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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Memorandum 33-385

Volume I

Tracking and Data System Support for the Mariner Venus 67 Mission

Planning Phase Through Midcourse Maneuver

N. A. Renzetti

JET PROPULSION LABORATORY

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

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Preface

The work described in this report was performed by the Tracking and Data Acquisition organizations of the Jet Propulsion Laboratory, Air Force Eastern Test Range, and Manned Space Flight Network and by the NASA Communications Network of Goddard Space Flight Center This volume covers the Tracking and Data System support for the *Mariner* Venus 1967 mission from the planning phase through the midcourse maneuver, Volume II of this report covers the period from the midcourse maneuver through the end of the mission

Acknowledgments

Valuable contributions were made to this report by many staff members of the Air Force Eastern Test Range (AFETR), Manned Space Flight Network of Goddard Space Flight Center (GSFC), and the Deep Space Network and the Near Earth Phase Network staff at Cape Kennedy of JPL Those people are

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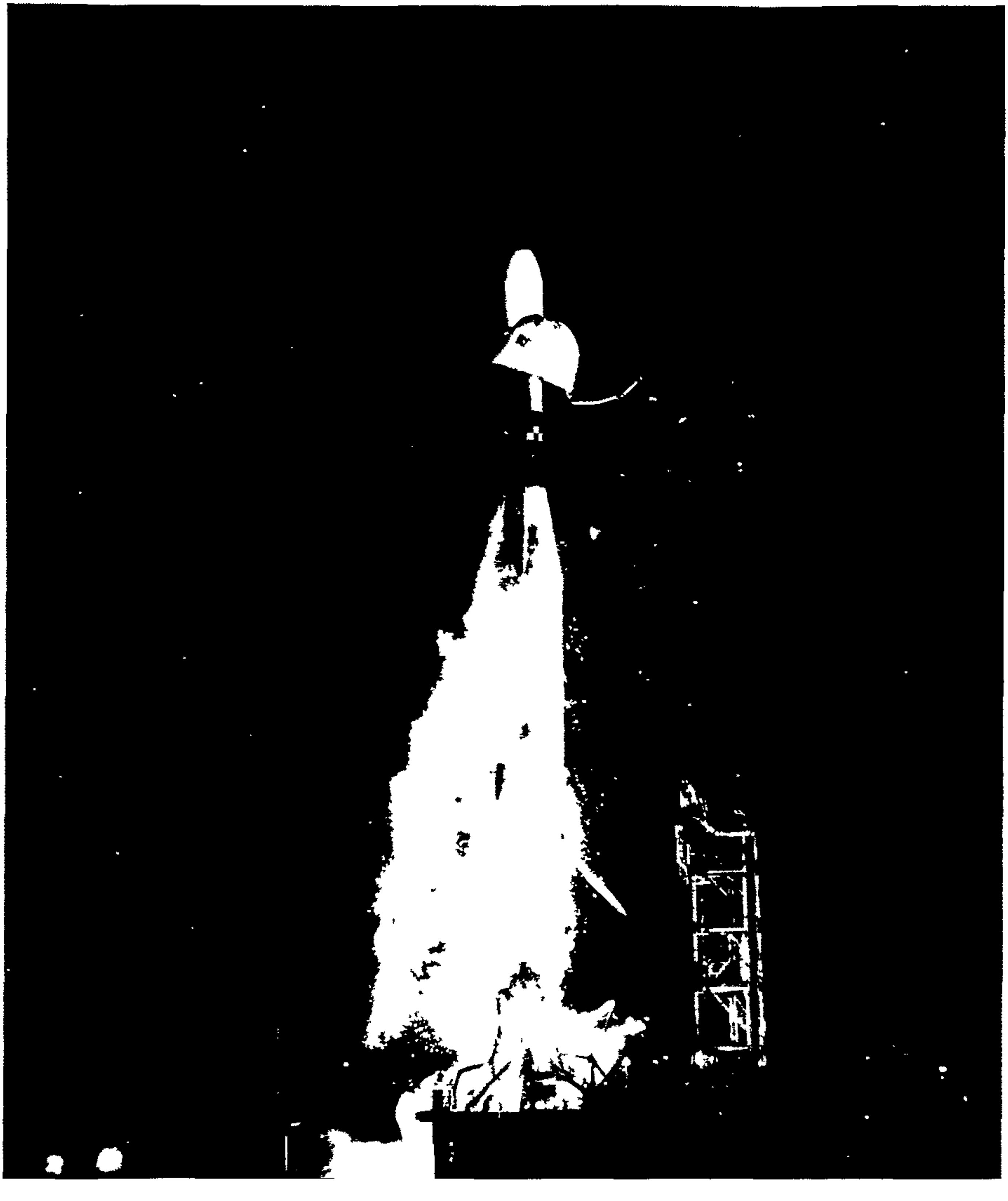
Abstract

This volume summarizes the technical activities of the Tracking and Data Acquisition facilities of the Air Force Eastern Test Range, the Manned Space Flight Network of Goddard Space Flight Center, and the Deep Space Network of JPL in support of the *Mariner* Venus 67 Mission, covering the period from the establishment of the requirements between the Project and the Tracking and Data System through the execution of the midcourse trajectory in flight The report delineates the following the metric, telemetry, and command requirements placed on the network, the equipment configuration needed to carry out the functions, the ground communications system configuration required to transmit data from Cape Kennedy and the Deep Space Stations to JPL, California, and the equipment configuration in the Space Flight Operations Facility necessary for the reception, processing, and display of data to support the conduct of flight operations A table summarizes the deep space phase flight support afforded this mission and data related to the performance of the networks Volume II will summarize similar subjects for the phase of flight from midcourse to the end of the mission, as well as mission activities necessary to bring the total support to the Project



Tracking and Data System Support for the *Mariner* Venus 67 Mission

Planning Phase Through Midcourse Maneuver

I. Introduction

A Organization and Scope

This document summarizes and evaluates all Tracking and Data System (TDS) activities in support of the *Mariner* Venus 67 Project, from the early planning stages through the midcourse maneuver With the inclusion of cruise, encounter, and postencounter activities in Volume II, the report constitutes the complete history of *Mariner* Venus 67 TDS activities

B *Mariner* Venus 67 Project Mission Objectives

The *Mariner* Venus 67 Project combined the operations of the *Mariner V* and *Mariner IV* spacecraft It was the intent of the combined operations plan to (1) utilize the *Mariner IV* spacecraft for some tests to ensure the accomplishment of the *Mariner* Venus 67 Mission objectives, and (2) complement the interplanetary science data return from both spacecraft because of their positions relative to each other and to earth

The *Mariner* Venus 67 mission was directed primarily at the determination of the nature of the Venusian atmosphere and the acquisition of scientific data concerning Venus and the interplanetary medium between earth and the sun The *Mariner V* spacecraft was launched on a flyby mission to Venus to complement the information gathered by *Mariner II* The *Mariner IV* spacecraft was designed to obtain scientific information on the interplanetary environment in a region of space farther from the sun than the orbit of earth during a period of increasing solar activity in 1967

Mission objectives were verified by tracking and data acquisition (TDA) and analysis in both the near-earth and deep space phases of the mission, the latter phase involving data from both spacecraft The near-earth elements of the TDS configuration consisted of selected radar and telemetry (TLM) stations of the Air Force Eastern Test Range (AFETR) and selected stations of the Deep Space Network (DSN) and the Manned Space Flight Network (MSFN) The deep space phase was supported by selected stations of the DSN, including the 210-ft-diam antenna at the Goldstone Deep Space Communications Complex (DSCC) The DSN provided all tracking, telemetry, and command functions for deep space operations

A secondary mission objective was the expected improvement to the science of orbit determination (OD) and the accuracy of space navigation

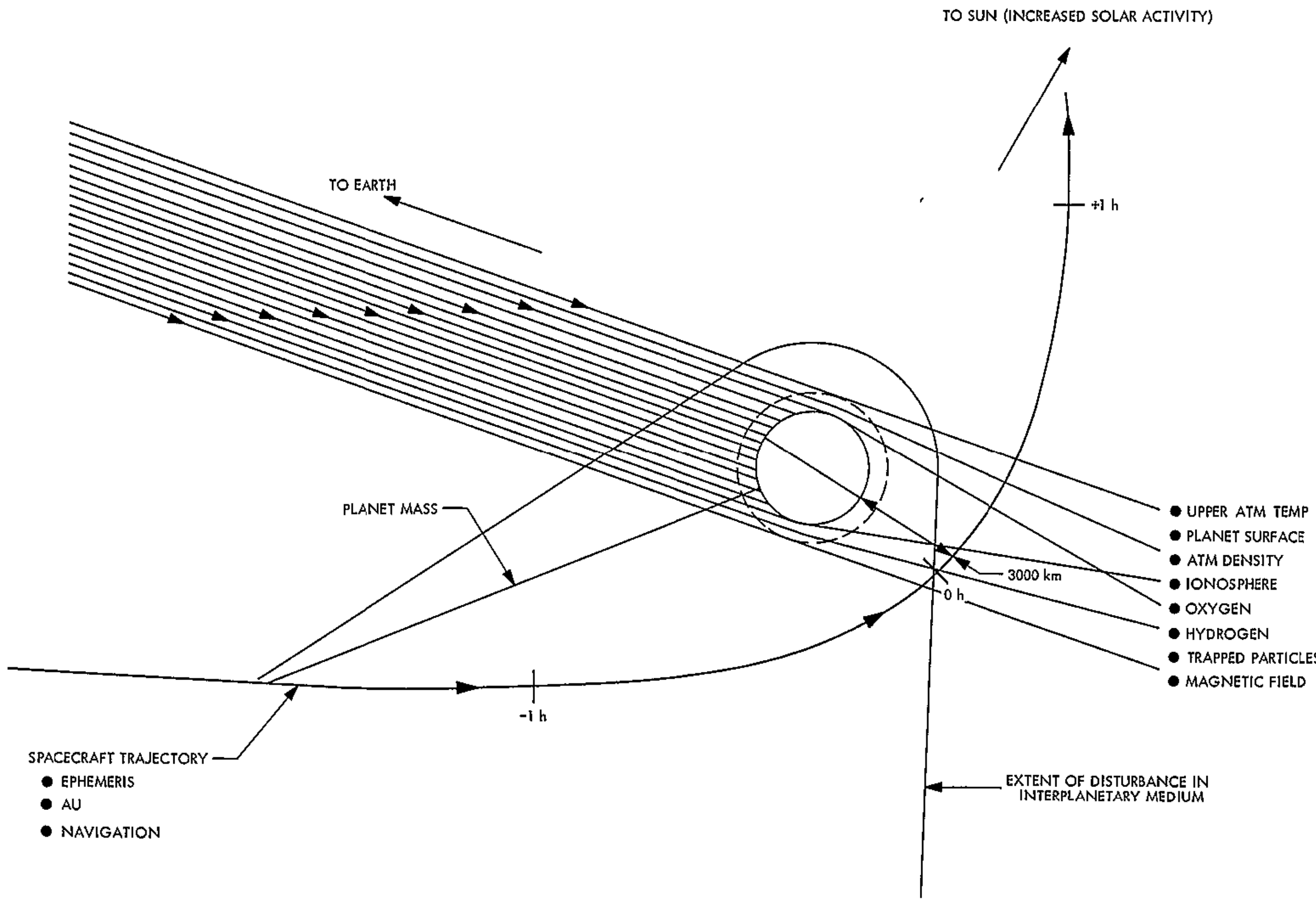


Fig 1 *Mariner V* encounter science

The TDS developed for the *Mariner* Venus 67 Mission (June to December 1967) was based on the configuration for the successful 1964 *Mariner* Mars Mission Advanced technology improvements were incorporated to simplify operations

The S-band and dual radio frequency (DFR) occultation experiments were designed to yield data on the density of the atmosphere at various altitudes, and the function of the photometers was to measure the density and temperature of the very high atmosphere (Fig 1)

The *Mariner II* spacecraft launch in 1962 toward Venus yielded only a rough upper limit to the planet's magnetic moment because the spacecraft passed at too great a distance (20,000 mi) and on the sunny side The trajectory of *Mariner V,* while selected for the radio occultation experiments, was almost ideal for detecting the Venus magnetic field The trajectory placed the spacecraft on the antisolar side, some 8000 km from the planet In this region, the existence of a cavity in the solar wind was predicted, and good measurements of the planet's magnetic field and trapped particles were made

The year 1967 was also a period of increasing solar activity The *Mariner V* cruise in space for nearly 5 mo provided an excellent opportunity to observe the effect of this activity on the interplanetary medium In addition, there was the possibility of correlating data from two spacecraft at widely different distances from the sun *Mariner V,* about 0 6 AU, and *Mariner IV,* nearly 1 4 AU

An understanding of the details of the propagation of magnetic fields, plasma, and charged particles in interplanetary space was unlikely to be achieved without simultaneous measurements of the phenomena at widely separated points in the solar system The almost ideal relative placement of three observation platforms (*Mariner IV, Mariner V,* and earth) during August and September of 1967 is shown in Fig 2 Figure 3 shows that the spacecraft were from 160 to 180 deg apart, as seen from earth, almost until Venus encounter The phenomena of interest in the two months were different, but throughout virtually the lifetime of the *Mariner V* spacecraft, the geometry was close enough to optimum to furnish valuable observations The configuration of the three observing stations evolved gradually into the *spiral* one, in which they all were very close to the same spiral magnetic field line The direction of the mean field depended on the solar wind velocity at any given time In early September, the nearly radial line produced by a solar plasma of maximum velocity (about 850 km/s) passed close to all three stations In late September, the spirals for a mean solar wind (500 km/s) were approached In early October, the configuration matched the spiral for a minimum solar wind (300 km/s)

During the spiral period, major interest focused on the streams of protons and electrons of high energy ejected from the sun, as the streams moved along the magnetic field lines Such streams were detected several times each week Transit times for these particles were only a few minutes, so that simultaneous observations were necessary

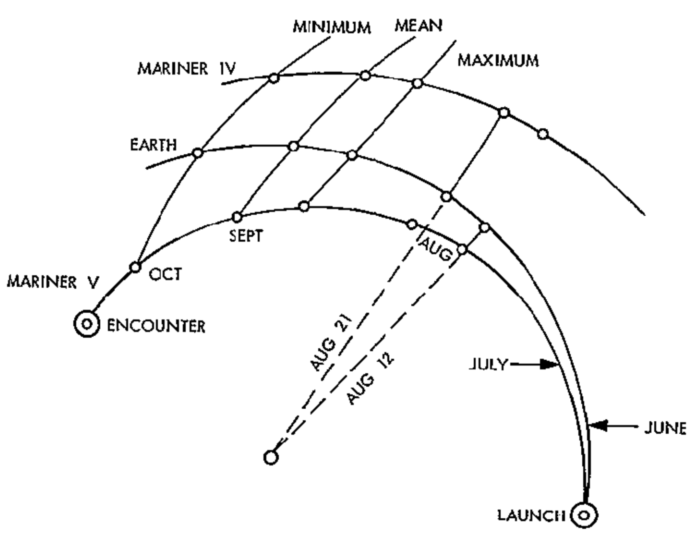


Fig 2 Spirals

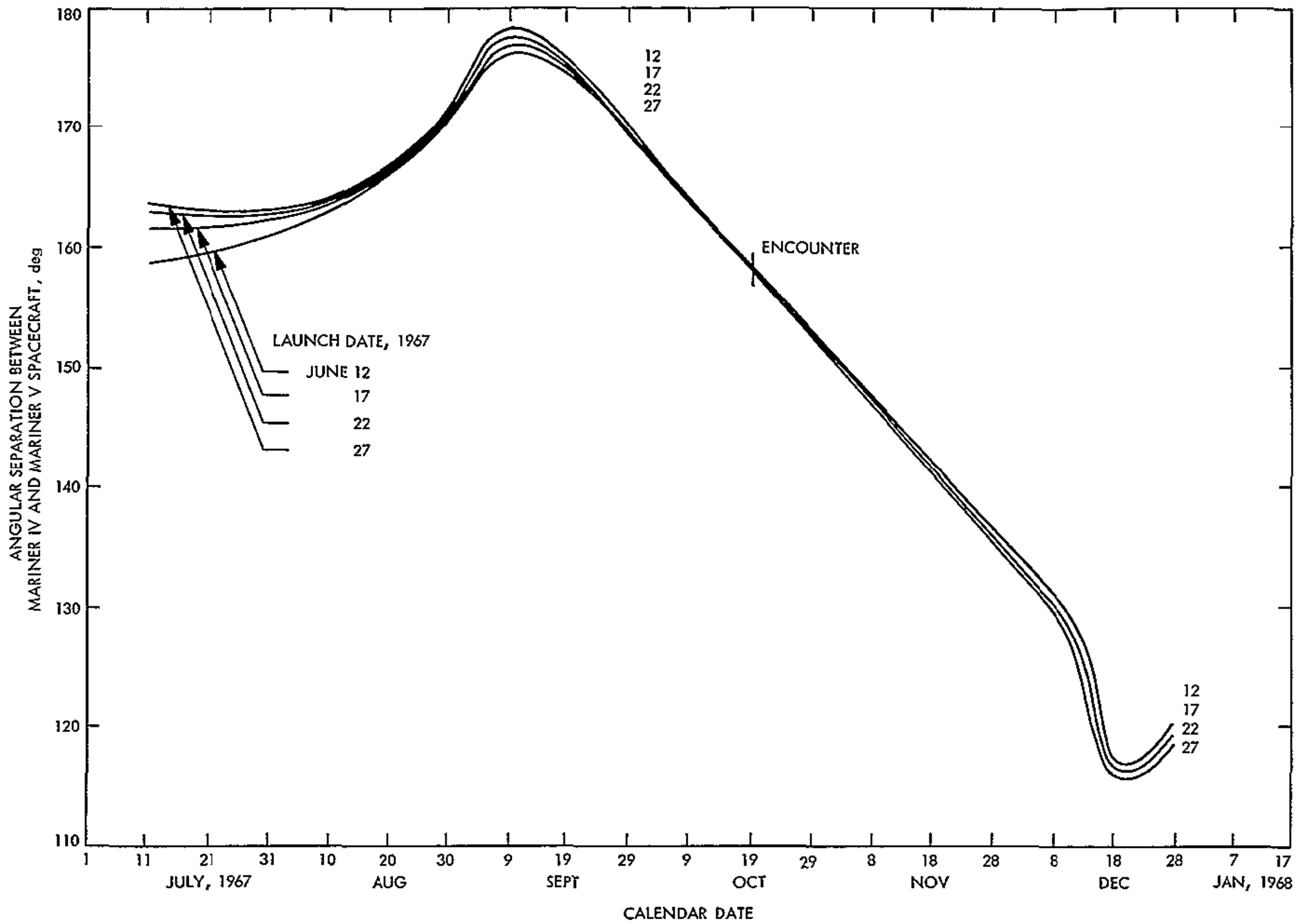


Fig 3 Angular separation between *Mariner IV* and *Mariner V* spacecraft vs calendar date

C Launch Vehicle Description

The *Mariner* Venus 67 space vehicle consisted of an *Atlas* SLV-3 first stage, an *Agena D* second stage, and the *Mariner V* spacecraft The combined launch vehicle is described in the following paragraphs and is shown in Fig 4

1 Atlas SLV-3 The *Atlas* SLV-3 booster comprised two main sections, the body or sustainer section and the aft or booster engine section The booster vehicle was stabilized and controlled by gimbaling the engine thrust chambers The propulsion system consisted of two booster engines, each with a thrust of 165,000 lb, a sustainer engine with a thrust of 57,000 lb, and two vernier engines, each with 670 lb of thrust The engines used liquid oxygen (lox) and kerosene as propellants The booster section was connected to the sustainer section thrust ring through a separation system All five engines were in operation at liftoff, the booster section was jettisoned after approximately 104 s of flight Vehicle attitude control was provided by a preprogrammed autopilot commanded by a ground communication guidance facility (GCF) and a ground computer

2 Agena D The *Agena D* is a multi-purpose, second-stage launch vehicle used in a variety of NASA and military aerospace applications It has a 16,000-lb thrust from its liquid-fueled engine, which has in-flight, multiple-start capability The engine uses unsymmetrical dimethylhydrazine (UDMH) and inhibited red fuming nitric acid (IRFNA) as propellants Attitude reference is provided by three integrating gyroscopes and a horizon sensor A velocity meter is used to terminate first- and second-engine burn when the preset velocity has been attained Attitude control is maintained by either gimbaling the engine or, when the engine is not burning, ejecting gas from pneumatic thrusters

Fig. 4. *Atlas* SLV-3, *Agena* D and *Mariner* V spacecraft stack

D. *Mariner IV* Spacecraft Description

The *Mariner IV* spacecraft is shown in Figs. 5 and 6. The spacecraft was fully attitude-stabilized and used the sun and the star Canopus as references. Cold-gas jets pointed the spacecraft in the pitch, yaw, and roll axes, and external torques were counteracted in two of the axes by changing the position of the movable solar pressure vanes. The spacecraft was capable of performing one trajectory correction maneuver, in addition to that performed during the pre-encounter phase. The propulsion system was designed so velocity increments as small as 0.1 m/s could be imparted to the spacecraft for the second maneuver.

A two-way S-band (2110–2120 MHz for earth-to-spacecraft transmission and 2290 and 2300 MHz for spacecraft-to-earth transmission) communications system was capable of carrying a steady stream of telemetry information to earth. A low-gain antenna and a body-fixed, high-gain antenna were included in the radio system of the spacecraft, and were used to either transmit or receive. Switching between the antennas was accomplished by logic on the spacecraft or by ground command. The command system detected and decoded incoming command messages and passed these to the various equipment on the spacecraft.

E. *Mariner V* Spacecraft Description

The *Mariner V* spacecraft is shown in Figs. 7 and 8. Utilizing the spacecraft equipment built to support the *Mariner IV* spacecraft as flight spares, the *Mariner* Venus 67 Project modified two *Mariner* Mars-type spacecraft, one for the flight to Venus and the other for testing, to accomplish *Mariner* Venus 67 Mission objectives. The interplanetary investigations were selected to meet the primary objectives within time, funding, and weight constraints. The spacecraft weighed less than 550 lb. It was fully attitude-stabilized, using the sun and Canopus as reference objects, and was capable of performing two trajectory correction maneuvers.

The significant configuration changes between the *Mariner IV* and *V* spacecraft were as follows:

(1) The solar panels were inverted so the cell side faced the sun. Also, the panel area was reduced from 70 to 40 ft^2 because the spacecraft traveled toward the sun.

(2) The scan platform was removed.

(3) Additional antennas were placed on the spacecraft to support the DFR experiment.

(4) The following instruments were omitted:

(a) Television (TV).

(b) Cosmic dust detector.

(c) Cosmic ray telescope.

(d) Ion chamber.

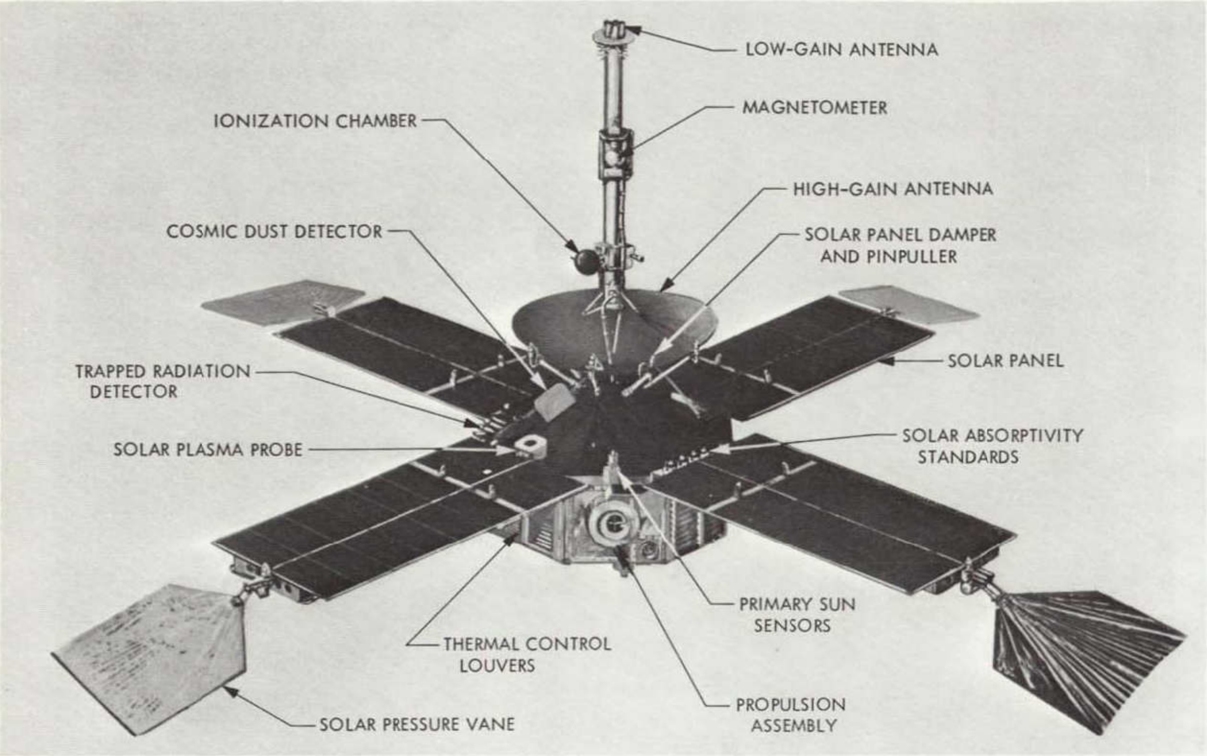


Fig. 5. ***Mariner IV*** **spacecraft configuration, top view**

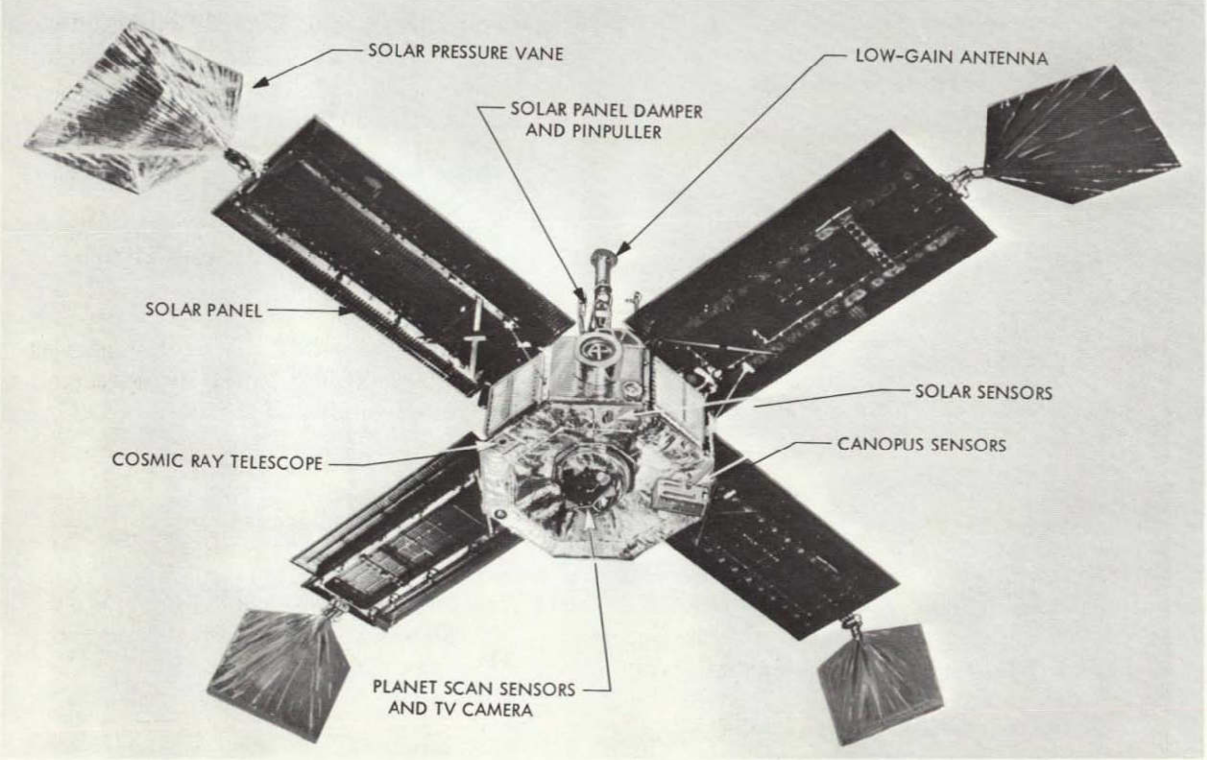


Fig. 6. ***Mariner IV*** **spacecraft configuration, bottom view**

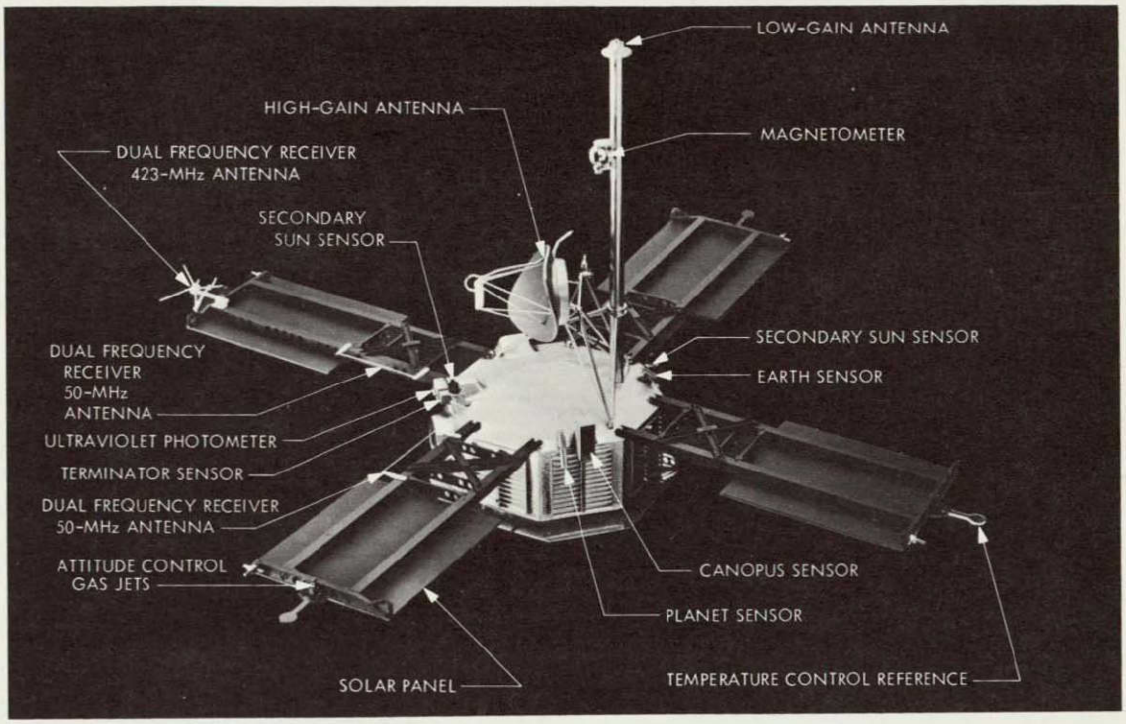


Fig. 7. ***Mariner V*** **spacecraft configuration, top view**

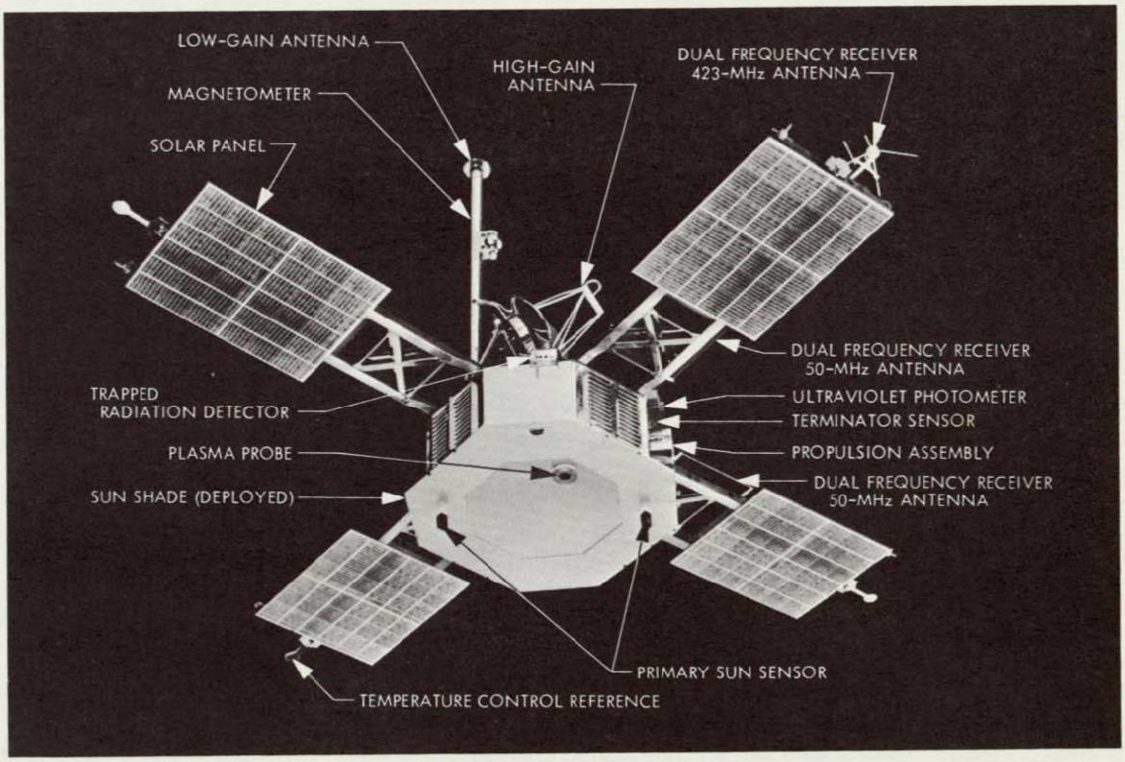


Fig. 8. ***Mariner V*** **spacecraft configuration, bottom view**

F. Scientific Experiments

The spacecraft carried a number of scientific instruments to measure the fields and particles during the mission in space. The science subsystem consisted of the following:

(1) Data automation subsystem (DAS).

(2) Scientific instruments.

(a) Helium magnetometer.

(b) Solar plasma probe.

(c) Trapped radiation detector.

(d) Cosmic ray telescope.

(e) Cosmic dust detector.

The following scientific experiments were conducted:

(1) Planetary experiments.

(a) S-band radio occultation.

(2) Interplanetary and planetary experiments.

(a) Ultraviolet photometer.

(b) Helium magnetometer.

(c) Celestial mechanics.

(d) Trapped radiation.

(e) Solar plasma.

(f) DFR propagation.

G. Description of the TDS

The TDS was composed of the facilities and resources of the following four major support agencies:

(1) TDS agencies

(a) Air Force Eastern Test Range. The U. S. Air Force, under the Air Force Systems Command and the National Range Division, manages AFETR for the Department of Defense (DOD). As lead range for *Mariner* Venus 67, AFETR arranged the required worldwide support from DOD resources. AFETR provided prelaunch, launch, and near-earth TDA support for *Mariner V*.

(b) Manned Space Flight Network. The MSFN is operated for NASA by the Goddard Space Flight Center (GSFC). The MSFN provided near-earth TDA support for *Mariner V*.

(c) NASA Communications System. The NASCOM, operated for NASA by the GSFC, provided ground communications circuits required for support of *Mariner* Venus 67.

(d) Deep Space Network. The DSN is operated for NASA by JPL. The DSN provided mission support in the areas of deep space tracking, telemetry data acquisition, commands, and operational control.

(2) TDS organization. The TDS organization, as developed to perform the TDA for the *Mariner* Venus 67 Project, is shown in Fig. 9. Figure 10 shows the DSN/Space Flight Operations (SFO) organization for *Mariner* Venus 67.

(3) Responsibilities

(a) The associate administrator (OTDA), NASA Headquarters, designated JPL as the TDA support center for *Mariner* Venus 67. JPL appointed a Tracking and Data System (TDS) manager, whose primary responsibility was to match the TDA requirements of the project with the capabilities of the TDS facilities which provided support. The manager's task was to organize and direct all cognizant agencies in accomplishing the evaluation, planning, and implementation of TDS capabilities.

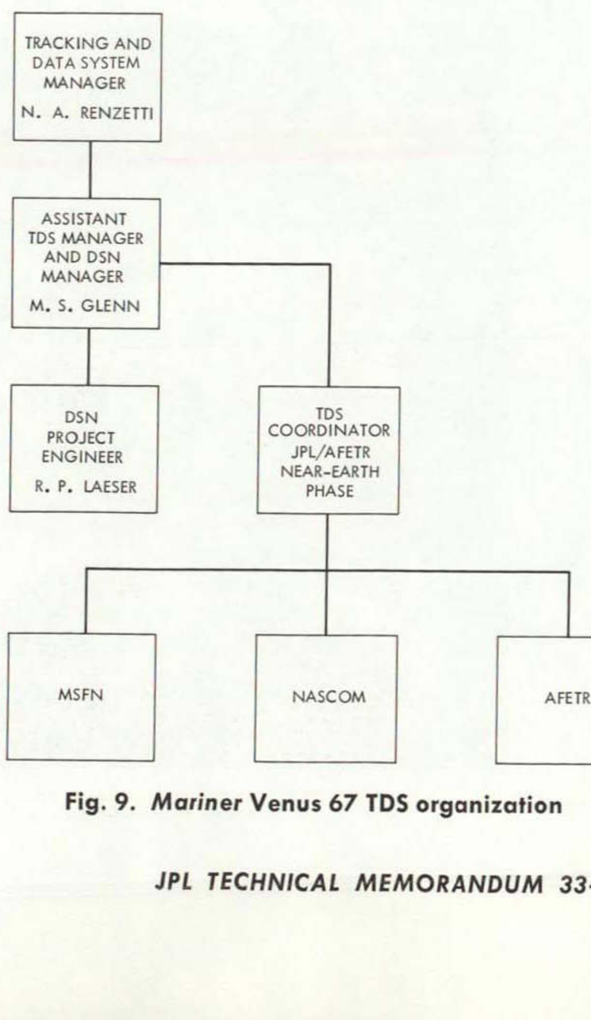


Fig. 9. *Mariner* Venus 67 TDS organization

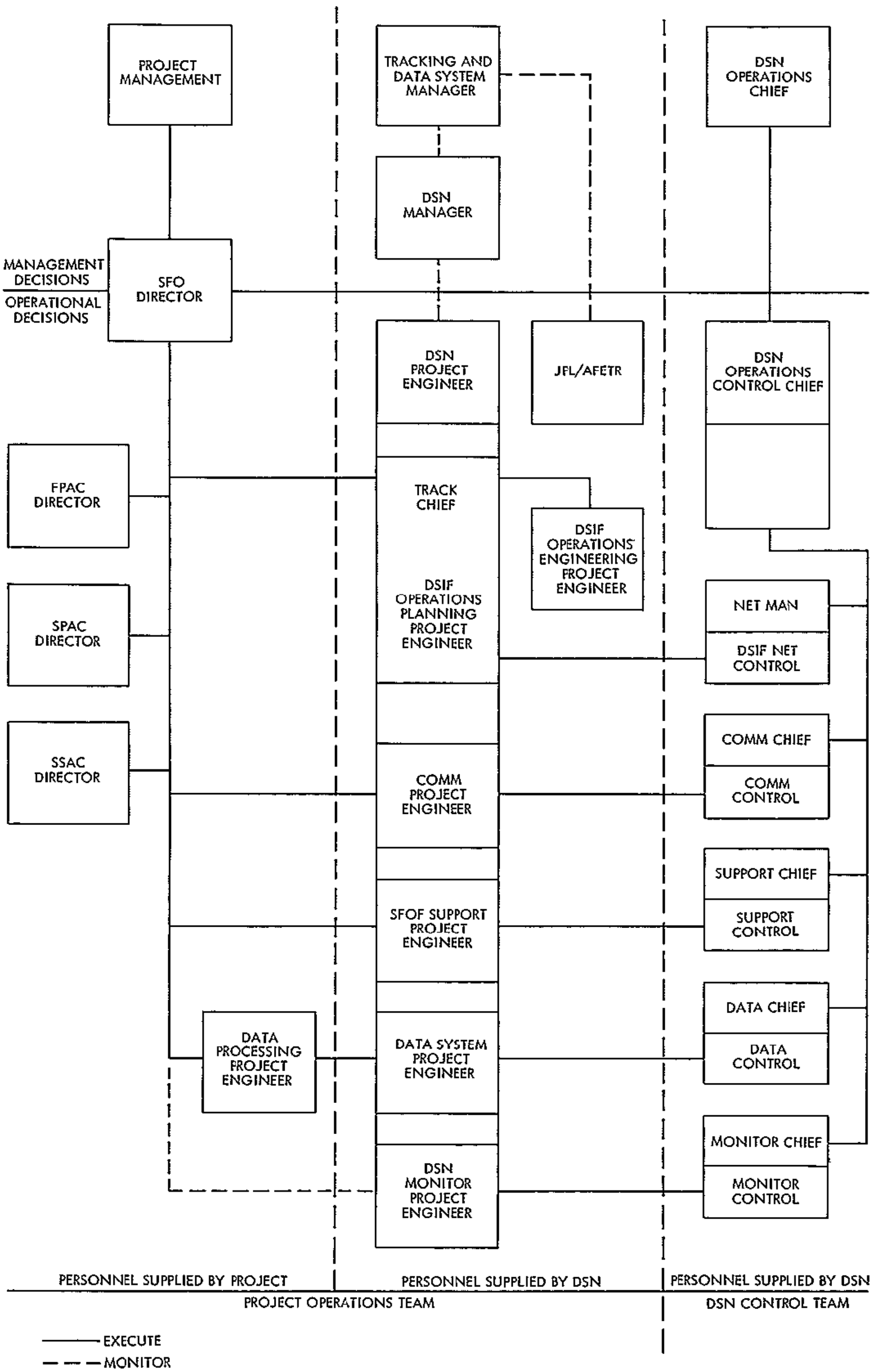


Fig 10 DSN/SFO operations organization for *Mariner* Venus 67

(b) The assistant TDS manager, who also served as the DSN manager, was assigned directly to the TDS manager He was responsible for the planning and implementation of DSN support In addition, he acted for the TDS manager in the latter's absence

(c) The TDS coordinator for the near-earth phase was a representative of the JPL/AFETR field station at Cape Kennedy He was responsible for integrating the required AFETR, MSFN, and DSN plans, testing, and operations to verify the TDS for the near-earth phase

(d) The MSFN coordinator was the central point of contact between MSFN elements and other interfacing agencies He was responsible for MSFN planning support and for ensuring that compatible interfaces were established to make the MSFN function as an integral part of the TDS in meeting project requirements assigned through the TDS He represented the MSFN at required TDS and Project meetings

(e) The AFETR program management officer was the single point of contact between AFETR elements and other interfacing agencies He was responsible for AFETR planning support and for ensuring that compatible interfaces were established to make the AFETR function as an integral part of the TDS in meeting Project requirements assigned through the TDS He represented the AFETR at required TDS and Project meetings

(f) The DSN project engineer coordinated all DSN systems and subsystems, working with representatives from numerous technical sections at JPL He ensured that all systems interfaced satisfactorily He was responsible to both the DSN and the *Mariner* Venus 67 Project for matching the requirements of the Project to the capability and commitments of the DSN He also served as the chairman of the DSN *Mariner* Venus 67 Project engineer planning and operations committee

(g) DSN systems project engineers were responsible for interface engineering and operations planning prior to launch (Fig 11). Interface engineering included the system-to-system integration and testing of hardware and software Operations planning included the design and preparation of the operational support to be supplied to the project by the DSN During prelaunch testing and during the flight, the DSN system project engineers functioned operationally They were assigned technically to the DSN project engineer

(h) The DSN/*Mariner* Venus 67 Project engineer planning and operations committee, which met once a week, was composed of the project engineers shown in Fig 11 and the following project representatives

Master Data Library (MDL) representative, R A Johannesen

Spacecraft telecommunications representative, J A Hunter

Mission-related hardware (MRH) representative, C W Harris

Mariner Venus 67 software (MRS) representative, W Scholey

Flight path analysis mission-related representative, G Pease

DSN mission simulation system representative, J W Gustafson

Occultation experiment representative, G S Levy

The committee was responsible for establishing the internal structure of configurations for DSN support of *Mariner* Venus 67, and continual review of implementation

II. Project Tracking and Data Acquisition Requirements

A General

Tracking and data acquisition (TDA) is the acquisition, transmission, and processing of information which enables the determination of space vehicle position, velocity, direction, system and subsystem performance, and experiment measurements, all with respect to a common time basis The *Mariner* Venus 67 Project's TDA requirements, which the TDS was tasked to support, are presented in this section

The project indicated the degree of importance of support requirements by categorizing them either as class I, II, or III, as follows

(1) Class I requirements included the minimum essential needs to ensure accomplishment of primary mission objectives These were mandatory requirements which, if they had not been met, could have resulted in a decision not to launch

