb. 21, 1972, and 8 h on Feb. 21, 1972, with finally 24 h on the stand.

The Group A and B tests are summarized as follows:

(a) RF system: compatible.

(b) Omnidirectional antenna polarization verification was not made. DSS 51/symbol synchronizer assembly (SSA) nominal signal power with correct direction sense was -120 dBmW, and with incorrect sense was -140 dBmW. This was 12 dB above threshold; therefore, wrong polarization sense could have impact on initial acquisition.

(c) Time commands: tests showed that DSN could send time command to 0.1 s of the requested time with an execution uncertainty of ±40 ms. This capacity was again verified during the Feb. 21 test. The command execution delay of the spacecraft had an apparent ±0.25-s uncertainty. Project planned to calibrate that deviation in flight before each backup-type conical scan system Conscan operation.

(d) Conscan automatic ground control (AGC): ground Conscan AGC and spacecraft Conscan processor AGC were 180 deg out of phase. This design error was corrected by operational procedures.

(e) Elapsed time measurement between command bit start and spacecraft execute time was not accurate because of DSS 71 test computer problem. Correction was made and was to be verified.

(f) a ±2 dB Conscan amplitude simulated by DSS 71 was not verified by the Pioneer Mission Support Area displays. The Project was not integrating Conscan AGC data as was recommended.

6. Systems and Facilities

a. Command. The DSN Command System testing and operations planning that occurred prior to launch was mainly intended to certify the command system capabilities for support of the mission. Emphasis was also placed on training DSIF personnel in the operation of the command system. Operations and Analysis personnel in the SFOF were well trained in the operation of the command system because of the experience gained from the Mariner Mars 1971 Mission. Relatively minor changes, operationally, were incorporated into the system for the support of Pioneer F.

Three command system items were of concern to operations and analysis personnel just prior to launch in the following respects:

(1) Testing had shown that timed commands would periodically fail to transmit.

(2) Testing and actual operation with the Mariner Mars 1971 Mission had shown that the command system software task in the SFOF could halt because of an interface problem with the tracking system software.

(3) Operation with previous versions of the software in the SFOF had shown that the data record generation function was unreliable.

b. Monitor. Prior to the launch, the DSN Monitor System at SFOF did not support the Pioneer Project. This non-support was due to the unavailability of a software program. However, the software programs at the Deep Space Stations were operational and did support the Pioneer Mission throughout the testing cycle.

During the testing, there were two operational software programs in use at the stations: DOI-5038-OP for the Mariner Project and DOI-5029-OP at the wing sites for the Pioneer Project. The software program at SFOF was not able to accept the DOI-5029-OP program at that time, but would accept program DOI-5029-OP. Therefore, the decision was made to make use of the DOI-5029-OP program even though it did not contain the parameters to completely monitor the stations configuration. It did, however, contain partial status on station configurations and status detectors on some of the equipment. The decision was made to launch Pioneer without the full capability of the Monitor System; therefore, the Monitor System was declared unoperational for the support of Pioneer.

c. Ground Communications Facility. The testing conducted by the Ground Communications Facility (GCF) to prepare for support of Pioneer F was as described here.

(1) Integration Tests. These included all GCF testing required to demonstrate that the GCF teletype, voice, high-speed data, and wideband systems were compatible with the communications support requirements of the mission.

Formal GCF integration tests for Pioneer F support were not required in the following areas:

(a) GCF Systems – DSIF, SFOF, and DSN Simulation Center (SIMCEN) Integration: detailed and extensive GCF engineering tests integrating the 1971-1972 GCF systems interfaces with these three areas were satisfactorily completed prior to the beginning of Pioneer F testing period. GCF engineering tests verified and certified that GCF systems were operational and could support Pioneer F communications requirements.

(b) GCF Systems – ARC Remote Information Center (RIC) Integration: integration of GCF voice and teletype systems which interfaced with the ARC RIC were completed prior to the beginning of the Pioneer F testing period. GCF 4800 bits/s high-speed capability between the GCF SFOF COMM Terminal Subsystem and ARC RIC were declared operational on 18 August 1971. Three 4-h HSD acceptance tests were conducted on Aug. 4, 5, and 6, respectively. The test resulted in the high-speed data capability being declared operational and capable of supporting the Pioneer F SFOF-ARC RIC high-speed data requirement.

As explained, existing GCF voice and teletype systems were employed and the voice and teletype circuits between the SFOF-ARC RIC had previously been declared operational and capable of supporting the Pioneer F voice and teletype circuit requirements.

(c) GCF Systems – JPL SDL Pioneer Mission Support Area (PMSA) Integration: integration of the GCF systems, which interfaced with the JPL System Development Laboratory (SDL) PMSA, was accomplished during the transition of the PMSA COMM circuits and equipment from the development and installation phase to the operable phase. GCF Development (JPL Section 918) and GCF Operations (JPL Section 916) jointly verified that the GCF voice, teletype and TV equipment and circuits installed in the PMSA had been properly tested, therefore, the systems were declared operable and capable of supporting the Pioneer Mission Support Area communications requirements.

(2) Operational Verification Tests (OVTs): these tests were designed to demonstrate and verify that GCF operating procedures (both mission-independent and mission-dependent) and communications configurations were operationally compatible with GCF circuits, equipment, and software committed to support Pioneer F.

Because of the general and routine nature of these activities, GCF OVTs were not scheduled as separate tests. GCF OVTs were performed immediately prior to the beginning of other DSN tests.

The objectives of the GCF OVTs were to:

(a) Demonstrate that GCF-NASCOM-STDN-DSIF communications operations personnel were adequately trained to support Pioneer F premission testing and subsequent flight operations.

(b) Demonstrate that GCF-NASCOM-STDN-DSIF communications operating procedures were adequate to support the communications requirements of Pioneer F premission testing and flight operations.

(c) Verify that GCF operational interfaces with the DSN Operations Control Team were correct and adequate for Pioneer F support.

(3) GCF OVT Results. A series of OVTs were conducted with Pioneer F prime DSSs 11, 42, 51, and 61 and with the STDN station at Ascension Island. The tests were conducted within the period Jan. 5 to Feb. 18, 1972. No major procedural deficiencies were uncovered. Communications personnel at the GCF SFOF Communications Terminal (SCT) and the stations accomplished the GCF OVT sequence of events items efficiently and in a timely manner. Simulated anomalies were introduced into the OVT and communications operations personnel at all participating locations responded correctly to the situation and quickly implemented appropriate emergency procedures.

The GCF OVT satisfactorily demonstrated that GCF Switching Center (SWCEN)-NASCOM-Station Communications Operations personnel were adequately trained and that GCF operating procedures were adequate to support the communications requirements of the mission.

(4) GCF Test Configurations. Detailed DSN-approved Pioneer F test-phase GCF communications circuit configurations and data routing plans to be used for support of both DSN and Pioneer Project Mission Operations System testing were contained in Section IIA of DSN Document 616-10, GCF Test Procedures and Communications Configurations, Volume IV of the DSN Test/Training Plan for Pioneer F and G Project. Figure 40 depicts the high-speed data Configuration and Utilization Plan in effect during the Pioneer F test/simulation phase.

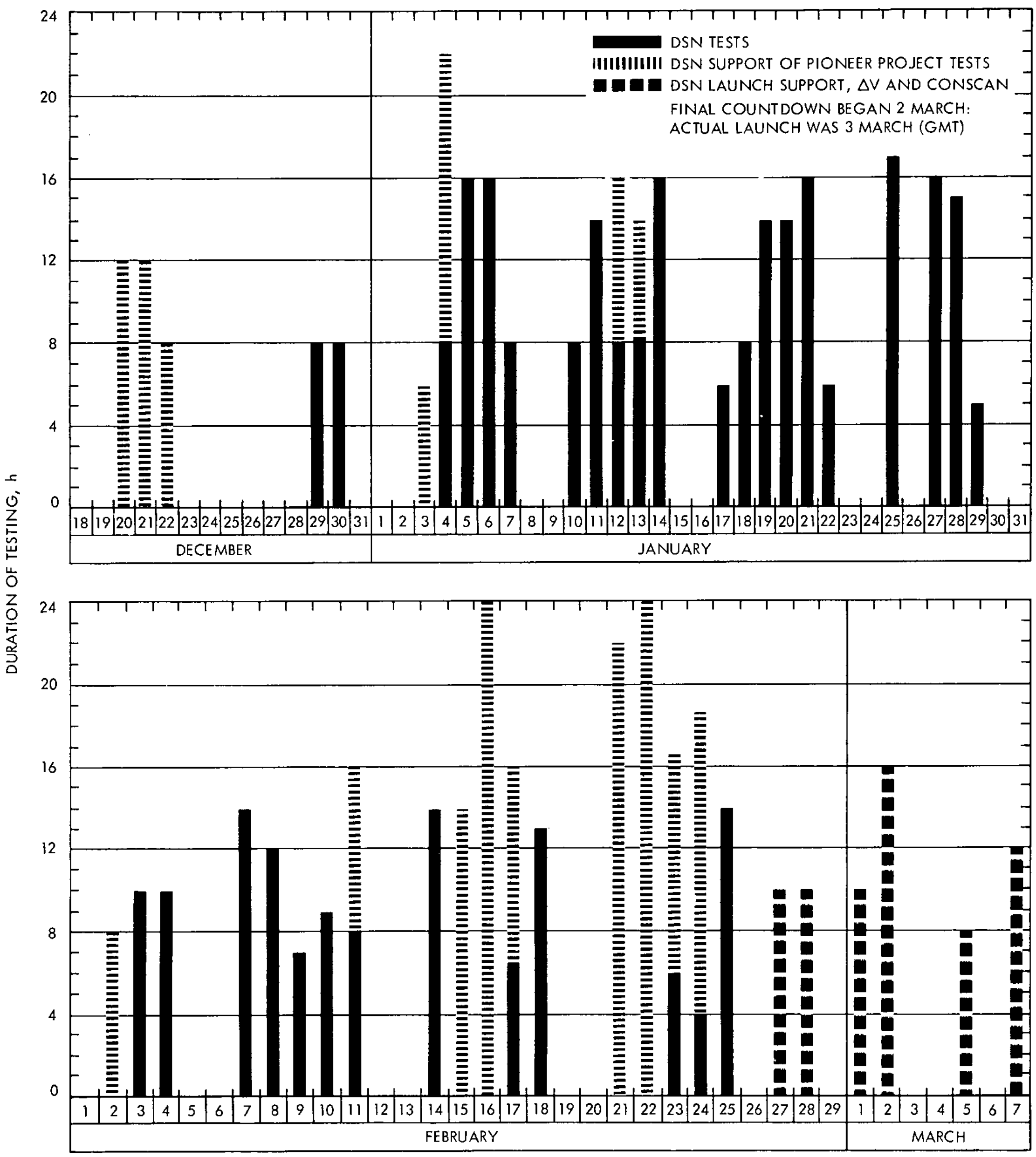

Fig. 39. DSN test and test support summary

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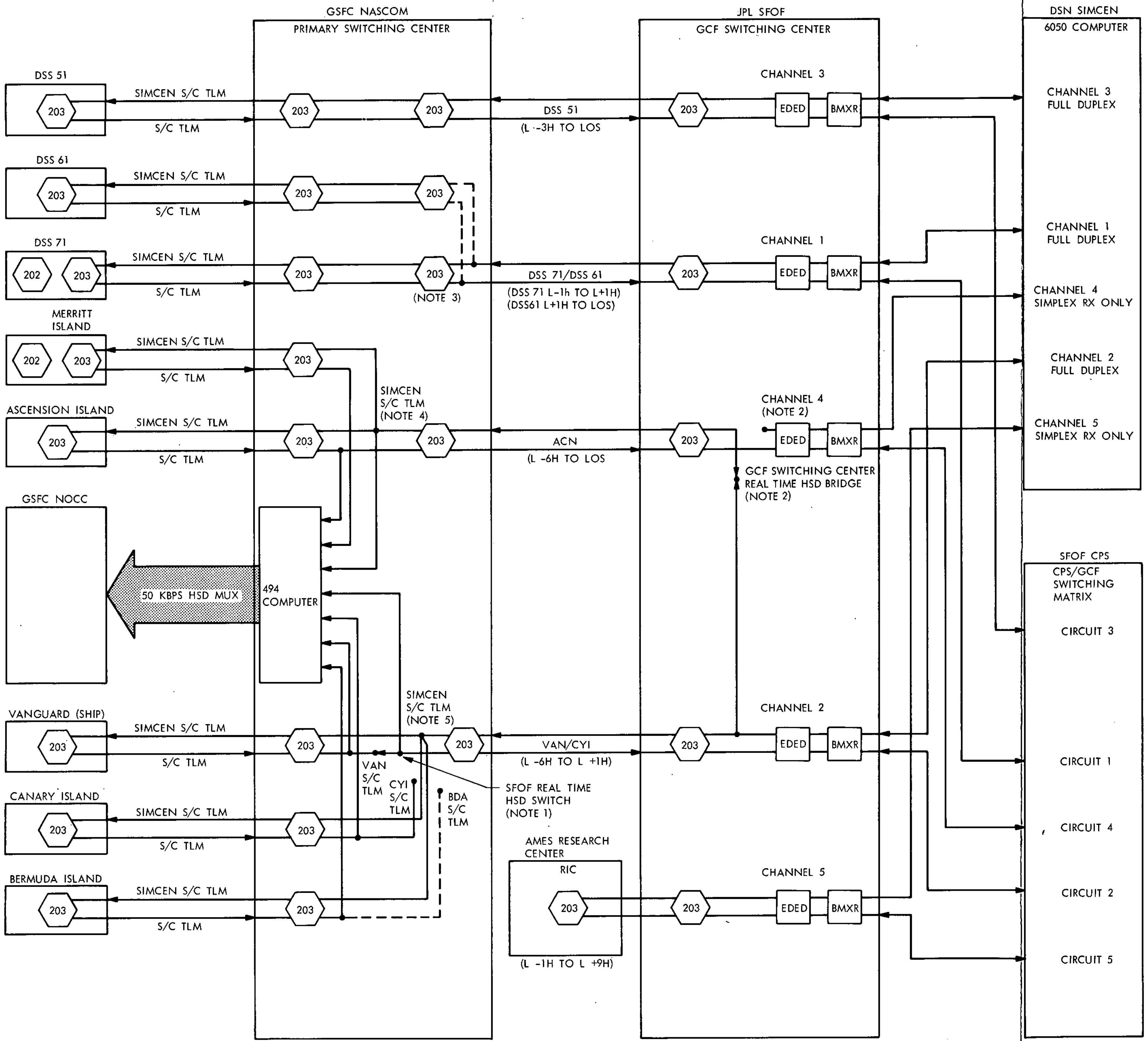

1 GODDARD COMM MANAGER WILL SWITCH FROM VAN S/C TLM TO CYI S/C TELEMETRY ON REAL-TIME REQUEST OF JPL COMM CHIEF. SWITCH TO CYI WILL BE REQUESTED AT VAN LOSS OF SIGNAL (NOMINALLY L+26MINUTES).
IF DSS 71 S/C TLM IS NOT AVAILABLE DURING BDA VIEW PERIOD (NOMINALLY L+5M TO L+10M), JPL COMM CHIEF WILL REQUEST A SWITCH FROM VAN TO BDA S/C TELEMETRY.

2 IF DSN SOE'S ARE TO BE TRANSMITTED TO NOCC VIA HIGH SPEED DATA LINES, DURING PERIOD L-6H TO L+1H, THEN SIMCEN S/C TELEMETRY BRIDGE WILL BE REMOVED FROM CHANNEL 4 AND EDED NORMALLED THROUGH TO DATA SET. BRIDGE WILL BE REMOVED ON DSN OC'S REAL-TIME REQUEST TO JPL COMM CHIEF.

3 DSS 61 TO USE HSD CIRCUIT NO LONGER REQUIRED BY DSS 71.

4 SIMCEN S/C TLM PATCHED BY GSFC TO ASCENSION WILL BE BRIDGED BY GSFC TO MIL AND NOCC.

5 SIMCEN S/C TLM PATCHED BY GSFC TO VANGUARD WILL BE BRIDGED BY GSFC TO CYI AND BDA.

Fig. 40. NASCOM-Networks-DSN high-speed data configuration and utilization plan (using GSFC NOCC) for Pioneer 10 test/simulation phase

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VII. TDS SUPPORT AND SUPPORT EVALUATION

A. General

The DSN 26-m-diam antenna network and 64-m-diam antenna station, with some early assistance from the Ascension Island MSFN station, after launch successfully tracked, maneuvered, acquired data from, and sent commands to the Pioneer 10 spacecraft through March 31, 1972. The complete pass chronology and sequence of events for this period are reported in Appendix C.

1. Time Expended. By the end of the reporting period of this document, 30 separate passes had been supported for a total of 800 h and 28 min by seven DSN stations, which expended a total of 12,252.5 man hours and 1,320 station hours. (The Ascension Island MFSN station assisted on seven passes, ending support on March 10.)

In addition, DSS 71 expended 280 man hours and 40 station hours support countdowns and launch.

The support by individual DSN stations was:

DSS	Total passes	Man hours	Station hours
11	17	2395	250
12	12	1233	148
14	3	298.5	26
41	5	570	72.5
42	23	3194	368
51	30	4231	410
61	4	331	45.5
71	--	280	40

2. Spacecraft Position. The spacecraft was approximately 22×10^6 km from Earth, traveling at 8.7 km/s relative to Earth, at the end of March.

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B. Countdowns to Launch

After three countdowns had been initiated and scrubbed, Pioneer 10 spacecraft was successfully launched on the sixth day of the 16-day launch opportunity period. First countdown was initiated Feb. 27, 1972, the first day of the period. The fourth and completed countdown was initiated March 2 and completed with launch on March 3 at 0149:03 GMT, 24 min into the 30-min window.

The four countdowns were reported as follows:

1. First Countdown, Feb. 27. The countdown proceeded normally until about 2338 GMT when a readout at a van observing station of the third-stage C-band beacon indicated a sensitivity of 6 to 8 dB less than normally acceptable. (The van observing station readout was -56 dBmW which was a Go for range safety; metric beacon sensitivity requires -63 dBmW, nominal beacon sensitivity is -72 dBmW.)

Readouts in the blockhouse did not indicate any malfunction of the beacon. AFETR and GSFC/STDN indicated that if the beacon sensitivity was indeed 6 to 8 dB low, their respective third-stage tracking support would be best obtainable. A subsequent readout by the AFETR using a radar indicated a Go beacon.

The checkout of the near-Earth TDS sites progressed on schedule.

At about 0031 GMT, there was a momentary power outage at Complex 36 because of a storm passing through the Cape area. At T minus 59:36 (0043 GMT), when the blockhouse attempted a transfer back to industrial power, the breakers would not transfer, and a hold was initiated at that time. At 0100, the launch vehicle test conductor indicated to the launch director that it would be one to two hours before the vehicle's posture could be evaluated. The upper winds were No-Go also. At 0101, the launch was scrubbed and rescheduled for a countdown on Feb. 28.

2. Second Countdown, Feb. 28. The countdown progressed normally with all near-Earth TDS data checks performed satisfactorily. The upper winds were marginal throughout the countdown. As the count entered the built-in hold at T minus 5 min, the winds were No-Go. During the hold, an attempt to provide a yaw-and-pitch program that would be satisfactory was

futile and, while in the extended hold, with approximately 3 min remaining in the window, the launch attempt was scrubbed.

Readouts at a van station of the third-stage C-band beacon resulted in a No-Go from the AFETR. However, AFETR indicated that the 12.16 radar support would be sufficient to provide data for a solution of orbital elements. The 1.16 radar readout of the third-stage beacon was Go.

Because of a previously scheduled satellite launch for Feb. 29, the next Pioneer countdown was scheduled for March 1.

3. Third Countdown, March 1. The range countdown was initiated with the Real-Time Computing System (RTCS) 3600B not operationally ready due to unknown problems. It had been not operationally ready since 2158 on Feb. 29. A Titan III was launched earlier in the day with the computer down.

The computer was operational at 0600 on March 2.

At T minus 200 min, STDN reported minor problems at Bermuda and the ship Vanguard. However, they were ready to support. Vanguard's problem was cleared at T minus 33 min.

The checkout of the near-Earth TDS stations progressed satisfactorily except there was no opportunity to perform data line checks with the RIA. Other users of the LES-6 relay satellite interfered with these checks.

The upper winds were marginal throughout the count. The built-in-hold at T minus 5 min was extended to allow time to establish a suitable pitch and yaw program. A program was provided, but, since it was not verified by Convair and LeRC, the launch attempt was terminated (0148) and rescheduled for March 2.

4. Fourth Countdown and Liftoff, March 2 and 3. The fourth countdown of Pioneer F was initiated on March 2, utilizing a 30-min window with a planned lift-off at 0125 GMT. The flight azimuth was to be 103.16 deg at opening.

a. Near-Earth TDS countdown. The AFETR computer (3600B) was not operationally ready from T -249 min till T -104 min; the STDN Merritt Island (MIL) station was not operationally ready for 18 min for a servo system problem in the unified S-band antenna. All other items in the near-Earth TDS count progressed satisfactorily. The Range Instrumentation Aircraft (RIA) staged from Raney AFB at 2217.

b. Spacecraft countdown. There were no significant spacecraft problems.

c. Launch vehicle countdown. The launch vehicle processed satisfactorily until T minus 10 s when it was recycled to T minus 5 min until 0144 because of an apparent problem in the second stage (Centaur). The problem was investigated and found to be associated with a faulty ground support equipment reading.

d. Weather. Conditions of weather throughout the count were good. High-altitude wind shear data remained within limits.

e. Liftoff. At 0149:03.575, with a flight azimuth of 104.037 deg, liftoff occurred. Six minutes remained in the window.

5. Tracking Predicts

Preflight predicts for the beginning of the window (set F007), for the end of the window (set F008) and for no-third-stage, burn (set PNA1) were generated and transmitted to Ascension Island STDN and DSS 51. Optional predicts sets scheduled during the countdown at L minus 90 min and a L minus 30 min were deemed unnecessary and not run because of stability in the spacecraft frequency standard.

Since launch occurred 24 min into the 30-min window, the closed-window nominal set (F008) was designed as the prime predicts. Doppler biases were provided to DSS 51 to adjust the closed-window doppler predicts (set F008). The D1 bias was computed incorrectly and was not effective, while the D2 bias reduced the predict error in set F008 by 50 percent.

During the launch phases, AFETR generated and transmitted three sets of predicts (sets 01N, 01A, and 02A). These were used to validate JPL predicts (see Deep Space Phase) and for pointing angles as Ascension Island.

A probe ephemeris tape (PET) based on the actual launch time was received.

C. Near-Earth Phase

1. Flight Events

Injection of the Pioneer F (now Pioneer 10) spacecraft into a Jupiter flyby trajectory took place at 0205:59.4 (Table 16 shows injection conditions;

Figure 41 is the injection target map.) First rise over the Ascension Island STDN station occurred at 0205.15; first rise over DSS 51 occurred at 0209:50.

Table 17 presents the powered flight tracking coverage. Table 18 sets forth the launch vehicle flight events.

The ship Vanguard provided these third-stage burn parameters:

Time - 0203:28 GMT

Inertial path angle - 10.79 deg

Inertial velocity - 46.69 km/s

Altitude - 194.23 nmi

2. AFETR Support. Figure 42 shows the test support position of the Vanguard and the range instrumentation aircraft.

Figures 43 through 47 present radar and telemetry coverage provided by the AFETR. The Centaur beacon is shown as 6 μs, which are the beacons' pulse spacings, respectively.

3. GSFC Support. Figure 48 presents the coverage by the STDN stations.

The Vanguard was the prime source for radio metric tracking during the third-stage ignition and burnout events. Radio metric tracking was accomplished, although the C-band signal fluctuated because of third-stage tumbling subsequent to Yo deployment. The tumbling is a normal mode.

Tananarive experienced beacon lobing from the Centaur.

A weak and very poor Centaur telemetry signal was experienced by the Vanguard. The Centaur signal ended abruptly approximately 36 s after third-stage ignition. This was caused by the angular separation between the third stage and Centaur.

Although the Centaur was tumbling and rolling, Tananarive reported good Centaur signal.

Third-stage and spacecraft telemetry was good. Third-stage telemetry signals were used as acquisition aids at Ascension and Canary Islands.

4. KSC Support. Figures 49 to 51 indicate usefulness of data processed at the Building AE telemetry lab.

Each presentation represents a classification of 0 = no signal; full scale = clean and useful; half scale = noisy and not too useful.

5. Real-Time Spacecraft Telemetry Transmission. DSS 71 processed in real-time spacecraft telemetry for transmission to the SFOF as follows:

Time	Source
L minus 15 min to L plus 467 s	Merritt Island USB
L plus 467 s to L plus 807 s	Antigua
L plus 744 s to L plus 1161 s	RIA (out of sync)
L plus 948 s to L plus 3093 s	Ascension Island

Telemetry data were processed from the near-Earth TDS in real time at the SFOF as follows:

Time	Source
Liftoff to 695 s	DSS 71 (MIL and Antigua)
695 to 1413 s	Vanguard

6. RTCS Computations. Tables 19 and 20 summarize the orbital elements computed by the AFETR RTCS. In addition to these, standard orbital parameters messages (SOPM), I-matrices, and mapping to Jupiter encounter messages (Figure 52) were also prepared for third-stage and spacecraft orbits. Figure 52 presents solutions to encounter using R-S-T coordinate system for the navigation team.

Predicts for the DSN and STDN were prepared also.

7. Near-Earth Performance Evaluation

a. General. The nominal flight of Pioneer 10 during the near-Earth phase did not tax the system so that much of the data recovered, although useful, did not provide a good measure of the performance of the near-Earth systems.

The launch vehicle and spacecraft telemetry data recovered were such that if one site's data were not too useful, another site probably had data for the same interval (Figs. 49 to 51).

The orbital computations made by the Real Time Computing System (RTCS) were never rated better than good (Table 19). Definitions for the quality estimates are shown here (when mapped to the planet, the results were excellent):

(1) Excellent: residuals on these data as small as can be obtained from this source. The input data appear valid in all respects. No unexplained inconsistencies in data.

(2) Good: same as above except residuals somewhat larger.

(3) Fair: orbit solution obtained, but residuals higher than normal or input data noisy and/or small number of data points available, thus reducing confidence in solution.

(4) Poor: high values in residuals and/or unexplained inconsistencies in data.

b. Testing. Although not normally reported, a note on testing performance is required. Many small problems were indicated that, if proper coordination was exercised, should not have occurred. This was to be corrected before the next Pioneer flight. An explanation for some of the problems was that the system was used only once a year and training was only intensive for two tests (ORTs) before the launch. It did not seem practical for the results achieved during launch to change this regime, however.

c. Tracking. Figure 43 shows a period of approximately 200 s during which time Patrick AFB had skin only track. This was caused by phase front shifts experienced by the radar.

The metric tracking data provided by the Vanguard for a third-stage transfer orbit computation was better than that provided on Mariner 9. This was borne out by the map computed on these data. The uncertainty in the ship's position contributed to this problem. The ship did report that for approximately the last half of their pass (5 min) that the third-stage beacon was fluctuating, apparently because of third-stage tumbling and rolling.

Tananarive reported only 176 s of valid Centaur track because of a lobing signal.

The RTCS performance was satisfactory. All of the required computations were provided on time or earlier.

d. Telemetry. Although all the data requirements were satisfied, note is made that certain stations experienced difficulty with the vehicle's signals. Most of these variations can be explained by the flight of the vehicle.

Both the aircraft and Vanguard reported degradation of the signal because of a spinup and third-stage burn. The Vanguard in particular felt that the third-stage telemetry was affected by thrust attenuation from the solid propellant engine.

Support of the recovery of spacecraft telemetry was hampered at Antigua when TAA-8A antenna slewed off track between T + 648 and T + 687 s. The TAA-3A at Antigua had no problem.

Ascension Island (AFETR) experienced less than 50 percent data coverage of the third-stage link because of tumbling. The STDN site at Ascension appeared to have the same experience. Canary Island (undergoing the same effects) was able to maintain RF contact for approximately 44 min.

The aircraft support of spacecraft telemetry was poor because personnel on board were unable to achieve phase lock on the received signal.

D. Deep-Space Phase

1. DSN Sequence and Midcourse Maneuvers

a. Acquisition. First rise for the spacecraft at DSS 51 at Johannesburg, South Africa, was at 0209:50, transmitter turn-on followed at 0213:36, and DSS 51 two-way S-band acquisition was at 0215:02 — officially initiating the deep-space phase of the Pioneer 10 Mission. This occurred at 25 min and 59 s after liftoff (0149:03).

b. Transmitter. Time for transmitter turn-on had been decided upon as when the doppler rate reached 1.5 Hz/s (at VCO level) and then allow the upward moving doppler to sweep into lock. The turn-on frequency was computed by starting with the XA (spacecraft center frequency plus doppler) and adding 20 Hz for temperature uncertainties, 30 Hz for trajectory ($\dot{R}$) uncertainties, and 50 Hz for all other unknowns. Using this scheme, it had been calculated that the nominal time to acquire should be about 1.5 min. Actual time, with transmitter turn-on at 0213:36 and two-way acquisition at 0215:02, was 1 min and 26 s.

c. Command execution. The first command — to execute the stored commands on the spacecraft — was transmitted immediately after two-way acquisition. During the first 72 h of flight, the flight control team transmitted 175 commands.

d. Tuning requirement. The DSS 51 ground receiver, using the acquisition tracking synthesizer frequency, built up an unexpected stress of more than 300 Hz by 0500, which was not acceptable during an upcoming turnaround maneuver. This fact was not relayed from the telecommunications analysts to the Network Analysis Team/Tracking System personnel in the preflight planning as required. However, a quickly planned and unexpected tuning was executed at 0519:30 and the loop stress was reduced to approximately 4 Hz, which was acceptable for the turnaround maneuver.

e. Station support. As planned, at the end of the view of DSS 51, the STDN station at Ascension Island took over the support for one hour to close the gap between the views of Johannesburg and the Goldstone DSCC in California. This gap was caused by the low declination angle (-33 deg) of the spacecraft trajectory.

Nine hours after launch, DSS 11 established two-way contact, and at the end of the California view, DSS 42 at Weemala, Australia, tracked Pioneer 10 and tied the next tracking and data acquisition pass into Johannesburg.

This sequence of DSN stations was followed during the second, third, and fourth days after launch with the addition that on the third day the DSN also provided support from DSS 14, the 64-m-diam antenna station at the Goldstone DSCC. DSS 14 was added to enhance velocity correction measurements. For this, the Project fired the velocity correction thruster of the spacecraft for a short time, and DSSs 11 and 14 furnished the telemetry, tracking, and command capabilities necessary to make these calibration measurements possible.

f. Reorientation. During reorientation of the spacecraft-to-Earth alignment after ejection, signal dropouts were experienced in the interference region between forward and aft spacecraft antennas. Therefore, as expected, the maneuvers were restricted to within 45 deg of Earth alignment. With equipment compartment temperatures near the upper design limits, it was decided to not turn the spacecraft backside toward the sun during this maneuver. The maneuver strategy was selected 48 h after launch and sustained by the excellent performance of the propulsion system and DSN's measurements during calibration maneuvers in the ensuing 15 h.

g. Initial ΔV calibration tests. For the purpose of calibrating the engine thrust, two small motor burns were conducted on March 5. Observed in near-real time by the pseudo-residual program, the burns yielded this data:

(1) The first burn began at approximately 1317:42 and had a duration of 30 s. The $\Delta\dot{R}$ imparted to the spacecraft was -18.610 Hz or -1.215 m/s.

(2) The second burn began at approximately 1348:42 and had a duration of 30 s. The $\Delta\dot{R}$ imparted to the spacecraft was +18.708 Hz or +1.221 m/s.

h. Midcourse maneuvers. The combined objective of the first two midcourse maneuvers was to time the spacecraft arrival at Jupiter for Dec. 4, 1973 at 0226 GMT when the Jupiter satellite Io would occult the spacecraft and optical observations of satellites would be possible. This goal was based upon a priority list previously made with the experimenters and upon subsequent analysis and was in addition to the primary objectives.

Figures 53, 54, and 55 display the relative Earth and spacecraft trajectories and positions, the initial and second midcourse maneuvers, and the DSN support. The first maneuver was performed March 7, the fourth day of flight. The primary objective of the maneuver was to move the encounter target zone to three radii from the center of Jupiter, 14 deg below a parallel to the ecliptic through the planet center. The periapsis arrival time was placed within the views of the 64-m-diam antennas at Goldstone DSCC and Canberra, Australia. (The latter antenna was still under construction at the time of this report.)

These conditions would satisfy the design objectives of the science experiments and would ensure against failure to receive data at either tracking station at the most critical hours of data acquisition.

The first midcourse maneuver was accomplished by processing 45 deg from the Earth line into a plane containing the required velocity vector and the Earth line, accelerating the spacecraft to a velocity increment of 18 m/s away from Earth and returning to the Earth line with a velocity increment of 9 m/s toward Earth. Because the maneuver would exceed the spacecraft antenna angle constraints, the maneuver was accomplished by two burns.

The first burn was planned to occur over DSS 11 at 12:20:00 and last for approximately 487 s. The doppler shift was plotted in near-real time using the results of the pseudo-residual program. The doppler shift was 205.298 Hz, or an approximate error or plus 6,367 Hz (0.416 m/s) from the expected (Figure 56).

Immediately following the first burn, a number of small vernier correction burns were executed to correct for the first burn error. At the conclusion of these correction burns the doppler shift was 199.694 Hz or plus 0.763 Hz off from the expected.

The second burn was planned to occur over DSS 42 at 19:31:18 and last for approximately 256 s. The doppler shift, derived from the pseudo-residual program, was 138.138 Hz, or minus 0.638 Hz (0.042 m/s) from the expected (Figure 57).

The second midcourse maneuver was completed March 24, the 21st day of flight. Accomplishment of the second maneuver also was in two burns lying very nearly in the spacecraft Earth/sun plane. The first burn was directly away from the Earth 1.8 m/s and the second component was 2.14 m/s, 24 deg off the Earth line away from the Sun and generally toward Earth. The Earth-line component was trimmed to within an estimated 0.3 mm/s upon completion of the maneuver. The spin axis was then turned 10 deg away from the Earth line toward the Sun to minimize the equipment heating.

The first burn occurred over DSS 42 on March 23 at 2203.47 and lasted for approximately 30 s. The doppler shift was 18.163 Hz, or plus 0.123 Hz from the expected (Figure 58). The second burn occurred over DSS 12 on March 24 at 1202:47 and lasted for approximately 65 s. The doppler shift was minus 30.0006 Hz, or plus 0.006 Hz from the expected (Figure 59).

2. Tracking. Bulk of spacecraft tracking during the report period was by the 26-m diam antenna stations, DSSs 11, 12, 41, 42, 51, and 61. The 64-m diam antenna station, DSS 14, supported only passes 3, 5, and 22 — all spacecraft correction passes.

The increment of spacecraft passes began with the initial acquisition number and changed each time that station (DSS 51), or another station with the same general view period, again acquired the spacecraft. For Pioneer 10 spacecraft, the pass number changed each time DSS 51, 61, or 62 acquired.

A March 1972 calendar of Pioneer 10 passes is shown in Table 21.

a. Predicts, DSN 360/75 Program. (The Predict Program produces tracking parameters such as one-way, two-way, and three-way doppler, angles and range on an incremental time basis, as well as computing ground observed spacecraft events such as rise, set, and occultations.)

By launch plus 30 min (a probe ephemeris tape based on the actual launch was received 10 min earlier) predicts were generated by the Network Analysis Team/Tracking System and transmitted to DSS 51. Generated quite rapidly, these predicts in GMT were doubly important in that they were the first set which enabled the pseudo-residual program to be used; all previous predicts were in time from launch instead of GMT.

The next PET received was generated from an AFETR-supplied vector based on Ascension Island and Antigua data. Predict set F001 was computed from that PET and was substantially increased in accuracy over the launch-plus-30-min predicts.

At launch plus 6 h, Pioneer 10 spacecraft was deemed to be in cruise phase. From this point on, predicts were generated on a routine, once-per-several-days basis.

On March 4 the spacecraft battery temperature went out of tolerance, and to correct this, the spacecraft orientation was changed. This caused a change in the spacecraft transmitter and receiver temperatures. Thus, because of a lack of appropriate frequency-versus-temperature graphs, the Network Analysis Team/Tracking System did not have accurate frequencies for use in the predicts.

Table 22 lists the predicts generated and transmitted from launch through the second midcourse maneuver.

b. Pseudo-Residual Program. This program, a near-real time DSN 360/75 program, compared radio metric data as it came in on a point-by-point basis to predicted data. It then computed residuals (actual data − predicted data) and noise statistics (also on a point-by-point basis).

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Operated on a 24-hour-per-day basis by the Network Analysis Team/Tracking System, the program exposed spacecraft characteristics and problems and station problems, as well as pinpointing current predict accuracy.

(1) Program Benefits. An event at DSS 41 during Pass 011 is an example of the program's usefulness for Pioneer Project. Early in the pass, the Network Analysis Team/Tracking System was able to alert the DSIF that doppler noise was approximately 0.020 Hz, or about twice the expected noise of 0.010 Hz. Before the end of the pass, the DSIF was able to locate the noise source — the station was using the wrong frequency standard (the cesium standard instead of the rubidium standard).

The program was also of great use in determining the magnitude of the many spacecraft burns and vernier corrections in near-real time (see Paragraph D-1-b).

(2) Initiation of Program. With the first predicts generated in GMT (the launch-plus-30 min set), pseudo-residuals became operative at launch plus 33 min and 28 s. At that time, two-way doppler data received from DSS 51 showed a raw residual of -150 Hz, which seemed very nominal for that early flight stage. At 0241:19, DSS 51 began taking one-second, two-way doppler data; it was apparent from the pseudo-residual output that the spacecraft was spinning at approximately 5 rpm. When predict set F001, based on Ascension Island data and Antigua data, became available to the pseudo-residual program, the two-way DSS 51 doppler residuals dropped to about -60 Hz. Finally, when the first JPL orbit solution became available for predicts and the pseudo-residual program, DSS 51 two-way doppler residuals dropped to less than 1 Hz.

c. Radio metric data. The collection of radio metric data for the Pioneer 10 mission was supported by the integrated DSN — MSFN antenna-pointing and tracking data processing system. The radio metric data received at the deep space stations and transmitted to the SFOF at JPL for processing, distribution, and display was made available by the tracking system at Project's option as raw, clean, or compressed data.[1] At the SFOF, the NAT

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[1] Raw data = data with minimum processing and provided in teletype form; clean data = data processed to some extent using the 360/75 computer tracking software programs; compressed data = selection of every 10th data point from large volumes of data.

Track team validated, edited, processed, displayed, and stored the radio metric data, as well as producing a data file for transfer to Project.

The radio metric data recorded for Pioneer 10 during the report period was of high quality.

d. Problems. Approximately three hours after launch, a decision was made to switch to the backup 360/75 computer string. The situation did not allow system data record (SDR) or predict Phi factor master file tapes to be written. Because there were no phi factors on the backup system and all Pioneer 10 data received on the backup string would require editing, all required tapes were written on the computer floor following an initial program load of the prime 360/75 computer. These tapes were then transferred to the backup system and data processing resumed. There was temporary data loss of approximately one hour at that time; however, data were recalled later to fill the void.

A data table problem occurred on the 360/75 computer that caused random loss of teletype assignments. Effect on operation was that the display of pseudo-residuals was limited to a great degree.

Another problem faced in support of Pioneer 10 during the report period occurred because the tracking data processor (TDP) data does not contain a voltage-controlled oscillator (VCO) field within the data. Voice verification through the DSIF Chief was the only way of being certain that the deep space station was using the correct tracking synthesizer frequency. Correct VCO frequency being of utmost importance, other means of communication than just voice was deemed desirable.

e. Residual data. Figures 60 through 63 illustrate the observed two-way doppler bias computed by pseudo-residual analysis. The appropriate doppler bias value for this report period range from ~ -1.50 to $\sim +2.0$ Hz. The absence of any data points indicate that the DSN was not tracking or was tracking in a mode other than two-way.

f. Project tracking tapes. Starting at launch plus 1 h and 50 min, the Project Navigation Team was provided with a project tracking tape of processed radio metric data hourly until launch plus 6 h and 50 min for use in orbit determination. Project tracking tapes were then delivered upon request. Table 23 lists tapes passed to the team from launch to second midcourse maneuver.

g. Effects of antenna polarization and spacecraft rotation. Certain unusual effects were introduced into the Pioneer 10 radio metric data because the spacecraft antenna was circularly polarized and the spacecraft rotated, and because of the alignment of the spacecraft at various angles with the Earth-spacecraft line of sight. Thus, with the antenna polarization adding a bias to the radio metric data while the spacecraft rotation adding a sinusoidal ripple to the data and thereby increasing the data noise, there was continuous need to monitor the data to assess the performance of the Tracking System. The responsibility was on the Network Analysis Team/Tracking System to analyze the polarization and rotation effects so that the spacecraft effects could be separated from possible system contributions.

The spacecraft had three conditions that caused sinusoidal ripple in the radio metric data (i.e., the spacecraft antenna moving alternately with a small velocity toward and away from the ground observer). These three conditions were: (1) spacecraft rotation; (2) spacecraft spin axis not coinciding with Earth line of sight; (3) antenna center point not being on the spacecraft spin axis. The antenna geometry is presented in Figure 64.

Polarization and rotation introduced a bias of -0.168616 Hz into the two-way doppler data. This was small and, in general, masked by the predicts usually having an absolute error of greater than 0.1 Hz at any given time. Spacecraft rotation also caused a sinusoid of period 400 s and of amplitude:

$$-\frac{r \sin \phi}{60}\left[\sqrt{\frac{1-\cos 2\pi\omega}{2}} \cos 2\pi\omega + \sqrt{\frac{1+\cos 2\pi\omega}{2}} \sin 2\pi\omega - \sqrt{\frac{1-\cos 2\pi\omega}{2}}\right]$$

to be introduced into the sixty-second data. During the time when

$\phi = 24$ deg

$\omega = 4.85$ rev/min

$r = 0.2032$ m

The expected amplitude was 0.1911 Hz, and both the calculated period and amplitude agreed very well with the observed data as seen in Figure 65.[2] This also produced an expected noise in the two-way, sixty-second sample doppler data of approximately 0.012 Hz, which closely agreed with the noise actually observed in the data.

h. Suggested improvements. Based on experience with Pioneer 10, the following procedures are advised for future Pioneer missions.

(1) Network Analysis Grading provide three cases of preflight nominal predicts: (a) open-window case, (b) mid-window case, and (c) closed-window case.

(2) A series of coordination meetings, with at least one representative from Project Spacecraft Radio Analyst Group, Project Thermal Group, DSIF, Tracking Analysis Group, and Telemetry Analysis Group.

(3) Project R/F Analysis Team provide a complete set of curves relative to frequency information to NAT Track Team: complete frequency versus temperature information, and predicted temperature information.

(4) Establish a formal voice net between Project R/F Analyst and Network Analysis/Tracking.

(5) Plans involving data manipulation, sample rate changes, and other events that cause deviations from the normal be given Network Analysis Tracking as soon as possible.

3. Telemetry. The overall performance of the DSN Telemetry System in support of Pioneer 10 spacecraft was nominal during the report period.

a. Residual data. Figures 66 through 70 show residual data plots of signal-to-noise ratio and received signal levels for each station tracking the

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[2] Figure 65 consists of pseudo-residual two-way doppler residuals from DSS 11 on March 13 through which an arbitrary sine wave of amplitude 0.020 Hz and of period 400 s has been fit. As can be seen; the data are in good agreement with the modeled effect. With a sine wave of this magnitude, a doppler noise figure of approximately 0.012 Hz would be expected, and this is quite close to the average noise value of 0.011 Hz observed in the two-way doppler data during the period when the Earth line of sight/spin axis angle was 24 deg and the doppler sample rate was 60 s.

spacecraft. (At the end of March, the downlink signal strength was -153.3 dBmW.) The values plotted were taken at meridian crossing for each pass.

Some of the residuals were shifted because of the inaccuracy in predicts during the time that the spacecraft was offset by 24 deg to protect the battery.

A statistical analysis on absolute data values yielded the results listed here.

(1) Signal-to-noise ratio: Plotted data contained 69 observations with a mean of 0.8188 dB, a variance of 0.3171 dB, and a standard deviation of 0.5632 dB. Of these observations, 61 percent had variations of less than 1.0 dB of the predicted values. The value that was most often observed was between 1.0 and 2.0 dB.

(2) Received signal level: Plotted data contained 63 observations with a mean of 1.454 dB, a variance of 1.113 dB, and a standard deviation of 1.055 dB. Of these observations, 38 percent had variations of less than 1.0 dB of the predicted values. The value that was most often observed was between 1.0 and 2.0 dB.

b. Bit rates. Telemetry bit rates during March were 2048, 1024, 512, and 128 bits/s, with the switch to coded bit rate mode being made on March 9 at DSS 51. The spacecraft was approaching the 512 bit/s rate threshold on the 26-m-diam antenna network with the Earth look offset of 12 deg as set by the second midcourse maneuver.

c. Data record tapes. During the report period, there were 52 original and 52 duplicate live spacecraft telemetry system data record (SDR) tapes and 137 original and 137 duplicate station recall SDR tapes.

4. Command System. Command activity in support of the spacecraft was fairly high with 1,498 commands being transmitted, but the Command System performed well and successfully accomplished the command function. No aborts were experienced. No problems were significant enough to affect the mission.

a. Summary of command activity for March 1972

DSS	No. of commands	Percent down[3]
11	132	5.41
12	34	3.14
41	128	4.03
42	870	2.66
51	334	4.02

b. Sequence of activity. With DSS 51 acquiring two-way acquisition 25 min after launch, the first command (execution of stored commands on spacecraft) was transmitted two minutes later. This action was well within Project expectations as were subsequent transmissions during the first critical period of DSN track.

The next critical mission time period occurred during the third and fourth days after launch as DSSs 11, 42, and 51 supported the first trajectory correction maneuver. The Command System performed satisfactorily with no anomalies noted. At 20 days after launch, the second trajectory correction maneuver also was successfully accomplished DSSs 12, 42, and 51 supported the command functions.

The anomalies that did occur in the operation of the command system were not during critical time periods. Three timed commands failed to transmit from DSS 42 on passes 18, 19, and 20. A hardware fix in the command modulator assembly (CMA) was incorporated through the network and the problem did not recur.

c. Problem solutions. An interface problem between the Command System software and the Tracking System software in the SFOF was fixed with a software update just after launch. The concern prior to launch about the ability to generate the command data record in a timely fashion proved to be unfounded. The software implemented in the SFOF just prior to launch solved the problems associated with this task.

[3]Includes 360/75 computer and high-speed data line outages.

Two problems discovered after launch did affect the Command System.

One of the parameters of the standards and limits used by the multimission command system was the abort error limit. By design, it was possible to allow a command that contained bit errors to be transmitted to the spacecraft. An incompatibility between the software in the SFOF and the TCP existed; thus two commands were transmitted to the spacecraft in error. This problem was being studied at the end of the report period. A manual typewriter input was performed at the TCP following each high-speed data block transmission of a command standards and limits message. Software changes to correct the problem were scheduled for implementation into the operational SFOF software by June 1972.

The second problem that appeared during the first month of the mission was the transmission to the spacecraft of a command that was not enabled by Project. The DSN Command System has the capability to send the enable instruction to the DSN TCP with the command message block, a process called "immediate enable." The Project sent a block of commands to the TCP with intentions of enabling them at a later time. The "immediate enable flag" contained in the high-speed data block was changed during the course of transmission to the TCP. Because the commands were non-timed (i. e., priority) commands, the first command in the block was transmitted to the spacecraft. The verification failed at the SFOF and the automatic retransmission of the block to the TCP overlayed the remaining commands in the block. These remaining commands were non-enabled and thus did not transmit to the spacecraft. The immediate enable function was to be deleted by software changes in the TCP during May 1972 and in the SFOF during June 1972.

d. Command data record tapes. No problems were encountered in the generation of 28 command master data records (MDR) during this report period and only one original data record (ODR) replay was required. The ODR replay was from DSS 42 and covered one pass. A total of 85 tapes, including MDR, System Data Record (SDR) and ODR playback, were generated in March.

Tapes generated were:

Tape Number	Start Time	End Time	
7287	062/0000Z	064/1030Z	
7293	064/1030Z	065/0930Z	
7299	065/0930Z	066/0830Z	
7807	066/0830Z	068/1000Z	
7813	068/1000Z	069/1000Z	
7816	069/1000Z	070/0100Z	
7822	070/0100Z	071/0110Z	
7825	071/0110Z	072/0110Z	
7831	072/0110Z	073/0052Z	
7836	073/0052Z	074/0100Z	
7842	074/0100Z	075/0130Z	
7848	075/0130Z	076/0200Z	
7854	076/0200Z	077/0200Z	
7860	077/0200Z	078/0130Z	
7866	078/0130Z	079/0100Z	
7872	079/0100Z	080/0100Z	
7878	080/0100Z	081/0100Z	
7884	065/1650Z	065/2100Z	ODR replay from DSS 42
7887	081/0100Z	082/0100Z	
7893	082/0001Z	083/0035Z	
7899	083/0035Z	084/0015Z	
6942	084/0001Z	085/0026Z	
6962	085/0001Z	086/0025Z	
	086/0025Z	087/0004Z	No CMDs sent, no MDR written
6979	087/0001Z	087/2348Z	
6991	088/0001Z	088/2342Z	
7004	088/2342Z	089/2345Z	
7014	089/2345Z	090/2340Z	
7027	091/0001Z	091/2300Z	

5. Monitor System. The Monitor System provided support to the Project by displaying available parameters via digital television (DTV), processing of the pass folder information, and, to a limited degree, monitoring the status of the tracking stations. This provided Project with gross status about the stations and SFOF and their ability to provide meaningful and useful data.

The SFOF Monitor Software Program was still incompatible with the Digital Instrumentation Subsystem (DIS) at DSSs 11 and 61. Deep Space Station 42 did not have a DIS at that time. Consequently Table 24, which gives a monitor summary for March 1972, does not show any DIS coverage for these stations.

There were no major problems during the report period. Thirty-one discrepancy reports were written against the DSN since launch as follows:

12 against telemetry, 6 against tracking, 12 against command and 1 against monitor. None of the discrepancy reports significantly affected the data flow from the stations through the 360/75 computer to Project.

Data on each Pioneer pass were collected, processed, and stored for future analysis and reference within the Operational Data Control (ODC) System at JPL. The data were cataloged by pass number, giving the status of DSN at the time of data flow. Each pass contained a composite summary showing the overall status of the DSN along with explanation of any problems that may have been present at the time. The DSN Monitor System was the focal point for the composite pass summary.

The DSN performance summary report, generated on a weekly and monthly basis by the DSN Operational Analysis System, contained the tracking time (actual and scheduled) for each station and the time devoted to the spacecraft. It also contained the mean time between failures (MTBF) and duration of each failure, the DIS at each station, and the MTBF and duration of each failure for the 360/75 computer and the 3100 computer located at Pasadena. (See Pass Chronology, Appendix C.)

To further support the Pioneer Project, the Monitor System provided high-speed data block definition and a format guide. The format guide gave definition of the parameters on each DSN data format. Also shown in the format guide were the algorithms used to process the DTV displayed parameters. The definitions and the format guide were made available to all users of the DSN data.

6. Central Processing System. The Pioneer 10 Mission was supported by the Central Processing System at the DSN SFOF through spacecraft testing, mission operations planning and testing, software development and testing, mission operations training, DSN operations training and testing, and prelaunch, launch, and flight phases.

This support was successfully provided concurrently with support of the critical activity period of a second major project (Mariner 9), thereby demonstrating the capability to provide multi-mission flight support with a single computer system.

The support is summarized in Tables 25 and 26. The quality of the performance is illustrated in Figures 71 and 72.

Table 16. Spacecraft injection conditions

Parameter	Nominal	Actual*
Altitude (km)	281.2408	290.21504
Latitude (deg)	12.737460	12.613989
Longitude (deg)	317.81683	318.004596
Earth-fixed speed (km/sec)	13.878920	13.865407
Earth-fixed path angle (deg)	8.4449492	8.650222
Earth-fixed injection azimuth (deg)	119.99291	120.061060
C_3 (km^2/sec^2)	84.399903	84.184484
Spin Rate (rpm)	58	53.27

*DSS 51 track ETR Solution

Table 17. Powered flight tracking coverage

Station	Expected AOS* (sec)	Actual AOS (sec)	Expected LOS** (sec)	Actual LOS (sec)
TEL 4	< 0	< 0	455-485	500
MILA	< 0	< 0	482-510	480
GBI (TAA-2)	115	58	500-530	550
GBI (TAA-3A)	115	81	500-530	485
BDA	320-330	240	605-660	600
Antigua (TAA-3A)	430-450	437	735-765	781
Antigua (TAA-8)	430-450	427	735-765	808
RIA	700-710	635	1060	2270
VAN	730-740	660	1560 → 1800	1680
Sta 12	960-1000	967	1540-1570	2937
Canary	950-1400	960	> 1800	> 1800
ASC	975-1060	960	> 1800	> 1800

*Acquisition of signal
**Loss of signal

Table 18. Summary of observed mark events

MARK EVENT NO.[a]	MARK EVENT	NOMINAL TIME L+Sec	OBSERVED GMT	OBSERVED GMT
-	Liftoff (5.08-cm or 2-in. motion)			0149:03.575
1	Atlas BECO	147.5	0151:32.7 M (149.12)	0150:32.5 T (See Note)
2	Atlas Booster Engine Jettison	150.6	0151:35.7 M (152.12)	0150:35.7 T (See Note)
3	Centaur Insulation Panel Jettison	192.5	0152:17.8 M (194.22)	
4	Sustainer Engine Cutoff	243.0	0153:06.5 M (242.92)	0153:07.3 T (243.72)
5	Atlas/Centaur Separation	244.9	0153:09.4 M (245.82)	0153:10.7 T (247.12)
6	Centaur Main Engine Start	254.5	0153:19.8 M (256.22)	0153:20.0 B (256.42)
7	Nose Fairing Jettison	266.5	0153:30.7 M (267.12)	0153:30.8 B (267.22)
8	Centaur Main Engine Cutoff	708.0	0200:48.8 V (705.22)	0200:49.0 T (705.42)

[a]Marks 1 and 2 were verified as recorded - apparently a time code error.

A = AFETR/Antigua
B = STDN/Bermuda
M = STDN/Merritt Island
R = AFETR/RIA
T = AFETR/TEL4
V = STDN/Vanguard

Table 18 (contd)

MARK EVENT NO.	MARK EVENT	NOMINAL TIME L+Sec.	OBSERVED GMT	OBSERVED GMT
9	Third-Stage Spin Up	778.0	0201:59.5 [V] (775.92)	0201:59.0 [A] (775.42)
10	Centaur/Third-Stage Separation	780.0	0202:00.9 [V] (777.31)	0202:00.8 [A] (777.21)
11	Start Centaur Retro	781.0	0202:02.0 [V] (778.42)	0202:02.0 [A] (778.42)
12	TE364 Ignition	793.1	0202:14.3 [V] (790.72)	0202:14.5 [A] (790.92)
13	Centaur Power Change-over	808.0	0202:32.6 [V] (809.0)	0202:29.0 [A] (805.42) [b]
14	TE364 Burnout	837.0	0202:56.8 [V] (833.22)	0203:00.3 [R] (836.72)
15	Pioneer Separation	938.0	0204:39.0 [V] (935.42)	
16	Yo Deploy	941.0	0204:41.5 [V] (937.92)	

[b] 0202:31.0 (802.42) [R]

OBSERVING STATION CODE

A - AFETR/Antigua
B - STDN/Bermuda
M - STDN/Merritt Island
R - AFETR/RIA
T - AFETR/TEL4
V - STDN/Vanguard

Table 19. Real-time computing system computations

Orbit	Time of Computation	Data Source	Quality
1. Centaur Pre-Retro	+ 18M	Antigua	Poor
2. TE364-4 Transfer Orbit	+ 27M	Vanguard	Fair
3. TE364-4 Transfer Orbit	+ 56M	Ascension	Good
4. Centaur Pre-Retro	+ 88M	Antigua	Fair
5. Centaur Post Retro	+ 108M	Tananarive	Fair
6. Spacecraft Orbit	+ 178M	DSS 51	Good

F

Table 20. Summary of real-time computing system computations

Parameters	ORBIT NUMBER (REFERENCE TABLE 19) 1	2	3	4	5	6
HMS	0200:55.6	0202:59.1	0202:59.1	0201:07.2	0216:40.0	0202:59.1
ECC	00.8498509	2.3879513	2.3880886	00.8505828	00.8505542	2.3869922
INC	31.4420404	31.4659650	31.4730142	31.4409156	31.4628246	31.4921885
C3	-9.1653666	84.1435940	84.2709962	-9.1195546	-9.12244778	84.1844865
R	6542.31333400	6667.91804320	6666.37449680	6547.97168580	9478.51537625	6668.37504420
LAT	18.14688326	12.62293714	12.61476440	17.66955509	-14.90301729	12.61398949
LON	307.57065758	317.96718144	317.95935020	308.53905983	1.74732481	318.00459633
VE	10.21075172	13.86379931	13.86970999	10.20779530	8.17289508	13.86540710
PTE	2.48021055	8.29174873	8.63286665	2.92717966	34.44631327	8.65022292
AZE	117.24768301	120.02671880	120.03835625	117.57582024	120.70355207	120.06106016

Explanation of parameters:

HMS - Epoch. Greenwich (hours, minutes and seconds); time for which osculating conic is calculated.
ECC - Eccentricity
INC - Inclination. Degrees 000-360
C3 - Twice total energy per unit mass or vis viva integral, km^2/sec^2
R - Injection radius in kilometers
LAT - Injection geocentric latitude, degrees
LON - Injection longitude, degrees
VE - Earth-fixed speed, kilometers/second
PTE - Earth-fixed path angle, degrees
AZE - Earth-fixed injection azimuth, degrees 000-360

Table 21. Pioneer calendar of spacecraft passes

Day of month	3	4	5	6	7	8	9	10	11	12	13	14
Day of year	63	64	65	66	67	68	69	70	71	72	73	74
DSS pass No.	1	2	3	4	5	6	7	8	9	10	11	12
DSS 51 pass No.	← Same →											
Day of month	15	16	17	18	19	20	21	22	23	24	25	26
Day of year	75	76	77	78	79	80	81	82	83	84	85	86
DSS pass No.	13	14	15	16	17	18	19	20	21	22	23	24
DSS 51 pass No.	← Same →									23	24	25
Day of month	27	28	29	30	31							
Day of year	87	88	89	90	91							
DSS pass No.	25	26	27	28	29							
DSS 51 pass No.	26	27	28	29	30							

Table 22. Predicts summary

PREDICT SET NO.	TFREQ MHZ	XMIT REF. MHZ	COVERAGE
F007	2292037037	21985233	Preflight Nominals
F008	2292037037	21985233	Preflight Nominals
PNA1	2292037037	21985233	No Third Stage Burn
L+30	2292037800	21985235	063/0208Z to 063/1000Z
F001	2292037800	21985235	063/0300Z to 063/1000Z
F002	2292037800	21985235	063/0800Z to 064/0200Z
F003	2292037800	21985235	063/2300Z to 065/0300Z
F004	2292037800	21985235	064/2300Z to 066/0300Z
F005	2292036000	21985217	065/2300Z to 067/0300Z
F006	2292036000	21985217	066/2100Z to 068/0300Z
F009	2292036000	21985233	068/0100Z to 070/0300Z
F010	2292037550	21985238	069/2000Z to 072/0300Z
F011	2292037550	21985238	071/2000Z to 073/0300Z
F012	2292037550	21985238	072/2000Z to 074/0300Z
F013	2292037550	21985238	073/2000Z to 075/0300Z
F014	2292037550	21985238	074/2000Z to 076/0300Z
F015	2292037550	21985238	075/2000Z to 077/0300Z
F016	2292037550	21985238	076/2000Z to 078/0300Z
F017	2292037550	21985238	077/2000Z to 079/0300Z
F018	2292037550	21985238	078/2000Z to 080/0300Z
F019	2292037550	21985238	080/2000Z to 082/0300Z
F020	2292037550	21985238	082/2000Z to 084/0300Z
F021	2292037550	21985238	084/2200Z to 086/0300Z

TFREQ = Spacecraft Auxiliary Oscillator or Driver Frequency.