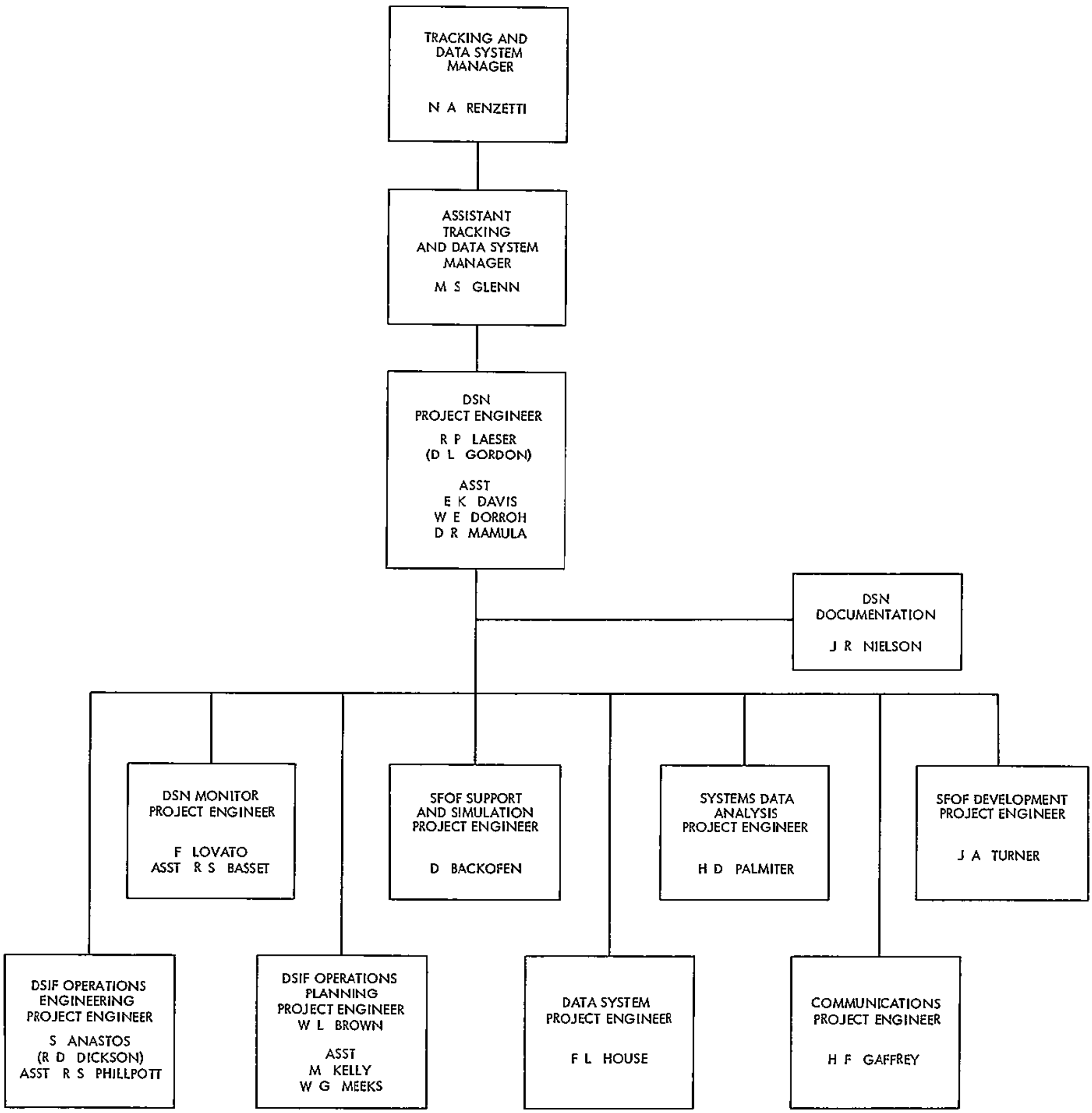


Fig. 11 DSN/*Mariner* Venus 67 planning organization

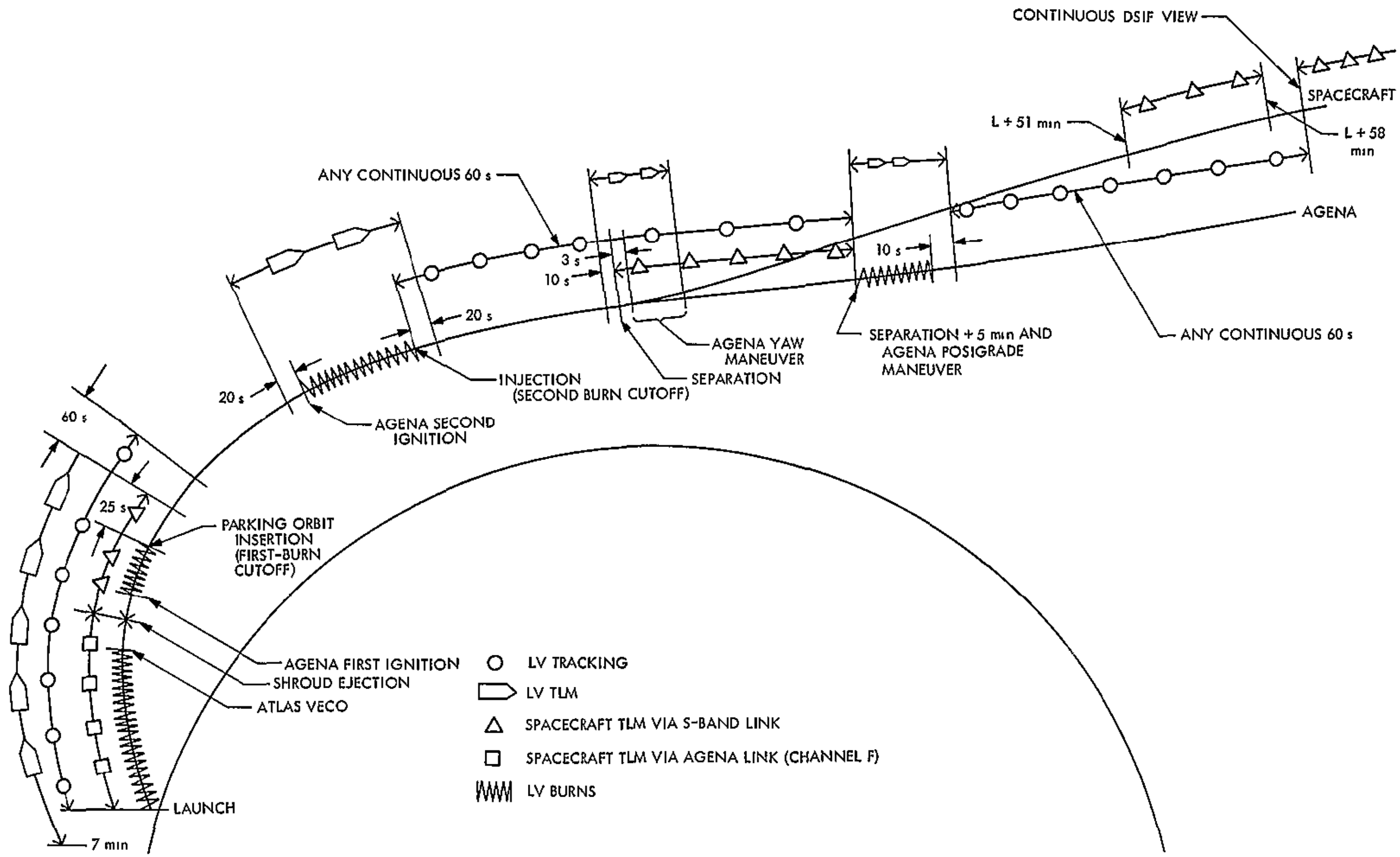


Fig 12 Trajectory profile Class I coverage requirements for near-earth phase

(2) Class II requirements defined the needs to accomplish all of the stated mission objectives Satisfactory class II coverage increased the probability of mission success and provided additional data for post-flight analysis

(3) Class III requirements defined the ultimate in desired support and set an upper limit on the mission TDA needs

Requirement types were also identified as occurring in either the near-earth or deep space phase and were grouped according to metric (tracking), telemetry, data transmission, communications, and data processing The near-earth phase began with prelaunch activities and continued through launch to continuous Deep Space Instrumentation Facility (DSIF) view At this point, the deep space phase began, and this phase continued until the end of the mission The remainder of the material in this publication was organized to generally follow this division of requirements

Generally, TDS requirements were well documented and timely New requirements and changes were neither numerous nor unreasonable Figure 12 shows the correlation of requirements to the flight profile

B Near-Earth Phase Tracking and Data Acquisition Requirements

1 Launch period and launch windows Originally, the project required the TDS to plan to support a launch period from June 12 to June 27, 1967 with a launch window each day of from 90 to 114 deg (Fig 13) This information was important to the TDS because it

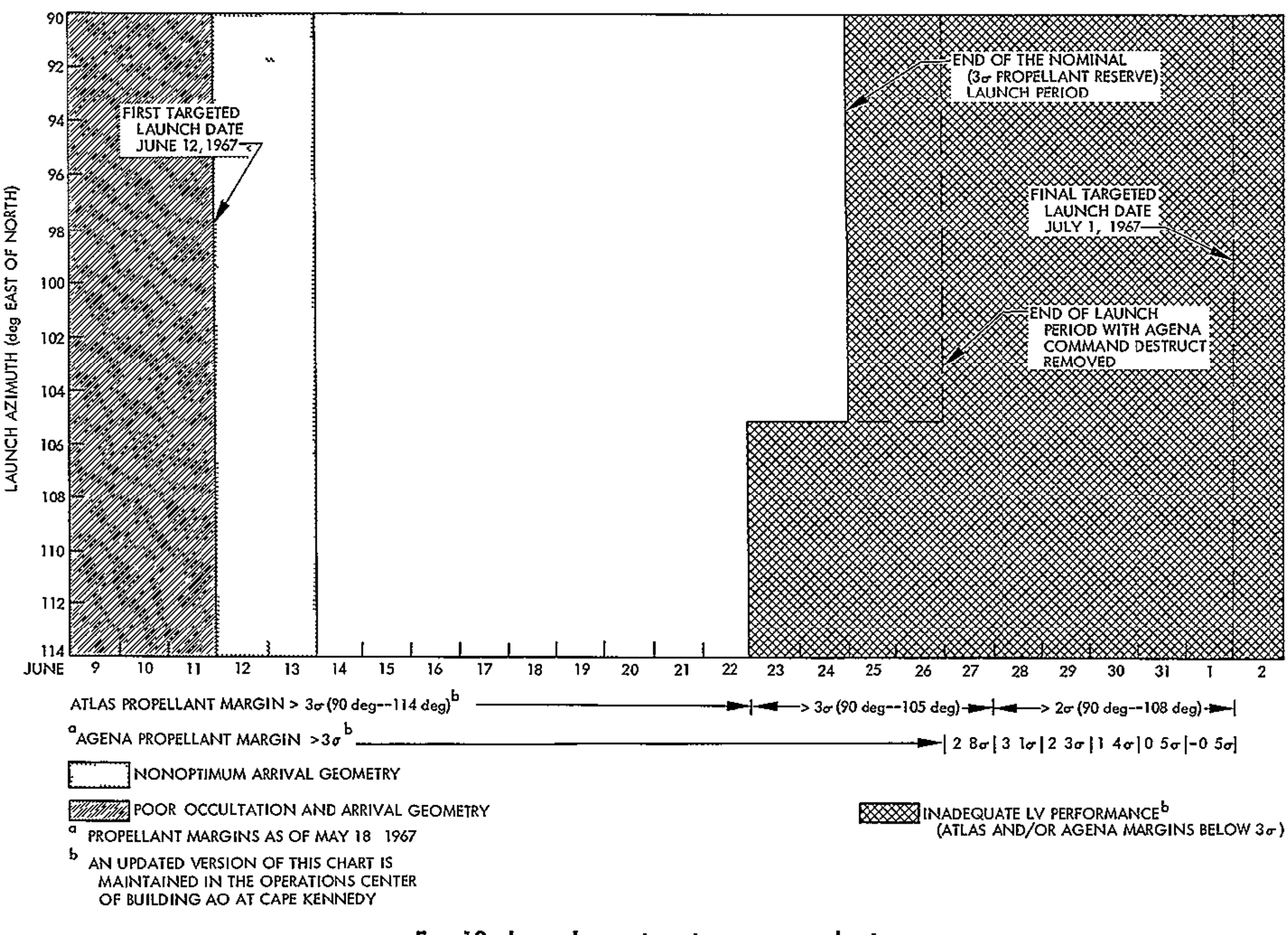


Fig 13 Launch constraints summary chart

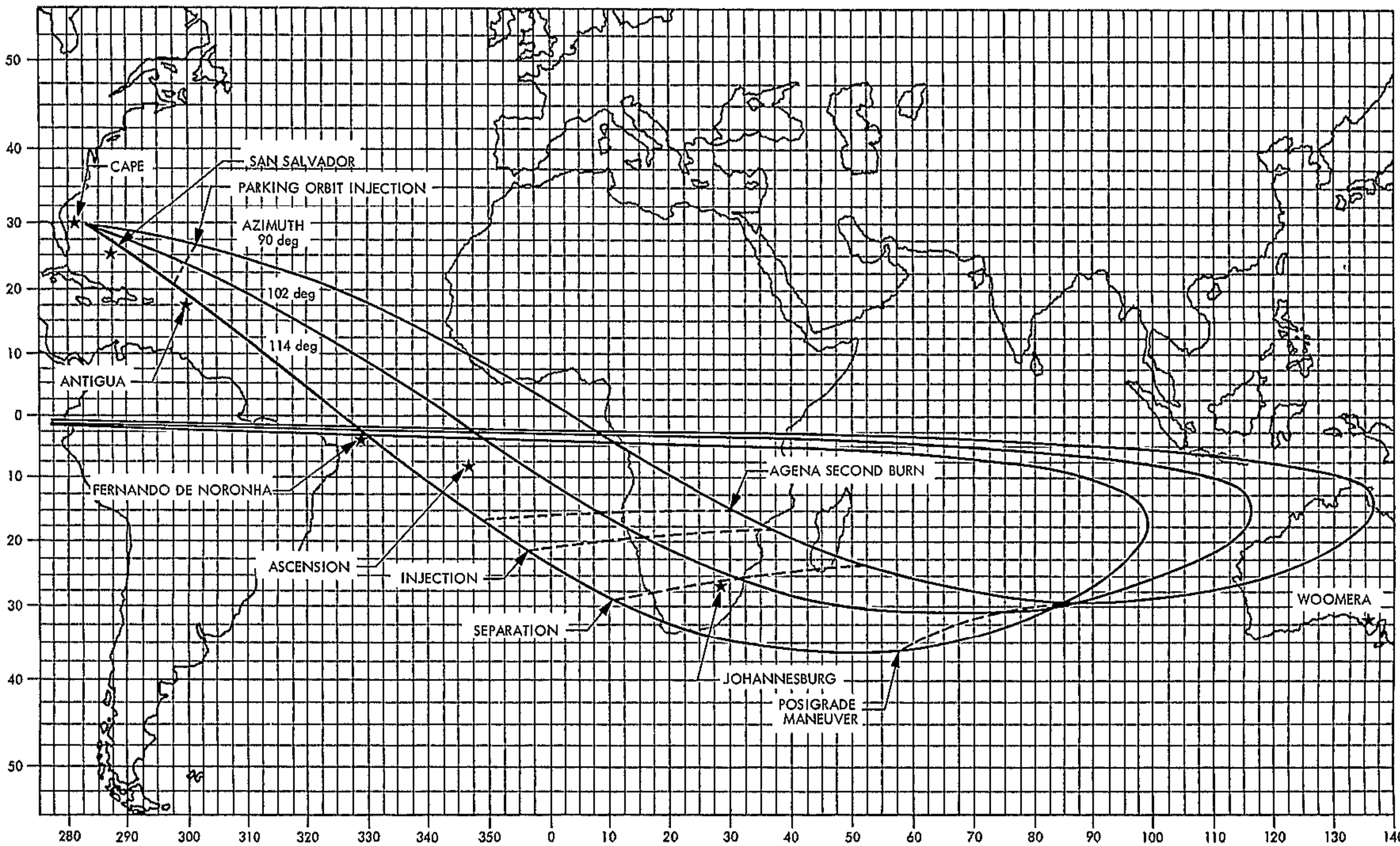


Fig. 14 Earth tracks for June 14, 1967, most uprange injection

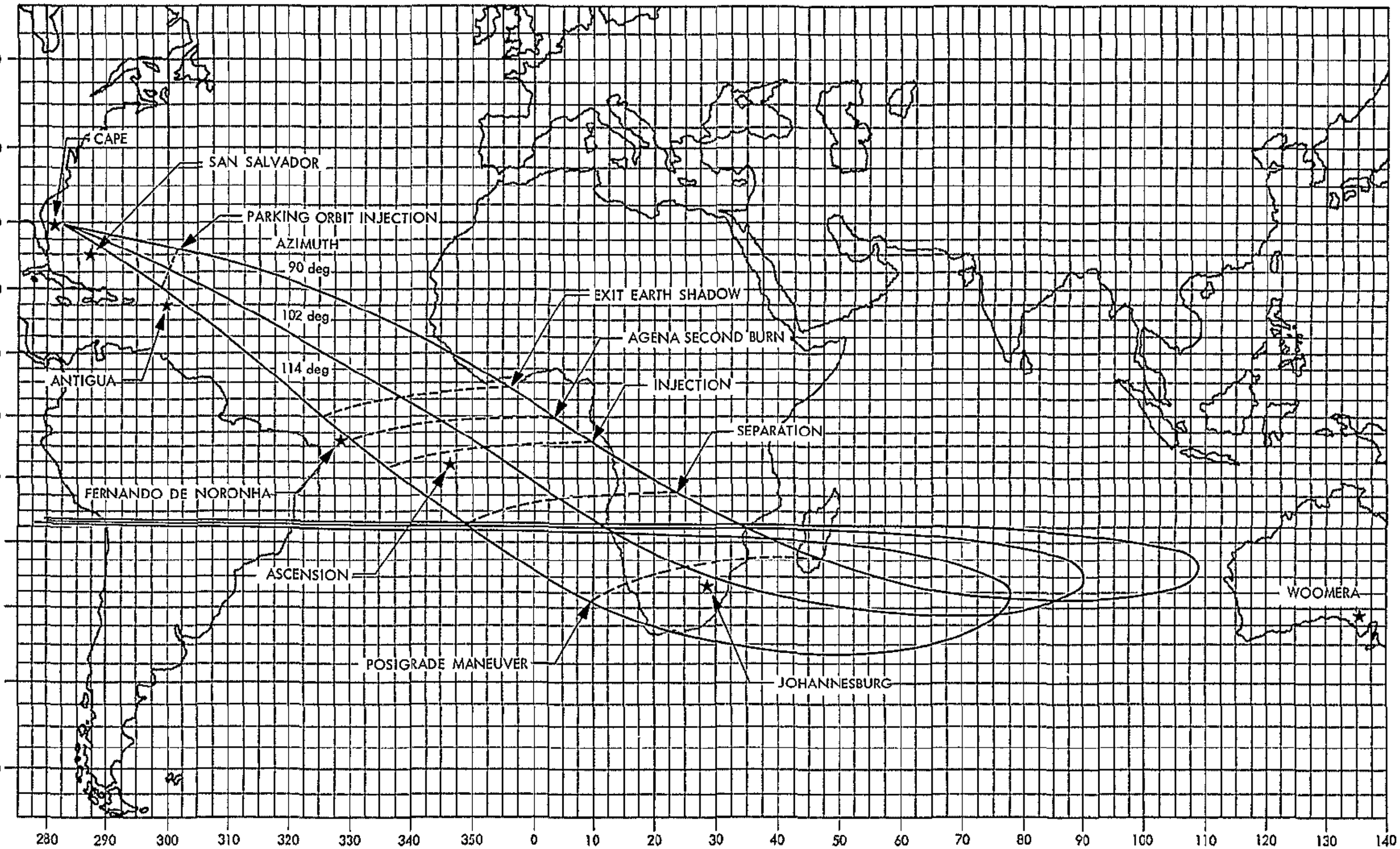


Fig 15 Earth tracks for June 27, 1967, most downrange injection

generally defined the scope of operations within which other requirements fell When a long launch period and extensive launch windows were possible, TDS support of all TDA requirements became difficult The earth maps and submissile points shown in Figs 14 and 15, reflect the changing locations of events associated with class I requirements To minimize TDS support difficulties, the project requested the TDS establish a configuration that would optimize support for the first 6 days, rather than over the entire period, thereby avoiding degradation of support in the early days June 12 and 13 were also deleted as possible launch dates

2. Near-earth phase metric requirements. Metric data, obtained by tracking the *Agena* C-band beacon, were required for several purposes, including launch vehicle performance evaluation, early spacecraft orbit determination (OD), range safety, and acquisition information for the supporting AFETR, MSFN, and DSN stations Specific metric requirements are given in Tables 1, 2, and 3

Table 1 Launch vehicle metric requirements

Data required	Interval	Data, points/s	Reduced data accuracy			Remarks
			Class I	Class II	Class III	
1 Position X, Y, and Z[a]	0–5000 ft	10	±25-ft slant range	±0 25-ft or 0 25% slant range	±0 1-ft or 0 1% slant range	Items 1–6 needed to verify *Agena* position, altitude, and velocity at SLV-3/*Agena* separation
2 Velocity Vx, Vy, Vz, and total V	0–5000 ft	10	±5 0 ft/s	±1 0 ft/s	—	
3 Acceleration Ax, Ay, Az, and total A	0–5000 ft	10	±5 0 ft/s²	±1 0 ft/s²	—	
4 Position X, Y, and Z[a]	5000 ft to SLV/*Agena* separation	10	±50 0 ft	±10 0 ft	±5 0 ft	
5 Velocity Vx, Vy, Vz and total V	5000 ft to SLV-3/*Agena* separation	10	±20 ft/s	±3 0 ft/s	±1 0 ft/s	
6 Acceleration Ax, Ay, Az, and total A	5000 ft to SLV-3/*Agena* separation	10	±10 ft/s²	±3 0 ft/s²	±1 0 ft/s²	
7 Band 10 radar data *T*, A, *E*, and R	Launch to SLV-3/*Agena* separation	10	±1000 ft	±500 ft	—	Postflight analysis of *Atlas*/*Agena* performance
8 Position X, Y, Z, and H[ab]	*L* to SLV-3/*Agena* separation	10	—	±500 ft	—	—
9 Velocity Vx, Vy, and Vz	*L* to SLV-3/*Agena* separation	10	—	Consistent with position data	—	—
10 Band 10 radar data—*T*, A, *E*, and R	*Atlas*/*Agena* separation through *Agena* first-burn cutoff +10 s	10	±1000 ft	±500 ft	—	For postflight analysis of *Agena* performance
11 Position X, Y, Z, and H[ab]	*Atlas*/*Agena* separation through *Agena* first-burn cutoff +10 s	10	—	±500 ft	—	—
12 Velocity and Vx, Vy, and Vz	*Atlas*/*Agena* separation through *Agena* first-burn cutoff +10 s	10	—	Consistent with position data	—	—

[a]X = downrange, Y = 90 deg ccw from the positive X axis and Z = upward from the XY plane
[b]H = upward referenced to the Kaula NASA spheroid

Table 2 Near-earth orbital metric requirements[a]

Class I	Class II	Class III	Remarks
L to P/O insertion + 85 s	*Agena* first burn cutoff to first burn cutoff + 180 s[b]	Same as class II + *Agena* first-burn cutoff to *Agena* second-burn ignition, and *Agena* second-burn	For calculation of TDS acquisition data and OD
Any continuous 60 s of coverage between *Agena* second-burn cutoff and *Agena*/SC separation[c]	Continuous tracking from transfer orbit injection to start of *Agena* retro thrusting[c]	—	Verify compliance with planet quarantine requirement
Any continuous 60 s of coverage after *Agena* retro thrusting termination	Any continuous 120 s of coverage after *Agena* retro termination and tracking to LOS, thereafter	—	—

[a]Data required are T, A, E, R, accuracy required for such data is given in Table 3 The desired sample rate is 1 point/6 s

[b]*Agena* first burn cutoff and parking orbit injection designate the same event

[c]*Agena* second burn cutoff and transfer orbit injection designate the same event

Table 3 Orbital tracking data accuracy requirements[a]

Class	Data type	Effective data noise at 1 sample/6 s[b]			Station timing requirements to WWV, s[c]
		$T_L < 6$ s	$6 \text{ s} \leq T_L < 10^m$	$T_L \geq 10^m$	
I	Range, m	25	50	200	0 003
	Angles, az/el deg	0 05	0 12	0 15	
II	Range, m	5	10	100	0 001
	Angles, az/el deg	0 01	0 04	0 045	
III	Range, m	1	1	10	0 00005
	Angles, az/el deg	0 005	0 005	0 007	

[a]Based on a 10 min pass occurring during near earth orbital phase

[b]Effective data noise $= \left[\sum_i S_i^2 \, g_i^2 \max\left(1, \frac{T_{L_i}}{T_S}\right)\right]^{1/2}$

[c]NBS time standard radio call

The following definitions apply to the orbital tracking data accuracy requirements given in Table 3

i = error mode index

S_i = standard deviation of error mode i at some reference conditions (i e , where $g_i = 1$)

g_i = shape factor of error mode i Equal to *one* at the reference condition As an example, the azimuth angle jitter error source may have

$$g_{AZA\,J} = \frac{1}{\cos(\text{elevation angle})}$$

and the range (ρ) error due to oscillator drift rate may have the form

$$g_{OSC\,DR} = \rho/\rho \text{ ref}$$

T_{L_i} = correlation width of the ith error source

T_S = time between successive data points, max $(1, T_{L_i}/T_S)$ This means use either 1 or T_{L_i}/T_S, whichever is larger

3 *Near-earth phase telemetry requirements*

a Launch vehicle telemetry These data were required for evaluating overall launch vehicle performance, the monitoring and verification of important launch vehicle events (mark events), and postflight analysis Launch vehicle (LV) telemetry requirements are listed in Table 4 Brief descriptions of the *Atlas/Agena* telemetry links are given in Tables 5 and 6

Table 4 Launch vehicle telemetry data requirements

Class I	Class II	Class III
Atlas TM from *L* — 120 s to *Atlas–Agena* separation	From *L* — 120 s to *Agena*–S/C separation and during *Agena* retro thrusting	From *L* through *Agena* retro thrusting
Agena TM from *L* — 120 s to parking orbit insertion + 25 s	—	—
Agena second ignition — 20 s to *Agena* second cutoff + 20 s	—	—
Agena–S/C separation — 10 s to *Agena*–S/C separation + 10 s		
Start of *Agena* yaw maneuver to termination of posigrade thrusting	—	—

Table 5 *Atlas* telemetry link (249 9 MHz, PAM/FM FM)[a]

Channel				Rate measurement, rev/s, and bit/s
No	Frequency, kHz	Deviation, ± %	Number of segments	
1	0 40	7 5		Direct
2	0 56	7 5		Direct
3	0 73	7 5		Direct
4	0 96	7 5		Direct
5	1 30	7 5		Continuous
6	1 70	7 5		Continuous
7	2 30	7 5		Continuous
8	3 00	7 5		Continuous
9	3 90	7 5		Continuous
10	5 40	7 5		Continuous
11	7 35	7 5	b	2 5 rev/s
12	10 50	7 5		Direct
13	14 50	7 5	b	5 rev/s
14	22 00	7 5	b	1/8 rev/s
15	30 00	7 5	b	10 rev/s
16	40 00	7 5	b	10 rev/s
17	52 50	7 5	b	1/8 rev/s
18	70 00	7 5	b	30 rev/s

[a]Permitted postflight evaluation of *Atlas* performance

[b]These commutators were 60 position, with only odd numbered segments used for data Even numbered segments returned to 9% bandwidth (9% were negative voltage since 0% calibrate was 20% bandwidth) CH 24 and 17 could be either continuous or commutated with 3- or 6 data segments

Table 6 *Agena* telemetry link (244 3 MHz, FM/FM)[a]

Channel[b]				Rate measurement, rev/s, and bit/s
No	Frequency, kHz	Deviation, ± %	Number of segments	
3	0 73	7 5	—	Continuous
4	0 96	7 5	—	Continuous
5	1 30	7 5	—	Continuous
6	1 70	7 5	—	Continuous
7	2 30	7 5	—	Continuous
8	3 00	7 5	—	Continuous
9	3 90	7 5	—	Continuous
10	5 40	7 5	—	Continuous
11	7 35	7 5	—	Continuous
12	10 50	7 5	—	Continuous
13	14 50	7 5	—	Continuous
14	22 00	7 5	—	Continuous
15	30 00	7 5	60	5 rev/s[d]
16	40 00	7 5	60	5 rev/s[d]
17	52 50	7 5	—	Continuous
18	70 00	7 5	—	Continuous
F[c]	98 00	15 0	—	Continuous[e]

[a]Link to telemeter *Agena* performance and environmetal data used in support of *Agena* primary (class I) and secondary (class II) test objectives Link also modulated by an on board transducer in the 0–525 Hz region Purpose for link is S/C engineering evaluation and failure detection

[b]Required for telemetering basic *Agena* performance and environmental data

[c]CH F carried S/C data and was submodulated

[d]Both commutators were 100% duty cycle, NRZ

[e]No IRIG conformance

b Spacecraft telemetry requirements Spacecraft data were needed to confirm the occurrence of critical events which occurred during the near-earth phase This telemetry was an early indication of the status of the mission and was of particular value in the event of nonstandard spacecraft performance These requirements are given in Table 7 Spacecraft data were available via the spacecraft S-band link or via the *Agena* link until *Agena*/spacecraft separation Table 8 and Figs 16 and 17 show the characteristics of the *Mariner* Venus 67 telemetry signal In Table 8 there is a notation to see this text for channel characteristics of the spacecraft signal via S-band These characteristics were as follows

(1) Type PCM/PSK/PM

(2) Commutator designation Solid-state, fully synchronous, four commutation rates (ratio 1 10 100 200)

(3) Frame format 100 words (segments—90 data words, four sync words, six subcommutation points)

Table 7. Spacecraft telemetry data requirements during near-earth phase of *Mariner V*

Class I[a]	Class II	Class III
	Agena link	
Pre *L* calibrations *L* to shroud ejection Shroud ejection to *Agena* first-burn cutoff + 25 s[b]	*L* to *Agena* first-burn cutoff + 25 s *Agena* second-burn ignition − 25 s to *Agena*–S/C separation + 5 s	From *L* to *Agena*–S/C separation + 5 s
	S/C link	
Pre-*L* calibrations Shroud ejection to *Agena* first-burn cutoff + 25 s[c]	*L* to *Agena* first burn cutoff + 25 s with real-time indication of increase in received S-band signal strength	From *L* to continuous DSIF view + 10 min[d]
Agena–S/C separation − 10 s to separation + 5 min	Second-burn ignition − 25 s to continuous DSIF view + 2 min[d]	
From *L* + 51 min to *L* + 58 min		

[a]Class I requirements for data were contingent on real or near real time reception of these data at SFOF as well as recording of data. By near real time reception the *Mariner* Venus 67 Project meant reception of data as close to real time as was feasible and in any case no later than 7 min after occurrence.

[b]Receipt of this class I data via S band link was preferred.

[c]Detection of increase in received S band signal strength was preferred method of confirming shroud ejection.

[d]DSIF continuous view began with DSS 42 rise.

(4) Synchronized word format: three frame synchronized words—seven *ones*

(5) Word format: seven bits; first bit most significant digit, seventh bit—least significant digit

(6) Data rate: 33⅓ bits/s

(7) Signal: two subcarriers: one data, one sync. Sync channel provided bit and word sync.

The *Mariner* Venus 67 composite telemetry signal, which consisted of two PCM/PSK subcarriers, had significant spectral components in the following ranges:

(1) Bit rate: 33⅓ bits/s

(2) Low-frequency limit: 15.0 Hz

(3) High-frequency limit: 1200 Hz

Table 8. Characteristics of spacecraft signal

Link frequencies (MHz) and type	No.	Channel: Frequency, kHz	Channel: Deviation, ± %
S/C, via S band[a] 2297.592593 PCM/ PSK/PM	—	(See text)	(See text)
S/C, via *Agena* link 244.3 FM/FM	F	98	15

[a]Purpose: S/C engineering evaluation and failure detection. No IPIG conformance.

Ground station limitations during the launch phase did not allow these specifications to be met in all cases. For this period, the absolute worst parameters acceptable for marginal performance were the following:

(1) Bit rate: 33⅓ bits/s

(2) Low-frequency limit: 144 Hz

(3) High-frequency limit: 900 Hz

(4) Gain deviation: ±1.0 db

(5) Time delay deviation: ±200 μs

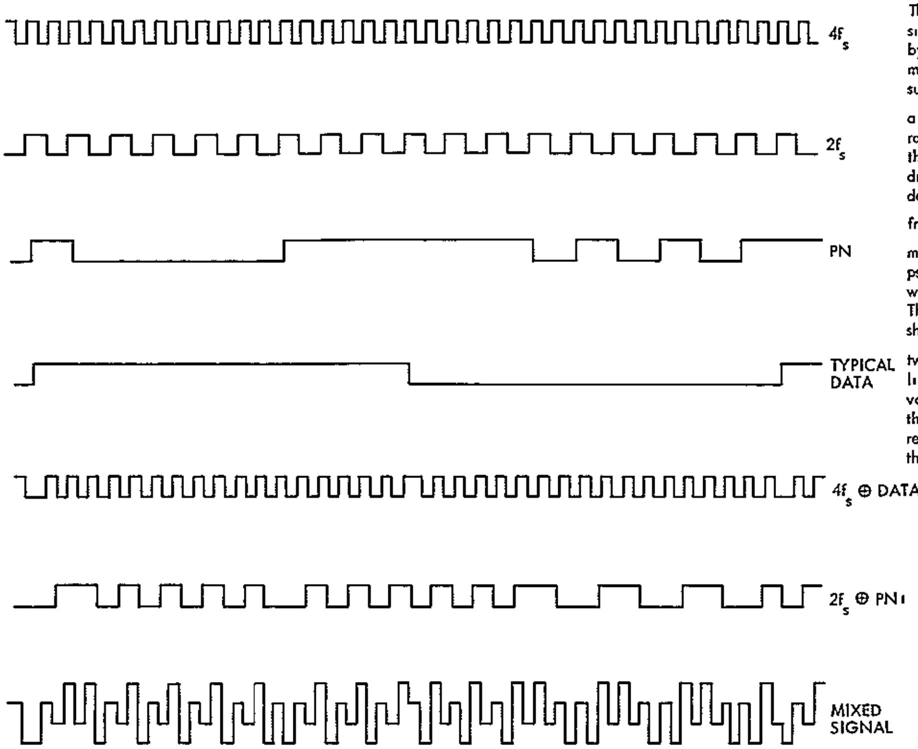
The measuring rate was 33⅓ and 8⅓ bits/s. The 33⅓-bit/s rate was maintained until approximately *L* + 30 days. The maximum tolerable percent error for the composite TV signal was ±0.5% and the maximum tolerable bit error rate for the PCM signal was 5/1000 bits.

4. Data transmission requirements

a. Metric data. Generally for range safety and acquisition information computation purposes, it was a class I requirement that metric data from the launch phase be transmitted to user areas in real time. Orbital metric data are generally desired in real time, but near-real time data were acceptable.

b. Launch vehicle telemetry data. The user required data from the launch phase to be transmitted and displayed in real time. Near-real-time playback and readouts were required of portions of data received during the earth-orbital phase.

c. Spacecraft telemetry data. The project required real- or near-real-time transmission of spacecraft data received by TDS stations during the four class I intervals



The Mariner composite TLM signal was generated as shown by wave forms on the biphase modulator timing diagram. A subcarrier denoted as $4f_s$ and at a frequency of 9 x the data bit rate was modulo-two added with the NRZ data as shown on the diagram. Another subcarrier denoted as $2f_s$, which was at a frequency 1/2 of $4f_s$, was modulo-two added with a pseudo noise code, a portion of which is shown on the diagram. This produced the signal shown as $2f_s \oplus$ PN. These two signals were then linearly added, using a voltage ratio as determined by the sync and data threshold requirements, to produce the composite TLM signal.

Fig 16. Biphase modulator timing

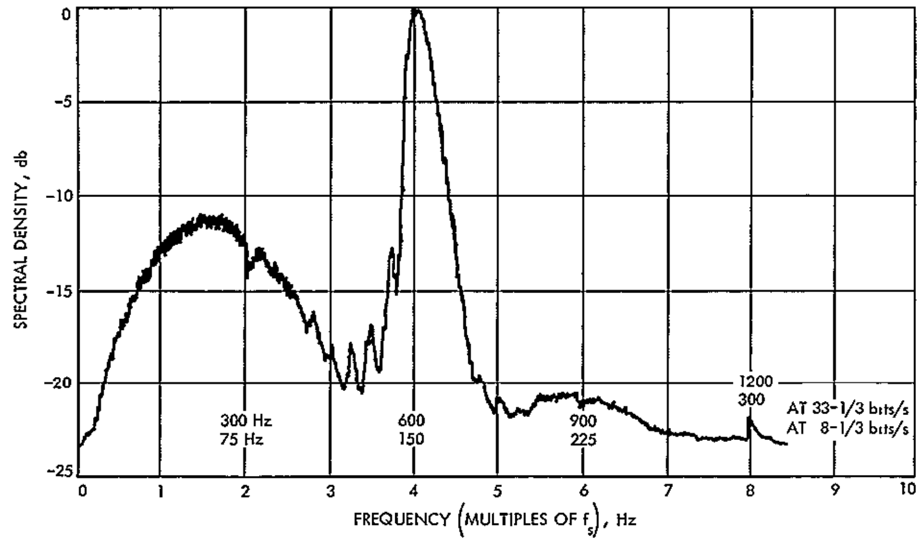


Fig 17. Measured power spectrum of composite telemetry signal

The project made the following comments to clarify data transmission requirements.

First: Most of the class I requirements implied real- or near-real-time reception of appropriate data at GSFC, AFETR, SFOF, Building AO, and Building AE. In a nonstandard mission, data were required in real time to determine the nature and extent of the problem and to provide information for corrective action. For example, if the spacecraft injection accuracy was beyond 3 σ, real-time data would have permitted computation of an early midcourse (M/C) maneuver (M), significantly increasing the probability of mission success.

Second: The *Mariner* Venus 67 Project defined *near-real-time reception* to mean reception of a particular data point at the using area no later than 7 min after the occurrence of the event which produced the data.

Third: Support of class II and class III requirements should not jeopardize the real-time transmission of data from class I intervals.

Fourth: Since a rise in signal strength of approximately 24 db was expected at shroud ejection, receipt of spacecraft data beginning with that function was preferred via the S-band link. However, spacecraft data via either the S-band or the *Agena* channel F link were acceptable.

Fifth: Continuous DSN view began with Tidbinbilla (DSS 42) rise.

Sixth: Circuits used for retransmitting spacecraft telemetry data had to have the following characteristics:

(1) Be capable of passing a frequency spectrum of 144–900 Hz.

(2) Gain duration not to exceed ± 1.0 db.

(3) Time deviation from a constant reference not to exceed ± 0.2 ms over the specified frequency band.

(4) All links have communications path diversity.

Seventh: Should any station acquire the *Mariner V* spacecraft in data bar condition prior to DSS 42 first acquisition, no attempt should be made to change to data. Stations should retain data bar for the entire pass. These procedures were necessary to maximize the telemetry data return during times of significant spacecraft events.

5. Data processing requirements. Data processing tasks which the TDS had to accommodate during the near-earth phase consisted primarily of trajectory computations and spacecraft engineering and science telemetry conversions. In this sense, data processing was defined as those requirements which required the use of central computer facilities. Because data processing was not an independent TDS function, the Project stated a portion of their requirements in terms of equipment needs, rather than data needs. For the near-earth phase, the Project required dual IBM 7044/7094 computers at the SFOF for conversion of spacecraft data to engineering and science units and for processing tracking data in providing trajectory computations and predict information.

Requirements for computations resulting from tracking data were as follows:

(1) Parking orbit. JPL elements, interrange vector (IRV) standard orbital parameter message (SOPM), I-matrix, and DSN predicts.

(2) Preposigrade transfer orbit. JPL elements, IRV, SOPM, I-matrix, DSN predicts, and planetary mapping.

(3) Postposigrade transfer orbit. JPL elements, IRV, SOPM, I-matrix, DSN predicts, and planetary mapping.

These items were computed by the AFETR real-time computer system (RTCS) and were required by the project at the SFOF and various supporting sites in near-real time. The data reports and their formats are further described in Section III.

6. Other requirements

a. Communications. Project communication requirements stemmed from data and voice transmission needs. Basic communications requirements are shown in Fig. 18. However, it should be pointed out that there are virtually hundreds of interfacility, interagency, and intra-agency communication links which were necessary for the mission but which cannot be discussed within the scope of this document.

b. Prelaunch test requirements. The TDS was required to furnish facilities and personnel for the following test activities: simulation, program checkout, hardware integration, software integration, facility integration, personnel training, ground communications, operational readiness, and spacecraft/ground system compatibility. Deep Space Network and TDS interface, system, and operational tests which led to a TDS operational capability and overall readiness are further defined in Section IV.

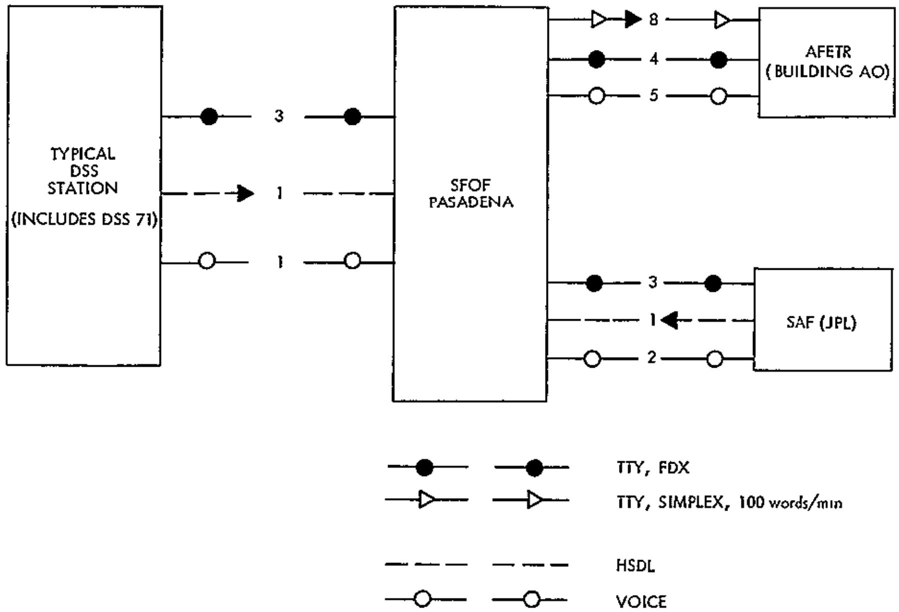


Fig 18 General communications requirements diagram, near-earth phase

c TDS commitments and coverage estimates The Project was responsible for defining the launch period and windows and for providing trajectory data (having an accuracy of ±10 s for mark events and ±1 deg in latitude and longitude) for the launch period This information was required about 10 wks prior to launch Based on this requirement, TDS identified committed supporting stations and provided estimates of coverage from each This information was required and furnished approximately 4 wks prior to launch Project definitions set the period and windows, however, precise trajectory tables were not available until launch minus 6 wks (average on other projects) The TDS was instructed to use trajectory data which were available in published conic approximations for planning purposes It was believed that these approximations would meet the stated accuracy requirements

C Deep-Space Phase TDA Requirements

1 General Project requirements on the TDS for TDA support during the deep space phase were extensive, but not as complex as the near-earth phase, because fewer agencies (only the DSN and the supporting NASA communication system) were involved Tracking, telemetry, data transmission, data processing, command, and other requirements are outlined in the following paragraphs

2 Deep space tracking requirements Table 9 lists the deep space tracking requirements for *Mariner V* and *Mariner IV* This listing defines class I tracking coverage requirements only, which were the minimum requirement The telemetry requirements given in Table 10 additionally define class II and class III tracking requirements There was a requirement for tracking data whenever telemetry data were being received Special remarks which applied to the tracking requirements are as follows

(1) Ranging data were required whenever two-way doppler was being received, on a best obtainable basis within existing capability

(2) Horizon-to-horizon coverage was required from all stations during the following intervals

(a) From continuous DSIF view through first $M+2$ days

(b) From second M through second $M+2$ days

(c) From $E-12$ h through $E+24$ h

(3) There was a mandatory requirement to provide one short two-way lockup once every 5 days from $E-45$ days to end of mission (EOM) This requirement existed to inhibit the switch of the spacecraft receiver from the high-gain to the low-gain antenna on every second cyclic pulse (66⅔ h between each cyclic)

(4) Data accuracy requirements which applied to the deep space tracking data are presented in Table 11

Table 9 Deep space tracking requirements[a]

a *Mariner V*

Time distance coverage	Data required
Continuous coverage Track S/C from separation to first $M - 1$ h	Angular position doppler (2-way) 1 min sample rate (from initial DSIF acquisition to $L + 1$ h at 5-s sample rate)
Data stream 1 Continuous coverage from first MC−1h to sun reacquisition	10-s sampling rate
Data stream 2 (first M/C) Pitch − 1 min to pitch + 1min Roll − 1 min to roll + 1 min Motor burn − 5 min to motor burn + 5 min Motor burn + 5 min to sun reacquisition	1-s sampling rate 10 s sampling rate
Continuous coverage Sun reacquisition to first $M + 2$ days 1 pass/day coverage First $M + 3$ days to second $M - 2$ days[a]	60 s sampling interval 60 s sampling interval
Continuous coverage Second $M - 1$ day to second $M - 1$ h	60 s sampling interval
Data stream 1 Second $M - 1$ day to second $M - 1$ h	60-s sampling interval
Data stream 2 Second $M - 1$ day to second $M - 1$ h	60 s sampling interval

[a]If separation of *M*s was less than 10 days, continuous tracking was required If no second *M* was required the tracking requirement was 1 pass/day from first $M + 2$ days to first $M + 30$ days

[b]A study was performed prior to second *M* (or first $M + 20$ days) to determine if this requirement had not proved to be valid, then 1 pass/5 days required and the pass should have coincided with the SC requirement

[c]Acquisition of post encounter playback of science data took priority over these requirements

Table 9 (contd)

a *Mariner V* (contd)

Time distance coverage	Data required
Continuous coverage Second $M + 30$ min to second $M + 2$ days	Angular position 2-way doppler, 60-s sampling interval
1 pass/day coverage Second $M + 3$ days to second $M + 10$ days 2 passes/5 days or 1 pass/2½ days[b] Second $M + 10$ days to encounter − 10 days	60 s sampling interval 60-s sampling interval
1 pass/day $E - 10$ days to $E - 2$ days	60-s sampling interval
Continuous coverage $E - 1$ day to $E - 1$ h	30 s sampling interval
Continuous coverage $E - 1$ h to $E + 30$ min	10-s sampling interval (data stream 1), 1-s sampling interval (data stream 2)
Continuous coverage $E + 100$ min to $E + 12$ h	30-s sampling interval
Continuous coverage $E + 12$ h to $E + 1$ day[b]	30-s sampling interval
Continuous coverage $E + 1$ day to $E + 3$ days[b]	60 s sampling interval
2 passes/day $E + 3$ days to $E + 10$ days[a]	60-s sampling interval
2 passes/5 days or 1 pass/2½ days $E + 10$ days to EOM	60-s sampling interval

b *Mariner IV*

Time distance coverage	Data required
Throughout *Mariner IV* operations in 1967, 1 pass per wk for first 4 wks, then 1 pass per 2 wks, coherent 2-way	Angular position, 2-way doppler sample/min
For a second *M*, 1 pass/day from $M - 1$ day to $M + 5$ days.	Sample rate same as *Mariner V* maneuver

Table 10. Deep space telemetry requirements for *Mariner V* and *IV* combined operations[a]

Class	Mission	Requirement for indicated activity and period					
		Mariner V launch, Canopus acquisition, and first M	Cruise establishment	*Mariner V* second M	Cruise and transition to radial *Mariner V/E/Mariner IV* position	*Mariner V/E/Mariner IV* radial solar position	Transition from radial to spiral position
		L to $M_1 + 2$ days ($\sim$8 days)	$M_1 + 3$ days to $M_2 - 2$ days	$M_2 - 1$ day to $M_2 + 2$ days (4 days)	$M_2 + 3$ days to Aug 11	Aug 12–21	Aug 22–Sept 9
I	*Mariner V*	Continuous	1 pass/day	Continuous	1 pass/day	2 passes/day	1 pass/day
	Mariner IV	1 pass/week	1 pass/day	1 pass	1 pass/day	2 passes/day	1 pass/day
II	*Mariner V*	Continuous with M_1 BU	2 passes/day	Continuous with M_1 BU	2 passes/day	2 5 passes/day	2 passes/day
	Mariner IV	3 passes/wk	2 passes/day	1 pass	2 passes/day	Continuous	2 passes/day
III	*Mariner V*	Continuous with L, S_1 and M_1 BU	Continuous	Continuous with M_2 BU	Continuous	Continuous	Continuous
	Mariner IV	1 pass/day	2 passes/day	2 passes/day	Continuous	Continuous	Continuous

Class	Mission	Requirement for indicated activity and period						
		Spiral *Mariner V/E/Mariner IV* (magnetic force line) solar position	*Mariner V*/85-ft antenna grayout region	Spiral *Mariner V/E/Mariner IV* (magnetic force line) solar position	*Mariner* Venus 67 E tests using *Mariner IV*	*Mariner* Venus 67 E and tape playback	*Mariner IV* engineering tests	
		Sept 10–14	Sept 15–25	Sept 26–Oct 5	Oct 6–17	Oct 18–29	Oct 30–Nov 15	Nov 16–Dec 13
I	*Mariner V*	2 passes/day	1 pass/day from DSS 14	2 passes/day	1 pass/day	Continuous + DSS 13 and 14 on E pass	1 pass/day	N/A
	Mariner IV	2 passes/day	2 passes/day	2 passes/day	2 passes/day	2 passes/wk	1 pass/day	2 passes/wk
II	*Mariner V*	2 5 passes/day	1 pass/day from DSS 14	2 5 passes/day	2 passes/day	Class I with first playback BU	2 passes/day	N/A
	Mariner IV	2 5 passes/day	Continuous	2 5 passes/day	2 passes/day	2 passes/wk	2 passes/day with BU for tests	4 passes/wk
III	*Mariner V*	Continuous	2 passes/day from DSS 14 and another equivalent station	Continuous	Continuous	Class I with first playback	Continuous	N/A
	Mariner IV	Continuous	Continuous	Continuous	Continuous	1 pass/day	Continuous with BU for tests	1 pass/day

[a]Includes class II and class III tracking requirements

Table 11 Required deep space tracking accuracies

Effective noise at 1 sample/min		Deviation[a]			Ranging[b]	
Data accuracy	Correlation width, T_p, min	2-way doppler (1-σ), Hz	Angles (1-σ), deg	3-way doppler (1-σ), deg	2-way ranging (1-σ), m	3-way ranging (1-σ), m
Guaranteed[c]	$T_p < 10$	0 010	0 050	0 050	1 0	5 0
	$T_p \geq 10$	0 100	0 200	20 000	10 0	$3 0 \times 10^3$
Desired	$T_p < 10$	0 005	0 010	0 005	0 5	3 0
Not guaranteed	$T_p \geq 10$	0 005	0 060	0 005	5 0	25 0
	$T_p < 10$	0 001	0 005	0 001	0 1	0 1
Ultimate	$T_p \geq 10$	0 001	0 014	0 001	1 0	1 0

[a]All 1 σ standard deviations were for tracking data taken above 17-deg local elevation

[b]Ranging accuracies refer to ground station performance

[c]Guaranteed S/C ranging for T_p 10 m was less than 100 m

(5) It was required that inflight tracking data be presented in teletype page print form and postflight data be recorded on magnetic tape

(6) Timing sync requirements were as follows

(a) Class I = 2 ms

(b) Class II = 0 3 ms

(c) Class III = 0 1 ms

3 Deep space telemetry requirements The deep space telemetry requirements for *Mariner V* and *Mariner IV* are listed in Table 10

4 Deep space data transmission and processing requirements

a General processing requirements For the mission operations team to have the information necessary to support the mission, engineering and science telemetry data and tracking data had to be transmitted to the SFOF and processed in real time whenever telemetry and tracking data were being received by the DSIF The amount of data processing required for *Mariner V* and *IV* varied as a function of spacecraft activity However, it was a *Mariner V* requirement that full data processing be made available within 30 min after a request was initiated by the space flight operations director (SFOD)

b Engineering and science telemetry data It was required that the deep space station record raw data on magnetic tape and process the data in the CTS and TCP for formatting and transmitting to the SFOF in real time Stations were also required to display spacecraft AGC and SPE, and to obtain recordings of pre- and post-demodulator and TCP digital data Ground receiver AGC had to be transmitted in real time to provide data for telecommunications analysis and for spacecraft inertial control A portion of the science telemetry stream DFR data was transmitted to Stanford University in real time

It was required that engineering and science telemetry data received at the SFOF be processed in real time in the 7044 computer. Required displays included high-speed teletype printout, high speed computer printout, 60-word/min teletype printout, and plots

Real-time telemetry data were acquired from *Mariner IV* during engineering tests and during the *Mariner V*- earth -*Mariner IV* radial solar period Analog recordings were required when the bit error rate of either spacecraft was greater than nominal

c Tracking data It was required that the DSS record tracking data on punched paper tape and format it for real-time transmission to the SFOF Tracking data received at the SFOF were processed in the 7044/7094 computers in real time during midcourse (M/C) and encounter (E) During noncritical phases, it was required that tracking data be recorded on magnetic tape and be immediately available as needed All tracking data received by the SFOF in real time had to be displayed on teletype printers

d Computer time requirements Computer time and configuration requirements needed by the project to support the data processing functions throughout the various phases of the mission are presented in Table 12

Table 12 Computer requirements for deep space support

Phase	Configuration			
	DFR 7044/7094	7044/7094	7044/7094 + single 7094	Single 7044 off-line (NRT) 7094
$L-6$ h to $L+36$ h	X	—	—	—
$L+36$ h to $L+48$ h	—	X	—	—
Cruise	—	—	—	X
$M-12$ h to $M+12$ h	—	—	X	—
$E-1$ day to $E-1$ day	X	—	—	—
$E+1$ day to end of M data playback	—	—	—	X

5 Other requirements

a Communications Basic communications requirements are shown in Fig 19 Section III provides a more comprehensive review of the communications system, which was established to support these requirements

b Commands Commands could be sent to the spacecraft during any phase of the mission It had to be possible to send any of the commands in either the automatic or manual mode at any preplanned time It had to be possible to send two consecutive commands with the time between them controllable to an accuracy of ±1 0 s It had to be possible to send any single command that had been preset in the read–write–verify (RWV) at any absolute time within ±0 5 s

III. Tracking and Data System Configuration

A General

This section describes the configurations and planned performance of the TDS that were established to meet the requirements outlined in Section II As before, the presentation is separated into the near-earth and deep space phases of the mission

B TDS Configuration for Near-Earth Phase

1. Supporting stations. For near-earth support, the TDS was composed of selected resources of the AFETR, MSFN, NASCOM, and DSN Within each agency, there were supporting stations, these are listed in Table 13

2. Data acquisition instrumentation To meet trajectory data and requirements, the TDS agencies selected the appropriate metric and telemetry data acquisition instrumentation from resources available at the sites listed in Table 13 Particular attention was given to class I intervals to ensure a high probability of providing the required coverage Table 14 describes these instruments, their

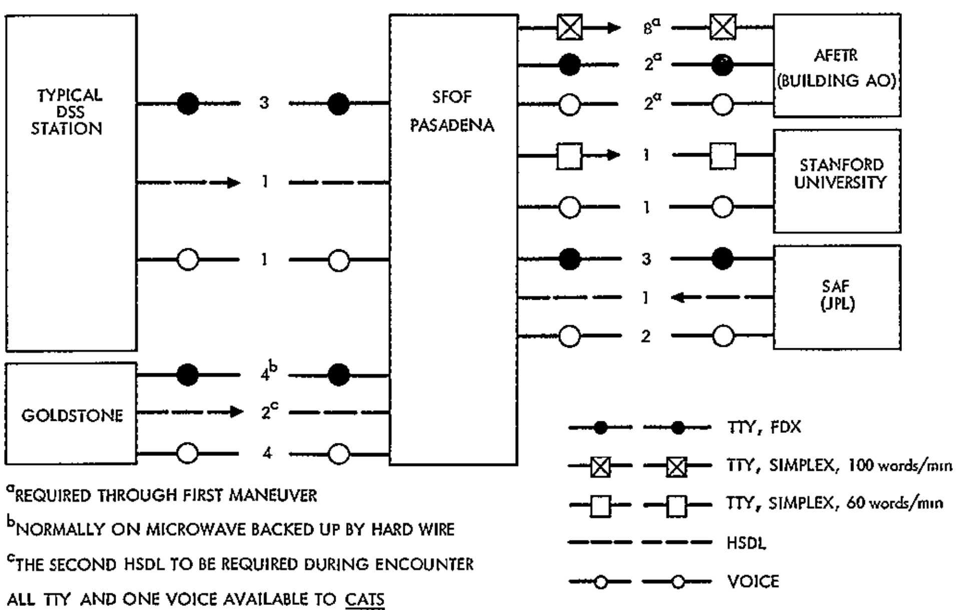


Fig 19 General communications requirements diagram, deep space phase

Table 13. TDS supporting facilities

Agency	Station and location
AFETR	Station 1, Cape Kennedy/Patrick AFB (CKAFS) Station 3, Grand Bahama Island (GBI) Station 7, Grand Turk Island (GTK) Station 91, Antigua Island (ANT) Station 12, Ascension Island (ASC) Station 13, Pretoria, South Africa (PRE) RIS *Twin Falls*, South Atlantic RIS *Coastal Crusader*, South Atlantic
MSFN	Bermuda Island station (BDA) MSFN/USB site, Ascension Island (ASC) Tananarive site, Malagasy (TAN) Carnarvon site, Australia (CRO) Goddard Space Flight Center (GSFC)
NASCOM	Worldwide facilities of NASCOM provided communications between supporting agencies
JPL/AFETR	Building AO, Cape Kennedy
DSN	SCS 71, Cape Kennedy DSS 72, Ascension Island DSS 51, Johannesburg SFOF, Pasadena

location, common identifying nomenclature, agency, and general use. A typical MSFN station is shown in Fig. 20 and a typical DSIF acquisition station is shown in Fig. 21. The DSN control room at Ascension Island is shown in Fig. 22.

3. *Configuration for metric data.* The AFETR is the primary agency responsible for meeting metric requirements during the launch and earth-orbital mission phases.

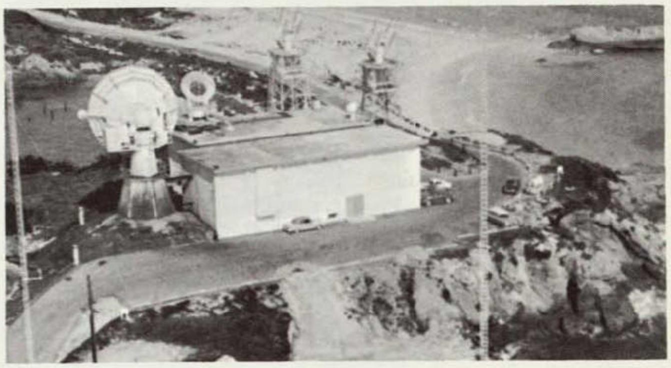


Fig. 20. MSFN BDA radars: FPQ-6 (large dish) and FPS-16 (small dish)

Table 14. Instrumentation summary chart, near-earth phase

Instrumentation	Location	ID	Agency	Use
4-ft diam, manual antenna, 2290–2300 MHz rcvr, 2110–2120 MHz transmitter	DSIF, Cape Kennedy	SCS 71	DSN	S/C DSN compatibility testing, S/C check-out, TLM reception in early *L* phase, and processing of AFETR TLM in *L* phase
TLM antenna, 85-ft parabolic, auto track, receives 130–2300 MHz, az/el mount	Tel 4, Cape Central TLM site Station 3	TAA-2A TAA-2A	AFETR AFETR	AFETR S/C compatibility, LV and S/C TLM coverage
TLM antenna, 30-ft parabolic, auto track, receives at 1000–2300 MHz, az/el mount	Cape central TLM site Station 3 Station 91 Station 12	TAA-3 TAA-3 TAA-3 TAA-3	AFETR AFETR AFETR AFETR	S/C S-band TLM coverage
TLM antenna, 60-ft parabolic, auto track, receives 130-1000 MHz, az/el mount	Station 1 Station 91 Station 12	TLM-18 TLM-18 TLM-18	AFETR AFETR AFETR	LV TLM coverage
TLM antenna, 60-ft parabolic reflector, auto track, receives 130–420 MHz	Station 13	AT-36	AFETR	LV TLM coverage
TLM antenna, log periodic, quad-conic array for VHF coverage with 3-ft disk on array for S-band reception, receives 130–2300 MHz	Station 13 (The log periodic now serves as BU to larger S-band antenna at Stations 1, 3, 12, and 91 and RISs)	Log periodic (broad band)	AFETR	Primarily S-band TLM coverage, range limited
TLM antenna, 12-ft, parabolic auto track, receives 2200–2300 MHz	RISs *Twin Falls* and *Coastal Crusader*	CTS	AFETR	S-band TLM coverage in broad ocean areas

Table 14 (contd)

Instrumentation	Location	ID	Agency	Use
TLM antenna, auto track, array of 16 dipoles on common ground plane, receives 225–260 MHz	RISs *Twin Falls* and *Coastal Crusader*	TAA-1	AFETR	VHF TLM coverage in broad ocean areas
Antenna, 30-ft az/el, operating 2290–2300 MHz	DSIF ASC	DSS 72	DSN	S/C TLM coverage
TLM antenna and quad helix	BDA and TAN		MSFN	LV (VHF) TLM coverage
TLM antenna, tel-track, 18-db gain, receives 225–260 MHz	CRO		MSFN	LV TLM coverage
TLM antenna, 30-ft parabolic dish, receives 2275–2300 MHz (USB)	CRO		MSFN	S/C TLM coverage
Tracking antenna, C-band monopulse radar, 29-ft cassegrain reflector, transmits and receives 5400–5900 MHz, peak power 2.5 MW	PAFB Merritt Island Station 3 Station 7 Station 91 AFETR, Station 12, ASC BDA CRO	FPQ6-(0.18) TPQ18-(19.18) TPQ18-(3.18) TPQ18-(7.18) FPQ6-(91.18) TPQ18-(12.18) FPQ-6 FPQ-6	AFETR AFETR AFETR AFETR AFETR AFETR MSFN MSFN	Radar tracking of LV C-band beacon to provide for acquisition information and orbital calculations
Tracking antenna, C-band monopulse radar, 12-ft parabolic reflector, transmits and receives 5450–5825 MHz, peak power 1 MW	CKAFS GBI ASC RIS *Twin Falls* BDA PRE	FPS-16 (1.16) FPS-16 (3.16) FPS-16 (12.16) FPS-16 FPS-16 FPS-16 (13.16)	AFETR AFETR AFETR AFETR MSFN AFETR	Radar tracking of LV C-band beacon to provide for acquisition information and orbital calculations

The addition of MSFN radar instrumentation to that of the AFETR provided the required coverage with a reasonable degree of redundancy. The radars listed in Table 14 tracked the *Agena* C-band beacon in meeting both launch vehicle and spacecraft metric requirements. In addition, AFETR optical tracking instruments provided the most accurate source of metric data from liftoff to 5000-ft altitude.

Figure 23 shows the configuration of the metric system and data flow which support the early launch phase. Optical instruments and C-band radars are shown.

Figure 24 shows the metric configuration for supporting the near-earth orbital phase. AFETR and MSFN C-band radars are shown, and the flow of data and its format are described.

4. Metric data transmission and processing. Radars 0.18, 1.16, 19.18, 3.18, 3.16, 7.18, 91.18, and Bermuda combined coverage provides continuous track from liftoff through parking orbit (P/O) injection. Received data are transmitted to the AFETR RTCS in real time via the AFETR communications and via GSFC (for Bermuda).

Radars 12.18, 12.16, RIS *Twin Falls,* and 13.16 combined coverage provides for meeting the requirement for 60 s of track between *Agena* second-burn cutoff and *Agena*/spacecraft separation. Data are transmitted to the RTCS in real/near-real time via radio communications. (The quality of the radio circuits to Ascension and South African areas is often poor because of RF propagation conditions.)

Radars 13.16 and Carnarvon provided adequate coverage for obtaining the required 60 s of track after *Agena* posigrade thrust termination. Carnarvon data were transmitted to the RTCS in real time via Goddard (GSFC).

The AFETR RTCS at Cape Kennedy was configured to process metric data received from the AFETR and MSFN sites. An important function is the computation and transmission of acquisition information to the various TDS sites supporting the near-earth phase. The flow of acquisition information, in the form of interrange vectors (IRV) and DSN predicts, is shown in Fig. 24.

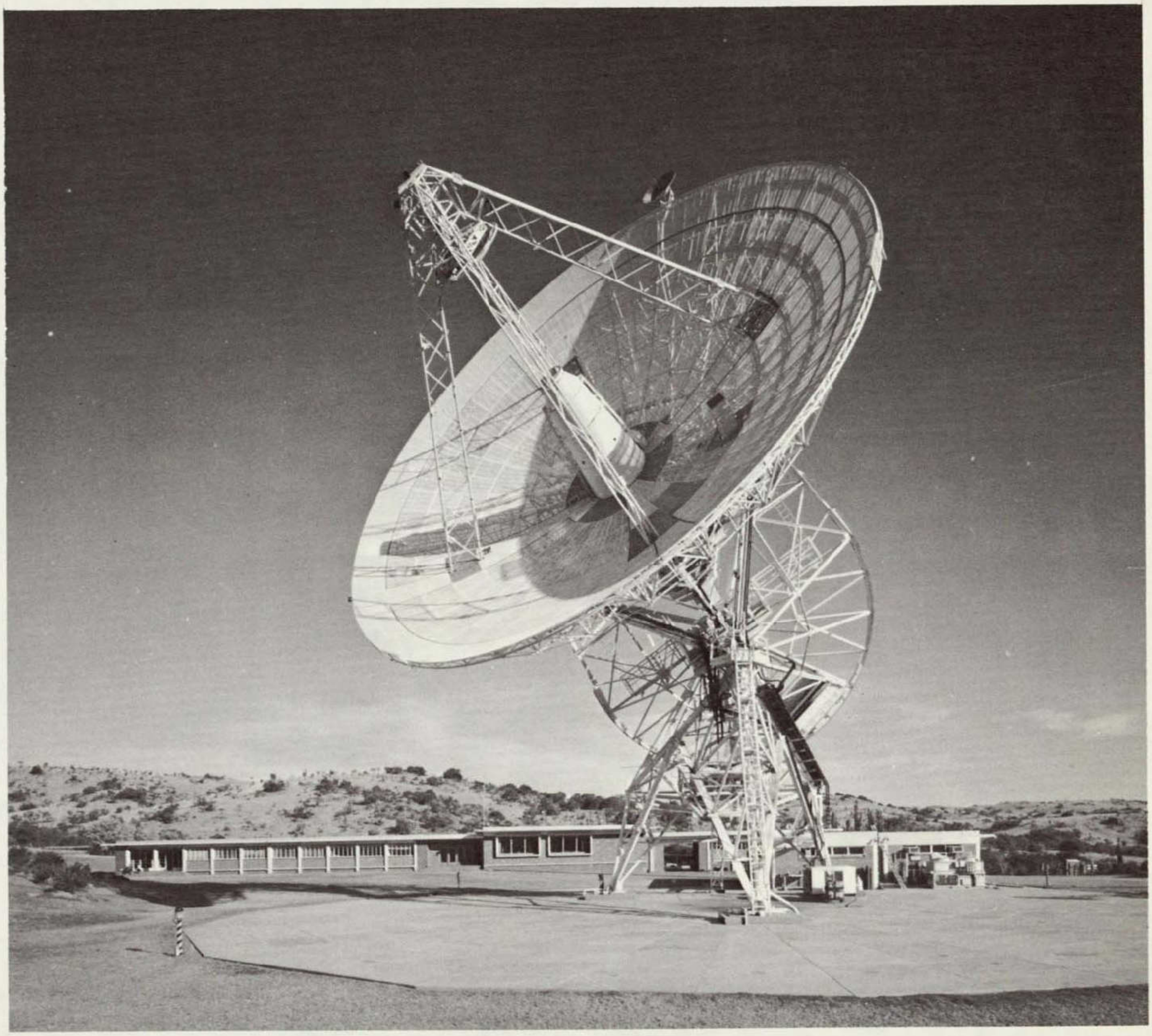


Fig. 21. The 85-ft antenna at DSS 51, Johannesburg

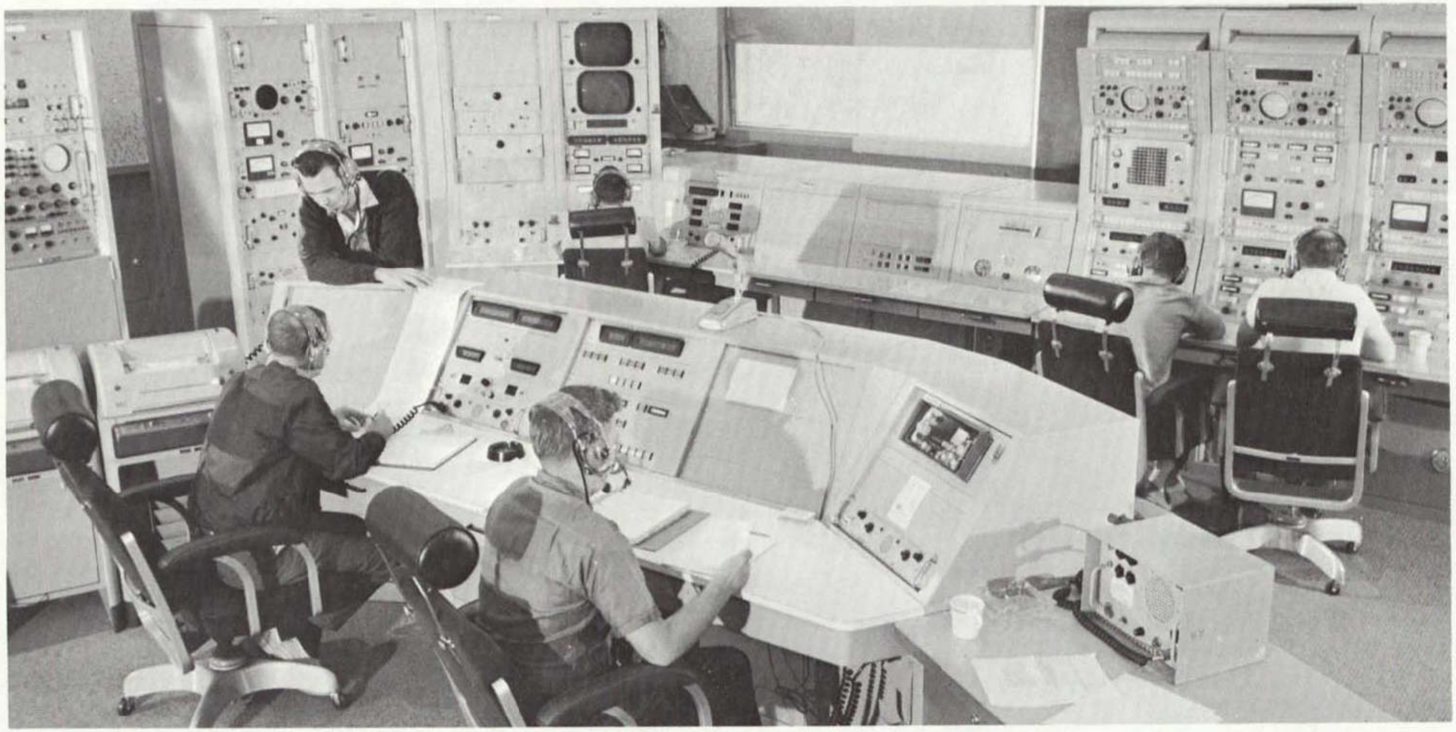


Fig. 22. Ascension Island DSN control room

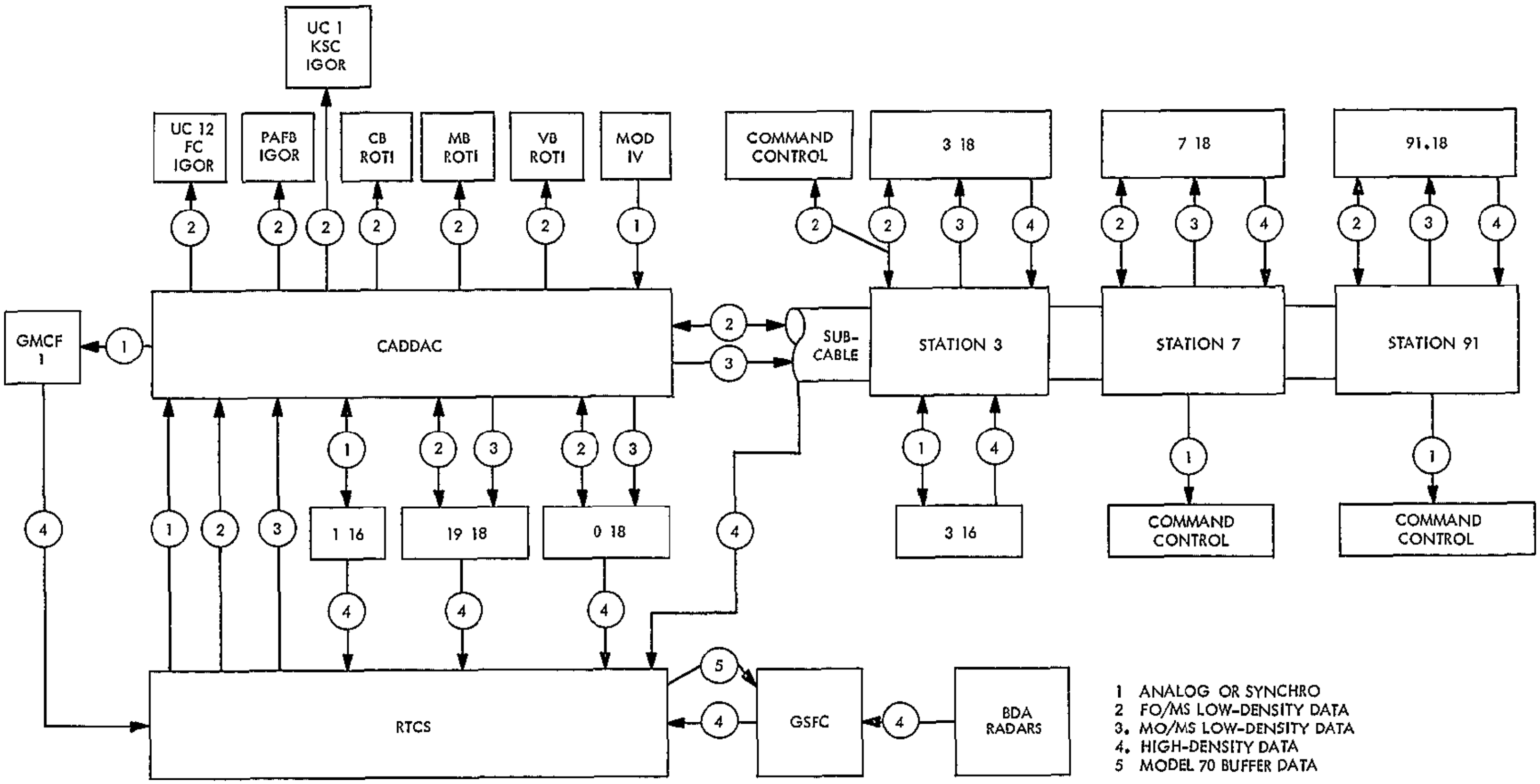
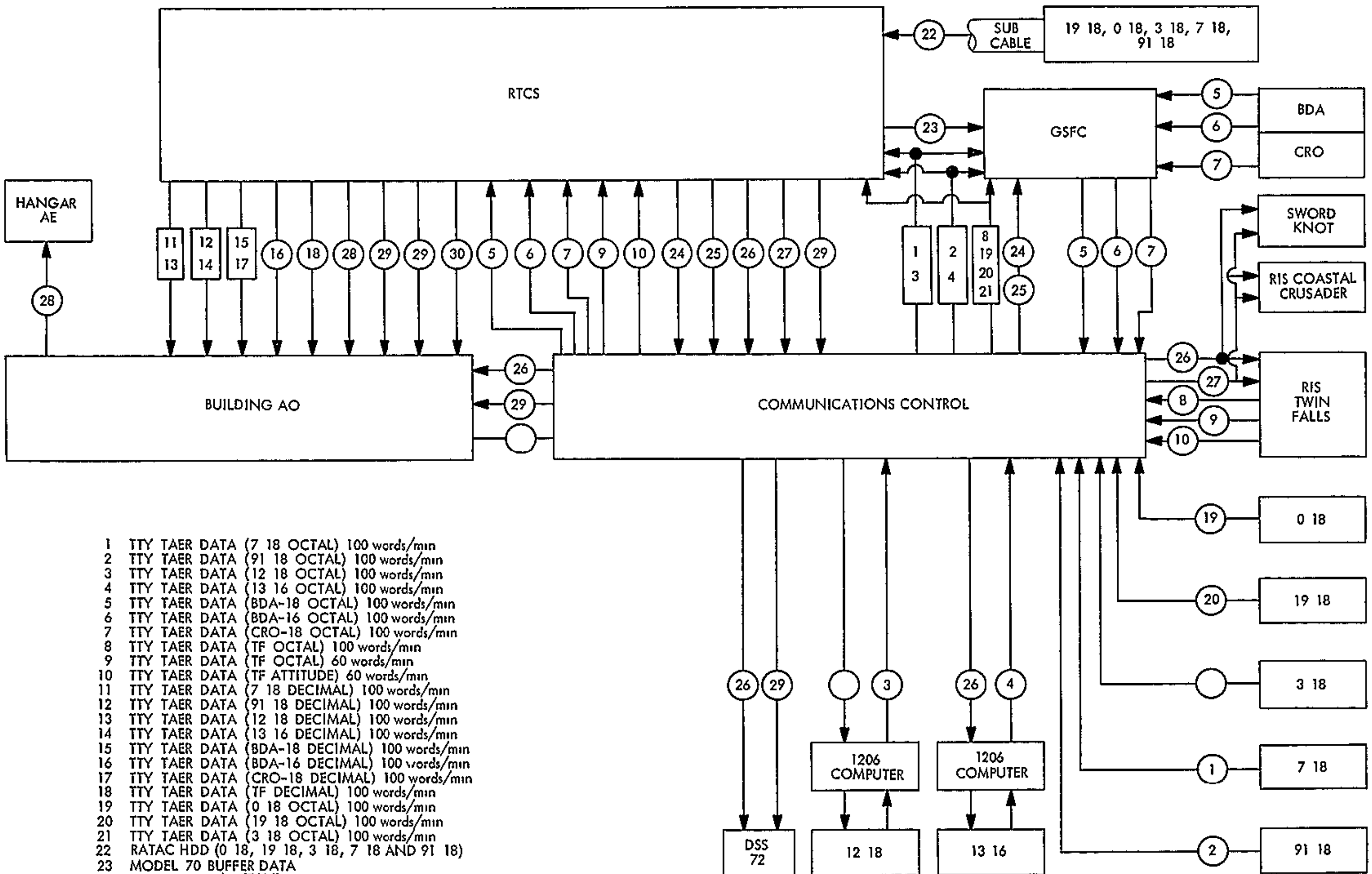


Fig 23 Metric data flow chart, launch phase



1 TTY TAER DATA (7 18 OCTAL) 100 words/min
2 TTY TAER DATA (91 18 OCTAL) 100 words/min
3 TTY TAER DATA (12 18 OCTAL) 100 words/min
4 TTY TAER DATA (13 16 OCTAL) 100 words/min
5 TTY TAER DATA (BDA-18 OCTAL) 100 words/min
6 TTY TAER DATA (BDA-16 OCTAL) 100 words/min
7 TTY TAER DATA (CRO-18 OCTAL) 100 words/min
8 TTY TAER DATA (TF OCTAL) 100 words/min
9 TTY TAER DATA (TF OCTAL) 60 words/min
10 TTY TAER DATA (TF ATTITUDE) 60 words/min
11 TTY TAER DATA (7 18 DECIMAL) 100 words/min
12 TTY TAER DATA (91 18 DECIMAL) 100 words/min
13 TTY TAER DATA (12 18 DECIMAL) 100 words/min
14 TTY TAER DATA (13 16 DECIMAL) 100 words/min
15 TTY TAER DATA (BDA-18 DECIMAL) 100 words/min
16 TTY TAER DATA (BDA-16 DECIMAL) 100 words/min
17 TTY TAER DATA (CRO-18 DECIMAL) 100 words/min
18 TTY TAER DATA (TF DECIMAL) 100 words/min
19 TTY TAER DATA (0 18 OCTAL) 100 words/min
20 TTY TAER DATA (19 18 OCTAL) 100 words/min
21 TTY TAER DATA (3 18 OCTAL) 100 words/min
22 RATAC HDD (0 18, 19 18, 3 18, 7 18 AND 91 18)
23 MODEL 70 BUFFER DATA
24 TTY MSFN L/A (TAN)
25 TTY MSFN L/A (CRO)
26 IRV 100 words/min
27 IRV 60 words/min
28 JPL ORBITAL ELEMENTS AND SOPM
29 DSN PREDICTS
30 PLANETARY MAPPING AND I-MATRIX

Fig. 24 Metric data flow chart, orbital phase

In addition, the RTCS was to use metric data for orbital computations and planetary mapping in meeting trajectory definition requirements Various computer runs are made, based on actual parking orbit conditions, nominal transfer orbit conditions, actual transfer orbit conditions, and actual postposigrade conditions

The RTCS was to retransmit octal teletype data from all radars to Goddard The RTCS converts AFETR radar teletype data to decimal format and transmits it to the JPL Operations Center in Building AO via 100-word/min teletype circuits The RTCS also receives high-density data from Bermuda and Carnarvon radars, converts it to decimal format, and transmits it to Building AO JPL personnel at Building AO select appropriate metric data and retransmit it to the SFOF via teletype, as needed, to meet requirements The octal format used for these transmissions is shown in Table 15, the decimal format in Table 16 A definition of the characters found in Table 15 is as follows

(1) Character 4, data type Beacon track, 7

(2) Characters 5 and 6, station IDs These characters are used to identify stations from which data are derived, for example

Station	*Character 5*	*Character 6*
0 18	2	1
19 18	7	1
3 18	4	1
7 18	5	1
91 18	9	1
12 18	7	5
12 16	7	5
13 16	7	6
RIS *Twin Falls* (T-11C)	7	7
BDA (67 16)	0	2
CRO (CRO)	0	8
BDA (67 18)	0	1

(3) Character 7, radar type
0—FPS—16
3—FPQ—6
4—TPQ—18
5—FPS—16 (modulated)

(4) Character 8-track code
Off-track—0
On-track—2

Table 15 The 38-character octal format

Character number in order transmitted	Character identification	Character number in order transmitted	Character identification
1	Line feed	20	Az 6, 5, and 4
2	Figure shift	21	Az 3, 2, and 1
3	Figure shift	22	El 21, 20, and 19
4	Data type	23	El 18, 17, and 16
5	Station ID	24	El 15, 14, and 13
6	Station ID	25	El 12, 11, and 10
7	Radar type	26	El 9, 8, and 7
8	Track code	27	El 6, 5, and 4
9	Time, h, (tenths)	28	El 3, 2, and 1
10	Time, h, (units)	29	R 27, 26, and 25
11	Time, min, (tenths)	30	R 24, 23, and 22
12	Time, min, (units)	31	R 21, 20, and 19
13	Time, s, (tenths)	32	R 18, 17, and 16
14	Time, s, (units)	33	R 15, 14, and 13
15	Az 21, 20, and 19	34	R 12, 11, and 10
16	Az 18, 17, and 16	35	R 9, 8, and 7
17	Az 15, 14, and 13	36	R 6, 5, and 4
18	Az 12, 11, and 10	37	R 3, 2, and 1
19	Az 9, 8, and 7	38	Carriage return

(5) Characters 9–14, time in decimal format

Data in following characters must be sampled on the whole second of above time word

(6) Characters 15–21, azimuth data in binary code converted to octal are as follows

(a) For FPS-16 and FPS-16 (modulated) radars, data bits 1–17 are used in characters 16–21 Bits 18, 19, 20, and 21 are *zeros*
Bit 1 (least significant digit) = 0 00274 deg
Bit 17 (most significant digit) = 180 deg

(b) For FPQ-6 and TPQ-18 radars, data bits 1–19 are used Bits 20 and 21 are *zeros*
Bit 1 (least significant digit) = 0 000686 deg
Bit 19 (most significant digit) = 180 deg

(7) Characters 22–28, elevation data in binary code

(a) For FPS-16 and FPS-16 (modulated) radars, data bits 1–17 are used in characters 23–28 Bits 18, 19, 20, and 21 are *zeros*
Bit 1 (least significant digit) = 0 00274 deg
Bit 17 (most significant digit) = 180 deg

(b) For FPQ-6 and TPQ-18 radars, data bits 1–19 are used Bits 20 and 21 are *zeros*
Bit 1 (least significant digit) = 0 000686 deg
Bit 19 (most significant digit) = 180 deg

Table 16 The 36-character decimal format

Character	Information content	Station ID		Data condition code
		ID	Radar	
1	Carriage return	73	7 18	0 off track
2	Line feed	74	91 18	1 on track S/C
3	Figure shift	75	12 16	
4 and 5	Station ID	76	13 16	2 on-track LV
6	Data condition code	77	Metric ship (corrected)	3 simulated
7	Space			
8–13	Time, (h, min, and s, GMT)	78	Metric ship (uncorrected)	7 last message
14	Space	79	12 18	
15–20[a]	Az, decimal deg			
21	Space			
22–27[a]	El, decimal deg[b]			
28	Space			
29–36[a]	Range, m			

[a]Decimal point assumed between 17–18, 24–25, and after 36

[b]Negative elevation is to be indicated by minus sign immediately preceding the first digit

Format example

4 5	6	7	8 9	10 11	12 13	14	15 16 17 18 19 20	21	22 23 24 25 26 27	28	29 30 31 32 33 34 35 36
7 6	0		2 3	5 9	4 2		0 1 0 2 3 1 ( )		0 0 5 3 9 7 ( )		0 9 9 8 6 2 8 3 ( )
station	condition	space	h	min	sec	space	azimuth	space	elevation	space	range

(8) Characters 29–37 range data in binary code

Bits 1–27 are used Range is an absolute range For the FPS-16 radars, the range bit weight is bit 1 (least significant bit) = 1 0 yd

(c) For the FPQ-6, TPQ-18, and FPS-16 (modulated) radars, the range bit weight is
Bit 1 (least significant bit) = 1 9531250 yd

(9) In the above format, all numeral *ones* are transmitted as an exclamation point (!)

```
The liftoff message will be provided from the RTCS in
  the following format

        LIFTOFF DAY XX HMS XXXX XX X GMT AZL
        XXX XXX MV-67
        LIFTOFF DAY - CONSECUTIVELY NUMBERED
        DAYS OF THE YEAR BEGINNING 1 JAN
        HMS - FIRST MOTION IN HOURS, MINUTES, SECONDS
        AZL - FLIGHT AZIMUTH IN DEGREES
        MV-67-MISSION DESIGNATOR
```

Fig 25 Liftoff message format

The series of orbital computations required to satisfy acquisition and trajectory requirements is planned as follows

(1) At approximately $L + 4$ min, the RTCS will transmit a liftoff message to Building AO The liftoff message format is shown in Fig 25

(2) After all range safety computation requirements are met, the RTCS provides the following computed data as soon as is possible

(a) IRV for transmission to Building AO, DSS 72, AFETR stations 12 and 13, and RISs The IRV message format is shown in Fig 26 and described in Table 17

To address a message to one of the following range agencies, following the format in Table 17, the appropriate letter code is inserted in character 5

E APGC, Eglin AFB, Fla
M PMR, Pt Mugu, Calif
W WSMR, N M
A AFWTR, Vandenberg AFB, Calif
P AFETR, Patrick AFB, Fla
B AFSCF, Sunnyvale, Calif
G GSFC, Greenbelt, Md
H MSC, Houston, Tex
K Kwajalein test site
D All DOD ranges
C All DOD and NASA ranges
S The RISs

```
IRSTAAAAA
N00000 MM DD PPPP B
$XXXXXXXXX CC $YYYYYYYYYY CC $ZZZZZZZZZZ CC
$XXXXXXX CC $YYYYYYY CC $ZZZZZZZ CC HHMMSSS CC
IRED

KEY     IRST        -  Start of message code
        A           -  Range address
        N           -  Data type
        0           -  Operation Number
        M           -  Month of year, Zero, if prelaunch data
        D           -  Day of month, Zero, if prelaunch data
        P           -  Orbit number
        B           -  Body number
        $           -  Sign of data
        X Y Z X Y Z -  Coordinate and velocity data, geocentric
                       feet  feet/sec
        C           -  Check sum of preceding characters
        H           -  Hours, Greenwich or T-Time
        M           -  Minutes  Greenwich or T-Time
        S           -  Seconds  Greenwich or T-Time
        IRED        -  End of message code
```

Fig 26 Interrange vector (IRV) message format

Table 17 Interrange vector message format definition

Line	Character number	Character	Note	Description
				Carriage return (preceded line 1)
				Carriage return (preceded line 1)
				Line feed (preceded line 1)
				Line feed (preceded line 1)
				Letter shift (preceded line 1)
1	1	1		Always same
	2	R		Always same
	3	S		Always same
	4	T		Always same
	5	A	1	Range address
	6	A	1	Range address
	7	A	1	Range address
	8	A	1	Range address
	9	A	1	Range address
	10			Carriage return
	11			Carriage return
	12			Line feed
	13			Line feed
	14			Figure shift
2	1	N		Indicated data type 1 = nominal, 2 = in flight, 3 = no data, 4 = simulated
	2	0	2	Indicated test number
	3	0	2	Indicated test number
	4	0	2	Indicated test number
	5	0	2	Indicated test number
	6	0	2	Indicated test number
	7			Single space
	8	M		Indicated month of year (tenths)
	9	M		Indicated month of year (units)
	10			Single space
	11	D		Day of month, (tenths)
	12	D		Day of month, (units)
	13			Single space
	14	P	3	Indicated orbit number (thousandths)
	15	P	3	Indicated orbit number (hundredths)
	16	P	3	Indicated orbit number (tenths)
	17	P	3	Indicated orbit number (units)
	18			Single space
	19	B	4	Indicated body number (units)
	20			Carriage return
	21			Carriage return
	22			Line feed
	23			Line feed
	24			Figure shift
3	1	S		Indicated sign of X data, negative and positive
	2	X	5	MSB of X parameter
	3	X		
	4	X		
	5	X		
	6	X		
	7	X		
	8	X		
	9	X		
3 (contd)	10	X		
	11	X		LSB of X parameter
	12			Single space
	13	C	6	Check sum for X parameter (tenths)
	14	C	6	Check sum for X parameter (units)
	15			Single space
	16	S		Indicated sign of Y data, negative and positive
	17	Y	5	MSB of Y parameter
	18	Y		
	19	Y		
	20	Y		
	21	Y		
	22	Y		
	23	Y		
	24	Y		
	25	Y		
	26	Y		LSB of Y parameter
	27			Single space
	28	C	6	Check sum for Y parameter (tenths)
	29	C	6	Check sum for Y parameter (units)
	30			Single space
	31	S		Indicated sign of Z data, negative and positive
	32	Z	5	MSB of Z parameter
	33	Z		
	34	Z		
	35	Z		
	36	Z		
	37	Z		
	39	Z		
	40	Z		
	41	Z		LSB of Z parameter
	42			Single space
	43	C	6	Check sum for Z parameter (tenths)
	44	C	6	Check sum for Z parameter (units)
	45			Carriage return
	46			Carriage return
	47			Line feed
	48			Line feed
	49			Figure shift
4	1	S		Indicated sign of X data, negative and positive
	2	X	7	MSB of X parameter (velocity)
	3	X		
	4	X		
	5	X		
	6	X		
	7	X		(tenths)
	8	X		LSB of X parameter (hundredths)
	9			Single space
	10	C	6	Check sum for X parameter (tenths)
	11	C	6	Check sum for X parameter (units)
	12			Single space
	13	S		Indicated sign of Y data, negative and positive

Table 17 (contd)

Line	Character Number	Character Note	Description
4 (contd)	14	Y 7	MSB of $\dot{Y}$ parameter (velocity)
	15	Y	
	16	Y	
	17	$\dot{Y}$	
	18	Y	
	19	$\dot{Y}$	(tenths)
	20	Y	LSB of $\dot{Y}$ parameter (hundredths)
	21		Single space
	22	C 6	Check sum for $\dot{Y}$ parameter (tenths)
	23	C 6	Check sum for Y parameter (units)
	24		Single space
	25	S	Indicated sign Z data, negative and positive
	26	$\dot{Z}$ 7	MSB of $\dot{Z}$ parameter (velocity)
	27	Z	
	28	Z	
	29	Z	
	30	Z	
	31	$\dot{Z}$	(tenths)
	32	$\dot{Z}$	LSB of Z parameter (hundredths)
	33		Single space
	34	C	Check sum for Z parameter (tenths)
	35	C	Check sum for Z parameter (units)

Line	Character Number	Character Note	Description
	36		Single space
	37	H 8	Tenths of h
	38	H	Units h
	39	M	Tenths of min
	40	M	Units min
	41	S	Tenths of s
	42	S	Units s
	43	S	Tenths of s
	44		Single space
	45	C 6	Check sum for time word (tenths)
	46	C 6	Check sum for time word (units)
	47		Carriage return
	48		Carriage return
	49		Line feed
	50		Line feed
	51		Letter shift
5	1	1	Always same
	2	R	Always same
	3	E	Always same
	4	D	Always same
			Carriage return
			Carriage return
			Line feed

For multiple address, appropriate code letter is inserted in characters 5–9 The sequence of letters is not important

Examples (~ indicated teletype spaces)

W~~~~, to WSMR
PWK , to AFETR, WSMR, and KTS

GDS~~, to GSFC, all DOD ranges, all RISs

CS~~~, to all DOD and NASA range agencies, and to all RISs

PAWEM, to AFETR, WTR, WSMR, APGC, and PMR

A four-digit operation number is placed in characters 3–6, three-digit operation number in characters 4–6 (operation number is always placed to the right)

An orbit is defined as a complete cycle around the earth, starting and ending with the same point of longitude, the first definition begins at launch

These characters are always *zero* for programs which consist of a single orbiting body, *Titan III* program was *zero* where *Gemini* was *one* or *two* (*one* indicated *Gemini* spacecraft and *two* indicated *Agena* craft)

Indicated earth-fixed position in feet with the decimal implied after characters 11, 26, and 41 The coordinate system is noninertial, right-hand cartesian with the positive X axis extending from the geocenter through the prime meridian at the equator, the positive Z axis extending from the geocenter through the North Pole, and the positive Y axis extending from the geocenter through the 90°E meridian at the equator

Decimal addition of characters in parameters indicated, add *one* to check sum if sign of parameter is negative, i e , −1234567890-46 where 46 is the check sum

Indicated earth-fixed velocity in feet, noninertial The decimal is implied between characters 6 and 7, 18 and 19, 30, and 31

This is the time of the point indicated by the vector and is in Zulu time A decimal is implied between characters 42 and 43

Zeros will be inserted in all data characters not used or needed Spaces are blank a Parking orbit

ELEMENTS AND INJECTION CONDITIONS OF PARKING ORBIT XXX XX MV-67

(Body of message same as c below)

b Transfer orbit from actual parking orbit and nominal 2nd Agena burn

INJECTION COND OF TRANSFER ORBIT FROM ACT P O AND NOM 2ND BURN MV-67

(Body of message same as c below)

c Actual transfer orbit

ELEMENTS AND INJECTION COND OF ACTUAL TRANSFER ORBIT XXX XX MV-67

HMS XX XX XX X L PLUS TIME XXXXX ALT XXX XX

SMA XXXXX X ECC X XXXXXXX INC XXX XXXXX C3 XX XX

LAN XXX XXXXX APF XXX XXXXX TA XXX XXX

R XXXXX XX LAT XXX XXX LON XXX XXX VE XXX XXX PTE XXX XXX AZE XXX XXX

d Post-retro transfer orbit

ELEMENTS AND INJECTION COND OF POSTRETRO ORBIT XXX XX MV-67

(Body of message same as c above)

Definitions of Message Header

XXX	XXX XX	XX	MV	67
Data source Station ID 073 - 7 18 074 - 91 18 075 - 12 16 076 - 13 16 077 - Metric ship (Corrected) 078 - Metric ship (Uncorrected) 079 - 12 18		Consecutively numbered computed message (01, 02, etc - 09) (A comparable number is found in header of DSIF acquisition message)	Mariner Venus	Year

Definitions of Message Body

HMS - Epoch Greenwich (hours, minutes and seconds), time for which osculating conic is calculated