XMIT REF = Ground Transmitter Synthesizer Frequency for Best-Lock at Zero Doppler.

Table 23. Project tracking tapes summary

TAPE NO.	DATA COVERAGE
H505	Launch to 063/0340Z
H506	Launch to 063/0440Z
H511	Launch to 063/2240Z
H512	Launch to 063/2330Z
H515	063/0202Z to 065/0113Z
H516	063/0202Z to 065/0752Z
H517	063/1730Z to 065/1800Z
H518	063/0202Z to 066/0041Z
H519	063/0202Z to 066/0826Z
H520	065/0000Z to 067/2320Z
H521	066/1600Z to 067/2320Z
H522	066/1600Z to 068/1400Z
H523	066/1600Z to 068/1526Z
H524	066/1600Z to 068/1834Z
H525	066/1600Z to 069/1244Z
H526	068/2300Z to 070/1428Z
H527	068/2300Z to 071/0251Z
H529	070/1523Z to 074/1620Z
H530	068/2301Z to 074/2332Z
H531	068/2301Z to 075/2340Z
H532	068/2300Z to 076/0134Z
H533	068/2300Z to 077/1635Z
H534	076/2300Z to 077/2113Z
H535	076/2300Z to 078/1719Z
H536	076/2300Z to 079/1706Z
H537	076/2300Z to 080/1952Z
H538	076/2300Z to 081/1517Z
H539	079/2300Z to 082/1925Z
H540	079/2300Z to 082/2203Z
H541	083/1700Z to 083/2245Z
H542	083/2100Z to 084/1215Z
H543	083/2100Z to 084/1215Z
H544	079/2300Z to 087/1935Z

Table 24. DSN monitor summary for March 1972

	DSS						
	11	12	14	41	42	51	61
PN Actual Track Time (Hours)	118.95	102.27	16.39	54.15	247.92	263.02	49.50
PN Passes Tracked	17	14	3	6	24	30	8
PN Scheduled Track Time (Hours)	121.07	105.17	16.18	57.50	251.70	262.70	50.07
DIS Down Time (Hours)	N/A	0.55	26.69	0.55	N/A	0.0	N/A
Total DIS Outages	N/A	2	8	2	N/A	None	N/A
% Scheduled Track	98.2%	96.4%	98.0%	96.2%	98.9%	100%	98.9%
% DIS Support	N/A	96.0%	94.8%	99.7%	N/A	100%	N/A
Mean Time Between Failures (Hours)	N/A	65.02	60.82	129.44	N/A	No Failures	N/A
Average Duration of each Failure (Hours)	N/A	0.28	3.34	0.28	N/A	N/A	N/A

Table 25. Central Processing System — Pioneer Project support

Inclusive	F&G Software Development	Prelaunch Testing	Single Mission Mode	Multi-Mission Mode
	Time in Hours			
9/27-10/31/71	81	-	-	-
11/1-11/28/71	67	-	-	-
11/29-12/26/71	101	27	-	-
12/27/71-1/30/72	29	242	-	-
1/31-2/27/72	9	158	-	66
2/28-3/26/72	4	62	-	572
3/27-4/30/72	4	-	460	379
Total	295	489	460	1017

Table 26. Pioneer 10 support magnetic tape usage

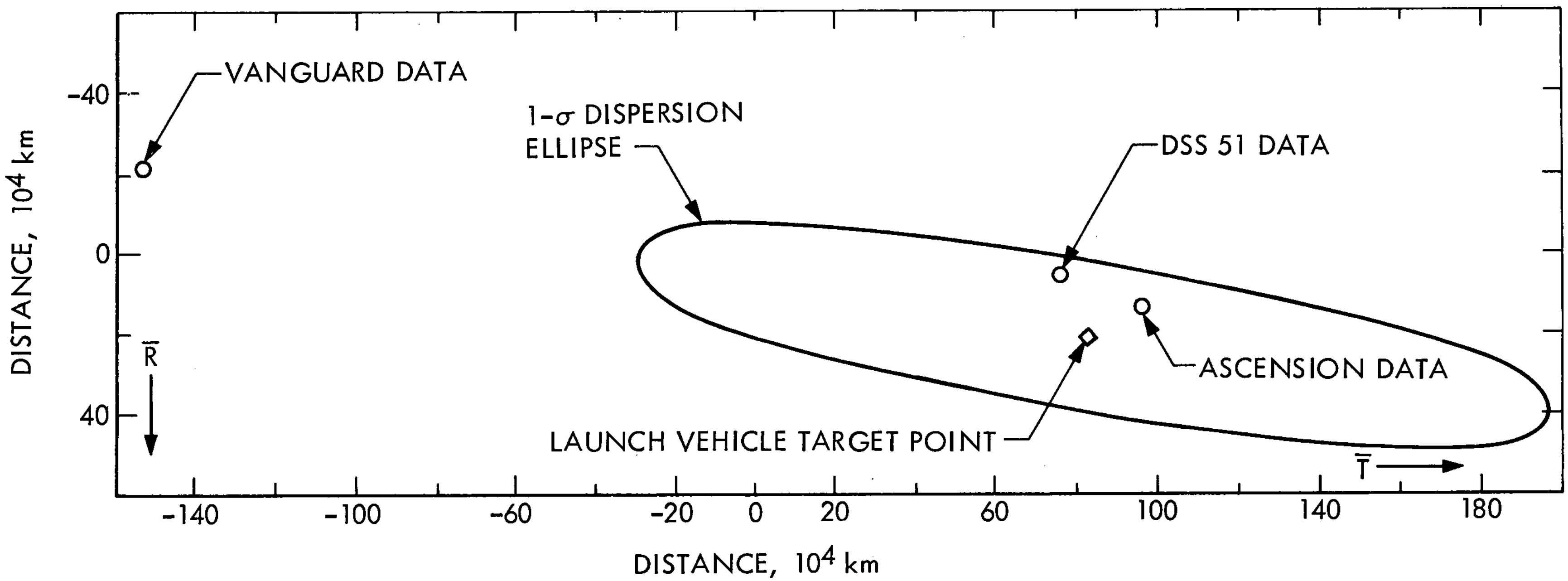
Period	Telemetry	Command	Tracking	360 Log	To ARC	ODC Storage
Prelaunch - 3/2/1972	1495	-	615	105	48	499
3/31/1972	188	93	599	181	229	533
4/30/1972	179	16	589	60	541	646

Pioneer Project tapes (TLM + CMD) = 1971

Pioneer related DSN tapes (TRK + LOG) = 2149

Pioneer MDR tapes sent to ARC = 818

MDR duplicates and TRK tapes to ODC = 646



	$B \cdot \bar{T}$, km	$B \cdot \bar{R}$, km	TIME OF CLOSEST APPROACH (GMT)
LAUNCH VEHICLE TARGET POINT	838900	209200	12-2-73, 2h 09m 00.0s
VANGUARD DATA	-1530986	-211663	12-8-73, 3h 18m 54.6s
ASCENSION DATA	969745	127519	12-3-73, 12h 36m 12.3s
DSS 51 DATA	760051	58554	12-4-73, 16h 30m 34.0s

MCR AT INJECTION PLUS 5 DAYS 13.103 m/s (MISS + TIME)

Fig. 41. Spacecraft injection target map

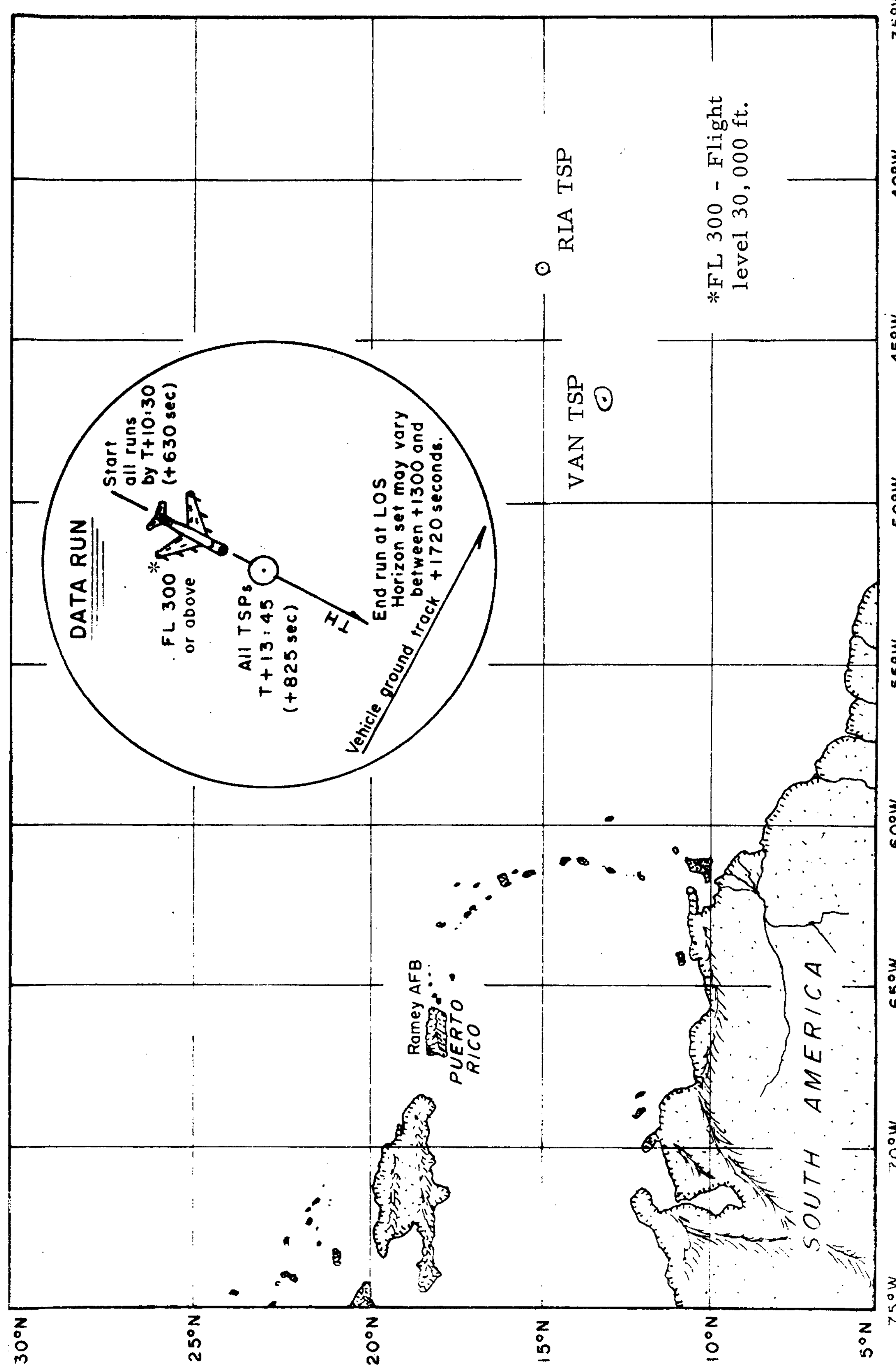


Fig. 42. Ship and aircraft support positions

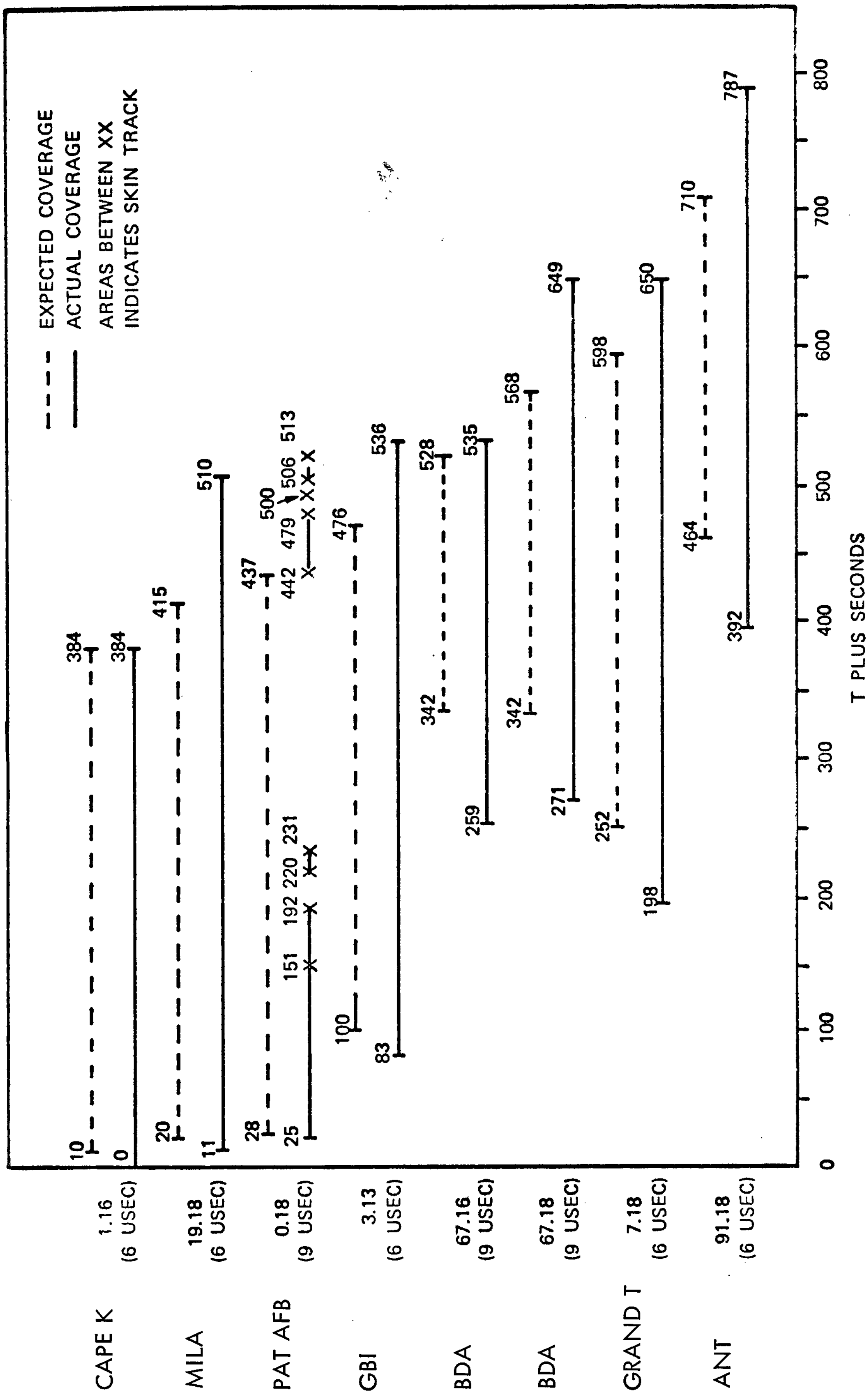


Fig. 43. AFETR uprange radar coverage – Pioneer 10

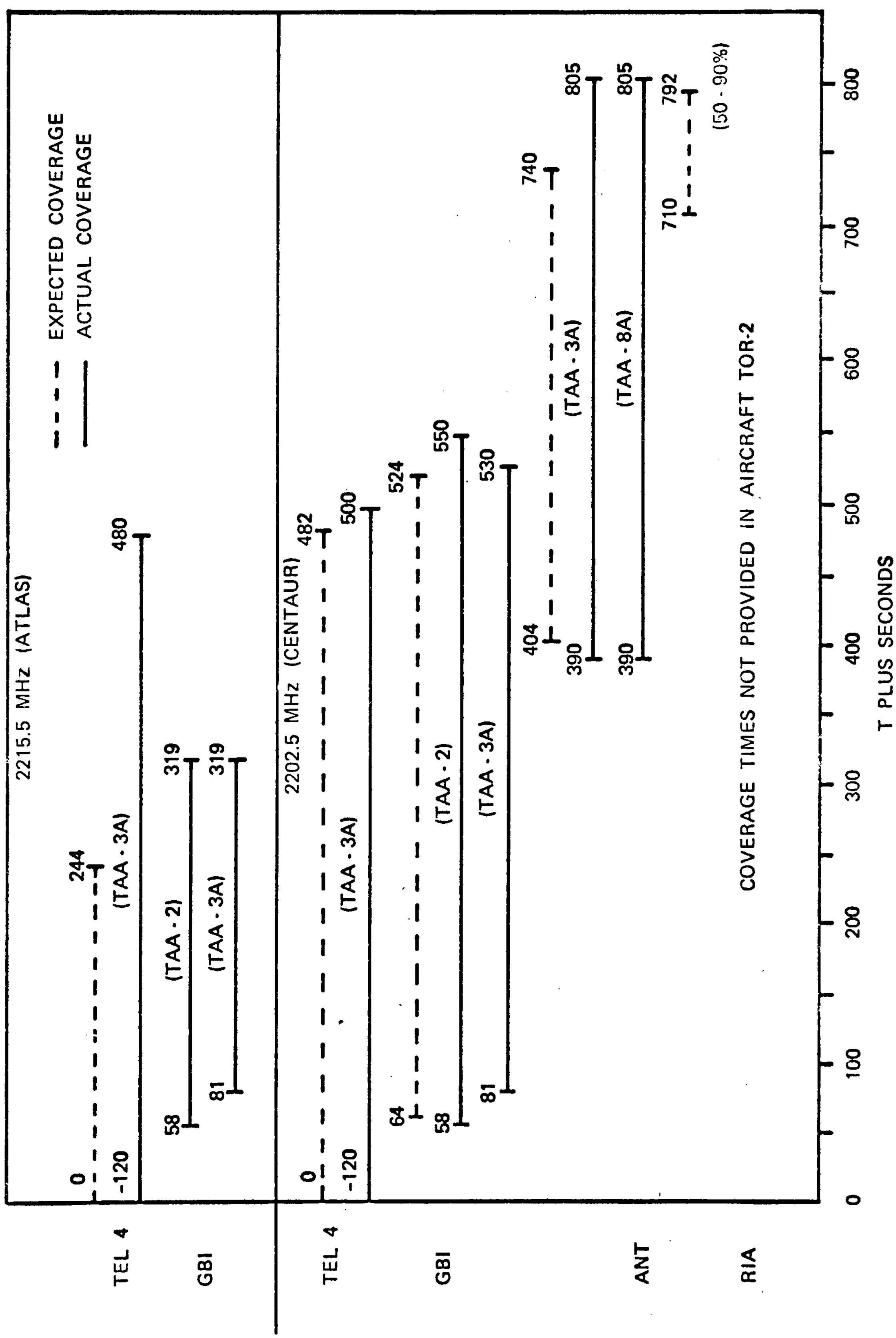


Fig. 44. AFETR telemetry coverage — Atlas

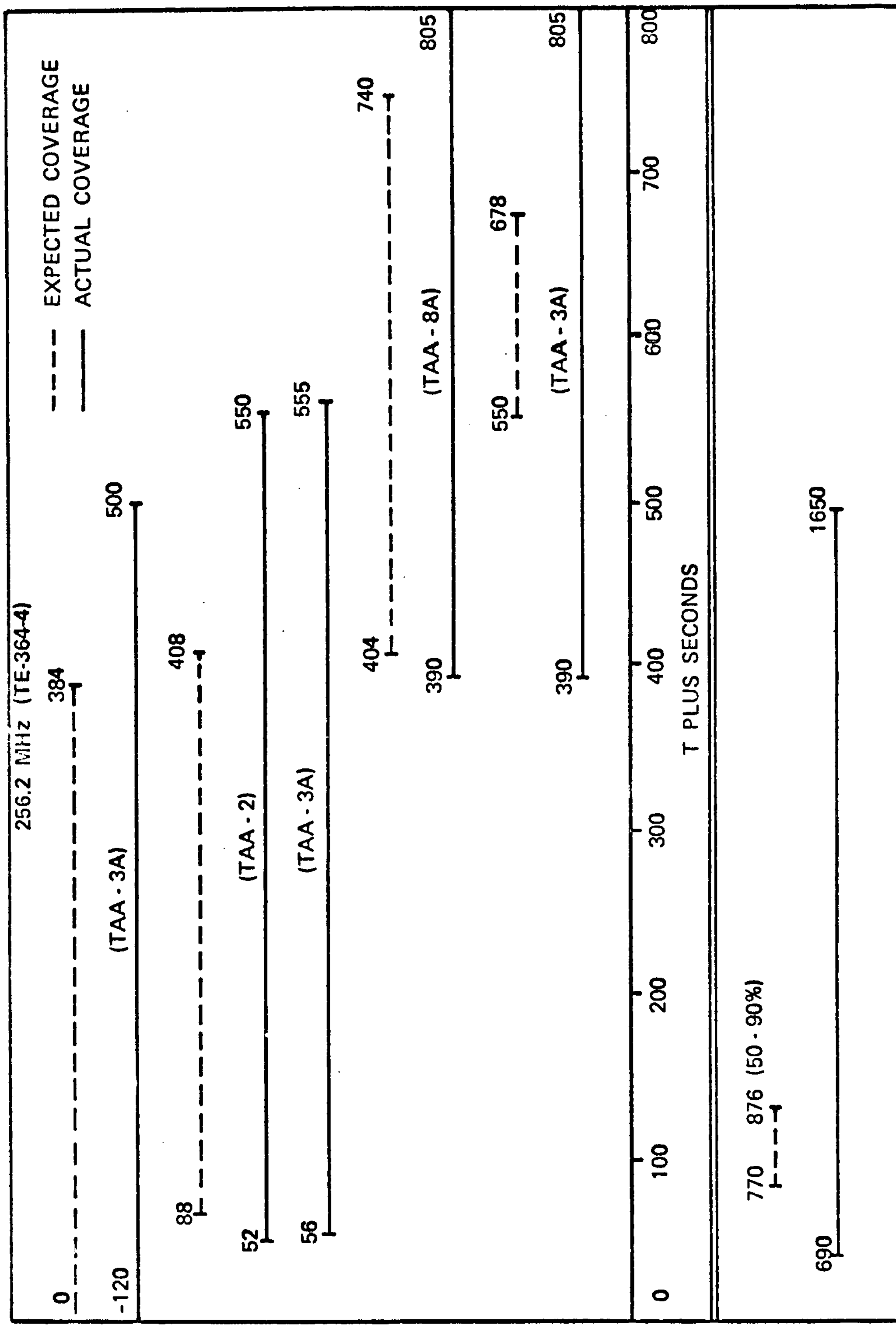


Fig. 45. AFETR telemetry coverage — TE-364-4

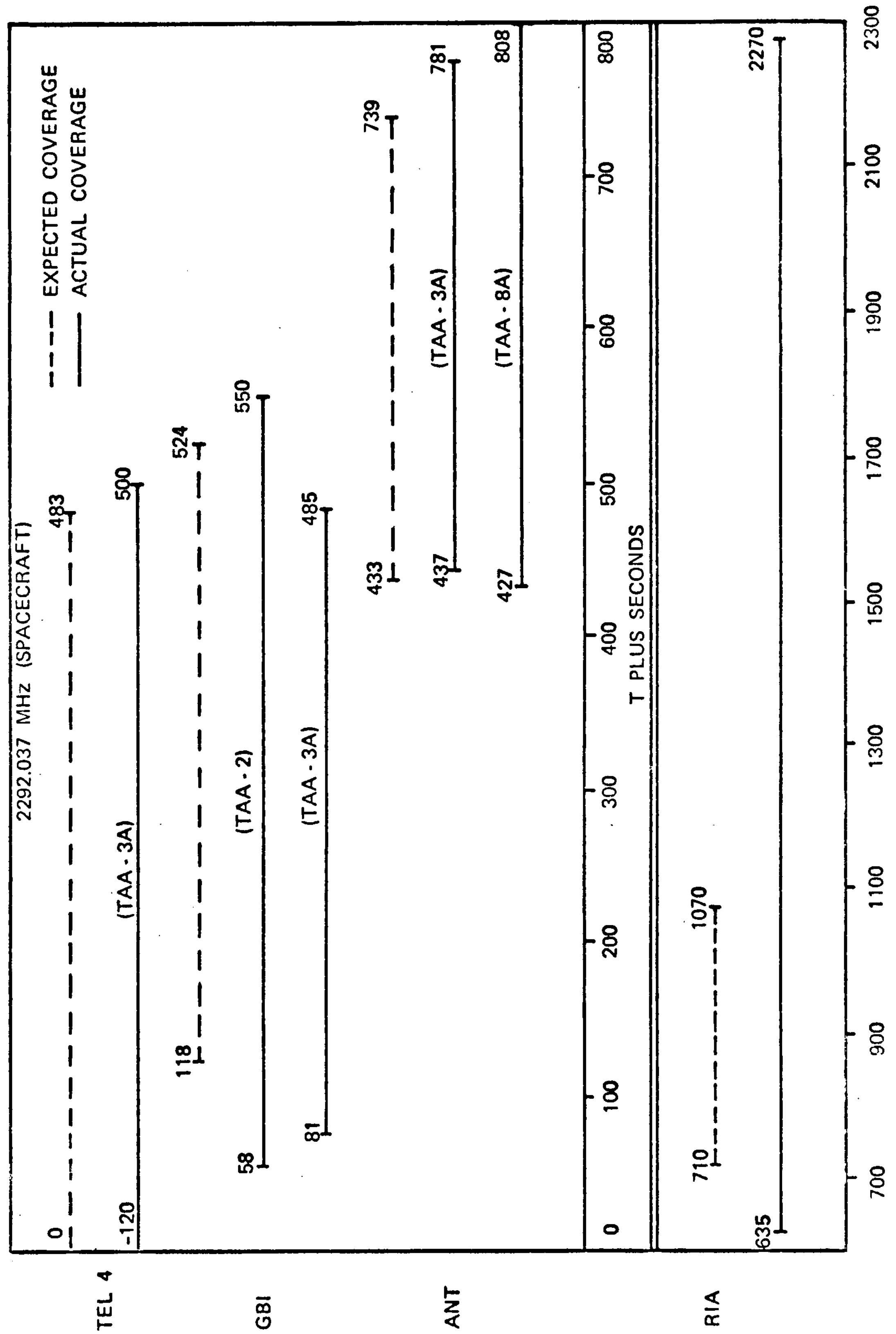


Fig. 46. AFETR telemetry coverage — spacecraft

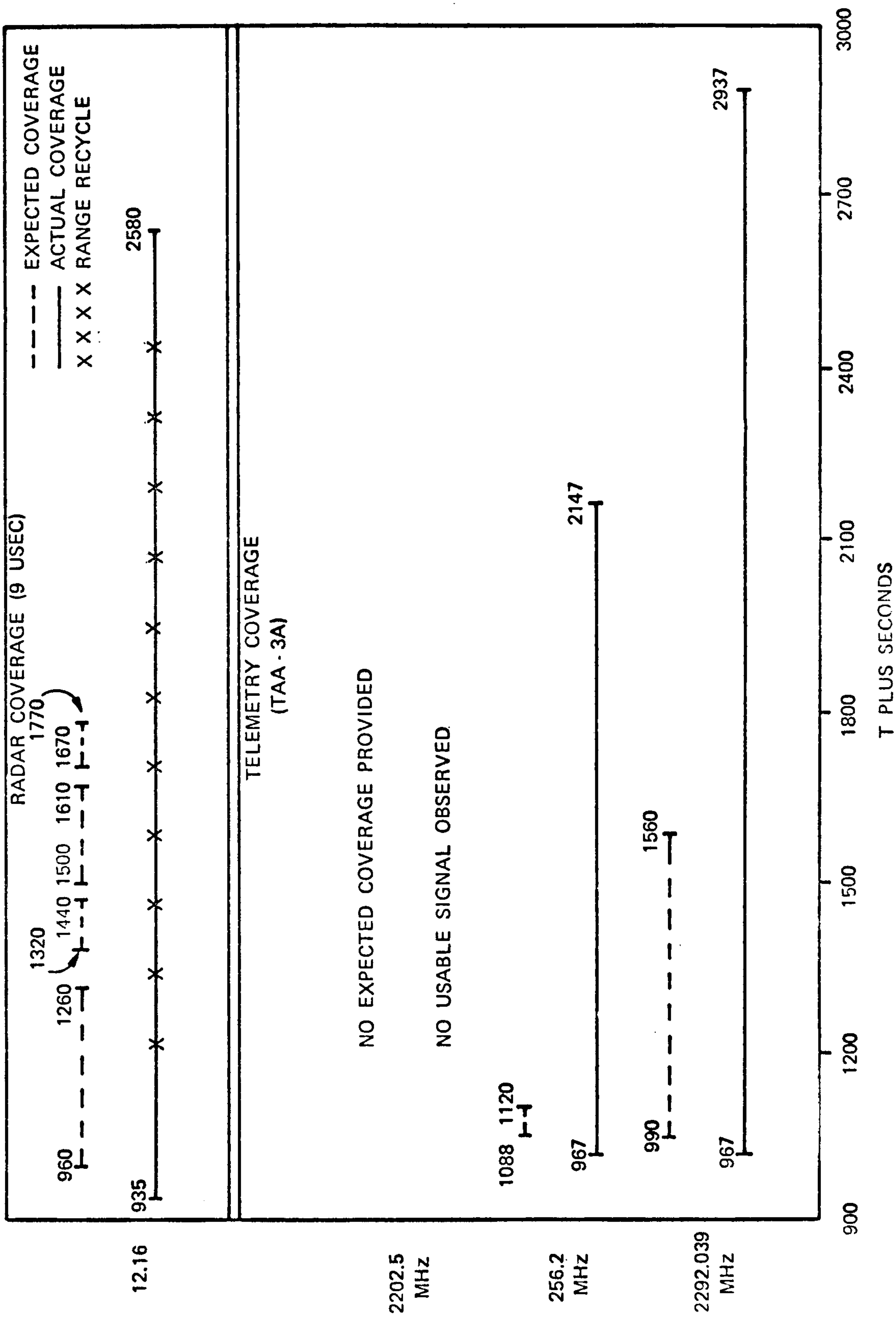


Fig. 47. AFETR ascension coverage — Pioneer 10

G

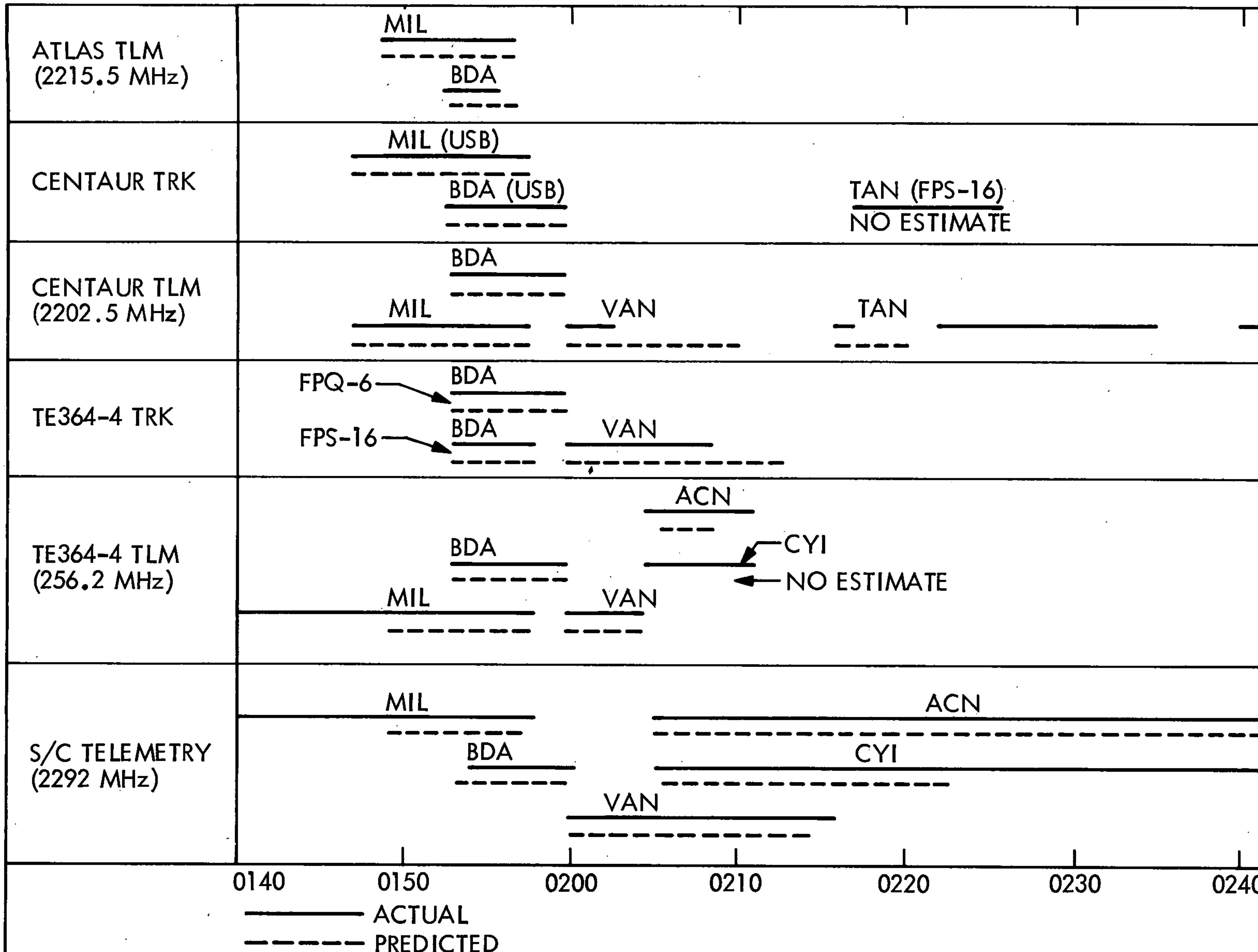


Fig. 48. STDN coverage – Pioneer 10

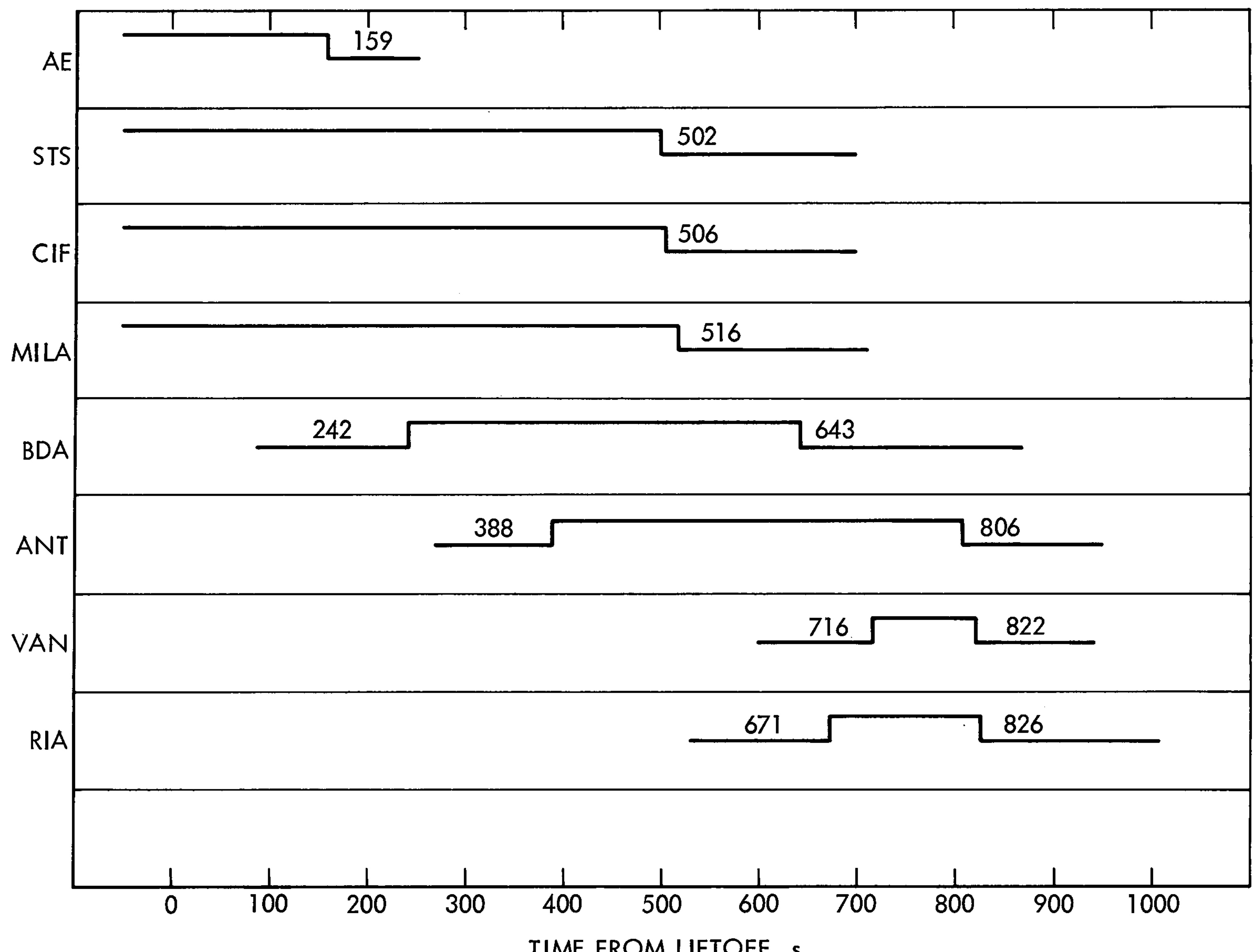


Fig. 49. AC-27 Pioneer 10 data coverage, frequency 22002.5 MHz

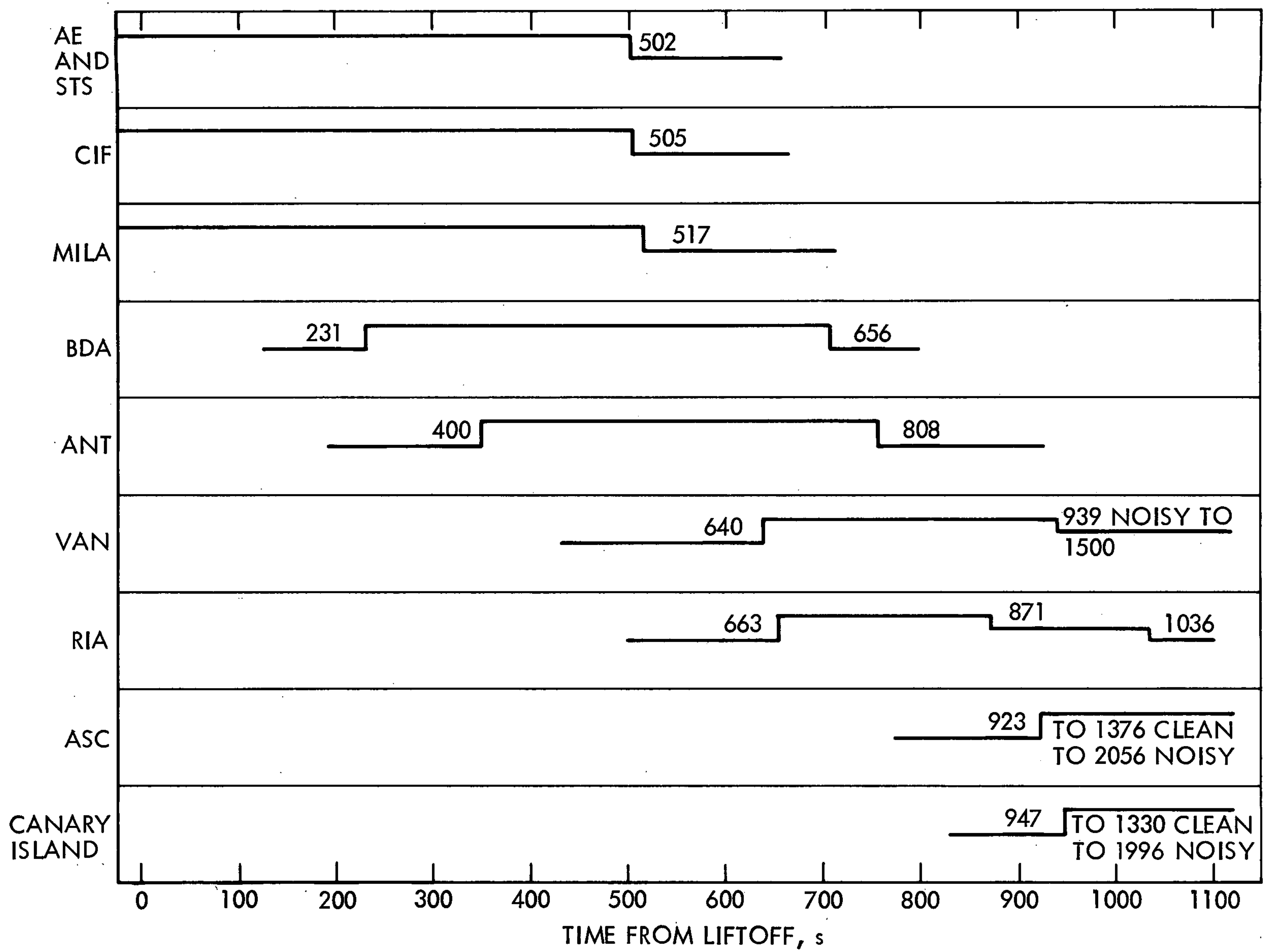


Fig. 50. AC-27 Pioneer 10 data coverage, third stage, frequency 256.2 MHz

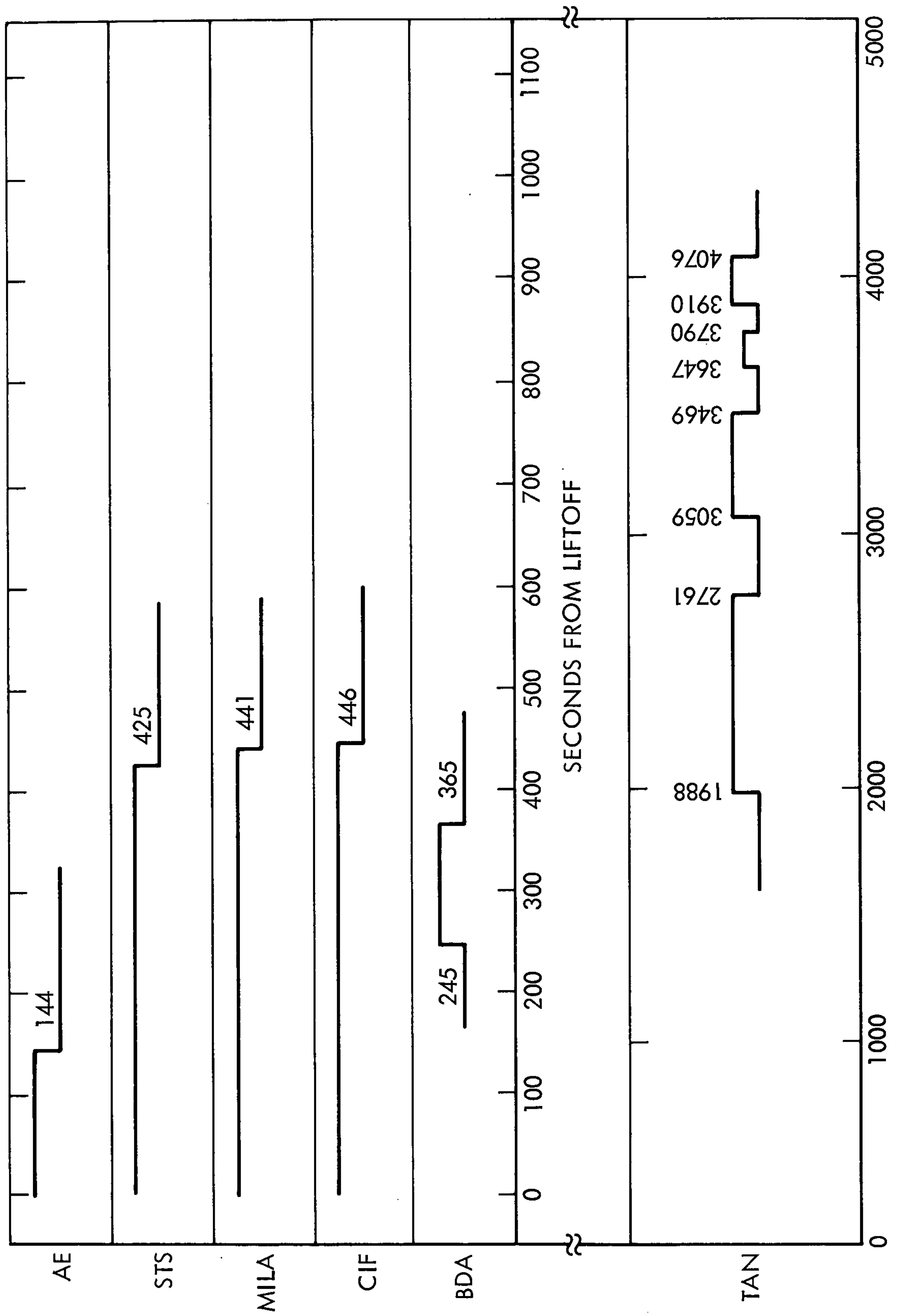


Fig. 51. AC-27 Pioneer 10 data coverage, Atlas, frequency 2215.5 MHz; Tananarive data coverage, frequency 2202.5 MHz

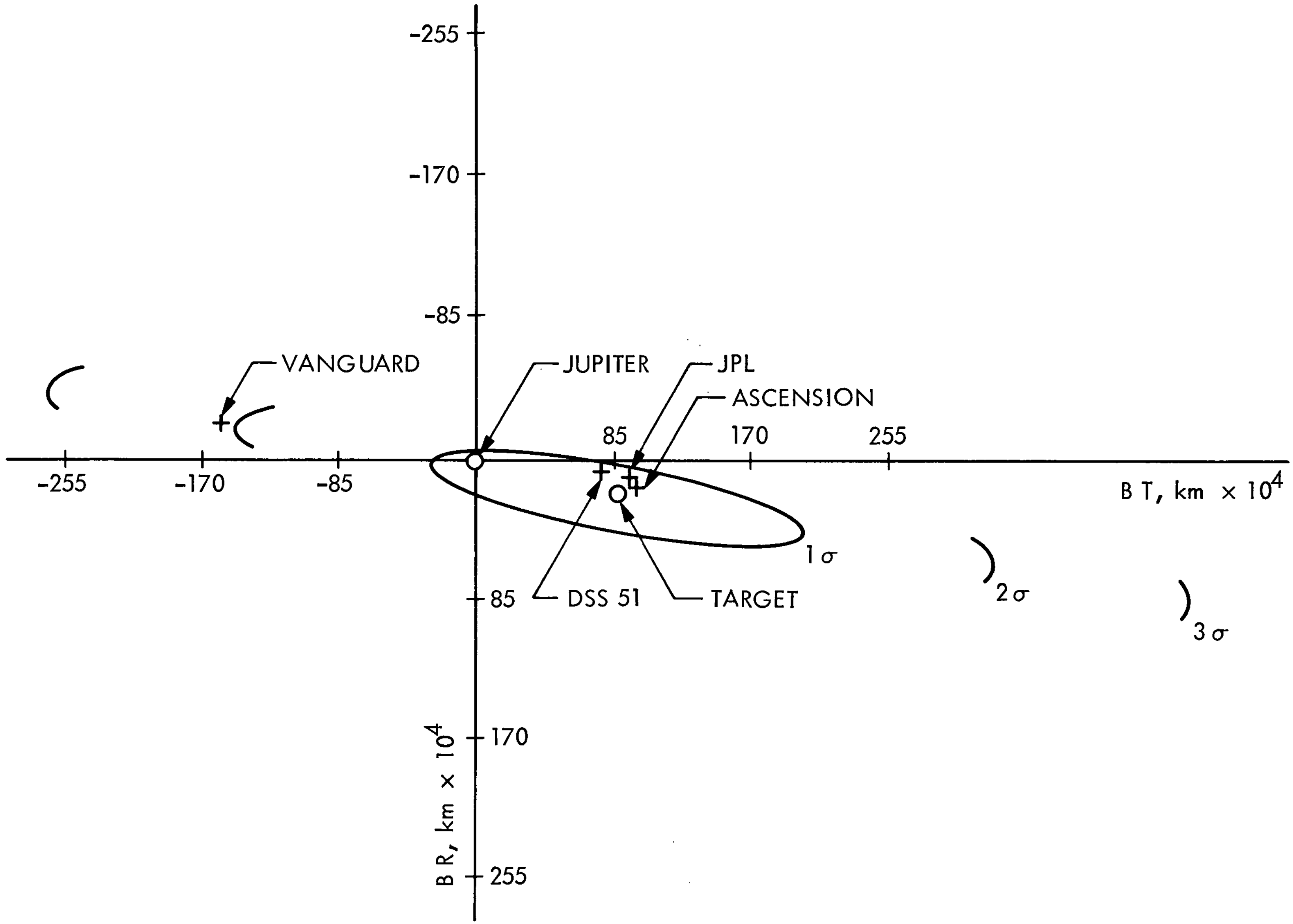


Fig. 52. Solutions to Jupiter encounter using R-S-T coordinate system (S axis is perpendicular to R and T)