L PLUS TIME - Epoch in seconds after liftoff
LAT - Altitude in kilometers
SMA - Semimajor axis of conic section in kilometers
ECC - Eccentricity
INC - Inclination Degrees 000-360
C3 - Twice the total energy per unit mass or vis viva integral, km^2/sec^2
LAN - Longitude of Ascending Node (Right Ascension), degrees 000-360
APF - Argument of perigee, degrees
TA - True anomaly at epoch, degrees
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

Fig 27 JPL elements and injection conditions

(b) JPL elements for transmission to Building AO/SFOF and injection conditions format are shown in Fig 27

(c) The SOPM format, for transmission to Building AO/SFOF, is shown in Fig 28 and explained in Table 18

(d) Format for the DSN predicts transmission to Building AO/SFOF is presented in Figs 29 and 30 and is explained in Table 19 Sample inputs to AFETR for DSN predicts are shown in Fig 31

(e) The format for look angles to the appropriate station is shown in Fig 32

(f) AFETR vector and I matrix format is shown in Fig 33

(3) The RTCS uses the vector from the previously discussed computations, combined with nominal *Agena* second-burn parameters, to generate theoretical preposigrade transfer orbit data The items generated are normally the same as (a) through (e)

(4) The RTCS uses the best available data immediately following *Agena* second-burn cutoff to compute actual preposigrade transfer orbit data Items computed are the same as (a) through (e), with the addition of mapping to planetary encounter

```
TEST NUMBER             XXXX
DATA SOURCE             XXXX
DATA SPAN               XXXX       PTS
FIRST POINT            XXXXX       SEC
LAST POINT             XXXXX       SEC
EPOCH XX/XX/XX          XXXX       XX X
X                  SXXXXXXXX       FT
Y                  SXXXXXXXX       FT
Z                  SXXXXXXXX       FT
XDOT                  SXXXXX       FT/SEC
YDOT                  SXXXXX       FT/SEC
ZDOT                  SXXXXX       FT/SEC
SEMAJAX              XXXXXXX       NM
ECC                  X XXXXX
INCL                 XXX XXX       DEG
OMEGA                XXX XXX       DEG
CAPOMEGA             XXX XXX       DEG
PERIOD               XXXXX X       MIN
APOGEE               XXXXXXX       NM
PERIGEE              XXXXXXX       NM
TRUEANOM            SXXX XXX       DEG
MEANANOM            SXXX XXX       DEG
LAN                 SXXX XXX       DEG
TSUBA                 XXXXXX       HMS
TSUBP                 XXXXXX       HMS
TSUBO                 XXXXXX       HMS
HTSUBA                XXXXXX       NM
HTSUBP                XXXXXX       NM
PHISUBA              SXX XXX       DEG
LAMSUBA             SXXX XXX       DEG
PHISUBP              SXX XXX       DEG
LAMSUBP             SXXX XXX       DEG
VELSUBI                XXXXX       FT/SEC
AZSUBI               XXX XXX       DEG
GAMSUBI               XX XXX       DEG
HTSUBI                 XXXXX       NM
PHISUBI              SXX XXX       DEG
LAMSUBI             SXXX XXX       DEG
INERVEL                XXXXX       FT/SEC
RADIUS               XXXXXXX       NM

S Denotes sign (blank or -)
```

Fig 28 Standard orbital parameter message (SOPM) format

Table 18 Standard orbital parameter message format definition[a]

Teletype line	Name	Description
1	AFETR TEST XXXXX	AFETR test No up to five digits
Data source		Name of site whose data was used to compute SOPM
Data span		Number of points used to compute SOPM
First point		Time of first data point used to compute the SOPM
Last point		Time of last data point used to compute SOPM
2	EPOCH	Time of the parameters given as mo/day/yr, h, min, s, and tenths of s
3 4 5 6 7 8	X Y Z X Y Z	Position and velocity components in ft and ft/s in Vernal equinox system where X and Y were in equatorial plane with X through point of Aries, Y 90 deg counterclockwise and Z through North Pole
9	SEMAJAXS	Semimajor axis one half longest diameter of elliptical orbit given in nmi

[a]Above description defines parameters for orbits elliptical in shape

For hyperbolic orbits
Line 9, negative
Line 10, greater than one
Lines 14, 15, 20–22, zeros

For parabolic orbits
Line 9, zeros
Line 10, equal to one
Lines 14 15, 20–22, zeros

Table 18 (contd)

Teletype line	Name	Description
10	ECC	Eccentricity of orbit defined as ratio of radius vector through point on ellipse to distance from point to directrix Parameter is nondimensional
11	INCL	Inclination angle angle is deg between orbit plane and equatorial plane
12	OMEGA	Argument of perigee–angular distance in deg measured in orbit plane from line of nodes to line of apsides
13	CAPOMEGA	Right ascension of ascending node angle in deg from Vernal equinox measured counterclockwise to line of ascending nodes in equatorial plane
14	PERIOD	Time in min, required to complete one revolution
15	APOGEE	Point on geocentric elliptical orbit farthest from earth s center in nmi
16	PERIGEE	Point on geocentric elliptical orbit nearest earth s center in nmi
17	TRUEANOM	True anomaly angle, in deg, at focus between line of apsides and radius vector measured from perigee in direction of motion
18	MEANANOM	Mean anomaly angle through which object moved at uniform average angular speed measured from perigee
19	LAN	Longitude of ascending mode angular distance from Greenwich meridian to intersection of orbit plane where object crosses from south to north Positive westward, negative eastward
20	TSUBA	GMT of arrival at apogee given in h, min, and s
21	TSUBP	GMT of arrival at perigee given in h, min, and s
22	TSUBO	GMT of arrival at the ascending node given in h, min, and s
23	HTSUBA	Height of apogee, in nmi, above earth's surface
24	HTSUBP	Height of perigee, in nmi above earth's surface
25	PHISUBA	Geodetic latitude of point of apogee in deg (positive N)
26	LAMSUBA	Longitude of point of apogee in deg (positive W)
27	PHISUBP	Geodetic latitude of point of perigee in deg (positive N)
28	LAMSUBP	Longitude of point of perigee, in deg (positive W)
29	VELSUBI	Magnitude of relative velocity vector at injection in ft/s
30	AFSUBI	Az from true N of relative velocity vector in deg
31	GAMSUBI	Path angle of relative velocity vector in deg (measured with respect to plane normal to radius vector from earth's center
32	HTSUBI	Height above earth's surface, in nmi, of the vehicle at injection
33	PHISUBI	Geodetic latitude of subvehicle point at injection in deg (positive N)
34	LAMSUBI	Longitude of subvehicle point at injection in deg (positive W)
35	INERVEL	Inertial velocity of vector in ft/s
36	RADIUS	At epoch time the geocentric radius from center of earth to vehicle in nmi

```
ETR PREDICTS FROM TRANSFER ORBIT
ETR PREDICTS 002 FOR DSIF 42 S BAND                          AC 6
XPONDER FREQ 2295 673150      XMITTER REF FREQ 22 038550
DRIFT 07 300   STEP SIZE 100            SYNFRQ 22 038600
THREE WAY FROM DSIF 11,51 AND 41

PRESET XMITTER VCO FREQ TO 22 038480 AT 080500
PRED 002, DSIF 42, 10 MAR 65, DAY 069, RT = 00M 00 2S, AC 6

H M S   HA     DEC    D1      D2      XA     D3 11   D3 41
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX

CHANGE XMITTER VCO FREQ TO 22 038680 AT 134500
PRED 002, DSIF 42, 10 MAR 65, DAY 069, RT = 00M 00 2S, AC 6

H M S   HA     DEC    D1      D2      XA     D3 51   D3 41
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX

CHANGE XMITTER VCO FREQ TO 22 038880 AT 165500
PRED 002, DSIF 42, 10 MAR 65, DAY 069, RT = 00M 00 2S, AC 6

H M S   HA     DEC    D1      D2      XA     D3 51   D3 41
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXXXXX XXXXXXX

PRED 002, DSIF 42, 10 MAR 65, DAY 069, RT = 00M 00 2S, AC 6

END OF ETR PREDICTS FROM TRANSFER ORBIT
```

Fig 29 AFETR predicts for DSN, S-band format

```
ETR PREDICTS FROM TRANSFER ORBIT
ETR PREDICTS 003 FOR DSIF 51 S BAND RANGING                 LO 5
XPONDER FREQ 2297 584320     XMITTER REF FREQ 22 040120
DRIFT 00 000          STEP SIZE 050     SYNFRQ 22 043500
THREE WAY FROM DSIF 41,11 AND 42,61
START XMITTER VCO FREQ AT 22 040350

PRESET TRANSMITTER VCO FREQ TO 22 040350 AT 123500
PRED 003, DSIF 51, 12 APR 66, DAY 102, RT = 00M 00 3S  LO 5

H M S   HA     DEC    D1      D2      XA     RG   D3 41   D3 42
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX

CHANGE TRANSMITTER VCO FREQ TO 22 040450 AT 172500
PRED 003, DSIF 51, 12 APR 66, DAY 102, RT = 00M 00 3S, LO 5

H M S   HA     DEC    D1      D2      XA     RG   D3 11   D3 61
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX         XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX
XXXXXX  XXXXXX XXXXXX XXXXXXX XXXXXXX XXX XX XXXX XXXXXXX XXXXXXX

PRED 003  DSIF 51, 12 APR 66  DAY 102, RT = 00M 00 3S, LO 5

END OF ETR PREDICTS FROM TRANSFER ORBIT
```

Fig 30 AFETR predicts for DSN, S-band ranging format

```
MISSION___MV-67____TEST________DATE_________

XPONDER FREQ (real time input) nominal__2298306333_0_cps_____
XMITTER REF FREQ (real time input) nominal__22045645_0_cps____
DRIFT (real time input) nominal ____0_0_______________
SYNFRQ__0_0_cps__________
INFREQ__23632500_0_cps______
MISSION ID__MV-67_________
PREDICT NUMBER 001
```

STATION ID______	72	51	41	12
THREE-WAY FROM____	51	72	51	41
XMITTER VCO INPUT __	N/A	0	0	22045645
STEP SIZE ______	400	400	150	50
DELAY ________	0	0	0	0
START TIME______	RISE	RISE	RISE	RISE
FIRST SAMPLE RATE __	10 sec	10 sec	10 sec	60 sec
NUMBER OF POINTS___	60	60	30	60
SECOND SAMPLE RATE__	-	-	60 sec	-
NUMBER OF POINTS___	-	-	20	-
THIRD SAMPLE RATE __	-	-	300	-
NUMBER OF POINTS___	-	-	10	-
BAND__________	S	L/S	S	S
ANTENNA ________	AZ/EL	HA/DEC	HA/DEC	HA/DEC
HEIGHT_________	1573 2 ft	4676 4 ft	425 9 ft	
LATITUDE_______	7 95246SS	25 88957S	31 38314S	35 11863N
LONGITUDE ______	345 67362E	27 68559E	136 88614E	116 80554W

INITIALS________DATE________

Fig 31 Inputs for DSN predicts

```
Line 1 Look Angles to
Lines 2-99
     DDD/HH/MM/SS AAA AA  EEE EE  RRRRRRRR
```

Notes	1	Line 1 specifies the Destination for the look angles
	2	DDD = Day of year, Jan 1 = Day 1
	3	HH = GMT hr
	4	MM = GMT min
	5	SS = GMT sec
	6	AA = Azimuth
	7	EE = Elevation
	8	RR = Range
	9	Angular units in degrees
	10	Range units in K yards

Fig 32 Look angles teletype format

(5) The RTCS uses the best available data after the end of the *Agena* posigrade maneuver to compute postposigrade transfer orbit data Items computed are the same as in item 4

(6) In addition, the RTCS receives DSN tracking data via Building AO and processes it on a noninterference basis If computations are made from these data, the results are made available to the user The RTCS uses the Kaula spheroid for all quick-look orbital computations for JPL

```
Date MM/DD/YY
Test Number XXXX
T/YYYY/MM/DD/HH/MM/SS SSS/
X/ XXXXXXXXEXX Y/  XXXXXXXXEXX Z /XXXXXXXXEXX
X /XXXXXXXXEXX Y / XXXXXXXXEXX Z /XXXXXXXXEXX
```

```
The next 12 lines contain the matrix elements of the 6x6 I matrix
The elements are transmitted row by row
    (a11, a12  a13,      a16, a21, a22,      a26, etc ) with three
     elements per line

The coordinate system may be

    1   Geocentric, earth-fixed cartesian
    2   Geocentric  inertial cartesian
    3   Geocentric  earth-fixed spherical

Units are kilometers or feet
```

Fig 33 AFETR vector and I matrix format

Metric data received at the SFOF, via Building AO, are processed much the same as that at the AFETR RTCS, but only to the extent to verify nominal DSS predicts or to begin computation of new predicts for the DSS, based on current data The SFOF data processing system is more fully described later

5 ***Configuration for telemetry data*** Launch vehicle telemetry, like metric data, requires standard and well-exercised TDS configuration support However, the TDS encountered some difficulty in establishing a configuration that would meet the spacecraft telemetry coverage and transmission requirements

a Launch vehicle telemetry AFETR, MSFN, and KSC/ULO instrumentation, as listed in Table 14, were selected to provide the required coverage The antennas at Stations 1, 3, 91, and Bermuda provide for continuous reception of LV telemetry from launch through injection and into the parking orbit, as required The VHF antennas at Stations 12, 13, Tananarive, and on RISs provide coverage for most of the class I interval associated with *Agena* second burn Depending on the launch azimuth and day, AFETR telemetry aircraft may be used to cover small gaps along the more northerly launch azimuths The same resources are applied to the class I intervals associated with *Agena*/spacecraft separation and *Agena* posigrade maneuver

Plans for real-time transmission and display of launch vehicle telemetry are as follows Launch vehicle telemetry received directly by launch vehicle personnel at Building AE, Cape Kennedy, is displayed in the vehicle analysis area Similarly, data received by AFETR Tel 4

Table 19 AFETR predicts for DSN, S-band format definition

Teletype line	Name	Description
1	PREDICTS	Subject title
2	IDENTIFIER	3-digit predict number, 2-digit DSS station number, format identifier for that station, and 2-letter and 2-digit mission identifier
3	XPONDER FREQ XMITTER REF FREQ	Inputs for S/C one way frequency (XPONDER FREQ) and reference frequency for the XA equation (XMITTER REF FREQ) Both frequencies were in MHz and output to nearest Hz
4	DRIFT STEP SIZE SYNFREQ	Displays drift input in Hz out to thousandths of cycles, the STEP SIZE in Hz to nearest Hz Furthermore, in S band format this line displays SYNFREQ input in MHz down to nearest Hz
5	STATIONS	Shows other stations assumed to be transmitting for D3 prediction Input is made in pairs and required logic system which (1) Decide whether a second D3 column is needed, depending on number of pairs input If more than two are input, second column is needed If not, there should not be second D3 column in output (2) Selected first pair to be output in first D3 column and the other pair in second column If second number of a pair is 00, that means that only one station is desired in that particular D3 column Care is taken to choose stations for one column such that their view periods do not overlap
6	VCO	Sixth line of the header is optional It is there only if input is made to control first transmitter VCO frequency If no input is made, this line should not appear (On samples shown, this line has not been completed) Line 6 completes header
7	PRESET XMITTER VCO FREQ	Displays first transmitter VCO frequency chosen and start time Similar line is printed out before time that change in the transmitter VCO occurs, breaking columnar output and separated by blank line from previous line This line will read CHANGE instead of PRESENT

Table 19 (contd)

Teletype line	Name	Description
8	Identifier line	Identifier line contains following Predict number Station number Date (day = 2 digits, month = 3 letters, year = 2 digits) Day of year Roundtrip travel time of signal in min and s Mission identifier Identifier line is printed out every time transmitter VCO frequency line prints out and immediately following that line Furthermore, it prints every time GMT goes through midnight and also at end of pass or end of predicts With the exception of end of pass and whenever identifier line prints out, a column designator line prints This line is separated from identifier line by blank line, but is not separated from columnar output following it Line includes
	HMS	h, min, and s (GMT)
	HA or AZ	Hour angle or az (deg)
	DEC or EL	Declination or el (deg)
	D1	One way doppler detector (Hz)
	D2	2-way doppler detector (Hz)
	XA	Transmitter zero static phase frequency (Hz)
	RG	Ranging (ms)
	D3 XX	3-way doppler detector (Hz)
9	D3 XX	Last column header D3 XX indicates this column is calculated for DSS XX transmitting This header appears twice only if second D3 column is needed The first time the column designator appears, the station number is the first one of each pair In subsequent printings of this line, check will be made to see if D3 quantity is output at the previous time point If there is an output, same station number will be used If there is not output, there was switch to the second number of the pair Check was made for each D3 column Columnar output, itself, was formatted as follows
	RMS	6 digits, 2 for h, 2 for min, 2 for s
	HA or AZ	6 digits without decimal point, the angles are output down to thousandths of a deg
	DEC or EL	
	D1	All 7-digit columns
	D2	This is 7-digit number output down to tenths of cycles, but with leading digit (either 0 or 1) truncated, thus, 1,258,342 6 Hz would be output as 2583426
	D3	
	XA	A 7-digit column is Hz output down to the hundredths of Hz, but with the first 5 digits truncated, for instance, if the value is 22038783 52, only 783 52 is output
	RG	4 digit column, the computed range being in ms, last 3 digits will be truncated before outputting

antennas are displayed, as well as remoted to Hangar E and Building AE AFETR DSS 91 transmits launch vehicle data (link 244 3) to Cape Kennedy user areas in real time via the submarine cable, subject to bandwidth limitations of the subcable (40 kHz) Data on channels with greater bandwidths are transmitted in near-real time via slow-speed tape playback techniques Launch vehicle data received by downrange sites are processed on-site to display selected channels for mark event identification and reporting Selected intervals and channels of data (chamber pressure and velocity meter) will be returned from downrange sites in near-real time via HF communications Launch vehicle personnel at Cape Kennedy are responsible for identifying and reporting mark events 1–10 Marks 11–16 are read out by the appropriate downrange station

b Spacecraft telemetry data As stated, establishing a TDS configuration for spacecraft telemetry support proved to be more difficult There were two basic problems one of receiving system configuration and one of real-time/near-real-time transmission system configuration

Receiving system configuration Because of the characteristics of the composite telemetry signal, it appeared that the receiver loop bandwidth ($2\beta_{L_0}$) should not exceed 48 Hz However, doppler rates expected shortly after launch and during *Agena* second burn would require a 100-Hz $2\,\beta_{L_0}$ to track Furthermore, use of the recommended 10-kHz IF by AFETR would reduce the expected coverage by more than 50% It was imperative that the TDS solve this problem before adequate support could be provided

Special tests were scheduled and conducted between AFETR and SCS 71 to determine the capability of the 5000B1 telemetry receiver to handle certain characteristics of the *Mariner* Mission telemetry signal. The composite signal was radiated from an encoder simulator via a stub antenna to the 5000B1 receiver. The receiver was set up as follows:

(1) Loop bandwidth ($2\,\beta_{L_0}$) = 100 Hz

(2) Intermediate frequency (IF) = 2500 Hz

(3) Signal levels ranged from -142 to -16 dbm

The composite signal from the receiver was transmitted to the ground tracking system at Cape Kennedy, where demodulator lock-up characteristics and data integrator output were monitored. For all signal levels, the demodulator acquired sync nominally and the data output was good. Use of the 2500-Hz intermediate frequency (IF) in conjunction with the 100-Hz loop provided satisfactory performance. As a result of tests and discussions, it was decided that the AFETR would use the 100-Hz $2\,\beta_{L_0}$ and 2500-Hz IF in the telemetry system.

The S-band acquisition at Ascension and Johannesburg was originally thought to be a problem. Results from a study of initial acquisition at DSS 72 and DSS 51 indicated that acquisition could be accomplished. Two problems, angular rates and doppler shift and rates, required additional detailed analysis.

With the exception of passes within the cone of silence at DSS 72 (approximately 105 to 108-deg launch azimuths), both stations could handle all angular rates.

Both stations are capable of handling doppler shifts. Assuming an allowable phase error of 30 deg and a receiver $2\,\beta_{L_0}$ of 48 Hz (low bandwidth to avoid tracking-out the telemetry in DSS receivers), almost all doppler rates can be handled. To ensure success, it was decided to use one receiver at 150-Hz bandwidth to maintain lock for automatic tracking and use the second receiver at 48 Hz for telemetry.

Also, as insurance against failure of the TDS to acquire the most important class I interval (from spacecraft separation to separation + 5 min), it was decided to establish a minimum capability at the MSFN USB site at Ascension. Data from the MSFN site would then be available to DSS 72 for transmission to user areas in real time, in cases of loss of signal (LOS) by DSS 72. *Mariner* Venus 67 crystals for the MSFN receiver voltage-controlled oscillator (VCO) were supplied and the appropriate wideband cables assigned (see Fig. 34).

Data transmission configuration. *Mariner* telemetry demodulators were not provided for installation at AFETR sites, and this was a basic cause of the problems encountered in establishing a spacecraft data transmission capability from AFETR sites. Without a demodulation capability, the entire composite signal would have to be transmitted. In the Cape Kennedy area, wideband circuits were used. From Antigua, the 40-kHz sub-cable circuit was available, and from downrange sites and ships radio communications imposed a 3-kHz bandwidth limitation. Because demodulators were available in the GTS at SCS 71, DSS 72, and DSS 51, in addition to the other DSSs, these stations were of primary importance in a system design to meet spacecraft telemetry requirements in the near-earth phase.

Through special tests, it was determined that Tel 4 could transmit the 98-kHz subcarrier of the *Agena* link containing spacecraft telemetry data to SCS 71 via wideband circuit. Also, it was determined the combined output of the S-band link, by using a 40-kHz data insertion converter (DIC), could be transmitted to SCS 71 in real time. Similarly, it was determined that Station 91 (Antigua) could feed the output of the S-band receiver to a 40-Hz DIC and transmit the DIC output to SCS 71 in real time via a 40-kHz submarine cable circuit. As an alternative, Antigua found it feasible to discriminate the output of the 98-kHz channel of the *Agena* link and transmit this data to SCS 71 in real time, using the same 40-kHz DIC submarine cable capability (Fig. 34).

To obtain a real-time capability in the uprange area, 40-kHz DICs were purchased and installed at Tel 4 and Antigua. Since data arrived at SCS 71 on 98-kHz or 40-kHz carriers, discriminators had to be purchased and installed ahead of the GTS.

It was found that AFETR downrange sites and ships could not transmit spacecraft telemetry in real time because of the incompatibility between the composite signal and the high-frequency (HF) communications systems. Various near-real-time plans (receive–record–tape playback) were studied, and the resulting plan was followed. The S-band receiver output would pass through a 6.75-kHz DIC to a recorder running at 60 in./s. Playback would be made at 15 in./s (1.69 kHz ±40%) via single sideband (SSB) circuit to DSS 72 via the Station 12 (Ascension) communications circuits. A sufficient number

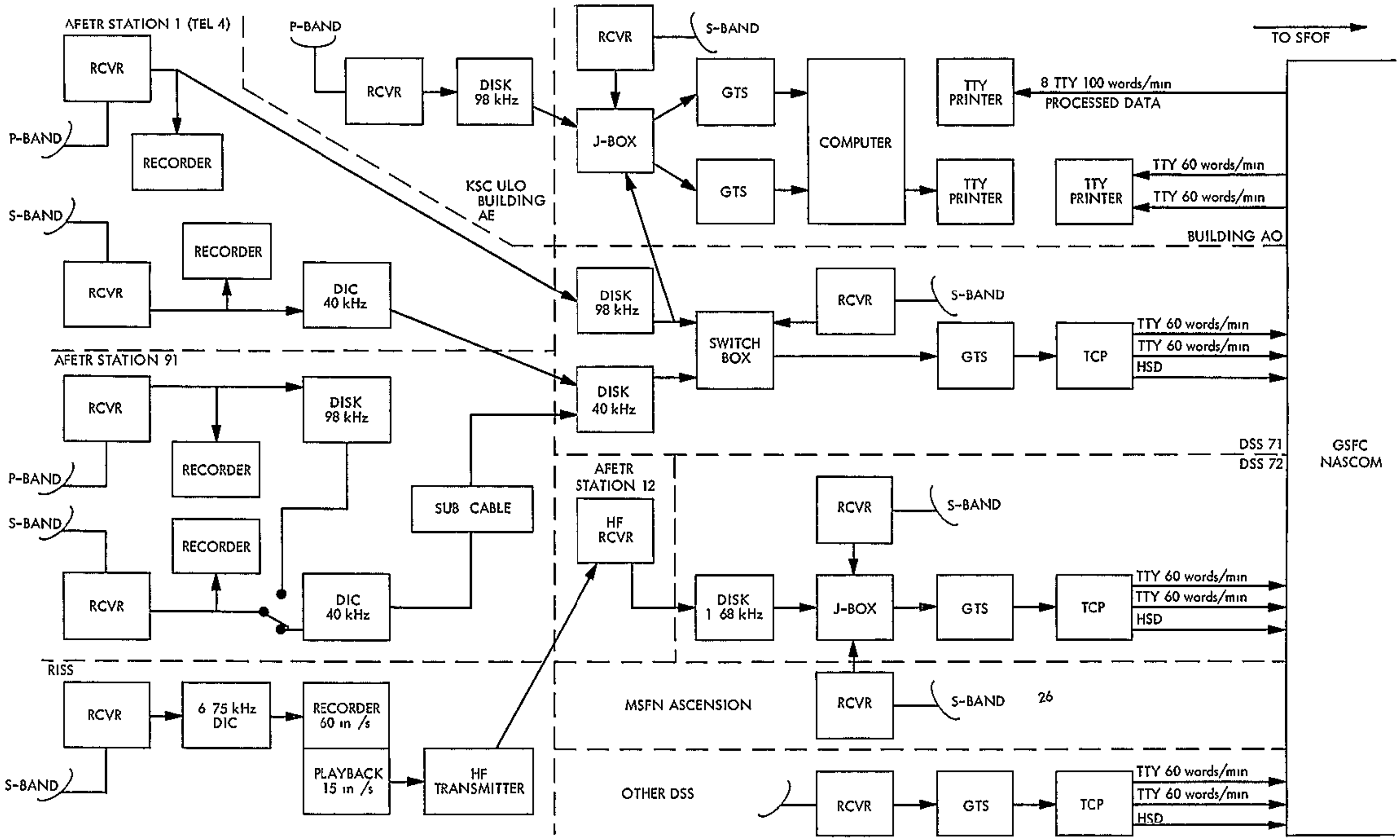


Fig 34 *Mariner* **Venus 67 TDS telemetry configuration, near-earth phase**

of 6.75-kHz DICs were purchased and installed at the appropriate AFETR downrange sites and ships. DSS 72 received the corresponding discriminator (Fig. 34).

Operational plan. The configurations which were established, as previously described, resulted in the following TDS plan for supporting near-earth phase spacecraft telemetry requirements (Fig. 34):

(1) In the launch phase, SCS 71 is the primary acquisition site for spacecraft data derived from the S-band link. Although shroud attenuation was expected to cause an early loss of signal, the use of a recently installed parametric amplifier was expected to extend SCS 71 coverage to the horizon. SCS 71 transmits these data to Building AO/SFOF in real time via GSFC/NASCOM teletype and high-speed data (HSD) circuits.

(2) In the launch phase, KSC/ULO, Building AE, is the primary acquisition site for spacecraft data derived from the *Agena* link. Data are transmitted from Building AE to Building AO in real time, input to the GTS, and displayed for data analysts' evaluations.

(3) AFETR's Tel 4 serves as a backup source of spacecraft data derived from the S-band link and as a second prime source of data derived from the *Agena* link. Tel 4 transmits both streams of data to SCS 71 in real time. After discrimination at SCS 71, both streams of data are available to the SCS 71 system (GTS and telemetry and command processor, TCP) in case of LOS by the S-band receiver at the station. The data stream derived from the *Agena* link is also available at Building AO as an input to the second GTS.

(4) AFETR Station 91/(Antigua) is the primary acquisition site during the interval from the Cape Kennedy's LOS through spacecraft insertion into the parking orbit. Both the *Agena* and S-band links are received. Either one or the other is transmitted to SCS 71 in real time via the submarine cable, S-band being preferred. After LOS, SCS 71 will switch to this source of spacecraft data. SCS 71 will continue to process and transmit the data to Building AO and the SFOF in real time.

(5) DSS 72 is the primary acquisition site for spacecraft telemetry data in the Ascension Island area. Received data are processed and transmitted in real time via HF or Communications Satellite (Comsat) circuits to Building AO and the SFOF. The MSFN Unified S-band site serves as a backup source during this interval in case of a signal loss at the Ascension receiver.

(6) The AFETR RISs are positioned in the Ascension/South African broad ocean area and are the primary acquisition sites for spacecraft telemetry in the event the particular flight azimuth does not provide for adequate coverage of requirements by DSS 72 and DSS 51. The RISs do not transmit data in real time. Using a one-fourth-speed-tape-playback technique, ships transmit data to Ascension in near-real time at 8⅓ bits/s. DSS 72 processes and retransmits the data to the SFOF only. To minimize the time required to play back and recover the class I interval data, RISs were instructed to set up one recorder and record only during the required interval.

(7) DSS 71 is the primary acquisition site for spacecraft coverage in the South African and Indian Ocean area. The DSS 51 view period extends to the occurrence of continuous DSIF view. Data are transmitted to Building AO and the SFOF in real time.

6. Near earth phase communications configuration. The NASCOM furnishes worldwide voice, data, and teletype facilities in support of NASA space flight projects and missions. The DSN Ground Communications Facility (GCF) is, in part, a peculiar configuration of the NASCOM. It is primarily this portion of the near-earth phase communications configuration that is discussed in the following paragraphs.

The *Mariner* Venus 67 Project was the first program to operationally use a GCF communications configuration containing the JPL communications processor (CP) as an integral part of the system. The CP constitutes a real-time computer system which is programmed to automatically switch teletype messages from the sending location to the desired receiving location. Switching is controlled by an element (preamble) within the message, itself. Figure 35 shows the NASCOM/JPL CP system which supported the *Mariner V* Mission.

However, AFETR RTCS teletype outputs to the SFOF are not compatible with the CP, because Cape Kennedy equipment is not programmed to automatically introduce the NASCOM message header required by the computerized system. To overcome this incompatibility, a torn-tape operation is conducted at the JPL Communications Center

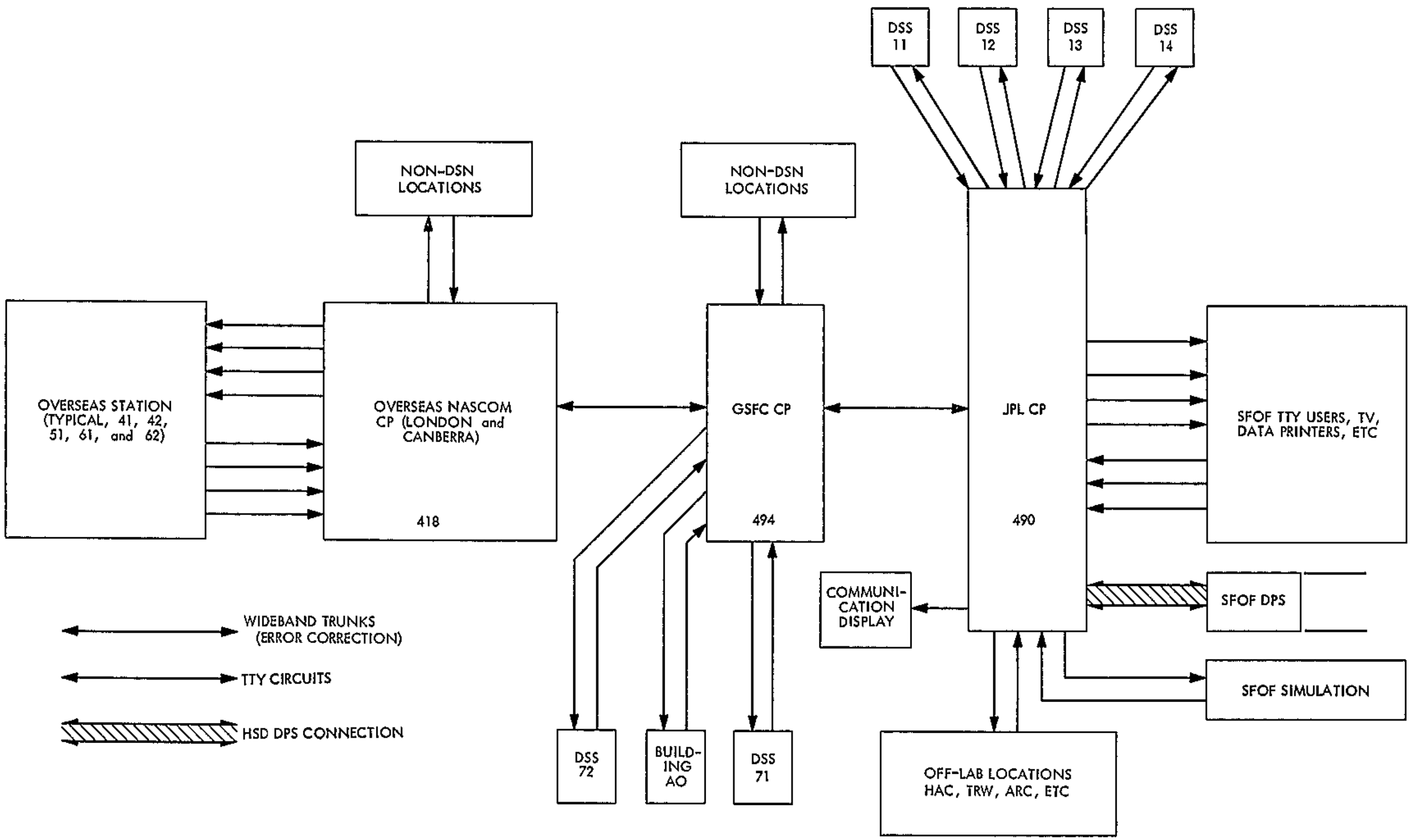


Fig 35 NASCOM/JPL CP system

in Building AO, wherein prepunched paper tapes containing the proper headers are inserted ahead of the RTCS teletype data prior to retransmission to the SFOF via GSFC

Figure 36 more specifically identifies the teletype circuitry configuration which supported both the near-earth and deep space phases of the mission Note the utilization of the Comsat as a functioning element in the near-earth phase

Figure 37 further illustrates the communications configuration for the near-earth phase by identifying specific teletype, voice, and HSD circuits which were established to meet specific data transmission and operational control requirements All circuits shown were scheduled from existing resources, except the eight 100-word/min teletype lines from the SFOF to Building AO These circuits required special ordering and were used to transmit processed telemetry data to analysts located at Building AO from launch through first maneuver

Figures 38–41 show the specific teletype configurations for Station 70 (JPL/AFETR, Building AO), Cape Kennedy, Ascension, and Johannesburg and show specific circuit designations and data types to be transmitted on each circuit

Figure 42 shows the launch area/SFOF voice/HSD configuration Figure 43 shows the DSN GCF HSD subsystem configuration for both the near-earth and deep space phases

7 TDS coverage estimates for near-earth phase Concurrent with configuration planning, the TDS analyzes trajectory data to obtain early estimates of station usage as a function of the telemetry and tracking coverage provided to meet requirements Such original estimates are usually based solely on trajectory approximations and the station 2-deg geometric horizon, without regard to precise trajectory data, signal strengths, slant ranges, station horizon masks, doppler rates, aspect angles, etc These original estimates generally permit the TDS to select the required supporting sites, to see large gaps in coverage, and to suggest general positions of the RIS Examples of the information produced by this gross study are provided in Figs 44, 45, and 46[1]

Later, the TDS engages in precise trajectory analysis to produce accurate coverage commitments To perform this task properly, the TDS placed a requirement on the project launch vehicle agencies for final trajectory data (firing tables) to be available by launch −10 wks rather than $L - 6$ wks This requirement could not be met and the TDS was instructed to use the available, previously mentioned conic approximations for near-earth phase coverage commitments

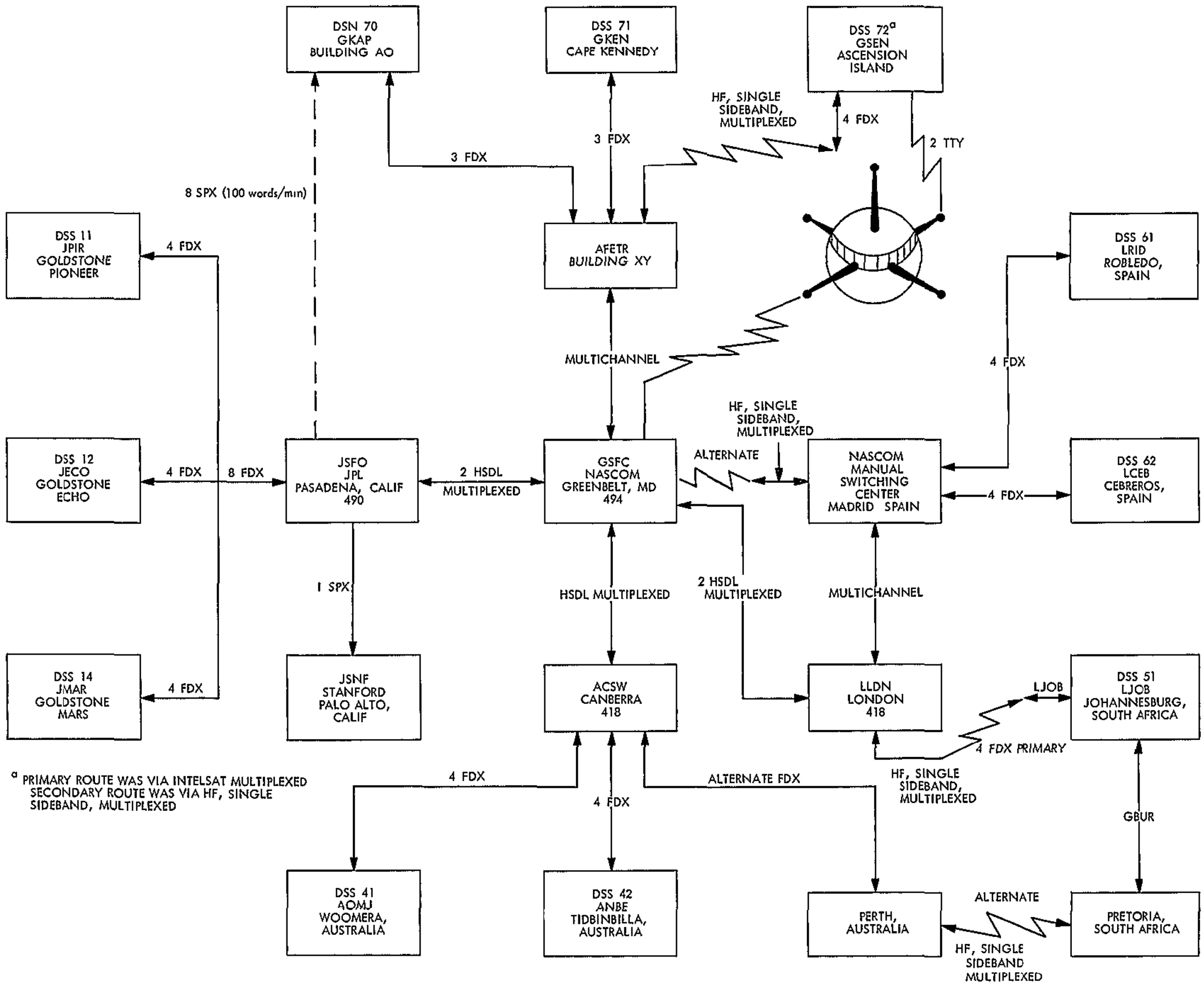
The TDS agencies used the approximations with the belief that variations between these data and the actual firing tables would be negligible However, at $L - 6$ wks it was found that there were significant variations in these two sets of trajectory data, the firing tables being more accurate The resulting problem had two parts Coverages based on the conics could not be committed but were close estimates, and station nominal acquisition data based on the conics were too inaccurate to ensure station acquisition of the spacecraft As a result, it was decided that the TDS would present coverage estimates, rather than commitments, and that look-angles would be rerun, based on the firing tables

The TDS requirement for earlier availability of the firing tables and the inability of the Launch Vehicle agency to provide them earlier is neither a new problem nor a solved one Near-earth phase coverage estimates for TDS, which were prepared by the AFETR, MSFN, and DSN, are presented in Tables 20, 21, and 22 and Figs 47–55 These estimates reflect the metric very-high frequency (VHF) telemetry, and S-band telemetry coverages expected from TDS resources during the near-earth phase[2]

8 TDS launch constraints A launch constraint may exist when one or more of the project requirements cannot be met because of an insufficient capability or the lack of resources within supporting agencies to provide coverage of class I TDS tracking or telemetry requirements Figure 56 shows the final restricting parameters, including those imposed by the TDS For the uprange (liftoff through injection into the parking orbit) portion of the flight, project requirements are well supported by a net of stations Because the trajectory of the uprange portion remains nearly the same on each launch day for a given flight azimuth, the TDS coverage capability exceeds requirements Figure 44 shows the uprange coverage geometry

[1]Where the figure was launch-date dependent, similar figures were produced for other possible launch dates Only the figure pertaining to the actual launch date is presented here

[2]Where the estimate is dependent on the launch date, similar figures were produced for other possible launch dates Only the figure pertaining to the actual launch date is presented here



[a] PRIMARY ROUTE WAS VIA INTELSAT MULTIPLEXED
SECONDARY ROUTE WAS VIA HF, SINGLE
SIDEBAND, MULTIPLEXED

Fig 36 DSN/GCF teletype circuitry

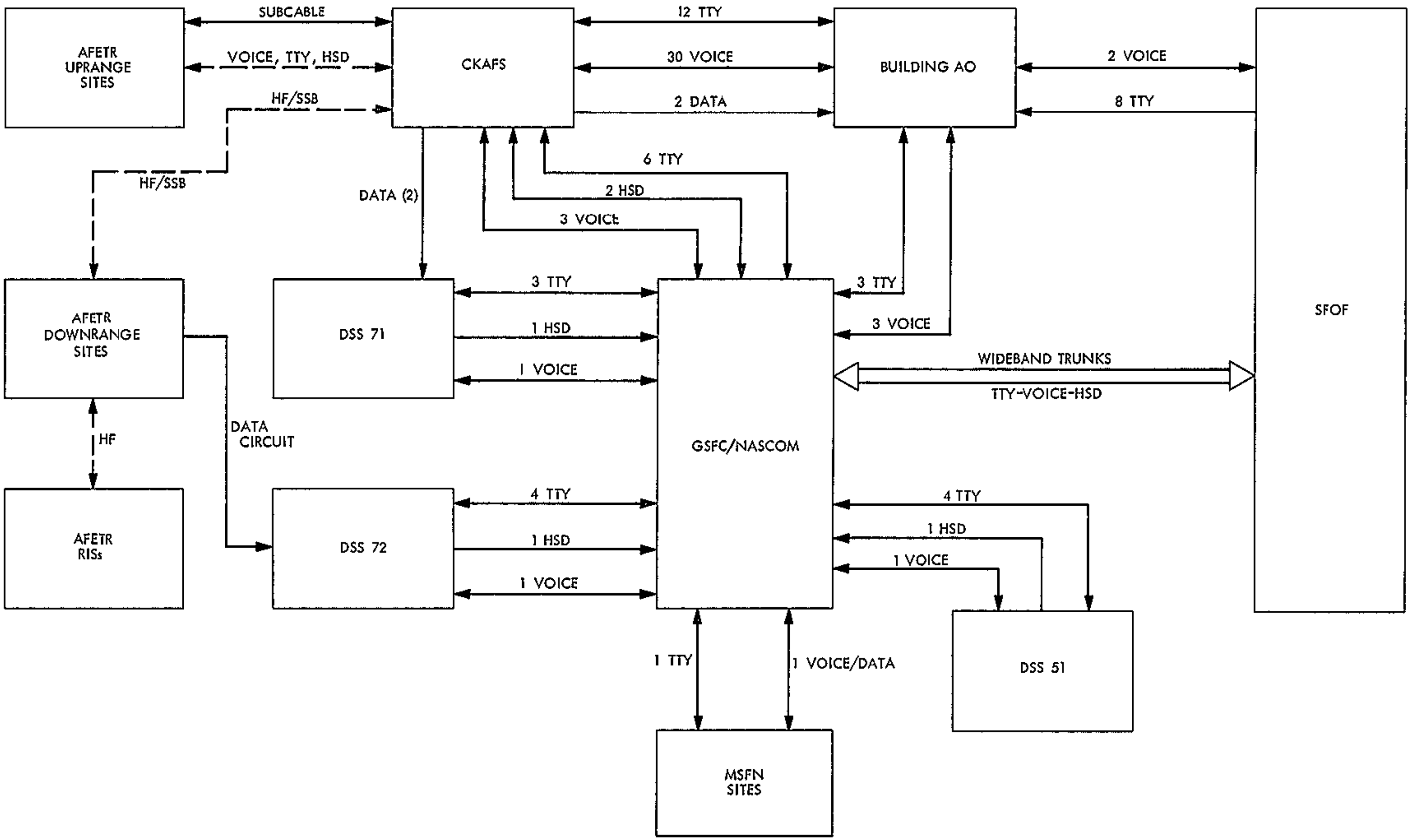


Fig. 37 *Mariner* Venus 67 ground communications, near-earth phase

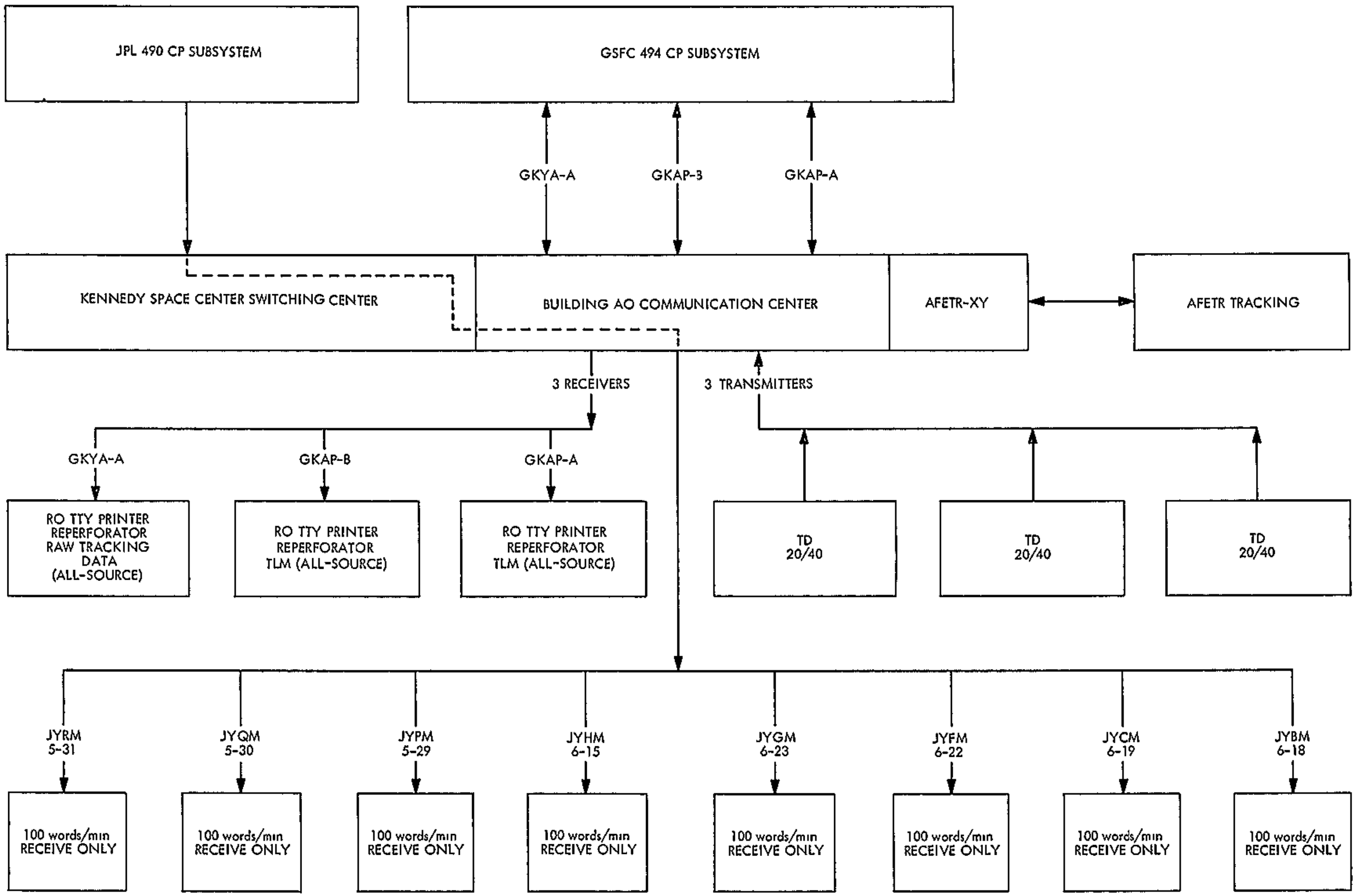
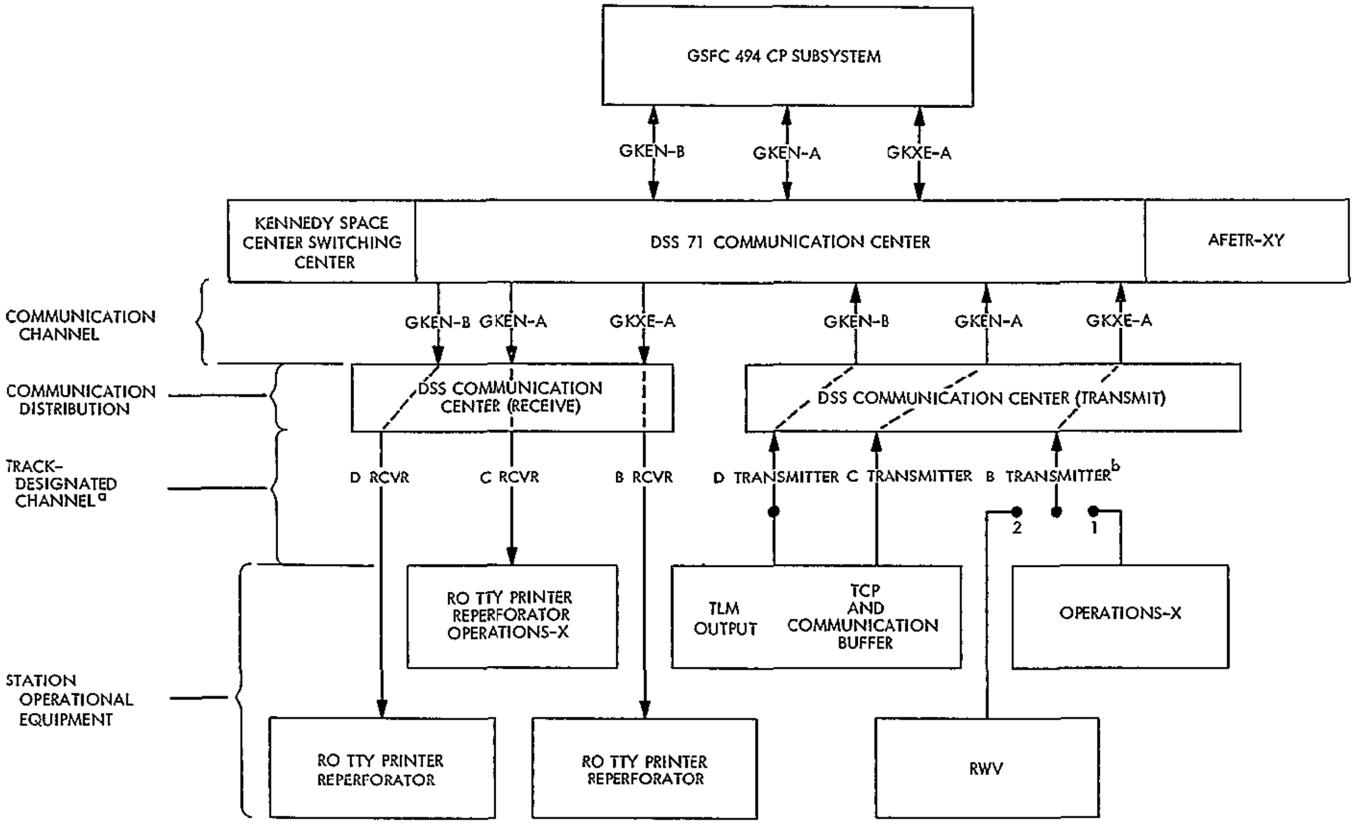


Fig 38 Station teletype configuration, DSN 70, AFETR Building AO, Cape Kennedy



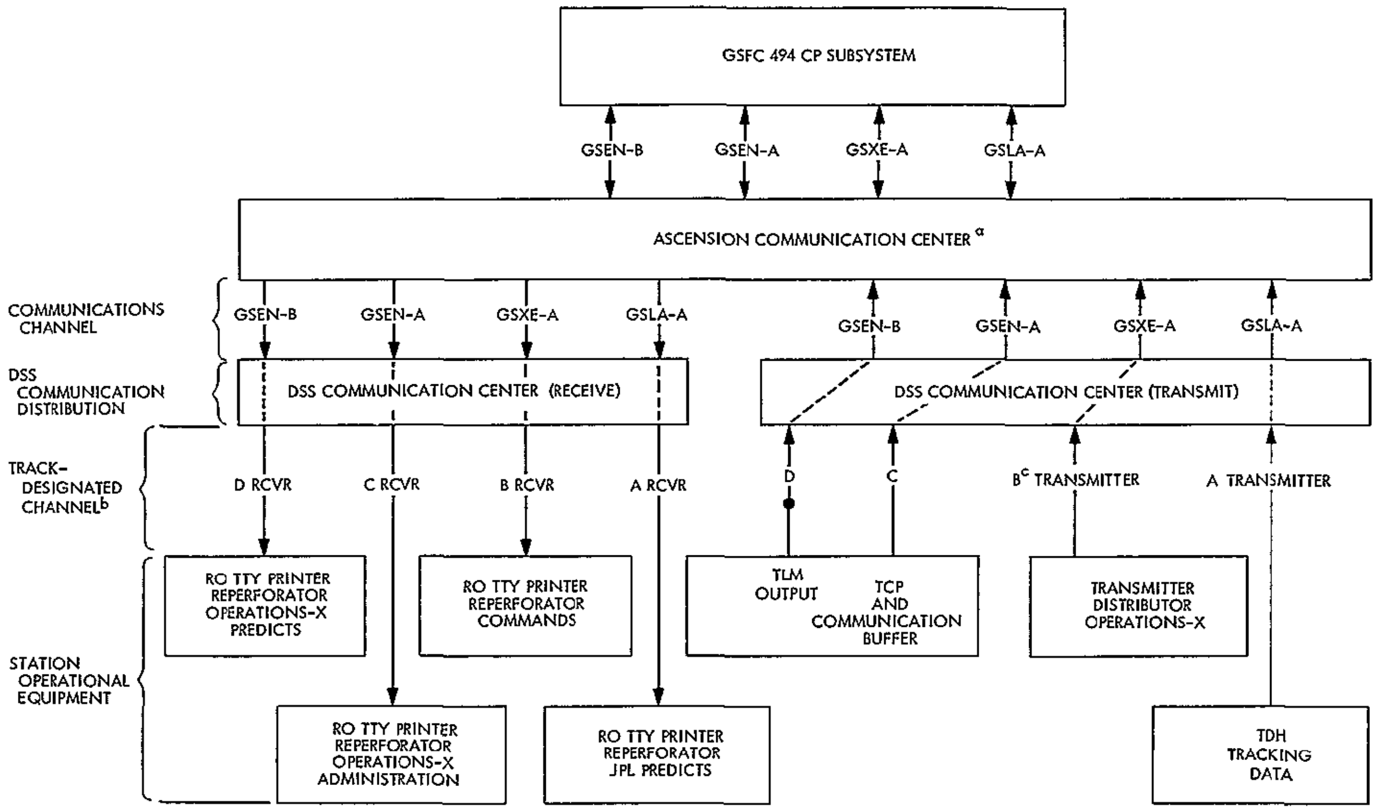
[a] STATION DATA ASSIGNMENTS

[b] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

[c] REFER TO PRELIMINARY REVISION OF NASCOP APPENDIX I FOR UNIVAC 490 CP, APRIL 21, 1967, TABLE III

TRACK-DESIGNATED CHANNEL	DATA TYPE[c]
B	20 and 70
C	50, 60, 51, and 61
D	52, 53, and 62

Fig 39 Station teletype configuration, DSS 71, Cape Kennedy



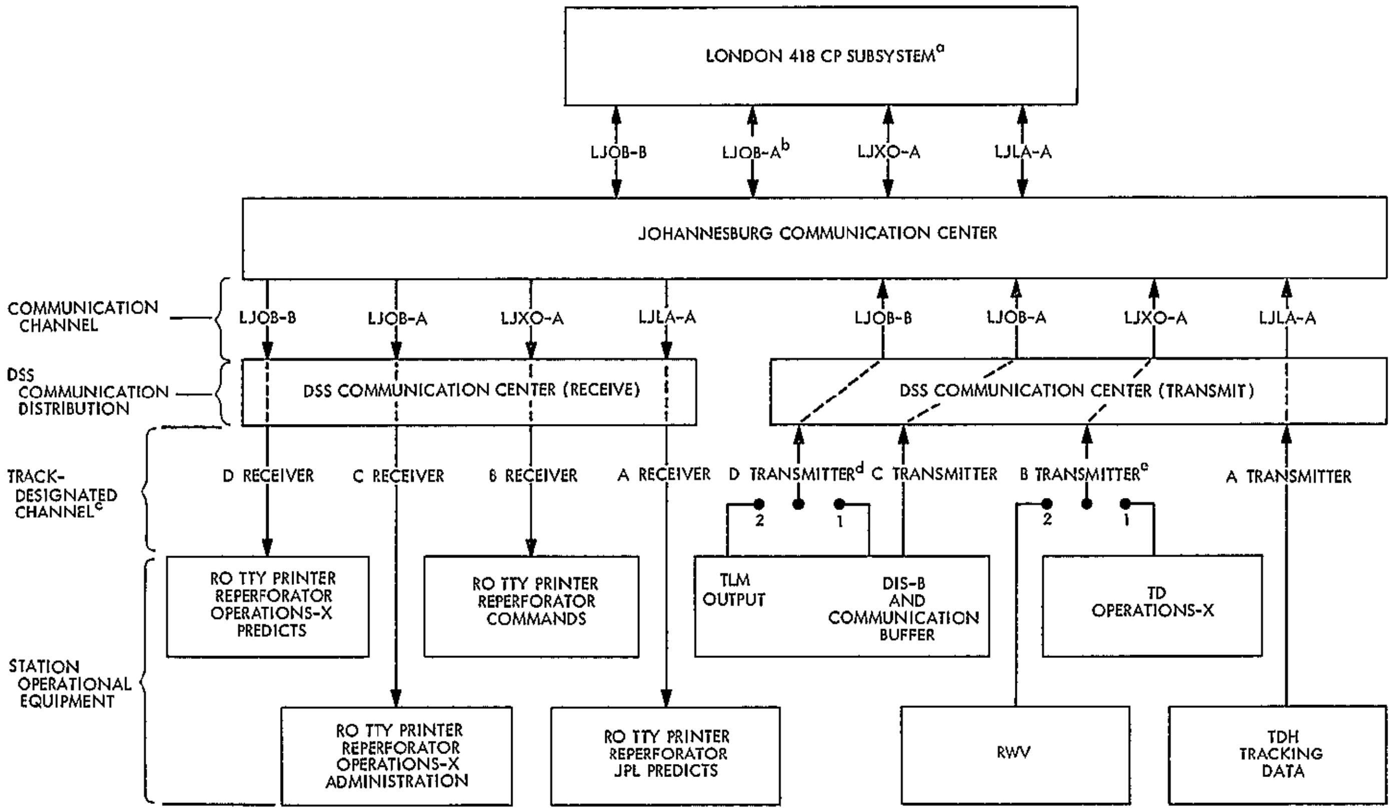
[a] TRANSMISSION ROUTE WAS VIA BOTH HF, SINGLE SIDEBAND, MULTIPLEXED TO AFETR-XY AND INTELSAT INTELSAT HAD 2 TTY AND 6 VD CHANNELS AND TRANSMITTED VIA THE GROUND STATION AT ANDOVER, MASS

[b] STATION DATA ASSIGNMENTS

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52 and 62
E	

Fig 40 Station teletype configuration, DSS 72, Ascension Island



[a] IF PRETORIA ALTERNATE ROUTED JOHANNESBURG TRAFFIC TO PERTH, THAN CANBERRA 418 CPS WAS USED, AND ROUTING WAS VIA GBUR INSTEAD OF LJOB

[b] TRANSMISSION WAS VIA HF, SINGLE SIDEBAND, MULTIPLEXED FROM PRETORIA

[c] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20, 70
C	50, 60, 51, 61
D	52, 53, 62
E	63

[d] D WAS CALLED CHANNEL E WHEN TRANSMITTING THE STANFORD FORMAT

[e] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig. 41 Station teletype configuration, DSS 51, Johannesburg

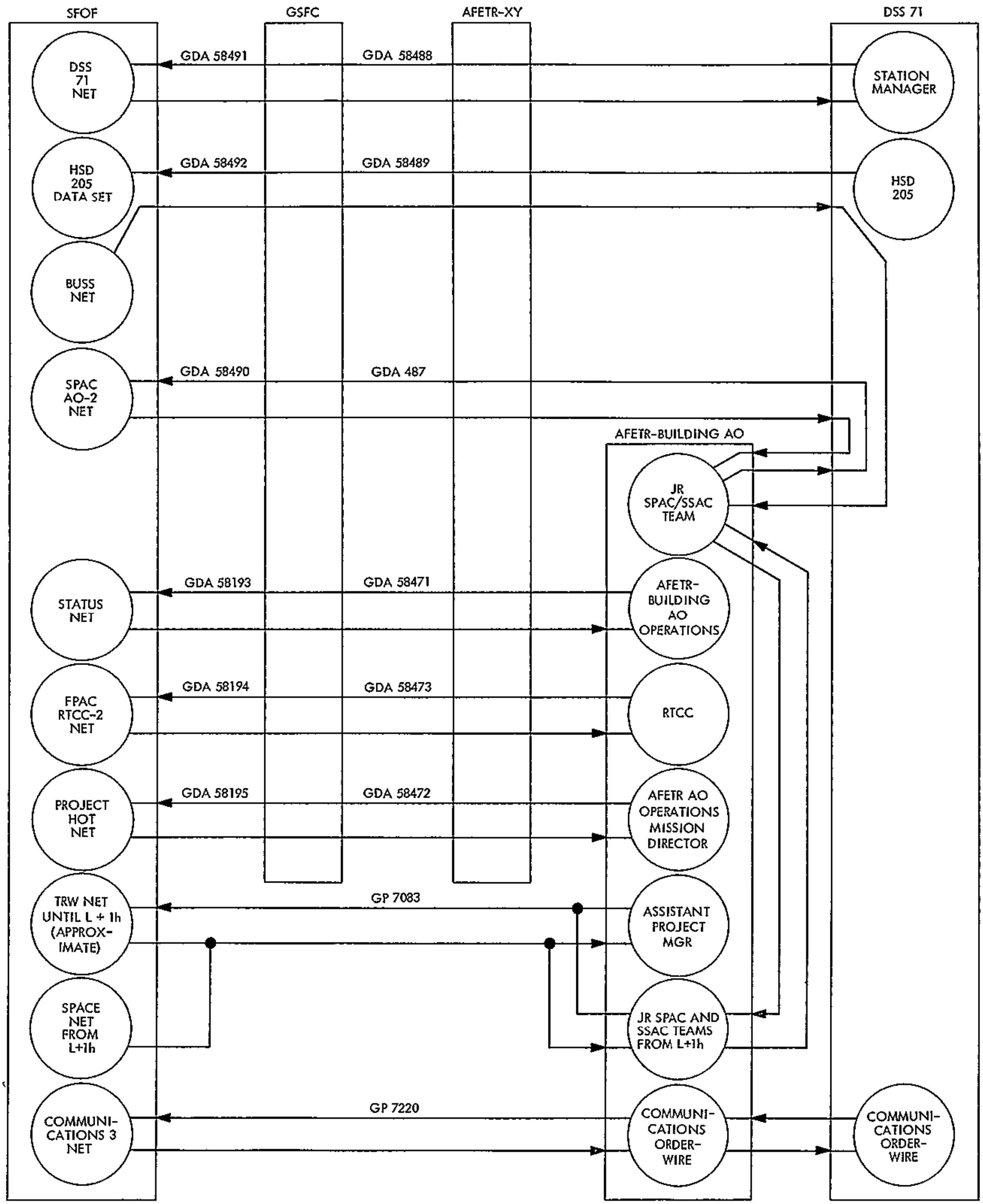


Fig 42 AFETR Building AO and DSS 71 voice/HSD configuration diagram

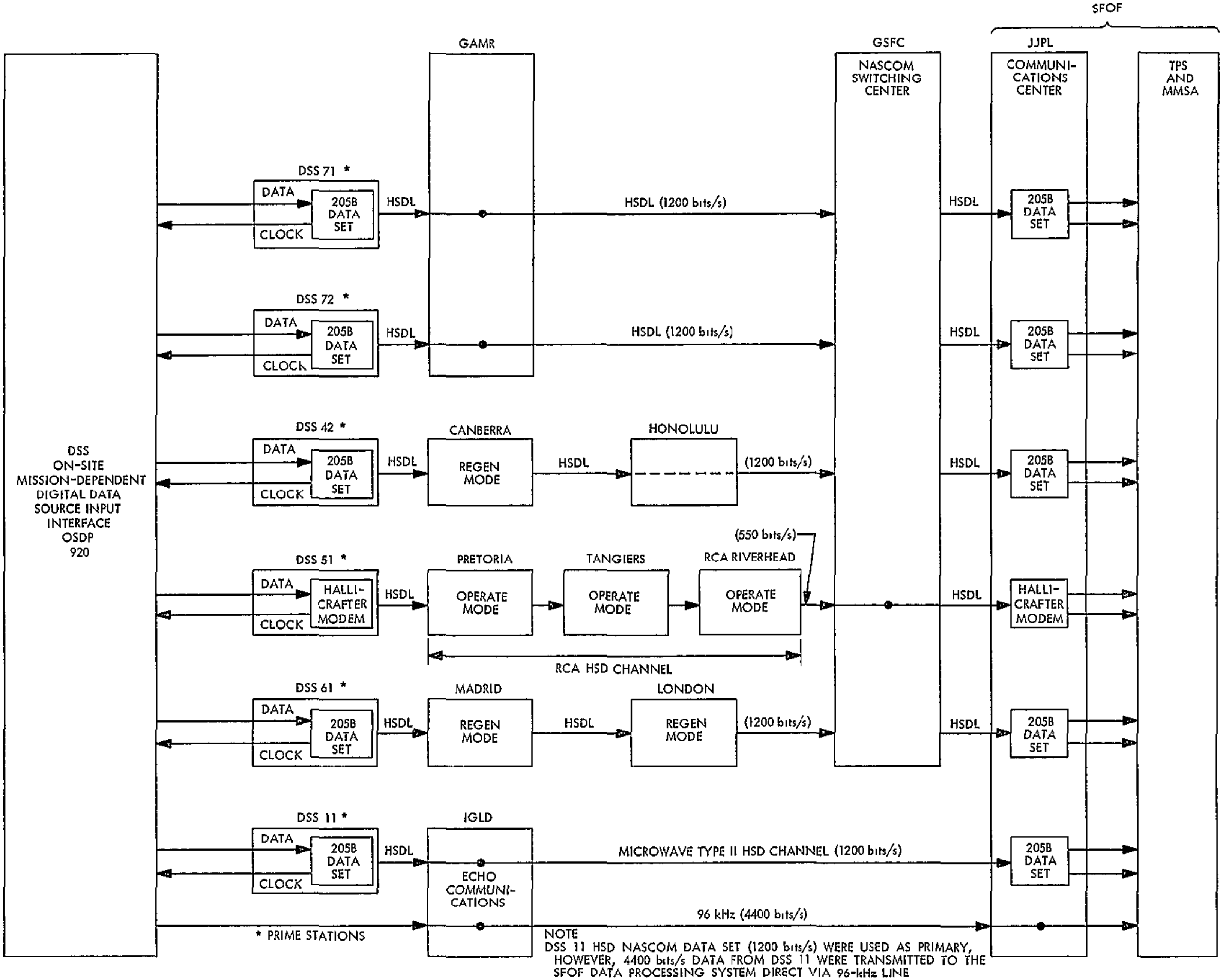


Fig 43. DSN/GCF HSD subsystem configuration diagram

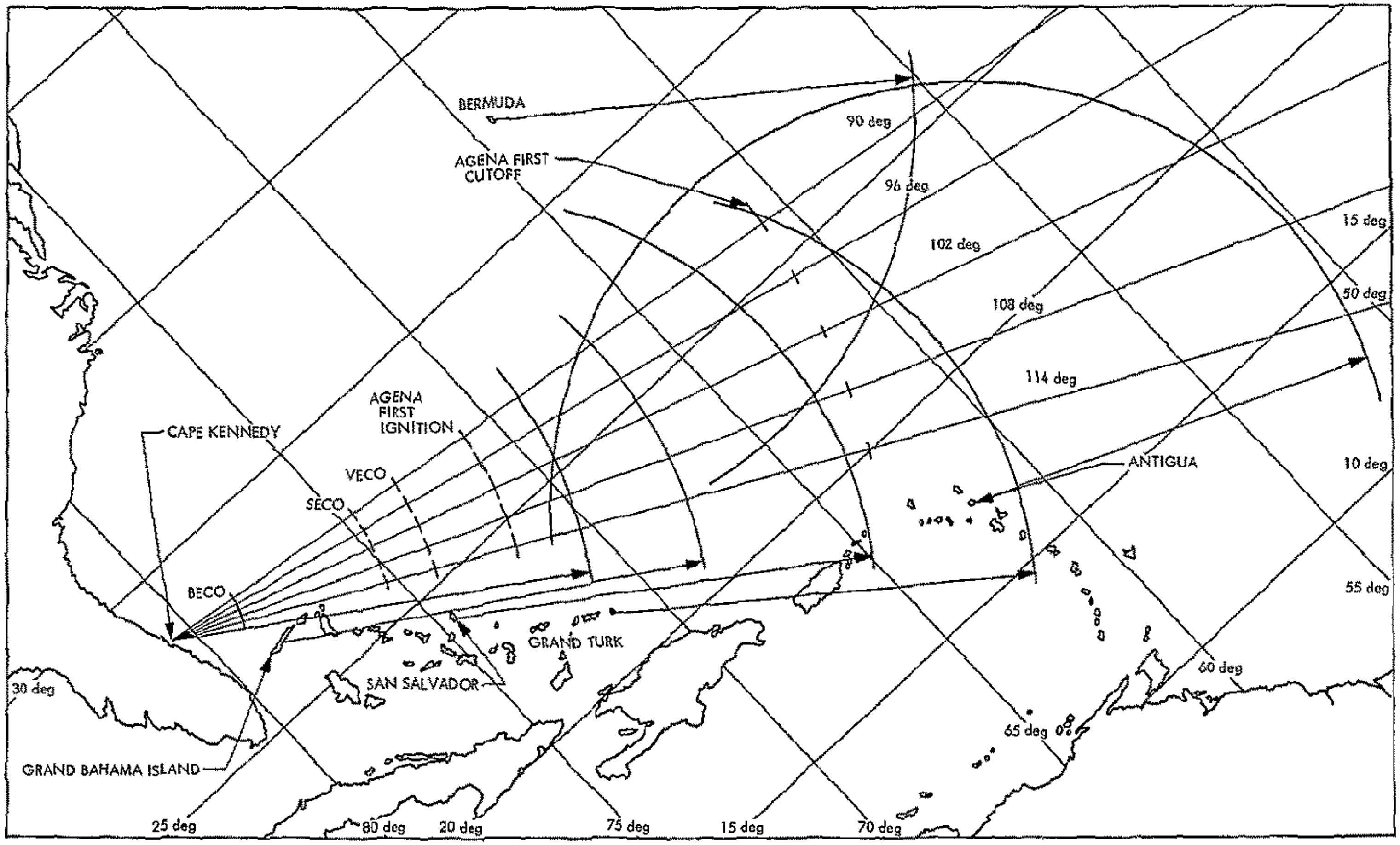


Fig 44 Uprange coverage geometry for *Mariner* Venus 67 (2-deg elevation constraints)

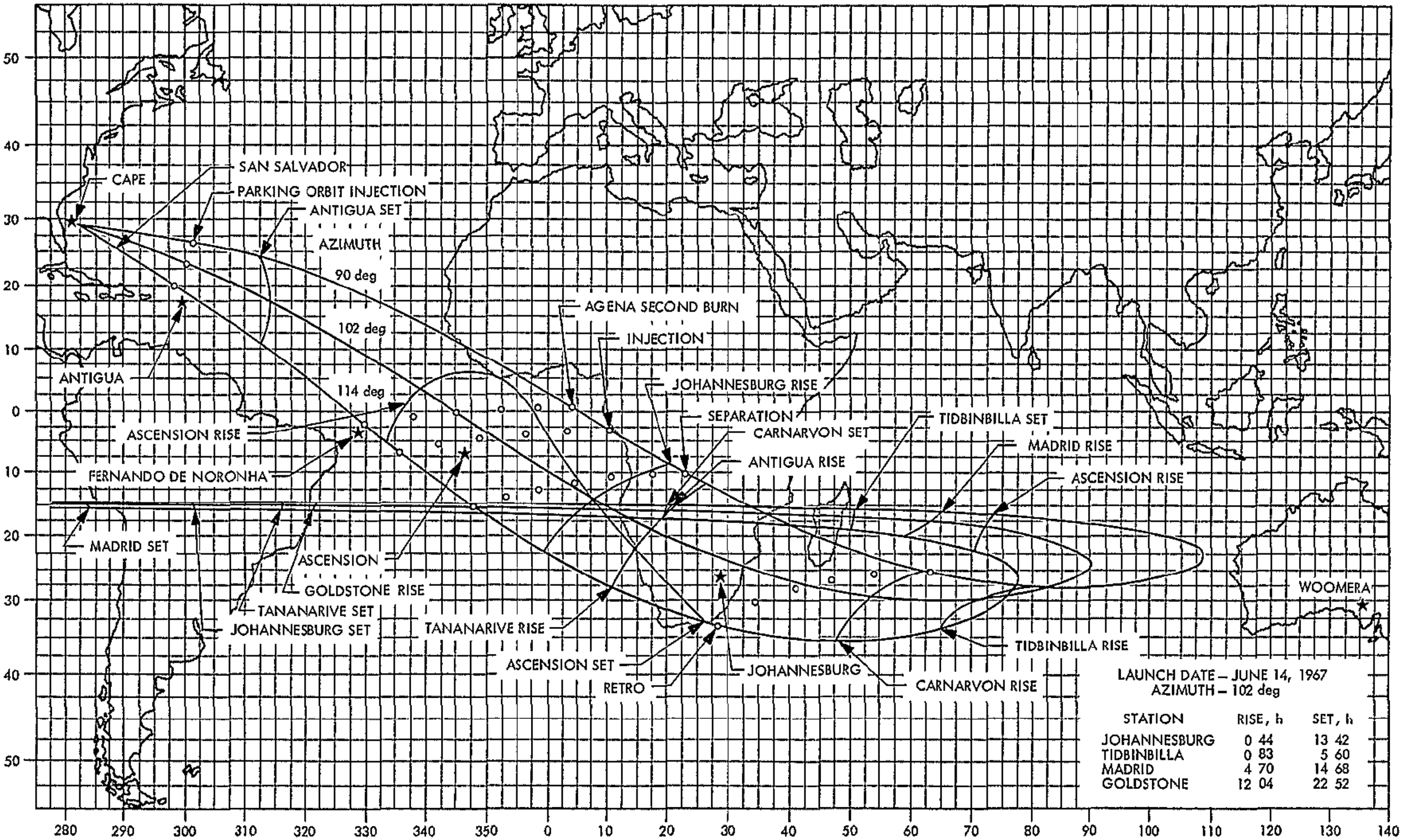


Fig. 45 Earth tracks for June 14, 1967

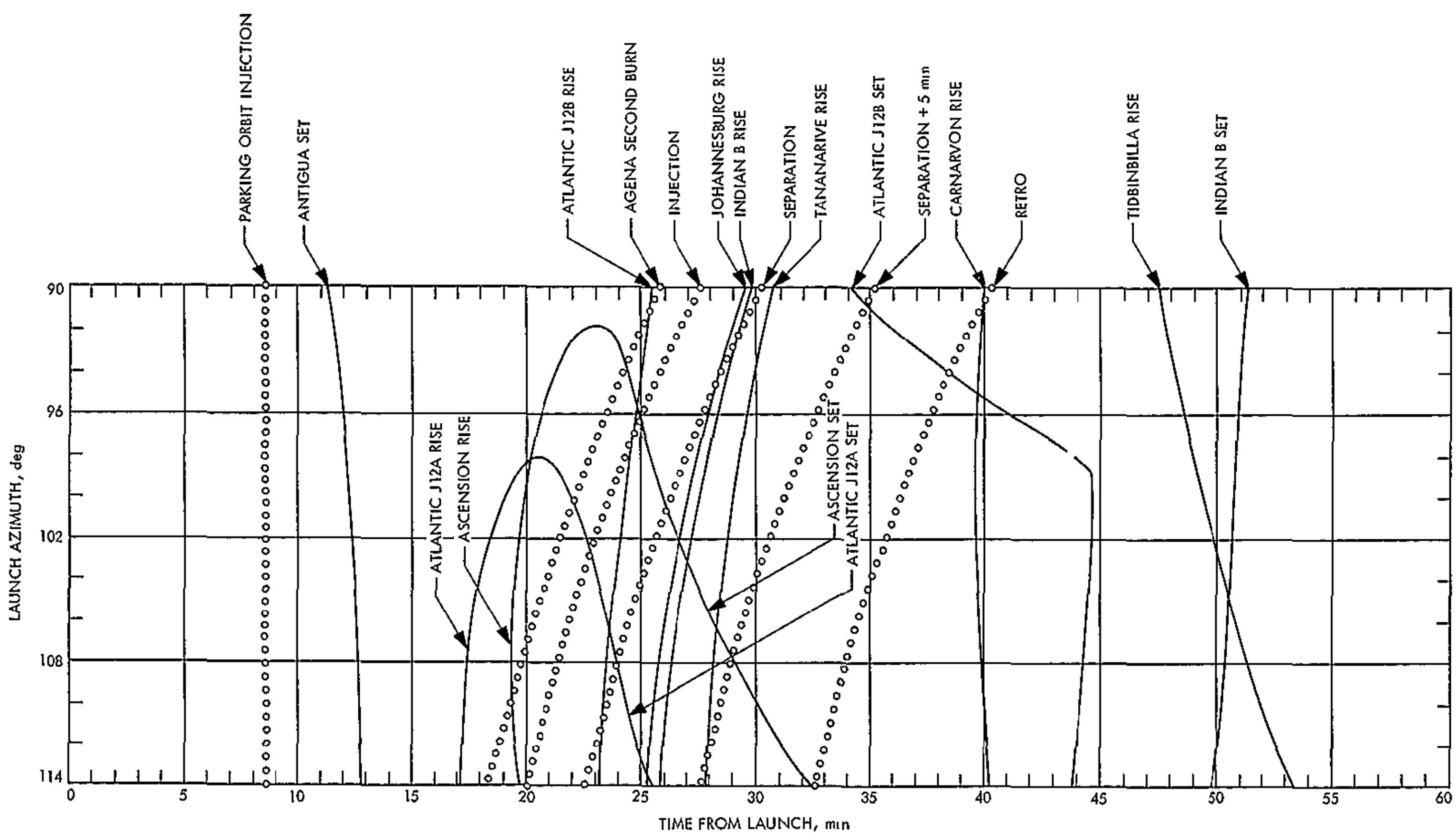


Fig. 46 Station view period chart for June 14, 1967

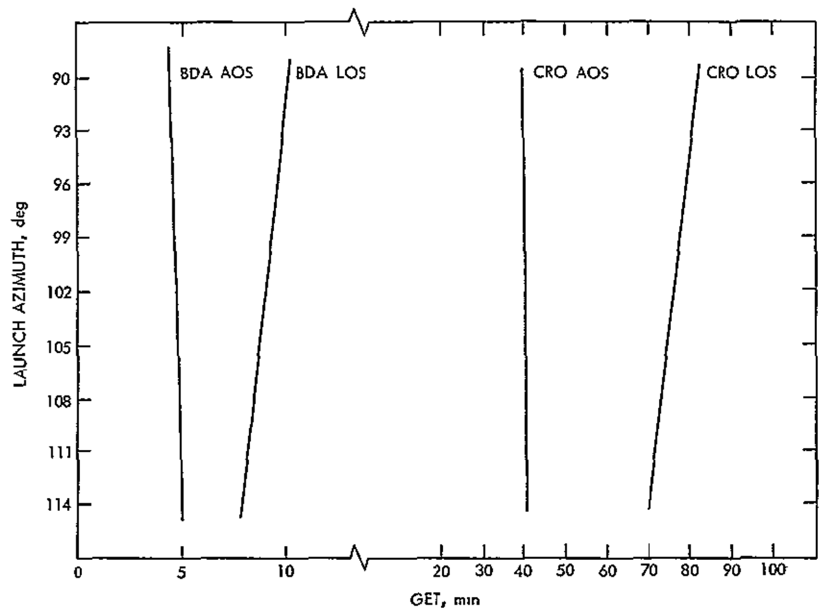


Fig 47 BDA/CRO radar coverage estimate for June 14, 1967

Table 20 Predicted BDA radar coverage, launch period, days 1–16[a]

Launch az, deg	Station	GET, h, min, s		Range, kyds		Elevation, deg	
		AOS	LOS	AOS	LOS	AOS	LOS
90	BDA	00 04 40	00 10 00	1158	1131	3	3
93	↓	00 04 40	00 09 50	1177	1300	3	3
96		00 04 44	00 09 45	1182	1350	3	3
99		00 04 48	00 09 30	1191	1339	3	3
102		00 04 52	00 09 15	1204	1294	3	3
105		00 05 00	00 09 00	1209	1345	3	3
108		00 05 04	00 08 40	1233	1337	3	3
111		00 05 12	00 08 24	1253	1359	3	3
114		00 05 24	00 08 00	1274	1363	3	3

[a]Coverage for BDA presented here is based on powered flight data for a similar launch

Table 21 Predicted CRO radar coverage for June 14 (Day 3)

Launch az, deg	Station	GET, h, min, s		Range, kyds		Elevation, deg	
		AOS	LOS	AOS	LOS	AOS	LOS
90	CRO	0 40 20	1 23 40	7187	19991	3	81 9
93	↓	0 40 30	1 22 00	7763	19996	3	74 8
96		0 40 30	1 20 20	8243	19909	3	69 2
99		0 40 30	1 19 00	8747	19992	3	63 9
102		0 40 40	1 17 20	9263	19976	3	58 7
105		0 40 50	1 15 40	9799	19963	3	53 7
108		0 41 00	1 14 20	10224	19961	3	50 0
111		0 41 10	0 56 10	10635	19993	3	46 7
114		0 41 30	1 11 40	11060	19891	3	43 3

Table 22 MSFN predicted VHF telemetry coverage for June 14

Launch az, deg	Station	AOS		TLM lock		TLM unlock		LOS	
		GET, h, min, s	Az, deg	GET, h, min, s	Az, deg	GET, h, min, s	Az, deg	GET, h, min, s	Az, deg
90	BDA								
	TAN	0 30 50	287	0 31 00	286	0 40 20	116	0 49 40	112
	CRO	0 40 10	258					0 53 00	256
93	BDA								
	TAN	0 30 10	280	0 30 20	280	0 39 40	123	0 49 20	113
	CRO	0 40 00	256					0 50 00	256
96	BDA								
	TAN	0 29 40	275	0 29 50	275	0 39 10	133	0 49 10	115
	CRO	0 39 50	255					0 47 10	255
99	BDA								
	TAN	0 29 10	270	0 29 30	269	0 38 20	150	0 48 50	118
	CRO	0 39 50	253					0 43 30	253
102	BDA								
	TAN	0 28 50	266	0 29 00	265	0 37 30	171	0 48 30	122
105	BDA								
	TAN	0 28 30	261	0 28 40	261	0 36 20	199	0 48 00	128
108	BDA								
	TAN	0 28 10	257	0 29 20	253	0 35 00	215	0 47 30	134
111	BDA	—	—	—	—	—	—	—	—
	TAN								
114	BDA								
	TAN	0 27 50	249	—	—	—	—	0 46 20	152

The TDS support of data requirements in the downrange portion of the near-earth phase varied with each day in the launch period, because the *Agena* has a different parking orbit coast time for each day This change in parking orbit coast time changes the point at which the spacecraft/*Agena* is injected into the desired interplanetary trajectory The variation in TDS downrange coverage, as a result of this change in injection point, causes the changes in the TDS constraints shown in Fig 56

Analysis of coverage estimates shows that all class I requirements cannot be met from 90 to 101 deg At 101 deg, requirements should be met, but at the coverage margins of supporting sites Coverage geometry rapidly improves for later launch azimuths and all requirements are supported with overlapping coverage .

Although the TDS limitations indicated a need to reduce the size of the available launch windows, the resulting windows proved to be adequate Table 23 lists the launch windows for the first 6 days of the period, the

Table 23 Opening and closing of launch window and launch window duration from June 14–19

Launch date, June	Launch az, deg	Launch time (GMT), h and min	Launch window duration, min
14	Open 101 Close 114	6 01 7 04	63
15	Open 102 Close 114	5 51 6 52	61
16	Open 102 Close 114	5 38 6 40	62
17	Open 102 Close 114	5 27 6 29	62
18	Open 90 Close 93 Open 102 Close 114	3 48 4 10 5 13 6 17	86
19	Open 90 Close 95 Open 102 Close 114	3 34 4 12 5 00 6 06	104

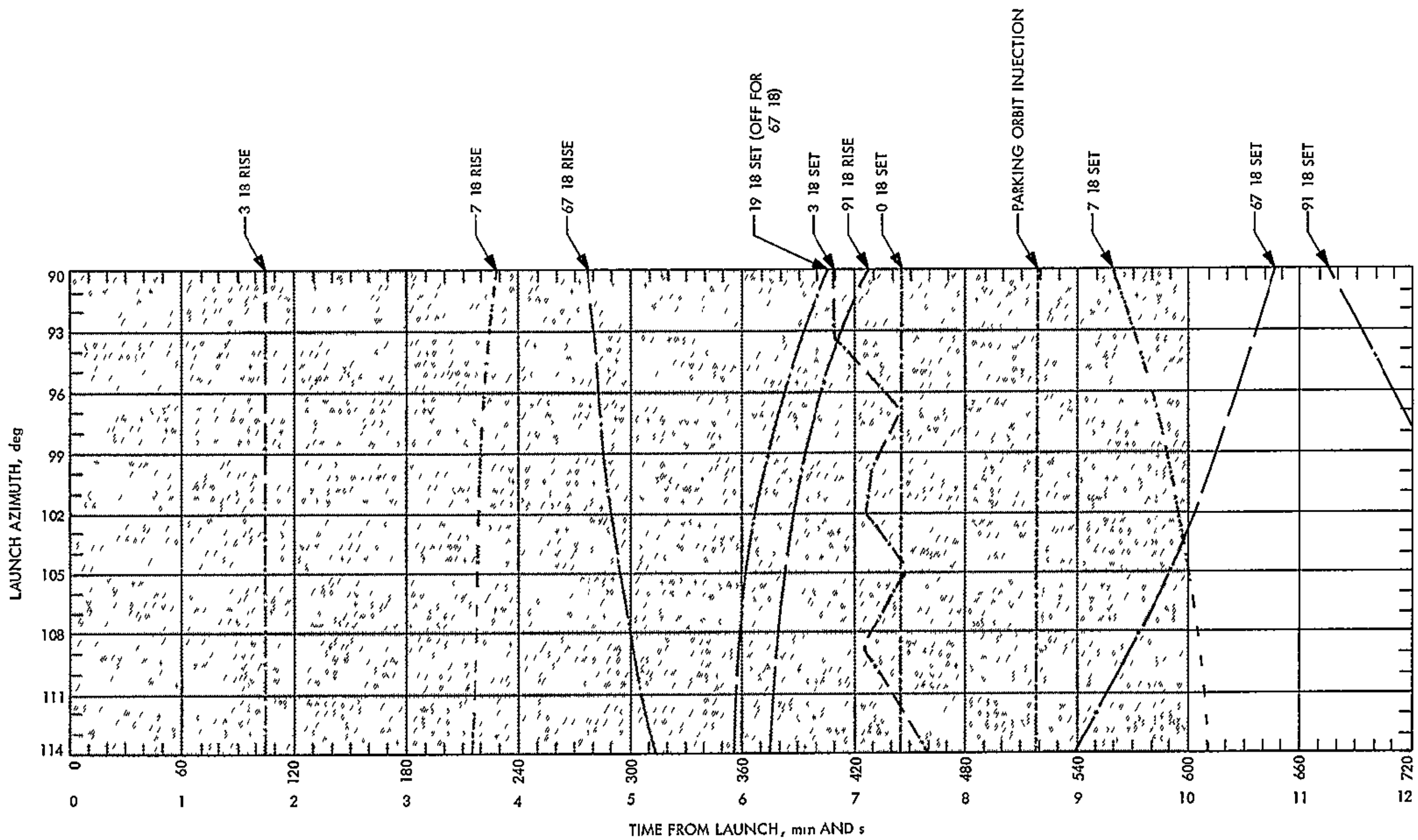


Fig 48. AFETR uprange coverage estimate for C-band tracking radar, all days

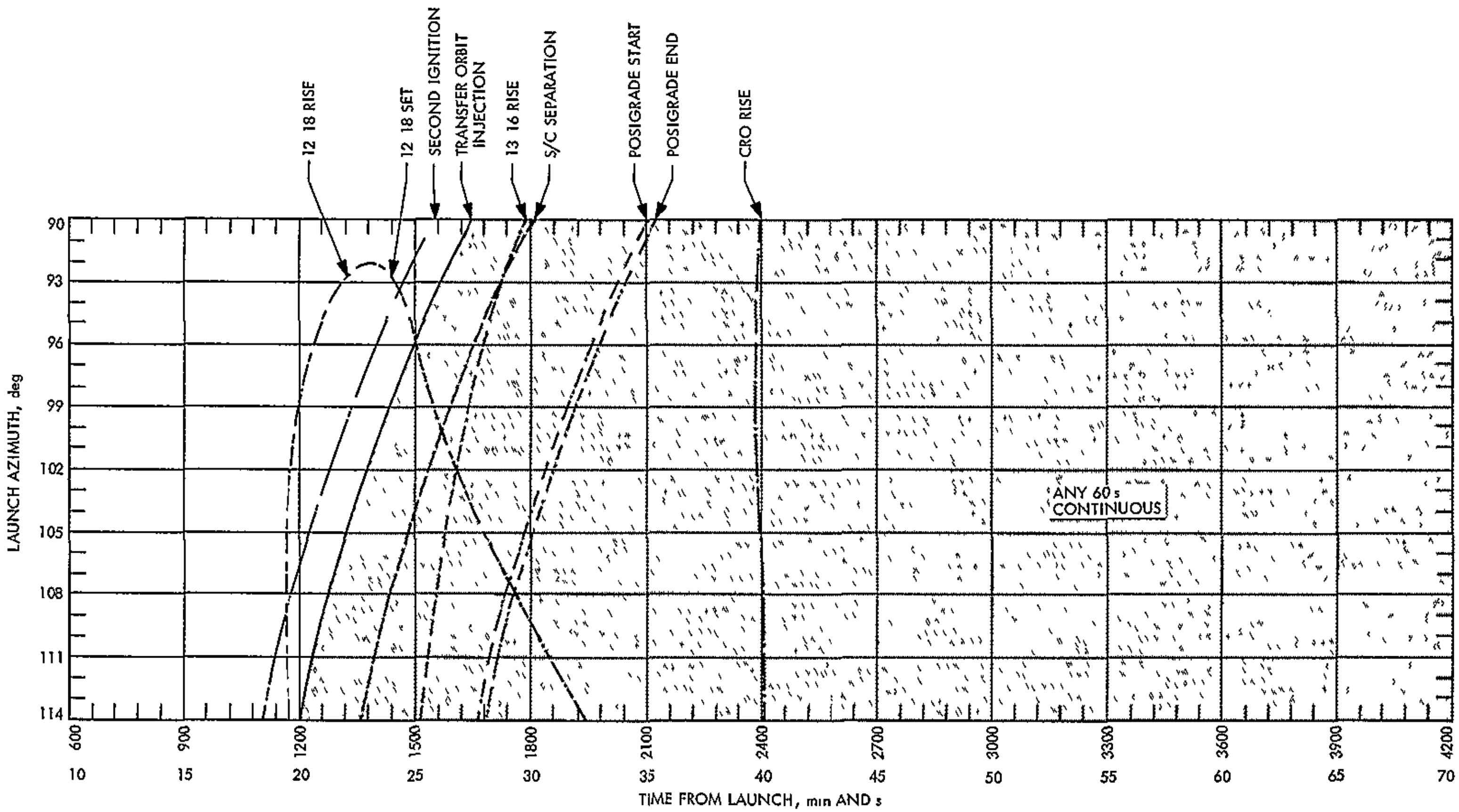


Fig 49 AFETR downrange coverage estimate for C-band tracking radar, June 14, 1967