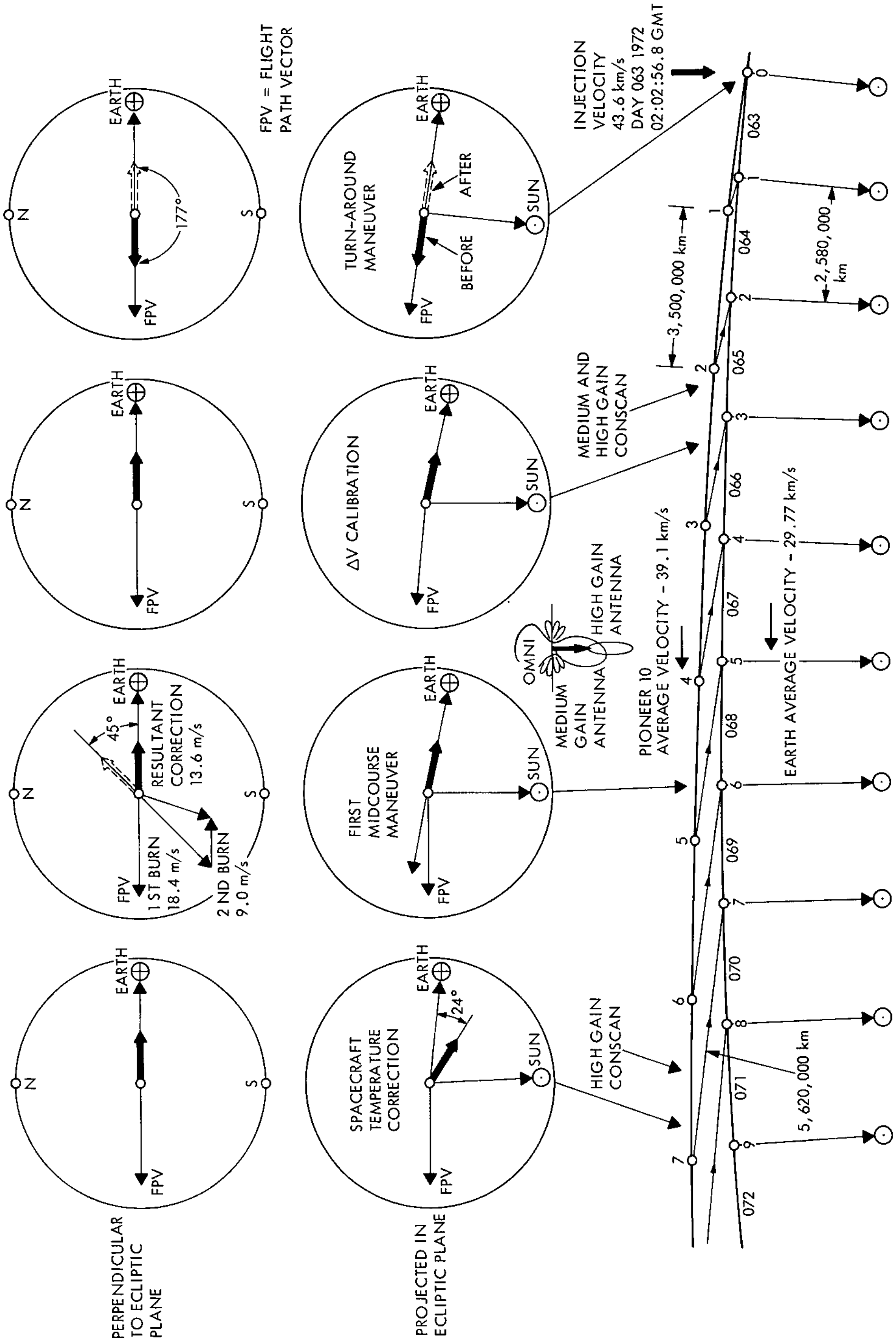


Fig. 53. Pioneer 10 initial maneuvers

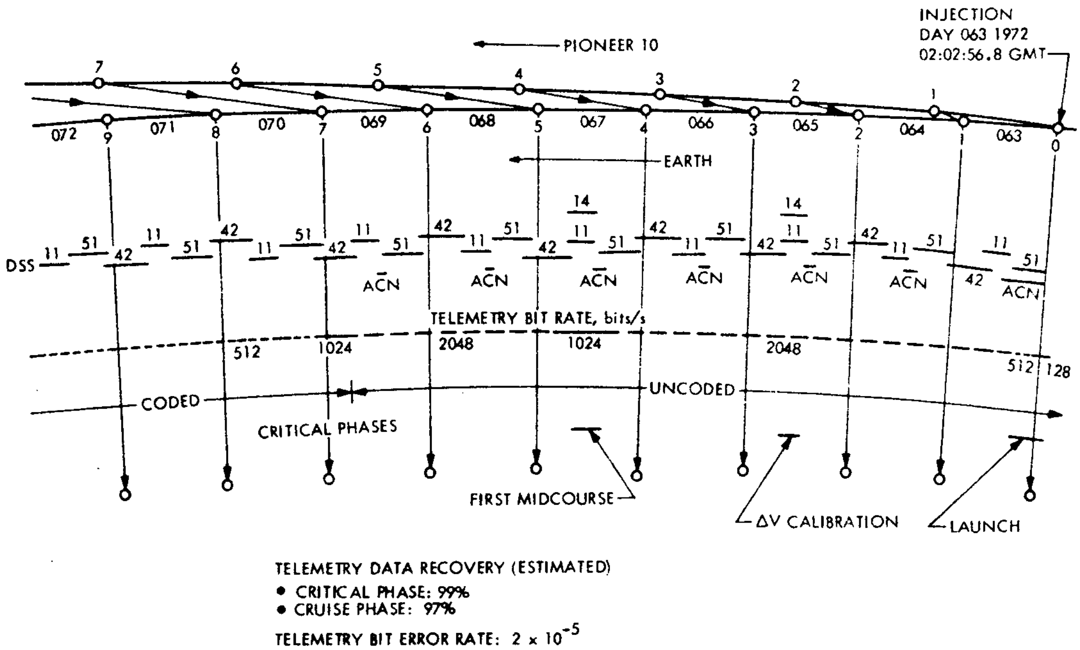


Fig. 54. DSN support

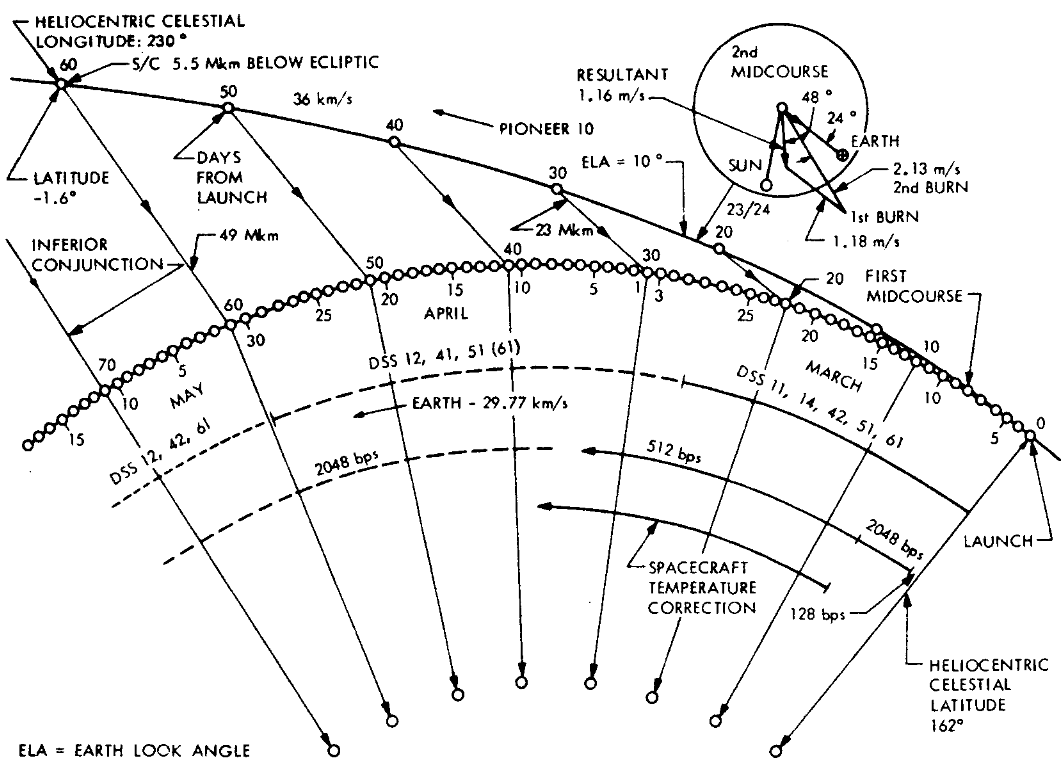


Fig. 55. Pioneer 10, first 60 days of flight

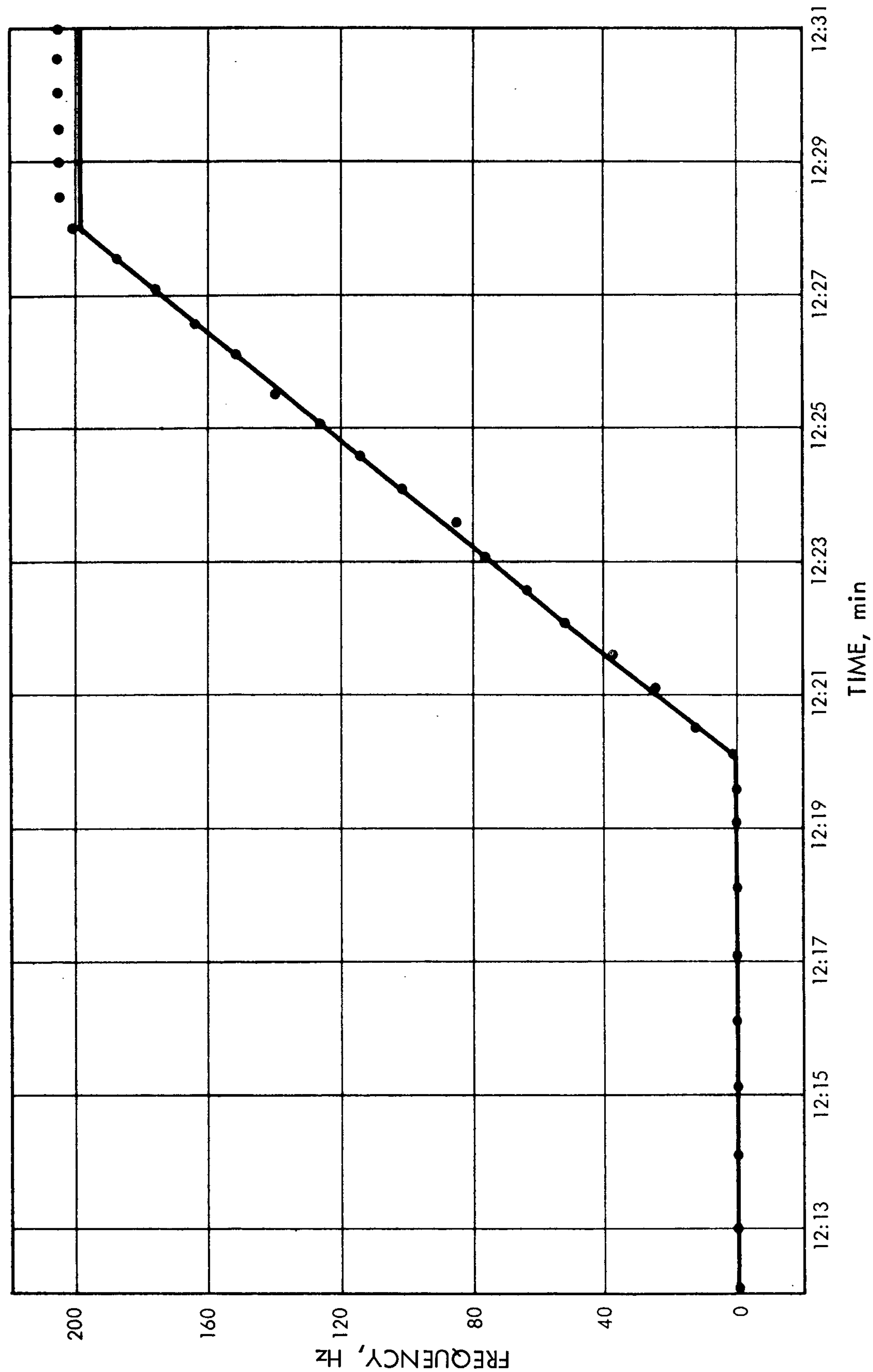


Fig. 56. First midcourse maneuver, burn No. 1

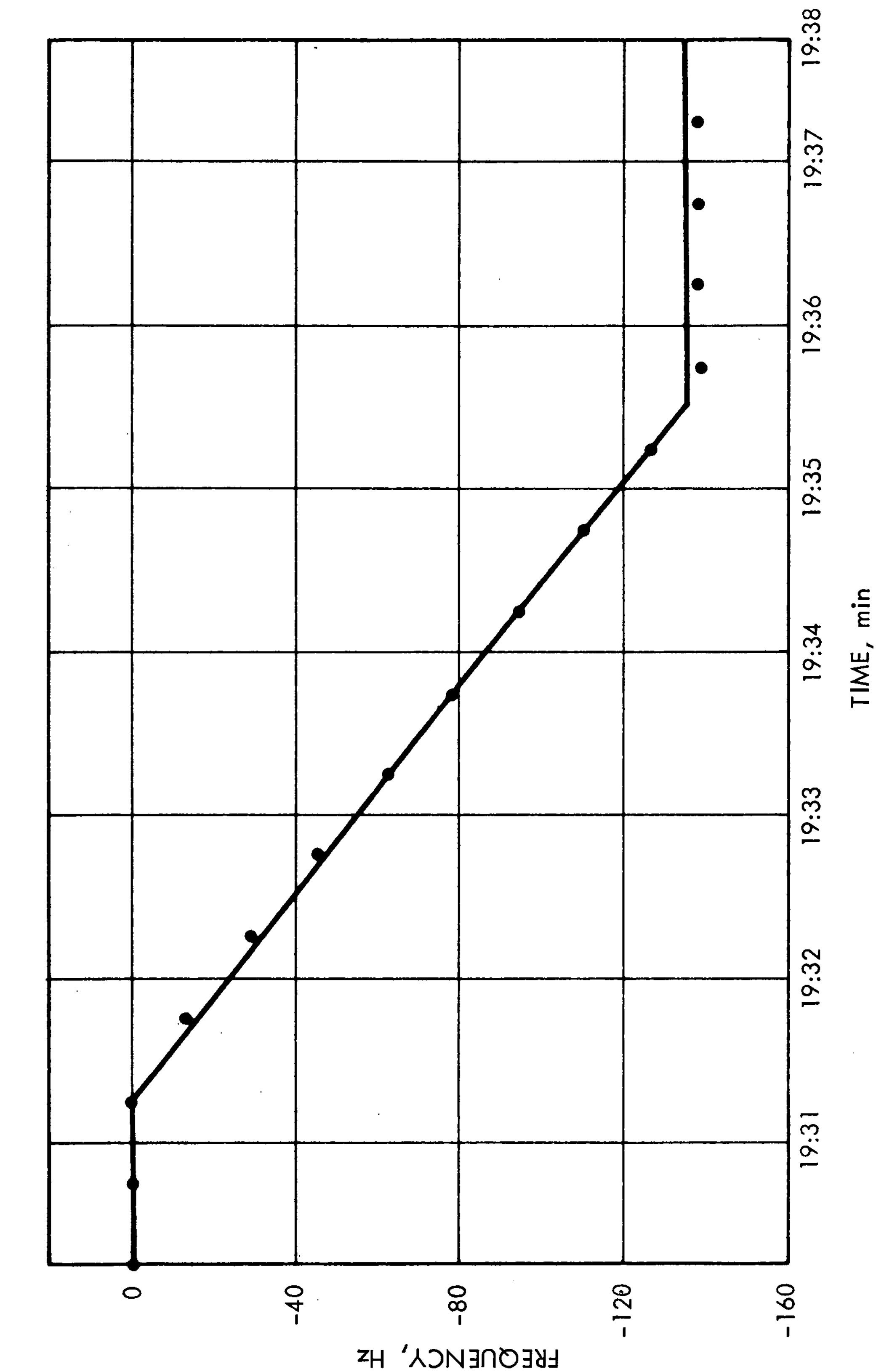


Fig. 57. First midcourse maneuver, burn No. 2

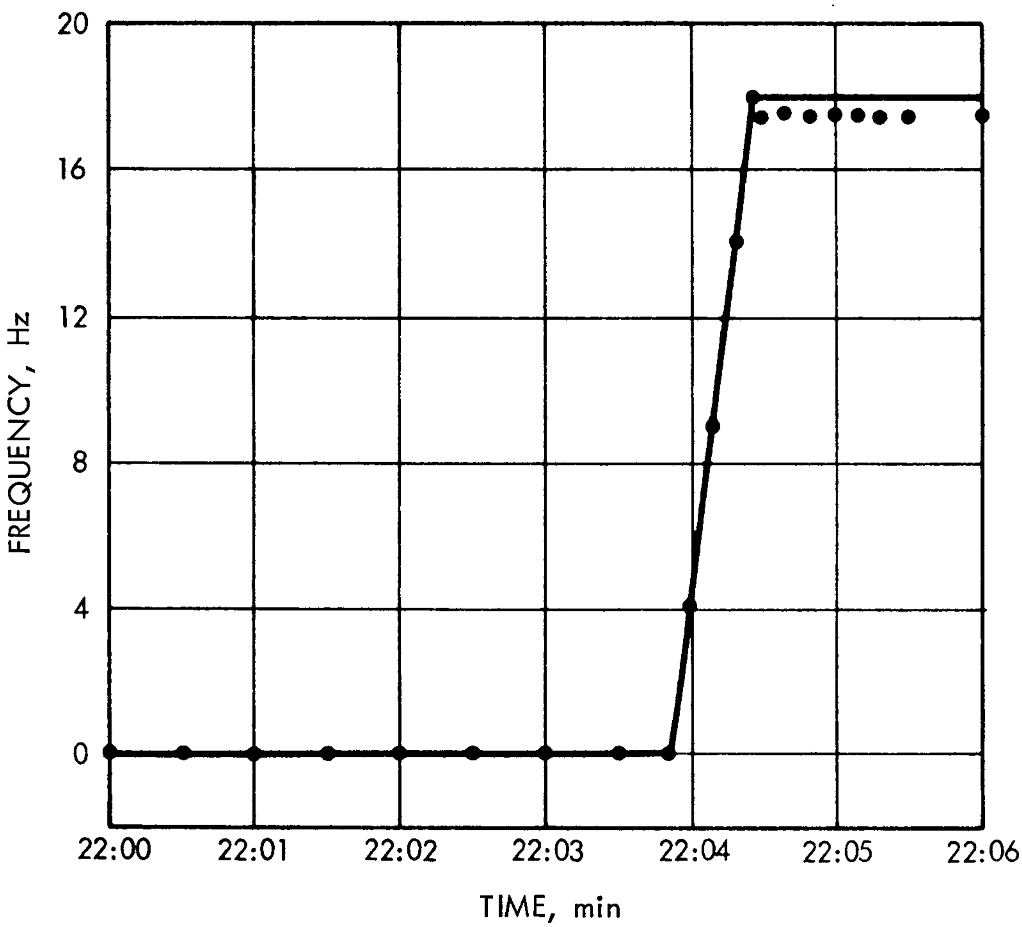


Fig. 58. Second midcourse maneuver, burn No. 1

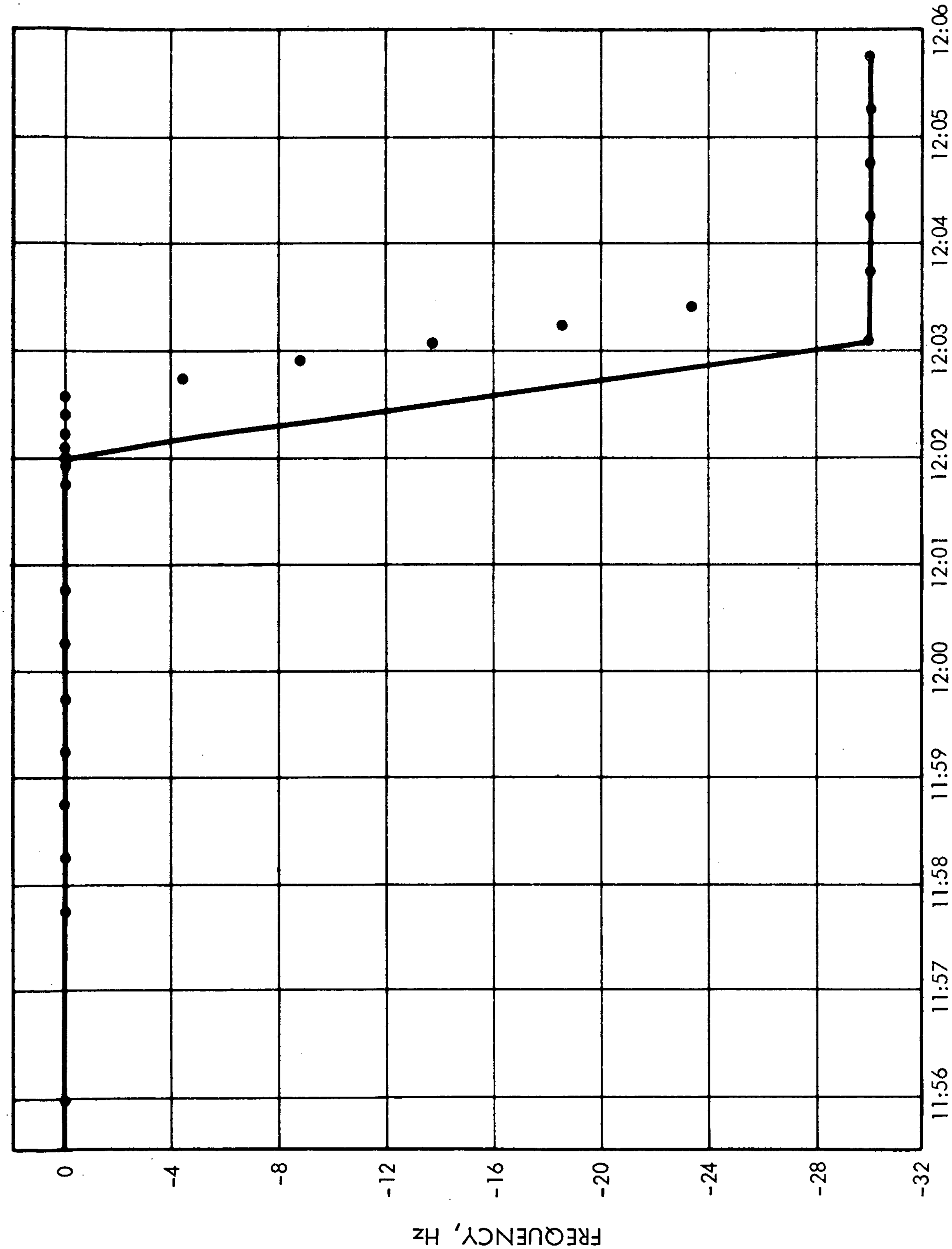


Fig. 59. Second midcourse maneuver, burn No. 2

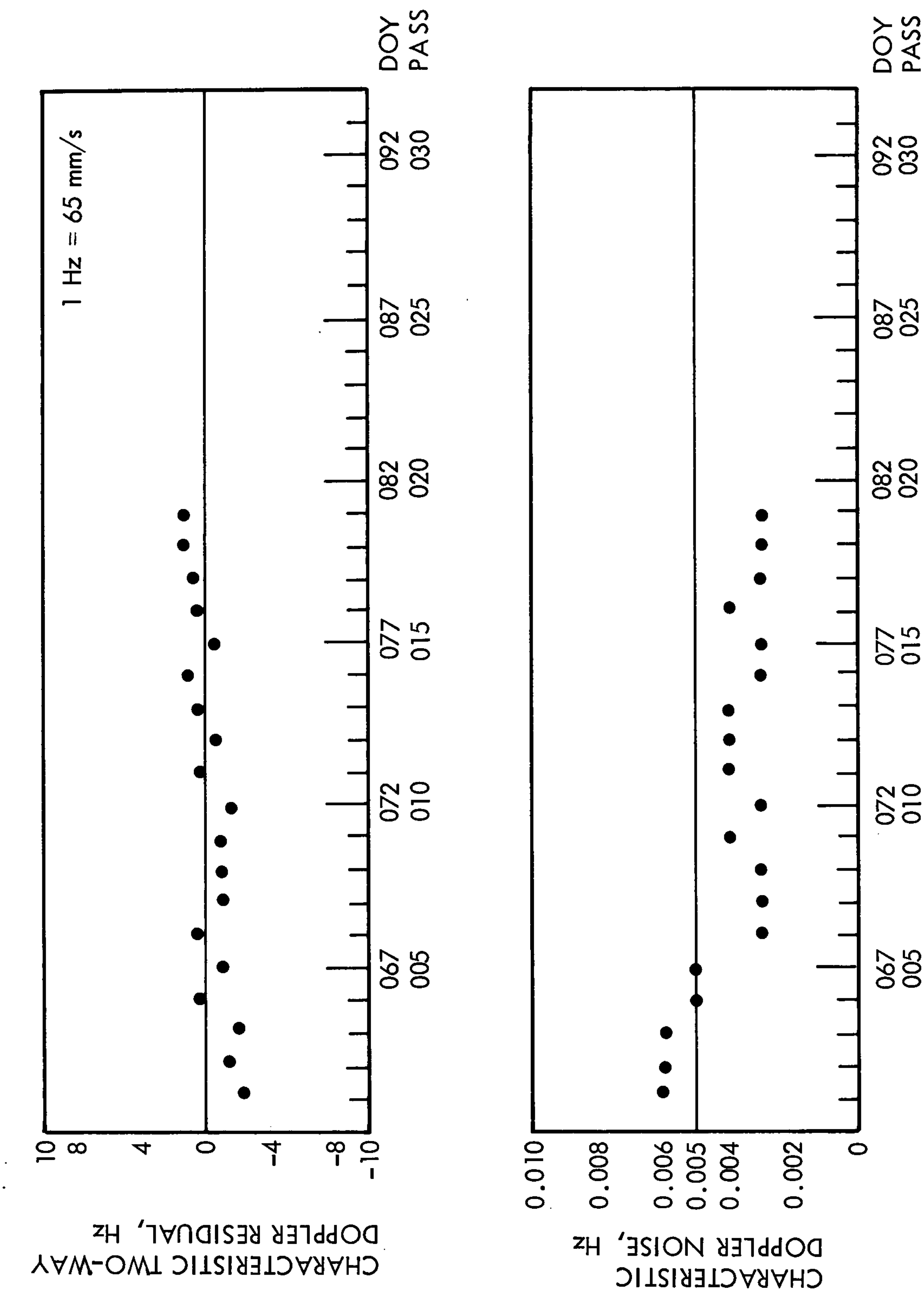


Fig. 60. Average DSS 11 residual plots for March (radio metric)

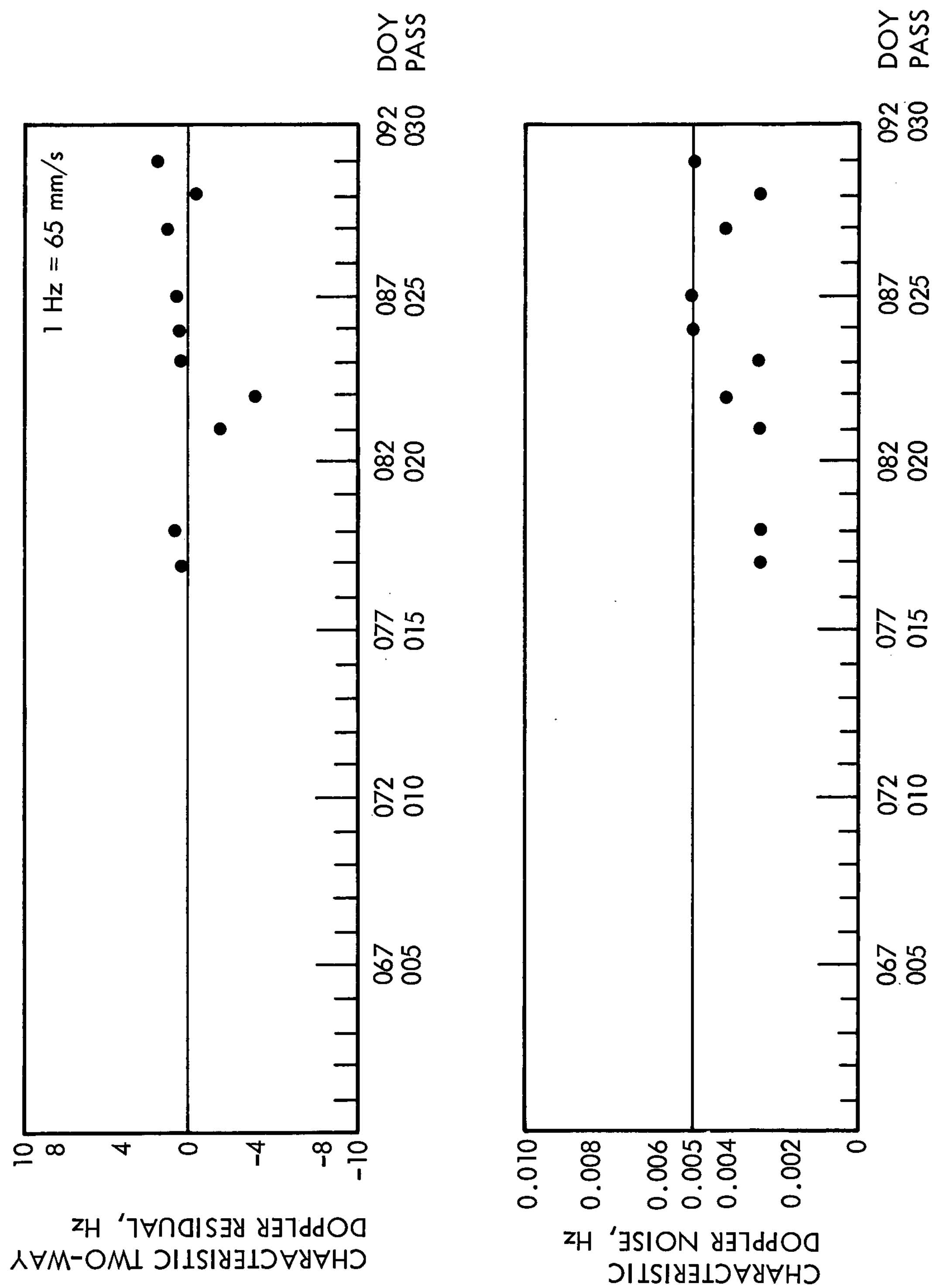


Fig. 61. Average DSS 12 residual plots for March (radio metric)

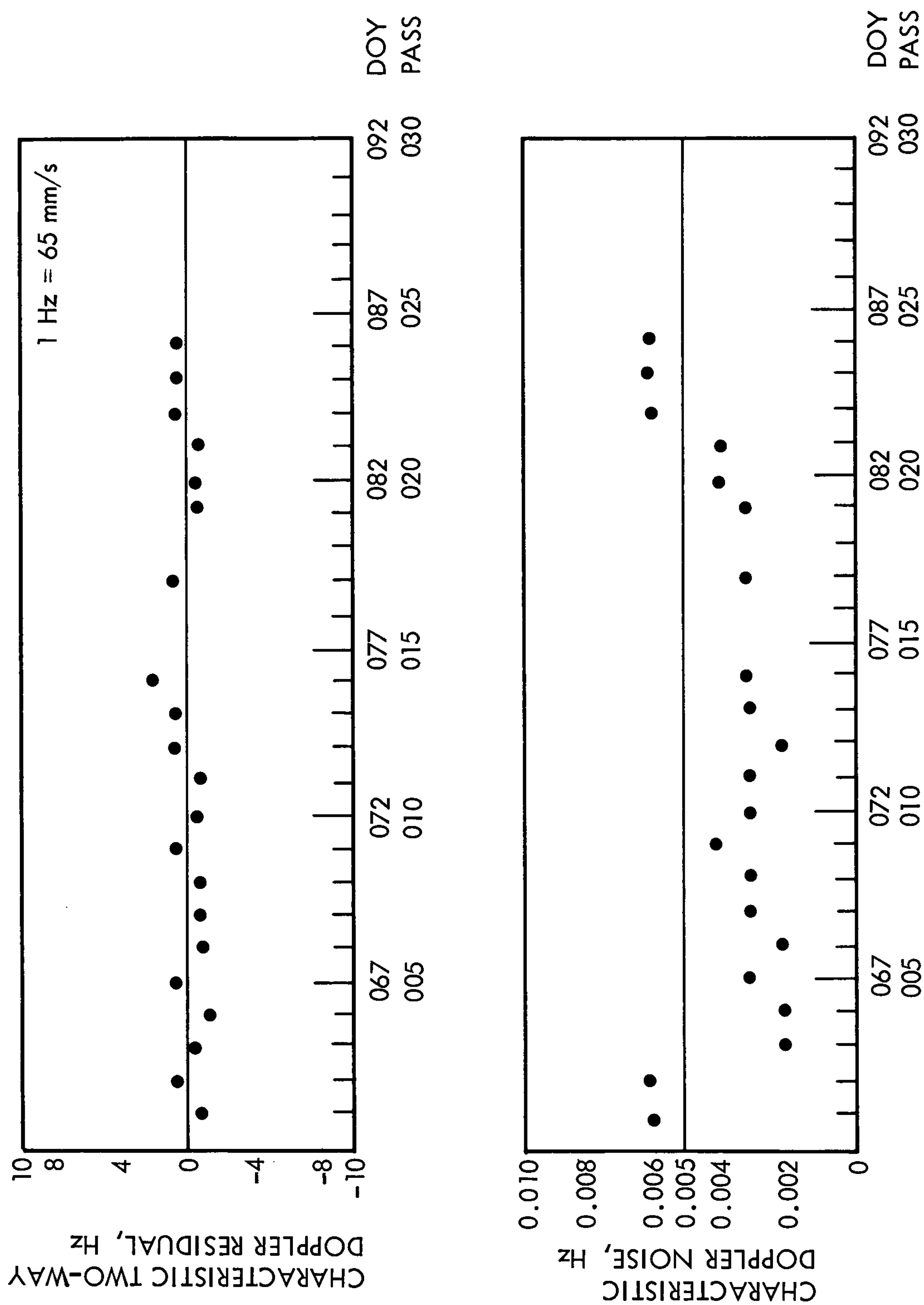


Fig. 62. Average DSS 42 residual plots for March (radio metric)

C3

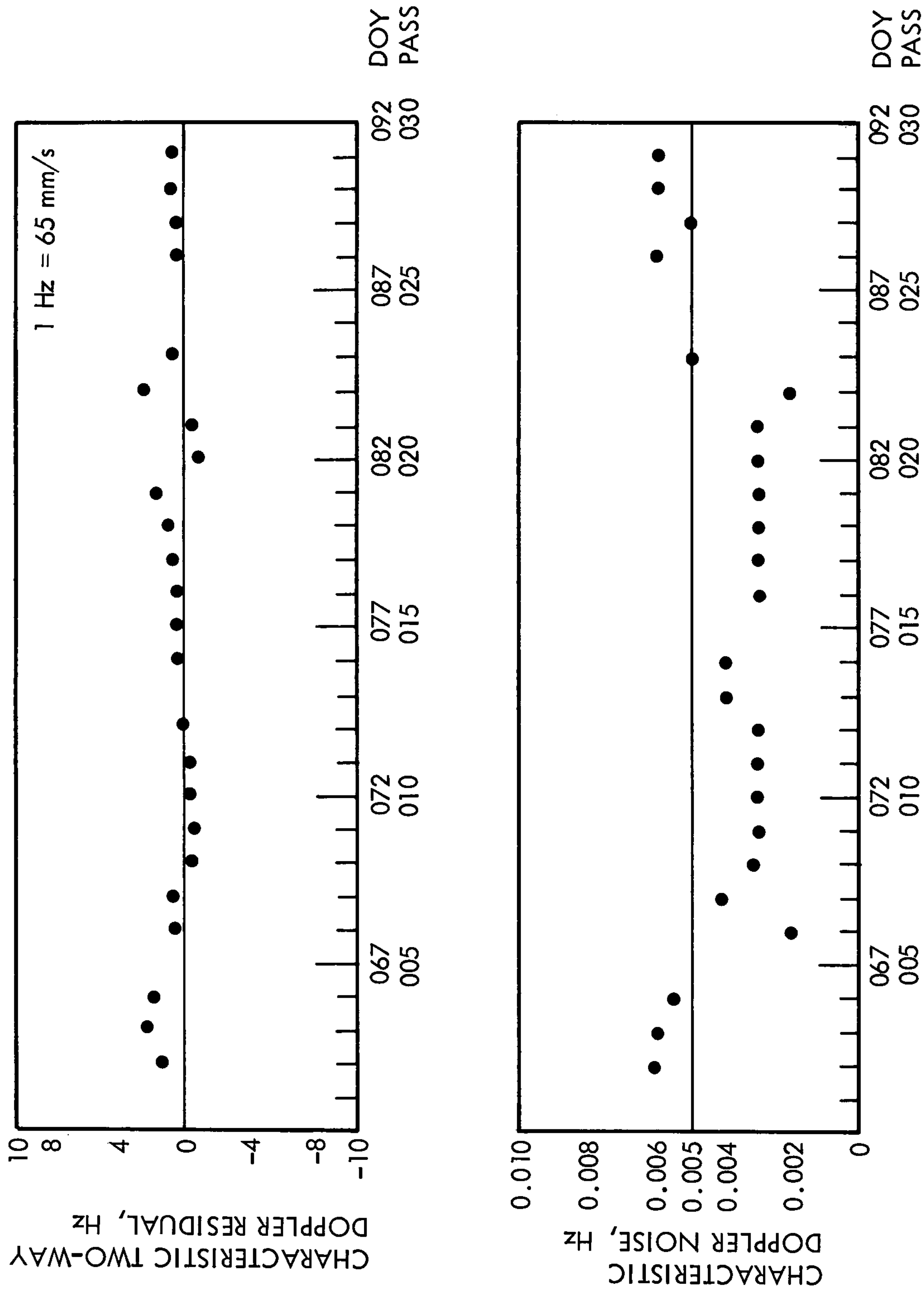


Fig. 63. Average DSS 51 residual plots for March (radio metric)

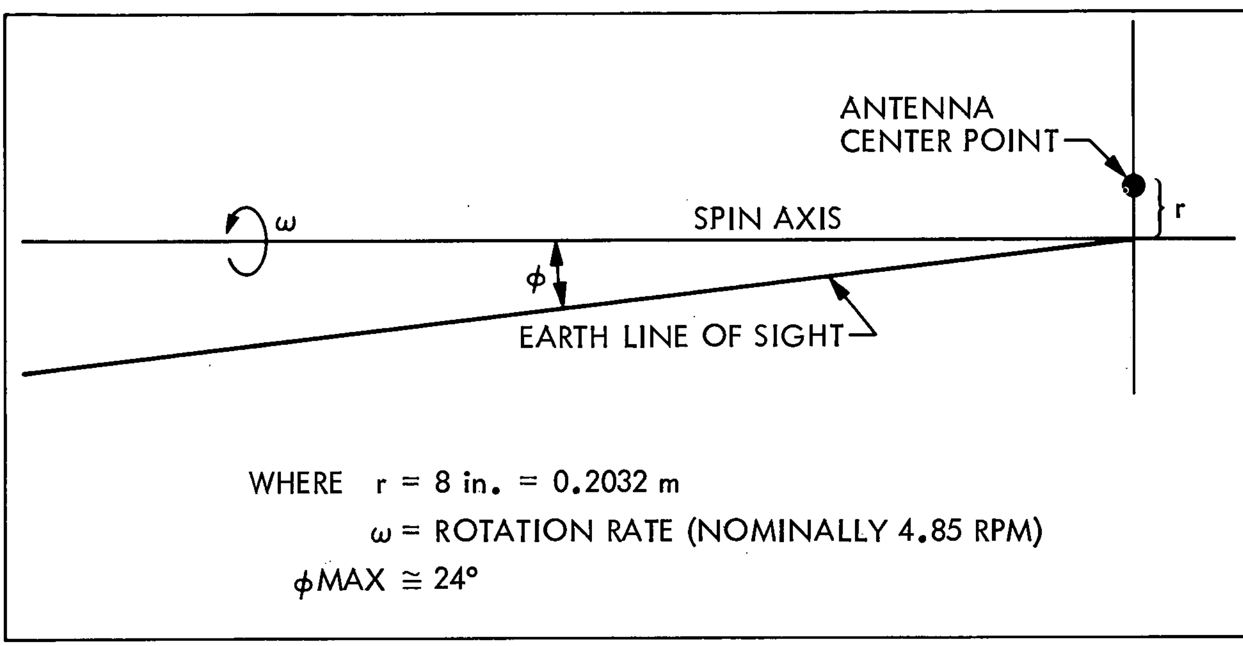


Fig. 64. Antenna geometry

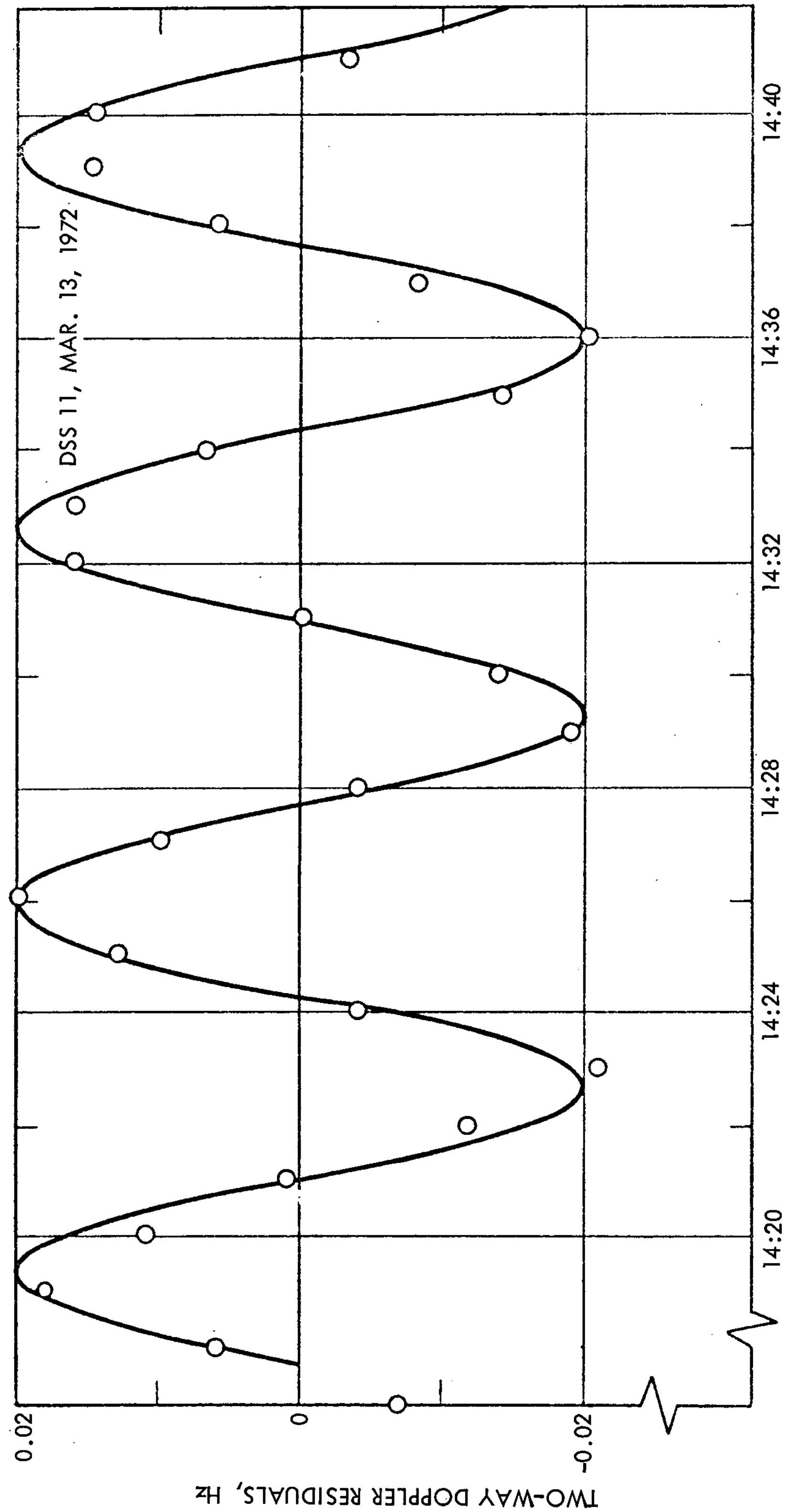


Fig. 65. Pioneer 10 two-way doppler vs time

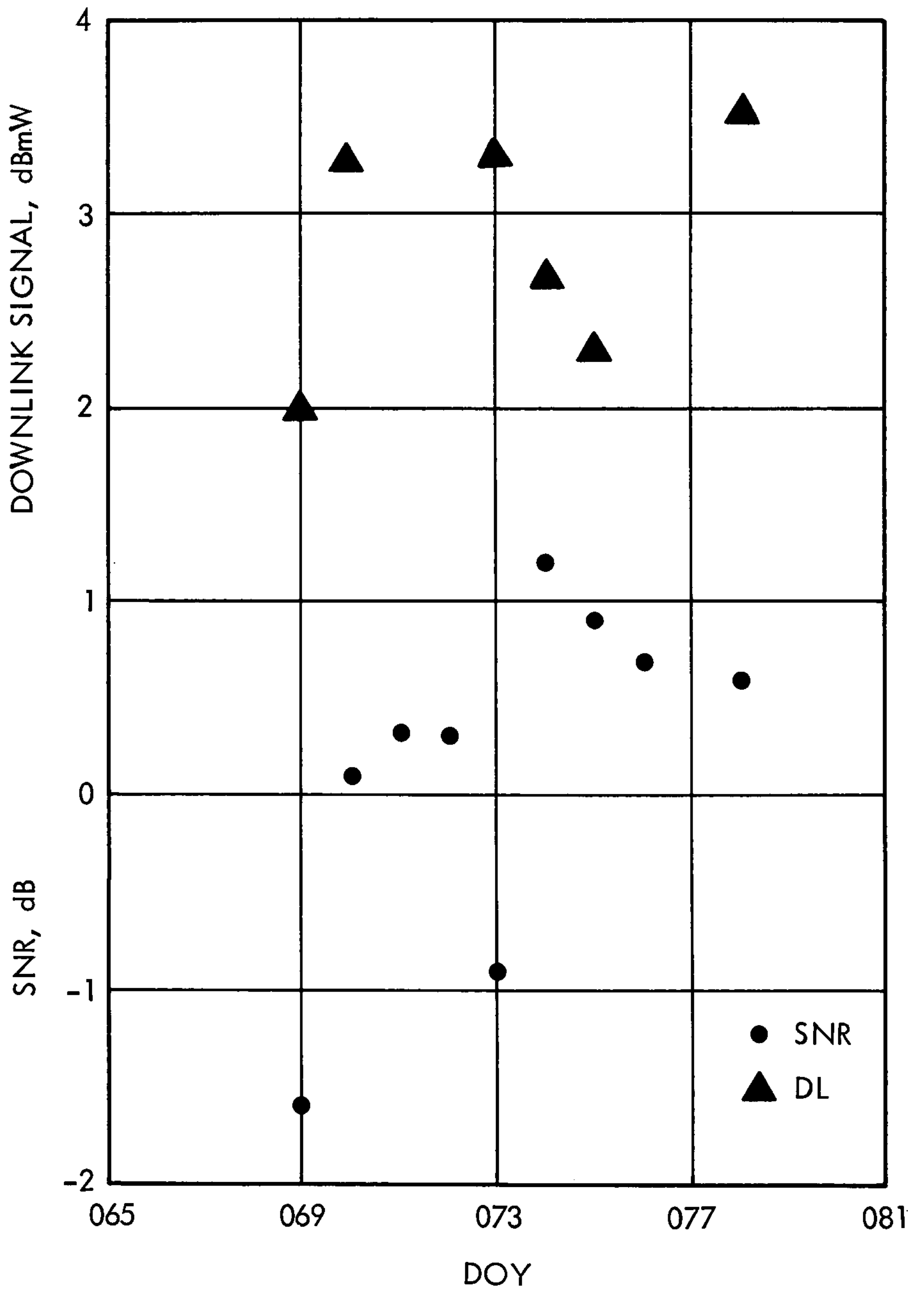


Fig. 66. DSS 11 residual data plots for Pioneer 10 (telemetry)

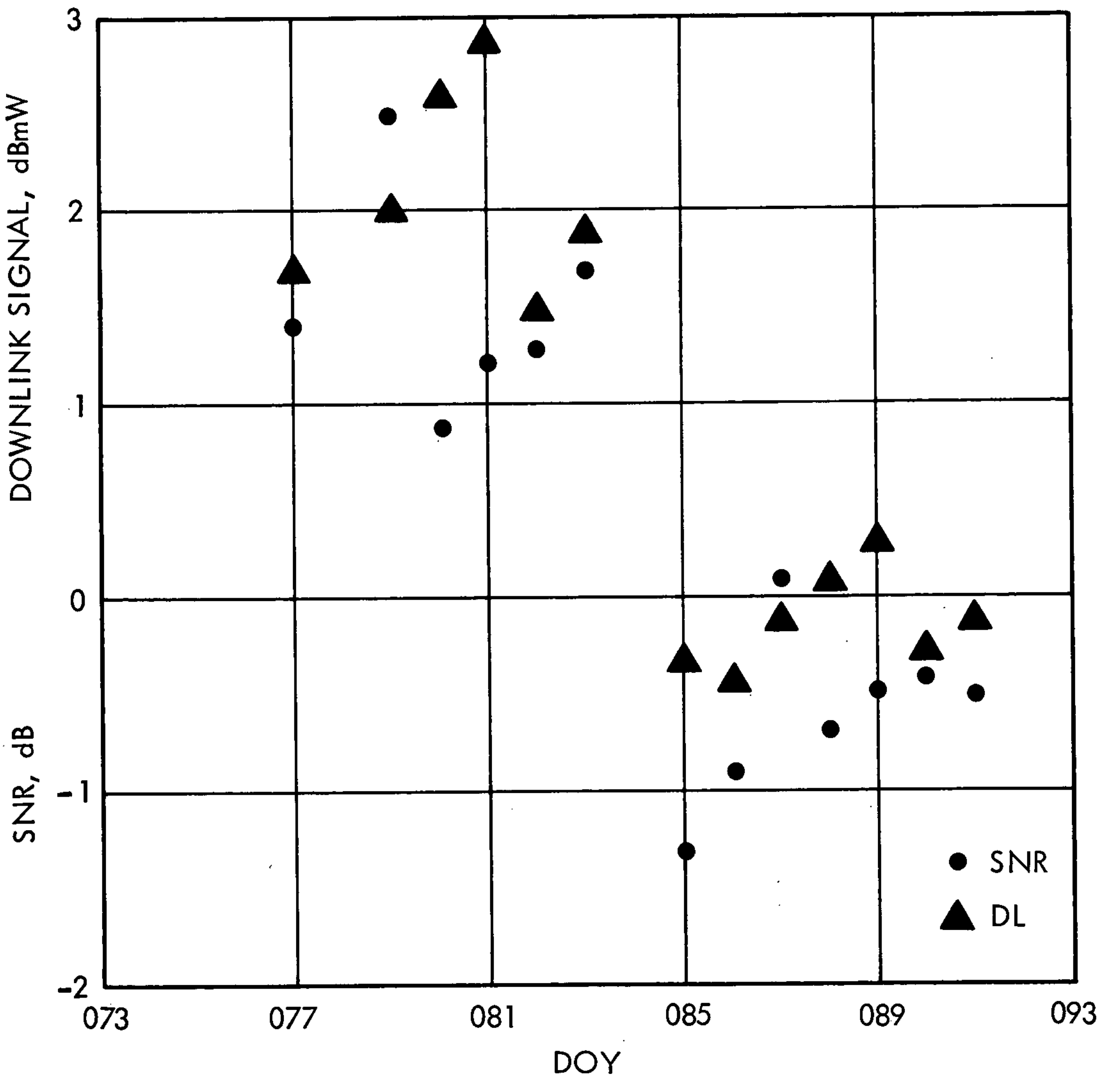


Fig. 67. DSS 12 residual data plots for Pioneer 10 (telemetry)

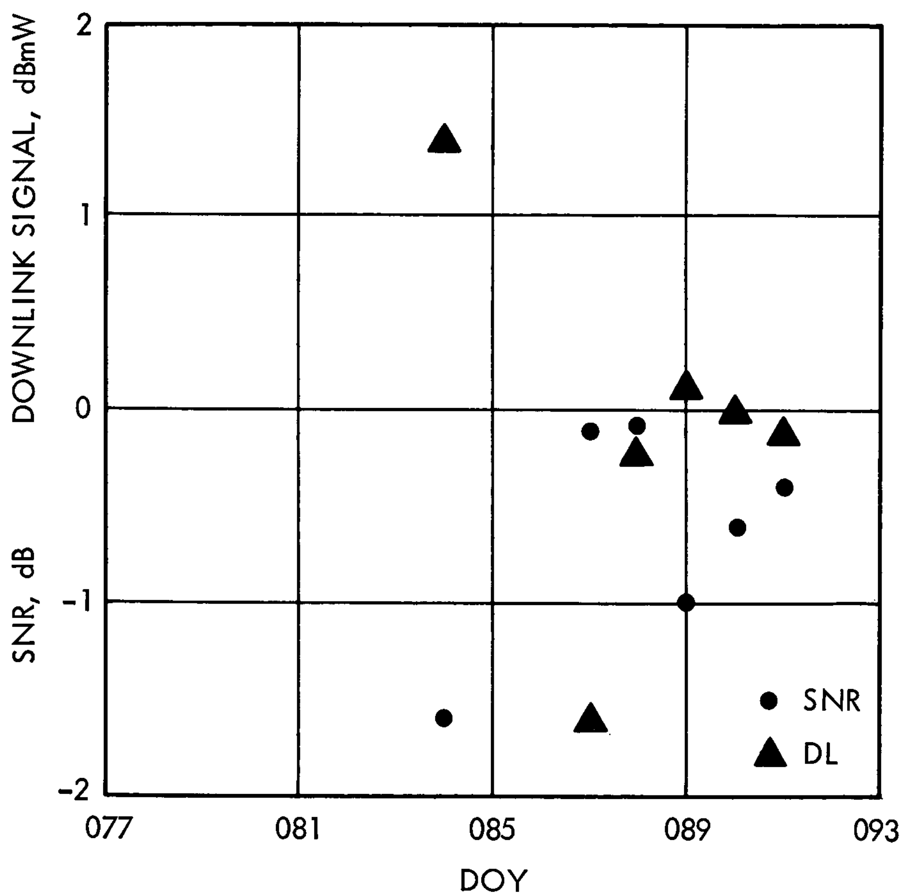


Fig. 68. DSS 41 residual data plots for Pioneer 10 (telemetry)

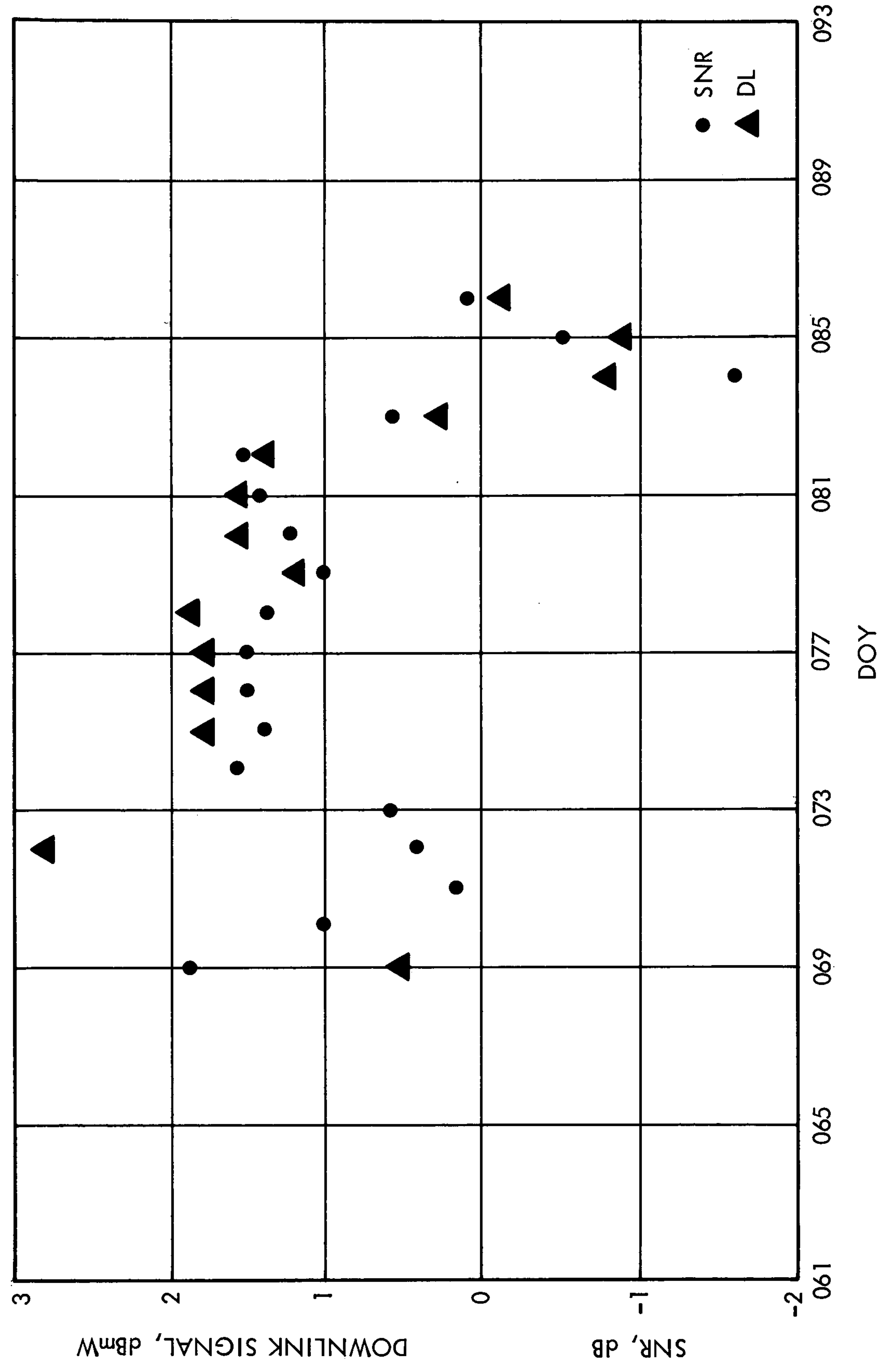


Fig. 69. DSS 42 residual data plots for Pioneer 10 (telemetry)

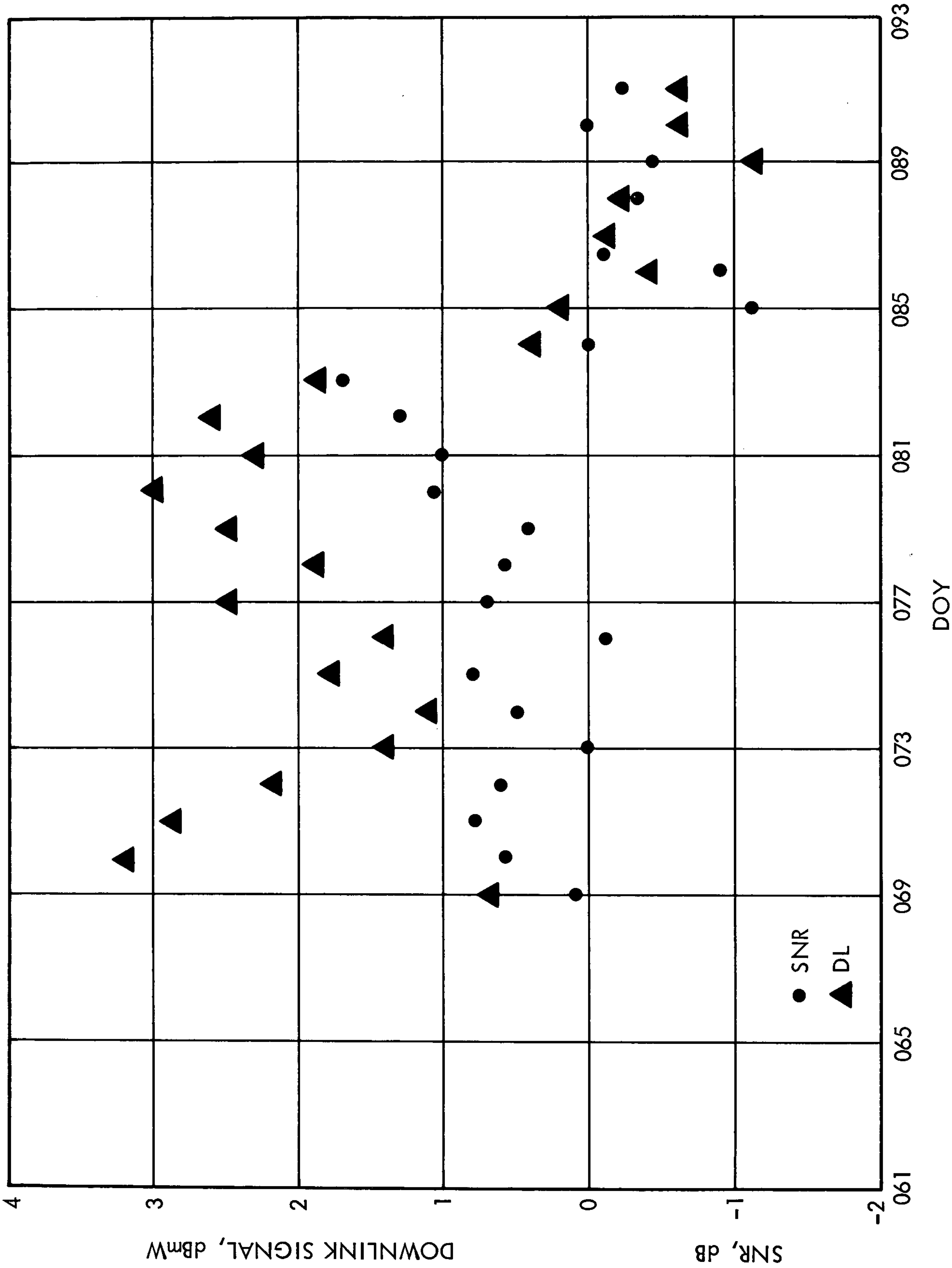


Fig. 70. DSS 51 residual data plots for Pioneer 10 (telemetry)

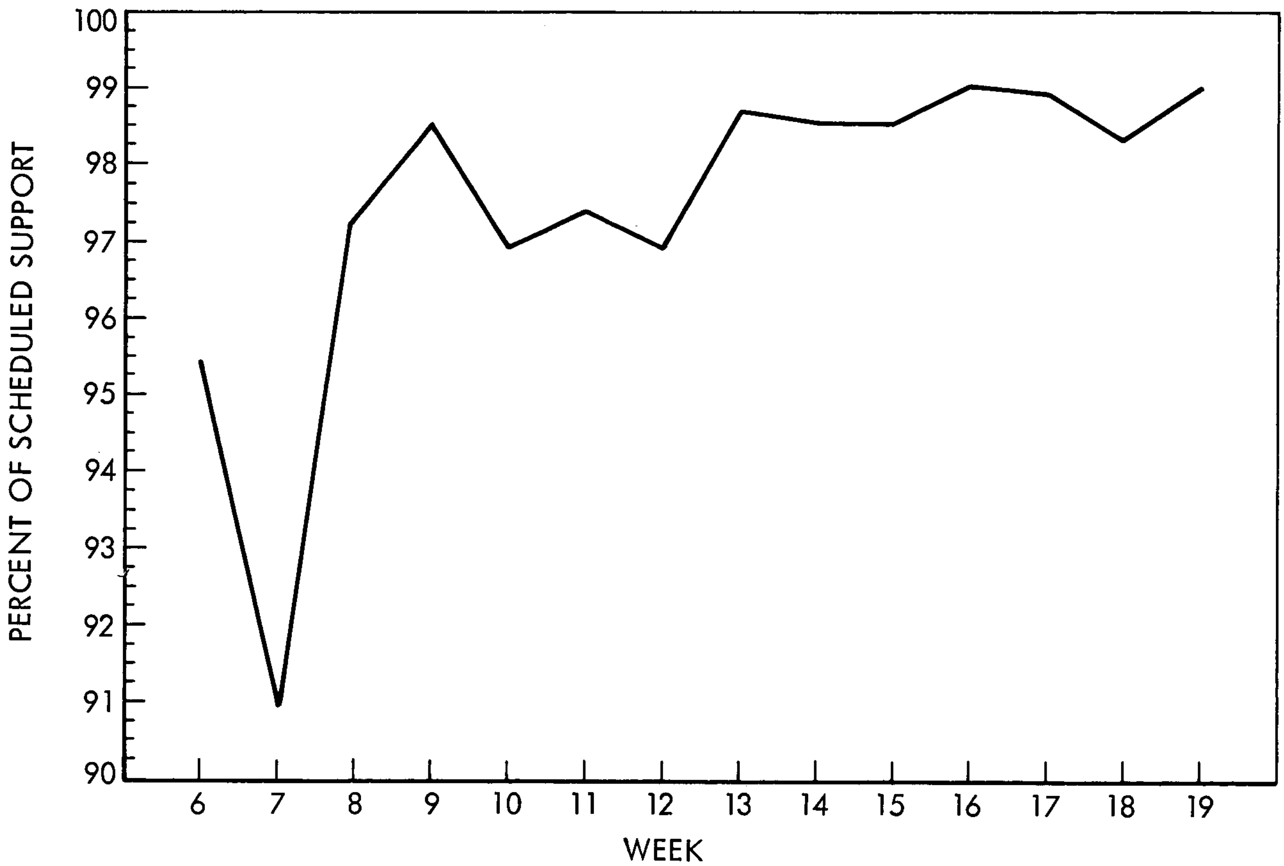


Fig. 71. Central Processing System performance percent of scheduled support

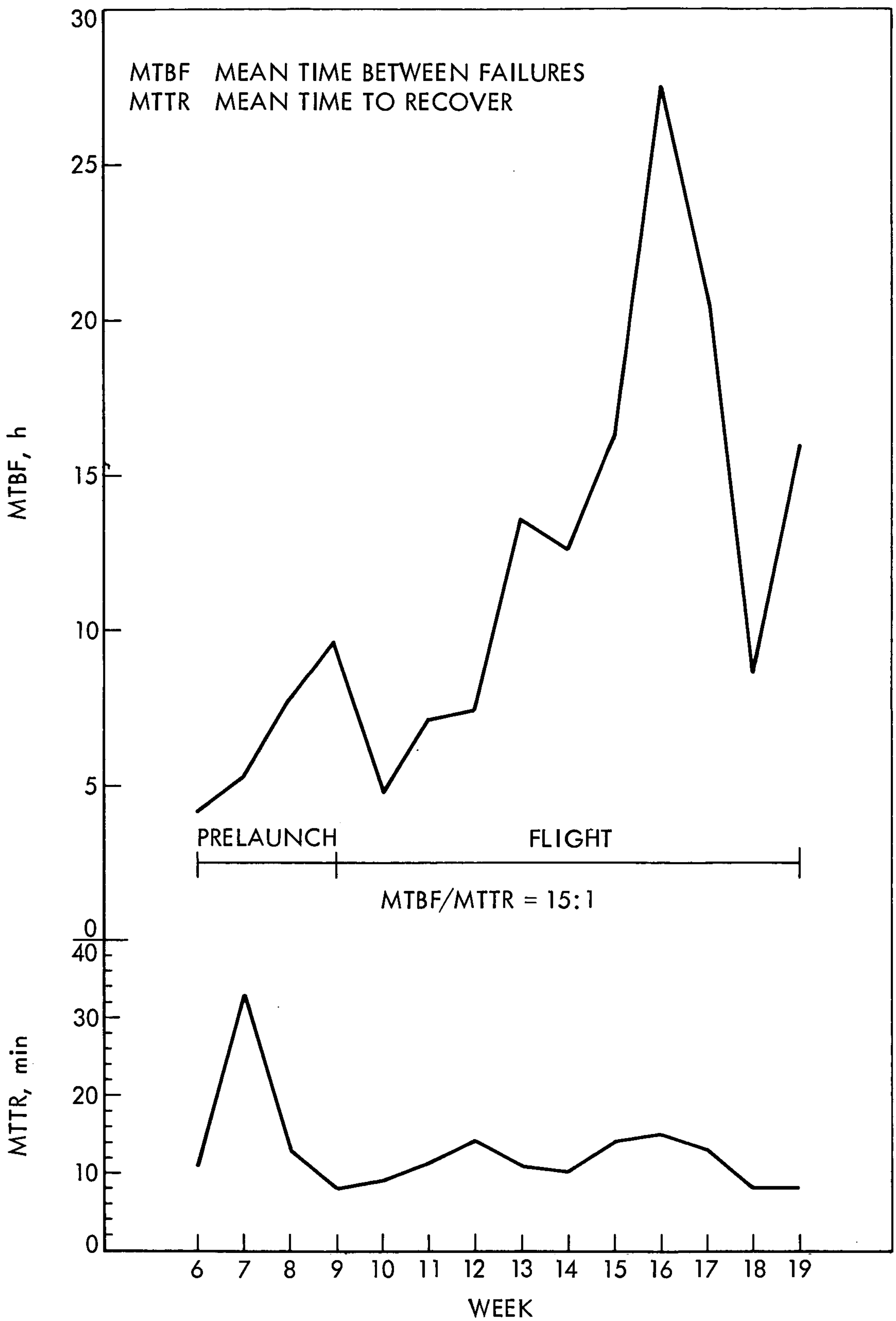


Fig. 72. Central Processing System performance

APPENDIX A

A MESSAGE FROM EARTH

I. INTRODUCTION

The following description, explanation, and history of the design of a metal plate carried aboard Pioneer 10 spacecraft as "a message from Earth" to whomever or whatever may be concerned in space was written by the plate's creators. They are: Dr. Carl Sagan, Professor of Astronomy and Director of the Laboratory for Planetary Studies, Cornell University; Linda Salzman Sagan, painter and film maker; and Dr. Frank Drake, Professor of Astronomy at Cornell University and Director of the National Astronomy and Ionosphere Center.