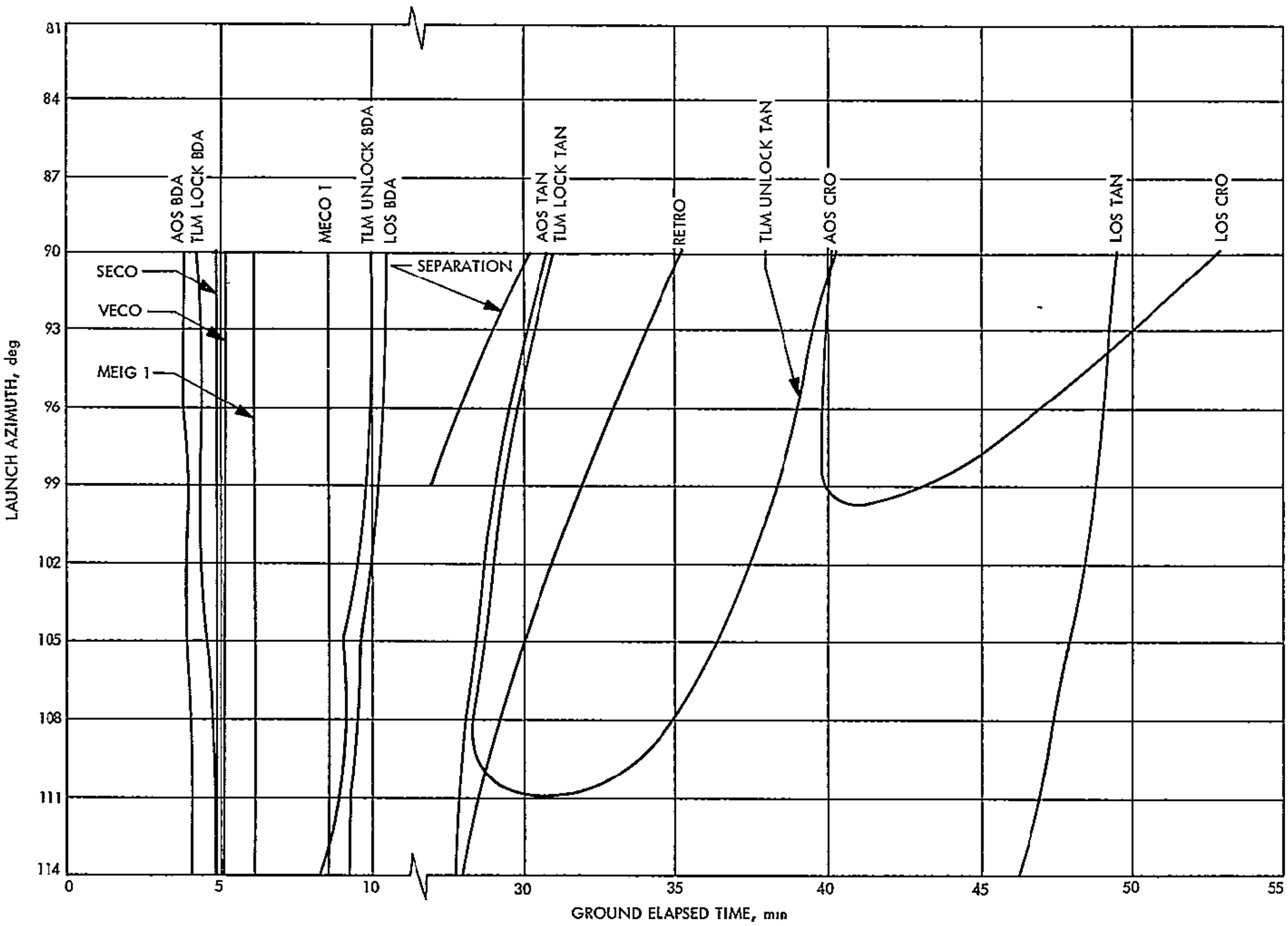


Fig 50 MSFN predicted VHF telemetry coverage, June 14, 1967

smallest of which is 61 min Such launch windows provide a relatively high probability of launch, based on past capability of the *Atlas/Agena* to launch on time

9 *TDS operational coordination* For *Mariner V*, the TDS planned to operate under a new philosophy, wherein the scope of TDS responsibilities and activities was extended beyond that of previous missions In addition to the standard responsibility for matching project requirements with TDS support centers' capabilities and establishing a support plan, the TDS manager was responsible for the following

(1) Establishing and conducting interface, system, and readiness tests under the provisions of a TDS test plan, as described in Section IV

(2) Operating direction and control of TDS functions during the countdowns of project operational tests and during the launch countdown It was established that the TDS, rather than the project, would conduct – count checks of the TDS configuration, bring the TDS to a *go* condition, and turn the TDS over to the space flight operations director at launch time −60 min (T −60 min) for operational control

The TDS manager planned to accomplish these new responsibilities through TDS coordinators at participating agencies The TDS coordinator (EOPS) at the JPL Mission Operations Center (MOC), Building AO, was established as the central coordinator for the near-earth phase TDS operations In this capacity, he directs, monitors, coordinates, and reports AFETR, MSFN, and DSN TDS activities The DSN system adviser (SYSAD) in the JPL Operations Control Center, Pasadena, acts as the central TDS coordinator during project operational readiness tests and during the actual launch operation Figure 57 shows the functioning of the TDS within the project organization

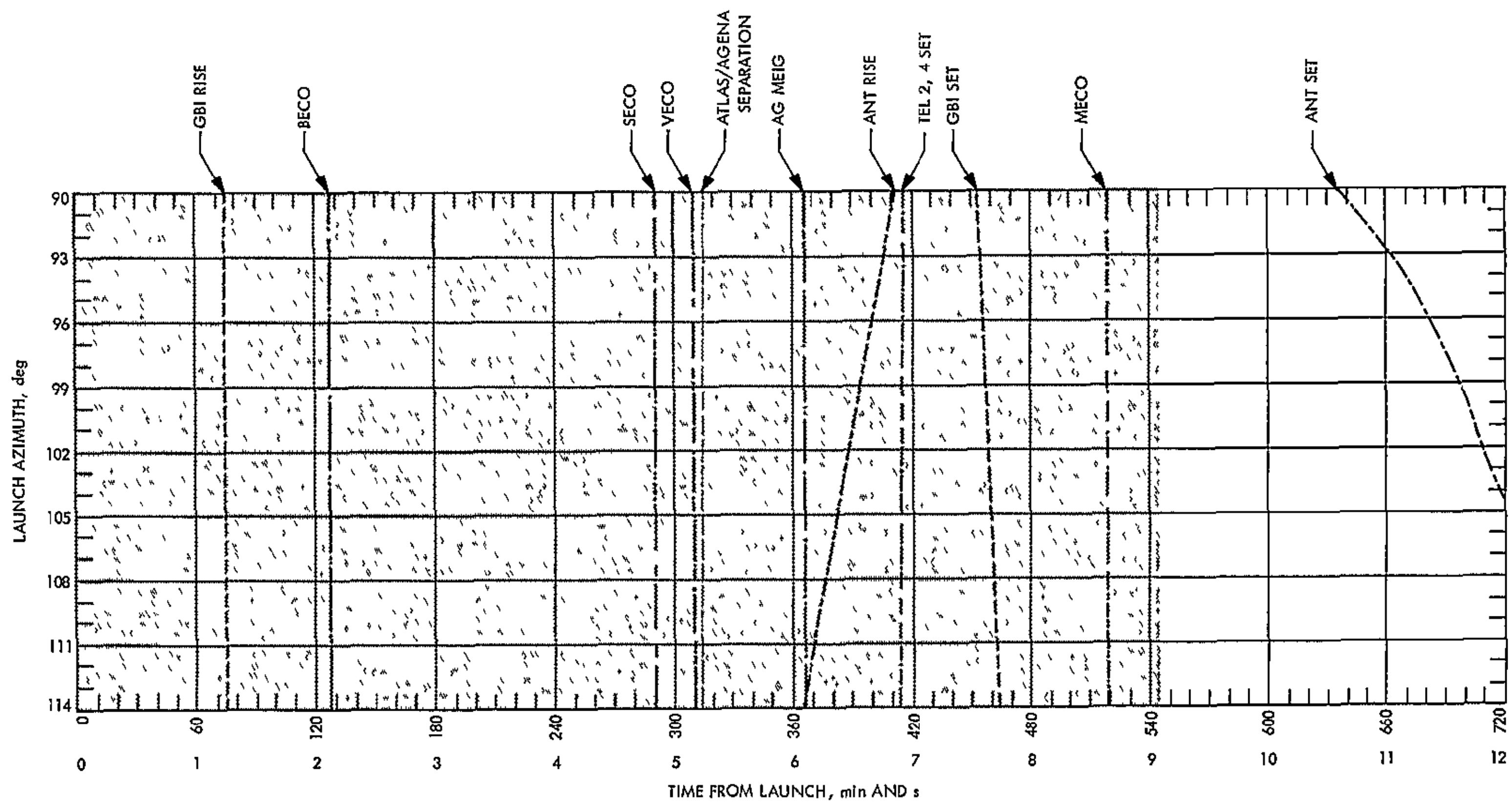


Fig 51 AFETR uprange coverage estimate for *Agena* telemetry (VHF), all days

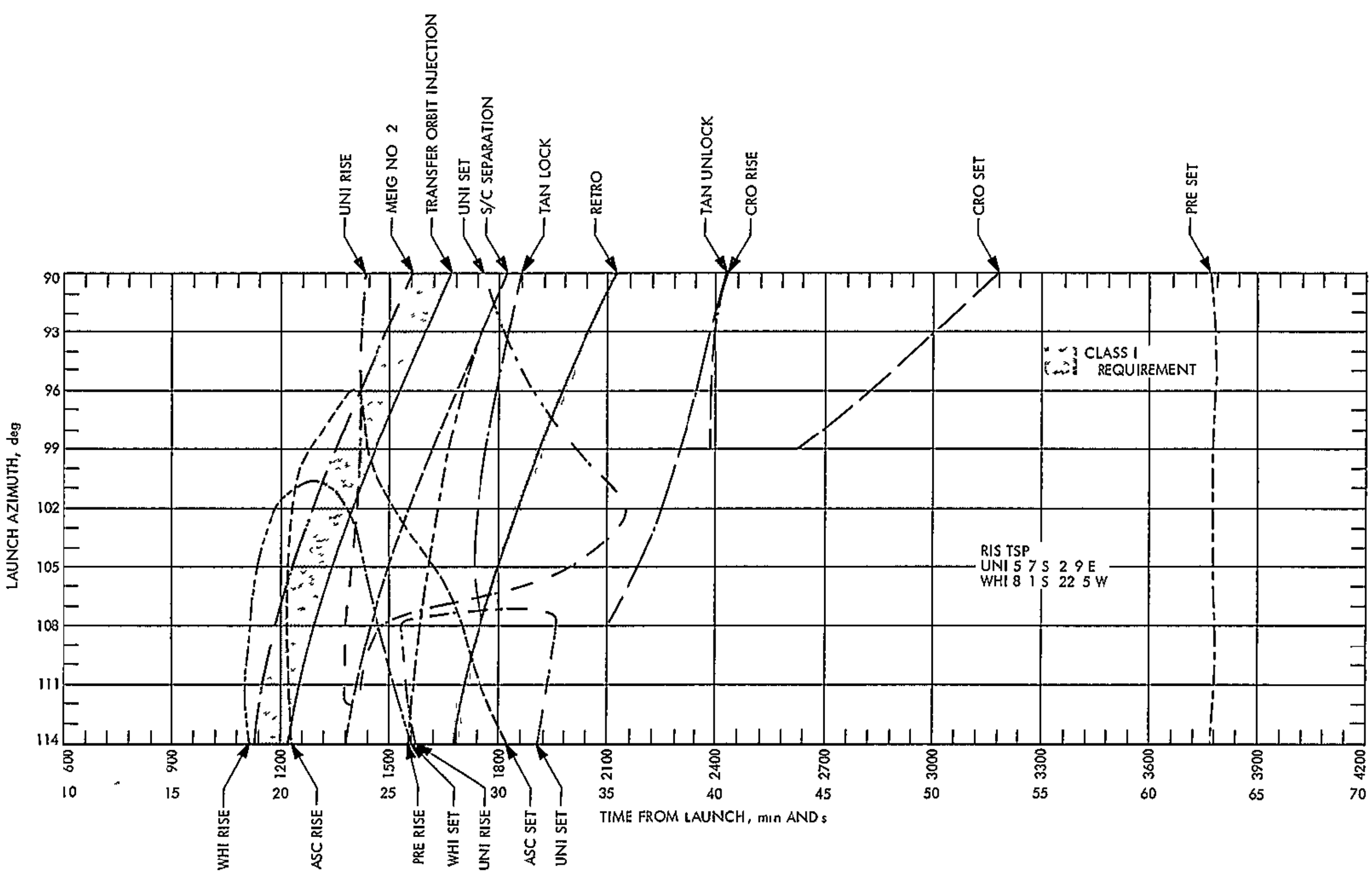


Fig 52 AFETR downrange coverage estimate for *Agena* telemetry (VHF), June 14, 1967

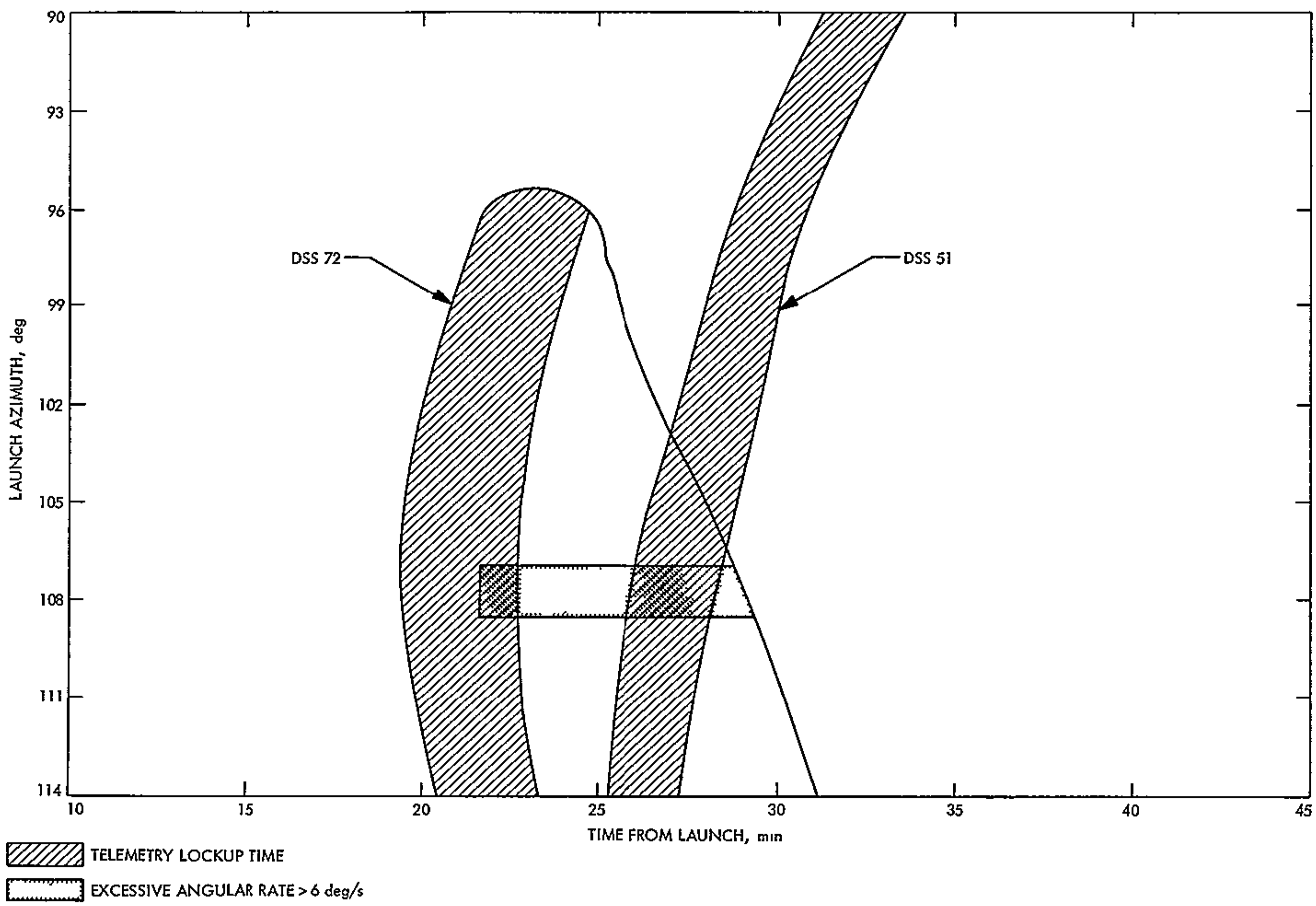


Fig 53 DSN estimated coverage for spacecraft telemetry (S-band), June 14, 1967

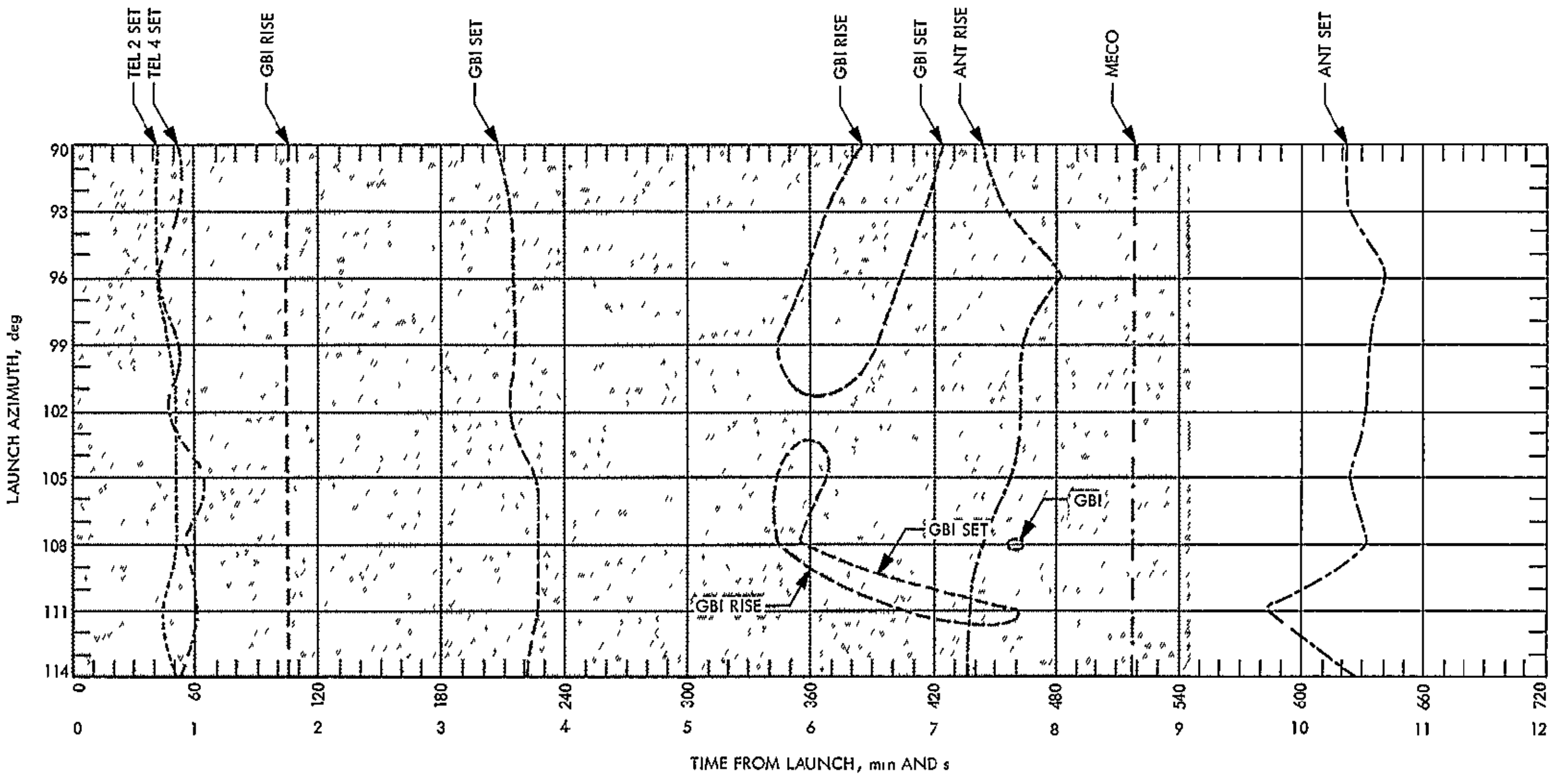


Fig 54 AFETR uprange coverage estimate for spacecraft telemetry (S-band), all days

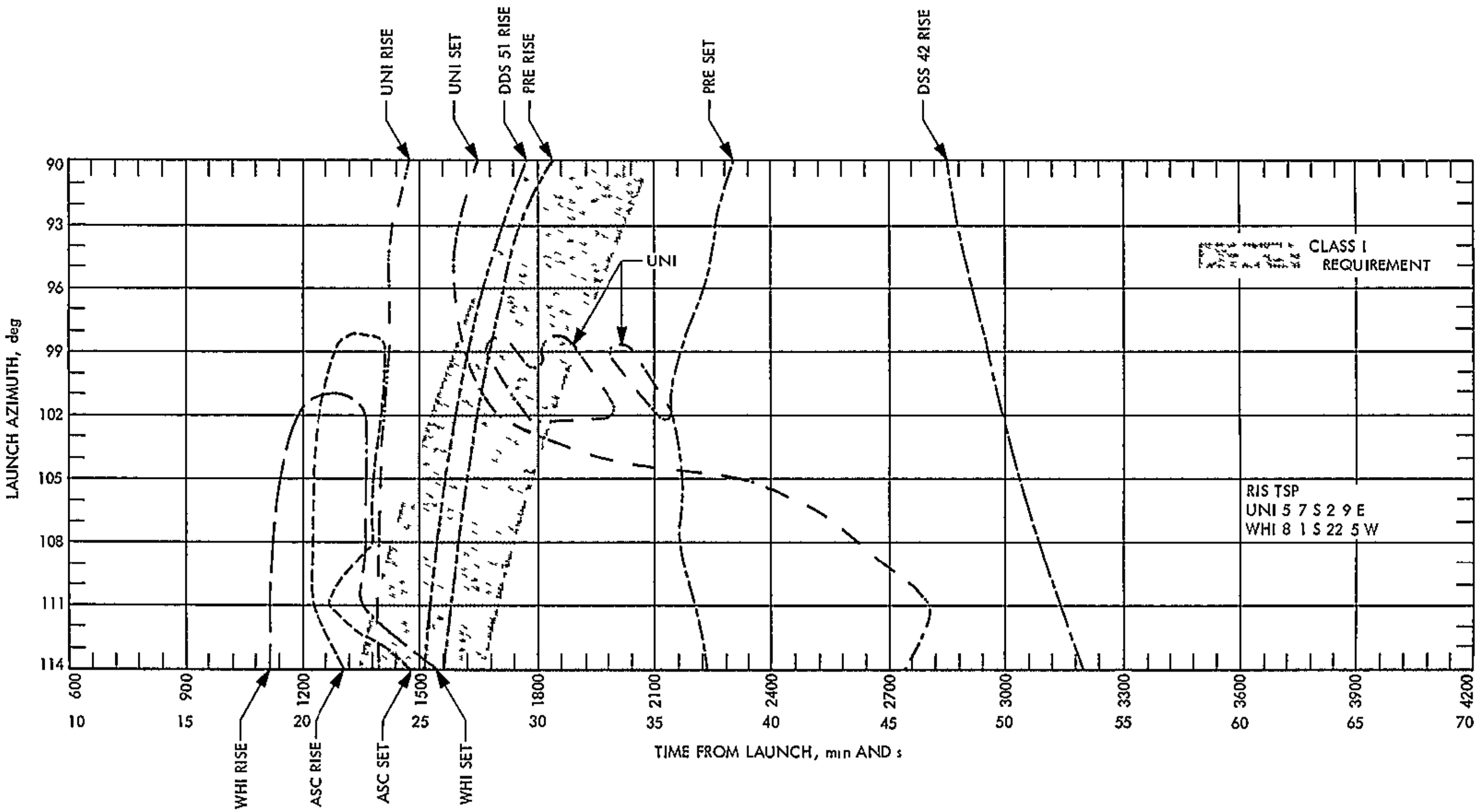


Fig 55 AFETR downrange coverage estimate for spacecraft telemetry (S-band), June 14, 1967

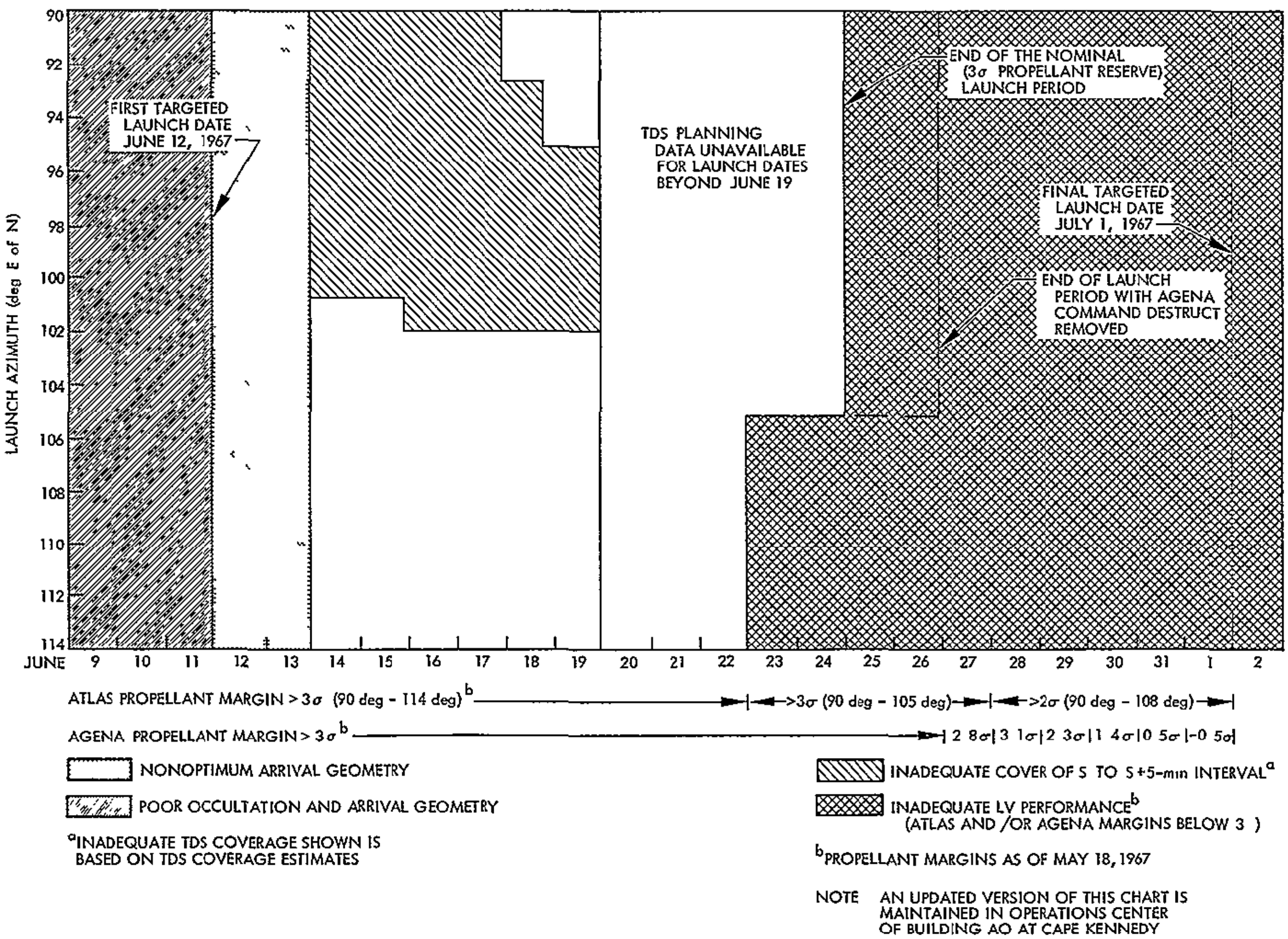


Fig. 56 Final launch constraints summary chart

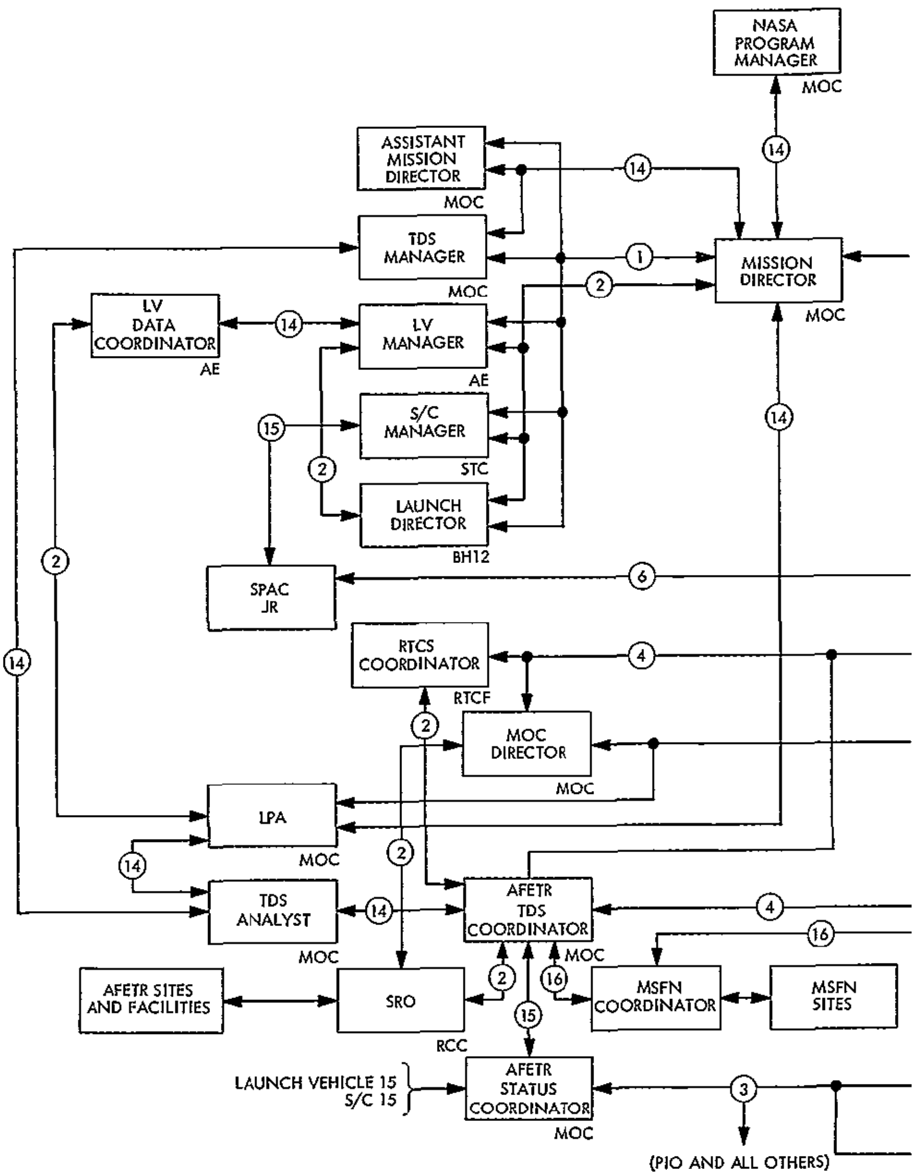
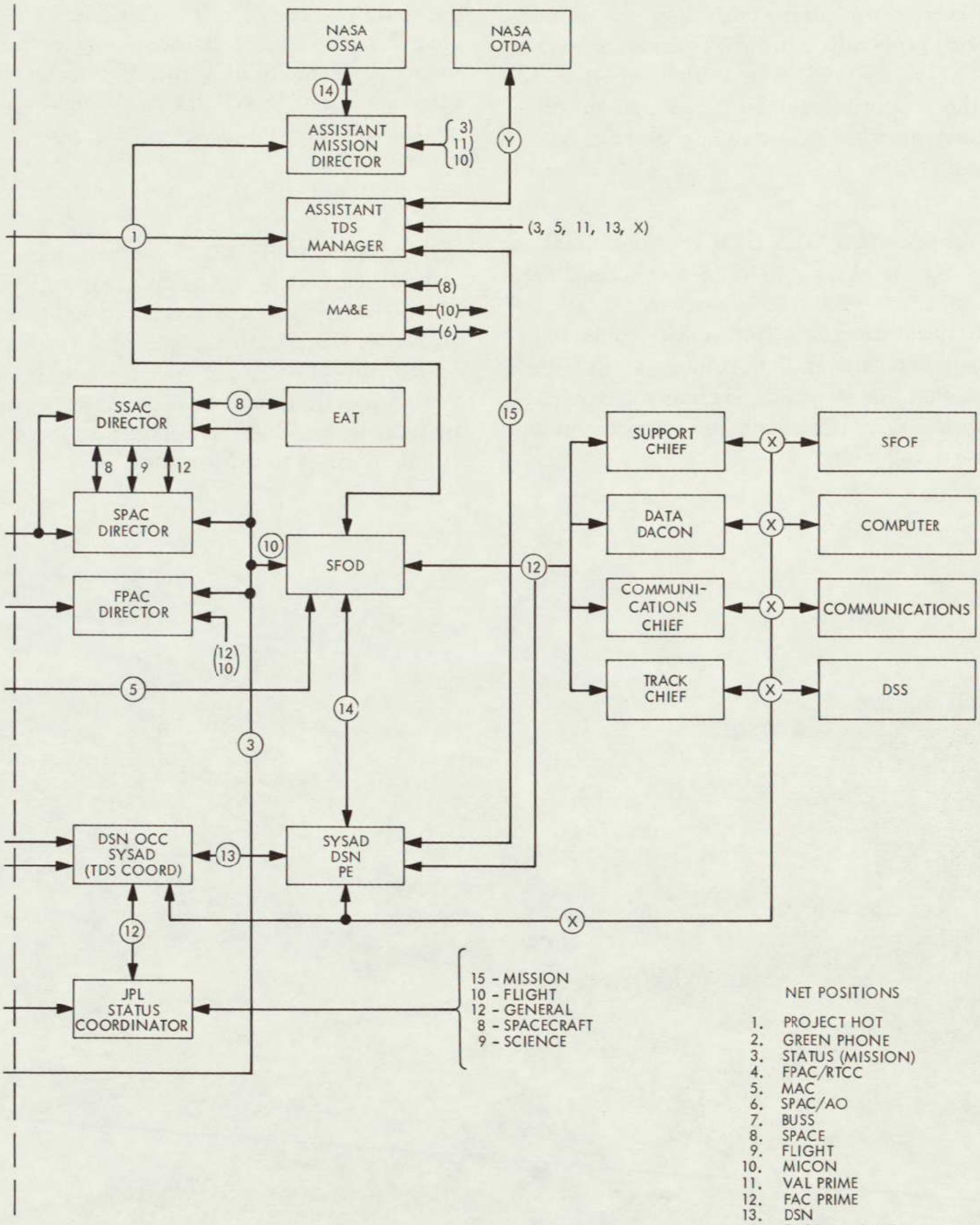


Fig 57 *Mariner* Venus 67 near-earth communication and response networks



NET POSITIONS

1. PROJECT HOT
2. GREEN PHONE
3. STATUS (MISSION)
4. FPAC/RTCC
5. MAC
6. SPAC/AO
7. BUSS
8. SPACE
9. FLIGHT
10. MICON
11. VAL PRIME
12. FAC PRIME
13. DSN
14. FACE-TO-FACE
15. INTERCOM
16. MSFN NET
X. SFOF/DSIF DSN NETS
Y. NASA HEADQUARTERS HOT LINES

Fig. 57 (contd)

Because the TDS was responsible for conducting numerous launch countdown events, system personnel played an important part in the preparation of the launch sequence of events (appendix). In the sequence of events, review of SYSAD and EOPS items in the "report by-to" column and the supporting subitems reported by other elements further provides understanding of TDS operational activities.

10. SFOF configuration. The DSN provided areas in the SFOF for *Mariner* Venus 67 data monitoring, data analysis, and mission operations. These areas were provisioned with furniture, audio and visual communication devices, computer-driven data printers and plotters, and communication line terminals, such as teletype page printers. Provision was also made for project-supplied special-purpose equipments.

The primary area provided and provisioned was the multiple-mission support area (MMSA), located in the southwest corner of the first floor of the SFOF. This area, shown in Fig. 58, housed the spacecraft analysis and command team (SPAC), the space science analysis and command team (SSAC), the space flight operations director (SFOD) and his staff, and the project management. The floor plan of the area, showing the location of all key personnel and equipment, is presented in Fig. 59.

In addition to the MMSA, other areas were provided and provisioned on a shared basis with other projects. The flight path analysis and command team (FPAC) was housed in flight path analysis area (FPAA) No. 2, adjacent to the MMSA, and was used by both the *Mariner* Venus 67 and *Lunar Orbiter* Projects. An engineering analysis team (EAT) area was provided for scientists visiting during critical periods.

Fig. 58. *Mariner* mission support area (MMSA) in SFOF

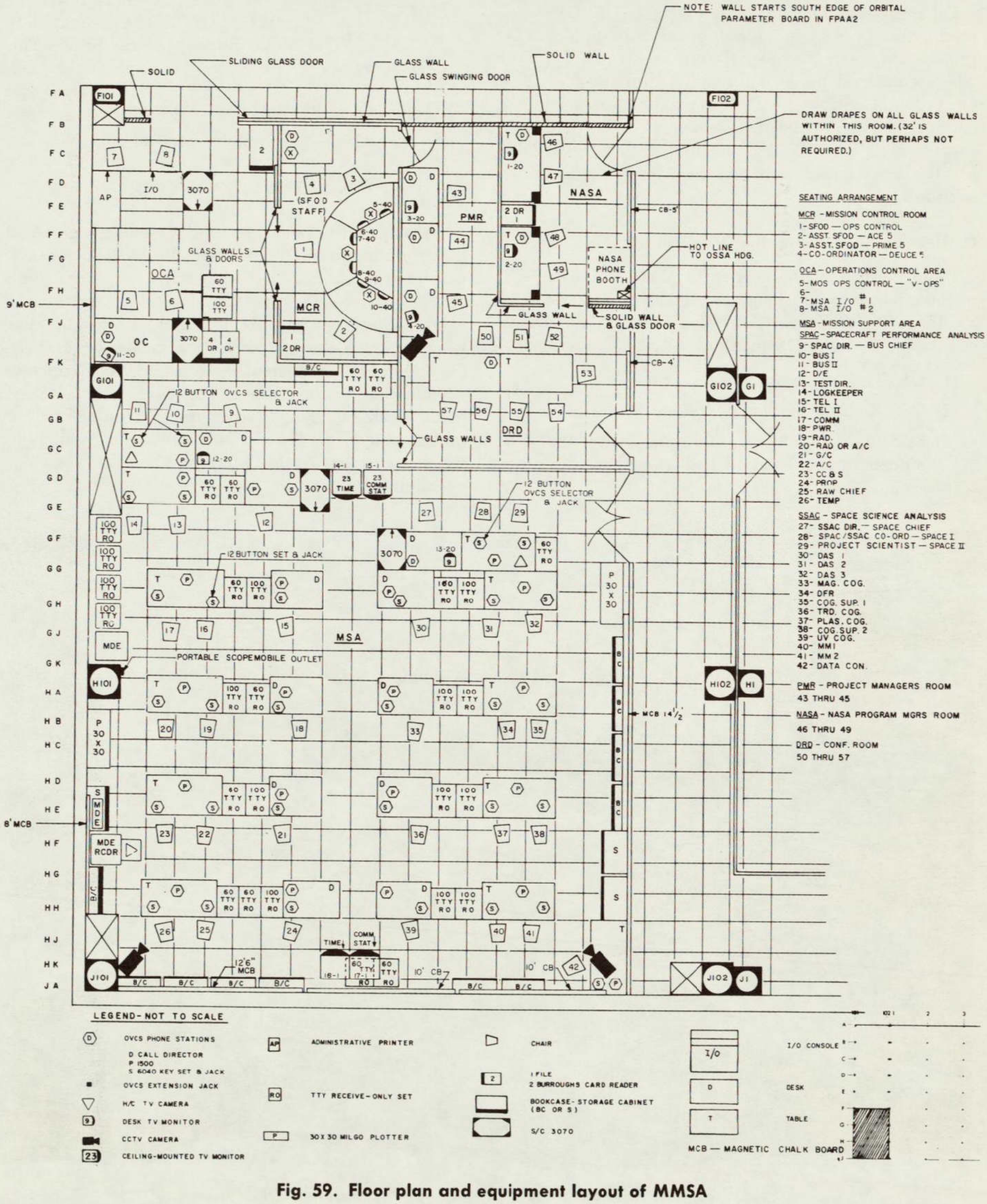


Fig. 59. Floor plan and equipment layout of MMSA

Other mission-independent areas of the SFOF were used by the DSN in the support of the *Mariner* Venus 67 project. These areas included the operations area (Fig. 60), which contained public information displays and DSN Operations Control; the DSIF operations area (station control), the communications center, and the data processing area. The SFOF configuration was essentially identical for the near-earth and deep space phases of the mission.

C. TDS Configuration for the Deep Space Phase

From the end of the near-earth phase to the end-of-mission, telemetry, tracking, and command requirements for the *Mariner* Venus 67 mission are met by various combinations of the DSN stations listed below:

(1) DSS 11, Pioneer Station, Goldstone.

(2) DSS 12, Echo Station, Goldstone.

(3) DSS 14, Mars Station, Goldstone (during the 85-ft antenna grayout period and at encounter for occultation).

(4) DSS 41, Woomera, Australia.

(5) DSS 42, Tidbinbilla, Australia.

(6) DSS 51, Johannesburg.

(7) DSS 61, Robledo Station, Madrid.

(8) DSS 62, Cebreros Station, Madrid.

A typical DSN station is shown in Fig. 61.

The capabilities and operating parameters of the stations in support of the *Mariner* Venus 67 project are presented in Table 24.

Deep Space Stations 11, 42, and 61 are considered prime through the first correction maneuver + 2 days ($M + 2$ days). Throughout the remainder of the mission, combinations of any other DSS were established, dependent on scheduling priorities, as required to meet mission objectives. The TDS plans outlined herein reflect the support needed for *Mariner V* and *IV* combined operations.

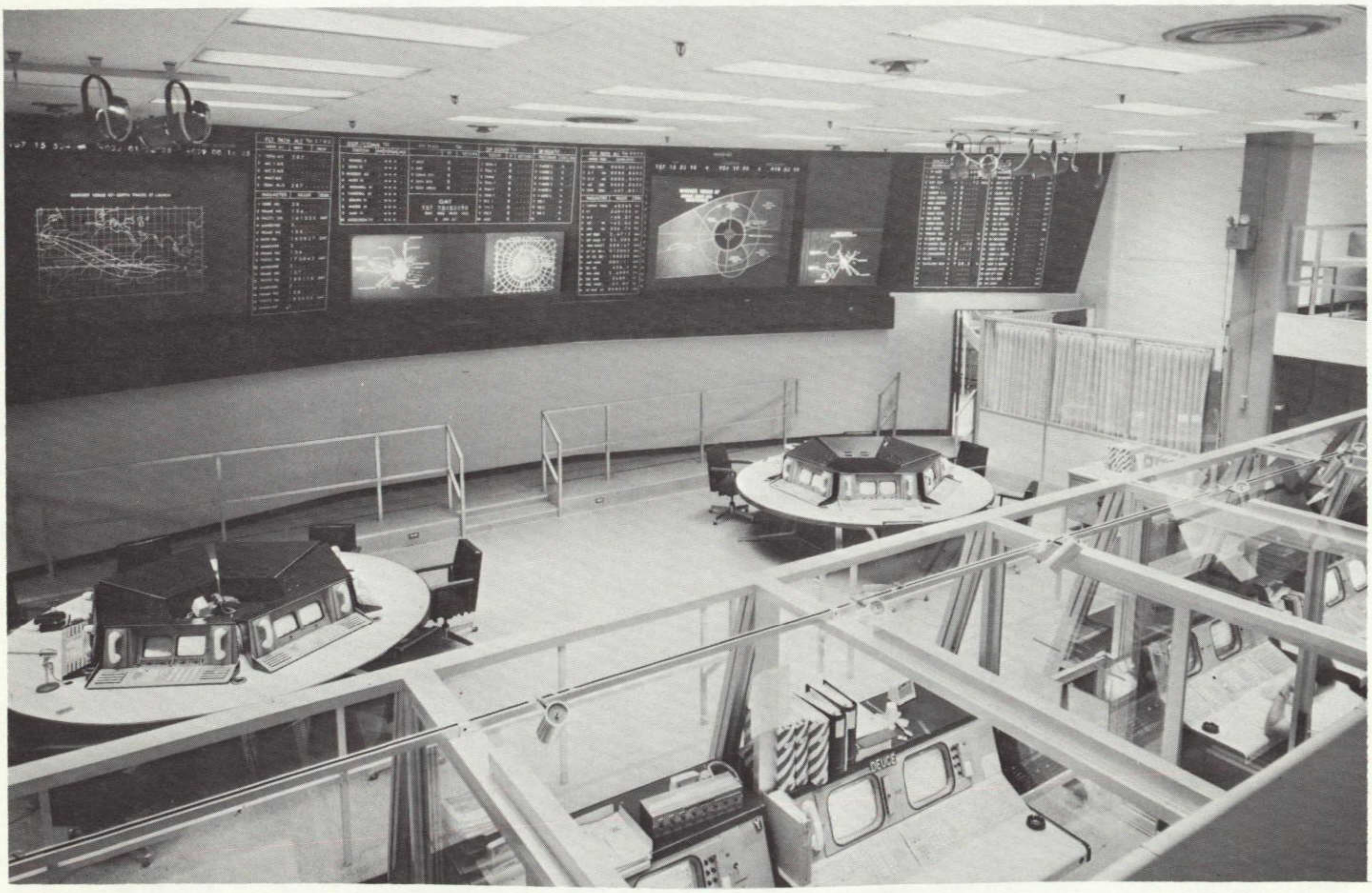


Fig. 60. Mission-independent operations area in SFOF

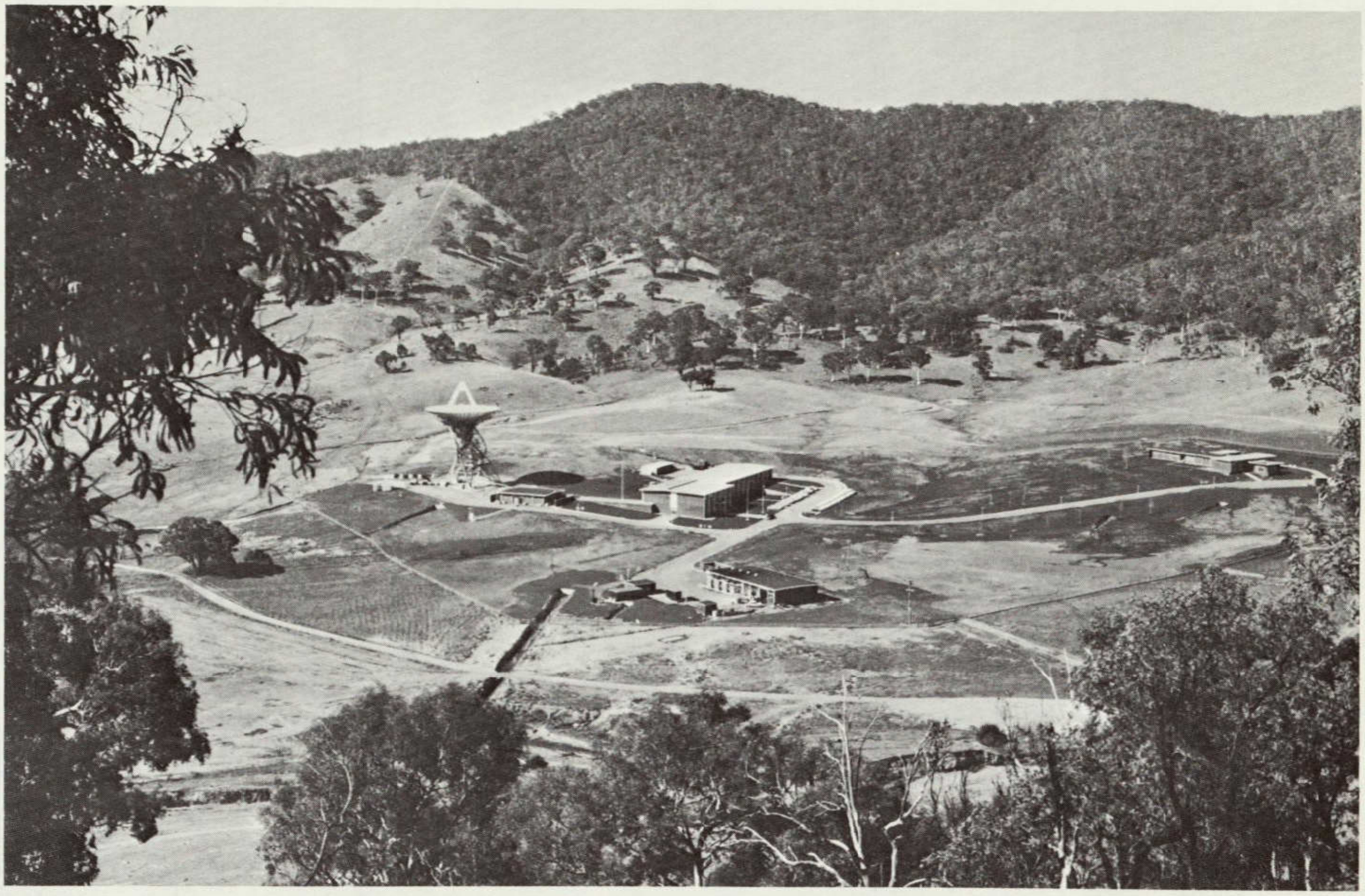


Fig. 61. General view of DSS 42, Tidbinbilla Deep Space Station

The DSN planned to meet the combined requirements with a three-station, 85-ft antenna network which provides the following:

(1) Four 8-h passes per day.

(2) Station pre- and post-track checkout time of 9 h during critical phases and 4 h during noncritical phases of the mission.

(3) Appropriate longitudinal separation between stations to provide continuous coverage when required.

Scheduling conflicts will not always permit the use of a three-station network. When this occurs, the DSN plans to meet requirements with a two-station configuration to provide two 8-h passes per day, station pre- and post-track checkout time, and longitudinal separation, with a minimum overlap. Using this philosophy in reviewing the DSN schedule, the support for the *Mariner* Venus 67 Mission would be provided as shown in Fig. 62.

Deep Space Station 14 supports the *Mariner* Venus 67 encounter sequence, periodically ranges with a research and development planetary ranging system, and supports other combined operations during critical intervals. The SFOF receives DSS data and furnishes validated tracking and telemetry data to the project. NASCOM provides ground communications circuits from the SFOF to the DSS and to Stanford.

1. Telemetry system configuration. The DSN telemetry configuration for *Mariner* Venus 67 is shown in Fig. 63. The TDS acquires spacecraft data from the radio frequency (RF) carrier and the composite signal is processed from the receiver to the demodulator, where data and bit and word sync are generated from the spacecraft signal. Recording of the input and output (I/O) of the demodulator is also performed.

The DSS further handles the spacecraft data by associating DSIF time with it, recording data in digital form, and formatting data for transmission to the SFOF via

Table 24. DSIF capabilities for the *Mariner* Venus 67 Project

Capability[a]	GSCS Pioneer GSDS S-band	GSCS Echo GSDS S-band	GSCS Mars	Woomera GSDS S-band	Tidbinbilla GSDS S-band	Johannesburg GSDS S-band	Robledo GSDS S-band	Madrid GSDS S-band
Station ID	DSS 11	DSS 12	DSS 14	DSS 41	DSS 42	DSS 51	DSS 61	DSS 62
Receiver capability	2	2	2	2	2	1	2	
Antenna	85-ft parabolic	85-ft parabolic	210 ft	85-ft parabolic	85-ft parabolic	85-ft parabolic	85-ft parabolic	
Mount	Polar (HA-dec)	Polar (HA-dec)	Az and el	Polar (HA-dec)	Polar (HA-dec)	Polar (HA-dec)	Polar (HA-dec)	
Maximum angular rate (both axes), deg/s	0.7	0.7	0.5	0.7	0.7	0.7	0.7	
Antenna gain, db								
Receiving	$53.0 \begin{smallmatrix} +1 \\ -0.5 \end{smallmatrix}$	$53.0 \begin{smallmatrix} +1 \\ -0.5 \end{smallmatrix}$	~61.0	$53.0 \begin{smallmatrix} +1 \\ -0.5 \end{smallmatrix}$	$53.0 \begin{smallmatrix} +1 \\ -0.5 \end{smallmatrix}$	$53.0 \begin{smallmatrix} +1 \\ -0.5 \end{smallmatrix}$	$53.0 \begin{smallmatrix} +1 \\ -0.5 \end{smallmatrix}$	
Transmitting	51.0 ± 1	51.0 ± 1	~59.0	51.0 ± 1	51.0 ± 1	51.0 ± 1	51.0 ± 1	
Antenna beamwidth, deg	~0.4	~0.4	0.1	~0.4	~0.4	~0.4	~0.4	
Typical system temperature, °K	55 ± 10	55 ± 10	—	55 ± 10	55 ± 10	55 ± 10	55 ± 10	
Transmitter power, kW	10	10	20	10	10	10	10	
Data transmission (TTY)								
Angles	Real time	Real time	Real time	Real time	Real time	Real time	Real time	
Doppler	Real time	Real time	Real time	Real time	Real time	Real time	Real time	
Ranging (to 800,000 km)	Real time	Real time	Real time	Real time	Real time	N/A	Real time	
TLM	Real and near-real time	Real and near-real time	Real and near-real time	Real and near-real time	Real and near-real time	Real and near-real time	Real and near-real time	
Demodulated TLM	Dual channel	Dual channel	Dual channel	Dual channel	Dual channel	1	Dual channel	
Command capability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Data pack air shipment time to JPL	1 day	1 day	1 day	2 wk	2 wk	2 wk	10 days	10 days

[a]The following stations have acquisition aid: DSS 11, DSS 41, DSS 42, and DSS 51.

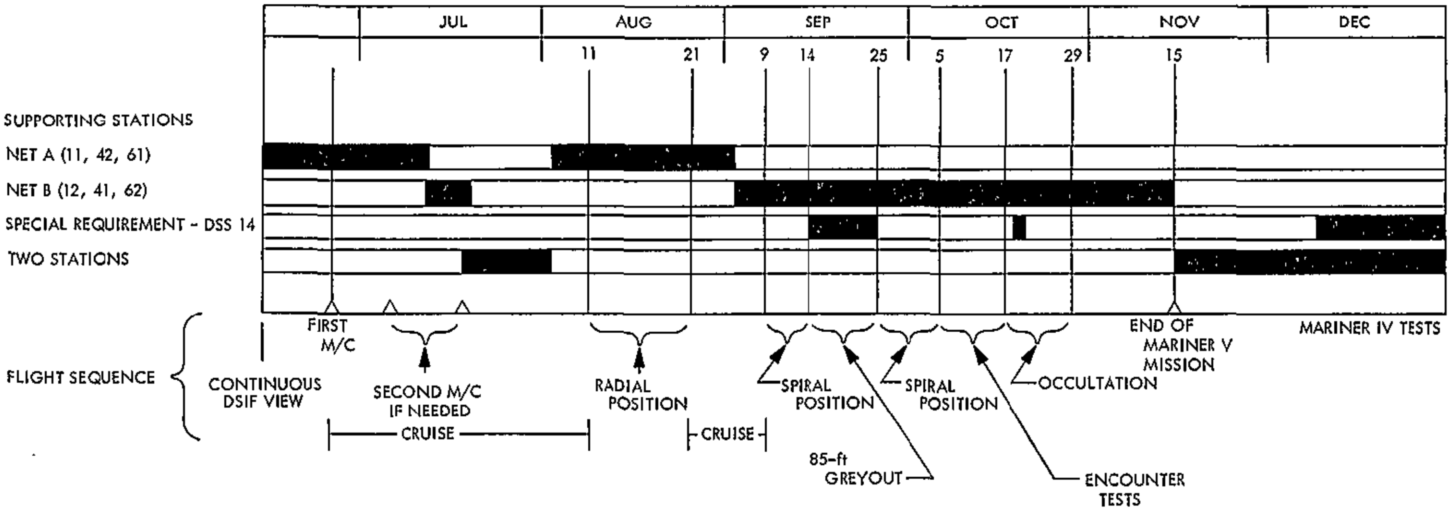


Fig 62 Planned tracking network configurations to meet *Mariner* Venus 67 tracking and data acquisition requirements

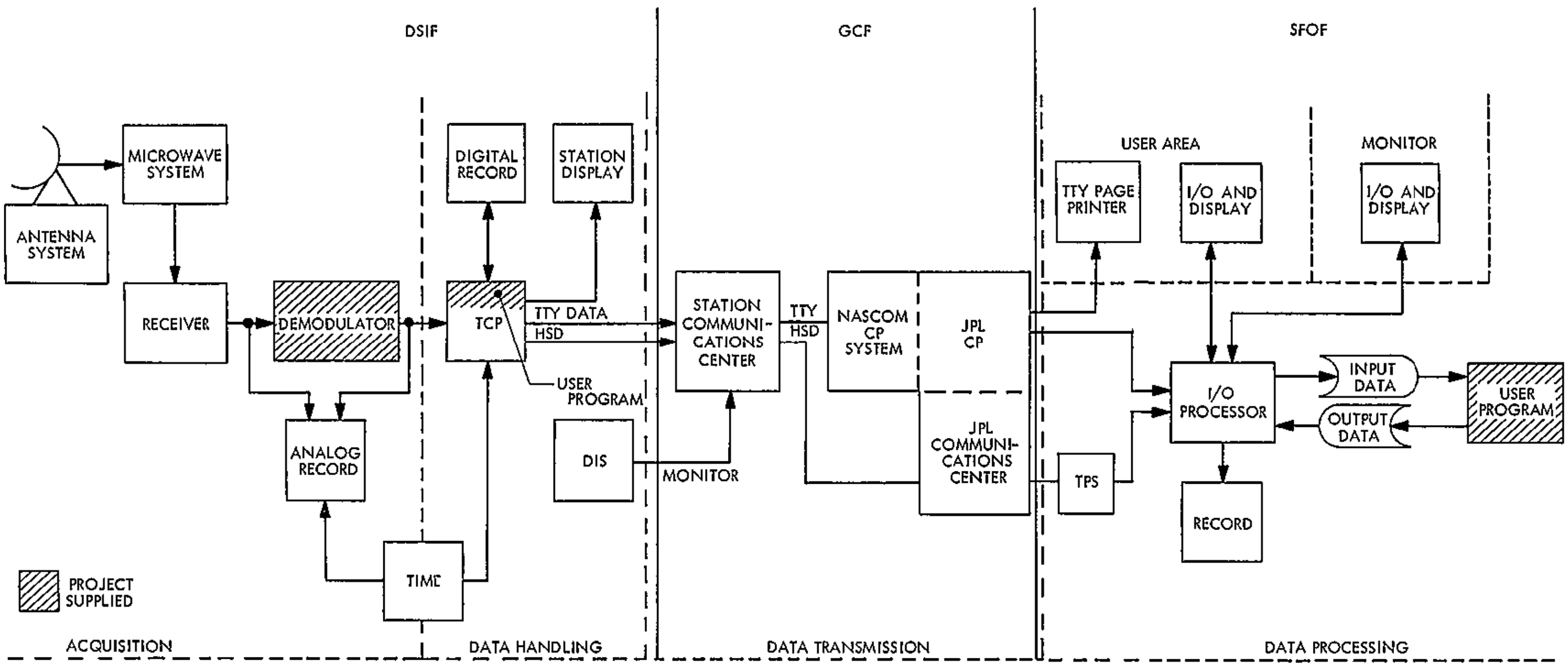


Fig 63 Telemetry system configuration for *Mariner* Venus 67

teletype and HSD circuits These operations are performed by the TCP at the DSIF A mission-dependent program, which resides in the TCP, performs manipulation of the data, as prescribed by the project The TCP also produces receiver automatic gain control (AGC) and static-phase error (SPE) data

Teletype and HSD are transmitted to the SFOF by the DSN GCF Teletype data arriving at the SFOF are processed by the CP, which routes data to various devices in the SFOF High-speed data are received at the SFOF Communications Center and are forwarded to the TPS to be formatted for entry into the input/output (I/O) processor (IBM 7044 computer) The data processing function is discussed later in this section

2 *Tracking data system configuration* The TDS configuration is shown in Fig 64 The purpose of the tracking data handling subsystem (TDH) is to process, display, record, and encode for teletype, the DSIF tracking data and doppler information Data are provided in digital form of angles representing antenna position, doppler frequency, transmitter VCO frequency, ranging data condition, time, and associated identification information The representation is in the form of standard five-level Baudot code punched on paper tape The prime function of the TDH is that of counting doppler, in addition, it acts as the assembly and formatting center for the other tracking data at the station There is one TDH subassembly at each DSS

Tracking data are transmitted from the DSSs to the JPL Communications Center via 60 word/min teletype lines by the GCF The JPL Communications Center route incoming teletype data through the CP to the 7044 I/O processor—which is the input computer for the SFOF data processing system (DPS)—and to teletype page printers

Raw teletype data from the CP will be passed by the 7044 directly to the 7044/7094 shared-disk and logged on tape Data will be tapped from the stream and processed for display purposes The 7044 I/O processor uses the teletype preambles to identify data types If these data types are missing or unrecognizable, the information will be entered from the SFOF data processing control console (DPCC)

3 *Command system* Commands can be sent to the spacecraft during any phase of the mission The spacecraft command system consists of a command detector and decoder and a set of switches that provide logical outputs to the spacecraft subsystems On receipt of a command in the spacecraft, a logical output is provided to the appropriate subsystem if it is a direct command (DC), and timing information is provided to the central computer and sequencer (CC&S) if it is a quantitative command (QC)

The functions performed by the ground command system are generation, transmission formatting, communications priority, processing, and transmission

a *Generation* DC tapes are prepared at GSCS and sent to DSIF operations DSIF operations verifies the received tapes for correctness and ships them to each DSS They must be received by the DSS 1 wk prior to the first possible launch date

Quantitative command messages are generated in the SFOF by the IBM 7094 in teletype format and placed on the IBM 1301 disk When requested, the computer output is on a teletype page printer and a reperforator On receiving a QC from the SFOF, the DSS retransmits the command to the SFOF The transmitted and the retransmitted tapes are compared and verified Command requests are made only by the technical and operational teams within the SFOF, using approved command decision procedures

b *Transmission formatting* All commands (QC or DC) are assigned a code word, frequency designation, and channel designation prior to being transmitted to a DSS

c *Communications priority* The primary mode for communicating command messages and verifications is teletype, the backup mode is voice Command messages transmitted by voice are in the format used for teletype, the backup mode is voice Command message as soon as possible

d *Processing* The ground command system provides a command interface between the SFOF and the transmitter at the DSS The subsystem has the following modes of operation

(1) Mode 1 verify is used to verify the command as received by teletype

(2) Mode 2 verify is used to verify that the ground modulator and detector are functioning properly

(3) Mode 3 transmit is used to transmit a command to the spacecraft If the ground command subsystem detects an error either in the command format or the ground command subsystem circuitry, the command transmission will be inhibited

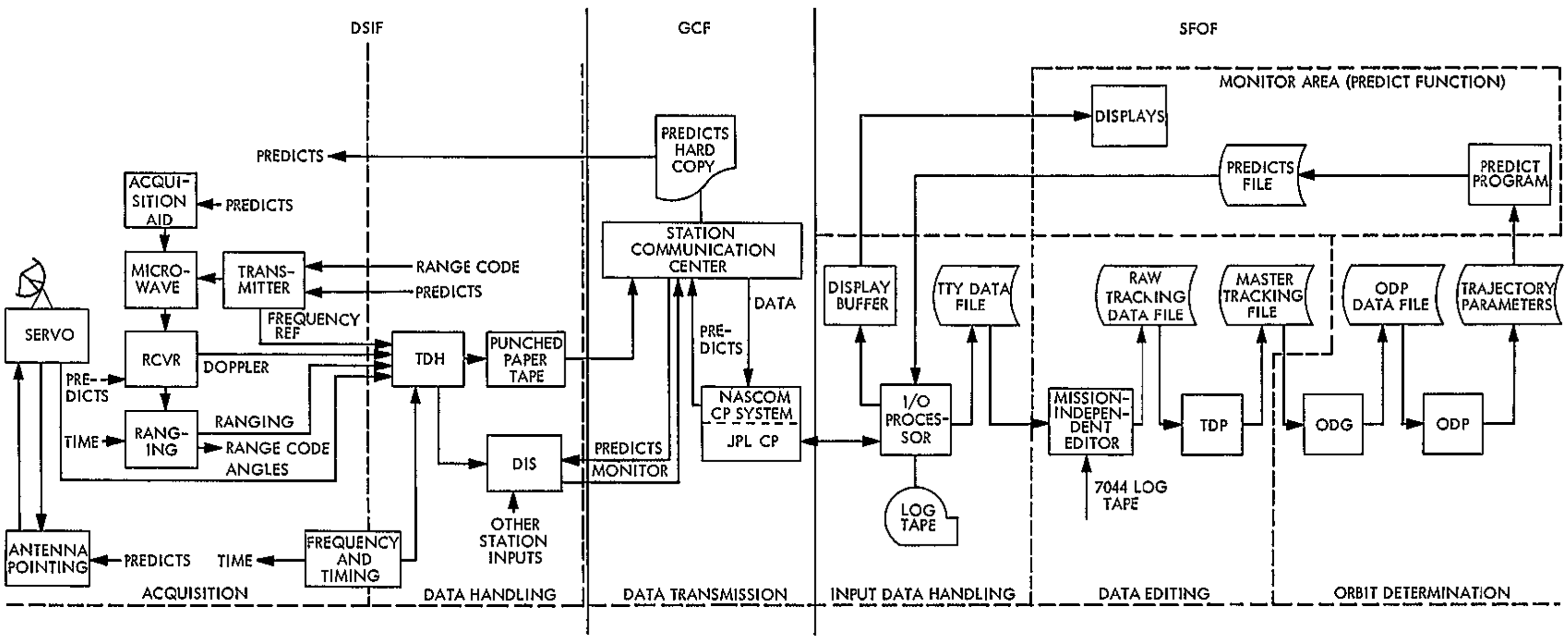


Fig. 64. Tracking system configuration for *Mariner* Venus 67

e Transmission The transmitter is modulated by the output of the read-write-verify (RWV) The transmitter output is sampled by a directional coupler in the transmitter exciter and is connected back to the RWV monitor receiver During the transmission of a command, the output to the transmitter is compared to the input from the exciter If an error is detected, the command is inhibited There are the three following modes used for transmitting a command

(1) Unless otherwise instructed, all commands are transmitted in the manual mode This consists of manually pressing the initiate pushbuttons at the time specified

(2) The command is initiated in the auto mode whereby the predetermined time of initiation is set into the timed-start thumbwheel switches When the time of day equals this setting, the command is automatically initiated

(3) An emergency mode is used to transmit a command to the spacecraft in the event of a system malfunction or system power supply failure Operating voltages are made available from an emergency power supply to a limited portion of the subsystem logic, using only the transmit function

4 Ranging configurations. The standard DSIF configuration with mark I ranging is used at any station in the early part of the mission (out to a few million miles) The second part of the mission ranging is conducted only from Goldstone, using research and development (R&D) personnel and equipment to supplement standard DSIF configuration The planetary ranging experiment requires the 210-ft Mars site antenna to be fitted with a 20-kW transmitter, plus a supplement to the existing receiver Measurements are necessary at least one to 1½ h/wk, during the pre-encounter period Measurements immediately prior to encounter, and as near to post-encounter emergence as feasible, are of extreme value in determining the astronomical unit Figure 65 shows the planetary ranging interface The salient planetary ranging system characteristics are as follows

(1) 920 computer based with one digital rack and two IF racks in the Alidade room of DSS 14

(2) Two correlation channels reduce acquisition time by one-half

(3) Doppler-aided tracking results, narrower code loop bandwidths (0 01 Hz)

(4) Resolution 0 15 m vs 1 0 m in mark I

(5) Range greater than 80 million km vs 0 08 million km in mark I

5. Occultation configuration. The high-atmospheric density of Venus causes doppler perturbations of the order of 30 kHz, as compared to 3 Hz (one-way) in case of the Mars-occulting *Mariner IV* The atmosphere also acts as a defocusing lens which produces refractive attenuation These conditions require a large aperture

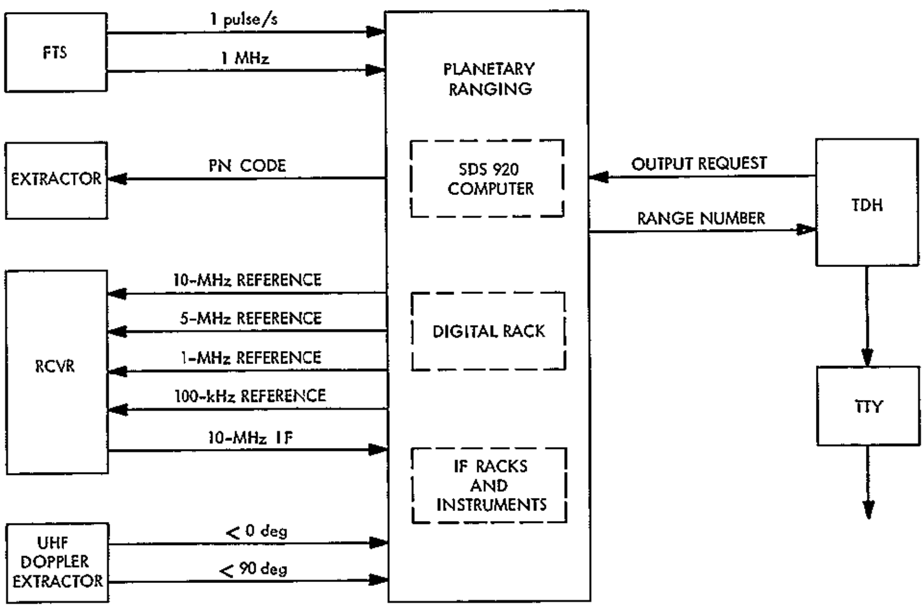
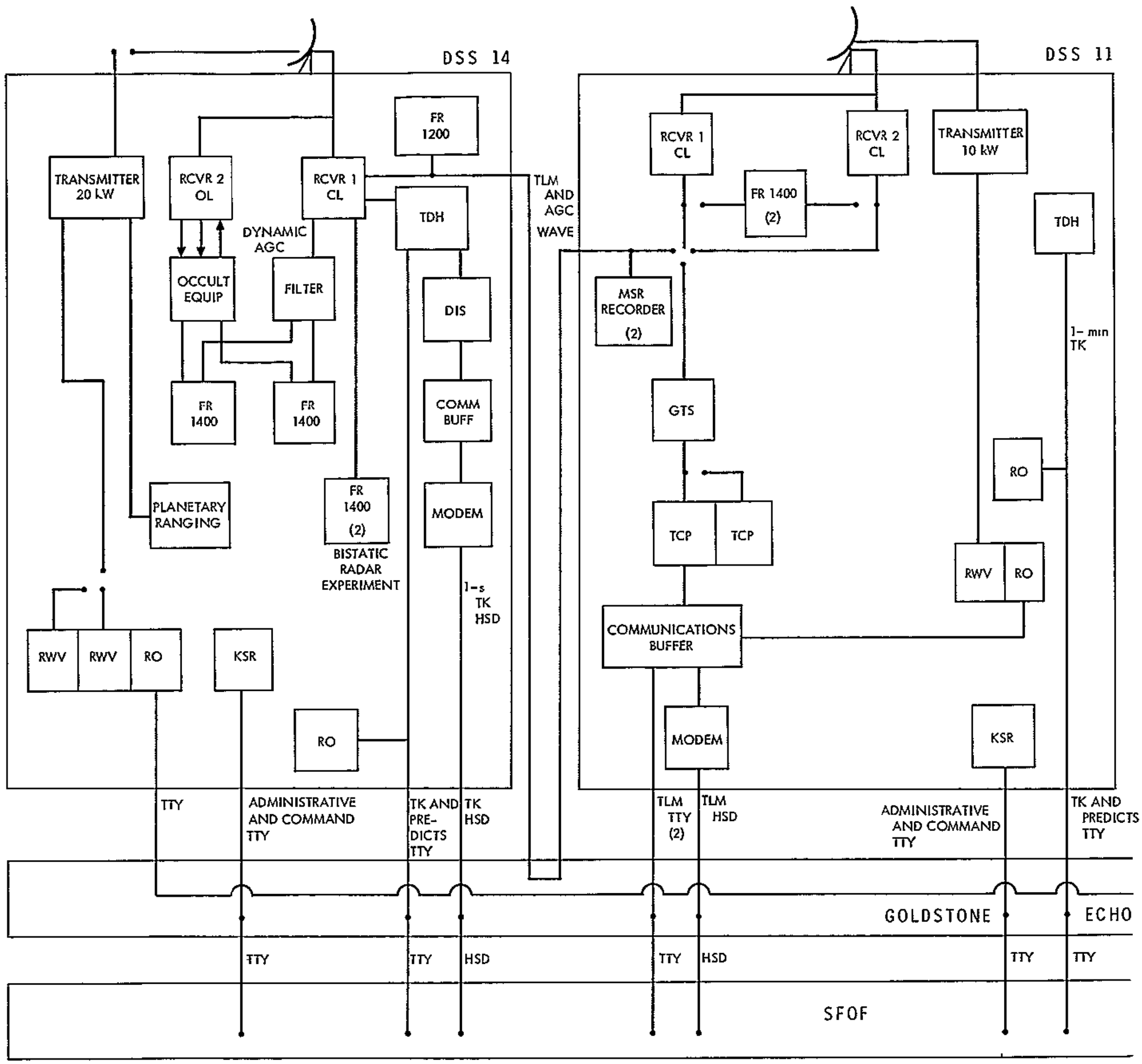


Fig 65. Planetary ranging system interface configuration



NOTE DSS 62 (DSS 51 BACKUP) AND DSS 41 (DSS 42 AS BACKUP) ARE IN STANDARD CONFIGURATIONS

Fig 66 DSIF/GCS configuration from *Mariner V* encounter

antenna to ensure the most favorable possible signal-to-noise ratio (SNR) To meet this requirement, a special configuration will be established, as shown in Figs 66 and 67, the site configuration is shown in Fig 66 and the SFOF configuration in Fig 67 The DSIF (Goldstone) occultation system characteristics are as follows

(1) DSS 14 Prime occultation station, one open-loop receiver, one closed-loop receiver, special occultation equipment with output recorded on FR-1400s, tracking HSD output from DIS

(2) DSS 13 Backup for open-loop receiver (using planetary radar system receiver)

(3) DSS 12 Backup for closed loop receiver (standard receiver)

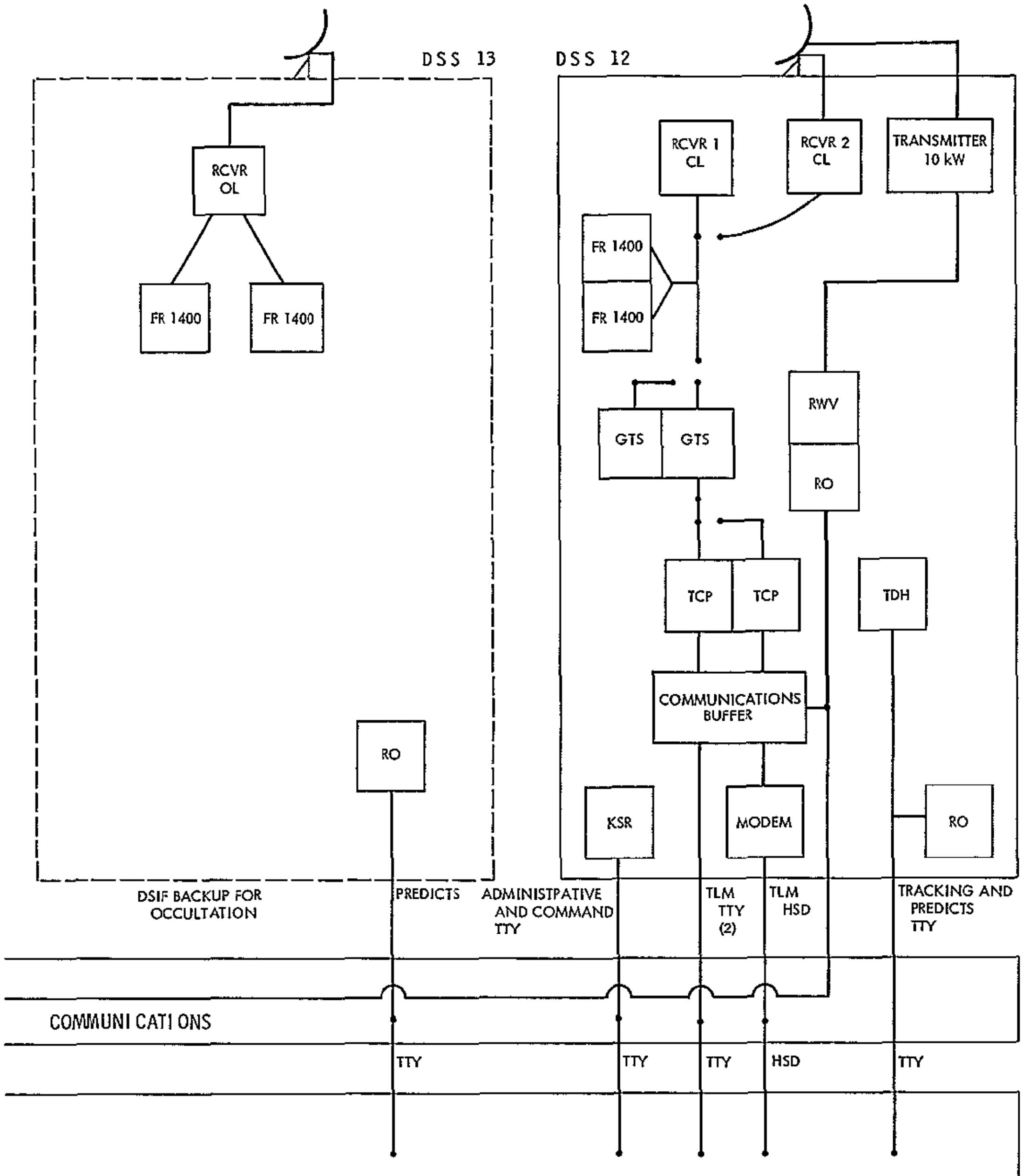


Fig. 66 (contd)

Required occultation system tests are listed below (additional DSN tests are discussed in Section IV)

(1) In-flight testing of spacecraft auxiliary oscillators to determine stability

(2) In-flight rehearsals for training of personnel and evaluation of equipment

(3) Simulator rehearsals to duplicate expected atmospheric effects

6 DFR experiment configuration JPL facilities also supported Stanford University's DFR experiment During the flight, Stanford radiated the 423 3-MHz and 49 8-MHz dual frequencies whenever the spacecraft was above the Stanford local horizon and the DSIF was

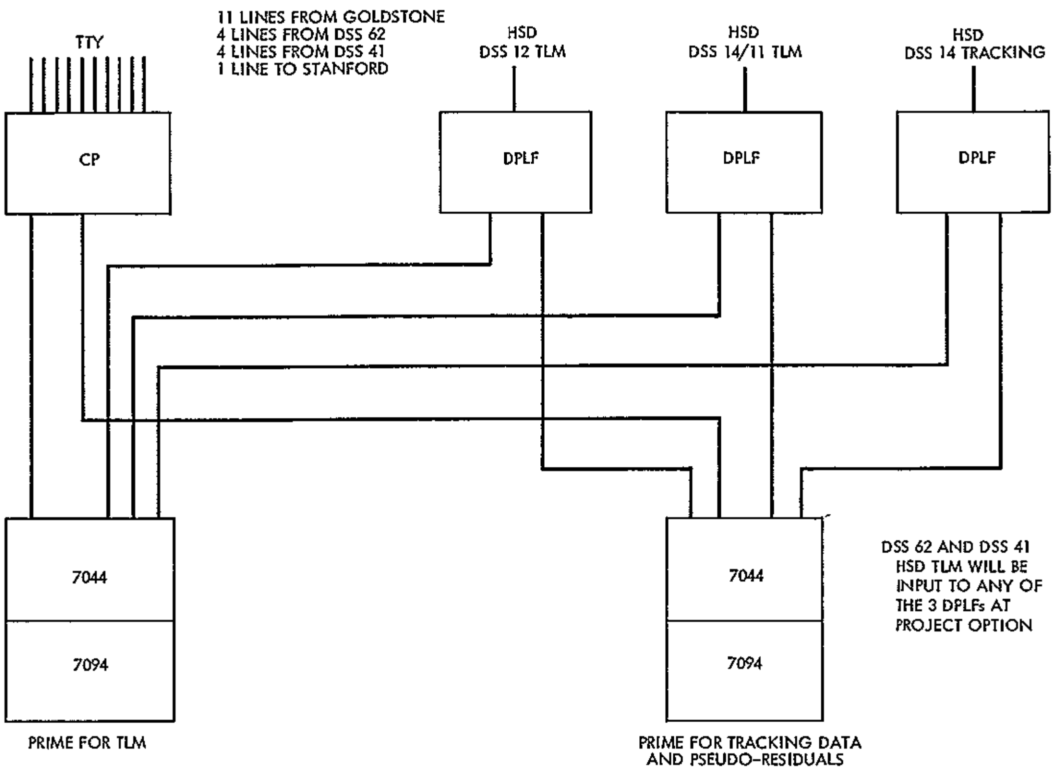


Fig. 67 SFOF configuration for *Mariner V* encounter

tracking The DFR telemetry data were routinely received by the DSS in real time during assigned tracking periods The data were relayed to the SFOF for real-time processing and transmission to Stanford, where the data were analyzed and evaluated The DFR experiment data flow is shown in Fig 68

7 DSN Ground Communications Facility

a General configuration The DSN GCF is a configuration of NASCOM facilities designed to provide those communications circuits, switching facilities, terminals, equipment, and personnel required to ensure the effective transfer of information between the DSS and the SFOF Figures 35 and 36 show a review of the CP and teletype systems Figure 69 further illustrates the communications configuration for the deep space phase by identifying specific teletype, voice, and HSD circuits which were established to meet requirements

b Voice communications The GCF provides a system of full-period, leased, four-wire, engineered voice circuits to a majority of the sites in the network Most of the voice circuits are routed via the GSFC switching center and comprise the signaling, conferencing, and monitoring arrangement (SCAMA) Circuits are routed by hardwire and microwave wherever possible These circuits extend to overseas points through transoceanic cables or by HF radio links in those cases where cables are not available They are used for both operational and nonoperational traffic Both common user and private lines are provided Voice HSD circuit configurations are shown in Figs 70 and 71

c High-speed data The GCF provides a system of full-period, leased, HSD circuits for the purpose of transmitting spacecraft telemetry requiring a higher bit rate than that of teletype These circuits are assigned solely to operational traffic At the SFOF, all HSD are routed to the TPS for preprocessing and then to the 7044 I/O processor

a Teletype The GCF provides a teletype system of full-duplex links composed of leased and commercial facilities obtained from national, international, and foreign common carrier agencies For reliability purposes, overseas circuits employ undersea cables wherever possible, but are necessarily routed via radio facilities to reach certain locations Error detection and correction systems are (where required and available) provided on

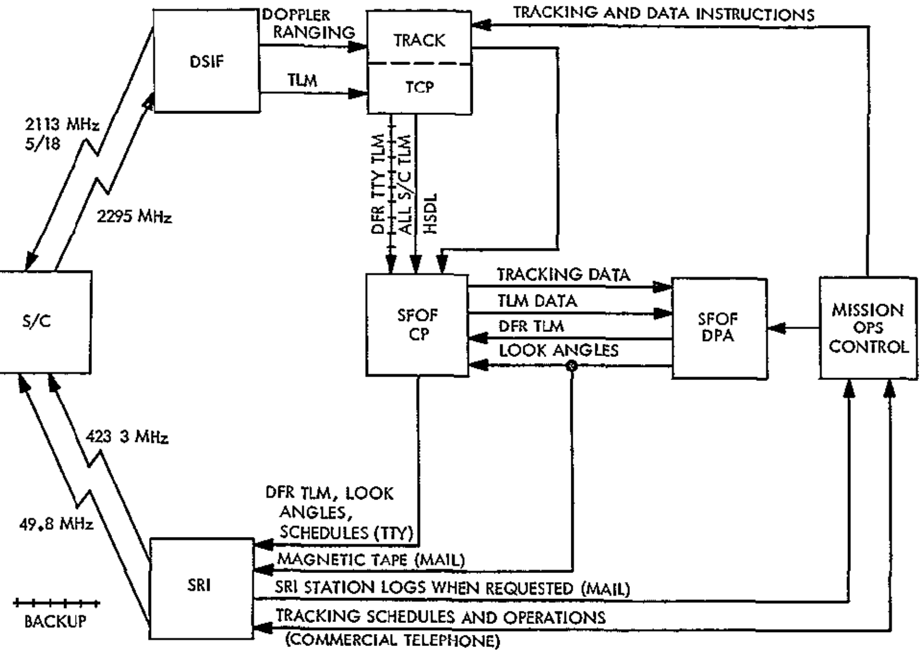


Fig. 68 DFR experiment operational data flow diagram

the overseas circuits by the common carriers to reduce error rates to the minimum possible within the state of the art All teletype circuits are used for operational and nonoperational traffic Both common user and private lines are provided In the nonoperational modes, these circuits are used for the non-real-time transmission of nonoperational messages

In the operational mode, teletype circuits are used for the transmission of

(1) Spacecraft tracking data

(2) Spacecraft telemetry data (low bit rates)

(3) Spacecraft commands, predictions, and reports

(4) SFOF information for control and coordination of launch and DSS operations

(5) SFOF information controlling and coordinating communications

Teletype data were switched on a message basis by the CPs of the NASCOM CP System (Figs 35 and 72) The CPs are located as follows

(1) A 418 computer at London, serving DSSs 51, 61, and 62

(2) A 418 computer at Canberra, serving DSSs 41 and 42

(3) A 498 computer at GSFC, serving SCS 71, DSS 72, and Building AO at AFETR

(4) A 490 computer at JPL, serving DSSs 11, 12, 14, and Stanford

All overseas teletype data are routed from the overseas CP to GSFC, and then to JPL over wideband trunks with error correction capability The JPL CP routes all data, based on preamble information, to the appropriate preplanned points in the SFOF DPS, teletype page printers, and closed-circuit TV

Figures 73–80 show the specific teletype configurations for DSS supporting the deep space phase showing specific circuit designators and data types transmitted on each circuit

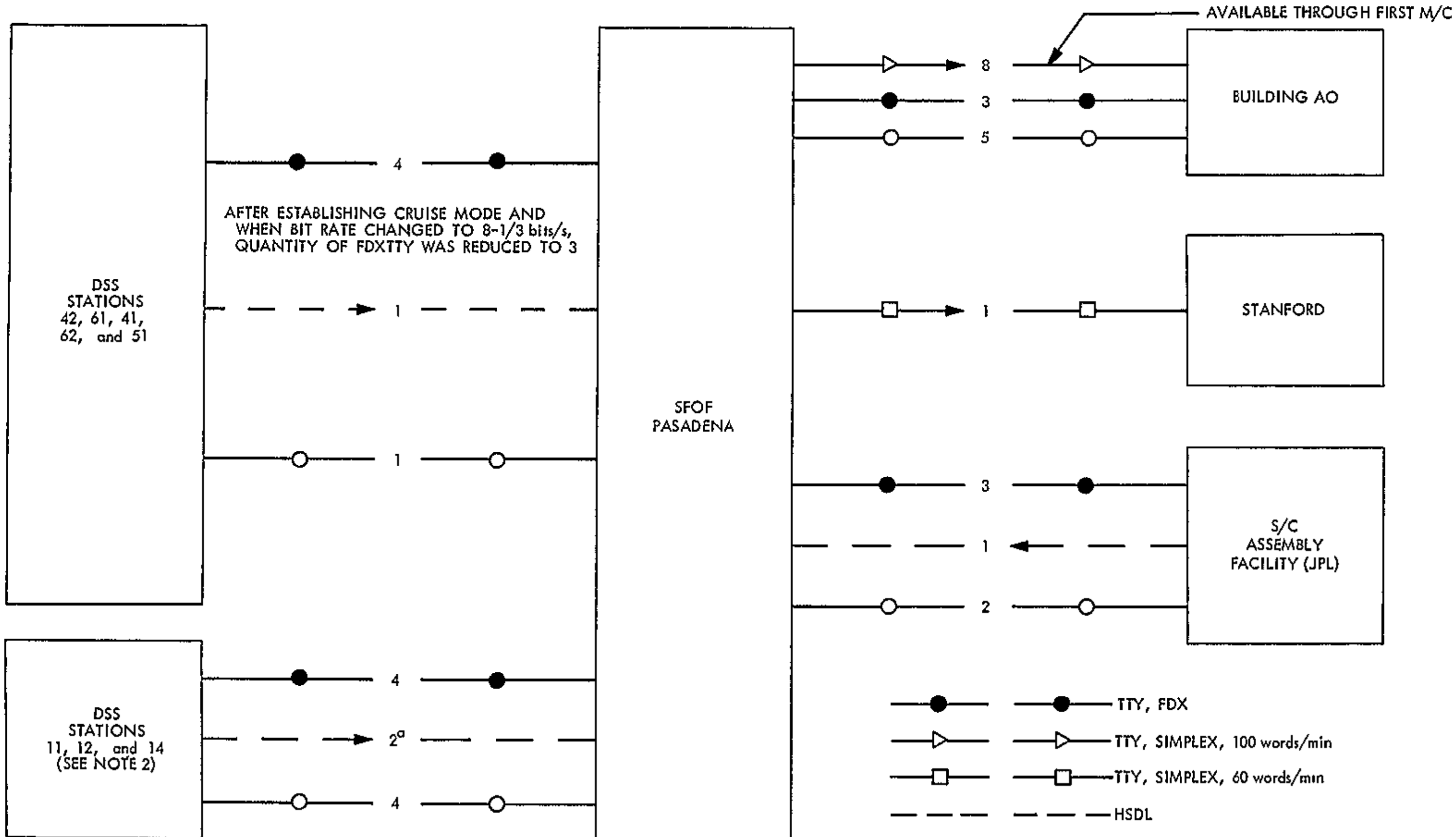
8 *DSIF data processing* The DSS planned to perform on-site data processing as follows

(1) The TCP

(a) Format the telemetry data received from the *Mariner* Mission-related-hardware (MRH) for transmission to the SFOF in real time

(b) Provide selected station functions to the SFOF (receiver in-out lock, demodulator in-out lock, and receiver AGC)

(c) Assign DSIF time to the telemetry data



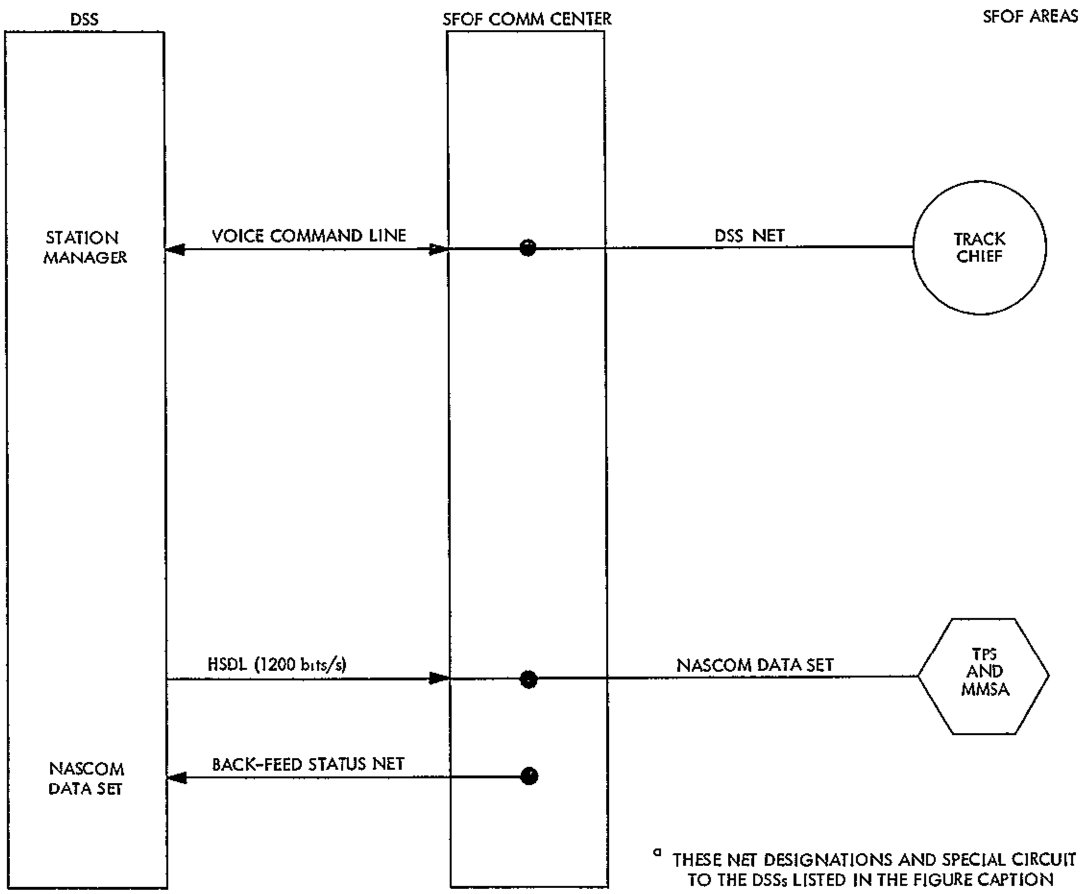
[a]SECOND HSDL TO BE REQUIRED DURING ENCOUNTER.