II. DESCRIPTION

A. Journey and Possibilities

"Pioneer 10 is the first spacecraft which will leave the solar system. Scheduled for a launch no earlier than 27 February 1972 (launch was 3 March 1972), its 630 to 790 day long flight will take it within two planetary radii of Jupiter, where, in a momentum exchange with the largest planet in the solar system, the spacecraft will be accelerated out of the solar system with a residual velocity at infinity of 11.5 km/sec. The spacecraft is designed to examine interplanetary space between the Earth and Jupiter, perform preliminary reconnaissance in the asteroid belt, and make the first closeup observations of Jupiter and its particles and fields environment.

"It seemed to us appropriate that this spacecraft, the first material object of mankind to leave the solar system, should carry some indication of the locale, epoch and nature of its builders. We do not know the likelihood that the Galaxy is filled with advanced technological societies capable of and interested in intercepting such a spacecraft. It is clear, however, that such interception is a very long-term proposition.

"With a residual interstellar velocity of 11.5 km/sec, the characteristic time for Pioneer 10 to travel one parsec (pc) — slightly less than the distance to the nearest star — is some 80,000 years. From the simplest collision physics it follows that the mean time for such a spacecraft to come within 30 astronomical units (1 AU = 1.5×10^{13} cm) of a star is much longer than the age of the Galaxy.

"Consequently there is a negligible chance that Pioneer 10 will penetrate the planetary system of a technologically advanced society. But it appears possible that some civilizations technologically much more advanced than we have the means of detecting an object such as Pioneer 10 in interstellar space, distinguishing it from other objects of comparable size but not of artificial origin, and then intercepting and acquiring the spacecraft.

"But, if the intercepting civilization is not within the immediate solar neighborhood, the epoch of such an interception can only be in the very distant future. Accordingly, we cannot see any conceivable danger in indicating our position in the Galaxy, even in the eventuality, which we consider highly unlikely, that such advanced societies would be hostile. In addition we have already sent much more rapidly moving indications of our presence and locale: the artificial radio-frequency emission which we use for our own purposes on earth."

B. The Hardware

"Erosional processes in the interstellar environment are largely unknown, but are very likely less efficient than erosion within the solar system, where a characteristic erosion rate, due largely to micrometeoritic pitting, is of the order of 1 Å/yr. Thus a plate etched to a depth $\sim 10^{-2}$ cm should survive recognizably at least to a distance ~ 10 pc, and most probably to $\gg 100$ pc. Accordingly, Pioneer 10 and any etched metal message aboard it are likely to survive for much longer periods than any of the works of Man on Earth.

"With the support of the Pioneer Project Office at NASA's Ames Research Center in Mountain View, Calif., and of NASA Headquarters in Washington, D.C., it was agreed to prepare a message on 6 × 9-in. surface of 6061 T6 gold-anodized aluminum plate, 50/1000 in. thick. The mean depth of engraving is 15/1000 in. The plate is mounted in an exterior but largely protected position on the antenna support structure, behind the ARC plasma experimental package, on the Pioneer 10 spacecraft."

C. Question of Contents

"The question of the contents of such a message is not an easy one. The message finally agreed upon (Figure A-1) is in our view an adequate but hardly ideal solution to the problem. A time interval of only three weeks

B

existed between the formulation of the idea of including a message on Pioneer 10, achieving NASA concurrence, devising the message, and delivering the draft message for engraving. We believe that any such message will be constrained, to a greater or lesser degree, by the limitation of human perceptual and logical processes. The message inadvertently contains anthropocentric content. Nevertheless we feel that an advanced technical civilization would be able to decipher it."

D. Symbols and Galactic Units

"At top left is a schematic representation of the hyperfine transition of neutral atomic hydrogen. A transition from anti-parallel nuclear and electronic spins to parallel nuclear and electronic spins is shown above the binary digit 1. So far the message does not specify whether this is a unit of length (21 cm) or a unit of time ((1420 MHz) -1). This fundamental transition of the most abundant atom in the Galaxy should be readily recognizable to the physicists of other civilizations. As a cross-check, we have indicated the binary equivalent of the decimal number 8 along the right-hand margin, between two tote marks corresponding to the height of the human beings shown. The Pioneer 10 spacecraft is displayed behind the human beings and to the same scale. A society which intercepts the spacecraft will of course be able to measure its dimensions, and determine what corresponds to 8 × 21 cm, the characteristic dimensions of the spacecraft.

"With this first unit of space or time specified, we now consider the radial pattern at left center. This is in fact a polar coordinate representation of the positions of some objects about some origin, with this interpretation being a probable, but not certain, initial hypothesis to scientists elsewhere. The two most likely origins in an astronomical interpretation would be the home star of the launch civilization and the center of the Galaxy. There are 15 lines emanating from the origin, corresponding to 15 objects. Fourteen of these objects have a long binary number attached, corresponding to a 10-digit number in decimal notation. The large number of digits is the key that these numbers indicate time intervals, not distances or some other quantity. A civilization at our level of technology (as evinced from the Pioneer 10 spacecraft itself) will not know the distance to galactic objects useful for direction-finding to 10 significant figures; and, even if we did, the proper motion of such objects within the Galaxy would render this degree of precision pointless. There are no other conceivable quantities which we might know to 10 significant figures for relatively distant cosmic objects. The numbers attached to the 14 objects are therefore most plausibly time intervals. From the unit of time, the indicated time intervals are all ~ 0.1 sec.

"For what objects might a civilization at our level of advance know time periods ~ 0.1 sec to 10 significant figures? Pulsars are the obvious answer. Since pulsars are running down at largely known rates they can be used as galactic clocks for time intervals of hundreds of millions of years. The radial pattern therefore must indicate the positions (obtained by us from the observed dispersion measures) and periods at the launch epoch of 14 pulsars, plus one additional object which is the most distant."

E. Locale and Epoch

"The problem thus reduces to searching the astronomical records to find a locale and epoch within the galaxy at which 14 pulsars were in evidence with the denoted periods and relative coordinates. Because the message is so overspecified, and because the pulsar periods are given to such precision, we believe that this is not an extremely difficult computer task, even with time intervals $\gg 10^6$ years between launch and recovery.

"The pulsars utilized, with their periods in seconds and in units of the hydrogen hyperfine transition, are indicated in Table A-1. The hyperfine period of $(1.420405752 \times 10^9 \text{ sec}^{-1})^{-1}$, a fraction of a nanosecond, is just small enough that all the known digits of the pulsar periods can just be written to the left of the decimal point. Accordingly decimals and fractions are entirely avoided with no loss of accuracy and without many non-informative digits.

"The presence of several consecutive terminal zeros (Table A-1), particularly in pulsars 1240 and 1727, imply that for these two pulsars we have given a precision greater than we now have. The problem of which end of a number is the most significant digit is expressed automatically in this formulation, since all binary numbers start with a 1 but end in a 1 or a 0.

"The binary notation, in addition to being the simplest, is selected in order to produce a message which can suffer considerable erosion and still be readable. In principle the reader only need determine that there were two varieties of symbols present, and the spacings alone will lead to a correct reconstruction of the number."

F. Pulsar Periods

"Those radial lines for which the Earth-pulsar distance is not accurately known are shown with breaks. All three spatial coordinates of the pulsars are indicated. The (r, θ) coordinates are given in the usual polar projection. The tick marks near the ends of the radial lines give the z coordinate normal to the galactic plane, with the distances measured from the far end of the line.

"The reconstruction of pulsar periods will indicate that the origin of (r, θ) coordinates is not the center of the Galaxy. Accordingly the long line extending to the right, behind the human beings, and which is not accompanied by a pulsar period, should be identifiable as the distance to the galactic center. Since the tick mark of this line is precisely at its end, this should simultaneously confirm that the ticks denote the galactic z coordinate and that the longest line represents the distance from the launch planet to the galactic center. The tick marks were intended to be asymmetric about the radial distance lines, in order to give the sign of the galactic latitude or z coordinate. In the execution of the message this convention was inadvertently breached. But the size of the z coordinate should be easily deductible without this aid. There is an initial ambiguity about whether the (r, θ) presentation is from the North or South Galactic Pole, but this ambiguity would be resolved as soon as even one pulsar was identified."

G. Selection of Pulsars

"The 14 pulsars denoted have been chosen to include the shortest period pulsars which give the greatest longevity and the greatest luminosity; they are, therefore, the pulsars of greatest use in this problem where interception of the message occurs only in the far future. They are also selected to be distributed as evenly as possible in galactic longitude. Included are both pulsars in the vicinity of the Crab Nebula; the second (PSR 0525) has the longest known period. Fourteen pulsars were included to provide redundancy for any position and time solutions, but also to allow for the good possibility that pulsar emission is highly beamed and that not all pulsars are visible at all view angles. We expect that some of the 14 would be observable from all locales.

"In addition a very advanced civilization might have information on astronomy from other locales in the Galaxy. If the spacecraft is intercepted after only a few tens of millions of years (having travelled several hundred pc), all 14 pulsars may still be detectable."

H. Reconstruction of Epoch

"The reconstruction of the epoch in which the message was devised should be performable to high precision: With 14 periods, almost all of which are accurate to 9 significant figures in decimal equivalent, a society which has detailed records of past pulsar behavior should be able to reconstruct the epoch of launch to the equivalent of the year 1971.

"If past records of pulsar 'glitches,' discontinuities in the period, are not kept, it should still be possible to reconstruct the epoch to the nearest century or millenium.

"Fortuitously, two of the pulsars are very near Earth. If either are correctly identified, they can be used to place the position of our solar system in the galaxy to approximately 20 pc, thereby specifying our location to approximately one in 10^3 stars."

I. Solar System Schematic

"To specify our position to greater accuracy, we have included a schematic solar system at the bottom of the diagram. Because of the limited plate dimensions, the solar system was engraved with the planets not in the solar equatorial plane. (If this were an accurate representation of our solar system, it would identify it very well indeed!)

"Relative distances of the planets are indicated in binary notation above or below each planet. The serifs on the binary 'ones' are presented to stress that the units are different from those of pulsar length and period. The numbers represent the semi-major axes of the planetary orbits in units of one-tenth the semi-major axis of the orbit of Mercury, or 0.0387 AU, approximately. There is no way for this unit of length to be deciphered in the message, but the schematic size and relative distances — given to three significant figures in decimal equivalent — of the planets in our solar system, as well as the schematic representation of the rings of Saturn seen edge-on, should easily distinguish our solar system from the few thousand nearest stars if they have been surveyed once.

"Also indicated is a schematic trajectory of the Pioneer 10 spacecraft; passing by Jupiter and leaving the solar system. Its antenna is shown pointing approximately back at Earth. The cross-correlation between this stage of solar system exploration and the instrumentation and electronics of the Pioneer 10 spacecraft itself should specify the level of contemporary human technology with some precision."

J. Man and Woman

"The message is completed by a representation at right of a man and woman before a schematic Pioneer 10 spacecraft, drawn to scale. The absolute dimensions of the human beings are specified in two ways: by comparison with the Pioneer 10 spacecraft and in units of the wavelength of the hyperfine transition of hydrogen, as described.

"It is not clear how much evolutionary or anthropological information can be deduced from such a sketch drawing. Ten fingers and ten toes may provide a clue to man's arboreal ancestry, and the fact that the distance of Mercury from the Sun is given as 10 units may be a clue to the development of counting. It seems likely, if the interceptor society has not had previous contact with organisms similar to human beings, that many of the body characteristics shown will prove deeply mysterious."

K. Rejections

"We rejected many alternative representations of human beings for a variety of reasons; for example, we do not shown them holding hands lest one rather than two organisms be deduced. With a set of human representations to this degree of detail, it was not possible to avoid some racial stereotypes, but we hope that this man and woman will be considered representative of all of mankind. A raised outstretched right hand has been indicated as a universal symbol of good will in many human writings; we doubt any literal universality, but have included it for want of a better symbol. It has at least the advantage of displaying an opposable thumb.

"Among the large number of alternative message contents considered and rejected, in the short period of time we pondered the problem, were radioactive time markers (rejected because of interference with the Pioneer radiation detectors), star map position indicators (rejected because of stellar proper motions and serious data handling problems in decoding), and schematic representations of the vascular, neurological, or muscular apparatus of human beings or some indication of the number of cortical neural connections (rejected because of the ambiguity of the envisioned representations). It is nevertheless clear that the message can be improved upon; and we hope that future spacecraft launched beyond the solar system will carry such improved messages."

L. Hopeful Symbol

"This message then is a first attempt to specify our position in the Galaxy, our epoch and something of our nature. We do not know if the message will ever be found or decoded; but its inclusion on the Pioneer 10 spacecraft seems to us a hopeful symbol of a vigorous civilization on Earth."

M. Acknowledgments

"We thank the Pioneer Project Office at Ames Research Center, especially Charles Hall, the Program Manager, and Theodore Webber; and officials at NASA Headquarters, particularly John Naugle, Ishtiaq Rasool, and Henry J. Smith, for supporting a small project involving rather longer time scales than government agencies usually plan for. The initial suggestion to include some message aboard Pioneer 10 was made by Eric Burgess and Richard Hoagland. A redrawing of the initial message for engraving was performed by Owen Finstad; the message was engraved by Carl Ray. We are grateful to A. G. W. Cameron for reviewing this message and for suggesting the serifs on the solar system distance indicators, and to J. Berger and J. R. Houck for assistance in computer programming."

Table A-1. The 14 selected pulsars

Pulsar	Period (1970/1971 epoch) in seconds	Period in units of H hyperfine transition
0328	$7.145186424 \times 10^{-1}$	$1.014906390 \times 10^{9}$
0525	3.745490800	$5.320116676 \times 10^{9}$
0531	$3.312964500 \times 10^{-2}$	$4.705753832 \times 10^{7}$
0823	$5.306595990 \times 10^{-1}$	$7.537519468 \times 10^{8}$
0833	$8.921874790 \times 10^{-2}$	$1.267268227 \times 10^{8}$
0950	$2.530650432 \times 10^{-1}$	$3.594550429 \times 10^{8}$
1240	$3.880000000 \times 10^{-1}$	$5.511174318 \times 10^{8}$
1451	$2.633767640 \times 10^{-1}$	$3.741018705 \times 10^{8}$
1642	$3.876887790 \times 10^{-1}$	$5.506753717 \times 10^{8}$
1727	$8.296830000 \times 10^{-1}$	$1.178486506 \times 10^{9}$
1929	$2.265170380 \times 10^{-1}$	$3.217461037 \times 10^{8}$
1933	$3.587354200 \times 10^{-1}$	$5.095498540 \times 10^{8}$
2016	$5.579533900 \times 10^{-1}$	$7.925202045 \times 10^{8}$

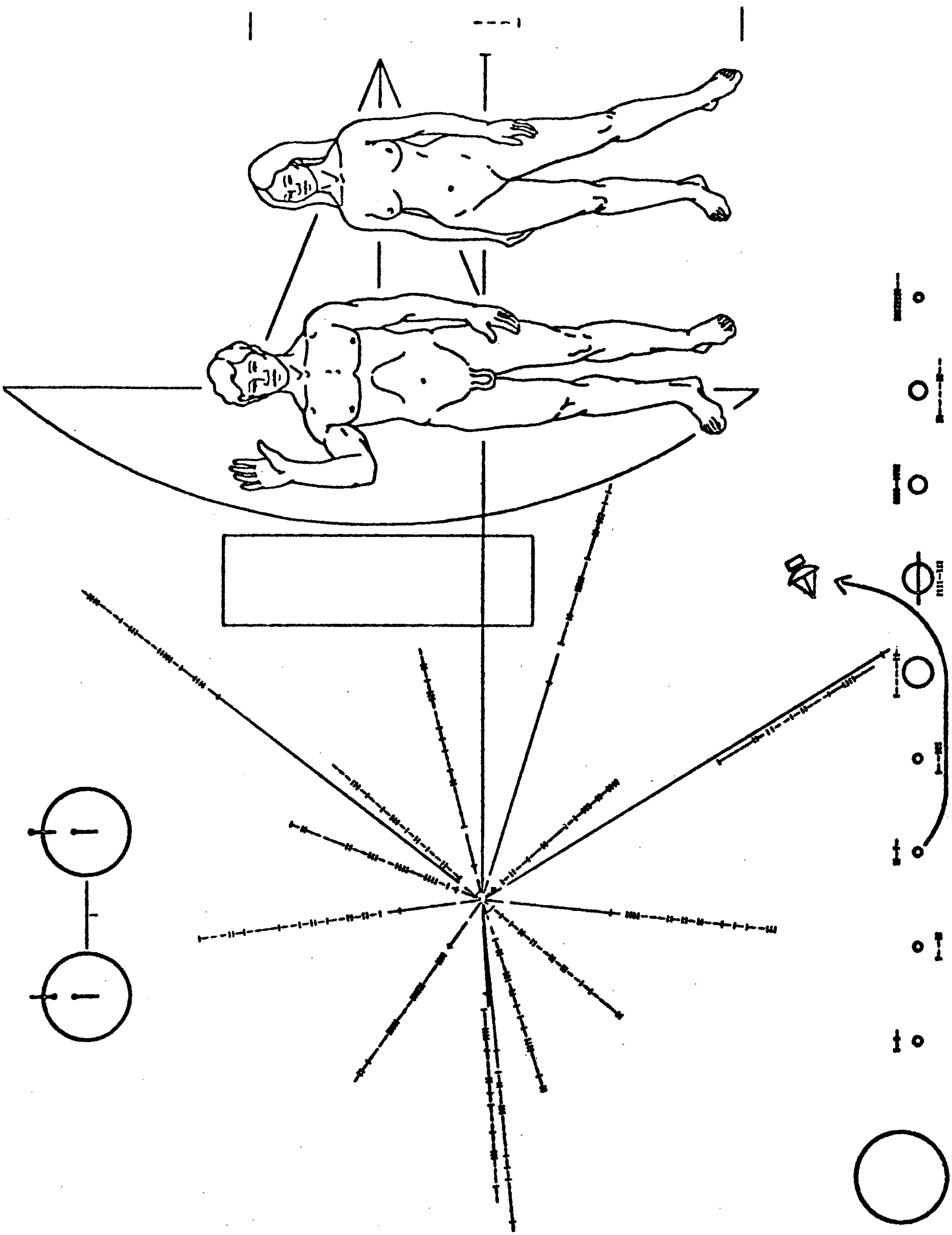


Fig. A-1. Message from Earth plaque carried by Pioneer 10 spacecraft

APPENDIX B

BLOCK DIAGRAMS OF DSN BASIC SYSTEMS

Each diagram, as viewed from left to right, is divided into the three DSN facilities: DSIF, GCF, and SFOF. Each facility is shown as a group of component subsystems connected with data flow points.

Table B-1. DSN Telemetry System equipment/subsystem capabilities for 26-m-diam antenna DSSs

(A) Output time to tag ground receiver data to 1 ms.
(B) System temperature.
(C) The High-Speed Data Assembly receives data from different DSIF systems. Priorities must be assigned by the Project/DSN for transmission of data to the SFOF.

Table B-2. DSN Telemetry System software capabilities for 26-m-diam antenna DSSs (Fig. B-1)

(a) DSIF Telemetry and Command Subsystem

a. *Input processing*

(1) Accept one bit stream of combined engineering and science telemetry data varying between 16 and 2048 bps uncoded, or between 32 and 4096 sps coded.

(2) Also accept associated input messages:

(a) Ground receiver automatic gain control (AGC).

(b) Time reference.

(c) Hardware lock status.

(d) Operator message through the computer console.

(e) Nonreal-time playback from digital and post-SDA analog records.

b. *Internal processing*

(1) Control bit synchronization and detection.

(2) Control decoding.

(3) Calculate signal-to-noise ratio (SNR) and ground AGC in dB.

c. *Output processing*

(1) Format and output for transmission to the SFOF via HSD circuits.

(2) Subsystem status to Monitor System.

(3) Data to digital ODR.

(b) Central Processing System—360/75

a. *Input processing*

(1) Accept data simultaneously from up to three HSD circuits, separate telemetry and partial status data, route data for internal processing, input process log tapes, and route telemetry HSD messages to Ames Research Center (ARC).

(2) Frame synchronization, pseudo-noise sync error calculation.

(3) Telemetry validation and selection on the basis of TCP signal-to-noise, GCF error, timing, and frame sync quality.

(4) Alarm limits, range suppression, suppression tolerances, data number to engineering unit conversion, data averaging, logic tests, continuity tests.

(5) Interface with SFOF Internal Communications Subsystem, drive hard copy, and volatile displays.

b. *Internal processing*

(1) Decommutate, and format telemetry data streams.

(2) Process and analyze DSN status and alarm data.

(3) Compare DSN standards (SNR ground AGC, frame sync quality) to predicts.

(4) Generate system log tapes, SDR and MDR files.

c. *Output processing*

(1) Hard copy and volatile display data to UTDS.

(2) Master Data Record (MDR) tapes.

(3) DSN status and alarms to Telemetry Analysis Group, Monitor System, and Mission Support Area (MSA).

(4) System configuration and replay request messages to the DSIF.

(5) Telemetry data to Remote Information Center via HSDL.

(6) Data to the 1108.

Table B-3. DSN Command System equipment/subsystem capabilities for 26- and 64-m-diam antenna DSSs (Fig. B-2)

Ⓐ DSS 14 will have capability for redundant exciters and dual carriers. All other stations shall have a single exciter and single carrier capability.

DSS 14 will have capability to transmit at 400 kW; the 26-m subnet stations will have 10-kW transmit capability; the 26-m mutual stations will have 20-kW transmit capability.

Ⓑ SDS 920 telemetry and command processor program capabilities for command: The following functions shall be available for one spacecraft, sharing the TCP with Telemetry System programs that are not to exceed 2 kbps uncoded.

a. Input processing

(1) HSD command, configuration, standards and limits, recall request, disable messages SFOF.

(2) Command messages, enables/disables, and recall messages via local DSS manual input (backup).

b. Output processing

(1) Output process and format, for HSD transmission, the following data:

(a) HSD verify messages to inform the SFOF that command HSD messages were received by the 920 with or without errors.

(b) Command recall response messages to inform the SFOF of either:

(i) The status of equipment and software of the multimission command system.

(ii) The current command messages stored within the TCP, but not yet processed.

(c) *Confirm/abort* messages to inform the SFOF that proper command was either transmitted by the DSS, or that an abort occurred while in process of transmitting. Transmitted bits are identified.

(2) Output process and format, for transmission to Digital Instrumentation Subsystem (DIS) computer, via 24-bit parallel register, the following types of monitor data:

(a) All hardware status indicator information from multimission command hardware.

(b) Error indication if bit-by-bit comparison between CMA and TCP shows difference.

(c) Error indicator when received HSD command message or request message blocks indicate HSD error.

(3) Output process and format teletype messages to SMC for local display containing such information as:

(a) Indication of *command* message or *enable/disable* received.

(b) Indication of command *request/response* messages.

(c) Command *confirm/abort* messages.

(d) Indication of command verification message sent.

(4) Output process and format digital magnetic log tape ODR containing all received commands, *enable/disable* messages, command instructions, command confirmation/abort (data combined on tape with telemetry data for the ODR).

(5) Transmit command bits to CMA.

c. Internal processing

(1) Extract spacecraft number from command instruction message and use to obtain parameters with which to initialize multimission command hardware.

(2) Keep time against computer clock reference until stored command is to be processed and sent to the CMA.

(3) Extract required parameters from command instruction message; buffer and store for recall response.

(4) If the command has been *enabled,* transmit command at time given in command message, or immediately, if specified.

(5) Perform verification on command message received over HSD (GCF error detection) and prepare verification message.

(6) Compare data in command instruction message and generate alarm if system is out of tolerance.

(7) If a command is *disabled,* remove it from storage; if command is in process, inhibit transmission of remaining bits.

Ⓒ Located at the station manager's console.

Ⓓ Not used.

Ⓔ The CMD Message Accountability Processor provides automatic interrogation of the DSSs as to status of the commands sent from the SFOF to the DSSs, and provides a continuous accounting of all commands entered into the DSN Command System at the SFOF.

Ⓕ The HSD Message Block Output Processor formats, buffers, and transmits command messages to the appropriate DSS. If no verified response is received, the message is repeated. The time between repeats and the number of repeats before an alarm is raised are controllable.

Ⓖ The HSD Block Return Processor handles verification, alarm, and abort messages received via HSD from DSSs and generates appropriate displays of status and alarms. The data are also presented to the SDR Processor.

Ⓗ The Message Construct Program performs the following functions:

(1) Accepts project generated command messages and prepares them for HSD transmission.

(2) Accepts control messages for command processing and display.

(3) Accepts configuration, standards and limits, and test command messages from Command Analysis Group.

(4) Accepts project generated *enable/disable* messages and transmits to DSS; rejects *enable* if the command message has not yet been verified.

(5) Accepts command recall request messages and prepares for transmission or interrogates CPS buffer and displays command recall response messages.

(6) Compares commands input against critical command table and stops further processing of command until interlock is input from 2260 to release inhibit.

(7) Translates alphanumeric input into binary bit stream for input to the HSD blocks.

Ⓘ The SDR Processor logs and verifies all SFOF–DSS HSD Command System traffic.

Ⓙ The MDR Processor extracts the *confirm* and *abort* message data from the SDR files, generates summaries and labels for the MDR, and writes the MDR data on file or tape.

Table B-4. DSN Tracking System equipment/subsystem capabilities for 26-m-diam antenna DSSs (Fig. B-3)

Ⓐ Not used for *Pioneer* Project.

Ⓑ The Tracking Data Processor samples and formats Greenwich Mean Time, doppler, range, angles, and partial status for transmission ⑩ to the Antenna Pointing Subsystem (prime) and/or via TTY ⑯ to the GCF Comm Processor Ⓝ. The reperforated TTY tape is maintained as the low-rate ODR ⑪ (rates 1 per 6 s).

Ⓒ The Antenna Pointing Subsystem receives metric data from the TDP ⑩. The metric data is reformatted to conform to standard National Aeronautics and Space Administration Communications Network (NASCOM) HSD block format and is transmitted via HSD ⑰ to the SFOF. The APS punches a tape for the DSIF ODR ⑫ for rates of 1 per 6 s. The APS also receives predictions via HSD ㉛ or TTY ㉞ (torn paper tape), interpolates these predictions to 1 per second, and provides interpolated angles to the Antenna Pointing Programmer (APP) ⑭. DSIF tracking system partial status is transmitted to the DIS via a 24-bit parallel transfer register ⑬.

Ⓓ The APP receives 1-per-second predicted angular positions from APS and further interpolates these angles to 50 per second; it compares the 50-per-second predictions with the antenna angle readout ⑨ and generates an error signal to the Antenna Servo Subsystem ⑮. The Antenna Servo Subsystem then drives the antenna to null this error signal.

Ⓔ The Digital Instrumentation Subsystem receives the tracking system partial status via the 24-bit parallel transfer register for display to DSS operational control. Predictions are transmitted from the SFOF to the DSS via HSDL ㉛ and are formatted and displayed ㉜ to DSS operational control for spacecraft acquisition.

Ⓕ The SFOF Tracking Data Input Processor provides a data format identification, decommutation, data conversion, and reformatting and displays input data. It also provides a capability of the derivation of the sample rate, line outage detection, and alarm classification.

Ⓖ The Pseudo-Residual Processor computes the difference between observables and predictions, identifies blunder points, computes data "noise" and provides a data quality index to the Master File Program (MFP) that is added to the SDR.

Ⓗ The MFP creates an SDR on disk or tape, provides a capability of rejecting data, provides a data accountability function, edits tracking data, tags the SDR with the quality indicator computed in Ⓖ, transfers data to the 1108 through the Project Data Selector Ⓙ ⑱, and provides a display capability.

Ⓘ The SDR Accountability Program computes the percentage of data received "good" as compared with the scheduled data availability.

Ⓙ The Project Data Selector Program provides a capability to a project for the data selection ⑱ based on spacecraft, station, data type, and sample rate. The selected data is transferred to the project by tape or the electrical interface. The data selection program is also used to provide a magnetic tape ⑱ by spacecraft identifier for the DSN Master Data Record.

Ⓚ The Tracking System Analytical Calibration (TSAC) Program computes calibrations for time and polar motion variations, transfers station locations, calibrates data for charged particles, and calibrates data for tropospheric corrections. These calibrations are made available to the project via the TSAC SDR ⑲ and Project Data Selector Ⓙ.

Ⓛ The Predict Program computes DSS observables from a project-supplied spacecraft ephemeris ㉘. Also computed are DSS view periods and spacecraft events, such as occultation.

Ⓜ The Operations Control Software formats and transmits to the DSS, via HSDL ㉛ or TTY ㉚ (dependent on availability), the validated predictions that were transferred to the Prediction File ㉙.

Ⓝ Communications Processor which routes TTY data.

Ⓞ The Orbit Data Editor (ODE) Program accepts data from the Project Data Selector Ⓙ. This data is edited, calibrated, and formatted for inclusion on the master file of DPODP Ⓟ.

Ⓟ The Double Precision Orbit Determination Program accepts data from the Orbit Data Editor Ⓞ and determines a "best" state vector for the observables.

Ⓠ The Trajectory Program (DPTRAJ) provides a spacecraft ephemeris tape based on DPODP ㉖ solution, or a state vector provided by other sources ㉗. This spacecraft ephemeris is transferred to the 360/75 via tape or the electrical interface ㉘.

Table B-5. DSN Tracking System equipment/subsystem capabilities for 64-m-diam antenna DSSs (Fig. B-4)

A	The DSIF Tracking Subsystem (DTS), a single multipurpose computer, performs the following functions: tracking data formatting, planetary ranging, error detection, predict generation, and antenna pointing.
B	The ranging function of the DTS provides ranging information at planetary distances (not used by *Pioneer* Project).
C	The Tracking Data Processor (TDP) function of the DTS samples and formats GMT, doppler, range, angles, errors, and partial status for transmission via HSD (17) to the SFOF. The TDP also generates onsite tracking data predictions for station use and for antenna pointing operations (14). Detected alarms are provided the Digital Instrumentation Subsystem (13). The DTS also receives predictions and control messages via HSDL (34) from the SFOF.
D	The antenna pointing function of the DTS receives information from the TDP, compares with predictions of antenna angles, and generates an error signal to the Antenna Servo Subsystem (15).
E	The Digital Instrumentation Subsystem receives partial status and error alarms from the TDP (13) for monitor and operational control. The DIS also receives predicts via HSDL (31) from the SFOF and outputs page prints of the predicts (32) for station spacecraft acquisition operations.
F	The SFOF Tracking Data Input Processor (TYDIP) provides a data format identification, decommutation, data conversion and reformatting, and displays input data. It also provides a capability of the derivation of the sample rate, line outage detection, and alarm classification.
G	The Pseudo-Residual Processor computes the difference between observables and predictions, identifies blunder points, computes data "noise" and provides a data quality index that is added to the SDR.
H	The Master File Program (MFP) creates an SDR on disk or tape, provides a capability of rejecting data, provides a data accountability function, edits radio metric data, tags SDR with the quality indicator computed in Pseudo-Residual Program (G), transfers data to the 1108, and provides a display capability.
I	The System Data Record accountability program computes the percentage of data received "good" as compared with the scheduled data availability.
J	The Project Data Selector Program provides a capability to a project for the data selection (18) based on spacecraft, station, data type, and sample rate. The selected data is transferred to the project by tape or electrical interface. The data selection program is also used to provide a magnetic tape (18) by spacecraft identifier for the DSN Master Data Record.
K	The Tracking System Analytical Calibration (TSAC) Program computes calibrations for time and polar motion variations, transfers station locations, calibrates data for charged particles and calibrates data for tropospheric corrections. These calibrations are made available to the project via the TSAC SDR (19).
L	The Predict Program computes DSS observables from a project-supplied spacecraft probe ephemeris (28). Also computed are DSS view periods and spacecraft events, such as occultation (29).
M	The DSN Operations Control software accepts the validated predicts from the prediction files and formats and transmits the predicts to the DSS via HSDL (31) or teletype (30), dependent on availability.
O	The Orbit Data Editor accepts data from the Project Data Selector (18), which is edited, calibrated, and formatted for inclusion on the master file of DPODP (P).
P	The Double Precision Orbit Determination Program accepts data from the Orbit Data Editor and determines a "best" state vector for the observables.
Q	The Trajectory Program (DPTRAJ) provides a spacecraft ephemeris tape based on DPODP solution or a state vector provided by other sources (27). This spacecraft probe ephemeris is transferred to the 360/75 via tape or the electrical interface (28).

Table B-6. DSN Simulation System (Fig. B-5)

EQUIPMENT/SUBSYSTEM CAPABILITIES

(A) High-speed data line is full duplex, one per DSS

SOFTWARE CAPABILITIES

(a) *DSS Simulation Conversion Assembly (SCA), 910 Real-Time Program (Control from DSN Simulation Center)*

A. *Input Processing*

1. Input process message blocks from one high-speed data (HSD) line, with contents listed in (1)

B. *Output Processing*

1. Output process simulated Pioneer telemetry on Channel No. 1. Encoding to be switched in as required by control message. (Three additional output channels available as alternates, but only for uncoded data.)
2. Output process bit rate control, subcarrier frequency control, modulation index control, and carrier attenuation control.

(b) *DSS SCA 910 Data Generation Program (Local Control)*

A. *Input Processing*

Input process operator controls and initialization

B. *Internal Processing*

Generate telemetry data patterns and attenuation control data according to operator controls and initialization

C. *Output Processing*

1. Output process telemetry data stream
2. Output process bit rate control, subcarrier frequency control, modulation index control, and attenuation control according to operator inputs

(c) *6050 Computer Program (DSN supplied)*

A. *Input Processing*

Input process:

1. Spacecraft math model data from the 1108
2. Spacecraft position as a function of time, in terms of station centered angles, range rates, and range from phi-factor tape obtained from 360/75 PREDICTS Program
3. DSS parameters which can be affected by the spacecraft condition. (Used for transmission to SCA in long-loop and to vary Monitor data in short-loop)
4. All HSD from up to three DSSs, when in long-loop mode, discarding all but command data, monitor data, and SCA display messages
5. All HSD to three (maximum) DSSs from SFOF, disregarding all but command system and standards and limits traffic (short-loop mode only)
6. Processing control messages for 6050 or 1108 and display-control messages

B. *Output Processing*

Output process and format:

1. HSD as listed in (1) and (2) for up to three DSSs
2. TTY tracking data as listed in (4)
3. Displays of system status and selected data
4. Processing control messages to 1108
5. Anticipated and actual commands to 1108

C. *Internal Processing*

1. Generate telemetry data streams (any rate) correctly formatted (frame sync words, etc.), but with controllable-pattern data values
2. Store the decommutated telemetry data received from the 1108 for construction of HSDA message blocks
3. Generate tracking data, based upon PREDICTS phi-factor tape input, for up to three DSSs. Effect a maneuver response in the data under input control of maneuver parameters
4. Generate DSS responses, in terms of command and monitor system data, when in the short-loop mode
5. Generate DSS parameters which may vary with change in spacecraft or DSS conditions

(d) *1108 Program (Project-supplied)*

A. *Input Processing*

Input Process:

1. Program control (including initialization and inputting of constants) from 6050 or 1108 I/O console
2. Anticipated or actual commands from 6050

B. *Output Processing*

Output process:

1. Spacecraft commutated telemetry output
2. Spacecraft parameters which affect DSS status
3. Spacecraft parameters which affect tracking data

C. *Internal Processing*

1. Generate with math models command responsive telemetry at any Pioneer data rate

Table B-7. DSN Monitoring System (Fig. B-6)

EQUIPMENT/SUBSYSTEM CAPABILITIES

Ⓐ Located in DSN Operations Area of SFOF

Ⓑ One 4800-bps full-duplex line, per DSS, shared by all systems; 1200-bit block size

SOFTWARE CAPABILITIES

ⓐ *DSIF Monitor System Phase II Program*

A. *Input Processing*

Input process:

1. Tracking parameter values and indicator settings from TDH-1[a] for one spacecraft consisting of the following:
   - (a) Hour angle and declination angle
   - (b) Doppler counts from counter
   - (c) Range units
   - (d) Exciter voltage-controlled oscillator (VCO) reference frequency
   - (e) Doppler resolver time
   - (f) Tracking data sample rate
   - (g) Doppler, angle, and range data condition codes
   - (h) Station ID
   - (i) Spacecraft ID
   - (j) Pass number
2. Input process DSS telemetry system monitor data from all TCP computers via the 24-bit parallel registers.
3. Parameter values and indicator settings associated with station hardware configuration for one or two spacecraft:
   - (a) SDA parameters and indicators
   - (b) Receiver parameters and indicators including doppler and range indicators
   - (c) Cassegrain and acquisition aid, right or left circular polarization indicators
   - (d) Antenna servo modes
4. DSS command system monitor data from all TCP computer via the 24-bit parallel registers.
5. Instrumentation parameter values consisting of:
   - (a) Ground AGC and SPE values
   - (b) Transmitter power
6. Time for labeling
7. Predicts and operations data received via HSDL from SFOF
8. Operator messages
9. Servo angle error values, antenna pointing subsystem (APS) modes and status, and angle data condition from APS computer program
10. Selected GCF HSD monitor data from DSS Comm equipment subsystem

B. *Output Processing*

Output process and format:

1. Parameter values and indicator settings (full DSS status) into HSD blocks for transmission to the SFOF 360/75s every 5 s
2. Selected monitor parameters and alarms to the station manager console area on a DTV display
3. Digital instrumentation subsystem (DIS) operator control messages to a page printer
4. Digital recording of monitor HSD blocks; capable of replay, postpass.
5. Page prints of predicts and operations data
6. Magpak recording of predicts

C. *Internal Processing*

1. The following calculations are made for the tracking system:
   - (a) Compute doppler measurement in counts per time unit
   - (b) Compute doppler residuals using predicts and compute mean and standard deviation of the residuals
   - (c) For alarm purposes, compare criteria data with selected tracking data, and compute mean and standard deviation for angle residuals
   - (d) Calculate doppler alarm limits from least squares or Lagrangian extrapolation, and perform blunder point alarm calculation using supplied limits
   - (e) Calculate range residual, range mean and standard deviation
   - (f) Calculate noise detection range parameter for range rejection
2. The following calculations are made for the monitor system:
   - (a) Convert DSS static phase error (SPE) from volts to degrees
   - (b) Convert RF angle errors from volts to degrees when angle channels have been calibrated
   - (c) Convert transmitter power from volts to kilowatts
   - (d) Register GCF (station comm) alarm occurrence; reset after each HSDA block output to DSN Monitor in SFOF

ⓑ *Communication Processor Program, Monitor portion*

In addition to its primary function of automatic message switching for TTY circuits, the following monitor functions are performed by the CP program:

A. *Input Processing*

Input process:

1. Operator Commands which control and direct HSD Line monitoring
2. Parameters which are received for each HSDA line being monitored. The signals are generated by GCF error detection decoders on the HSD Lines and are passed to a teletype character generator which outputs TTY characters to the GCF communications processor (CP).

B. *Output Processing*

Output process and format:

1. Data blocks to each active 360/75 comprised of the following:
   - (a) The on-line CP and its busy rate
   - (b) The mode of the off-line CP
   - (c) Accounting information and status on each HSDA line monitored
2. Data to the digital TV for each HSDA line being monitored
3. Advisory messages to the CP operator when the carrier ON/OFF status changes for a HSD line being monitored
4. Account blocks for each HSDA line to the CP log tape and to the 360/75 on termination of a monitoring period

C. *Internal Processing*

1. The CP calculates the time it is actively processing data as a percentage of time available for such processing in a given period (busy rate)
2. The following internal calculations are performed by each HSD line monitored:
   (a) Error rate
   (b) Total amount of carrier off time
   (c) Number of null sample periods
   (d) Total number of sample periods

Ⓒ *The 360/75 DSN Monitor Real Time (RT) Software*
Part I—Collection and Processing of Monitor Data for Real-Time Display

A. *Input Processing*

Input process:

1. HSD blocks containing DSIF and station command monitor data: Parameter values, and indicator settings every 5 seconds, summary data every 30 seconds
2. GCF monitor messages from SFOF communications terminal subsystem via normal input lines from the CP
3. Operator messages input from the DSN monitor area
4. MCD set generation, modification and storage (see following Part III)

B. *Output Processing*

1. *Output process DSN Monitor SDR*

   All input data shall be logged on magnetic tape in a format suitable for playback on the 360/75, or for use as input to the 360/75 post-processor program

2. *Output process digital TV displays*

   DTV displays will be available over computer-driven channels, allowing, for example, simultaneously, display of the same information for several tracking stations. Many of the displays have more than one selectable format, allowing the grouping of display parameters as subsets. The displays fall into three basic groups:

   (a) DSN operations
   (b) Facility operations
   (c) System operations

   Each contains a spectrum of displays and format, ranging from gross status and alarming to detailed status and performance data for troubleshooting. By procedurally controlling the assignment of displays to the DTV channels, the number of tracking stations that are simultaneously monitored is selectable to all DSN stations with digital instrumentation system (DIS II) monitor capability.

3. *Output Process Monitor Alarms*

   All monitor alarms are printed on TTY character printers in the DSN area of the SFOF. Alarms are also displayed on DTV adjacent to the anomalous parameter

C. *Internal Processing*

Internal processing of monitor data is restricted to:

1. Display definition
2. Formatting for displays
3. Routing of display data
4. Conversion of monitor input parameters for display purposes
5. Comparison of real-time data with MCD sets to yield alarms (see Part III)

Part II—360/75 Processors for Other Systems

The mission-dependent processor supplies to the mission-independent system accounting and status information on all telemetry tracking and command streams currently being processed or logged.

Part III—Monitor Criteria Data Control Program

The purpose of monitor criteria data (MCD) sets is to provide facility configuration and tolerance masks against which subsystem configuration and performance can be compared. Configurations different from the one defined by the MCD set, or parameter variations larger than the tolerances in the MCD set cause an alarm.

Part IV—Data Summaries

This part of the program uses a monitor data file as input and generates summary reports.

1. *Input Processing*
   (a) Input process the data from file
   (b) Input process control cards via magnetic tape
2. *Output Processing*
   Output process on to 1443 line printer in DSN Operations Area and into Ops control output router for transmission to DSS

Part V—DSN Status MDR

This part of the program accepts and time-merges replayed monitor data from the facilities on to the monitor SDR. When all available data have been merged, the monitor SDR becomes the DSN status MDR.

[a]Does not apply to prototype DSIF Tracking System DTS at DSS 14.

Table B-8: DSN Operations Control System (Fig. B-8)

EQUIPMENT CAPABILITIES

A GCF HSD Lines: one-half of full duplex 4800 bps line with 1200-bit data blocks

B DSIF Processor for Operations Control Messages: shared computer with other DSS functions

C SFOF/DSN real time and nonreal-time processor: redundant IBM 360/75's shared with other system processing and project processing

D Non-real Time Processor: single Univac 1108 in scientific computer facility (SCF), controlled by DSN; project analysis software and DSN Simulation System software only

E Project MSA: except as noted for display of DSN status (data flow paths 7 and 29), applies to both local and remote MSAs. (Systems Development Laboratory is defined as local MSA.)

F DSN simulation subsystem: shown for reference only. (See simulation system description for capabilities.)

SOFTWARE CAPABILITIES

a *Telemetry Predicts: (For MM'71, obtained from project analysis program[a] and transferred to 360 via tape)*

A. *Output Process*

1. Predicted downlink AGC as a function of time
2. Predicted subcarrier SNRs as a function of time
3. Items 2 and 3 are functions of spacecraft data mode
4. Other parameters are contained in TPAP output (such as uplink AGC) but are not extracted by DSN

b *SFOF General Purpose Program in Master Control and User Interface Subsystem to Format Outbound Blocks*

A. *Input Processing*

1. Tracking predicts from tracking system software
2. Telemetry predicts from telemetry predicts analysis program (TPAP) (MM'71 only[a])
3. DSN MCD sets from DSN monitor real-time software
4. DSN seven-day schedule software output
5. DSN SOE software output

B. *Internal Processing*

1. Accept data in formats defined by data source
2. Format HSD blocks in formats defined by Document 820-13

C. *Output Processing*

Route HSD blocks to SFOF Comm Terminal

c *DSN Seven-Day Schedule Program*

A. *Input Processing*

1. Accept midrange schedule as base schedule
2. Accept real-time change requests

B. *Internal Processing*

1. Modify seven-day schedule in accordance with approved real-time change requests
2. Tabulate listing of DSN resources committed at any point in time
3. Tabulate status of uncommitted resources at any point in time
4. Tabulate history of real-time changes to Seven-Day Schedule for selectable intervals

C. *Output Processing*

1. Transfer Seven-Day Schedule to Master Control and User Interface Subsystem (Program *b* above) for transmission to remote sites
2. Output items c to DTV for display to DSN operation via closed-circuit Television
3. Transfer seven-day schedule to DSN sequence of events (SOE) program for use as constraints (see d below)
4. Create historical file (tape) of DSN SOE resources as actually used

d *DSN SOE PROGRAM*[b]

A. *Input Processing*

1. Accept all supported projects' SOEs in machine language
2. Accept card and manual inputs to build or modify sequences
3. Accept card, manual, and machine language inputs (e.g., Tracking predicts to build or modify a subsequence library)
4. Accept card, manual and machine language inputs (e.g., seven-day schedule in c B. 3. above) to build or modify a constraints library
5. Accept card and manual inputs to define or modify format of outputs

B. *Internal Processing*

1. Identify all events which are keyed as "triggers" and insert subsequence(s) appropriate for each such event
2. Insert event time for each event in a subsequence; fixed delta-T if so defined, or use round-trip light time (RTLT), obtained via interface with tracking predicts if delta-T is trajectory dependent
3. Sort and time-order resulting master multimission sequence
4. Check resulting master multimission sequence against library of constraints (e.g., seven-day schedule for simultaneous mutually exclusive events)

C. *Output Processing*

1. Real-time alarms to SOE program operator of constraints violations
2. Uniquely identify each production run so that the "most recently produced" SOE for a given period of support operations can be easily and clearly recognized.
3. Output to 1443's in DSN Operations Area in SFOF and via master control and user interface subsystem (MCUIS) and HSDL to remote sites
4. Tailor outputs to individual users by suppressing predefined unwanted data from master multimission sequence
5. Output a predefined format to digital television system for display to DSN Operations via CCTV
6. Create historical file (tape) of each SOE production run

e *DSIF Page Prints of Operations Control Information*

A. *Input Processing*

1. Accept incoming HSD blocks
2. Check for blocks in errors by means of GCF error code
3. Check for mission blocks by consecutiveness of HSD block serial numbers

Table B-8 (contd)

B. *Internal Processing*

1. Format for output to 132-column-line printer

C. *Output Processing*

1. Produce page prints
2. Flag received lines suspected of errors
3. Insert dummy lines flagging suspected missing lines

(f) *DSN discrepancy report (DR) Data Bank (Off-line Process with SCF Software)*

A. *Input Processing*

1. Accept (DR) data manually transferred from discrepancy report forms to IBM cards
2. Accept instructions on format of output

B. *Internal Processing*

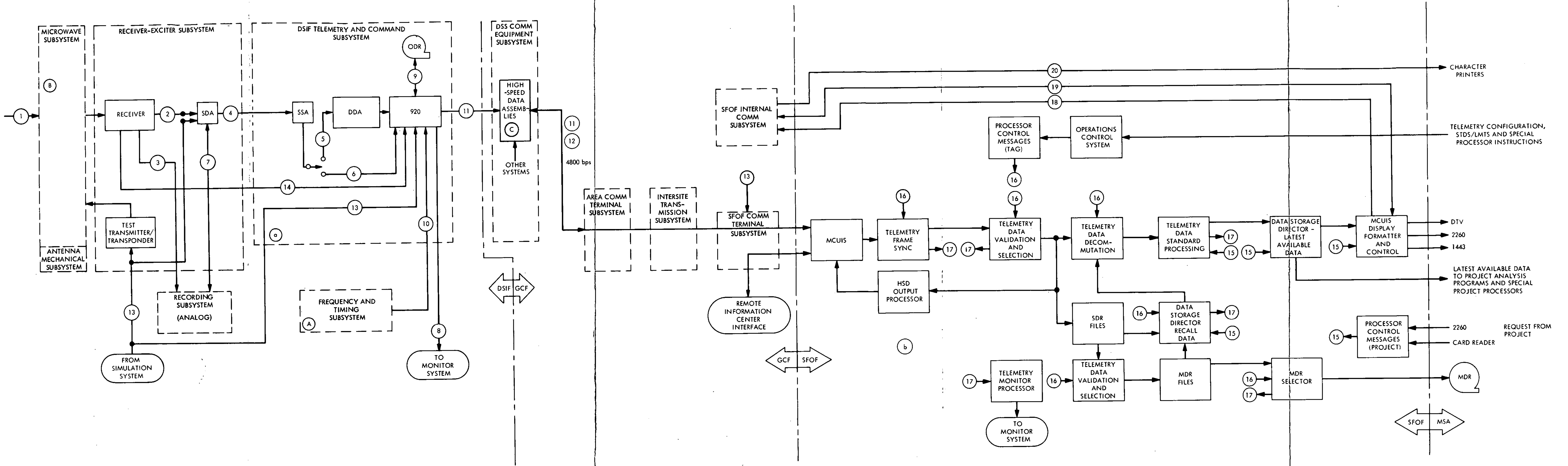
1. Create master data bank
2. Update individual discrepancy report entries if new data is input relative to that discrepancy report
3. Invoke security measures to protect discrepancy report data

C. *Output Processing*

1. Output periodic reports to predefined recipients in predefined formats
2. Output special reports in a format which is determined by recipient in near-real time
3. Create historical tape file of data no longer needed in the active data bank

[a]To be replaced by DSN multimission telemetry predicts program prior to *Pioneer F* support operations

[b]This program is multimission. It is used by supported projects in data files assigned to them.



1 CARRIER FROM ONE SPACECRAFT
2 32.768-kHz SUBCARRIER PHASE-MODULATED ON 10-MHz CARRIER
3 32.768-kHz SUBCARRIER WITH TELEMETRY DATA (NO PLAYBACK CAPABILITY)
4 DATA STREAM 16-2048 bps UNCODED OR 32-4096 sps CODED
5 CODED DATA
6 UNCODED DATA
7 SUBCARRIER DEMODULATOR ASSEMBLY (SDA) OUTPUT AND PLAYBACK OF RECORDED SDA OUTPUT
8 INITIAL CONFIGURATION AND EVENT, TELEMETRY INSTRUMENTATION STATUS
9 DIGITAL ODR RECORDING AND PLAYBACK (DELETED, CODED FRAMES WILL BE PLAYED BACK THROUGH THE DDA FOR REPLAYED DATA)
10 TIME FOR GROUND DATA TAGGING
11 TELEMETRY DATA TO SFOF VIA HIGH-SPEED DATA LINE, INCLUDES:
(a) ENGINEERING AND SCIENCE DATA AT 2048 bps MAXIMUM,
(b) REPLAY OF ODR NOT SIMULTANEOUS WITH (a), AND (c) DSS TELEMETRY SYSTEM PARTIAL STATUS (SNR, LOCK, AND CONFIGURATION INDICATORS) AND SUPPLEMENTARY DATA (GROUND ACG AT 10 samples/s MAXIMUM)
12 CONFIGURATION AND REPLAY REQUEST MESSAGES FROM THE SFOF TO THE DSIF VIA HSDL
13 SIMULATED TELEMETRY INPUTS
14 GROUND RECEIVER AGC
15 CONTROL FOR TELEMETRY DATA PROCESSING BY THE PROJECT FROM USER TERMINAL AND DISPLAY SUBSYSTEM (UTDS)
16 CONTROL FOR TELEMETRY MDR PROCESSING BY DSN TELEMETRY ANALYSIS GROUP FROM UTDS
17 DSN TELEMETRY SYSTEM INSTRUMENTATION STATUS AND SELECTED DECOMMUTATED SPACECRAFT PARAMETERS FOR MONITOR DISPLAY
18 CONTROL TO SFOF INTERNAL COMM SUBSYSTEM FOR DIGITAL TV
19 DIGITAL TV SIGNALS FOR DISPLAY
20 360/75 CHARACTER PRINTER OUTPUT FROM COMMUNICATIONS PROCESSOR

A TO C DEFINED IN TABLE A-1

a TO b DEFINED IN TABLE A-2

Fig. B-1. DSN Telemetry System for 26-m-diam antenna DSS functional block diagram for Pioneer 10 cruise mode configuration

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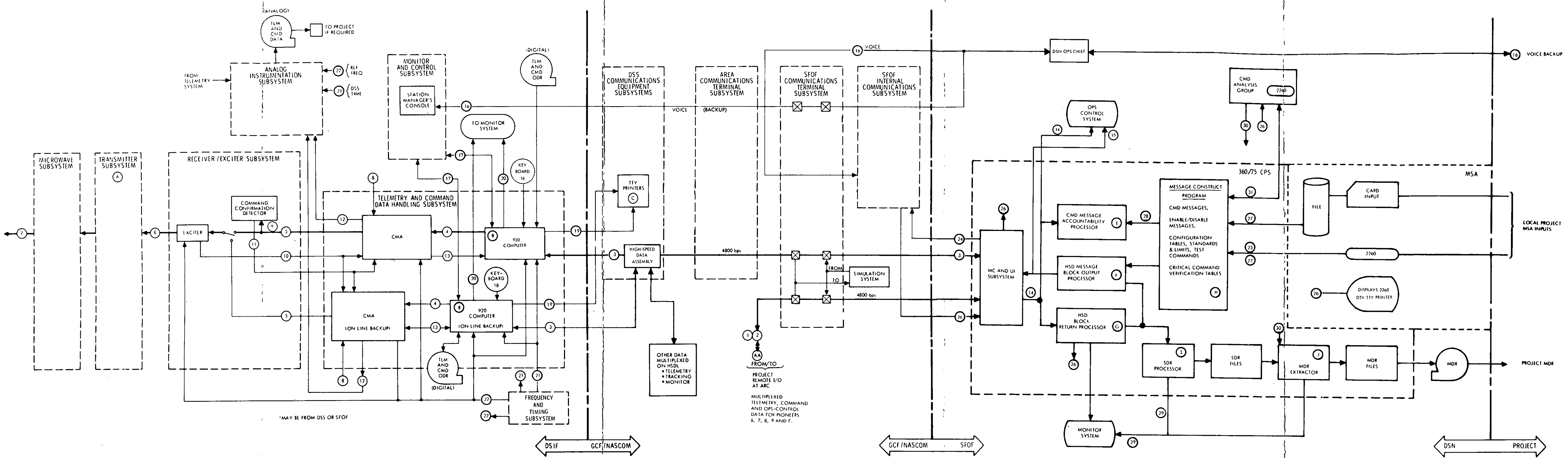
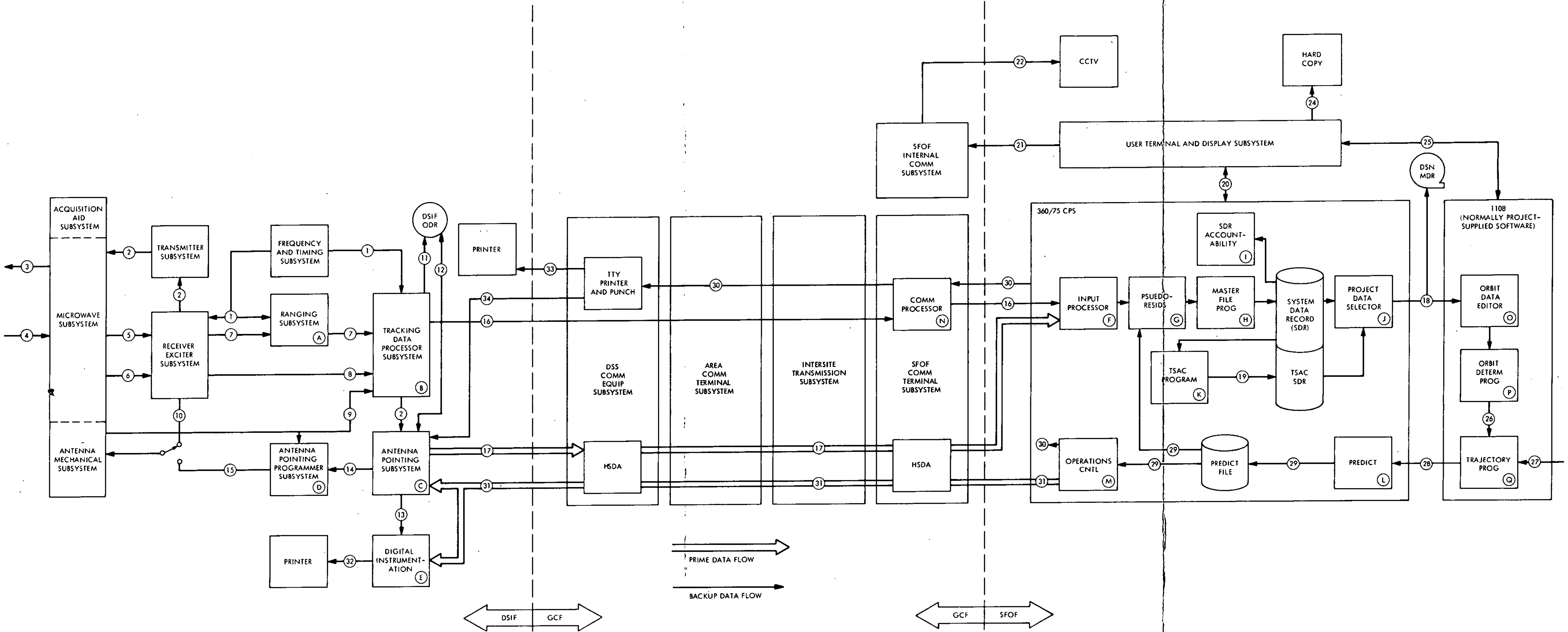
A B C



① COMMAND MESSAGE OUTPUTS FROM REMOTE MSA TO SFOF
② SFOF-PROCESSED COMMAND INFORMATION RESPONDING TO ① AND PROVIDING INFORMATION FOR REMOTE MSA DISPLAYS
③ COMMAND MESSAGES, COMMAND INSTRUCTION MESSAGES, AND COMMAND RECALL REQUEST MESSAGES TO DSS; COMMAND VERIFICATION, CONFIRM/ABORT, ALARM, AND RECALL RESPONSE MESSAGES TO SFOF
④ COMMAND WORD BITS
⑤ COMMAND MODULATED SUBCARRIER
⑥ TRANSMITTER DRIVE
⑦ AMPLIFIED, MODULATED S-BAND UPLINK CARRIER
⑧ TRANSMITTER, EXCITER, AND MODULATOR, ON OR OFF INDICATION
⑨ MODULATOR OUTPUT FOR COMMAND CONFIRMATION
⑩ EXCITER FREQUENCY
⑪ DETECTED MODULATOR OUTPUT, ITEM ⑨ FOR ABORT OR CONFIRMATION
⑫ COMMAND MODULATION ASSEMBLY OUTPUT FOR RECORDING ON ANALOG TAPE
⑬ CONTROL INFORMATION, COMMAND BITS, AND CONFIGURATION INFORMATION FED BACK TO THE COMPUTER
⑭ COMMAND SYSTEM MESSAGES SENT FROM DSS TO SFOF
⑮ COMMAND MESSAGES TO BE USED BY OPERATIONS CONTROL SYSTEM TO LIST EXPECTED DSN CONFIGURATION CHANGES RESULTING FROM COMMANDS TRANSMITTED
⑯ VOICE CIRCUITS FOR EMERGENCY MODE COMMAND COORDINATION
⑰ MANUAL MODE ENABLE AND DISPLAY CONTROL SIGNALS
⑱ MANUAL MODE COMMAND INPUT, ENABLED BY STATION MANAGER
⑲ COMMANDS, VERIFICATION, CONFIRMATION, ABORT, AND ALARM INFORMATION FOR LOCAL DISPLAY AT DSS
⑳ COMMAND SYSTEM CONFIGURATION, STATUS, AND ALARMS
㉑ DSS TIME
㉒ REFERENCE FREQUENCIES
㉓ CONTROL MESSAGES FOR COMMAND PROCESSING AND DISPLAY, RECALL RESPONSE MESSAGES, AND DATA DISPLAY
㉔ CONTROL TO SFOF INTERNAL COMMUNICATIONS SUBSYSTEM FOR CHARACTER PRINTER AND CLOSED-CIRCUIT TELEVISION (CCTV) DISPLAY
㉕ NOT USED
㉖ DATA FOR CHARACTER PRINTER, CCTV DISPLAY, DTV DISPLAYS, AND HIGH-SPEED PRINTERS
㉗ COMMAND MESSAGE INPUTS
㉘ COMMAND MESSAGES FOR ACCOUNTABILITY PROCESSOR
㉙ DATA SUMMARIES AND ALARMS
㉚ INPUTS, RECALL REQUESTS TO MDR PROCESSOR FROM COMMAND ANALYSIS GROUP
㉛ CONFIGURATION, STANDARDS AND LIMITS, TEST COMMANDS, RECALL REQUEST INPUTS
Ⓐ TO Ⓙ DEFINED IN TABLE B-3

Fig. B-2. DSN Command System 26- and 64-m-diam antenna DSS functional block diagram for Pioneer 10 cruise mode configuration



(1) REFERENCE FREQUENCY/TIME
(2) TRANSMITTER DRIVE
(3) AMPLIFIED, MODULATED S-BAND CARRIER
(4) S-BAND DOWNLINK
(5) RECEIVER 1 INPUT
(6) RECEIVER 2 INPUT
(7) RANGE DATA AND RANGE PARTIAL STATUS (NOT USED BY PIONEER PROJECT)
(8) DOPPLER DATA, TRANSMITTER VCO FREQUENCY, AND DOPPLER PARTIAL STATUS
(9) ANGLE DATA AND ANGLE PARTIAL STATUS
(10) AUTOTRACK FEEDBACK
(11) LOW-RATE ODR (RATES EQUAL TO OR LESS THAN 1 PER 6 s)
(12) HIGH-RATE ODR (RATES GREATER THAN 1 PER 6 s)
(13) TRACKING SYSTEM PARTIAL STATUS TO MONITOR
(14) ANGLE PREDICTIONS INTERPOLATED TO 1 PER SECOND
(15) ANTENNA SERVO-DRIVE SIGNALS
(16) LOW-RATE FORMATTED METRIC DATA VIA TTY (BACKUP)
(17) LOW- AND HIGH-RATE FORMATTED METRIC DATA VIA HSD (PRIME)
(18) METRIC DATA FROM SYSTEM DATA RECORD TO PROJECT AND DSN MDR
(19) CALIBRATIONS FOR METRIC DATA
(20) SFOF TRACKING SYSTEM I/O INSTRUCTIONS
(21) DATA AND STATUS FOR DISPLAY VIA CCTV
(22) CCTV DISPLAYS OF (21)
(23) NOT USED
(24) HARD COPY DISPLAY OF REQUESTED DATA
(25) PROJECT I/O INSTRUCTIONS TO ORBIT SOFTWARE
(26) STATE VECTOR FROM DOUBLE PRECISION ORBIT DETERMINATION PROGRAM
(27) STATE VECTOR FROM EXTERNAL SOURCE
(28) SPACECRAFT EPHEMERIS
(29) DSS PREDICTED OBSERVABLES
(30) DSS PREDICTIONS TRANSMITTED VIA TTY BY OPERATIONS CONTROL SOFTWARE
(31) DSS PREDICTIONS TRANSMITTED VIA HSDL BY OPERATIONS CONTROL SOFTWARE
(32) PAGE PRINT OF (31) FOR DSS ACQUISITION OF SPACECRAFT (PRIME)
(33) PAGE PRINT OF (30) FOR DSS ACQUISITION OF SPACECRAFT (BACKUP)
(34) PAPER TAPE OF PREDICTIONS FOR ANTENNA POINTING SUBSYSTEM (BACKUP)

(A) TO (Q) DEFINED IN TABLE B-4

Fig. B-3. DSN Tracking System 26-m-diam antenna DSS functional block diagram for Pioneer 10 cruise mode configuration

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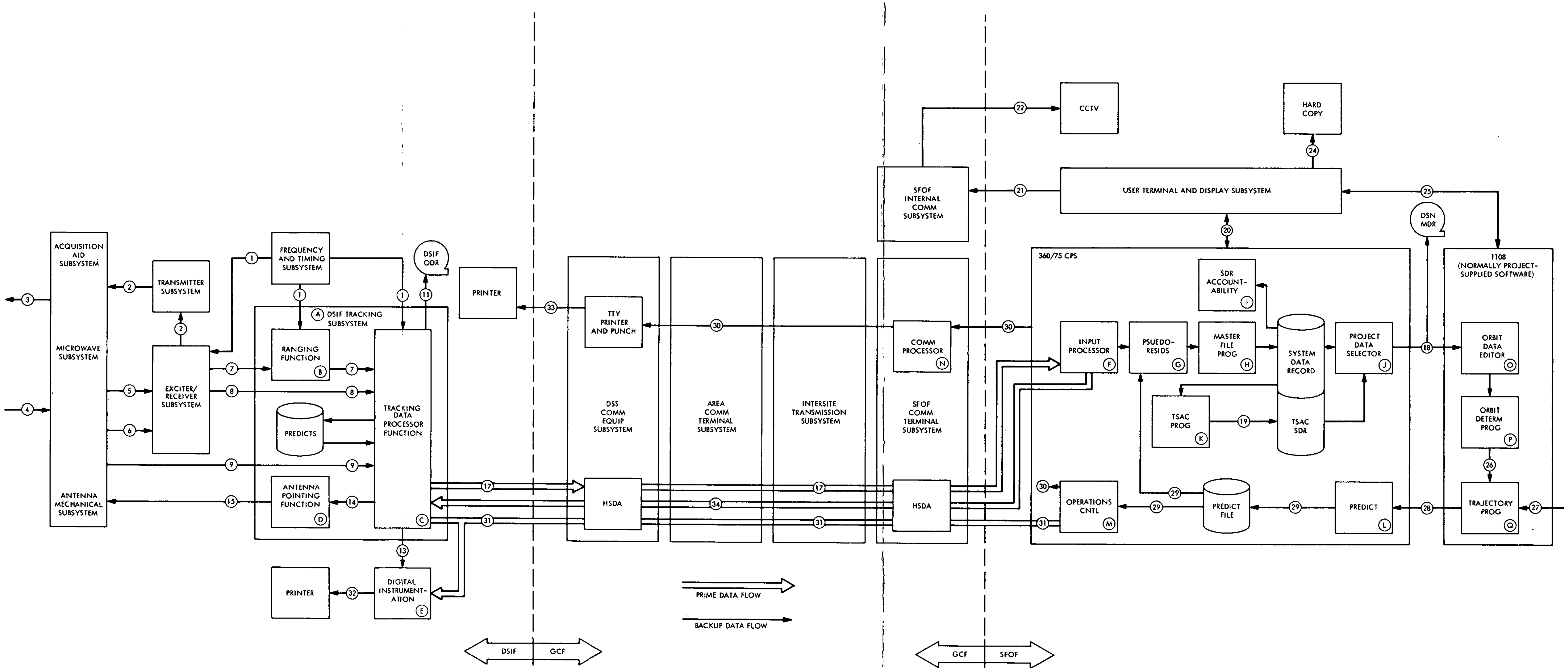
A FOLDOUT FRAME 1 B FOLDOUT FRAME 2

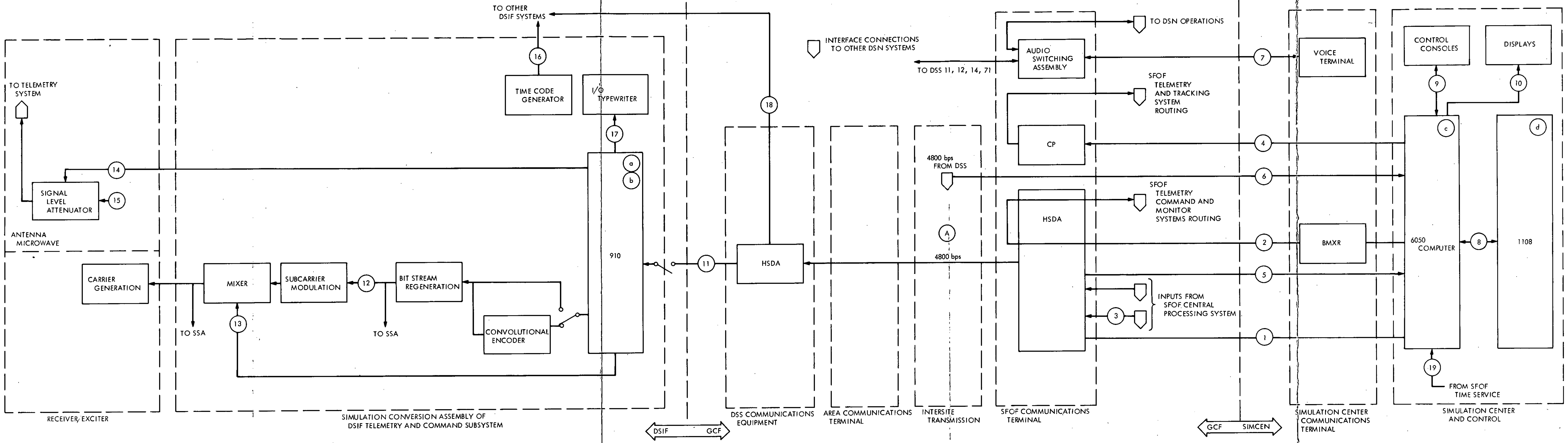


(1) REFERENCE FREQUENCY/TIME
(2) TRANSMITTER DRIVE
(3) AMPLIFIED, MODULATED S-BAND CARRIER
(4) S-BAND DOWNLINK
(5) RECEIVER 1 INPUT
(6) RECEIVER 2 INPUT
(7) RANGE DATA AND RANGE PARTIAL STATUS (NOT USED BY PIONEER PROJECT)
(8) DOPPLER DATA, TRANSMITTER VCO FREQUENCY, AND DOPPLER PARTIAL STATUS
(9) ANGLE DATA AND ANGLE PARTIAL STATUS
(10) NOT USED
(11) DSIF ODR
(12) NOT USED
(13) TRACKING SYSTEM PARTIAL STATUS TO MONITOR
(14) ANGLE PREDICTIONS
(15) ANTENNA SERVO-DRIVE SIGNALS
(16) NOT USED
(17) FORMATTED METRIC DATA VIA HSDA
(18) METRIC DATA FROM SDR TO PROJECT AND DSN MDR
(19) CALIBRATIONS FOR METRIC DATA
(20) I/O INSTRUCTIONS TO SFOF TRACKING SOFTWARE
(21) DATA AND STATUS FOR DISPLAY ON CCTV
(22) CCTV DISPLAYS OF (21)
(23) NOT USED
(24) HARD COPY DISPLAY OF REQUESTED DATA
(25) PROJECT I/O INSTRUCTIONS TO ORBIT SOFTWARE
(26) STATE VECTOR FROM DPODP
(27) STATE VECTOR FROM EXTERNAL SOURCE
(28) SPACECRAFT EPHEMERIS
(29) DSS PREDICTED OBSERVABLES
(30) DSS PREDICTIONS TRANSMITTED VIA TTY BY OPERATIONS CONTROL SOFTWARE
(31) DSS PREDICTIONS TRANSMITTED VIA HSDL BY OPERATIONS CONTROL SOFTWARE
(32) PAGE PRINT OF (31) FOR DSS ACQUISITION OF SPACECRAFT (PRIME)
(33) PAGE PRINT OF (30) FOR DSS ACQUISITION OF SPACECRAFT (BACKUP)
(34) PAPER TAPE OF PREDICTIONS FOR ANTENNA POINTING SUBSYSTEM (BACKUP)

(A) TO (Q) DEFINED IN TABLE B-5

Fig. B-4. DSN Tracking System 64-m-diam antenna DSS functional block diagram for Pioneer 10 cruise mode configuration

A B B



DATA FLOW PATHS

(1) SIMULATED DATA FORMATTED FOR HSDA TRANSMISSION, TO ANY DSS (LONG-LOOP MODE), AND CONSISTING OF THE FOLLOWING:
- a. TELEMETRY DATA BLOCKS (16 TO 2048 bps DATA RATES)
- b. BIT RATE, SUBCARRIER FREQUENCY, ATTENUATION AND MODULATION INDEX CONTROL INFORMATION
- c. SIMULATION INSTRUCTIONS

NOTE: DUPLICATED AT ANY GIVEN TIME FOR TWO OTHER DSSs (INCLUDING CTA 21, DSS 71) OR MSFN

(2) SIMULATED DATA FORMATTED FOR HSDA TRANSMISSION, SIMULATING OUTPUT OF ONE DSS TO SFOF (SHORT-LOOP MODE), AND CONSISTING OF THE FOLLOWING:
- a. TELEMETRY DATA BLOCKS (16 TO 2048 bps DATA RATES)
- b. MONITOR DATA
- c. COMMAND TRAFFIC
- d. PARTIAL STATUS AND SUPPLEMENTAL DATA
- e. HIGH-SPEED TRACKING DATA (DSSs 11, 14, 42, 61 SIMULATION ONLY)

NOTE: DUPLICATED FOR TWO OTHER DSS

(3) SFOF MESSAGES TO DSIF SYSTEMS MULTIPLEXED ON TO HIGH-SPEED DATA LINE

(4) TTY FORMATTED SIMULATED TRACKING DATA REPRESENTING UP TO THREE DSSs

(5) COMMAND AND STANDARD AND LIMITS RECEIVED FROM SFOF WHEN SIMULATION SYSTEM IS SIMULATING DSS

NOTE: DUPLICATED FOR TWO OTHER DSSs

(6) COMMAND AND MONITOR TRAFFIC FROM DSS, ALSO SCA DISPLAY (IF FROM DSS 11, 42, OR 61) PARALLEL-ROUTED TO 6050 (DUPLICATED FOR TWO OTHER DSSs)

(7) VOICE TRAFFIC TO DSIF FOR TEST COORDINATION AND TO DSN OPERATIONS FOR SIMULATION OF VARIOUS DSS OPERATING POSITIONS

(8) DATA TRANSFER FROM 1108 MATH MODEL TO 6050, AND CONTROL INFORMATION IN BOTH DIRECTIONS

(9) PROCESSING CONTROL INFORMATION

(10) SELECTED DATA AND SYSTEM STATUS

(11) HIGH-SPEED DATA BLOCKS CONTAINING DATA TYPES LISTED, NOTE (1), ITEMS a, b, c.

(12) CODED (32 TO 4096 sps) OR UNCODED (16 TO 2048 bps) TELEMETRY DATA STREAM

(13) MIXING RATIO (MODULATION INDEX) CONTROL

(14) S-BAND CARRIER ATTENUATION CONTROL

(15) S-BAND EQUIVALENT OF ONE SPACECRAFT DOWNLINK (WITHOUT DOPPLER)

(16) BINARY-CODED DECIMAL TIME CODE FOR USE THROUGHOUT DSS

(17) SIMULATION INSTRUCTIONS AND SIMULATION CONVERSION ASSEMBLY CONTROL AND DISPLAY

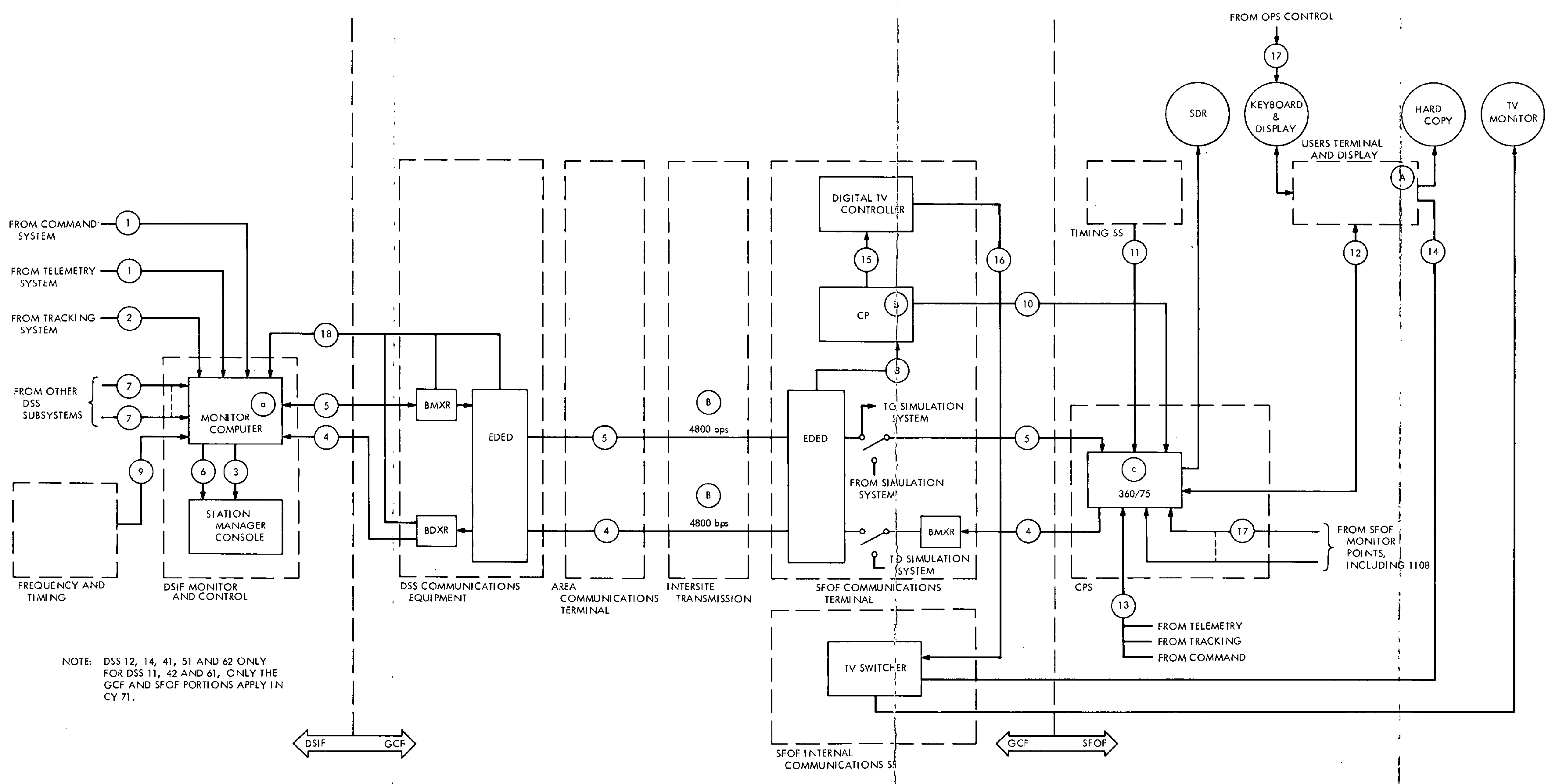
(18) COMMANDS TO TCP, MONITOR STANDARDS AND LIMITS TO DIS, AND TRAFFIC TO OTHER DSIF SYSTEMS FROM SFOF

(19) SIMULATED GMT AND INTERVAL TIMING INTERRUPT

(A) AND (a) TO (d) DEFINED IN TABLE B-6

Fig. B-5. DSN Simulation System for Pioneer 10 at 26- and 64-m-diam antenna DSSs

A 219. B C



NOTE: DSS 12, 14, 41, 51 AND 62 ONLY FOR DSS 11, 42 AND 61, ONLY THE GCF AND SFOF PORTIONS APPLY IN CY 71.

DATA FLOW PATHS

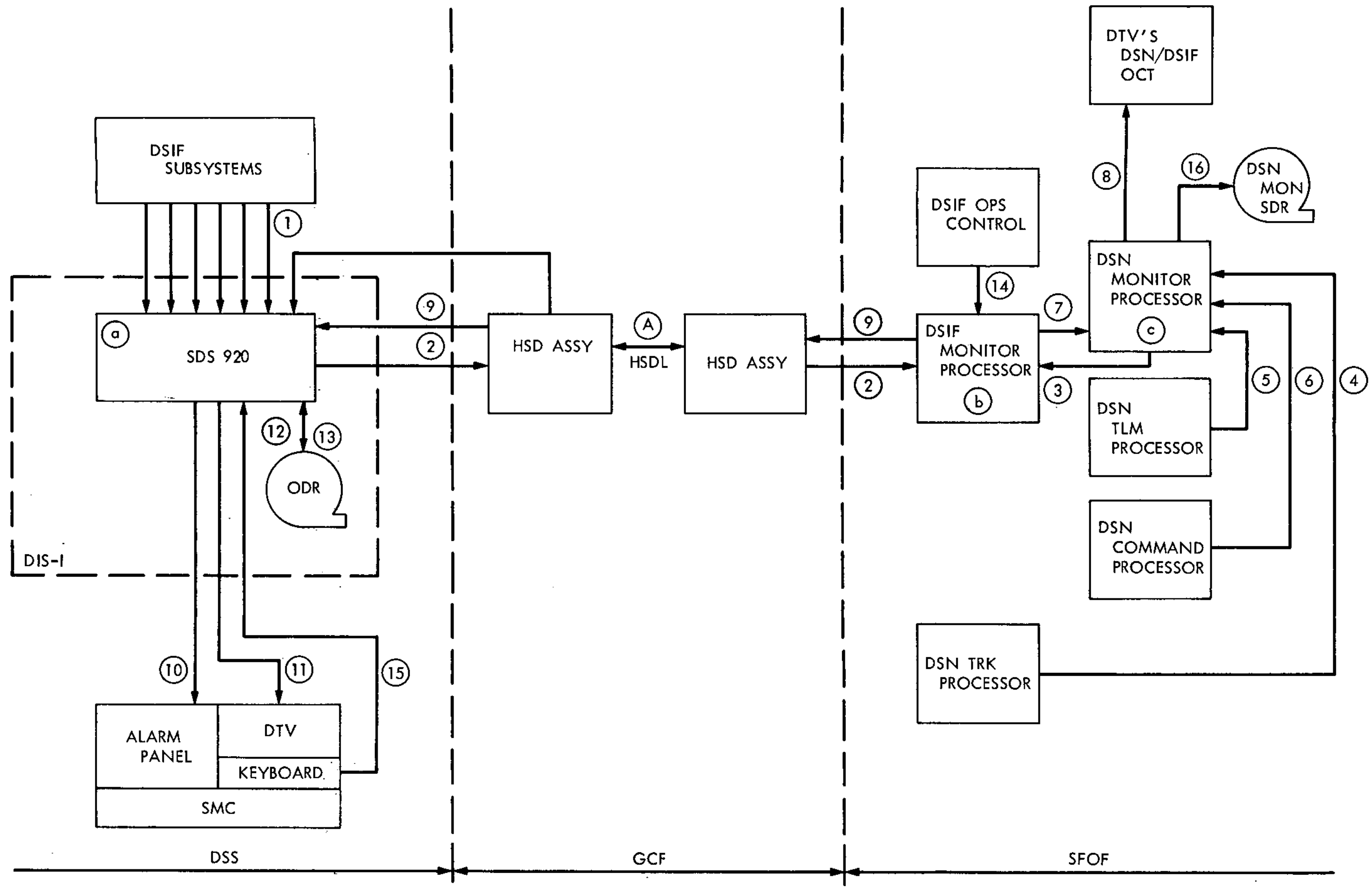
1. DSIF TELEMETRY SYSTEM AND COMMAND SYSTEM ALARMS AND STATUS (DOES NOT INCLUDE DECOMMUTATED SPACECRAFT DATA)
2. DSIF TRACKING SYSTEM DATA, STATUS, AND ALARMS
3. DSIF ALARMS FOR CORRECTIVE ACTION BY STATION MANAGER (NO GCF STATUS DATA OR ALARMS)
4. DSS INSTRUMENT STANDARDS AND LIMITS (PREDICTS)
5. DSS STATUS DATA; INCLUDES ALL DATA PROCESSED BY DSS MONITOR COMPUTER EXCEPT ALARMS FROM DSS INSTRUMENT STANDARDS AND LIMITS
6. DSS TRACKING SYSTEM ALARMS FROM TRACKING ERROR DETECTION FUNCTION LOCATED IN MONITOR COMPUTER
7. INSTRUMENT STATUS FROM OTHER DSS SUBSYSTEMS
8. GCF HSD INSTRUMENT ALARMS FOR ALL HIGH-SPEED TRAFFIC INBOUND TO SFOF
9. TIME
10. GCF INSTRUMENT STATUS AND DATA STATUS TO 360/75
11. TIME
12. MONITOR PROGRAM/OPERATOR INTERPLAY, PLUS STATUS DISPLAYS
13. DATA ALARMS GENERATED WITHIN SFOF, TRACKING, TELEMETRY, AND COMMAND SYSTEMS, AND PERIODIC PROCESSING STATUS MESSAGES. INCLUDES DECOMMUTATED S/C TELEMETRY.
14. VIDEO IMAGES OF DIGITAL DISPLAYS
15. GCF INSTRUMENT ALARMS FORMATTED FOR GCF CONTROL TV DISPLAY
16. GCF ALARM DISPLAY FOR CORRECTIVE ACTION BY GCF CONTROL
17. SFOF MONITOR DATA, BOTH 360/75 AND 1108
18. SELECTED GCF STATION HSDA TERMINAL MONITOR DATA FOR RETURN TO SFOF

(A) AND (B) AND (a) TO (c) ARE DEFINED IN TABLE B-7

Fig. B-6. DSN Monitoring System for Pioneer 10 at SFOF, GCF, and DSSs 12, 14, 41, 51, and 62

A

B



DATA FLOW PATHS

1. RAW MONITOR DATA INPUTS
2. RAW MONITOR DATA HSD BLOCKS
3. SELECTED DSN MONITOR; INCLUDES PSEUDO-RESIDUALS, DECOMMUTED TELEMETRY
4. PROCESSED TRACKING DATA AND ALARMS
5. TELEMETRY SYSTEM MONITOR MESSAGES
6. COMMAND SYSTEM MONITOR MESSAGES
7. PROCESSED DSIF MONITOR DATA AND ALARMS
8. MONITOR DTV DISPLAYS FOR DSIF/DSN OCT
9. PROCESSED DSIF MONITOR DATA TO ORIGINATING DSS; INCLUDES DATA IN (3)
10. ALARM SIGNALS TO STATION MONITOR AND CONTROL CONSOLE (SMC) ALARM PANEL
11. DTV DISPLAYS
12. NON-REAL TIME DUMP OF DSIF MONITOR ODR
13. RAW MONITOR DATA TO LOG TAPE (ODR)
14. OPERATION CONTROL OF DSIF PROCESSOR IN 360/75
15. STATION MONITOR CONTROL FROM KEYBOARD
16. DSN MONITOR SDR

EQUIPMENT/SUBSYSTEM CAPABILITIES

(A) ONE 4800-bps FULL-DUPLEX LINE PER DSS, SHARED BY ALL SYSTEMS; 1200-BIT BLOCK SIZE

SOFTWARE CAPABILITIES

(a) DSIF MONITOR BACKFEED DIS PROGRAM (TO BE ADDED)

(b) DSIF MONITOR PROGRAM IN 360/75 (TO BE ADDED)

(c) DSN MONITOR PROGRAM

A. THIS PROGRAM IS THE SAME AS THAT WHICH DESCRIBED SOFTWARE CAPABILITY, ITEM (c), OF THE MONITOR SYSTEM, AS CONFIGURED FOR DSSs 12, 14, ETC, BUT WITH THE ADDITION OF THE FOLLOWING:

1. OUTPUT PROCESS SELECTED DSN MONITOR DATA TO THE DSIF PROCESSOR IN THE 360/75. THIS DATA WILL INCLUDE PSEUDO-RESIDUALS AND SELECTED DECOMMUTATED S/C TELEMETRY.
2. INPUT PROCESS DSIF MONITOR DATA BLOCKS FROM THE DSIF MONITOR PROCESSOR IN THE 360/75. BLOCK FORMAT AND RATE ARE IDENTICAL TO THOSE RECEIVED VIA HSDA LINE FROM DSS 12, 14, ETC.

Fig. B-7. DSN Monitoring System for Pioneer 10 at SFOF, GCF, and DSSs 11, 42, and 61

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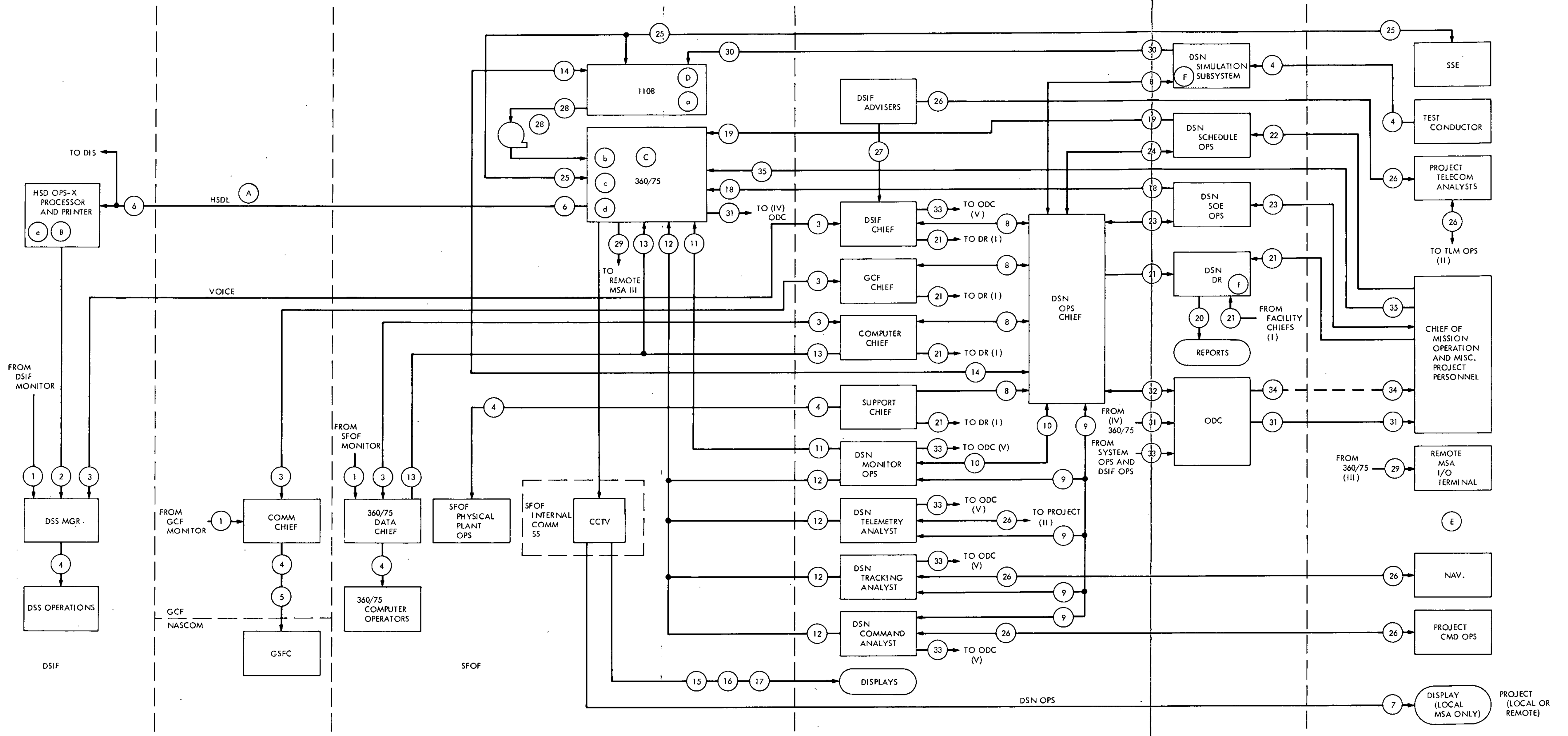

DATA FLOW PATHS

1. FACILITY STATUS AND ALARMS FOR ACTION AT FACILITY OPERATION SUPERVISOR'S INITIATIVE
2. PAGE PRINTS OF DSIF OPERATION CONTROL DATA, e.g., SEQUENCE OF EVENTS (SOE), DSIF (S AND L)
3. FACILITY INTERNAL ACTIVITY COORDINATION
4. OPERATIONAL DIRECTION
5. RESOURCE REQUIREMENTS AND COMMITMENTS
6. HSDA BLOCKS OF DSIF OPERATIONS CONTROL DATA AND DSIF S AND L, e.g., SOE, PREDICTS
7. DSN MONITOR DISPLAY FOR DSN OPERATION OF "DSN STATUS INFORMATION FOR PROJECT" (LOCAL MSA ONLY)
8. FACILITY INTERFACE ACTIVITY COORDINATION
9. SYSTEM DATA STATUS, TROUBLESHOOTING ADVICE, DATA RECALL REQUIREMENTS
10. COORDINATION OF NETWORK S AND L
11. REAL-TIME CONTROL OF NETWORK S AND L (LIMITED TO DSIF IN CY 71 AND 72
12. CONTROL OF EACH SYSTEM DATA PROCESSOR, INCLUDING MDR
13. CONTROL OF 360/75
14. COORDINATION OF 1108 CONTROL
15. DSN MONITOR DISPLAYS FOR DSN OPERATION
16. DSN MONITOR DISPLAYS FOR FACILITY OPERATION
17. DSN MONITOR DISPLAYS FOR SYSTEMS OPERATION
18. CONTROL OF SOE SOFTWARE
19. CONTROL OF SCHEDULING SOFTWARE (SKED S/W)
20. REPORTS ON DISCREPANCY REPORT (DR) DATA VIA OFFLINE PROCESSING FOR MANAGEMENT, DSN OPERATION, FACILITY OPERATION, SYSTEMS OPERATION
21. REPORTING OF RECOVERY OPERATIONS
22. PROJECT RESOURCE AND SUPPORT REQUIREMENTS
23. COORDINATION OF SEQUENCE PLANNING
24. COORDINATION OF REAL-TIME CHANGES OF SUPPORT REQUIREMENTS
25. CONTROL OF PROJECT ANALYSIS PROGRAMS IN 1108 AND 360/75
26. TECHNICAL INFORMATION EXCHANGE
27. SPECIALIZED ADVISORY SUPPORT (NOT OPERATIONAL DIRECTION)
28. TELEMETRY PREDICTS FROM TELEMETRY PREDICTS ANALYSIS PROGRAM (TRAP[a]), VIA TAPE INTERFACE
29. SAME DSN MONITOR DATA AS 7, BUT FORMATTED FOR ROUTING TO REMOTE MSA I/O TERMINAL IN MACHINE LANGUAGE
30. CONTROL OF DSN SIMULATION SOFTWARE IN 1108
31. TRACKING, TELEMETRY AND COMMAND MDRs
32. COORDINATION OF PHYSICAL TRANSFER OF MDRs TO PROJECT
33. INPUTS TO DSN PASS FOLDERS
34. PASS FOLDERS AVAILABLE (ORIGINAL FOR CURRENT DAY, MICROFILM FOR HISTORICAL FOLDERS) FOR PROJECT PERUSAL. MAY SEND TO PROJECT IF SO NEGOTIATED AS INTERFACE.
35. CONTROL OF SOE GENERATION PROGRAM IN 360/75 BY PROJECT

A TO F AND a TO f ARE DEFINED IN TABLE B-8

[a] SEE NOTES ON a AND b IN "SOFTWARE CAPABILITIES"

Fig. B-8. DSN Operations Control System for Pioneer 10

A

223.1

B

223.2

FOLDOUT FRAME 1

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FOLDOUT FRAME

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APPENDIX C

PIONEER 10 SEQUENCE OF EVENTS AND PASS CHRONOLOGY MARCH 3, 1972 THROUGH MARCH 31, 1972

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MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65186

0001 720630210 720630942 AM PF 0001
DSS 51 PASS 002 CL H-B CTDN N/A GCF S60J CPS T701 DSS J000

CONFIG --

ACS DOY 064		LCS DOY 064		TOTAL	
SCHEDULED	0045Z	SCHEDULED	0947Z	SCHEDULED	9H 02M
ACTUAL	0040Z	ACTUAL	0947Z	ACTUAL	9H 07M
ST XFR	0000Z	RELEASE	0947Z	DSS TIME	9H 47M

COMMAND --

TOTAL 12 AUTO 12 MANUAL 0 ABORT 0

TELEMETRY --

POWER 1 KW BIT RATES 1024

	RX 1	RX 2	TCP A	TCP B
ACTUAL	124.0	N/A	25.4	N/A
PREDIC	124.1	N/A	22.5	N/A
RESID	+0.1	N/A	+2.9	N/A

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS .071HZ C NOS .006HZ EXP .005HZ

MONITOR --

	LGWR	LGER	BLRC	BLER
DIS	1612	0	819	0

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

```
0001  720630210   720630942    AM   PF   0001
                  TCP  N/A   N/A   N/A   N/A
```

CCMMENTS

0155Z LCST ALL H/S AND TTY CIRCUITS TC SS 51

0156Z-0206Z 360/75 DCWN FCR RESTART DUE TO DOA A BENDS FOR TTY

DISPLAY DR 3233

0508Z-0520Z 360/75 DCWN-2260'S LCCK CUT, WARM RESTART AND

WARM IPL REG DR 3233

0759-0805Z 36C/75 DCWN-SYSTEM SWAP-UP CN CBC STRING NO DR

0116Z-0935Z 2 WAY

0120Z-0930Z CMD XMITTED

PICNEER 10 S/C 23

P10CCZ65181

```
0001  720630952   720631625    AA   PF   0001
      DSS 11 PASS 001  CL P-1 CTDN 101131 GCF S60A CPS N/A  DSS A000
```

CCNFIG

```
ACS DOY 063   LCS DOY 063          TOTAL
SCHEDULED 1000Z SCHEDULED 1700Z SCHEDULED   7H 00M
ACTUAL    0953Z ACTUAL    1627Z ACTUAL      6H 28M
ST XFR    0930Z RELEASE   1625Z DSS TIME N/RH   M
```

CCMMAND

TOTAL 7   AUTO 7   MANUAL 0   ABCRT 0

MCNTHLY REPORT FOR MARCH 1972

```
---------------------------------------------------------------------------
PASS  GMT-START      GMT-END      CRIG  TYPE  DATA
NO.                               CODE  CODE  CAY
---------------------------------------------------------------------------

        TELEMETRY ---------------------------------------------------------

                  POWER  10KW  BIT RATES   2048      MMT

                         RX 1    RX 2  TCP A      TCP B

                  ACTUAL 155.5   N/A    26.7       N/A

                  PRECIC 155.7   N/A     N/A       N/A

                  RESIC   +0.2   N/A     N/A       N/A

        TRACKING ----------------------------------------------------------

                  TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                  DOP BIAS   -0.12HZ C NOS 0.010HZ EXP 0.005HZ

        MCNITOR -----------------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  CIS  N/R   N/R   N/R   N/R


     PICNEER 10 S/C 23

 0001  720630952     720631625    AA   PF   0001
                  TCP  N/R   N/R   N/R   N/R


        CCMMENTS ----------------------------------------------------------
```

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CCDE	CATA CAY

PICNEER 10 S/C 23

P10CCZ65193

0002 720640040 720640947 AM PF C002
DSS 51 PASS 002 CL H-B CTDN N/A GCF S60J CPS T701 DSS J000

CCNFIG

ACS DOY 064	LCS DCY 064	TOTAL
SCHEDULED 0045Z	SCHEDULED 0947Z	SCHEDULED 9H 02M
ACTUAL CC40Z	ACTUAL C947Z	ACTUAL 9H 07M
ST XFR 0000Z	RELEASE 0947Z	DSS TIME 9H 47M

CCMMAND

TOTAL 12 AUTO 12 MANUAL 0 ABCRT 0

TELEMETRY

POWER 1 KW BIT RATES 1024

	RX 1	RX 2	TCP A	TCP B
ACTUAL	124.0	N/A	25.4	N/A
PREDIC	124.1	N/A	22.5	N/A
RESID	+0.1	N/A	+2.9	N/A

TRACKING

TRACK MC 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS .071HZ C NOS .006HZ EXP .005HZ

MCNITCR

	LGWR	LGER	BLRC	BLER
DIS	1612	0	819	0

```
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  CODE  DAY

     PIONEER 10 S/C 23

 0002  720640040     720640947     AM   PF   C002
                     TCP  N/A     N/A  N/A   N/A

        COMMENTS

        0155Z LOST ALL H/S AND TTY CIRCUITS TO DSS 51

        0156Z-0206Z 360/75 DOWN FOR RESTART DUE TO CCA A BENDS

        FOR TTY DISPLAY DR 3233

        0508Z-0520Z 360/75 DOWN-2260'S LOCKED OUT, WARM RESTART AND

        WARM IPL REG. DR 3233

        0759Z-0805Z 360/75 DOWN SYSTEM SWAP-UP ON "B" STRING NO DR

          0116Z-0935Z 2 WAY

          0120Z-0930Z CMD XMITTED

     PIONEER 10 S/C 23

  P10CCZ65189

 0002  720641010     720641704     AA   PF   0002
        DSS 11 PASS 002  CL H-B CTDN  N/A   GCF S60A CPS T701 DSS A000

        CONFIG

                  AOS DOY 064  LOS DOY 064        TOTAL

                  SCHEDULED 0948Z SCHEDULED 1700Z SCHEDULED   7H 12M

                  ACTUAL    0930Z ACTUAL    1704Z ACTUAL      7H 34M

                  ST XFR    0910Z RELEASE   1704Z DSS TIME    7H 54M

        COMMAND

                  TOTAL  0   AUTO  0   MANUAL  0   ABORT  0
```


E

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 2048 MMT

	RX 1	RX 2	TCP A-ENG	TCP B-SCI
ACTUAL		126.8	22.2	N/A
PREDIC		126.5	N/A	N/A
RESID		-0.3	N/A	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.06HZ C NOS 0.006HZ EXP .005HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY
0002	720641010	720641704	AA	PF	0002

TCP	N/R	N/R	N/R	N/R

COMMENTS

1128Z-1135Z 360 "B" DOWN RESTART DR 3236

1155Z-1210Z GODDARD CP DOWN DR 4973

```
--------------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
--------------------------------------------------------------------------------

     PIONEER 10 S/C 23

  P10C0Z65191

 0002  720641548     720650145    AJ   PF   0002
        DSS 42 PASS 002  CL H-B CTDN N/A    GCF S60G CPS T701 DSS G000

        CONFIG      ------------------------------------------------------------

                    AOS DOY 064  LOS DOY 065         TOTAL

                    SCHEDULED 1600Z SCHEDULED 0145Z SCHEDULED  9H 45M

                    ACTUAL     1548Z ACTUAL     0145Z ACTUAL     9H 57M

                    ST XFR     1518Z RELEASE    0145Z DSS TIME  10H 27M

        COMMAND     ------------------------------------------------------------

                    TOTAL N/A  AUTO N/A  MANUAL N/A  ABORT N/A

        TELEMETRY   ------------------------------------------------------------

                    POWER  1 KW  BIT RATES 2048    MMT

                          RX 1   RX 2  TCP A     TCP B

                    ACTUAL 127.6   N/A      23.0      N/A

                    PREDIC 128.1   N/A      27.7      N/A

                    RESID   +0.6   N/A      -4.7      N/A

        TRACKING    ------------------------------------------------------------

                    TRACK MD 2,3WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                    DOP BIAS   +0.07HZ C NOS 0.006HZ EXP 0.005HZ

        MONITOR     ------------------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                    DIS  N/R   N/R   N/R   N/R
```

```
                    MONTHLY REPORT FOR MARCH 1972
--------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
--------------------------------------------------------------------------

      PIONEER 10 S/C 23

 0002  720641548    720650145    AJ   PF   0002
                    TCP  N/R   N/R   N/R   N/R


         COMMENTS  ------------------------------------------------------

         2 WAY TRACK 1631Z-0117Z

         CMD XMITT 1645Z

         1750Z-1759 360 DOWN WARM RESTART AND IPL DR 3234

         TCP SNR LOW DUE TO SATURATION OF TCP CURVE


      PIONEER 10 S/C 23

  P1000Z65220

 0003  720650044    720650945    AM   PF   0003
         DSS 51 PASS 003  CL H-B CTDN  N/A   GCF S60J CPS T701 DSS J000

         CONFIG  --------------------------------------------------------

                    AOS DOY 065  LOS DOY 065        TOTAL

                    SCHEDULED 0045Z SCHEDULED 0945Z SCHEDULED   9H 00M

                    ACTUAL    0044Z ACTUAL    0945Z ACTUAL      9H 01M

                    ST XFR    0000Z RELEASE   0945Z DSS TIME    9H 45M

         COMMAND  -------------------------------------------------------

                    TOTAL 54   AUTO  54  MANUAL  0   ABORT  0
```

MCNTHLY REPURT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

TELEMETRY

POWER 10KW BIT RATES 2048

	RX 1	RX 2	TCP A	TCP B
ACTUAL	129.0	N/A	22.3	N/A
PREDIC	129.6	N/A	23.4	N/A
RESID	+0.6	N/A	-1.1	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS N/A HZ C NCS .006HZ EXP .005HZ

MCNITCR

	LGWR	LGER	BLRC	BLER
DIS	1522	0	3125	2

PICNEER 10 S/C 23

C003	720650044	720650945	AM	PF	0003
	TCP	N/A	N/A	N/A	N/A

CCMMENTS

NC TCP/DIS INTERFACE

CMD XMITT 0107Z-0117Z

0404Z-0412Z 360 DOWN SCHEDULE RE IPL NO DR

0813Z-0827Z 360/75 DOWN-SCHEDULE STRING SWAP

DR 3288

AT END OF PASS

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

P10CC Z65209

```
0003   72065C930     72C651002    AT   PF   0003
         DSS 75 PASS 003  CL A-   CTDN   N/A   GCF N/A   CPS N/A   DSS N/A

         CCNFIG    ----------------------------------------------

                   ACS DCY 065  LCS DCY 065        TOTAL

                   SCHEDULED 0930Z SCHEDULED 1000Z SCHEDULED 00H 30M

                   ACTUAL    C930Z ACTUAL    1002Z ACTUAL    00H 32M

                   ST XFR    C830Z RELEASE   1002Z DSS TIME  01H 32M

         CCMMAND   ----------------------------------------------

                   TCTAL N/A  AUTC N/A  MANUAL N/A  ABORT N/A

         TELEMETRY ----------------------------------------------

                   POWER N/AKW  BIT RATES  N/A

                          RX 1    RX 2   TCP        TCP

                   ACTUAL  N/A     N/A    N/A        N/A

                   PRECIC  N/A     N/A    N/A        N/A

                   RESIC   N/A     N/A    N/A        N/A

         TRACKING  ----------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS  N/A   HZ C NOS  N/A HZ EXP  N/A HZ

         MCNITCR   ----------------------------------------------

                       LGWR  LGER  BLRC  BLER

                   DIS   N/A   N/A   N/A   N/A
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0003  720650930     720651002     AT   PF   0003
                   TCP    N/A    N/A   N/A   N/A
```

COMMENTS ---

PIONEER 10 S/C 23

P10CCZ65196

```
0003  720650941     720651419     AD   PF   0003
          DSS 14 PASS 003  CL J-A CTDN  N/A   GCF S600 CPS T701 DSS D000
```

CONFIG ---

```
ACS DOY 065  LOS DOY 065         TOTAL

SCHEDULED 1000Z SCHEDULED 1430Z SCHEDULED  4H 30M

ACTUAL    0941Z ACTUAL    1419Z ACTUAL     4H 38M

ST XFR    0915Z RELEASE   1419Z DSS TIME   5H 04M
```

COMMAND ---

TOTAL N/A AUTO N/A MANUAL N/A ABORT N/A

TELEMETRY ---

POWER N/AKW BIT RATES N/A

	RX 1	RX 2	TCP A	TCP B
ACTUAL	N/A	N/A	N/A	N/A
PREDIC	N/A	N/A	N/A	N/A
RESID	N/A	N/A	N/A	N/A

MONTHLY REPORT FOR MARCH 1972

```
--------------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
--------------------------------------------------------------------------------

         TRACKING  --------------------------------------------------------------

                   TRACK MD N/AWAY RANGING N/A BIAS N/A RU NOISE N/A RU

                   DOP BIAS   N/A   HZ  C NOS   N/A HZ EXP   N/A HZ

         MONITOR   --------------------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  885   306    0     0


      PIONEER 10 S/C 23

 0003  720650941     720651419    AC  PF  0003
                   TCP  N/A   N/A   N/A   N/A


         COMMENTS  --------------------------------------------------------------

         NO DIS/TCP INTERFACE
```

```
                              MONTHLY REPORT FOR MARCH 1972
--------------------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  CODE  DAY
--------------------------------------------------------------------------------

      PIONEER 10 S/C 23

  P10CCZ65195

 0003  720650943    720651659    AA   PF   0003
         DSS 11 PASS 003  CL H-B CTDN  N/A   GCF S60A CPS T701 DSS A000

         CONFIG     --------------------------------------------------------

                    ADS DOY 065  LOS DOY 065          TOTAL

                    SCHEDULED 0944Z SCHEDULED 1657Z SCHEDULED  7H 13M

                    ACTUAL    0943Z ACTUAL    1659Z ACTUAL     7H 16M

                    ST XFR    0900Z RELEASE   N/A Z DSS TIMEN/A H   M

         COMMAND    --------------------------------------------------------

                    TOTAL 74   AUTO 74   MANUAL  0   ABORT  0

         TELEMETRY  --------------------------------------------------------

                    POWER  1 KW  BIT RATES 2048

                           RX 1   RX 2  TCP A     TCP B

                    ACTUAL 131.5   N/A      19.9      N/A

                    PREDIC 130.8   N/A      22.0      N/A

                    RESID   -0.7   N/A       3.1      N/A

         TRACKING   --------------------------------------------------------

                    TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                    DOP BIAS   -0.25HZ C NOS  N/A HZ EXP  N/A HZ

         MONITOR    --------------------------------------------------------

                         LGWR  LGER  BLRC  BLER

                    DIS  N/A   N/A   N/A   N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NC.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
CCC3  720650943    720651659    AA   PF   0003
                TCP   N/A   N/A  N/A    N/A
```

CCMMENTS --

PICNEER 10 S/C 23

P10CC265198

```
C003  720651556    720660145    AJ   PF   0003
      DSS 42 PASS 003  CL H-B CTDN   N/A  GCF S60G CPS T701 DSS G000
```

CCNFIG --

```
AOS COY 065   LCS DOY 065          TOTAL

SCHEDULED 1600Z SCHEDULED 0145Z SCHEDULED   9H 45M

ACTUAL    1556Z ACTUAL    0145Z ACTUAL      9H 49M

ST XFR    1515Z RELEASE   0145Z DSS TIME   10H 30M
```

CCMMAND --

```
TCTAL  37  AUTC  37  MANUAL  0   ABORT  0
```

TELEMETRY --

```
POWER  1 KW  BIT RATES  2048    MMT

        RX 1    RX 2  TCP A      TCP B

ACTUAL 131.2    N/A    24.4       N/A

PRECIC 132.0    N/A    23.9       N/A

RESIC   +0.8    N/A    -1.5       N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD 2.3WAY RANGING NIL BIAS N/ARU NOISE N/A RU

DOP BIAS -0.26HZ C NCS 0.001HZ EXP 0.005HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

0003	720651556	720660145	AJ	PF	0003
		TCP N/R	N/R	N/R	N/R

COMMENTS

2 WAY TRACK 1632Z.TO 0115Z CMD XMIT: 1700Z.TO 2012Z

2039Z-2048Z 3100 DOWN FOR RESTART DR 3021

2351Z-2357Z 360 DOWN "A" RESTART REQ: DR 3236

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END      CRIG  TYPE  DATA
NO.                               CODE  CODE  CAY
------------------------------------------------------------------------

     PICNEER 10 S/C 23

 P10CCZ65200

0004  720660042     720660940     AM   PF   CCC4
        DSS 51 PASS 004  CL H-B CTDN N/A    GCF S60J CPS T701 DSS J000

        CCNFIG     --------------------------------------------------

                   ACS DOY 066  LCS DOY C66          TOTAL

                   SCHEDULED 0045Z SCHEDULED 0942Z SCHEDULED   7H 57M

                   ACTUAL    CC42Z ACTUAL    C940Z ACTUAL      7H 58M

                   ST XFR    CC00Z RELEASE   0940Z DSS TIME    9H 40M

        CCMMAND    --------------------------------------------------

                   TCTAL  1   AUTC  1   MANUAL  0   ABCRT  0

        TELEMETRY  --------------------------------------------------

                   POWER  1 KW  BIT RATES 2C48       MMT

                          RX 1    RX 2   TCP A      TCP B

                   ACTUAL 133.0   N/A     21.6       N/A

                   PREDIC 133.1   N/A     22.7       N/A

                   RESIC   +0.1   N/A     -1.1       N/A

        TRACKING   --------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NCISE  N/ARU

                   DOP BIAS  -0.236HZ C NOS  .003HZ EXP  .005HZ

        MCNITCR    --------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  1622  2     254   1
```

MONTHLY REPORT FOR MARCH 1972

```
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY

      PIONEER 10 S/C 23

0004  720660042     720660540    AM   PF   0004
                  TCP  N/A     N/A  N/A    N/A


        COMMENTS  ------------------------------------------------------


      PIONEER 10 S/C 23

  P10002652O1

0004  720660217     720660530    AO   PF   0004
        DSS 11 PASS 004  CL G-  CTDN  N/A  GCF S60K CPS T701 DSS K000

        CONFIG    ------------------------------------------------------

                  ACS DOY 066  LOS DOY 066        TOTAL

                  SCHEDULED 0130Z SCHEDULED 0530Z SCHEDULED  4H 00M

                  ACTUAL    0217Z ACTUAL    0530Z ACTUAL     3H 13M

                  ST XFR    N/A Z RELEASE   N/AZ DSS TIMEN/A H    M

        COMMAND   ------------------------------------------------------

                  TOTAL N/R  AUTO N/R  MANUAL N/R  ABORT N/R

        TELEMETRY ------------------------------------------------------

                  POWER N/AKW  BIT RATES  N/A

                         RX 1   RX 2  TCP        TCP

                  ACTUAL  N/A     N/A      N/A      N/A

                  PREDIC  N/A     N/A      N/A

                  RESID   N/A     N/A      N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD N/AWAY RANGING N/A BIAS N/A RU NCISE N/A RU

DOP BIAS N/A HZ C NCS N/A HZ EXP N/A HZ

MCNITCR

	LGWR	LGER	BLRC	BLER
DIS	N/A	N/A	N/A	N/A

PICNEER 10 S/C 23

C004	720660217	720660530	AC	PF	C004

TCP	N/A	N/A	N/A	N/A

CCMMENTS

RECCRD CNLY PASS

MCNTHLY REPURT FCR MARCH 1972

```
-------------------------------------------------------------------------
PASS  GMT-START      GMT-END      CRIG  TYPE  CATA
NO.                               CODE  CODE  DAY
-------------------------------------------------------------------------

     PICNEER 10 S/C 23

  P10CCZ6521C

0004  720660930    720661019    AT   PF   0004
         DSS 75 PASS 004  CL      CTDN  N/A   GCF S60Y CPS N/A  DSS R600

         CCNFIG    ----------------------------------------------------

                   AOS DOY 066  LOS DOY 066         TOTAL

                   SCHEDULED 0900Z SCHEDULED 1130Z SCHEDULED  2H 30M

                   ACTUAL    0930Z ACTUAL    1019Z ACTUAL      H    M

                   ST XFR    0818Z RELEASE   1019Z DSS TIME    H    M

         CCMMAND   ----------------------------------------------------

                   TOTAL N/A  AUTC N/A  MANUAL N/A  ABORT N/A

         TELEMETRY ----------------------------------------------------

                   POWER  2 KW  BIT RATES 512

                          RX 1   RX 2  TCP A    TCP B

                   ACTUAL 145.5   N/A      N/A       N/A

                   PREDIC 141.8   N/A      N/A       N/A

                   RESID   -3.7   N/A      N/A       N/A

         TRACKING  ----------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS   N/A   HZ C NOS  N/A HZ EXP  N/A HZ

         MCNITOR   ----------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  N/A    N/A   N/A   N/A
```


F

```
                    MONTHLY REPORT FOR MARCH 1972
---------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  CODE  DAY
---------------------------------------------------------------------

     PIONEER 10 S/C 23

 0004  720660930      720661019     AT   PF   0004
                   TCP  N/A     N/A    N/A    N/A


        COMMENTS  ------------------------------------------------


     PIONEER 10 S/C 23


 P100CZ65203

 0004  720660941      720661657     AA   PF   0004
        DSS 11 PASS 004  CL H-B CTDN  N/A   GCF S60A CPS  N/A DSS A000

        CONFIG    ------------------------------------------------

                  ACS DOY 066  LCS DOY 066         TOTAL

                  SCHEDULED 0941Z SCHEDULED 1654Z SCHEDULED  7H 13M

                  ACTUAL    0941Z ACTUAL    1657Z ACTUAL     7H 16M

                  ST XFR    0850Z RELEASE   1816Z DSS TIME   9H 26M

        COMMAND   ------------------------------------------------

                  TOTAL  1   AUTO  1   MANUAL  0   ABORT  0

        TELEMETRY ------------------------------------------------

                  POWER  1 KW  BIT RATES  2048

                        RX 1   RX 2  TCP A     TCP B

                  ACTUAL 139.9  N/A      18.9      N/A

                  PREDIC 139.9  N/A      22.0      N/A

                  RESID      0  N/A      -3.1      N/A
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.14HZ C NOS 0.002HZ EXP .005HZ

MONITOR --

LGWR LGER BLRC BLER

DIS

PIONEER 10 S/C 23

0004	720660941	720661657 TCP	AA	PF	0004

COMMENTS --

```
------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
------------------------------------------------------------------------

     PIONEER 10 S/C 23

  P100C265208

0005  720670040     720670938     AM   PF   0005
      DSS 51 PASS 0C5  CL H-B CTDN  N/A   GCF S60J CPS T701 DSS J000

      CONFIG    ----------------------------------------------------

                AOS DOY 067  LOS DOY 067         TOTAL

                SCHEDULED 0045Z SCHEDULED 0938Z SCHEDULED  8H 53M

                ACTUAL    0040Z ACTUAL    0938Z ACTUAL     8H 58M

                ST XFR    2350Z RELEASE   0938Z DSS TIME   9H 48M

      COMMAND   ----------------------------------------------------

                TOTAL 35   AUTO  35  MANUAL  0   ABORT  0

      TELEMETRY ----------------------------------------------------

                POWER  1 KW  BIT RATES 2048

                       RX 1   RX 2  TCP A     TCP B

                ACTUAL 135.2   N/A      19.6      N/A

                PREDIC 135.5   N/A      20.4      N/A

                RESID   +0.3   N/A      -0.8      N/A

      TRACKING  ----------------------------------------------------

                TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                DOP BIAS   -0.16HZ C NOS  .003HZ EXP  .005HZ

      MONITOR   ----------------------------------------------------

                    LGWR  LGER  BLRC  BLER

                DIS  1631    1   331    1
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA DAY

PICNEER 10 S/C 23

```
CCC5  720670C40   720670938   AM   PF   0005
                  TCP  N/A    N/A  N/A   N/A
```

CCMMENTS

2303Z-231CZ LCST HSD, LINE CUTAGE BETWEEN CANBERRA AND STA.

0313Z-0331Z 360 "B" DCWN, WARM RESTART DR 3248

1710Z-1722Z 360 STRING SWAP A TC B DR 3311

0806Z-0813Z 360 "B" DCWN, SCHEDULE WARM/WARM RESTART

CR 3312

PICNEER 10 S/C 23

P10CCZ65221

```
CC05  72C670900   720670945   CJ   PF   CC05
   DSS 75 PASS 005  CL C-  CTDN  N/A   GCF 560Y CPS N/A  DSS N/A
```

CCNFIG

AOS DOY C67	LCS DCY C67	TCTAL
SCHEDULED 0900Z	SCHEDULED 1130Z	SCHEDULED 2H 30M
ACTUAL C900Z	ACTUAL 0945Z	ACTUAL H 45M
ST XFR 0753Z	RELEASE 0945Z	DSS TIME 1H 53M

CCMMAND

TCTAL N/A   AUTC N/A   MANUAL N/A   ABCRT N/A

MCNTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
------------------------------------------------------------------------

        TELEMETRY  ---------------------------------------------------

                   POWER N/AKW  BIT RATES  N/A

                          RX 1    RX 2   TCP        TCP

                   ACTUAL  N/A     N/A       N/A        N/A

                   PREDIC  N/A     N/A       N/A        N/A

                   RESID   N/A     N/A       N/A        N/A

        TRACKING   ---------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS  N/A   HZ C NOS  N/A HZ EXP       HZ

        MCNITOR    ---------------------------------------------------

                        LGWR  LGER  BLRC  ELER

                   DIS   N/A   N/A   N/A   N/A


      PICNEER 10 S/C 23

 0005  720670900     720670945    CJ   PF   0005
                   TCP   N/A   N/A   N/A   N/A


        CCMMENTS   ---------------------------------------------------
```

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA CAY

PICNEER 10 S/C 23

P10CCZ65212

```
0CC5  72067C934    72C671615    AD   PF   C005
      DSS 14 PASS 005  CL J-A CTDN   N/A  GCF S600 CPS T701 DSS D000

      CCNFIG    -------------------------------------------------

                ACS DOY 067  LCS DOY C67         TOTAL

                SCHEDULED 1655Z SCHEDULED 1655Z SCHEDULED  7H 21M

                ACTUAL    1615Z ACTUAL    1615Z ACTUAL     8H 41M

                ST XFR    1617Z RELEASE   1617Z DSS TIME   7H 25M

      CCMMAND   -------------------------------------------------

                TCTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY -------------------------------------------------

                POWER  1 KW  BIT RATES  N/A

                       RX 1   RX 2   TCP A     TCP B

                ACTUAL  N/A    N/A     N/A       N/A

                PREDIC  N/A    N/A     N/A       N/A

                RESID   N/A    N/A     N/A       N/A

      TRACKING  -------------------------------------------------

                TRACK MD N/AWAY RANGING N/A BIAS N/A RU NOISE N/A RU

                DOP BIAS  N/A   HZ C NOS  N/A HZ EXP  N/A HZ

      MCNITOR   -------------------------------------------------

                    LGWR  LGER  BLRC  BLER

                DIS  1015  277   564    0
```

```
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY

      PIONEER 10 S/C 23

 0005  720670934    720671615    AD   PF   0005
                   TCP  N/A    N/A  N/A    N/A


         COMMENTS  -----------------------------------------------

         TEP SATURATED, BAD READING DUE TO CONSCAN DATA PROCESS SNR

         DEGRATED DUE TO PRECESSION AWAY FROM EARTH

         1430Z-1440Z 360/75B DOWN FOR WARM/WARM RESTART DR 3250

         1617Z-STATION RELEASE


      PIONEER 10 S/C 23

  P100CZ65214

 0005  720670936    720671630    AA   PF   0005
         DSS 11 PASS 005  CL P-B CTDN  N/A   GCF S60A CPS T701 DSS A000

         CONFIG    -----------------------------------------------

                   ACS DOY 067  LOS DOY 067        TOTAL

                   SCHEDULED 0937Z SCHEDULED 1650Z SCHEDULED   7H 13M

                   ACTUAL    0936Z ACTUAL    1630Z ACTUAL      6H 54M

                   ST XFR    0848Z RELEASE   1630Z DSS TIME    7H 42M

         COMMAND   -----------------------------------------------

                   TOTAL 46   AUTO 46   MANUAL 0    ABORT  0
```

MONTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
------------------------------------------------------------------------

         TELEMETRY  -------------------------------------------------

                    POWER  1 KW  BIT RATES  N/A

                           RX 1    RX 2  TCP  N/A  TCP

                    ACTUAL N/A     N/A        N/A

                    PREDIC N/A     N/A        N/A

                    RESID  N/A     N/A        N/A

         TRACKING   -------------------------------------------------

                    TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                    DOP BIAS  N/A   HZ C NOS  N/A HZ EXP N/A  HZ

         MONITOR    -------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                    DIS  N/A   N/A   N/A   N/A


      PIONEER 10 S/C 23

 0005  720670936    720671630    AA   PF  0005
                    TCP  N/A    N/A   N/A   N/A


         COMMENTS   -------------------------------------------------

         NO PASS AVERAGE CONSCAN DATA IN PROCESS
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

P10CCZ65216

```
0005  720671309   720680145    AJ   PF   CCC5
      DSS 42 PASS 005  CL F-B CTDN  N/A   GCF S606 CPS T701 DSS 6000

      CCNFIG    ------------------------------------------------------------

                ACS DOY 067  LCS DOY 068          TOTAL

                SCHEDULED 1240Z SCHEDULED 0210Z SCHEDULED 12H 30M

                ACTUAL     1309Z ACTUAL     0145Z ACTUAL     12H 36M

                ST XFR     1230Z RELEASE   0145Z DSS TIME   13H 15M

      CCMMAND   ------------------------------------------------------------

                TOTAL  47  AUTC  47  MANUAL  0   ABCRT  0

      TELEMETRY ------------------------------------------------------------

                POWER  1 KW  BIT RATES  2048       1024

                       RX 1    RX 2   TCP A     TCP B

                ACTUAL  N/A    135.6    21.5       N/A

                PREDIC  N/A    136.6    21.3       N/A

                RESID   N/A     +1.0    +0.2       N/A

      TRACKING  ------------------------------------------------------------

                TRACK MD 2,3WAY RANGING NIL BIAS N/A RU NCISE N/A RU

                DOP BIAS     +0.2HZ C NOS 0.003HZ EXP 0.005HZ

      MCNITOR   ------------------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                DIS   N/R   N/R   N/R   N/R
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

0005 720671309 720680145 AJ PF 0005
TCP N/R N/R N/R N/R

COMMENTS

2 WAY TRACK 1557Z-0126Z

CMD XMIT 1622Z-2056Z

PIONEER 10 S/C 23

P10CCZ65218

0006 720680040 720680934 AM PF 0006
DSS 51 PASS 006 CL H-B CTDN N/A GCF S60J CPS T701 DSS J000

CONFIG

AOS DOY 068		LOS DOY 068		TOTAL	
SCHEDULED	0045Z	SCHEDULED	0934Z	SCHEDULED	8H 49M
ACTUAL	0040Z	ACTUAL	0934Z	ACTUAL	8H 53M
ST XFR	0005Z	RELEASE	0934Z	DSS TIME	9H 29M

COMMAND

TOTAL 0 AUTO 0 MANUAL 0 ABORT 0

TELEMETRY

POWER 1 KW BIT RATES 1024

	RX 1	RX 2	TCP A	TCP B
ACTUAL	136.9	N/A	21.2	N/A
PREDIC	137.5	N/A	20.8	N/A
RESID	+0.6	N/A	+0.4	N/A

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	DATA CAY

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -.481HZ C NOS 0.002HZ EXP 97 HZ

MCNITOR --

	LGWR	LGER	BLRC	BLER
DIS	1290	0	254	0

PICNEER 10 S/C 23

C006	720680040	720680934	AM	PF	CCC6
		TCP N/A	N/A	N/A	N/A

CCMMENTS --

0148Z-0154Z 360 DCWN, TTY GUIDE TABLE CLOBBERED, RESTART

DR 3252

0924Z-0931Z 360 "B" CCWN-WARM RESTART DR 3253

0116Z-0900Z 2 WAY

0130Z-0855Z CMC XMITTEC

MCNTHLY REPORT FOR MARCH 1972

```
PASS  GMT-START    GMT-END     ORIG  TYPE  CATA
NO.                            CODE  CODE  CAY

     PICNEER 10 S/C 23

  P10CCZ65228

0006   720680830    720681C17   CJ   PF   C006
       DSS 75 PASS 006  CL C-  CTDN N/A   GCF S60Y CPS  N/A DSS N/A

       CCNFIG     -----------------------------------------------

                  ACS COY C68  LOS COY C68        TOTAL

                  SCHEDULED 0900Z SCHEDULED 0900Z SCHEDULED  2H 30M

                  ACTUAL    C830Z ACTUAL    0830Z ACTUAL     1H 47M

                  ST XFR    N/R Z RELEASE   N/R Z DSS TIME   1H 47M

       CCMMAND    -----------------------------------------------

                  TCTAL N/A  AUTC N/A  MANUAL N/A  ABCRT N/A

       TELEMETRY  -----------------------------------------------

                  POWER N/AKW  BIT RATES  N/A

                       RX 1   RX 2  TCP N/A   TCP N/A

                  ACTUAL  N/A    N/A     N/A      N/A

                  PRECIC  N/A    N/A     N/A      N/A

                  RESIC   N/A    N/A     N/A      N/A

       TRACKING   -----------------------------------------------

                  TRACK MD N/AWAY RANGING N/A BIAS N/A RU NOISE N/A RU

                  DOP BIAS  N/A   HZ C NCS  N/A HZ EXP  N/A HZ

       MCNITCR    -----------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  DIS  N/A   N/A   N/A   N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NC.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

FICNEER 10 S/C 23

```
0006  72068C830    72C681017    CJ   PF   0006
                TCP  N/A    N/A   N/A   N/A
```

CCMMENTS

0924Z-C931Z 36C "B" DOWN-WARM RESTART DR 2253

PICNEER 10 S/C 23

P10CCZ65223

```
0006  720680930    72C681647    AA   PF   C006
      DSS 11 PASS 006  CL H-B CTDN  N/A   GCF S60A CPS T701 DSS A0CO
```

CCNFIG

```
ACS DOY 068  LCS DCY C68          TOTAL

SCHEDULED 0933Z SCHEDULED 1647Z SCHEDULED  7H 14M

ACTUAL    C932Z ACTUAL    1647Z ACTUAL     7H 15M

ST XFR    C910Z RELEASE   1745Z DSS TIME   8H 35M
```

CCMMAND

TOTAL C   AUTO C   MANUAL 0   ABORT 0

TELEMETRY

POWER 1 KW BIT RATES 1024   MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	137.8	N/A	18.0	N/A
PREDIC	137.7	N/A	20.4	N/A
RESIC	+0.1	N/A	-2.4	N/A

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -.453HZ C NOS 0.002HZ EXP 0.002HZ

MCNITOR --

	LGWR	LGER	ELRC	ELER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY
0006	720680930	720681647	AA	PF	CCC6

TCP N/R N/R N/R N/R

CCMMENTS --

1045Z-1100Z 360 "B" DCWN, FOR IPL, DR 3254

1212Z-1241Z 360 "B" DCWN, FCR STRING SWAP WITH WARM START,

UP CN "A" STRING DR 3255

2 WAY TRACK 1000Z-1615Z

CMD MOD CN/OFF 1005Z-1615Z NO CMDS XMTD

```
----------------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  CODE  DAY
----------------------------------------------------------------------------

     PIONEER 10 S/C 23

  P10CCZ65226

 0006  720681529    720690136    AJ   PF   0006
      DSS 42 PASS 006  CL F-B CTDN  N/A   GCF S60G CPS N/A  DSS GOOD

      CONFIG    ------------------------------------------------

                ACS DOY 068  LCS DOY 069          TOTAL

                SCHEDULED 1545Z SCHEDULED 0145Z SCHEDULED 10H 00M

                ACTUAL    1529Z ACTUAL    0136Z ACTUAL    10H 07M

                ST XFR    1502Z RELEASE   0335Z DSS TIME  13H 33M

      COMMAND   ------------------------------------------------

                TOTAL  32  AUTO  32  MANUAL  0   ABORT  0

      TELEMETRY ------------------------------------------------

                POWER  10KW  BIT RATES 1024   MMT

                       RX 1   RX 2  TCP A     TCP B

                ACTUAL 137.5   N/A      20.4      N/A

                PRECIC 138.0   N/A      20.2      N/A

                RESIC   +0.5   N/A      +0.2      N/A

      TRACKING  ------------------------------------------------

                TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                DOP BIAS  -0.434HZ C NOS  .002HZ EXP  .005HZ

      MONITOR   ------------------------------------------------

                    LGWR  LGER  BLRC  BLER

                DIS  N/R    N/R    N/R    N/R
```

```
PASS  GMT-START     GMT-END     CRIG  TYPE  CATA
NO.                             CODE  CODE  DAY

   PICNEER 10 S/C 23

0006  720681529     72C690136    AJ    PF   CC06
                 TCP   N/R      N/R   N/R   N/R


      CCMMENTS

      CC59Z-0102Z FSD DCWN, LINE DCWN BETWEEN GSFC AND CANBERRA

      DR 5020

      2 WAY TRACK 1616Z-0115Z

      CMDS XMTD AT 2357Z-0105Z



   PICNEER 10 S/C 23

 P10CCZ65227

0OC7  720690042     72C690931    AM    PF   CCC7
      DSS 51 PASS 007  CL F-B CTCN  N/A   GCF S60J CPS T701 DSS J000

      CCNFIG

             ACS DOY C69   LCS DCY C69         TOTAL

             SCHECULED 0045Z SCHEDULED 0931Z SCHEDULED  8H 46M

             ACTUAL    CC42Z ACTUAL    C931Z ACTUAL     8H 49M

             ST XFR    C007Z RELEASE   1931Z DSS TIME   9H 24M

      CCMMAND

             TOTAL  35  AUTC  34  MANUAL  1   ABORT  0
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 1024

	RX 2	RX 1	TCP B	TCP A
ACTUAL	145.6	N/A	8.8	N/A
PREDIC	148.7	N/A	7.8	N/A
RESID	+3.1	N/A	+1.0	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/ARU NOISE N/A RU

DOP BIAS .590HZ C NOS .004HZ EXP .005HZ

MONITOR

	LGWR	LGER	BLRC	ELER
DIS	N/A	N/A	N/A	N/A

PIONEER 10 S/C 23

0007	720690042	720690931	AM	PF	0007
		TCP N/A	N/A	N/A	N/A

COMMENTS

DIS/TCP INTERFACE NOT AVAILABLE

0338Z-0340Z 360/75A DOWN, DUE CORE FRAGMENTATION, WARM

RESTART CR 3258

MCNTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     CRIG  TYPE  DATA
NO.                              CODE  CODE  CAY
------------------------------------------------------------------------

     PICNEER 10 S/C 23

  P10CCZ65229

 0007  72C69CE45    720691003    CJ   PF   CCC7
       DSS 75 PASS 0C7  CL N/A CTON  N/A  GCF S60V CPS N/A  DSS N/A

       CCNFIG     ----------------------------------------------------

                  ACS COY 069  LCS DOY 069        TOTAL

                  SCHEDULED 09C0Z SCHEDULED 1130Z SCHEDULED  2H 30M

                  ACTUAL    0845Z ACTUAL    1003Z ACTUAL     1H 18M

                  ST XFR    C830Z RELEASE   1003Z DSS TIME   1H 18M

       CCMMAND    ----------------------------------------------------

                  TCTAL N/A  AUTC N/A  MANUAL N/A  ABORT N/A

       TELEMETRY  ----------------------------------------------------

                  PCWER N/AKW  BIT RATES  N/A

                         RX 1   RX 2  TCP       TCP

                  ACTUAL  N/A     N/A     N/A       N/A

                  PRECIC  N/A     N/A     N/A       N/A

                  RESID   N/A     N/A     N/A       N/A

       TRACKING   ----------------------------------------------------

                  TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS   N/A  HZ C NCS  N/A HZ EXP  N/A HZ

       MCNITOR    ----------------------------------------------------

                       LGWR  LGER  BLRC  BLER

                  DIS   N/A   N/A  N/A   N/A
```

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
0007  72C69C845    72C691003    CJ   PF   0007
                  TCP    N/A    N/A  N/A   N/A
```

CCMMENTS ---

PICNEER 10 S/C 23

P10CCZ65233

```
0007  72C690928    720691640    AA   PF   CC07
      DSS 11 PASS 0C7  CL H-B CTDN 202231 GCF S00A CPS N/A  DSS A000
```

CCNFIG ---

```
AOS DOY C69  LOS DOY C69          TOTAL
SCHEDULED 0929Z SCHEDULED 1643Z SCHEDULED  7H 14M
ACTUAL     C928Z ACTUAL    1640Z ACTUAL     7H 12M
ST XFR     C845Z RELEASE   1815Z DSS TIME   9H 30M
```

CCMMAND ---

```
TCTAL  0   AUTO  0   MANUAL  0   ABORT  0
```

TELEMETRY ---

```
POWER  1 KW  BIT RATES  1024
        RX 1   RX 2   TCP A     TCP B
ACTUAL 147.5   N/A     5.5       N/A
PREDIC 149.3   N/A     5.7       N/A
RESID   +1.8   N/A    -0.2       N/A
```

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS -0.435HZ C NOS .011HZ EXP .002HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PICNEER 1C S/C 23

0007 720690928 720691640 AA PF 0007

TCP	N/R	N/R	N/R	N/R

CCMMENTS

1102Z-1116Z 36C/75A DCWN RESTART REQUIRED DR 3259

2 WAY TRACK 1000Z-1615Z

CMDS 1005Z-1610Z (MOC CN/CFF) NC CMDS XMTD

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

FICNEER 10 S/C 23

P10CC265235

0CC7	72C691551	72C700145	AJ	PF	CCC7

DSS 42 PASS 0C7 CL H-B CTDN 202231 GCF S00G CPS N/A DSS G0C0

CCNFIG

ACS COY 069		LCS DOY C70		TOTAL	
SCHEDULED	1545Z	SCHEDULED	0145Z	SCHECULED	10H 0CM
ACTUAL	1557Z	ACTUAL	0145Z	ACTUAL	9H 48M
ST XFR	1524Z	RELEASE	0300Z	DSS TIME	11H 36M

CCMMAND

TCTAL 49 AUTO 49 MANUAL 0 ABORT 0

TELEMETRY

POWER	KW	BIT RATES	1024	512
	RX 1	RX 1	TCP	TCP
ACTUAL	148.C	149.8	7.8	8.6
PRECIC	149.6	149.8	6.1	8.0
RESIC	+1.6	0.0	+1.7	+C.6

TRACKING

TRACK MC 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -C.375HZ C NCS .011HZ EXP .005HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0007  720691551    72070O145    AJ   PF   0007
                  TCP   N/R   N/R   N/R   N/R
```

COMMENTS --

1721Z-1725Z 360/75A DOWN, BACKLOGGING, WARM RESTART DR 3259

1828Z-1838Z 360/75A DOWN, DISPLAY TASKS A BENDS, WARM

DR 3259

0008Z-0016Z 360/75A DOWN, SKED FOR VERSION SWITCH TO V 27.3

0022Z-0027Z 360/75A DOWN, DUE TO BAD LOAD ON VERSION SWITCH,

RESTART REQ

2 WAY TRACK 1611Z-0100Z

CMDS XMTD 1742Z-0041Z

PIONEER 10 S/C 23

P100CZ65242

```
0008  620700923    620701639    AA   PF   0008
       DSS 11 PASS 008  CL H-B CTDN 202231 GCF 500A CPS  N/A DSS A000
```

CONFIG --

```
          AOS DOY 070  LOS DOY 070        TOTAL
          SCHEDULED 0925Z SCHEDULED 1639Z SCHEDULED  7H 14M
          ACTUAL    0923Z ACTUAL    1639Z ACTUAL     7H 16M
          ST XFR    0840Z RELEASE   1700Z DSS TIME   8H 20M
```

COMMAND --

```
          TOTAL  0   AUTO  0   MANUAL  0   ABORT  0
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED

	RX 1	RX 2	TCP A	TCP B
ACTUAL	146.8	N/A	7.4	N/A
PREDIC	150.5	N/A	7.4	N/A
RESID	-3.7	N/A	0.0	N/A

TRACKING

TRACK MD 2,3WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.35HZ C NOS 0.010HZ EXP 0.012HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

0008	620700923	620701639	AA	PF	0008
		TCP	N/R	N/R	N/R	N/R

COMMENTS

1000Z-1600Z 2 WAY

1045Z-1053Z 360/75A DOWN-WARM RESTART REQUIRED. DR 3269

1315Z-1321Z 360/75A DOWN-SCHEDULED STRING SWAP TO 360/75B

1339Z-1344Z 360/75B DOWN-DISK SWAP

MCNTHLY REPCRT FOR MARCH 1972

```
-------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
-------------------------------------------------------------------------

      PICNEER 10 S/C 23

  P10CCZ65238

 CCC8  72070C044    72C70C927    AM   PF   CC08
         DSS 51 PASS OC8  CL H-B CTDN 202231 GCF SOOJ CPS  N/A DSS N/A

         CCNFIG     -----------------------------------------------------

                    ACS DOY 070  LOS DOY C70        TOTAL

                    SCHEDULED 0045Z SCHEDULED 0937Z SCHEDULED  8H 52M

                    ACTUAL    CC44Z ACTUAL    0927Z ACTUAL     8H 43M

                    ST XFR    CCC5Z RELEASE   0927Z DSS TIME   9H 22M

         CCMMAND    -----------------------------------------------------

                    TCTAL  4   AUTC  3   MANUAL 1   ABORT  0

         TELEMETRY  -----------------------------------------------------

                    POWER  1 KW  BIT RATES  512 CODED MMT

                           RX 1   RX 2  TCP A     TCP B

                    ACTUAL 146.3   N/A     9.5        N/A

                    PREDIC 150.2   N/A     8.6        N/A

                    RESIC   +0.9   N/A    +0.9        N/A

         TRACKING   -----------------------------------------------------

                    TRACK MC  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                    DOP BIAS  -C.379HZ C NCS  .011HZ EXP  .005HZ

         MCNITOR    -----------------------------------------------------

                         LGWR  LGER  BLRC  BLER

                    DIS  1562   0    508    0
```

PASS NC.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
C008  72C700044   72C700927   AM   PF   CCC8
                  TCP  N/A    N/A  N/A   N/A
```

CCMMENTS --

PICNEER 10 S/C 23

P10CCZ65230

```
CCC8  72C7CC8C6   72C701CC5   CJ   PF   CCC8
      DSS 75 PASS C08  CLN/A  CTDN  N/A  GCF S60X CPS N/A  DSS N/A

   CCNFIG ------------------------------------------------

          AOS DOY C70   LCS DOY C70         TOTAL

          SCHEDULED C900Z SCHEDULED 1130Z SCHEDULED   2H 50M

          ACTUAL    C806Z ACTUAL    1005Z ACTUAL      1H 59M

          ST XFR    C756Z RELEASE   1005Z DSS TIME    2H 09M

   CCMMAND -----------------------------------------------

          TOTAL N/A  AUTO N/A  MANUAL N/A  ABORT N/A

   TELEMETRY ---------------------------------------------

          POWER N/AKW  BIT RATES N/A

                  RX 1    RX 2   TCP A      TCP B

          ACTUAL N/A      N/A    N/A         N/A

          PREDIC N/A      N/A    N/A         N/A

          RESID  N/A      N/A    N/A         N/A
```

MCNTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NC.                             CODE  CODE  DAY
------------------------------------------------------------------------

        TRACKING  ----------------------------------------------------

                  TRACK MD 2  WAY RANGING NIL BIAS N/A RU NCISE N/A RU

                  DOP BIAS  N/A  HZ C NOS N/A  HZ EXP  .005HZ

        MCNITOR   ----------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  DIS  N/A   N/A  N/A   N/A


      PICNEER 10 S/C 23

 CC08  72C7CC8C6   72C701CC5   CJ  PF  C008
                  TCP  N/A   N/A  N/A   N/A


        CCMMENTS  ----------------------------------------------------



      PICNEER 10 S/C 23

  P10CCZ65243

 0CC8  720701520   720710143   AJ  PF  C008
         DSS 42 PASS 008  CL H-B CTDN 202231 GCF S00G CPS N/A  CSS G000

        CCNFIG    ----------------------------------------------------

                  AOS DOY C7C  LOS DOY C71        TOTAL

                  SCHEDULED 1530Z SCHEDULED 0145Z SCHEDULED 10H 15M

                  ACTUAL    1520Z ACTUAL    0143Z ACTUAL    10H 23M

                  ST XFR    1448Z RELEASE   0150Z DSS TIME  11H 02M

        CCMMAND   ----------------------------------------------------

                  TOTAL 66   AUTO 66   MANUAL  0   ABORT  0
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER	1 KW	BIT RATES	512	1024	MMT
	RX 1	RX 1	TCP A	TCP B	
ACTUAL	146.1	146.0	8.7	6.5	
PREDIC	149.9	150.0	8.5	5.6	
RESIC	-3.8	+4.0	+0.2	+0.9	

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.344HZ C NOS 0.011HZ EXP .005HZ

MCNITOR

	LGWR	LGER	BLRC	ELER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

0008	720701520	720710143	AJ	PF	0008

TCP	N/R	N/R	N/R	N/R

COMMENTS

1825Z-1832Z 360/75B DOWN DUE TO SUSPECTED S/W PROBLEM-UNABLE

TO ACCESS SOME TTY'S. DUMP, WARM RESTART REQ DR 3275

2044Z-2047Z GODDARD CP FAULTED, RECOVERY REQUIRED DR 5034

2301Z-2311Z 360/75 TAKEN DOWN TO INSERT CHANGE IN VERSION 27.3

CMD MSG 005 1 ABORTED DUE TO BEING DISABLED WHILE IN ACTIVE

MODE

2 WAY TRACK 1602Z-0115Z

CMDS XMTD AT 1502Z-0108Z

```
---------------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CCDE  CCDE  CAY
---------------------------------------------------------------------------

     PICNEER 10 S/C 23

   P10CCZ65245

 0C09  720710044   720710923   AM  PF  CC09
       DSS 51 PASS 009  CL H-B CTDN 202231 GCF 500J CPS  N/A DSS JC00

       CCNFIG    -------------------------------------------------------

                 ACS DOY C71  LCS DOY C71        TOTAL

                 SCHEDULED 0045Z SCHEDULED 0923Z SCHEDULED  8H 38M

                 ACTUAL    0044Z ACTUAL    0923Z ACTUAL     8H 39M

                 ST XFR    0000Z RELEASE   0923Z DSS TIME   9H 28M

       CCMMAND   -------------------------------------------------------

                 TCTAL 47   AUTO  47  MANUAL  0   ABCRT  0

       TELEMETRY -------------------------------------------------------

                 POWER  1 KW  BIT RATES   512      MMT

                        RX 1   RX 2  TCP A      TCP B

                 ACTUAL 147.8   N/A      8.9       N/A

                 PRECIC 150.3   N/A      8.4       N/A

                 RESIC   +2.5   N/A     +0.5       N/A

       TRACKING  -------------------------------------------------------

                 TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE  N/ARU

                 DOP BIAS    -0.3HZ C NCS 0.011HZ EXP  .005HZ

       MCNITOR   -------------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                 DIS  1576   0    1322   0
```


C4

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA CAY

PICNEER 10 S/C 23

```
0009  720710044    720710923    AM   PF   CC09
                   TCP  N/A     N/A  N/A  N/A
```

CCMMENTS --

2 WAY TRACK: C123Z-0523Z AND C536Z-C923Z

CMD XMIT: 0239Z-0432Z

0439Z-0443Z 360 DOWN, SCH.

PICNEER 10 S/C 23

P10CCZ65247

```
0009  720710915    720711635    AA   PF   CC09
      DSS 11 PASS 009  CL H-B CTDN 202231 GCF 500A CPS  N/A DSS A000
```

CCNFIG --

ACS DOY C71		LCS DOY C71		TOTAL	
SCHEDULED	C921Z	SCHEDULED	1635Z	SCHEDULED	7H 14M
ACTUAL	C915Z	ACTUAL	1635Z	ACTUAL	7H 19M
ST XFR	C838Z	RELEASE	1740Z	DSS TIME	8H 02M

CCMMAND --

TOTAL 0   AUTO 0   MANUAL 0   ABORT 0

MCNTHLY REPORT FOR MARCH 1972

```
-------------------------------------------------------------------------
PASS  GMT-START     GMT-END     CRIG  TYPE  CATA
NO.                             CODE  CODE  CAY
-------------------------------------------------------------------------

        TELEMETRY -----------------------------------------------------

                  POWER  1 KW  BIT RATES  512  CODED

                       RX 1   RX 2  TCP A     TCP B

                  ACTUAL 149.2  N/A      N/A        7.2

                  PRECIC 150.6  N/A      N/A        6.4

                  RESID   +1.4  N/A      N/A       +0.8

        TRACKING ------------------------------------------------------

                  TRACK MD 2,3WAY RANGING NIL BIAS  N/ARU NCISE  N/ARU

                  DOP BIAS   -0.25HZ C NCS 0.011HZ EXP 0.012HZ

        MCNITCR -------------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  DIS  N/R   N/R   N/R   N/R


      PICNEER 10 S/C 23

 0009  720710915   720711635    AA   PF  C009
                  TCP   N/R   N/R   N/R   N/R


        CCMMENTS ------------------------------------------------------

        0923Z-1600Z 2 WAY

        1230Z-1241Z 360/75 DOWN, UNABLE TO ACESS UTILITY FMTS CR 3270
```

MCNTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END    ORIG   TYPE   CATA
NO.                             CODE   CODE   CAY
------------------------------------------------------------------------

     PICNEER 10 S/C 23

  P10CCZ65249

 C009  720711507    720720145    AJ   PF   C009
          DSS 42 PASS C09  CL H-B CTCN 202231 GCF 500G CPS  N/A DSS G000

          CCNFIG     -----------------------------------------------

                     ACS DOY C71  LCS DCY C72          TCTAL

                     SCHEDULED 1530Z SCHECULED 0145Z SCHEDULED 10H 15M

                     ACTUAL    1507Z ACTUAL    0145Z ACTUAL    10H 38M

                     ST XFR    1445Z RELEASE   0245Z DSS TIME  12H 00M

          CCMMAND    -----------------------------------------------

                     TOTAL  55  AUTO  55  MANUAL  0   ABCRT  0

          TELEMETRY  -----------------------------------------------

                     POWER  1 KW  BIT RATES  1024       512   MMT

                            RX 1   RX 1` TCP        TCP

                     ACTUAL 147.3  146.6     5.1      8.4

                     PREDIC 151.1  150.8     4.9      8.1

                     RESID   +3.8   +3.2    +0.2     +0.3

          TRACKING   -----------------------------------------------

                     TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                     DOP BIAS  -0.256HZ C NOS  .011HZ EXP  .005HZ

          MCNITCR    -----------------------------------------------

                         LGWR  LGER  BLRC  BLER

                     DIS  N/R   N/R   N/R   N/R
```

MCNTHLY REPCRT FCR MARCH 1972

PASS NO.	GMT-START	GMT-ENC	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

```
0009   720711507    720720145    AJ   PF   CC09
                  TCP   N/R   N/R   N/R   N/R
```

CCMMENTS --

2 WAY TRACK 1603Z-0115Z

CMDS XMTD 1752Z-0100Z

PICNEER 10 S/C 23

P10CCZ65253

```
0010   720720100    720720918    AM   PF   C010
      DSS 51 PASS 010  CL H-B CTDN 202231 GCF S00J CPS N/A  DSS J000
```

CCNFIG --

```
ACS DOY 072   LCS DCY 072          TOTAL

SCHEDULEC 0045Z SCHEDULED 0919Z SCHEDULED   8H    M

ACTUAL    0100Z ACTUAL    0918Z ACTUAL      8H 18M

ST XFR    0002Z RELEASE   0918Z DSS TIME    9H 16M
```

CCMMAND --

```
TCTAL 25   AUTC  25   MANUAL  0   ABCRT  0
```

TELEMETRY --

```
POWER  1 KW  BIT RATES  512

          RX 1    RX 2   TCP B      TCP A

ACTUAL  149.5    N/A      7.7        N/A

PREDIC  151.4    N/A      7.1        N/A

RESID    +1.9    N/A     +0.6        N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.20HZ C NOS 0.011HZ EXP 0.005HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	1572	6	254	0

PICNEER 10 S/C 23

0010	720720100	720720918	AM	PF	CC10
		TCP N/A	N/A	N/A	N/A

CCMMENTS

2 WAY TRACK 0116Z-C917Z

CMD XMIT C129Z-C836Z

0457Z-0512Z 360 DCWN; WARM RESTART REQ, DR 3282

0747Z-C819Z 360 DOWN FOR SKED STRING SWAP

```
PASS  GMT-START     GMT-END     CRIG  TYPE  CATA
NO.                             CODE  CODE  DAY

     PICNEER 10 S/C 23

  P10CCZ65254

 0010  720720911    720921631    AA  PF  0010
       DSS 11 PASS 01C  CL H-B CTCN 202231 GCF S00A CPS N/A  DSS A000

       CCNFIG     --------------------------------------------------

                  ACS DOY C72  LCS DCY C72        TCTAL

                  SCHEDULEC C917Z SCHEDULED 1631Z SCHEDULED  7H 14M

                  ACTUAL    C915Z ACTUAL    1631Z ACTUAL     7H 16M

                  ST XFR    C830Z RELEASE   1730Z DSS TIME   9H 00M

       CCMMAND    --------------------------------------------------

                  TCTAL  C   AUTC  0   MANUAL  0   ABCRT  0

       TELEMETRY  --------------------------------------------------

                  PCWER  1 KW  BIT RATES  512  CODED

                         RX 1   RX 2  TCP A     TCP B

                  ACTUAL 148.4  N/A      5.8       N/A

                  PRECIC 151.6  N/A      5.4       N/A

                  RESID   +3.2  N/A     +0.4       N/A

       TRACKING   --------------------------------------------------

                  TRACK MD 23 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS  -0.18HZ C NCS 0.011HZ EXP 0.012HZ

       MCNITOR    --------------------------------------------------

                      LGWR  LGER  BLRC  ELER

                  DIS  N/R   N/R  N/R   N/R
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0010  720720911    720921631    AA   PF   0010
                   TCP  N/R    N/R  N/R    N/R
```

COMMENTS --

2 WAY 0915Z-1600Z

1310Z-1320Z-360/75 DOWN DR 3284

PIONEER 10 S/C 23

P10CCZ65256

```
0010  720721501    720730145    AJ   PF   0010
      DSS 42 PASS 010  CL H-B CTDN 202231 GCF GOOD CPS N/A  DSS GOOD
```

CONFIG --

```
ACS DOY 072  LCS DOY 073          TOTAL
SCHEDULED 1530Z SCHEDULED 0145Z SCHEDULED 10H 15M
ACTUAL    1501Z ACTUAL    0145Z ACTUAL    10H 44M
ST XFR    1437Z RELEASE   0315Z DSS TIME  12H 48M
```

COMMAND --

```
TOTAL  28  AUTO  28  MANUAL  0   ABORT  0
```

TELEMETRY --

```
POWER  1 KW  BIT RATES  512 CODED  MMT
       RX 1   RX 2  TCP        TCP
ACTUAL 149.0   N/A       7.6       N/A
PREDIC 151.8   N/A       6.9       N/A
RESID   +2.8   N/A      +0.7       N/A
```

```
--------------------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  COCE  CAY
--------------------------------------------------------------------------------

        TRACKING   ------------------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS -0.160 HZ C NCS  .011HZ EXP  .C05HZ

        MCNITOR    ------------------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  N/R   N/R   N/R   N/R


      PICNEER 10 S/C 23

0010  720721501      720730145    AJ   PF   0010
                   TCP  N/R   N/R   N/R   N/R

        CCMMENTS   ------------------------------------------------------------

        2 WAY TRACK 1600Z-0100Z

        CMDS XMTD 1845Z-2338Z
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65258

```
0011  720730020    720730914    AM  PF  0011
      DSS 51 PASS 011  CL H-B CTDN 202231 GCF S00J CPS N/A  DSS J000

      CONFIG     ----------------------------------------------------------

                 AOS DOY 073  LOS DOY 073        TOTAL

                 SCHEDULED 0045Z SCHEDULED 0915Z SCHEDULED  8H 30M

                 ACTUAL    0020Z ACTUAL    0914Z ACTUAL     8H 56M

                 ST XFR    2345Z RELEASE   0914Z DSS TIME   9H 29M

      COMMAND    ----------------------------------------------------------

                 TOTAL 19   AUTO 19   MANUAL  0   ABORT  0

      TELEMETRY  ----------------------------------------------------------

                 POWER  1 KW  BIT RATES  512  CODED

                        RX 1   RX 2  TCP B     TCP A

                 ACTUAL 151.2   N/A     7.0       N/A

                 PREDIC 152.3   N/A     6.5       N/A

                 RESID   +1.1   N/A    -0.5       N/A

      TRACKING   ----------------------------------------------------------

                 TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                 DOP BIAS  -0.104HZ C NOS 0.011HZ EXP 0.005HZ

      MONITOR    ----------------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                 DIS   N/R   N/R  N/R    N/R
```

```
---------------------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  CODE  CAY
---------------------------------------------------------------------------------

     PICNEER 10 S/C 23

 0011  720730020     720730914      AM   PF   CC11
                    TCP    N/R    N/R  N/R     N/R


        CCMMENTS  -------------------------------------------------------------



     PICNEER 10 S/C 23

 P10CCZ65260

 0011  720730911     720731600     AA   PF   0011
        DSS 11 PASS 011  CL H-B CTDN 202241 GCF S00A CPS N/A  DSS A000

        CCNFIG    -------------------------------------------------------------

                  ACS COY 073  LOS DOY 073          TOTAL

                  SCHEDULED C912Z SCHEDULED 1600Z SCHEDULED   6H 48M

                  ACTUAL    C911Z ACTUAL    1600Z ACTUAL      6H 49M

                  ST XFR    C827Z RELEASE   1630Z DSS TIME    8H 03M

        CCMMAND   -------------------------------------------------------------

                  TCTAL  0   AUTO  0   MANUAL  0   ABORT  0

        TELEMETRY -------------------------------------------------------------

                  POWER  1 KW  BIT RATES  512 CODED

                         RX 1   RX 2  TCP A     TCP B

                  ACTUAL 149.C   N/A    4.1       N/A

                  PRECIC 152.5   N/A    4.7       N/A

                  RESIC   +3.5   N/A   -C.6       N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.C81HZ C NCS 0.011HZ EXP 0.012HZ

MCNITOR --

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY
CC11	720730911	720731600	AA	PF	0C11

TCP	N/R	N/R	N/R	N/R

CCMMENTS --

C915Z-16CCZ 2 WAY

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65262

```
0011  720731445    720740116    AJ   PF   0C11
      DSS 42 PASS 011  CL H-B CTCN 202241 GCF 500G CPS N/A  DSS G000

      CONFIG    ----------------------------------------------------

                ACS DOY 073  LCS DOY 07          TOTAL

                SCHEDULED 1500Z SCHEDULED 0130Z SCHEDULED 10H 30M

                ACTUAL    1445Z ACTUAL    0109Z ACTUAL    10H 24M

                ST XFR    1415Z RELEASE   0300Z DSS TIME  12H 45M

      COMMAND   ----------------------------------------------------

                TOTAL 46   AUTO  46   MANUAL  0   ABORT  0

      TELEMETRY ----------------------------------------------------

                POWER  1 KW  BIT RATES 1024       512  CODED  MMT

                       RX 1    RX 2   TCP B     TCP A

                ACTUAL 148.9  149.0     3.6       6.5

                PREDIC 152.6  152.5     3.4       5.8

                RESID   +3.7   +3.5    +0.2      +0.7

      TRACKING  ----------------------------------------------------

                TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                DOP BIAS   -.014HZ C NOS  .020HZ EXP  .010HZ

      MONITOR   ----------------------------------------------------

                     LGWR  LGER  BLRC  ELER

                DIS  N/R    N/R  N/R    N/R
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA CAY

PICNEER 10 S/C 23

```
0011  720731445    720740116    AJ   PF   C011
                TCP  N/R    N/R  N/R    N/R
```

CCMMENTS --

2351Z-0C08Z 36C/75A DCWN, DUE TO 2260'S LOCKEDOUT. WARM

RESTART CR 3294

NAT TRACK- CR N-0133 CCPPLER NOISE EXCEEDS EXPECTED TWO

CCMMANDS (26-1 27-1) WERE SENT AND CCNFIRMED BUT S/C DID NOT

RE-ACT TO THEM DUE TC INCCRRECT PARITY CHECK AT S/C REF

CR 0132

2 WAY TRACK 1601Z-0100Z

CMDS XMTC 1700Z-0054Z

PICNEER 10 S/C 23

P10CCZ65269

```
0012  720740039    720740911    AM   PF   0012
      DSS 51 PASS 012  CL H-B CTDN 202241 GCF S00J CPS N/A  DSS J000
```

CCNFIG --

```
          AOS DOY 074  LOS DOY C74        TOTAL
          SCHEDULED 0030Z SCHEDULED 0910Z SCHEDULEDN/AH   M
          ACTUAL    0039Z ACTUAL    0911Z ACTUAL  N/A H   M
          ST XFR    2345Z RELEASE   1100Z DSS TIMEN/A H   M
```

CCMMAND --

TOTAL 6   AUTO 6   MANUAL 0   ABORT 0

B

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	151.7	N/A	6.4	6.4
PREDIC	152.9	N/A	5.4	5.4
RESID	+1.2	N/A	-1.0	-1.0

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS -0.01HZ C NCS 0.011HZ EXP 0.011HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

0012	720740039	720740911	AM	PF	0012
		TCP	N/R	N/R	N/R N/R

COMMENTS

2 WAY TRACK: 0101Z-0911Z

CMD XMIT: 0107Z-0132Z

0151Z-0157Z 360 DOWN, RESTART REC. DR 3296

0307Z-0309Z 3100 STOPPED UPDATING, RESTART DR 3297

0333Z-0338Z 3100 STOPPED UPDATING, RESTART DR 3297

```
                    MONTHLY REPORT FOR MARCH 1972
-------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
-------------------------------------------------------------------------

     PIONEER 10 S/C 23


 P10CCZ65265

 0012  720740908    720741538    AA   PF   0012
         DSS 11 PASS 012  CL H-B CTDN 202241 GCF 500A CPS N/A  DSS A000

         CONFIG    ---------------------------------------------------

                   ACS DOY 074  LCS DOY 074        TOTAL

                   SCHEDULED 0908Z SCHEDULED 1600Z SCHEDULED   6H 52M

                   ACTUAL    0908Z ACTUAL    1538Z ACTUAL      6H 39M

                   ST XFR    N/A Z RELEASE   N/A Z DSS TIMEN/A H    M

         COMMAND   ---------------------------------------------------

                   TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

         TELEMETRY ---------------------------------------------------

                   POWER  1 KW  BIT RATES  512   CODED     MMT

                          RX 1   RX 2  TCP B     TCP A

                   ACTUAL 150.4   N/A      5.1       N/A

                   PREDIC 153.1   N/A      4.1       N/A

                   RESID   +2.7   N/A     +1.0       N/A

         TRACKING  ---------------------------------------------------

                   TRACK MD 2,3WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS    +0.04HZ C NOS 0.011HZ EXP 0.012HZ

         MONITOR   ---------------------------------------------------

                        LGWR  LGER  BLRC  ELER

                   DIS  N/R    N/R   N/R   N/R
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

```
0012  720740908    720741538    AA   PF   C012
                TCP  N/R    N/R   N/R   N/R
```

CCMMENTS --

0909Z-1520Z 2 WAY

DR T-1923

DR 3301

1000Z-1528Z ERRONEOUS SNR READOUT FROM TCP "A" CHANGED ARITH-

METIC ADDER UNIT IN SSA. DR T-1921

1440Z-MSFN TIMING SYSTEM JUMPED TO 1541Z DR 1922

PICNEER 10 S/C 23

P10CCZ65267

```
0012  720741431    720750130    AJ   PF   C012
   DSS 42 PASS 012  CL H-B CTDN 202241 GCF S40G CPS N/A  DSS GOOD
```

CCNFIG --

AOS DOY 074		LOS DOY 074		TOTAL	
SCHEDULED	1500Z	SCHEDULED	0130Z	SCHEDULED	10H 30M
ACTUAL	1431Z	ACTUAL	0130Z	ACTUAL	10H 50M
ST XFR	1414Z	RELEASE	0130Z	DSS TIME	11H 10M

CCMMAND --

TOTAL 46   AUTO 46   MANUAL 0   ABORT 1

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 2	RX 1	TCP B	TCP A
ACTUAL	148.8	N/A	6.4	N/A
PREDIC	153.3	N/A	5.0	N/A
RESID	+4.5	N/A	+1.4	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS +0.059HZ C NCS .011HZ EXP .011HZ

MCNITOR

	LGWR	LGER	BLRC	ELER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

0012	720741431	720750130	AJ	PF	0012
		TCP	N/R	N/R	N/R N/R

CCMMENTS

CMD MSG (006-01) ABORTED DUE TO BEING DISABLED WHILE IN

ACTIVE MODE

2 WAY TRACK 1521Z-0100Z

CMDS XMTD 1750Z-2238Z

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	DATA DAY

FICNEER 10 S/C 23

P10CCZ65270

```
0013  720750028    72C750906    AM  PF  0013
        DSS 51 PASS 013  CL H-B CTDN 202241 GCF S00J CPS N/A  DSS J000

        CCNFIG     ------------------------------------------------

                   AOS DOY 075  LCS DOY C75        TOTAL

                   SCHEDULED 0030Z SCHEDULED 0906Z SCHEDULED  8H 36M

                   ACTUAL    0028Z ACTUAL    0906Z ACTUAL     8H 38M

                   ST XFR    2345Z RELEASE   0906Z DSS TIME   9H 21M

        CCMMAND    ------------------------------------------------

                   TCTAL  C   AUTO  0   MANUAL  0   ABORT  0

        TELEMETRY  ------------------------------------------------

                   POWER  1 KW  BIT RATES 512       MMT

                          RX 1   RX 2  TCP B     TCP A

                   ACTUAL 152.6   N/A     5.6         N/A

                   PRECIC 153.6   N/A     4.8         N/A

                   RESID   +1.C   N/A    +0.8         N/A

        TRACKING   ------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DCP BIAS   +0.12HZ C NCS 0.011HZ EXP 0.011HZ

        MCNITOR    ------------------------------------------------

                       LGWR  LGER  BLRC  BLER

                   DIS  N/R    N/R  N/R    N/R
```

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
0013  720750028    720750906    AM   PF   0013
                  TCP  N/R     N/R  N/R     N/R
```

CCMMENTS

2 WAY TRACK: 0101Z-0806Z

CMD XMIT: N/A

0143Z-0156Z 360 DCWN, SYSTEM HUNG AND LOCKED OUT, IPL-WARM

DR 3307

0700Z-0706Z 360 DCWN, SYSTEM HUNG AND LOCKED OUT, IPL-WARM

DR 3308

PICNEER 10 S/C 23

P10CCZ65273

```
0013  720750903    720751612    AA   PF   0013
      DSS 11 PASS 013  CL H-B CTDN 202241 GCF S00A CPS  N/A DSS A000
```

CCNFIG

AOS DOY 075		LOS DOY 075		TOTAL	
SCHEDULED	0904Z	SCHEDULED	1600Z	SCHEDULED	6H 56M
ACTUAL	0903Z	ACTUAL	1612Z	ACTUAL	7H 05M
ST XFR	0801Z	RELEASE	1710Z	DSS TIME	9H 09M

CCMMAND

TOTAL 1 AUTO 1 MANUAL 0 ABORT 0

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

TELEMETRY

POWER 3 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	151.5	N/A	4.0	N/A
PREDIC	153.9	N/A	3.3	N/A
RESID	+2.4	N/A	+.7	N/A

TRACKING

TRACK MD1,23WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DCP BIAS +0.14HZ C NOS 0.011HZ EXP 0.011HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

0013	720750903	720751612	AA	PF	0013

TCP	N/R	N/R	N/R	N/R

CCMMENTS

0918Z-1612Z 2 WAY

0925Z-1555Z 1 CMD

0907Z-0918Z ATTEMPTED AUTO-TRACK CN HORIZON-ANT DROVE OFF POINT

CAUSING LCSS OF BOTH UPLINK AND DOWNLINK LOCK DR T-1927

```
                    MONTHLY REPORT FOR MARCH 1972
------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
------------------------------------------------------------------

     PIONEER 10 S/C 23

 P10CCZ65275

0013  720751535    720760042    AJ  PF  0013
        DSS 42 PASS 013  CL H-B CTDN 202241 GCF S00G CPS N/A  OSS G000

        CONFIG    ------------------------------------------------

                  AOS DOY 075  LOS DOY 076         TOTAL

                  SCHEDULED 1500Z SCHEDULED 0130Z SCHEDULED 10H 30M

                  ACTUAL    1535Z ACTUAL    0042Z ACTUAL     9H 07M

                  ST XFR    1412Z RELEASE   0042Z DSS TIME  10H 30M

        COMMAND   ------------------------------------------------

                  TOTAL 47   AUTO 47   MANUAL  0   ABORT  0

        TELEMETRY ------------------------------------------------

                  POWER  1 KW  BIT RATES 512

                        RX 1   RX 2  TCP B     TCP A

                  ACTUAL 152.3   N/A      5.9       N/A

                  PREDIC 154.1   N/A      4.6       N/A

                  RESID   +1.8   N/A     +1.3       N/A

        TRACKING  ------------------------------------------------

                  TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS   0.176HZ C NOS 0.011HZ EXP  .005HZ

        MONITOR   ------------------------------------------------

                      LGWR  LGER  BLRC  ELER

                  DIS   N/A   N/A   N/A   N/A
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

0013	720751535	720760042	AJ	PF	0013
	TCP	N/A	N/A	N/A	N/A

COMMENTS

PIONEER 10 S/C 23

P10CCZ65277

0014 720760020 720760902 AM PF 0014
DSS 51 PASS 014 CL H-B CTDN 202241 GCF S00J CPS N/A DSS J000

CONFIG

AOS DOY 076		LOS DOY 076		TOTAL	
SCHEDULED	0030Z	SCHEDULED	0902Z	SCHEDULED	8H 32M
ACTUAL	0020Z	ACTUAL	0902Z	ACTUAL	8H 42M
ST XFR	2345Z	RELEASE	0902Z	DSS TIME	9H 17M

COMMAND

TOTAL 0 AUTO 0 MANUAL 0 ABORT 0

TELEMETRY

POWER 1 KW BIT RATES 512

	RX 1	RX 2	TCP B	TCP A
ACTUAL	152.9	N/A	5.0	N/A
PREDIC	154.4	N/A	5.0	N/A
RESID	+1.5	N/A	0.0	N/A

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.25HZ C NCS 0.012HZ EXP 0.011HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	1399	8	0	0

PIONEER 10 S/C 23

0014	720760020	720760902	AM	PF	0014
		TCP N/A	N/A	N/A	N/A

COMMENTS

2 WAY TRK: 0031Z-0236Z AND 0350Z-0902Z

0237Z-0351Z XMITTER DOWN DR T-1931

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65278

```
0014  720760151    720760839    AC   PF   CC14
      DSS 61 PASS 014  CL H-B CTDN  N/A   GCF S60K CPS  N/A DSS K0G0

      CONFIG     --------------------------------------------------

                 AOS DOY C76  LOS DOY C76        TOTAL

                 SCHEDULED 0138Z SCHEDULED 0840Z SCHEDULED  7H 02M

                 ACTUAL    C151Z ACTUAL    C839Z ACTUAL     6H 48M

                 ST XFR    C117Z RELEASE   0839Z DSS TIME   7H 22M

      COMMAND    --------------------------------------------------

                 TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY  --------------------------------------------------

                 POWER N/AKW  BIT RATES  512

                        RX 1   RX 2  TCP A     TCP B

                 ACTUAL  N/A    N/A      N/A        N/A

                 PREDIC  N/A    N/A      N/A        N/A

                 RESID   N/A    N/A      N/A        N/A

      TRACKING   --------------------------------------------------

                 TRACK MD 2,3WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                 DOP BIAS   N/A  HZ C NOS   N/AHZ EXP  N/A HZ

      MONITOR    --------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                 DIS   N/R   N/R   N/R   N/R
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0014  720760151     720760839     AO   PF   0014
                    TCP    N/R    N/R    N/R    N/R
```

COMMENTS --

2 WAY TRK: 0236Z-0350Z

CMD XMIT: N/A

PIONEER 10 S/C 23

P10CCZ65279

```
0014  720760859     720761600     AA   PF   0014
   DSS 11 PASS 014  CL H-B CTDN 202241 GCF 500A CPS N/A  DSS A000
```

CONFIG --

AOS DOY 076		LOS DOY 076		TOTAL	
SCHEDULED	0900Z	SCHEDULED	1600Z	SCHEDULED	7H 00M
ACTUAL	0859Z	ACTUAL	1600Z	ACTUAL	7H 01M
ST XFR	0800Z	RELEASE	1715Z	DSS TIME	9H 15M

COMMAND --

TOTAL 1   AUTO 1   MANUAL 0   ABORT 0

TELEMETRY --

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	149.3	N/A	3.6	N/A
PREDIC	154.6	N/A	2.6	N/A
RESID	+5.3	N/A	+1.0	N/A

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/ARU NOISE N/A RU

DOP BIAS +.224HZ C NOS .010HZ EXP .011HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

0014 720760859 720761600 AA PF 0014

TCP	N/R	N/R	N/R	N/R

COMMENTS

0859Z-1600Z 2 WAY

0916Z-1555Z 1 CMD

1040Z-1100Z 360/75 DOWN DUE TO ERRORS ON MSB PACK DR 3314

PASS NC.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

FICNEER 10 S/C 23

P10CCZ65281

0014 720761455 72C770043 AJ PF 0014

DSS 42 PASS C14 CL H-B CTDN 202241 GCF S00G CPS N/A CSS G000

CCNFIG --

AOS DCY C76 LCS DOY C77 TOTAL

SCHEDULED 1500Z SCHEDULED 0130Z SCHEDULED 10H 30M

ACTUAL 1455Z ACTUAL 0043Z ACTUAL 9H 48M

ST XFR 1410Z RELEASE 0043Z DSS TIME 10H 33M

CCMMAND --

TOTAL 52 AUTO 52 MANUAL 0 ABCRT 0

TELEMETRY --

POWER 1 KW BIT RATES 512 CODED

	RX 1	RX 2	TCP A	TCP B
ACTUAL	153.0	N/A	5.0	N/A
PRECIC	154.8	N/A	3.9	N/A
RESID	+1.8	N/A	+1.1	N/A

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS 0.301HZ C NCS 0.011HZ EXP 0.012HZ

MCNITOR --

	LGWR	LGER	BLRC	BLER
DIS	N/A	N/A	N/A	N/A

C

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA DAY

FICNEER 10 S/C 23

```
0014  720761455      72C770043    AJ   PF   0014
                   TCP  N/A     N/A   N/A  N/A
```

CCMMENTS --

NC CIS

PICNEER 1C S/C 23

P10CCZ65283

```
0015  72C770020     72C770857    AM   PF   0C15
     DSS 51 PASS 015  CL H-B CTDN 202241 GCF S00J CPS N/A  DSS J000
```

CCNFIG --

```
ACS DOY 077   LCS DCY C77        TOTAL

SCHEDULED 0030Z SCHEDULED 0858Z SCHEDULED  8H 28M

ACTUAL    CC20Z ACTUAL    C857Z ACTUAL     8H 37M

ST XFR    2345Z RELEASE   0857Z DSS TIME   9H 12M
```

CCMMAND --

```
TOTAL  1   AUTC  1   MANUAL  0   ABCRT  0
```

TELEMETRY --

```
POWER  1 KW  BIT RATES  512        256

       RX 1   RX 2  TCP A      TCP A

ACTUAL 154.2   N/A    4.3        5.2

PREDIC 155.0   N/A    3.7        5.0

RESID   +0.8   N/A   +0.6       +0.2
```

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-ENC	CRIG CODE	TYPE CCDE	CATA CAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS +0.25HZ C NOS 0.011HZ EXP 0.011HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	1390	C	0	0

PICNEER 10 S/C 23

0015	720770020	72C770E57	AM	PF	CC15
		TCP N/A	N/A	N/A	N/A

CCMMENTS

0219Z-0236Z 360/75B DCWN FCR IPL, DR 3316

2 WAY TRACK 0045Z-0E57Z

CMDS XMITTED 0625Z

MCNTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     CRIG  TYPE  CATA
NO.                              CODE  CODE  CAY
------------------------------------------------------------------------

     PICNEER 10 S/C 23

  P10CCZ65297

0015  72C770153    72C770835    AO   PF   0015
       DSS 61 PASS 015  CL H-B CTDN  N/A   GCF S60K CPS N/A  DSS K000

       CCNFIG     --------------------------------------------------

                  AOS COY 077  LCS DOY C77        TOTAL

                  SCHEDULED C134Z SCHEDULED C836Z SCHEDULED  7H 02M

                  ACTUAL    0153Z ACTUAL    0835Z ACTUAL     6H 42M

                  ST XFR    0100Z RELEASE   N/A Z DSS TIMEN/A H   M

       CCMMAND    --------------------------------------------------

                  TCTAL  0   AUTO  0   MANUAL  0   ABORT  0

       TELEMETRY  --------------------------------------------------

                  PCWER N/AKW  BIT RATES  N/A         N/A

                         RX 1   RX 2  TCP N/A   TCP N/A

                  ACTUAL N/A     N/A     N/A        N/A

                  PRECIC N/A     N/A     N/A        N/A

                  RESIC  N/A     N/A     N/A        N/A

       TRACKING   --------------------------------------------------

                  TRACK MD  3 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS  N/A   HZ C NCS  N/A HZ EXP  N/A HZ

       MCNITCR    --------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  DIS  N/A    N/A   N/A   N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
0015  72C77C153    72C770835    AC   PF  0015
                   TCP  N/A     N/A  N/A  N/A
```

COMMENTS --

C219Z-0236Z 36C/75B CCWN FCR IPL, CR 3316

PICNEER 10 S/C 23

P10CCZ65285

```
0015  72C77C856    72C771600    AA   PF  0015
      DSS 11 PASS 015  CL H-B CTDN 202241 GCF S00A CPS  N/A DSS A000
```

CCNFIG --

```
ACS COY 077  LCS CCY C77          TOTAL

SCHECULEC C855Z SCHEDULED 1600Z SCHEDULED  7H 05M

ACTUAL    C856Z ACTUAL    1600Z ACTUAL     7H 04M

ST XFR    C803Z RELEASE   1659Z DSS TIME   8H 56M
```

CCMMAND --

TCTAL 0   AUTO 0   MANUAL 0 ABORT 0

TELEMETRY --

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	153.1	N/A	4.4	N/A
PRECIC	155.1	N/A	4.3	N/A
RESIC	+2.0	N/A	+0.1	N/A

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CCDE	DATA CAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS 0.38HZ C NOS .011HZ EXP .011HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	N/A	N/A	N/A	N/A

PICNEER 10 S/C 23

0015	72077C856	72C771600	AA	PF	0015
		TCP N/A	N/A	N/A	N/A

COMMENTS

1510Z-1526Z 360 DOWN WARM/WARM DR 3319

POST TRACK REPORT 0947Z-0949Z, TFR 803566, RCVR NO. OUT OF LOCK, CAUSE UNKNOWN

```
-----------------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  CATA
NO.                             CODE  CODE  CAY
-----------------------------------------------------------------------------------

      PICNEER 10 S/C 23

  P10CCZ65286

 0015  720771000     720771600     AB   PF   CC15
       DSS 12 PASS 015  CL H-B CTDN 202231 GCF S00B CPS  N/A DSS B000

       CCNFIG      ---------------------------------------------------------

                   AOS DOY 077  LCS DOY C77          TCTAL

                   SCHECULEC 0900Z SCHEDULED 1600Z SCHEDULED   7H 00M

                   ACTUAL     1000Z ACTUAL     1600Z ACTUAL      6H 00M

                   ST XFR     C916Z RELEASE    N/A Z DSS TIMEN/A H    M

       CCMMAND     ---------------------------------------------------------

                   TOTAL  1   AUTO  1   MANUAL  0   ABORT  0

       TELEMETRY   ---------------------------------------------------------

                   POWER  1 KW  BIT RATES  256 CODED MMT

                          RX 1    RX 2   TCP A      TCP B

                   ACTUAL 152.3    N/A     7.0        N/A

                   PREDIC 155.2    N/A     4.7        N/A

                   RESID   +2.9    N/A    +2.3        N/A

       TRACKING    ---------------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NCISE N/A RU

                   DOP BIAS   +0.38HZ C NCS  .011HZ EXP  .011HZ

       MCNITOR     ---------------------------------------------------------

                       LGWR  LGER  BLRC  ELER

                   DIS  671    0     0     0
```

```
---------------------------------------------------------------------------
PASS  GMT-START     GMT-END      ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
---------------------------------------------------------------------------

     PIONEER 10 S/C 23

 0015  72C771000     72C771600     AB   PF   0015
                   TCP  N/A     N/A  N/A    N/A


        COMMENTS  ----------------------------------------------------

        DIS LOG TAPE NOT COMITTED TO P-10



     PIONEER 10 S/C 23

  P1OCCZ65287

 0015  720771450    72C780135    AJ  PF  0015
        DSS 42 PASS 015  CL F-B CTDN 202241 GCF 500G CPS  N/A DSS G000

        CONFIG    ----------------------------------------------------

                  ACS DOY C77  LOS DOY C78        TOTAL

                  SCHEDULED 1500Z SCHEDULED 0130Z SCHEDULED 10H 30M

                  ACTUAL    1450Z ACTUAL    0135Z ACTUAL    10H 45M

                  ST XFR    1427Z RELEASE   0135Z DSS TIME  10H 45M

        COMMAND   ----------------------------------------------------

                  TOTAL 24   AUTO  24   MANUAL  0   ABORT  0

        TELEMETRY ----------------------------------------------------

                  POWER  1 KW  BIT RATES  256        512   CODED

                        RX 1   RX 2  TCP A      TCP  A

                  ACTUAL 154.4   N/A       4.8        5.7

                  PREDIC 155.3   N/A       3.2        5.5

                  RESID   +0.9   N/A      +1.6       +0.2
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS C.435HZ C NOS .011HZ EXP .011HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/A	N/A	N/A	N/A

PIONEER 10 S/C 23

0015	720771450	720780135	AJ	PF	0015

TCP	N/A	N/A	N/A	N/A

COMMENTS

1602Z-0045Z 2 WAY

1606Z-0037Z CMC MOD ON

1932Z-1944Z 360/75B DOWN, NAT TEL ENTERED ERRONEOUS T-MED

WARM IPL/RESTART, DR 3323

```
-----------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  COCE  CAY
-----------------------------------------------------------------------

     PICNEER 10 S/C 23

  P10CCZ65289

 0016  72C780CCO     72C780E54    AM   PF   0016
         DSS 51 PASS 016  CL F-B CTDN 202241 GCF S00J CPS N/A  DSS J000

         CCNFIG     ---------------------------------------------------

                    ACS DCY C78  LCS DCY C78         TCTAL

                    SCHEDULED 0030Z SCHEDULED 0854Z SCHEDULED   8H 24M

                    ACTUAL    0000Z ACTUAL    0854Z ACTUAL      8H 54M

                    ST XFR    2330Z RELEASE   1000Z DSS TIME   10H 0CM

         CCMMAND    ---------------------------------------------------

                    TCTAL  3   AUTO  3   MANUAL  0   ABCRT  0

         TELEMETRY  ---------------------------------------------------

                    PCWER  1 KW  BIT RATES  512   CODED  MMT

                           RX 1   RX 2  TCP A     TCP B

                    ACTUAL 153.5  N/A     3.6       N/A

                    PREDIC 155.5  N/A     3.1       N/A

                    RESID   +2.0  N/A    +0.5       N/A

         TRACKING   ---------------------------------------------------

                    TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                    DOP BIAS   +C.49HZ C NOS 0.010HZ EXP 0.011HZ

         MCNITCR    ---------------------------------------------------

                         LGWR  LGER  BLRC  BLER

         2-W TK CC48Z-C854Z
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0016  720780000    720780854    AM   PF   0016
                   DIS    N/A    N/A    N/A    N/A

                   TCP    N/A    N/A    N/A    N/A
```

COMMENTS --

CMDS XMTD 0133Z-0305Z

PIONEER 10 S/C 23

P10CCZ65290

```
0016  720780136    720780830    AO   PF   0016
      DSS 61 PASS 016  CL H-B CTDN 202241 GCF S60K CPS  N/A DSS K000

   CONFIG    ------------------------------------------------

             ACS DOY 078  LCS DOY 078          TOTAL

             SCHEDULED 0130Z SCHEDULED 0832Z SCHEDULED   7H 02M

             ACTUAL    0136Z ACTUAL    0830Z ACTUAL      6H 54M

             ST XFR    0100Z RELEASE   0830Z DSS TIME    7H 30M

   COMMAND   ------------------------------------------------

             TOTAL  0    AUTO  0   MANUAL  0    ABORT  0

   TELEMETRY ------------------------------------------------

             POWER N/AKW  BIT RATES  N/A

                    RX 1    RX 2   TCP        TCP

             ACTUAL  N/A     N/A       N/A        N/A

             PREDIC  N/A     N/A       N/A        N/A

             RESID   N/A     N/A       N/A        N/A
```

```
                         MCNTHLY REPORT FOR MARCH 1972
--------------------------------------------------------------------------------
PASS  GMT-START      GMT-END     CRIG  TYPE  CATA
NO.                              CODE  CODE  CAY
--------------------------------------------------------------------------------

         TRACKING  ----------------------------------------------------------

                   TRACK MC  3 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS   +0.47HZ C NCS C.011HZ EXP 0.012HZ

         MCNITOR   ----------------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS   N/R   N/R   N/R   N/R


      PICNEER 10 S/C 23

 0016  720780136     72C78C830    AC   PF  0016
                   TCP   N/R   N/R   N/R   N/R


         CCMMENTS  ----------------------------------------------------------
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	DATA DAY

FICNEER 10 S/C 23

P10CCZ65293

```
0016  720780851    720781604    AA  PF  0016
      DSS 11 PASS C79  CL H-B CTDN 202241 GCF S00A CPS N/A  DSS A000

      CCNFIG     ------------------------------------------------------

                 ACS DOY C78  LCS DOY C78          TOTAL

                 SCHEDULEC C851Z SCHEDULED 1600Z SCHEDULED  7H 09M

                 ACTUAL    C851Z ACTUAL    1604Z ACTUAL     7H 13M

                 ST XFR    0750Z RELEASE   1704Z DSS TIME   9H 14M

      CCMMAND    ------------------------------------------------------

                 TCTAL  1   AUTO  1   MANUAL  0   ABORT  0

      TELEMETRY  ------------------------------------------------------

                 POWER  1 KW  BIT RATES  256  CODED  MMT

                        RX 1   RX 2   TCP A     TCP B

                 ACTUAL 152.4  N/A      2.6       N/A

                 PREDIC 155.7  N/A      2.2       N/A

                 RESID   +3.3  N/A     +0.4       N/A

      TRACKING   ------------------------------------------------------

                 TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                 DOP BIAS  +0.5C5HZ C NOS  .011HZ EXP  .011HZ

      MCNITCR    ------------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                 DIS  N/R   N/R   N/R   N/R
```

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

FICNEER 10 S/C 23

```
0016   72C78C851    72C7816C4    AA   PF   0016
                   TCP    N/R    N/R    N/R    N/R
```

CCMMENTS --

1C01Z CMC MCD CN, STA RELCADED TCP W/O TELLING CSIF CCNTRCL,

REF: CR T-1937

2 WAY TRK C851Z-1600Z

CMDS XMTC 0856Z-1554Z (1 CMC)

FICNEER 10 S/C 23

P10CCZ65295

```
0016   720781448    72C790055    AJ   PF   0016
   DSS 42 PASS 016  CL H-B CTDN 202241 GCF S00G CPS N/A  CSS G00
```

CCNFIG --

AOS COY 078	LOS COY C79	TOTAL	
SCHEDULED 1500Z	SCHEDULED 0115Z	SCHEDULED	10H 15M
ACTUAL 1448Z	ACTUAL 0055Z	ACTUAL	10H 07M
ST XFR 1420Z	RELEASE 0055Z	DSS TIME	10H 35M

CCMMAND --

TCTAL 2   AUTO 2   MANUAL 0   ABORT 0

MONTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
------------------------------------------------------------------------------------------

       TELEMETRY ----------------------------------------------------------------------

                   POWER    KW  BIT RATES  512       25

                          RX 1   RX 2  TCP A     TCP A

                   ACTUAL 155.0   N/A      5.8        4.3

                   PREDIC 155.9   N/A      4.8        2.8

                   RESID   +0.9   N/A     +1.0       +1.3

       TRACKING -----------------------------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS    .549HZ C NCS  .011HZ EXP  .011HZ

       MONITOR ------------------------------------------------------------------------

                       LGWR  LGER  BLRC  BLER

                   DIS  N/A   N/A   N/A   N/A


    PIONEER 10 S/C 23

 0016  720781448    720790055    AJ   PF  0016
                   TCP  N/A   N/A   N/A   N/A


       COMMENTS -----------------------------------------------------------------------

       2047Z-2100Z TCP-A PROG. BOMBED WHEN STA ENTERED BIT RATE

       CHANGE, RELOAD REQ, DR T-1939

       2241Z-2255Z 360/75B DOWN, 2260'S LOCKED OUT, WARM IPL/RESTART

       DR 3326
```

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CCCE	CATA CAY

FICNEER 10 S/C 23

P10CCZ65296

```
0017  72C79CC10    720790845    AM  PF  0017
      DSS 51 PASS 017  CL H-B CTDN 202241 GCF S00J CPS N/A  DSS J000

      CCNFIG  ---------------------------------------------------------

              AOS DOY C79   LCS DOY C79         TOTAL

              SCHEDULED 0015Z SCHEDULED 0850Z SCHEDULED  8H 35M

              ACTUAL    0010Z ACTUAL    0845Z ACTUAL     8H 35M

              ST XFR         Z RELEASE  C948Z DSS TIME  10H 18M

      CCMMAND ---------------------------------------------------------

              TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY -------------------------------------------------------

              POWER  1 KW  BIT RATES  256  CODED MMT

                     RX 1   RX 2  TCP A     TCP B

              ACTUAL 153.9  N/A    5.6       N/A

              PREDIC 156.1  N/A    5.1       N/A

              RESID   +2.2  N/A   +0.5       N/A

      TRACKING --------------------------------------------------------

              TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NCISE N/A RU

              DOP BIAS   +0.63HZ C NOS 0.011HZ EXP 0.012HZ

      MCNITOR ---------------------------------------------------------

                   LGWR  LGER  BLRC  BLER

              DIS  N/R   N/R   N/R   N/R
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

0017 720790010 720790845 AM PF 0017
TCP N/R N/R N/R N/R

COMMENTS --

0802Z-LOS 360/75B DOWN FOR STRING SWAP, UNABLE TO MAKE

SWAP DR 3329

PIONEER 10 S/C 23

P10CCZ65306

0017 720790824 720791540 AB PF 0017
DSS 12 PASS 017 CL H-B CTDN N/A GCF 500B CPS N/A DSS 8000

CONFIG --

AOS DOY 079		LOS DOY 079		TOTAL	
SCHEDULED	0845Z	SCHEDULED	1600Z	SCHEDULED	7H 15M
ACTUAL	0824Z	ACTUAL	1540Z	ACTUAL	7H 16M
ST XFR	0738Z	RELEASE	1540Z	DSS TIME	8H 02M

COMMAND --

TOTAL 0 AUTO 0 MANUAL 0 ABORT 0

TELEMETRY --

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	153.8	N/A	6.7	N/A
PREDIC	156.2	N/A	4.0	N/A
RESID	+2.4	N/A	+2.7	N/A

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.66HZ C NOS .011HZ EXP .011HZ

MONITOR

	LGWR	LGER	BLRC	ELER
DIS	1236	0	509	15

PIONEER 10 S/C 23

0017	72079C824	72C791540	AB	PF	0017
		TCP	N/A	N/A	N/A	N/A

COMMENTS

0802Z-0855Z 360/75B DOWN FOR STRING SWAP, UNABLE TO SWAP

DR 3329

1108Z-1116Z 360/75B DOWN SKED STRING SWAP

2 WAY TRACK 0841Z-1530Z

CMDS XMTD AT 0905Z-1525Z NO CMDS

MCNTHLY REPCRT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

P10CCZ65300

```
0017  720790857   720791500   AA  PF  0017
      DSS 11 PASS 017  CL H-B CTDN  N/A   GCF S00A CPS  N/A DSS

      CCNFIG   ----------------------------------------------------

               ACS DOY 079  LOS DOY 079         TOTAL

               SCHEDULED 0847Z SCHEDULED 1600Z SCHEDULED  7H 13M

               ACTUAL    0557Z ACTUAL    1500Z ACTUAL     6H 03M

               ST XFR    0802Z RELEASE   1505Z DSS TIME   6H 08M

      CCMMAND  ----------------------------------------------------

               TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY -------------------------------------------------

               POWER N/AKW  BIT RATES  N/A

                      RX 1   RX 2  TCP N/A   TCP N/A

               ACTUAL N/A     N/A    N/A        N/A

               PREDIC N/A     N/A    N/A        N/A

               RESID  N/A     N/A    N/A        N/A

      TRACKING -------------------------------------------------

               TRACK MD  3 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

               DOP BIAS   +0.66HZ C NOS 0.011HZ EXP 0.012HZ

      MCNITOR  -------------------------------------------------

                    LGWR  LGER  BLRC  BLER

               DIS   N/R   N/R   N/R   N/R
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA CAY

PIONEER 10 S/C 23

```
0017   72079C857    72C791500    AA   PF   0017
                   TCP    N/R    N/R    N/R    N/R
```

COMMENTS --

ACS-C855Z-360/75B DOWN FOR STRING SWAP. UNABLE TO MAKE SWAP

DR 3329

1108Z-1116Z 360/75B DOWN FOR STRING SWAP NO DR

STA RELEASED EARLY BY TK-CHIEF (STA 12 ON S/C)

PIONEER 10 S/C 23

P10CCZ65302

```
0017   72C791452    72C800050    AJ   PF   0017
   DSS 42 PASS 017  CL H-B CTDN  N/A   GCF SOOG CPS  N/A DSS GOOD
```

CONFIG --

```
AOS DOY 079   LOS DOY 080          TOTAL
SCHEDULED 1500Z SCHEDULED 0115Z SCHEDULED 10H 15M
ACTUAL    1452Z ACTUAL    0050Z ACTUAL     9H 58M
ST XFR    1415Z RELEASE   0050Z DSS TIME  10H 35M
```

COMMAND --

TOTAL 4   AUTO 4   MANUAL 0   ABORT 0

MCNTHLY REPORT FOR MARCH 1972

```
PASS  GMT-START      GMT-END     CRIG  TYPE  CATA
NC.                              CODE  CODE  DAY

      TELEMETRY ------------------------------------------------

                 POWER  1 KW  BIT RATES  256  128 CODED

                        RX 1    RX 2   TCP A      TCP B

                 ACTUAL 155.8    N/A       6.1         N/A

                 PREDIC 156.4    N/A       5.1         N/A

                 RESIC    +0.6   N/A      +1.0         N/A

      TRACKING ------------------------------------------------

                 TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                 DOP BIAS      .72HZ C NOS  .011HZ EXP  .011HZ

      MCNITOR ------------------------------------------------

                     LGWR   LGER   BLRC   ELER

                 DIS   N/A    N/A    N/A    N/A


    PICNEER 10 S/C 23

0017  720791452    72C800050    AJ   PF   0017
                 TCP   N/A    N/A    N/A    N/A


      CCMMENTS ------------------------------------------------

      NC CIS

      2039Z-2056Z TCP-A HUNG UP WHEN STATICN ATTEMPTED BIT RATE

      CHANGE, RELOAC REQUIREC
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65305

```
0018  72080CCC6    72C800839    AM  PF  0018
      DSS 51 PASS 018  CL H-B CTDN  N/A   GCF S00J CPS  N/A DSS J000

      CONFIG    -----------------------------------------------------

                AOS DOY 080  LOS DOY 080          TOTAL

                SCHEDULED 0015Z SCHEDULED 0845Z SCHEDULED  8H 30M

                ACTUAL    0006Z ACTUAL    0839Z ACTUAL     8H 33M

                ST XFR    2334Z RELEASE   0951Z DSS TIME  10H 17M

      COMMAND   -----------------------------------------------------

                TOTAL  1   AUTO  1   MANUAL  0   ABORT  0

      TELEMETRY -----------------------------------------------------

                POWER  1 KW  BIT RATES 256   CODED  MMT

                       RX 1   RX 2   TCP A    TCP B

                ACTUAL 153.4   N/A      5.4      N/A

                PREDIC 156.6   N/A      4.5      N/A

                RESID   +3.2   N/A     +0.9      N/A

      TRACKING  -----------------------------------------------------

                TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                DOP BIAS   +0.79HZ C NCS 0.011HZ EXP      HZ

      MONITOR   -----------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                DIS  N/A   N/A   N/A   N/A
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

0018 720800006 720800839 AM PF 0018
TCP N/A N/A N/A N/A

CCMMENTS --

2 WAY TRACK 0046Z-0830Z

CMDS XMTD 0100Z

PICNEER 10 S/C 23

P10CCZ65307

0018 72080C759 720801538 AB PF 0018
DSS 12 PASS 018 CL H-B CTDN 202241 GCF S00B CPS N/A DSS B000

CCNFIG --

AOS DOY 080		LCS DOY 080		TOTAL	
SCHEDULED	0843Z	SCHEDULED	1558Z	SCHEDULED	7H 15M
ACTUAL	0759Z	ACTUAL	1538Z	ACTUAL	7H 39M
ST XFR	0705Z	RELEASE	1609Z	DSS TIME	9H 04M

CCMMAND --

TOTAL 0 AUTO 0 MANUAL 0 ABORT 0

TELEMETRY --

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	154.5	N/A	6.2	N/A
PREDIC	156.7	N/A	5.5	N/A
RESID	+2.2	N/A	+0.7	N/A

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

DOP BIAS +.826HZ C NOS .011HZ EXP .011HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
CIS	1274	0	1617	0

PICNEER 10 S/C 23

0018 720800759 720801538 AB PF 0018
TCP N/R N/R N/R N/R

CCMMENTS

1102Z-1105Z H/S ENG STOPPED, CCA HALT, RE-INIT. "A" T-1943

1340Z-1345Z HSD DOWN (ENG. AND MCNITOR DATA) R T-1944

1350Z TCP A DECLARED RED DUE TO HARDWARE PROBLEMS WITH I/O

BUFFER REF T1944

2 WAY TRK 0831Z-1530Z

CMD MOD CN/OFF 0836Z-1525Z

```
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY

    PIONEER 10 S/C 23

  P10CCZ65310

0018  720801446     720810035    AJ   PF   0018
         DSS 42 PASS 018  CL E-B CTDN 302241 GCF 5006 CPS  N/A DSS GOOD

         CONFIG     ---------------------------------------------------

                    AOS DOY 080  LOS DOY 081        TOTAL

                    SCHEDULED 1445Z SCHEDULED 0100Z SCHEDULED 10H 15M

                    ACTUAL     1446Z ACTUAL     0035Z ACTUAL     9H 49M

                    ST XFR     1425Z RELEASE    0035Z DSS TIME  10H 10M

         COMMAND    ---------------------------------------------------

                    TOTAL  62  AUTO  62  MANUAL  0   ABORT  0

         TELEMETRY  ---------------------------------------------------

                    POWER  1 KW  BIT RATES  256 CODED  MMT

                          RX 1   RX 2   TCP A    TCP B

                    ACTUAL 155.3  N/A     5.6      N/A

                    PREDIC 156.9  N/A     4.4      N/A

                    RESID   +1.6  N/A    +1.2      N/A

         TRACKING   ---------------------------------------------------

                    TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                    DOP BIAS    .859HZ C NCS  .011HZ EXP  .011HZ

         MONITOR    ---------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                    DIS  N/A   N/A   N/A   N/A
```

```
PASS  GMT-START      GMT-END     CRIG  TYPE  CATA
NO.                              CODE  CODE  CAY

     FICNEER 10 S/C 23

 0018  720801446     720810035    AJ   PF   0018
                    TCP    N/A    N/A   N/A   N/A

        CCMMENTS

        NC CIS

        1953Z-1959Z 360/75A CCWN. CANX R/T JOB, WARM RESTART DR 3333

        2314Z-2346Z 360/75A CCWN, CORE FRAG., WARM IPL/RESTART

        DR 3333

     FICNEER 10 S/C 23

  P10CCZ65312

 0019  720810CC5     720810839    AM   PF   0019
        DSS 51 PASS 019  CL E-B CTDN 302241 GCF S00J CPS N/A  DSS J000

        CCNFIG

                 ACS DOY 081  LOS DOY C81        TOTAL

                 SCHEDULED 0000Z SCHEDULED 0841Z SCHEDULED   8H 41M

                 ACTUAL    0005Z ACTUAL    0840Z ACTUAL      8H 35M

                 ST XFR    2348Z RELEASE   0925Z DSS TIME    9H 37M

        CCMMAND

                 TCTAL  0   AUTO  0   MANUAL  0   ABORT  0
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	155.0	N/A	5.1	N/A
PREDIC	157.1	N/A	4.2	N/A
RESID	+2.1	N/A	+0.9	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.93HZ C NOS 0.011HZ EXP 0.012HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

0019 720810005 720810839 AM PF 0019
TCP N/R N/R N/R N/R

COMMENTS

0156Z-0202Z 360/75A DOWN, IPL, WARM RESTART DR 3337

0440Z-0447Z 360/75A DOWN, RESTART REQ. DR 3338

0522Z-0528Z 360/75A DOWN, RESTART REQ. DR 3339

0554Z-0610Z 360/75A DOWN, RESTART REQ. DR 3340

2 WAY TRACK 0033Z-0837Z

NO CMDS

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

P10CCZ65314

```
0019  720810804    720811520    AB   PF   0019
      DSS 12 PASS 019  CL H-B CTDN 202241 GCF S00B CPS      DSS

      CCNFIG     ---------------------------------------------------

                 ACS DOY 081   LCS DOY 081        TOTAL

                 SCHEDULED 0838Z SCHEDULED 1554Z SCHEDULED   7H 16M

                 ACTUAL    0803Z ACTUAL    1520Z ACTUAL      7H 17M

                 ST XFR    0715Z RELEASE   1530Z DSS TIME    8H 15M

      CCMMAND    ---------------------------------------------------

                 TCTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY  ---------------------------------------------------

                 POWER  1 KW  BIT RATES  256 CODED

                        RX 1   RX 2  TCP A     TCP B

                 ACTUAL 154.3   N/A     5.7        N/A

                 PREDIC 157.1   N/A     4.4        N/A

                 RESID   +2.8   N/A    +1.3        N/A

      TRACKING   ---------------------------------------------------

                 TRACK MD 2  WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                 DOP BIAS   -0.08HZ C NOS 0.011HZ EXP 0.012HZ

      MCNITOR    ---------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                 DIS 1357    1     0     0
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

0019	720810804	720811520	AB	PF	0019
		TCP N/A	N/A	N/A	N/A

COMMENTS

2 WAY TRACK 0838Z-1515Z

NO CMDS

PIONEER 10 S/C 23

P10CCZ65316

0019	720811443	720820035	AJ	PF	0019

DSS 42 PASS 019 CL E-B CTDN 302241 GCF 5006 CPS N/A DSS G000

CONFIG

ACS DOY 081		LCS DOY 082		TOTAL	
SCHEDULED	1445Z	SCHEDULED	0100Z	SCHEDULED	10H 15M
ACTUAL	1443Z	ACTUAL	0035Z	ACTUAL	9H 52M
ST XFR	1415Z	RELEASE	0035Z	DSS TIME	10H 20M

COMMAND

TOTAL 8 AUTO 8 MANUAL 0 ABORT 0

TELEMETRY

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	156.3	N/A	4.9	N/A
PREDIC	157.5	N/A	3.6	N/A
RESID	+1.2	N/A	+1.3	N/A

E

```
--------------------------------------------------------------------------
PASS   GMT-START      GMT-END     ORIG   TYPE   DATA
NO.                               CODE   CODE   CAY
--------------------------------------------------------------------------

        TRACKING  ----------------------------------------------------

                  TRACK MC  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS    .C79HZ C NCS  .011HZ EXP  .011HZ

        MCNITCR   ----------------------------------------------------

                       LGWR   LGER   BLRC   BLER

                  DIS  N/A    N/A    N/A    N/A



      PICNEER 10 S/C 23

 0C19  720811443    72C820035    AJ   PF   C019
                    TCP  N/A     N/A  N/A    N/A


        CCMMENTS  ----------------------------------------------------

        1738Z-175CZ 36C/75A DCWN, REASCN UNKNCWN, NO DR WRITTEN

        2255Z-2309Z 36C/75A DOWN, 2260'S LOCKED OUT, WARM IPL/RESTART

        DR 3346
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65318

0020 720812345 720820835 AM PF 0020
DSS 51 PASS 020 CL E-B CTDN 302241 GCF S00J CPS N/A DSS J000

CONFIG

AOS DOY 082		LOS DOY 082		TOTAL	
SCHEDULED	0000Z	SCHEDULED	0837Z	SCHEDULED	8H 37M
ACTUAL	2345Z	ACTUAL	0835Z	ACTUAL	8H 50M
ST XFR	2315Z	RELEASE	0921Z	DSS TIME	10H 06M

COMMAND

TOTAL 0 AUTO 0 MANUAL 0 ABORT 0

TELEMETRY

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	155.5	N/A	5.1	N/A
PREDIC	157.4	N/A	3.7	N/A
RESID	+1.9	N/A	+1.4	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/ARU NOISE N/ARU

DOP BIAS -0.08HZ C NOS 0.011HZ EXP 0.012HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 1C S/C 23

```
0020  720812345    720820835    AM   PF   C020
                   TCP    N/R    N/R   N/R    N/R
```

CCMMENTS

0114Z-0130Z 360/75A CCWN, 2260'S LOCKED OUT OF SYSTEM IPL/

RESTART WARM REF. DR 3348

2 WAY TRACK 0034Z-C830Z

CMDS XMTD-NCNE

PICNEER 10 S/C 23

P10CCZ65320

```
0020  72C82C811    72C821525    AB   PF   0020
      DSS 12 PASS 020  CL H-B CTDN 202241 GCF S00B CPS N/A  DSS B000
```

CCNFIG

```
ACS DOY C82   LOS DOY C82          TOTAL

SCHEDULED C834Z SCHEDULED 1550Z SCHEDULED  7H 16M

ACTUAL    C811Z ACTUAL    1525Z ACTUAL     7H 14M

ST XFR    NCNEZ RELEASE   1530Z DSS TIME   7H 19M
```

CCMMAND

TOTAL 0   AUTO 0   MANUAL 0   ABORT 0

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	156.2	N/A	5.5	N/A
PREDIC	157.7	N/A	3.8	N/A
RESID	+1.5	N/A	+1.7	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.05HZ C NCS 0.011HZ EXP 0.012HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	1236	11	368	0

PIONEER 10 S/C 23

0020 720820811 720821525 AB PF 0020
TCP N/A N/A N/A N/A

COMMENTS

0916Z-0948Z 360/75A DOWN; SYS BACKLOGGED, RESTART OR 3349

POST TRACK 1002Z-1004Z-RCVR O/LOCK DUE TO MOMENTARY LOSS OF ANT

HYDRAULIC PRESSURE, UNDER INVESTIGATION, TFR 802857, OR T-1947

REFERS

2 WAY TRACK 0831Z-1515Z

CMD ON/OFF 0835Z-1510Z NO CMDS XMTD

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

FICNEER 10 S/C 23

P1CCCZ65324

```
0020  720821439    72C830035   AJ  PF  0020
       DSS 42 PASS 020  CL E-B CTDN 302241 GCF SOUG CPS  N/A DSS G000

       CCNFIG    ---------------------------------------------------

                 ACS DOY 082  LCS DOY C83        TOTAL

                 SCHEDULED 1445Z SCHEDULED 0100Z SCHEDULED  10H 15M

                 ACTUAL     1439Z ACTUAL     0035Z ACTUAL      9H 56M

                 ST XFR     N/A Z RELEASE   N/A Z DSS TIMEN/A H    M

       CCMMAND   ---------------------------------------------------

                 TCTAL 51   AUTO  51  MANUAL  0   ABORT  0

       TELEMETRY ---------------------------------------------------

                 POWER  1 KW  BIT RATES  256  CODED  MMT

                        RX 1   RX 2  TCP A     TCP B

                 ACTUAL         N/A      5.2        N/A

                 PREDIC         N/A      3.4        N/A

                 RESIC          N/A     +1.8        N/A

       TRACKING  ---------------------------------------------------

                 TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                 DOP BIAS  -0.042HZ C NCS 0.011HZ EXP 0.011HZ

       MCNITOR   ---------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                 DIS   N/A   N/A   N/A   N/A
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0020  720821439   720830035   AJ  PF  0020
              TCP   N/A   N/A   N/A   N/A
```

COMMENTS

1546Z TCP/CMA "B" BIT RATE ERRORS DR T-1948

0025Z-0037Z 360 A DOWN-DTV FORMATS BACKLOG; 2260 LOCKOUT,

WARM RESTART DR 3333

PIONEER 10 S/C 23

P10CC265323

```
0021  720822358   720830818   AM  PF  0021
    DSS 51 PASS 022  CL E-B CTDN 302241 GCF S00J CPS  N/A DSS J000
```

CONFIG

```
AOS DOY 083   LOS DOY 084        TOTAL
SCHEDULED 0000Z SCHEDULED 0832Z SCHEDULED  8H 32M
ACTUAL    2358Z ACTUAL    0820Z ACTUAL     8H 22M
ST XFR    2323Z RELEASE   0920Z DSS TIME   9H 57M
```

COMMAND

```
TOTAL  0   AUTO  0   MANUAL  0   ABORT  0
```

MCNTHLY REPORT FOR MARCH 1972

PASS NC.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA CAY

TELEMETRY

POWER 1 KW BIT RATES 256 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	155.9	N/A	4.2	N/A
PREDIC	158.0	N/A	3.0	N/A
RESID	+2.1	N/A	+1.2	N/A

TRACKING

TRACK MD 2 WAY RANGING N/A BIAS N/A RU NOISE N/A RU

DOP BIAS -0.08HZ C NCS 0.011HZ EXP 0.011HZ

MCNITCR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PICNEER 10 S/C 23

0021 720822358 720830818 AM PF 0021

TCP	N/R	N/R	N/R	N/R

CCMMENTS

0013Z-0025Z 360/75A DCWN, DTV BACKLOG; 2260 LCCKCUT WARM RESTART CR 3333

0235Z-0252Z 360/75A DCWN, CUT OF CORE; WARM RESTART CR 3354

MCNTHLY REPORT FCR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CCDE	CATA CAY

PICNEER 10 S/C 23

P10CCZ65326

0021 720830750 720831545 AB PF CC21
DSS 12 PASS 021 CL H-B CTDN 202241 GCF S00B CPS N/A DSS 8000

CCNFIG

ACS DCY C83		LCS DCY 083		TCTAL	
SCHEDULED	0829Z	SCHEDULED	1546Z	SCHEDULED	7H 46M
ACTUAL	C750Z	ACTUAL	1545Z	ACTUAL	7H 55M
ST XFR	C705Z	RELEASE	1600Z	DSS TIME	8H 55M

CCMMAND

TCTAL C AUTO 0 MANUAL 0 ABCRT 0

TELEMETRY

POWER 1 KW BIT RATES 256 CODED

	RX 1	RX 2	TCP B	TCP A
ACTUAL	156.2	N/A	5.1	N/A
PREDIC	158.1	N/A	3.6	N/A
RESID	+1.9	N/A	+1.5	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS -0.04HZ C NOS 0.011HZ EXP 0.012HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	1335	0	1081	0

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
0021  720830750    720831545    AB   PF   CC21
                TCP  N/A     N/A   N/A   N/A
```

CCMMENTS ---

1450Z-1505Z 36C/75A CCWN EARLY FCR SKED SYSTEM CLEAN-UP

2 WAY TRACK C816Z-1515Z

NC CMCS

PICNEER 10 S/C 23

P10CCZ65328

```
0C21  72C831441    72C840100    AJ   PF   0021
      CSS 42 PASS 021  CL E-B CTDN 302241 GCF SOOG CPS  N/A DSS GOOD
```

CCNFIG ---

```
AOS DOY 083   LOS DOY C84           TCTAL
SCHEDULED 1445Z SCHEDULED 0100Z SCHEDULED 10H 15M
ACTUAL      1441Z ACTUAL     0100Z ACTUAL     10H 19M
ST XFR      N/A Z RELEASE    N/A Z DSS TIMEN/A H    M
```

CCMMAND ---

TCTAL 122 AUTC 122 MANUAL 0   ABORT 0

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 2048 1024

	RX 1	RX 2	TCP A	TCP B
ACTUAL	149.4	155.3	5.2	4.4
PREDIC	149.3	158.2	6.0	3.1
RESID	+0.1	+2.9	-0.8	+1.3

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/ARU NOISE N/A RU

DOP BIAS -0.12HZ C NCS 0.008HZ EXP 0.011HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/A	N/A	N/A	N/A

PIONEER 10 S/C 23

0021	720831441	720840100	AJ	PF	0021

TCP	N/A	N/A	N/A	N/A

COMMENTS

1450Z-1505Z 360A DOWN EARLY FOR SYST CLEANUP-IPL WARM/WARM, SOFTWARE PROB ENCOUNTERED DR 3355

0034Z-0051Z 360A DOWN DTV BACKLOG, 2260 LOCKOUT, RTJS DR 3358

```
--------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
--------------------------------------------------------------------------

      PIONEER 10 S/C 23


  P10CCZ65330

 0022  720832355   720840828    AM   PF   0022
        DSS 51 PASS 022  CL E-B CTDN 302241 GCF SOOJ CPS  N/A DSS J000

        CONFIG     -----------------------------------------------------

                   ACS DOY 084  LCS DOY 084        TOTAL

                   SCHEDULED 0000Z SCHEDULED 0828Z SCHEDULED   8H 28M

                   ACTUAL     2355Z ACTUAL     0828Z ACTUAL      8H 33M

                   ST XFR     2315Z RELEASE    0850Z DSS TIME    9H 45M

        COMMAND    -----------------------------------------------------

                   TOTAL 42   AUTO  42  MANUAL  0   ABORT  0

        TELEMETRY  -----------------------------------------------------

                   POWER  1 KW  BIT RATES  1024  CODED  MMT

                          RX 1   RX 2  TCP B     TCP A

                   ACTUAL  N/A   150.0     6.0       N/A

                   PREDIC  N/A   149.3     6.4       N/A

                   RESID   N/A    -0.7    -0.4       N/A

        TRACKING   -----------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS   +18.0HZ C NOS 0.003HZ EXP 0.005HZ

        MONITOR    -----------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  1422   18   184     0
```

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	DATA CAY

PICNEER 10 S/C 23

```
0022  720832355   720840828    AM  PF  0022
               TCP  N/A   N/A    0     0
```

CCMMENTS --

0034Z-0051Z 360 A DOWN DTU BACKLCG AND 2260Z LCCKOUT RTJS

CR 3358

0816Z-0818Z HSD DCWN CR C 5157

2 WAY TRACK 0017Z-0810Z

CMDS XMTD 0108Z-0758Z

PICNEER 10 S/C 23

P10CCZ65331

```
0022  720840737   720841505    AB  PF  0022
      DSS 12 PASS 022  CL L-B CTDN 201141 GCF S008 CPS  N/A DSS 8000
```

CCNFIG --

ACS DOY 084		LCS DOY C84		TCTAL	
SCHEDULEC	0825Z	SCHEDULED	1541Z	SCHEDULED	7H 16M
ACTUAL	C837Z	ACTUAL	1505Z	ACTUAL	6H 28M
ST XFR	0606Z	RELEASE	1510Z	DSS TIME	9H 04M

CCMMAND --

TOTAL 30   AUTO 30   MANUAL 0   ABCRT 0

```
--------------------------------------------------------------------------
PASS  GMT-START      GMT-END      CRIG  TYPE  CATA
NC.                               CODE  COCE  CAY
--------------------------------------------------------------------------

         TELEMETRY  ----------------------------------------------------

                    POWER  1 KW  BIT RATES  512       2C48 CODED  MMT

                           RX 1    RX  1 TCP A     TCP  A

                    ACTUAL 149.8   149.8    12.8        3.6

                    PRECIC 149.5   149.5     11.6       3.7

                    RESID   -0.3    -0.3    +1.2       -0.1

         TRACKING  -----------------------------------------------------

                    TRACK MD  2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

                    DOP BIAS   -18.5HZ C NCS 0.011HZ EXP 0.011HZ

         MCNITOR  ------------------------------------------------------

                         LGWR  LGER  BLRC  ELER

                    CIS  1443    0   185     0


      PICNEER 10 S/C 23

 0022  720840737     720841505    AB   PF   0022
                    TCP    N/A    N/A  N/A    N/A


         CCMMENTS  -----------------------------------------------------

         C906Z-0914Z 360/75A CCWN, SFED. IPL WARM/WARM

         2 WAY TRACK C812Z-144CZ

         CMCS XMTC AT
```

```
------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
------------------------------------------------------------------------

     PIONEER 10 S/C 23

 P10CCZ65333

 0022  720840830    720841330    AD   PF   0022
       DSS 14 PASS 022  CL C-P CTDN 303343 GCF S00D CPS  N/A DSS D000

       CONFIG     -----------------------------------------------------

                  ACS DOY 084  LOS DOY 084        TOTAL

                  SCHEDULED 0828Z SCHEDULED 1248Z SCHEDULED  4H 20M

                  ACTUAL    0830Z ACTUAL    1334Z ACTUAL     5H 04M

                  ST XFR    0745Z RELEASE   1345Z DSS TIME   6H 00M

       COMMAND    -----------------------------------------------------

                  TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

       TELEMETRY  -----------------------------------------------------

                  POWER N/AKW  BIT RATES   512

                         RX 1   RX 2  TCP B     TCP A

                  ACTUAL 146.1   N/A      16.3      N/A

                  PREDIC 141.4   N/A      19.8      N/A

                  RESID   -4.7   N/A      -3.5      N/A

       TRACKING   -----------------------------------------------------

                  TRACK MC  3 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                  DOP BIAS   -20.0HZ C NOS 0.010HZ EXP 0.011HZ

       MONITOR    -----------------------------------------------------

                       LGWR  LGER  BLRC  BLER

                  DIS  0832   0     0     0
```


F

MONTHLY REPORT FOR MARCH 1972

```
-------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
-------------------------------------------------------------------------

      PIONEER 10 S/C 23

 0022  720840830     720841330    AD   PF   0022
                   TCP  N/A     N/A  N/A    N/A


         COMMENTS  ---------------------------------------------------

         3 WAY

         0906Z-0914Z 360/75A DOWN, SKED IPL WARM/WARM

         TRACK TIME EXTENED

         M/C SUPPORT



      PIONEER 10 S/C 23

  P10CCZ65342

 0022  720841252     720842300    AI   PF   0022
          DSS 41 PASS 022  CL F-B CTDN  N/A   GCF SOOF CPS  N/A DSS FOOO

         CONFIG    ---------------------------------------------------

                   AOS DOY 084  LOS DOY 084        TOTAL

                   SCHEDULED 1300Z SCHEDULED 2300Z SCHEDULED 10H 00M

                   ACTUAL    1252Z ACTUAL    2300Z ACTUAL    10H 08M

                   ST XFR    1225Z RELEASE   2300Z DSS TIME  10H 35M

         COMMAND   ---------------------------------------------------

                   TOTAL  7   AUTO  7   MANUAL 0    ABORT  0
```

MCNTHLY REPORT FOR MARCH 1972

PASS NC.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	CATA CAY

TELEMETRY

POWER 1 KW BIT RATES 512 1024 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	148.6	N/A	7.5	5.0
PREDIC	149.6	N/A	9.1	6.2
RESID	+1.0	N/A	-1.6	-1.2

TRACKING

TRACK MC 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS .035HZ C NCS .005HZ EXP .007HZ

MCNITOR

	LGWR	LGER	BLRC	BLER
DIS	1332	0	0	0

PICNEER 10 S/C 23

0022 720841252 720842300 AI PF C022
TCP N/A N/A N/A N/A

CCMMENTS

NC DIS/TCP INFACE FOR PICNEER MCNITCR PROGRAM

APPROX. 1530Z CIS BROUGHT UP ON MARINER PROGRAM

1957Z-2003Z 360/75A COWN FOR VERSION SWAP (27.3 TO 27.4)

PASS NC.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	DATA CAY

PICNEER 10 S/C 23

P10CCZ65334

```
0022  720841430    720850026    AJ  PF  0022
   DSS 42 PASS 022  CL E-B CTDN 302241 GCF S00G CPS N/A  DSS G00D
   CCNFIG     ------------------------------------------------
              ACS DOY 084  LCS DOY C85          TOTAL
              SCHEDULED 1430Z SCHEDULED 0045Z SCHEDULED 10H 15M
              ACTUAL    1430Z ACTUAL    0025Z ACTUAL     9H 55M
              ST XFR    1400Z RELEASE   N/A Z DSS TIMEN/A H    M
   CCMMAND    ------------------------------------------------
              TOTAL 49   AUTO  49  MANUAL  0   ABCRT  0
   TELEMETRY  ------------------------------------------------
              POWER  1 KW  BIT RATES  512         1024
                     RX 1    RX 1   TCP B      TCP A
              ACTUAL 150.9  151.7     4.2        7.5
              PREDIC 149.6  149.6     6.4        9.1
              RESIC   -1.3   -2.1     2.2       +0.6
   TRACKING   ------------------------------------------------
              TRACK MD 2.3WAY RANGING NIL BIAS N/A RU NCISE N/A RU
              DOP BIAS   +0.03HZ C NOS 0.CO7HZ EXP 0.011HZ
   MCNITOR    ------------------------------------------------
                    LGWR  LGER  BLRC  BLER
              DIS   N/A   N/A   N/A   N/A
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

```
0022  720841430    72C850026    AJ   PF   C022
              TCP    N/A    N/A    N/A    N/A
```

CCMMENTS --

1957Z-2003Z 360A DOWN FOR VERSION SWAP 27.3 TO 27.4

PICNEER 10 S/C 23

P10CCZ65336

```
0023  720842340    72C850819    AM   PF   C023
   DSS 51 PASS 023  CL E-B CTDN 302241 GCF 500J CPS  N/A DSS J000
```

CCNFIG --

```
          AOS DOY 084  LOS DOY 084        TOTAL
          SCHEDULED 2345Z SCHEDULED 0823Z SCHEDULED  8H 38M
          ACTUAL    2340Z ACTUAL    0819Z ACTUAL     8H 39M
          ST XFR    2300Z RELEASE   0930Z DSS TIME  10H 30M
```

CCMMAND --

```
          TOTAL  2   AUTO  2   MANUAL  0   ABORT  0
```

TELEMETRY --

```
          PCWER  1 KW  BIT RATES  512        1024    MMT
                 RX 1   RX 1   TCP A      TCP A
          ACTUAL 150.9  151.2     4.1        +6.4
          PREDIC 150.7  150.7     5.1        +7.6
          RESID  -0.2   -C.5     -1.0        -1.2
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.027HZ C NCS .007HZ EXP .011HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY
0023	720842340	720850819	AM	PF	0023
	TCP	N/R	N/R	N/R	N/R

COMMENTS

0348Z-0354Z 360 DOWN, CCLC RESTART DR 3366

2 WAY TRACK 0018Z-0815Z

CMDS XMTD 0018Z-0811Z

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

PICNEER 10 S/C 23

P10CCZ65337

```
0023  720850800    720851512    AB  PF  0023
      DSS 12 PASS 023  CL H-B CTCN  N/A  GCF S00B CPS N/A  DSS B000

      CCNFIG   ----------------------------------------------------

               ACS DOY 085  LCS DOY 085          TOTAL

               SCHEDULED 0820Z SCHEDULED 1537Z SCHEDULED  7H 17M

               ACTUAL    C800Z ACTUAL    1512Z ACTUAL     7H 12M

               ST XFR    0700Z RELEASE   1600Z DSS TIME   9H 10M

      CCMMAND  ----------------------------------------------------

               TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY ---------------------------------------------------

               POWER  1 KW  BIT RATES 512  CODED  MMT

                      RX 1   RX 2   TCP B     TCP A

               ACTUAL 151.1  N/A     6.8      N/A

               PREDIC 150.8  N/A     7.7      N/A

               RESID  -0.3   N/A    -0.9      N/A

      TRACKING ----------------------------------------------------

               TRACK MC  2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

               DOP BIAS   +.038HZ C NOS 0.007HZ EXP 0.011HZ

      MCNITOR  ----------------------------------------------------

                    LGWR  LGER  BLRC  BLER

               DIS  1206  0      0     0
```

MCNTHLY REPORT FOR MARCH 1972

```
PASS  GMT-START    GMT-END     ORIG  TYPE  DATA
NO.                            CODE  CCDE  CAY

     PICNEER 10 S/C 23

0023  72085C800    720851512    AB   PF   0023
                  TCP   N/A    N/A   N/A   N/A

        CCMMENTS ------------------------------------------------

        1127Z-1143Z 360/75A DCWN FOR SKED. STRING SWAP TC "B"

        1444Z-1450Z 360/75B DCWN, SYSTEM DIEC, WARM RESTART CR 3368

        2 WAY TRACK 0819Z-1500Z

        NC CMDS


     PICNEER 10 S/C 23

 P10CCZ65341

0024  720852338    720860819    AM   PF   0024
       DSS 51 PASS 024  CL E-B CTDN  N/A  GCF S00J CPS N/A  DSS J000

        CCNFIG   ------------------------------------------------

                 ACS DOY C85  LCS DOY C86        TOTAL

                 SCHEDULED 2345Z SCHEDULED 0819Z SCHEDULED  8H 34M

                 ACTUAL    2338Z ACTUAL    C819Z ACTUAL     8H 41M

                 ST XFR    2309Z RELEASE   0916Z DSS TIME  10H 07M

        CCMMAND  ------------------------------------------------

                 TOTAL  C   AUTC  0   MANUAL  0   ABCRT  0
```

MONTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
------------------------------------------------------------------------

     TELEMETRY ---------------------------------------------------

               POWER  1 KW  BIT RATES  512 CODED   MMT

                    RX 1   RX 2   TCP A     TCP B

               ACTUAL 151.6   N/A      6.4       N/A

               PREDIC 151.0   N/A      7.4       N/A

               RESID   -0.6   N/A     -1.0       N/A

     TRACKING ---------------------------------------------------

               TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

               DOP BIAS  +0.030HZ C NOS 0.007HZ EXP 0.011HZ

     MONITOR ---------------------------------------------------

                   LGWR  LGER  BLRC  BLER

               DIS  N/R    N/R   N/R   N/R



   PIONEER 10 S/C 23

 0024   72C852338    72C860819    AM   PF   0024
               TCP  N/R    N/R   N/R   N/R


     COMMENTS ---------------------------------------------------

     0425Z-0438Z 360/75B DOWN, 2260'S LOCKED OUT, WARM IPL/RESTART

     DR 3371

     2 WAY TRACK 0015Z-0810Z

     NO CMDS
```

```
--------------------------------------------------------------------------------
PASS  GMT-START     GMT-END      CRIG  TYPE  CATA
NO.                              CODE  CODE  DAY
--------------------------------------------------------------------------------

      PICNEER 10 S/C 23

 P10CCZ65343

0024  72C860800    72C861510    AB   PF   0024
        DSS 12 PASS 024  CL H-B CTDN  N/A   GCF SOOB CPS  N/A DSS B000

        CCNFIG     -----------------------------------------------------

                   AOS DOY 086  LOS DOY C86         TOTAL

                   SCHECULED 0815Z SCHEDULED 1533Z SCHEDULED  7H 18M

                   ACTUAL    C800Z ACTUAL    1510Z ACTUAL     7H 10M

                   ST XFR    C711Z RELEASE   1520Z DSS TIME   8H 09M

        CCMMAND    -----------------------------------------------------

                   TCTAL  0   AUTO  0   MANUAL 0   ABORT  0

        TELEMETRY  -----------------------------------------------------

                   POWER  1 KW  BIT RATES 512 CODED

                          RX 1   RX 2  TCP B     TCP A

                   ACTUAL 151.7  N/A     6.3       N/A

                   PRECIC 151.1  N/A     7.2       N/A

                   RESID   -0.6  N/A    -C.9       N/A

        TRACKING   -----------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS  +C.042HZ C NCS 0.007HZ EXP 0.011HZ

        MCNITOR    -----------------------------------------------------

                       LGWR  LGER  BLRC  BLER

                   DIS  1197   1    110    0
```

```
------------------------------------------------------------------------------
PASS  GMT-START     GMT-END     ORIG  TYPE  DATA
NO.                             CODE  CODE  DAY
------------------------------------------------------------------------------

    PIONEER 10 S/C 23

0024  720860800     720861510    AB   PF   0024
                    TCP  N/A    N/A  N/A    N/A


      COMMENTS  --------------------------------------------------------

      1057Z-1108Z 360/75B DOWN FOR SKED. STRING SWAP TO "A"

      1157Z-1202Z 360/75A DOWN, WRONG VER ON-LINE (27.3A) WARM

      IPL/RESTART NO DR

      2 WAY TRACK 0814Z-1500Z

      NO CMDS


    PIONEER 10 S/C 23

 P100CZ65345

0024  720861351     720870004    AJ   PF   0024
      DSS 42 PASS 024  CL E-B CTDN  N/A   GCF S00G CPS  N/A DSS G000
      CONFIG   --------------------------------------------------------

               ACS DOY 086  LOS DOY 087        TOTAL

               SCHEDULED 1430Z SCHEDULED 0045Z SCHEDULED 10H 15M

               ACTUAL    1351Z ACTUAL    0004Z ACTUAL    10H 13M

               ST XFR    1340Z RELEASE   N/A Z DSS TIMEN/A H   M
      COMMAND  --------------------------------------------------------

               TOTAL  0   AUTO  0   MANUAL 0   ABORT  0
```

MCNTHLY REPORT FCR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  CAY
------------------------------------------------------------------------

        TELEMETRY  ---------------------------------------------------

                 POWER  1 KW  BIT RATES  512  CODED

                        RX 1   RX 2   TCP B     TCP A

                 ACTUAL 151.4  N/A     6.9       N/A

                 PREDIC 151.3  N/A     7.0       N/A

                 RESIC   -0.1  N/A    -0.1       N/A

        TRACKING  ----------------------------------------------------

                 TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                 DOP BIAS   +0.06HZ C NOS 0.007HZ EXP 0.011HZ

        MCNITOR  -----------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                 DIS  N/A   N/A   N/A   N/A



      PICNEER 10 S/C 23

 0024  720861351    720870004    AJ   PF   0024
                 TCP  N/A   N/A   N/A   N/A


        CCMMENTS  ----------------------------------------------------
```

```
------------------------------------------------------------------------------
PASS  GMT-START      GMT-END      ORIG  TYPE  DATA
NO.                               CODE  CODE  DAY
------------------------------------------------------------------------------

     PIONEER 10 S/C 23

 P10CCZ65347

0025  720862340     72C870815    AM   PF   CC25
          DSS 51 PASS 025  CL E-B CTDN  N/A   GCF S00J CPS  N/A DSS J000

          CCNFIG  ----------------------------------------------------------

                  ACS DOY 086  LOS DOY 087        TOTAL

                  SCHEDULED 2345Z SCHEDULED 0814Z SCHEDULED  8H 29M

                  ACTUAL    2330Z ACTUAL    0814Z ACTUAL     8H 44M

                  ST XFR    2300Z RELEASE   0912Z DSS TIME  10H 12M

          CCMMAND ----------------------------------------------------------

                  TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

          TELEMETRY --------------------------------------------------------

                  POWER  1 KW  BIT RATES  512   CODED  MMT

                         RX 1   RX 2  TCP B    TCP A

                  ACTUAL  N/A   151.9    6.2       N/A

                  PREDIC  N/A   151.5    6.9       N/A

                  RESID   N/A    -0.4   -C.7       N/A

          TRACKING ---------------------------------------------------------

                  TRACK MC  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS  +C.043HZ C NCS 0.006HZ EXP 0.011HZ

          MCNITCR ----------------------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  DIS  N/R   N/R   N/R   N/R
```

MCNTHLY REPORT FOR MARCH 1972

```
-----------------------------------------------------------------------------
PASS   GMT-START      GMT-END      ORIG   TYPE   DATA
NO.                                CODE   CODE   DAY
-----------------------------------------------------------------------------

      PICNEER 10 S/C 23

 0025   720862340     72087C815     AM    PF   0025
                     TCP   N/R     N/R    N/R    N/R


         CCMMENTS  --------------------------------------------------

         CHG FROM TCP-A TO TCP-B AT 0305Z

         2 WAY TRACK 0004Z-0800Z

         NO CMDS



      PICNEER 10 S/C 23

  P10CCZ65348

 0025   720870730     720871505     AB    PF   0025
         DSS 12 PASS 025  CL C-B CTDN  N/A   GCF S00B CPS  N/A DSS B000

         CCNFIG     --------------------------------------------------

                    AOS DOY C87  LCS DOY C87        TOTAL

                    SCHEDULED 0730Z SCHEDULED 1530Z SCHEDULED 11H 00M

                    ACTUAL    C730Z ACTUAL    1505Z ACTUAL     7H 35M

                    ST XFR    C644Z RELEASE   1614Z DSS TIME   9H 30M

         CCMMAND    --------------------------------------------------

                    TOTAL  C   AUTO  0   MANUAL  0   ABORT  0
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	151.6	N/A	6.7	N/A
PREDIC	151.5	N/A	7.0	N/A
RESID	-0.1	N/A	-0.3	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.057HZ C NOS 0.007HZ EXP 0.011HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	1166	0	1081	0

PIONEER 10 S/C 23

0025	720870730	720871505	AB	PF	0025
		TCP N/A	N/A	N/A	N/A

COMMENTS

0759Z-0803Z DIS DOWN, LOSS OF /C ACESS, RELOAD REQ. NO DR

0808Z-0837Z DIS DOWN, LOSS OF I/O ACESS, RELOAD REQ. NO DR

1033Z-1046Z 3100 DOWN, KEYBOARD I/O LOCKED UP, SWAPPED SYSTEMS, NO DR

STA. REL AFTER 2 WAY XFER

2 WAY TRACK 0800Z-1500Z NO CMDS

G

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65349

```
0025  72C871430    72C872348    AI   PF   0025
      DSS 41 PASS 025  CL H-B CTDN   N/A  GCF SOOF CPS  N/A DSS F000

      CONFIG    -----------------------------------------------------

                ACS DOY 087  LCS DOY C88          TOTAL

                SCHEDULED 1430Z SCHEDULED 0000Z SCHEDULED   9H 30M

                ACTUAL    1430Z ACTUAL    2348Z ACTUAL      9H 18M

                ST XFR    1353Z RELEASE   N/A Z DSS TIMEN/A H    M

      COMMAND   -----------------------------------------------------

                TOTAL  8   AUTO  8   MANUAL  0   ABORT  0

      TELEMETRY -----------------------------------------------------

                POWER  1 KW  BIT RATES  512

                      RX  2  RX  1 TCP B      TCP A

                ACTUAL 153.7   N/A      6.7       N/A

                PREDIC 151.7   N/A      6.8       N/A

                RESID  -2.0    N/A     -0.1       N/A

      TRACKING  -----------------------------------------------------

                TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                DOP BIAS    .066HZ C NCS  .007HZ EXP 0.011HZ

      MONITOR   -----------------------------------------------------

                     LGWR  LGER  BLRC  BLER

                DIS  1132  0     1090  0
```

MCNTHLY REPURT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

FICNEER 10 S/C 23

0025 720871430 720872348 AI PF 0025
TCP N/A N/A N/A N/A

COMMENTS

161CZ-1613Z HSCL CCWN DR 5178

1622Z-1623Z HSCL DCWN DR 5179

1834Z-1845Z HSDL DOWN DR 5183

23482-PROCESS PULLED NC LCS DIS READING

FICNEER 10 S/C 23

P10CCZ65351

0026 72C87230C4 72C880810 AM PF 0026
DSS 51 PASS 026 CL N/A CTDN N/A GCF SOOJ CPS N/A DSS J000

CCNFIG

ACS DOY C87		LCS DOY C88		TOTAL	
SCHEDULED	2300Z	SCHEDULED	0815Z	SCHECULED	9H 15M
ACTUAL	2304Z	ACTUAL	0810Z	ACTUAL	9H 06M
ST XFR	2225Z	RELEASE	0916Z	DSS TIME	10H 51M

CCMMAND

TCTAL C AUTO 0 MANUAL 0 ABORT 0

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	N/A	152.3	6.3	N/A
PREDIC	N/A	151.9	6.6	N/A
RESID	N/A	-0.4	-0.3	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.063HZ C NOS 0.007HZ EXP 0.011HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

0026	720872304	720880810	AM	PF	0026

TCP	N/R	N/R	N/R	N/R

COMMENTS

2 WAY TRACK 2332Z-0745Z

NO CMDS

MCNTHLY REPORT FOR MARCH 1972

```
-----------------------------------------------------------------------------
PASS  GMT-START      GMT-END    ORIG  TYPE  DATA
NO.                             CODE  CODE  CAY
-----------------------------------------------------------------------------

     PICNEER 10 S/C 23

 F10CCZ65352

 0026  72C880730    72C881505   AB   PF  0026
        CSS 12 PASS 026  CL C-B CTDN  N/A   GCF S00B CPS N/A  DSS B000

        CCNFIG     ---------------------------------------------------------

                   ACS DOY C88  LCS DOY 088        TOTAL

                   SCHEDULED C730Z SCHEDULED 1530Z SCHEDULED  8H 00M

                   ACTUAL    C730Z ACTUAL    1505Z ACTUAL     7H 35M

                   ST XFR    C645Z RELEASE   1621Z DSS TIME   9H 36M

        CCMMAND    ---------------------------------------------------------

                   TCTAL  0   AUTC  0   MANUAL  0   ABORT  0

        TELEMETRY  ---------------------------------------------------------

                   POWER  1 KW  BIT RATES  512   CODED

                          RX 1   RX 2  TCP B    TCP A

                   ACTUAL 151.8   N/A     6.3      N/A

                   PREDIC 151.9   N/A     6.7      N/A

                   RESID   -0.1   N/A    -0.4      N/A

        TRACKING   ---------------------------------------------------------

                   TRACK MC  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                   DOP BIAS    .C68HZ C NCS  .006HZ EXP  .C08HZ

        MCNITOR    ---------------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  1259    1     0     0
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0026  720880730     720881505     AB   PF   0026
                 TCP  N/A     N/A   N/A   N/A
```

COMMENTS

STA. REL AFTER 2 WAY XFER TO DSS-41

2 WAY TRACK 0745Z-1500Z

NO CMDS

PIONEER 10 S/C 23

P100CZ65354

```
0026  720881420     720882348     AI   PF   0026
      DSS 41 PASS 026  CL H-B CTDN  N/A   GCF S00F CPS N/A  DSS F000
```

CONFIG

```
ACS DOY 088   LOS DOY 088          TOTAL
SCHEDULED 1430Z SCHEDULED 1430Z SCHEDULED  9H 30M
ACTUAL    1420Z ACTUAL    1420Z ACTUAL     9H 22M
ST XFR    1345Z RELEASE   1345Z DSS TIMEN/A H    M
```

COMMAND

TOTAL 5   AUTO 5   MANUAL 0   ABORT 0

MCNTHLY REPORT FOR MARCH 1972

```
------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
------------------------------------------------------------------------

        TELEMETRY ----------------------------------------------------

                  POWER  1 KW  BIT RATES  512  CODED

                        RX 1   RX 2  TCP A     TCP B

                  ACTUAL 152.0   N/A      6.4        N/A

                  PREDIC 152.1   N/A      6.5        N/A

                  RESID   +0.1   N/A     -0.1        N/A

        TRACKING -----------------------------------------------------

                  TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

                  DOP BIAS  +0.068HZ C NOS 0.007HZ EXP 0.011HZ

        MONITOR  -----------------------------------------------------

                      LGWR  LGER  BLRC  ELER

                  DIS  1549    2     0     0


      PIONEER 10 S/C 23

 0026  720881420    720882348    AI   PF   C026
                   TCP  N/A    N/A   N/A   N/A


        COMMENTS -----------------------------------------------------

        1508Z-1512Z DCA HUNG UP RELOAD-RE: DR T1962

        1858Z-1902Z DCA HUNG UP RELOAD-RE: DR T1962

        1920Z-1924Z DCA HUNG UP RELOAD-RE: DR T1962
```

MCNTHLY REPORT FOR MARCH 1972

```
PASS  GMT-START     GMT-END     ORIG  TYPE  CATA
NO.                             CODE  CODE  CAY

     PICNEER 10 S/C 23

 P10CCZ65356

0027  720882248    72C890806    AM   PF   CC27
        DSS 51 PASS 027  CL C-B CTDN  N/A   GCF 500J CPS N/A  DSS J0C0

        CCNFIG      ------------------------------------------------

                    ACS DOY C88  LCS DCY C89       TCTAL

                    SCHEDULED 2300Z SCHEDULED C815Z SCHEDULED  9H 15M

                    ACTUAL    2248Z ACTUAL    0806Z ACTUAL     9H 18M

                    ST XFR    2215Z RELEASE   C900Z DSS TIME  10H 45M

        CCMMAND     ------------------------------------------------

                    TCTAL  1   AUTC  1   MANUAL  0   ABORT  0

        TELEMETRY   ------------------------------------------------

                    POWER  1 KW  BIT RATES  512  CODED    MMT

                           RX 1   RX 2  TCP B     TCP A

                    ACTUAL  N/A   153.8     N/A       N/A

                    PRECIC  N/A   152.3     N/A       N/A

                    RESID   N/A    -1.5     N/A       N/A

        TRACKING    ------------------------------------------------

                    TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                    DOP BIAS  +0.063HZ C NOS 0.006HZ EXP 0.008HZ

        MCNITCR     ------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                    DIS   N/R   N/R   N/R   N/R
```

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

```
0027  720882248    720890806    AM  PF  0027
                  TCP   N/R   N/R   N/R   N/R
```

CCMMENTS

MCNITOR DATA NOT CCMMITTED FOR P-10 SUPPORT

0234Z-0259Z 360/75A DCWN, POWER SUPPLY FAILURE, SWAPPED TO

"B" STRING DR 3381

POST TRACK-CHANGED THYROTRCN ON TCP-B-MAG UNIT, TFR

2 WAY TRACK 2332Z-0745Z

CMDS XMTD 2335Z-0740Z (1) CMD MOD ON/OFF

PICNEER 10 S/C 23

P10CCZ65357

```
0027  720890730    720891505    AB  PF  C027
      DSS 12 PASS 027  CL H-B CTDN  N/A   GCF 500B CPS  N/A DSS 8000
```

CCNFIG

```
ACS DOY 089   LCS DOY 089          TCTAL
SCHEDULED C730Z SCHEDULED 1530Z SCHEDULED   8H 00M
ACTUAL     C730Z ACTUAL     1505Z ACTUAL      7H 35M
ST XFR     N/A Z RELEASE    N/A Z DSS TIMEN/A H    M
```

CCMMAND

```
TCTAL  C   AUTC  0   MANUAL  0   ABCRT  0
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	152.0	N/A	5.8	N/A
PREDIC	152.3	N/A	6.2	N/A
RESID	+0.3	N/A	-0.4	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/ARU

DOP BIAS +0.089HZ C NOS 0.006HZ EXP 0.008HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	1270	0	0	0

PIONEER 10 S/C 23

0027	720890730	720891505	AB	PF	0027
		TCP N/A	N/A	N/A	N/A

COMMENTS

1227Z-1230Z HSC LINE DOWN, NO DR

1325Z-1332Z LOST XMTR, WAVE GUIDE PRESSURE ALARM, REPLACED BOTTLE, TFR E02882, DR T-1965

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CC265359

```
0027  720891420    720892330    AI  PF  0027
    DSS 41 PASS 027  CL H-B CTDN  N/A   GCF 500F CPS  N/A DSS F000

    CONFIG    ---------------------------------------------------

              AOS DOY 089  LOS DOY 090         TOTAL

              SCHEDULED 1430Z SCHEDULED 0000Z SCHEDULED   9H 30M

              ACTUAL    1420Z ACTUAL    2330Z ACTUAL     8H 50M

              ST XFR    N/A Z RELEASE   0057Z DSS TIME  10H 37M

    COMMAND   ---------------------------------------------------

              TOTAL 44   AUTO  44  MANUAL 0    ABORT  0

    TELEMETRY ---------------------------------------------------

              POWER  1 KW  BIT RATES  512  CODED  MMT

                     RX 1   RX 2  TCP A     TCP B

              ACTUAL 152.5   N/A      6.6       N/A

              PREDIC 152.5   N/A      7.1       N/A

              RESID      0   N/A     -0.5       N/A

    TRACKING  ---------------------------------------------------

              TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

              DOP BIAS    .093HZ C NOS  .007HZ EXP  .008HZ

    MONITOR   ---------------------------------------------------

                   LGWR  LGER  BLRC  BLER

              DIS  1457   2    268    2
```

MCNTHLY REPCRT FOR MARCH 1972

```
-----------------------------------------------------------------------------
PASS  GMT-START      GMT-END      CRIG  TYPE  CATA
NC.                               CODE  CODE  CAY
-----------------------------------------------------------------------------

      PICNEER 10 S/C 23

 C027  72C891420     720892330     AI   PF   C027
                 TCP  N/A     N/A  N/A    N/A


         CCMMENTS  ------------------------------------------------------

         1E16Z-1820Z SWITCHED TLM PRCCESS FM TCP-A TC TCP-B DUE DCA

         HALT. TIME PRCBLEM CF SOFTWARE CR 1966

         2103Z-2112Z TCP-B TLM HALTED. DCA HUNG-UP DR 1967 REFERS



      PICNEER 10 S/C 23

  P1CCCZ65361

 0028  720892234     720900755     AM   PF   C028
         DSS 51 PASS 028  CL H-B CTDN  N/A   GCF S00J CPS  N/A DSS J000

         CCNFIG     --------------------------------------------------

                    AOS DOY C89  LCS DOY 090        TCTAL

                    SCHEDULED 2300Z SCHEDULED 0815Z SCHEDULED   9H 15M

                    ACTUAL    2234Z ACTUAL    C755Z ACTUAL      9H 21M

                    ST XFR    2215Z RELEASE   0917Z DSS TIME  11H 02M

         CCMMAND    --------------------------------------------------

                    TOTAL  0   AUTO  0   MANUAL  0   ABCRT  0
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	153.3	N/A	5.2	N/A
PREDIC	152.6	N/A	5.9	N/A
RESID	-0.6	N/A	-0.2	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/ARU NOISE N/ARU

DOP BIAS +0.073HZ C NOS .006HZ EXP .008HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	N/R	N/R	N/R	N/R

PIONEER 10 S/C 23

0028	720892234	720900755	AM	PF	0028
		TCP N/R	N/R	N/R	N/R

COMMENTS

MONITOR DATA NOT COMMITTED FOR P-10 SUPPORT

0057Z-0105Z 360/75B DOWN, RE-IPL, DR 3386

0041Z-0105Z,3100 DOWN DUE 360/75 TIME OUTS

2 WAY TRACK 2330Z-0740Z

NO CMDS

MONTHLY REPORT FOR MARCH 1972

```
-----------------------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
-----------------------------------------------------------------------------

    PIONEER 10 S/C 23


  P10CCZ65362

0028  720900730    720901513    AB   PF   0028
        DSS 12 PASS 028  CL C-B CTDN 303343 GCF S00B CPS  N/A DSS B000

        CONFIG     -------------------------------------------------

                   ACS DOY 090  LOS DOY 090        TOTAL

                   SCHEDULED 0730Z SCHEDULED 1530Z SCHEDULED  8H 00M

                   ACTUAL    0730Z ACTUAL    1513Z ACTUAL     7H 43M

                   ST XFR    0645Z RELEASE   1536Z DSS TIME   9H 51M

        COMMAND    -------------------------------------------------

                   TOTAL  1   AUTO  1   MANUAL  0   ABORT  0

        TELEMETRY  -------------------------------------------------

                   POWER  1 KW  BIT RATES  512  CODED   MMT

                         RX 1   RX 2  TCP B     TCP A

                   ACTUAL 153.0   N/A      5.7       N/A

                   PREDIC 152.6   N/A      6.1       N/A

                   RESID   -0.6   N/A     -0.4       N/A

        TRACKING   -------------------------------------------------

                   TRACK MD  2 WAY RANGING NIL BIAS  N/ARU NOISE N/A RU

                   DOP BIAS  +0.098HZ C NOS  .006HZ EXP  .008HZ

        MONITOR    -------------------------------------------------

                        LGWR  LGER  BLRC  BLER

                   DIS  1289   0     0     0
```

PASS NO.	GMT-START	GMT-END	CRIG CODE	TYPE CODE	CATA CAY

FICNEER 10 S/C 23

```
0028  720900730     720901513    AB   PF   0028
                  TCP   N/A   N/A   N/A   N/A
```

CCMMENTS

2 WAY TRACK 1740Z-150CZ

CMD MCD CN/OFF 0742Z-1455Z (1 CMC)

PICNEER 10 S/C 23

P1CCCZ65363

```
0028  720901429     720902309     AI   PF   CC28
    DSS 41 PASS 028  CL H-B CTDN 202241 GCF S00F CPS N/A  DSS F000
```

CCNFIG

AOS DCY C9C		LCS DCY.C90		TCTAL	
SCHEDULED	1430Z	SCHEDULED	0000Z	SCHEDULED	9H 3CM
ACTUAL	1424Z	ACTUAL	2309Z	ACTUAL	8H 45M
ST XFR	1403Z	RELEASE	2333Z	DSS TIME	9H 30M

CCMMAND

TCTAL 2   AUTO 2   MANUAL 0   ABCRT 0

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP A,B	TCP
ACTUAL	152.9	N/A	6.1	N/A
PREDIC	152.8	N/A	6.5	N/A
RESID	-0.1	N/A	-0.4	N/A

MCNTHLY REPORT FCR MARCH 1972

```
-----------------------------------------------------------------
PASS  GMT-START      GMT-END     ORIG  TYPE  DATA
NO.                              CODE  CODE  DAY
-----------------------------------------------------------------

        TRACKING  -----------------------------------------------

                  TRACK MD  2 WAY RANGING NIL BIAS N/A RU NCISE N/A RU

                  DOP BIAS  +0.100HZ C NCS  .006HZ EXP  .008HZ

        MCNITOR   -----------------------------------------------

                      LGWR  LGER  BLRC  BLER

                  DIS 1512    0     0     0


      PICNEER 10 S/C 23

 0028  720901429     720902309    AI  PF  0028
                  TCP  N/A   N/A   N/A   N/A


        COMMENTS  -----------------------------------------------

        1810Z-1820 HSD DOWN; TCP "B" DOWN SWAPPED TC TCP "A" DR T-1969

        1938Z-1950Z 360/75 DCWN FCR RELCAD, REF. DR 3354

        2021Z-2036Z DCA TCP A HUNG UP, RELOAD REQUIRED DR T-1962

        2113Z-2124Z DCA TCP-A HUNG-UP, RELOAD DR T-1962 BOTH DCA'S

        2136Z BOTH DCA'S DECLARED RED BY TRACK CHIEF, FOR CODED MODE

        2218Z-2238Z DCA HUNG UP, RELOAD, DR T-1962

        1626Z XMTR FAILURE DR T-1968 (RELEASED EARLY DUE TO DCA

        PROBLEMS)
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

P10CCZ65366

```
0029  720902239   720910855   AM  PF  0029
      DSS 51 PASS 029  CL C-B CTDN 303343 GCF S00J CPS N/A  DSS J000

      CONFIG   ------------------------------------------------

               AOS DOY 090  LOS DOY.091         TOTAL

               SCHEDULED 2300Z SCHEDULED 0815Z SCHEDULED  9H 15M

               ACTUAL    2239Z ACTUAL    0755Z ACTUAL     9H 16M

               ST XFR    2 15Z RELEASE   0859Z DSS TIME  10H 44M

      COMMAND  ------------------------------------------------

               TOTAL  0   AUTO  0   MANUAL  0   ABORT  0

      TELEMETRY ------------------------------------------------

               POWER  1 KW  BIT RATES  512  CODED MMT

                      RX 1   RX 2  TCP B     TCP A

               ACTUAL 153.8   N/A       5.3      N/A

               PREDIC 152.9   N/A     5.5      N/A

               RESID   -0.9   N/A      -0.2      N/A

      TRACKING ------------------------------------------------

               TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

               DOP BIAS  +0.086HZ C NOS  .006HZ EXP  .008HZ

      MONITOR  ------------------------------------------------

                   LGWR  LGER  BLRC  BLER

               DIS   N/R   N/R   N/R   N/R
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
0029  720902239    720910855    AM   PF   0029
                   TCP   N/R    N/R  N/R   N/R
```

COMMENTS --

0230Z-0245Z 360/75B DOWN, LOCKED OUT; RE-IPL W/W DR 3393

0754Z-LOS-HSD LINE DOWN

MONITOR DATA NOT COMMITTED FOR PN-10 SUPPORT

2 WAY TRACK 2300Z-0740Z

NO CMDS

PIONEER 10 S/C 23

P10CCZ65367

```
0029  720910730    720911507    AB   PF   0029
   DSS 12 PASS 029  CL C-B CTDN 303343 GCF 500B CPS  N/A DSS 8000
```

CONFIG --

AOS DOY 091		LOS DOY 091		TOTAL	
SCHEDULED	0730Z	SCHEDULED	1530Z	SCHEDULED	8H 00M
ACTUAL	0730Z	ACTUAL	1507Z	ACTUAL	7H 37M
ST XFR	0648Z	RELEASE	1540Z	DSS TIME	8H 52M

COMMAND --

TOTAL 2 AUTO 2 MANUAL 0 ABORT 0

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP B	TCP A
ACTUAL	152.0	N/A	5.4	N/A
PREDIC	152.0	N/A	5.7	N/A
RESID	0	N/A	-0.3	N/A

TRACKING

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS +0.100HZ C NOS 0.006HZ EXP 0.008HZ

MONITOR

	LGWR	LGER	BLRC	BLER
DIS	1164	1	0	0

PIONEER 10 S/C 23

0029	720910730	720911507	AB	PF	0029
		TCP N/A	0	N/A	N/A

COMMENTS

MCNTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PICNEER 10 S/C 23

P10CCZ65368

```
0029  720911421    720912347    AI   PF   CC29
   DSS 41 PASS 029  CL F-B CTDN 202241 GCF SOOF CPS  N/A DSS F0C0

   CCNFIG     ----------------------------------------------

              ACS DOY 091  LCS DOY 091        TOTAL

              SCHEDULED 1430Z SCHEDULED 0000Z SCHEDULED  9H 30M

              ACTUAL    1421Z ACTUAL    2347Z ACTUAL     9H 26M

              ST XFR    NCNEZ RELEASE   0000Z DSS TIME   9H 39M

   CCMMAND    ----------------------------------------------

              TCTAL 62   AUTC 62   MANUAL  0   ABORT 0

   TELEMETRY  ----------------------------------------------

              POWER  1 KW  BIT RATES 512       512   CODED   MMT

                     RX 1   RX 2  TCP A     TCP B

              ACTUAL 153.2  153.4   5.5      5.6

              PREDIC 153.1  153.1    5.4      5.4

              RESID   -0.1   -0.3   +.1      +.2

   TRACKING   ----------------------------------------------

              TRACK MD  2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

              DOP BIAS   C.107HZ C NOS 0.006HZ EXP 0.C08HZ

   MCNITOR    ----------------------------------------------

                   LGWR  LGER  BLRC  BLER

              DIS  N/R    N/R  N/R   N/R
```

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

PIONEER 10 S/C 23

```
 0029  720911421     720912347     AI   PF   0029
                    TCP   N/R   N/R   N/R   N/R

       COMMENTS  ----------------------------------------------

       2041Z-2047Z 36C "B" DOWN NEBULAS CAUSES NO DR

       1913Z TCP A WOULD NOT PROCESS. ADI DATA SUITABLE TO TCP-B

       DR T-1971
```

PIONEER 10 S/C 23

```
 P10CCZ65369

 0030  720912244     720920752     AM   PF   0030
       DSS 51 PASS 030  CL C-B CTDN 303343 GCF S00J CPS N/A  DSS J000

       CONFIG  ----------------------------------------------

                  AOS DOY 091  LOS DOY 092          TOTAL

                  SCHEDULED 2300Z SCHEDULED 0815Z SCHEDULED   9H 15M

                  ACTUAL    2244Z ACTUAL    0752Z ACTUAL      9H 08M

                  ST XFR    2220Z RELEASE   0752Z DSS TIME    9H 32M

       COMMAND  ----------------------------------------------

                  TOTAL 21   AUTO 21   MANUAL  0   ABORT  0
```

MONTHLY REPORT FOR MARCH 1972

PASS NO.	GMT-START	GMT-END	ORIG CODE	TYPE CODE	DATA DAY

TELEMETRY --

POWER 1 KW BIT RATES 512 CODED MMT

	RX 1	RX 2	TCP A	TCP B
ACTUAL	153.4	N/A	5.3	5.3
PREDIC	153.2	N/A	5.4	5.4
RESID	-0.2	N/A	-0.1	-0.1

TRACKING --

TRACK MD 2 WAY RANGING NIL BIAS N/A RU NOISE N/A RU

DOP BIAS HZ C NOS HZ EXP HZ

MONITOR --

	LGWR	LGER	BLRC	ELER
DIS	N/A	N/A	N/A	N/A

PIONEER 10 S/C 23

0030	720912244	720920752	AM	PF	0030
		TCP N/A	N/A	N/A	N/A

COMMENTS --

Table C-1. Pioneer 10 sequence of events, March 1972

GR. CONFIRM TIME				EVENT	SPACECRAFT POSITION									SPIN-AXIS ATTITUDE					RTLT	
					DISTANCE, 10^6 KM			SUN		EARTH		JUPITER								
DATE	HR	MN	SEC	DESCRIPTION	SUN	EARTH	JUPITER	LON	LAT	LON	LAT	LON	LAT	LON	LAT	SLA	ELA	CKAH + SPGR	MIN	SEC
				POWERED FLIGHT																
Mar 3	1	49	3.6	Lift-Off															0	0
	1	51	32.8	Atlas Booster Engine Cutoff																
	1	51	34.8	Booster Package Jettison																
	1	52	17.8	Insulation Panels Jettison																
	1	53	6.5	Atlas Sustainer Engine Cutoff																
	1	53	9.8	Atlas/Centaur Separation																
	1	53	20.1	Centaur Main Engine Start																
	1	53	32.5	Nose Fairing Jettison																
	2	0	48.9	Centaur Main Engine Cutoff																
	2	1	59.6	TEM-364-4 Spinup																
	2	2	0.8	TEM-364-4 Separation																
	2	2	2	Centaur Retrothrust																
	2	2	14.7	TEM-364-4 Ignition																
	2	2	28.7	Centaur Power Changeover																
	2	2	59.4	TEM-364-4 Burnout										230.9	-9.7	111.1	96.1			
	2	3	0	Indication of S/C Sequencer Start																
	2	4	39.0	S/C Separation																
	2	4	41.5	TEM-364-4 Yo Deployment																
				INSTRUMENT TURN ON																
	2	16	33	TRD Turn On, Format B, TLM Store																
	2	18	56	Format C5	148.33	0.013	831.85	342.6	0	29.4	7.9	274.2	+0.3							
				APPENDAGE DEPLOYMENT																
	2	20	4.8	Despin Start																
	2	21	10.8	Despin Stop																
	2	26	3.9	RTG Deploy Start																
	2	26	45.5	RTG Deploy Complete																
	2	37	13.7	Mag. Boom Deploy Complete																
				INSTRUMENTS TURN ON																
	2	33	0	Format B	148.33	0.023	831.82	342.6	0	45.6	8.8	274.2	0.3							
	2	36	28.0	GTT Turn On																
	2	36	50.0	CPD Turn On																
	2	42	20.0	Format C5																
	2	56	10.2	Format B																
	2	57	22.2	HVM Turn On																
				PRECESSION																
	4	48	20.3	Format C-4	148.33	0.102	831.53	342.8	0	64.6	9.0	274.3	0.3							
	4	59	17.1	Precession Start										230.9	-9.7	111.2	163.7		0	1.0
	7	3	5.0	Precession Complete										70.2	3.3	87.6	4.2	0.1		
				SRA DIAGNOSTIC																
	8	4	7	Start	148.34	0.212	831.13	342.9	0.1	67.6	8.9	274.3	0.4							
	8	15	0	End																

DSS 51 first rise - 0209:50
transmitter turn-on - 0213:36
DSS 2-way acquisition - 0215:02

Table C-1 (contd)

GR. CONFIRM TIME				EVENT	SPACECRAFT POSITION									SPIN-AXIS ATTITUDE					RTLT	
					DISTANCE, 10^6 KM			SUN		EARTH		JUPITER								
DATE	HR	MN	SEC	DESCRIPTION	SUN	EARTH	JUPITER	LON	LAT	LON	LAT	LON	LAT	LON	LAT	SLA	ELA	CKAH + SPGR	MIN	SEC
				INSTRUMENT TURN ON																
Mar 3	8	24	35.4	Format B																
	8	27	41.4	MD Turn On																
				BATTERY DIAGNOSTIC																
	8	30	7.4	Battery Heater Off															0	1.5
	8	59	38.5	Battery to Float Charge	148.35	0.246	831.00	343.0	0	68.0	8.9	274.3	0.3						0	3.2
	16	34	47.2	Battery Heater On																
	16	36	17.2	Battery Heater Off																
				INSTRUMENT MODE CHANGES																
	20	49	26.1	CPD Calibrate															0	4.1
	21	9	26.1	CPD Reset	148.39	0.646	829.51	343.6	0	69.5	8.9	274.4	0.3							
				BATTERY DIAGNOSTIC																
Mar 4	2	40	31.5	Format C5															0	5.5
	3	24	9.7	Battery Heater On																
	3	44	47.8	Battery Heater Off																
	4	6	31.8	Format B	148.42	0.879	828.64	344.0	0.1	69.7	8.8	274.4	0.4							
				SRA DIAGNOSTIC																
Mar 5	4	32	37.2	Format C5															0	11.2
	4	45	0	Start																
	5	0	0	End																
				THRUSTER CALIBRATION																
	5	50	3.5	Conscan On Med. Gain Ant. Start										70.2	3.7	85.1	5.2	0.2	0	11.5
	6	0	43.5	Conscan On Med. Gain Ant. Complete	148.55	1.740	825.40	345.4	0.1	70.0	8.8	274.6	0.4							
	6	34	38.7	Conscan On High Gain Ant. Start																
	6	45	18.7	Conscan On High Gain Ant. Complete										69.8	9.3	84.8	0.5	0.8		
	13	17	39.2	ΔV Pair 1 Calibration Start																
	13	18	9.2	ΔV Pair 1 Calibration Complete																
	13	48	39.3	ΔV Pair 2 Calibration Start																
	13	49	9.3	ΔV Pair 2 Calibration Complete																
	15	47	35.7	Pre Pair 1 Cal., Pre 1 Start																
	16	11	23.8	Pre Pair 1 Cal., Pre 2 Complete	148.61	2.070	824.16	346.0	0.1	70.1	8.8	274.7	0.4							
				INSTRUMENT TURN ON AND MODE CHANGES																
	18	35	36.3	Format A															0	14.3
	18	37	36.3	CRT Turn On																
	18	49	36.3	CRT Mode/Cal Start																
	19	13	36.4	CRT Mode/Cal End															0	20.2
Mar 6	21	20	42.2	UVP Turn On																
	22	3	42.4	CRT Turn Off	148.83	3.060	820.40	347.6	0.2	70.2	8.8	274.9	0.4							
	22	4	42.4	CRT Turn On																
	22	5	42.4	CRT Mode/Cal Start																
	22	11	42.4	CRT Mode/Cal End																
Mar 7	0	50	43.0	UVP Turn Off																
	3	10	47.5	CRT Turn Off																

Table C-1 (contd)

GR. CONFIRM TIME DATE	HR	MN	SEC	EVENT DESCRIPTION	SPACECRAFT POSITION DISTANCE, 10^6 KM SUN	EARTH	JUPITER	SUN LON	SUN LAT	EARTH LON	EARTH LAT	JUPITER LON	JUPITER LAT	SPIN-AXIS ATTITUDE LON	LAT	SLA	ELA	CKAH + SPGR	RTLT MIN	RTLT SEC
				FIRST MIDCOURSE																
Mar 7	8	43	12.7	Format C5															0	22.7
	10	42	49.0	Precession 1 Start										69.8	9.7	82.0	0.9	1.2		
	11	15	37.0	Precession 1 Complete										91.8	49.9	98.7	44.9	349.5		
	12	19	37.0	ΔV Start	148.94	3.522	818.65	348.4	0.2	70.2	8.8	275.0	0.4							
	12	27	44.0	ΔV Complete																
	13	1	38.7	ΔV Trim Start																
	13	29	33.8	ΔV Trim End																
	13	31	44.0	Precession 2 Start										91.8	49.9	98.6	44.9	349.5	0	23.8
	14	9	12.0	Precession 2 Complete	148.96	3.587	818.39	348.5	0.2	70.2	8.8	275.0	0.4							
	14	22	26.9	Conscan On Med. Gain Ant. Start																
	14	24	0	Conscan On Med. Gain Ant. Complete																
	16	22	46.4	Spin Rate Decrease Start																
	17	20	35.6	Spin Rate Decrease End																
	18	18	27.8	Conscan On High Gain Ant. Start	149.00	3.719	817.89	348.7	0.2	70.2	8.8	275.0	0.4							
	18	38	0	Conscan On High Gain Ant. Complete										69.8	9.0	81.7	0.2	1.1		
	19	30	12.3	ΔV Start																
	19	34	28.3	ΔV Complete																
				INSTRUMENTS TURN ON																
	20	51	42.4	Format A															0	25.4
	20	56	51.4	UVP Turn On																
	20	57	52.4	CRT Turn On																
Mar 8	0	15	48.1	CRT Turn Off																
				SRA DIAGNOSTIC																
Mar 9	0	20	55.4	Format C5															0	31.4
	1	0	0	Start	149.30	4.725	813.99	350.2	0.3	70.2	8.8	275.2	0.4							
	1	10	0	End																
				PRECESSION																
	3	0	36.0	Precession Start	149.32	4.803	813.75	350.2	0.3	70.2	8.8	275.2	0.4	69.8	9.3	79.8	0.5	1.5	0	32.0
	3	21	16.0	Precession End										46.0	7.7	56.2	23.7	4.9		
				INSTRUMENT TURN ON																
	4	56	42.4	Format A															0	32.4
	5	14	36.5	AMD Turn On																
	19	0	12.2	UVP Release Cover	149.50	5.329	811.72	351.3	0.3	70.2	8.8	275.3	0.4	46.0	7.8	55.4	23.7	4.9		
				SRA DIAGNOSTIC																
	20	34	16.5	Format C4															0	35.8
	20	51	41.4	Star Gate Enable 45° Sector																
	20	58	42.5	Roll Reference 0°																
	21	9	3.7	Star Gate Enable 360° Sector																
	21	17	56.7	Roll Reference 180°																
	22	45	7.3	Star Gate Enable 45° Sector																
	23	41	0.5	Sensor Select Star																
	23	43	0.5	Sensor Select Sun B																
Mar 10	1	32	7.5	Star Gate Enable 360° Sector																

Table C-1 (contd)

GR. CONFIRM TIME				EVENT	SPACECRAFT POSITION									SPIN-AXIS ATTITUDE					RTLT	
					DISTANCE, 10^6 KM			SUN		EARTH		JUPITER								
DATE	HR	MN	SEC	DESCRIPTION	SUN	EARTH	JUPITER	LON	LAT	LON	LAT	LON	LAT	LON	LAT	SLA	ELA	CKAH + SPGR	MIN	SEC
				INSTRUMENTS TURN ON																
Mar 10	21	16	3.2	Format ADI	149.85	6.210	808.42	352.7	0.4	70.2	8.8	275.5	0.4	45.9	8.0	54.0	23.7	4.9	0	41.2
	21	32	7.3	IPP Turn On																
				ZODIACAL LIGHT																
	21	37	2.3	Zodiacal Light Map Start																
Mar 11	4	24	34.8	Zodiacal Light Map End															0	42.8
	4	33	27.8	Format A																
	21	50	23.1	Format ADI	150.17	6.996	805.27	353.9	0.4	70.2	8.9	275.6	0.4	45.8	8.2	52.7	23.7	5.0	0	46.6
	22	26	53.2	Zodiacal Light Map Start															0	47.6
Mar 12	2	27	58.6	Zodiacal Light Map End																
	2	30	14.6	Format A																
	22	14	17.9	Format ADI	150.53	7.778	802.23	355.2	0.5	70.2	8.9	275.8	0.4	45.8	8.3	51.4	23.7	5.1	0	51.9
	22	46	48.0	Zodiacal Light Map Start																
Mar 13	1	14	57.5	Zodiacal Light Map End															0	52.5
	1	18	18.5	Format A																
				INSTRUMENT TURN ON AND MODE CHANGES															0	56.0
	17	12	16.0	CRT Turn On																
	17	25	23.0	CRT Mode/Cal Start																
	17	58	8.2	CRT Mode/Cal End	150.86	8.427	799.69	356.4	0.5	70.2	8.9	275.9	0.4	45.7	8.5	50.5	23.7	5.3	0	56.9
	21	21	22.9	PA Turn On																
	21	25	7.9	PA Exercising Start																
Mar 14	1	34	0.8	PA Exercising End																
				ZODIACAL LIGHT															1	1.3
	17	51	23.3	Format ADI																
	17	59	57.4	Zodiacal Light Map Start																
	20	46	7.0	Zodiacal Light Map End	151.30	9.273	799.39	357.7	0.5	70.1	8.9	276.1	0.4	45.7	8.6	49.0	23.7	5.4	1	2.4
	22	39	28.4	Format A																
Mar 15	12	4	-	TRAJECTORY	151.60	9.790	794.35	358.6	0.6	70.1	8.9	276.2	0.4	45.6	8.8	48.0	23.6		1	5.2
				INSTRUMENT MODE CHANGE															1	6
	16	54	38	HVM Manual Range Start																
	17	28	6	HVM Manual Range End																
				ZODIACAL LIGHT																
	17	44	28	Format ADI																
	17	53	2	Zodiacal Light Map Start															1	7
	20	11	33	Zodiacal Light Map End																
	20	41	29	Format A																
Mar 16	12	4	-	TRAJECTORY	151.91	10.565	791.30	359.4	0.6	70.0	8.9	276.3	0.5	45.7	8.9	46.3	23.6		1	10
				ZODIACAL LIGHT															1	11
	16	46	33	Format ADI																
	16	55	44	Zodiacal Light Map Start															1	12
	19	22	5	Zodiacal Light Map End																
	19	26	38	Format A																

Table C-1 (contd)

GR. CONFIRM TIME				EVENT	SPACECRAFT POSITION									SPIN-AXIS ATTITUDE					RTLT	
					DISTANCE, 10^6 KM			SUN		EARTH		JUPITER								
DATE	HR	MN	SEC	DESCRIPTION	SUN	EARTH	JUPITER	LON	LAT	LON	LAT	LON	LAT	LON	LAT	SLA	ELA	CKAH + SPGR	MIN	SEC
				INSTRUMENT MODE CHANGE																
Mar 16	18	36	22	AMD Star Exclusion																
	23	51	34	Wide Band/Star Exclusion															1	12
Mar 17	16	31	38	TRD High Voltage Mode															1	16
	17	1	38	CPD Calibrate																
	17	20	38	CPD Reset																
	17	39	38	TRD Low Voltage Mode																
				SRA DIAGNOSTIC																
	18	9	38	Format C4, Diagnostic Start																
	18	20		End																
				ZODIACAL LIGHT																
	18	27	38	Format AD1																
	19	51	38	Map Start																
	22	32	39	IPP Turn Off, Map End																
	22	46	39	Format A															1	17
Mar 18	12	4		TRAJECTORY	153.08	12.107	785.18	2.3	0.7	69.9	8.9	276.6	0.5	45.5	9.2	44.8	23.6		1	21
Mar 20	12	4		TRAJECTORY	154.21	13.642	779.07	4.7	0.8	69.8	8.9	276.9	0.5	45.4	9.5	42.3	23.6		1	31
				INSTRUMENT MODE CHANGES																
	17	4	54	HVM Range Increment															1	32
				ZODIACAL LIGHT																
	17	41	54	IPP Turn On																
	17	56	54	Format AD1, Map Start																
	20	24	32	IPP Turn Off, Map End															1	33
	21	1	55	Format A																
				INSTRUMENT MODE CHANGES																
Mar 21	21	22	0	AMN Thresh., BW, Star Ex., Start															1	38
	23	22	0	AMD Changes, End																
Mar 22	12	4		TRAJECTORY	155.45	15.168	772.96	7.1	0.9	69.6	8.9	277.1	0.5	45.3	9.8	39.7	23.6		1	41
				INSTRUMENT MODE CHANGES																
	15	50	48	CPD Calibrate															1	42
	16	18	38	CPD Reset																
				ZODIACAL LIGHT																
	15	44	9	IPP Turn On															1	42
	16	44	20	Format AD1, Map Start																
	19	36	21	Format A, Map End																
	19	57	12	IPP Turn Off																

Table C-1 (contd)

GR. CONFIRM TIME DATE	HR	MN	SEC	EVENT DESCRIPTION	SPACECRAFT POSITION DISTANCE, 10^6 KM SUN	EARTH	JUPITER	SUN LON	SUN LAT	EARTH LON	EARTH LAT	JUPITER LON	JUPITER LAT	SPIN-AXIS ATTITUDE LON	LAT	SLA	ELA	CKAH + SPGR	RTLT MIN	RTLT SEC
				INSTRUMENT TURN OFF																
Mar 23	16	18	9	UVP Turn Off															1	47
	16	20	9	AMD Turn Off																
				SRA DIAGNOSTIC																
	17	12	9	Format C-4, Start															1	47
	17	30	9	Format C-5 End																
				SECOND MIDCOURSE, PART 1																
	18	2	49	Precession to Earth Line. Start										45.2	10.1	37.8	23.6	11.9		
	18	24	41	Precession to Earth Line Complete										71.9	7.3	63.7	3.1	2.7		
	19	47	30	Conscan On Med. Gain Ant., Start										71.9	7.3	63.6	3.2	2.7	1	48
	19	54		Conscan On Med. Gain Ant., Complete																
	20	28	28	Conscan On High Gain Ant., Start																
	20	40		Conscan on High Gain Ant., Complete										69.4	8.8	61.2	0.3	3.9		
	22	2	30	ΔV Start																
	22	3	4	ΔV Complete																
	22	24	25	ΔV Trim																
				ZODIACAL LIGHT																
	23	7	10	Format AD1																
	23	14	35	IPP Turn On, Map Start																
Mar 24	2	33	11	Format A, Map End															1	49
	2	42	11	IPP Turn Off																
				SECOND MIDCOURSE, PART 2																
Mar 24	7	37	22	Format C5																
	10	36	8	Precession 1 Start										69.4	8.8	60.6	0.3	4.0	1	50
	10	57	12	Precession 2 Complete										45.3	6.2	36.6	23.7	6.9		
	12	2	23	ΔV Start															1	51
	12	3	27	ΔV Complete																
	12	30	23	ΔV Trim Start																
	12	48	32	ΔV Trim End																
	13	7	23	Precession 2 Start										45.3	6.0	36.4	23.7	6.7		
	13	28	31	Precession 2 Complete										69.0	8.9	60.0	0.1	4.1		
	14	4	23	Spin Rate Decrease Start																
	14	32	56	Spin Rate Decrease End																
	12	4	-	TRAJECTORY	156.79	16.688	766.86	9.4	0.9	69.4	8.9	277.4	0.5						1	51
				PRECESSION																
	15	52	37	Start										69.0	8.9	59.8	0.1	4.1		
	15	52	37	Complete										59.0	5.0	49.7	10.7	3.0		
				SRA DIAGNOSTIC																
	16	32	24	Format C-4, Start															1	52
	16	47	24	Format A, End																

B

Table C-1 (contd)

GR. CONFIRM TIME DATE	HR	MN	SEC	EVENT DESCRIPTION	SPACECRAFT POSITION DISTANCE, 10^6 KM SUN	EARTH	JUPITER	SUN LON	SUN LAT	EARTH LON	EARTH LAT	JUPITER LON	JUPITER LAT	SPIN-AXIS ATTITUDE LON	LAT	SLA	ELA	CKAH + SPGR	RTLT MIN	RTLT SEC
				INSTRUMENT TURN ON AND MODE CHANGES																
Mar 24	17	2	24	AMD Turn On																
	17	13	24	TRD High Voltage																
	17	13	46	UVP Turn On																
	17	14	6	HVM Range Increment																
	17	14	30	AMD Star Ex, Data Readout, Wide BW																
	18	20	24	TRD Low Voltage																
Mar 27	12	4		TRAJECTORY	158.98	18.956	757.74	12.9	1.0	69.0	8.8	277.7	0.5	59.0	5.4	46.7	10.2	3.7	2	6
				INSTRUMENT MODE CHANGES																
	18	59	16	PA Data Source, Integ. Period, H.V. Step; Start																
	19	27	16	PA Changes End																
				INSTRUMENT MODE CHANGES																
Mar 28	16	37	23	CPD Calibrate																
	17	2	23	CPD Reset																
Mar 29	17	43	25	HVM Range Increment										59.0	5.7	44.8	9.8	4.2	2	17
				ZODIACAL LIGHT																
	17	42	39	IPP Turn On																
	18	22	39	Format AD1, Map Start																
	21	20	39	IPP Turn Off, Map End																
	21	32	39	Format A																
Mar 30	12	4		TRAJECTORY	161.39	21.215	748.67	16.3	1.2	68.5	8.8	278.1	0.6	59.0	5.8	43.7	9.6	4.5	2	21
				SRA DIAGNOSTIC																
	19	22	44	Format C-4, Start										59.0	5.9	42.4	9.4	4.1	2	22
	19	30		Format A, End																
				INSTRUMENT MODE CHANGES																
Mar 31	12	17	48	TRD High Voltage Mode															2	26
	13	32	48	TRD Low Voltage Mode																
				ZODIACAL LIGHT																
	18	37	49	Format AD1															2	27
	18	49	49	IPP Turn On, Map Start																

APPENDIX D

GLOSSARY

GLOSSARY

ACS	Attitude Control System
ADSS	Automatic Data Switching System
AFETR	Air Force Eastern Test Range
AGC	automatic gain control
ANT	Antigua
AOS	acquisition of signal
APS	Antenna Pointing Subsystem
ARC	Ames Research Center
ASC	Ascension
BDA	Bermuda
BER	bit error rate
CDC	Command and Data Handling Console
CKAFS	Cape Kennedy Air Force Station
CLT	communications line terminal
CMA	Command Modulator Assembly
CRO	Carnarvon
Conscan	Conical Scan System
CMO	Chief of Mission Operations
CP	Communications Processor
CPS	Central Processing System
CTRVC	Corrected time required velocity correction
DIS	Digital Instrumentation Subsystem
DOY	Day of Year
DPTRAJ	Double Precision Trajectory Program
DSIF	Deep Space Instrumentation Facility
DSN	Deep Space Network

DSS	Deep Space Station
EDR	Experiment Data Record
ELA	Earth look angle
EOM	end of mission
EOT	end of track
FD	Flight Director
FPAC	flight path analysis and computation
FTS	Frequency and Timing Subsystem
GCF	Ground Communications Facility
GBI	Grand Bahama Island
GMT	Greenwich Mean Time
GOE	ground operations equipment
GSFC	Goddard Space Flight Center
GTK	Grand Turk
HSD	high speed data
HSDL	high speed data line
IRS	Information Retrieval System
JPL	Jet Propulsion Laboratory
LOS	loss of signal
MCD	monitor criteria data
MDE	mission dependent equipment
MDF	Master Data File
MDR	Master Data Record
MMC	Multiple Mission Command
MMT	Multiple-Mission Telemetry
MOS	Mission Operations System

MRL	Maneuver Readiness Log
MSA	Mission Support Area
MSFN	Manned Space Flight Network
MUX Line	Multiplexed Communication Line
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NAA	Network Analysis Area
NAT	Network Analysis Team
NSP	NASA Support Plan
OC	Operations Chief
OCT	Operations Control Team
OD	orbit determination
ODC	Operational Data Control
ODR	Original Data Record
ORT	Operational Readiness Test
OVT	Operational Verification Test
PDS	polarimeter diplexed S-band
PE	Project Engineer
PER	parity error rate
PMSA	Pioneer Mission Support Area
POGASIS	Planetary Orbiting Geometry and Scientific Simulation Computer Program
PPO	Pioneer Project Office
PRE	Pretaria
PSE	Pioneer Storage and Execution
RIC	Remote Information Center

RIS	Range Instrumentation Ship
RTCS	Real Time Computing System
RTLT	round-trip light time
S/C	spacecraft
SCT	SFOF Communications Terminal
SCU	S-band Cassegrain Ultracone
SDA	Subcarrier Demodulator Assembly
SDCC	Simulation Data Conversion Center
SDL	System Development Laboratory
SDR	System Data Record
SFOF	Space Flight Operations Facility
SFOP	Space Flight Operation Plan
SIRD	Support Instrumentation Requirements Document
SIMCEN	Simulation Center
SLA	Sun look angle
SMT	S-band megawatt transmit
SNR	signal-to-noise ratio
SNT	system noise temperature
SOPM	Standard Orbital Parameters Messages
SPU	S-band polarized ultracone
SSA	Symbol Synchronizer Assembly
SWCEN	Switching Center
TCD	Telemetry and Command Data Handling Subsystem
TCP	Telemetry and Command Processor
TDA	Tracking and Data Handling Subsystem
TDS	Tracking and Data System

TLM	telemetry
T_s	system temperature
TTY	teletype
TWT	traveling wave tube
UPS	Uninterruptible Power System
USB	unified S-band
VAN	Vanguard (Apollo Ship)
VCO	Voltage controlled oscillator
VOCA	Voice Operational Communications Assembly

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