NASCOM PROVIDED CIRCUITS AS SHOWN.
ALL TTY AND ONE VOICE AVAILABLE TO CATS. QUANTITIES INCLUDE DSN/PROJECT REQUIREMENTS

Fig. 69. Ground communications, deep space phase

DSS[a]

CIRCUIT TYPE/MODE	SFOF DISPLAY DESIGNATION	DIRECTION OF DATA (DSS-JPL)	SPECIAL CIRCUIT USES AND REMARKS
VOICE	DSS[a] NET	⟷	STATION VOICE LINE, DSIF CONTROL TRAFFIC
DATA	HSDL	⟷	S/C HSD TLM DATA TO SFOF VIA NASCOM SATELLITE OR AFETR DOWNRANGE HF CIRCUIT (1200 bits/s) THE STATUS NET WILL BE BACK-FED TO STATIONS DURING HSD ACTIVATION PERIOD



[a] THESE NET DESIGNATIONS AND SPECIAL CIRCUIT USES APPLY TO THE DSSs LISTED IN THE FIGURE CAPTION

Fig 70 Voice/HSD circuit configuration diagram, SFOF/DSS 72, 61, 62, 41, 42, 11, and 12

(2) The TDH

(a) Format tracking (angle, doppler, ranging and/or transmitter frequency) for transmission to the SFOF

(b) Assign DSIF time to the tracking data

(3) The recording subsystem

(a) Records telemetry data (composite and MRH output)

(b) Records selected station functions

(c) Records DSIF time

DSS 51

CIRCUIT TYPE/MODE	SFOF DISPLAY DESIGNATION	DIRECTION OF DATA (DSS-JPL)	SPECIAL CIRCUIT USES AND REMARKS
VOICE	DSS 51 NET	⟷	STATION VOICE LINE DSIF CONTROL TRAFFIC
DATA	HSDL	⟶	S/C HSD TLM DATA TO SFOF VIA SIMPLEX HF HSDL (550 bits/s) VIA DSS 51 TO PRETORIA TO TANGIERS TO RIVERHEAD, N Y

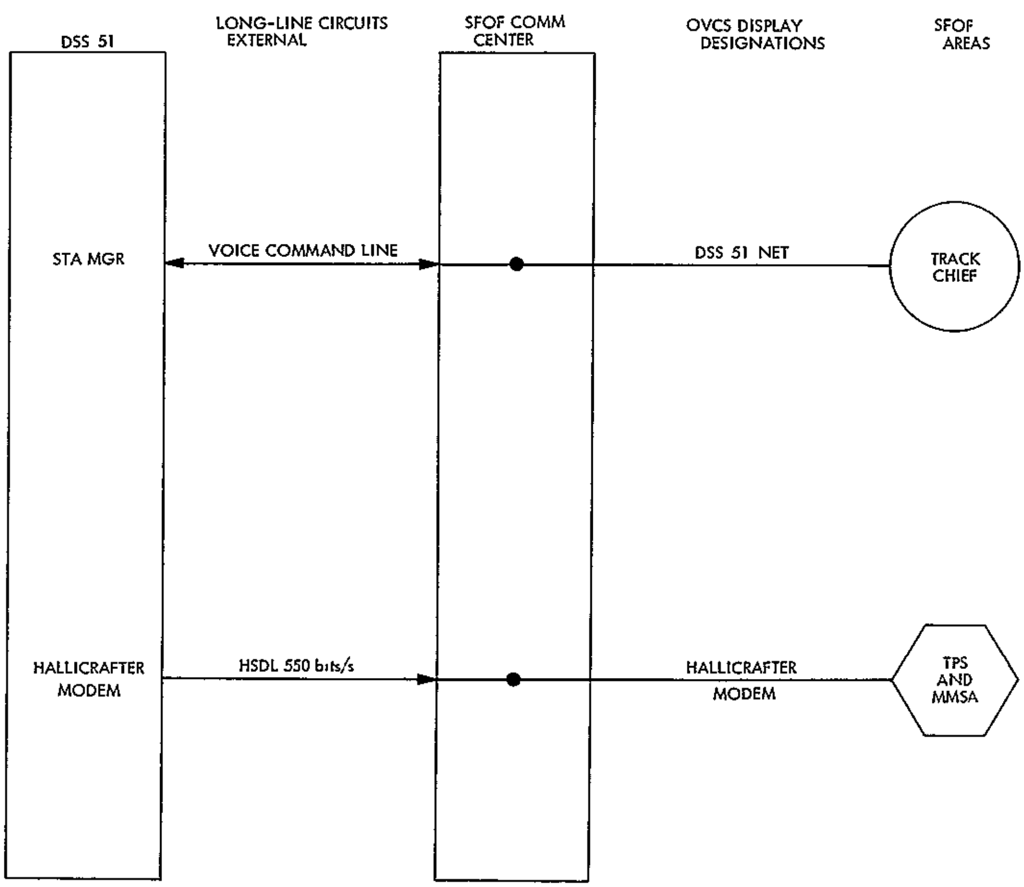
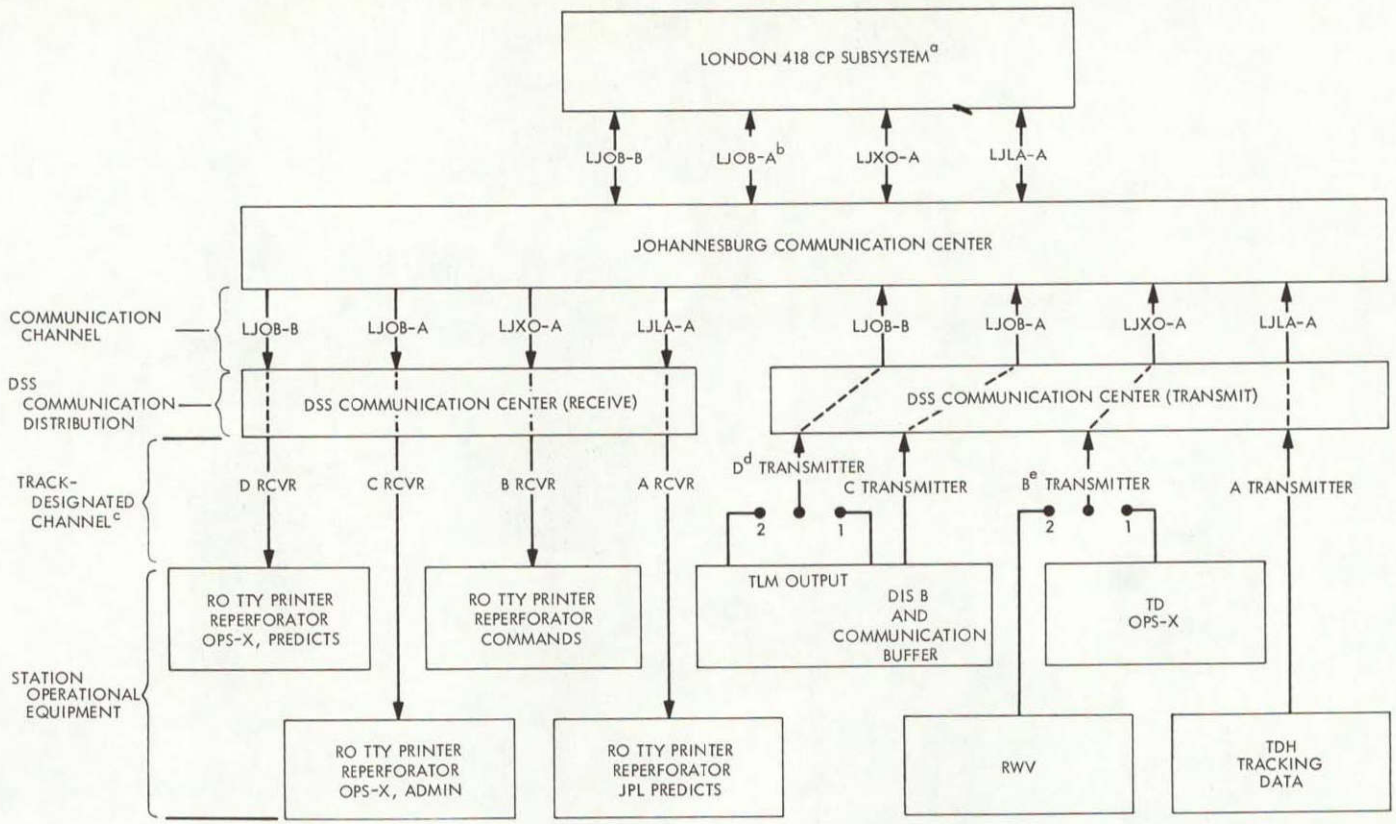


Fig 71 Voice/HSD, SFOF/DSS 51 circuit configuration diagram

Fig. 72. JPL communications processor



[a] IF PRE ALTERNATE ROUTED JOHANNESBURG TRAFFIC TO PERTH, THEN THE CANBERRA 418 CPS WAS USED, AND ROUTING WAS VIA GBUR INSTEAD OF LJOB

[b] TRANSMISSION WAS VIA HF SINGLE SIDEBAND, MULTIPLEXED FROM PRE

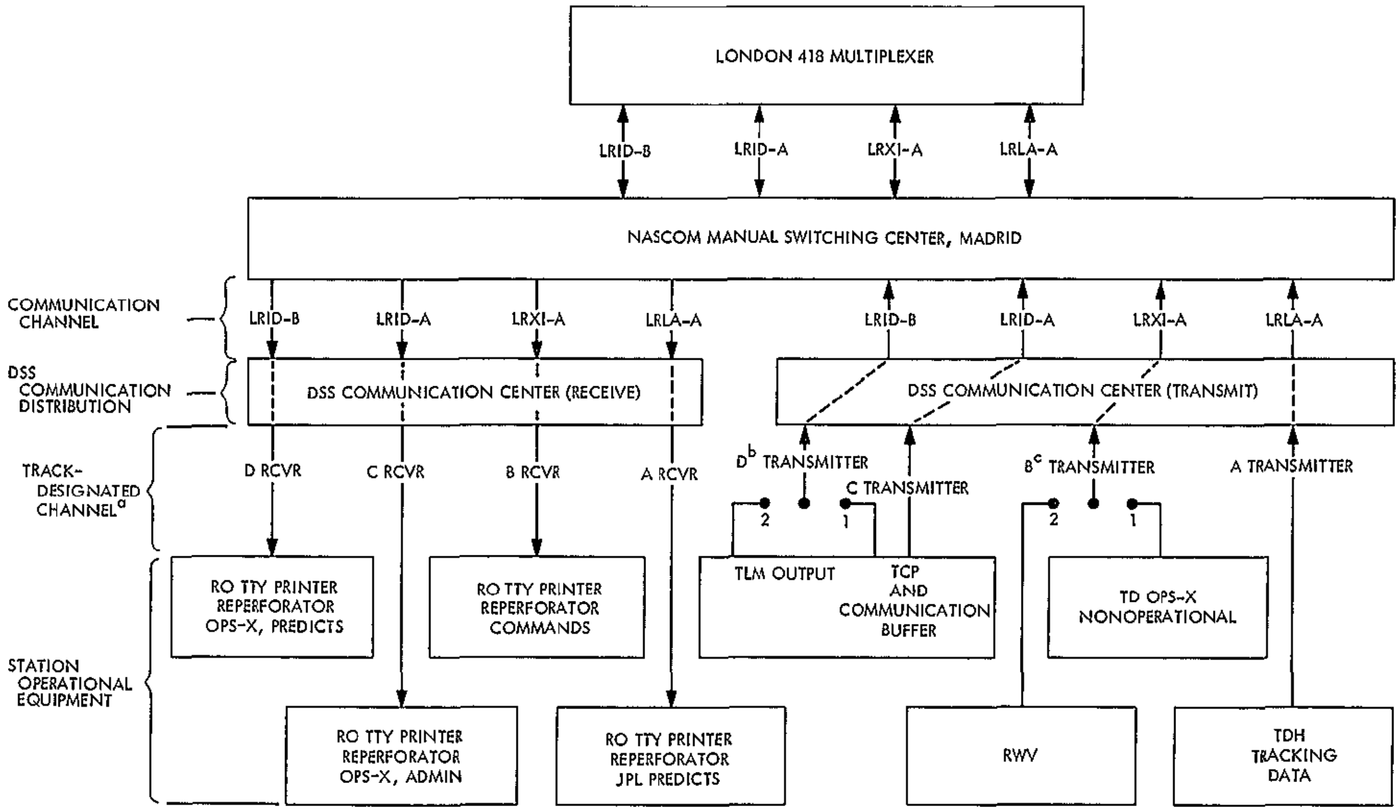
[c] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53 and 62
E	63

[d] D WAS CALLED CHANNEL E WHEN TRANSMITTING THE STANFORD FORMAT

[e] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig. 73. Station teletype configuration, DSS 51, Johannesburg



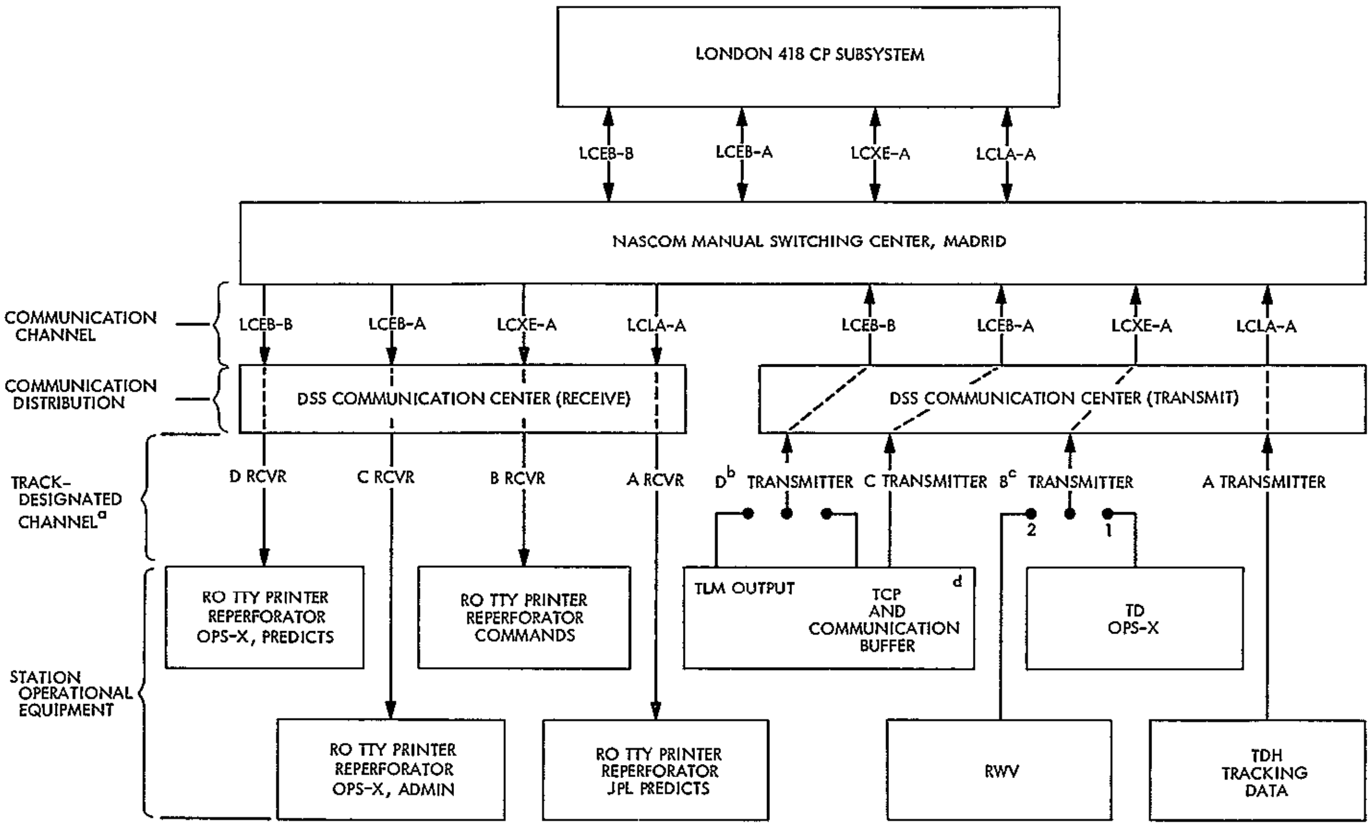
[a] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53, and 62
E	63

[b] D WAS CALLED CHANNEL E WHEN TRANSMITTING THE STANFORD FORMAT

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig. 74 Station teletype configuration, DSS 61, Robledo



[a] STATION DATA ASSIGNMENT

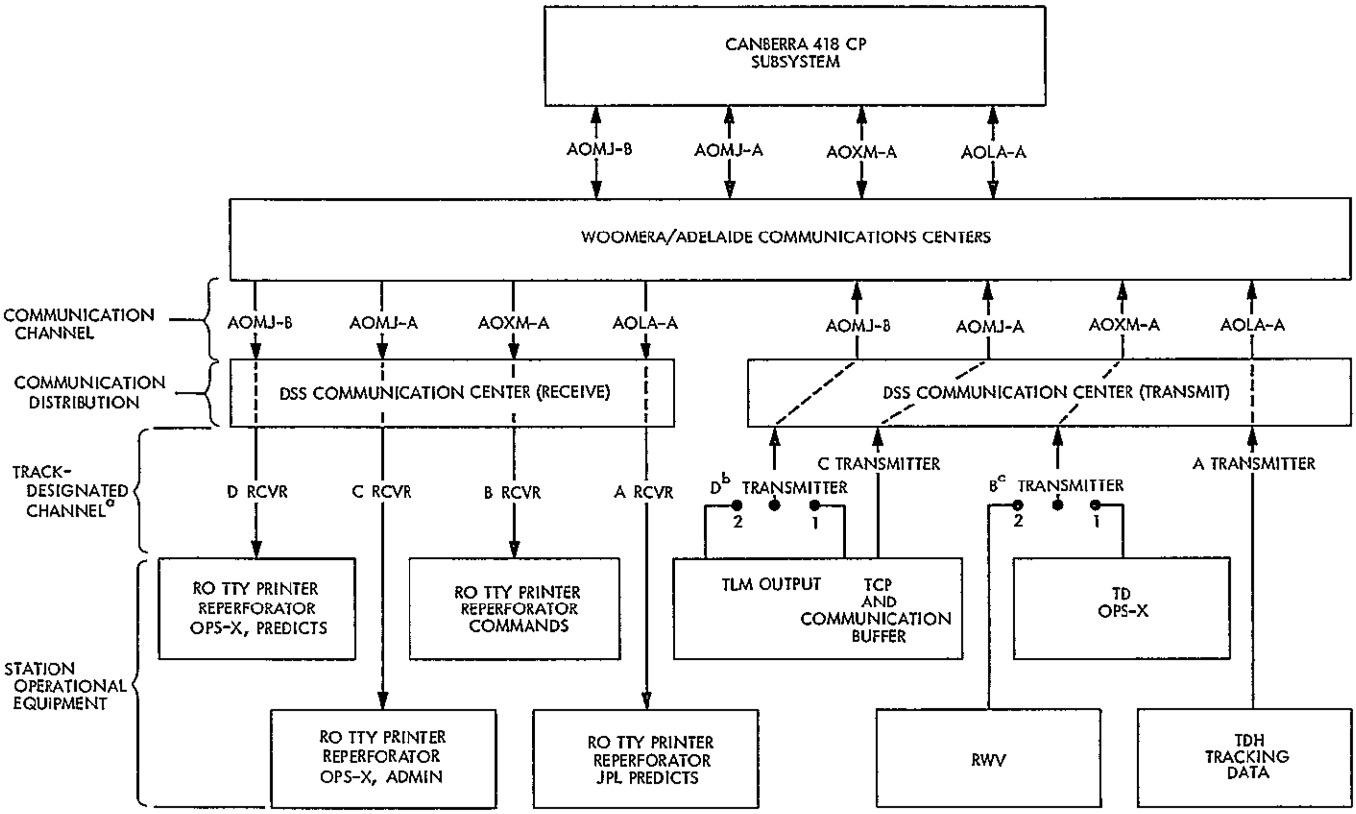
TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53, and 62
E	63

[b] D (TX) BECAME CHANNEL E WHEN STANFORD FORMAT WAS TRANSMITTED

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

[d] DSS 62 HAD NO TCP TLM WAS SENT TO DSS 61 FOR FORMATTING AND WAS THEN PATCHED DIRECTLY TO NASCOM SWITCHING CENTER

Fig 75 Station teletype configuration, DSS 62, Cebreros



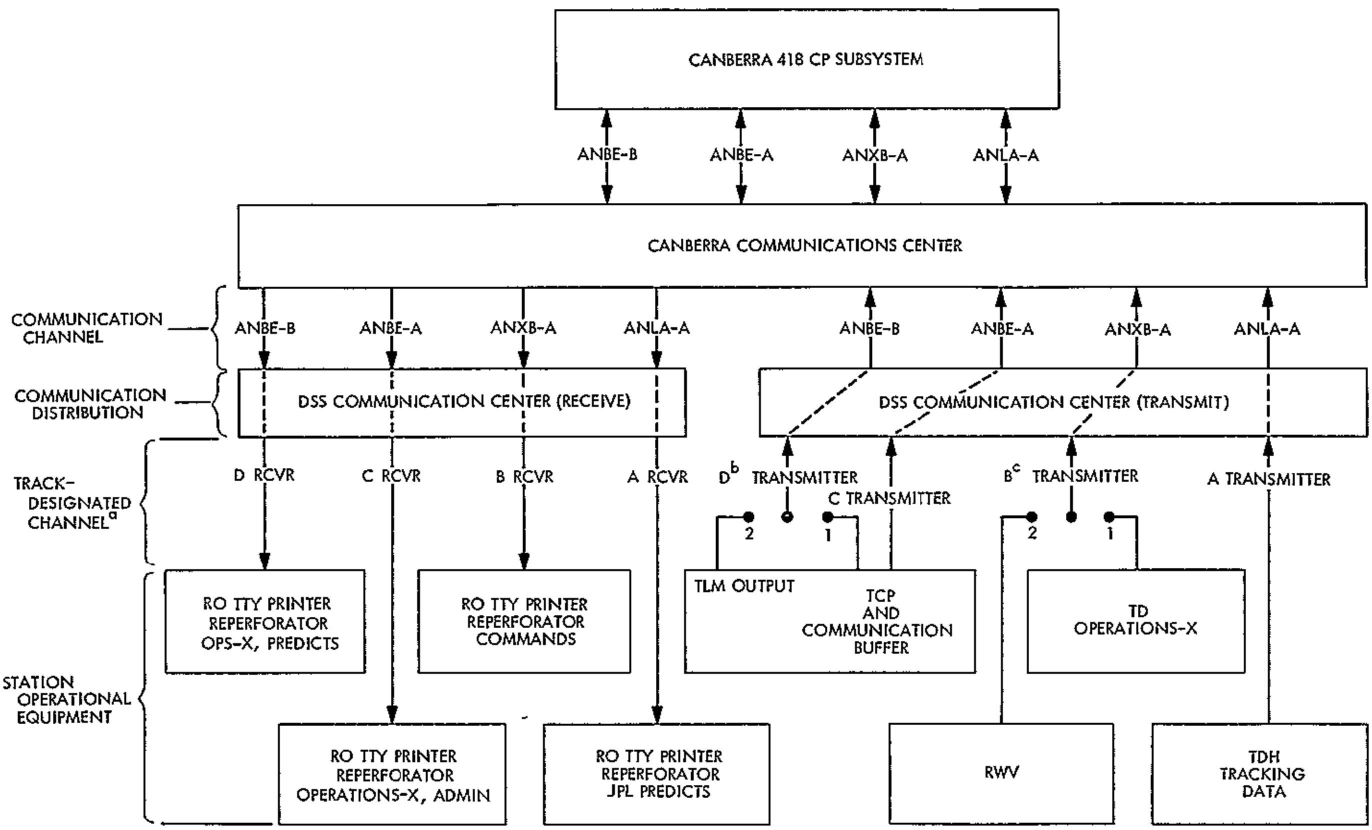
[a] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53, and 62
E	63

[b] D WAS CALLED CHANNEL E WHEN TRANSMITTING THE STANFORD FORMAT

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig 76 Station teletype configuration, DSS 41, Woomera



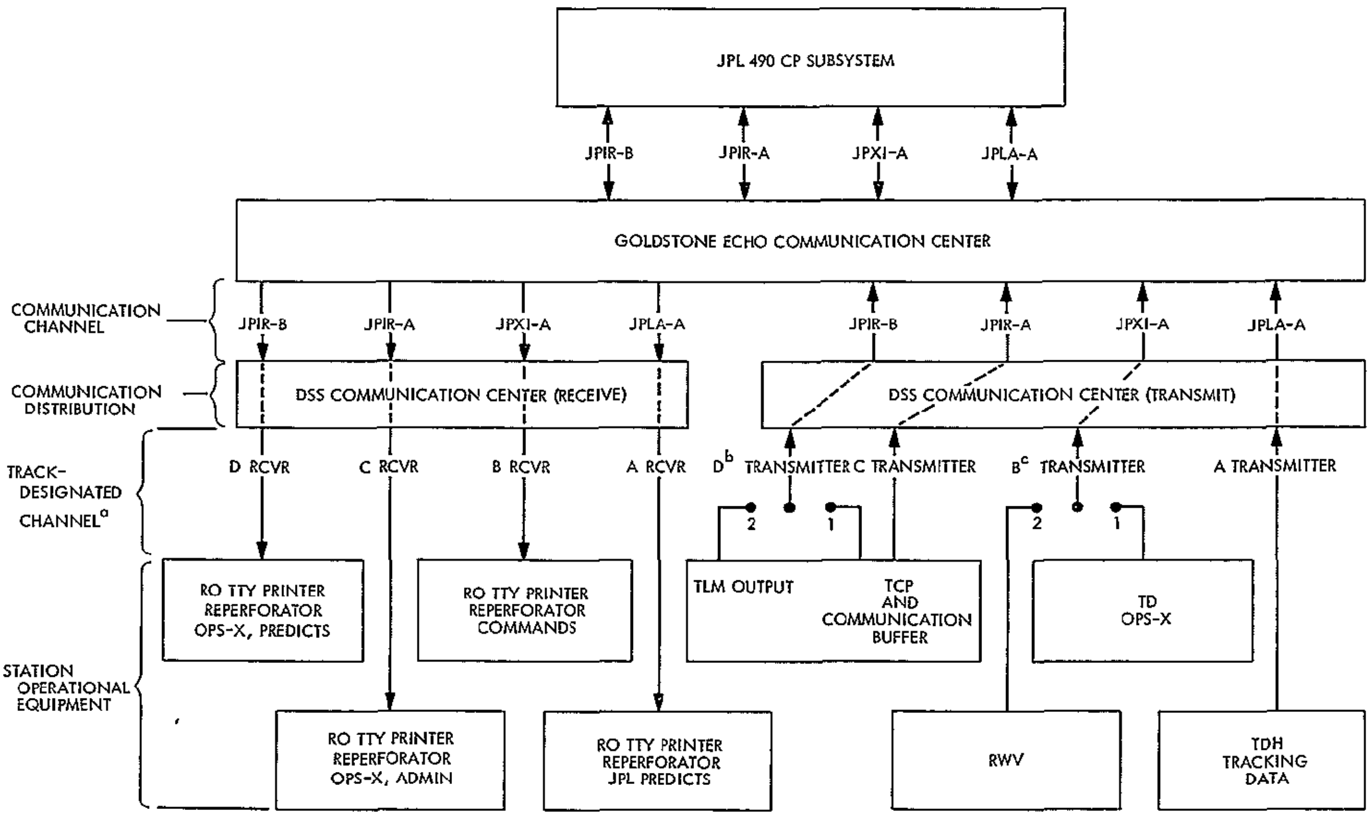
[a] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53 and 62
E	63

[b] D TRANSMITTER WAS CALLED CHANNEL E THIS WAS FOR STANDFORD FORMAT TRANSMISSION

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig 77. Station teletype configuration, DSS 42, Tidbinbilla



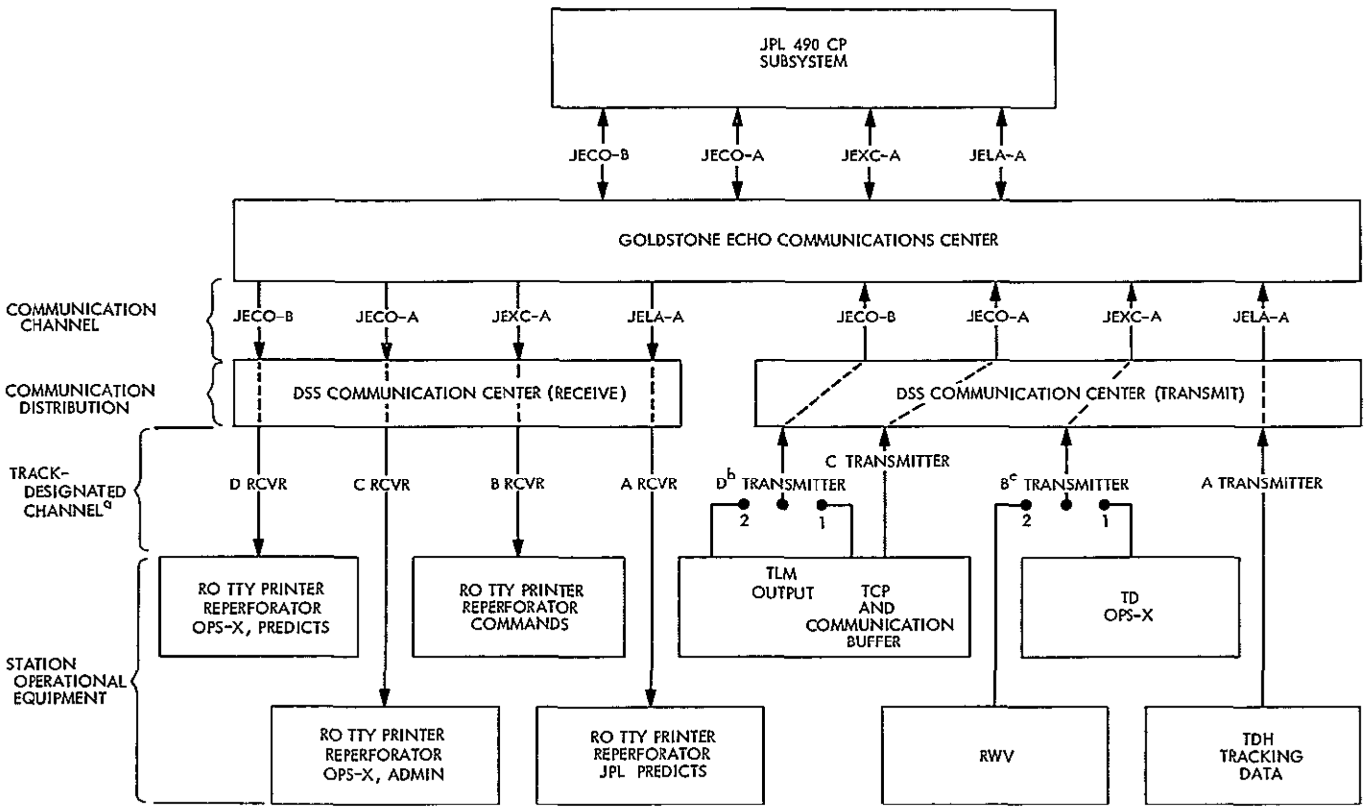
[a] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53 and 62
E	63

[b] D WAS CALLED CHANNEL E WHEN TRANSMITTING THE STANFORD FORMAT

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig 78 Station teletype configuration, DSS 11 (Pioneer Station)



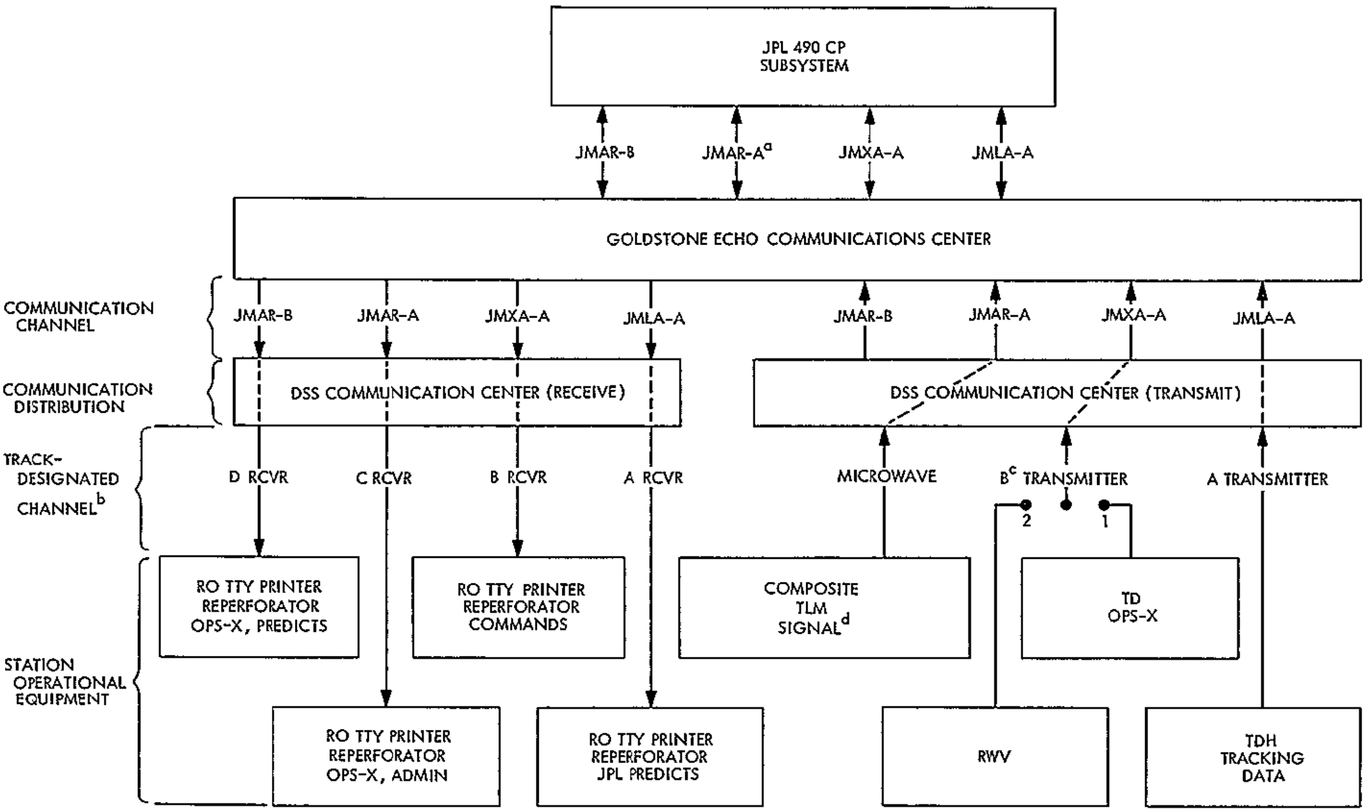
[a] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70
C	50, 60, 51 and 61
D	52, 53, and 62
E	63

[b] D WAS CALLED CHANNEL E WHEN TRANSMITTING THE STANFORD FORMAT

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

Fig 79 Station teletype configuration, DSS 12 (Echo Station)



[a] ONLY 3 FDX CHANNELS COULD BE ACTIVATED BECAUSE OF EQUIPMENT LIMITATIONS

[b] STATION DATA ASSIGNMENTS

TRACK-DESIGNATED CHANNEL	DATA TYPE
A	40
B	20 and 70

[c] B WAS EITHER 1 OR 2 DEPENDING ON REAL-TIME SELECTION

[d] TLM WAS PATCHED TO DSS 11 OR 12 VIA MICROWAVE FOR TCP AND THEN TO ECHO COMMUNICATIONS EITHER JECO OR JPIR CIRCUITS WERE USED TO FORWARD DEMODULATED TLM TO SFOF

Fig 80 Station teletype configuration, DSS 14 (Mars Station)

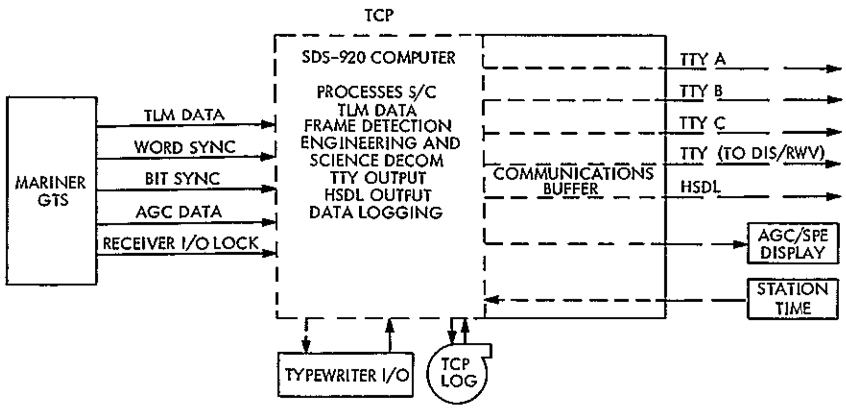


Fig 81. Telemetry and command processing at typical DSS

Figure 81 shows a DSS configuration for performing telemetry and command processing

9 SFOF data processing configuration and plans. The major data-handling effort within the SFOF is the processing and display of incoming tracking and telemetry data The SFOF data processing subsystems provide the following services in meeting user requirements

(1) Input-output processor (7044)

   (a) Format, convert to engineering units, and output in real time to display devices the telemetry and tracking data received from the DSIF and spacecraft testing areas

   (b) Alarm-monitor engineering and science telemetry data from the spacecraft

   (c) Record all incoming DSIF data on digital magnetic tape

   (d) Transmit tracking predictions and commands to the DSIF

(2) Main processor (7094), which has the following functions

   (a) Perform detailed analysis of spacecraft engineering and scientific data in non-real time when required by the sequence of events (see Table 33) or upon request from the space flight operations director (SFOD)

   (b) Perform spacecraft positioning analysis

   (c) Determine spacecraft orbit and generate tracking predictions

   (d) Generate maneuver commands

   (e) Generate a MDL consisting of all spacecraft data forwarded from the DSIF

DSIF and SFOF data processing functions are shown further in Fig 82

10 Summary of SFOF data processing operations and programs. Teletype data are received from the NASCOM system by the CP and provided to the 7044 In addition, information generated by the 7044 or 7094 is routed to the CP for distribution to SFOF user areas or remote sites In the 7044 redesign system, the mission-dependent equipment (MDE) telemetry program performs data processing functions similar to the TCP The program performs frame detection, decommutation, identification, and time tagging of spacecraft telemetry data These data can be transmitted by the 7044 to user areas and to other places in the NASCOM network The pseudo-residual plot program (PRPP) compares tracking data and prediction data obtained from the predict data tape Residuals are computed, based on incoming tracking data and predicted tracking observables, and displayed as plots in the user areas All data entering the 7044 system are logged on magnetic tapes

The user programs, shown in Figs 83–87, are shown operating in SFOF mode 2 A 7044, a 1301 disk, and a 7094 are shown operating and communicating with one another Control inputs, usually from punched cards or switches, are entered at the user areas, received by the 7044, and sent to the 7094 via the direct data channel (DDC) Modes 3 and 4 are shown in Figs 88 and 89 Figure 90 shows the master data library (MDL) programs

a Tracking data handling (TDH) and orbit determination (OD) As raw tracking data are received they are placed on the disk (Fig 83) by the 7044 system These data are then accessible to the 7094 user programs

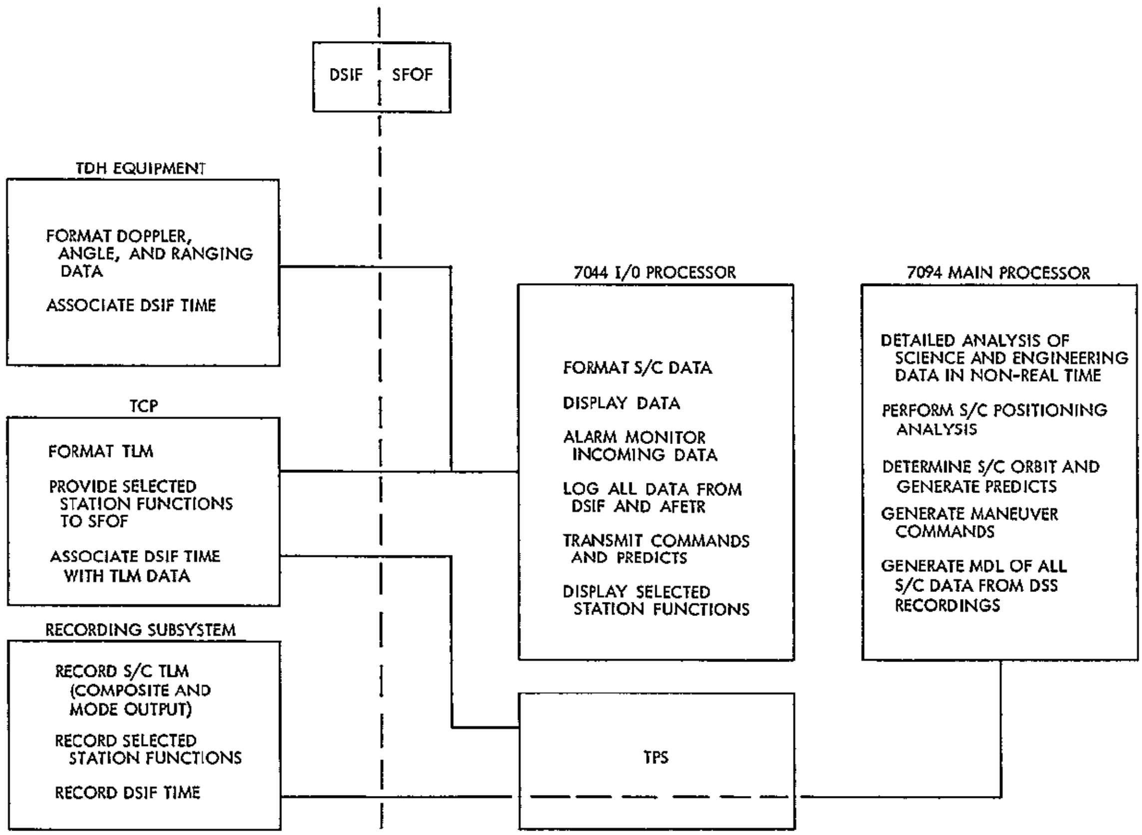


Fig 82. Data processing functions performed by DSN elements

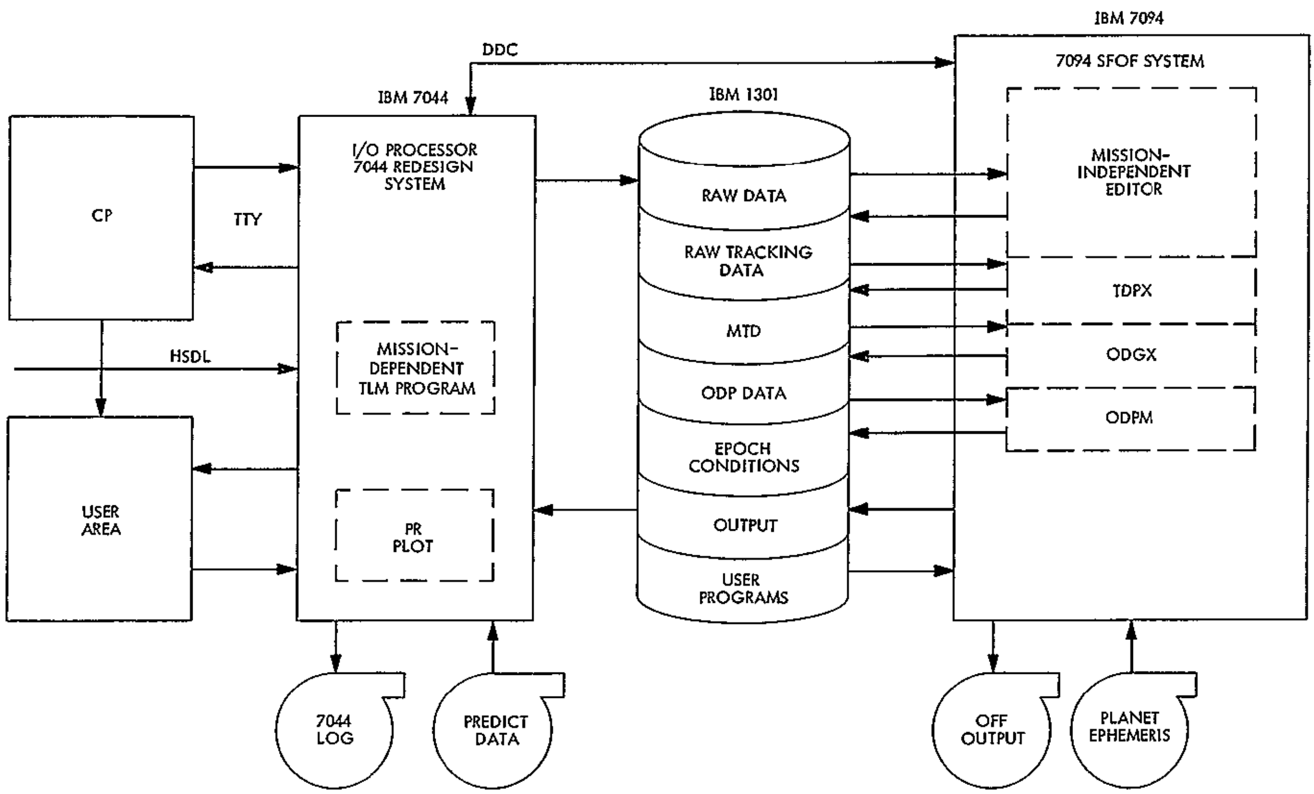


Fig 83 Tracking data handling and orbit determination

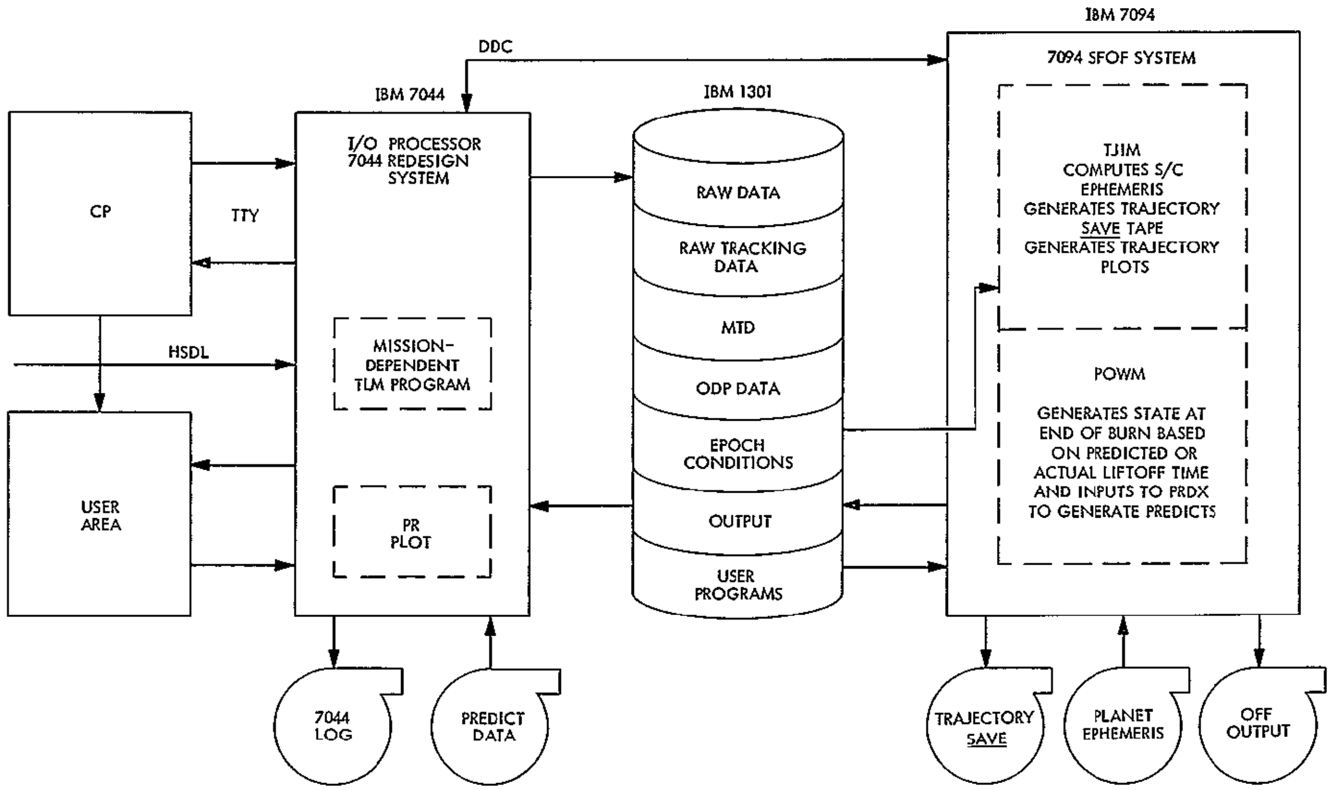


Fig 84 Trajectory computations

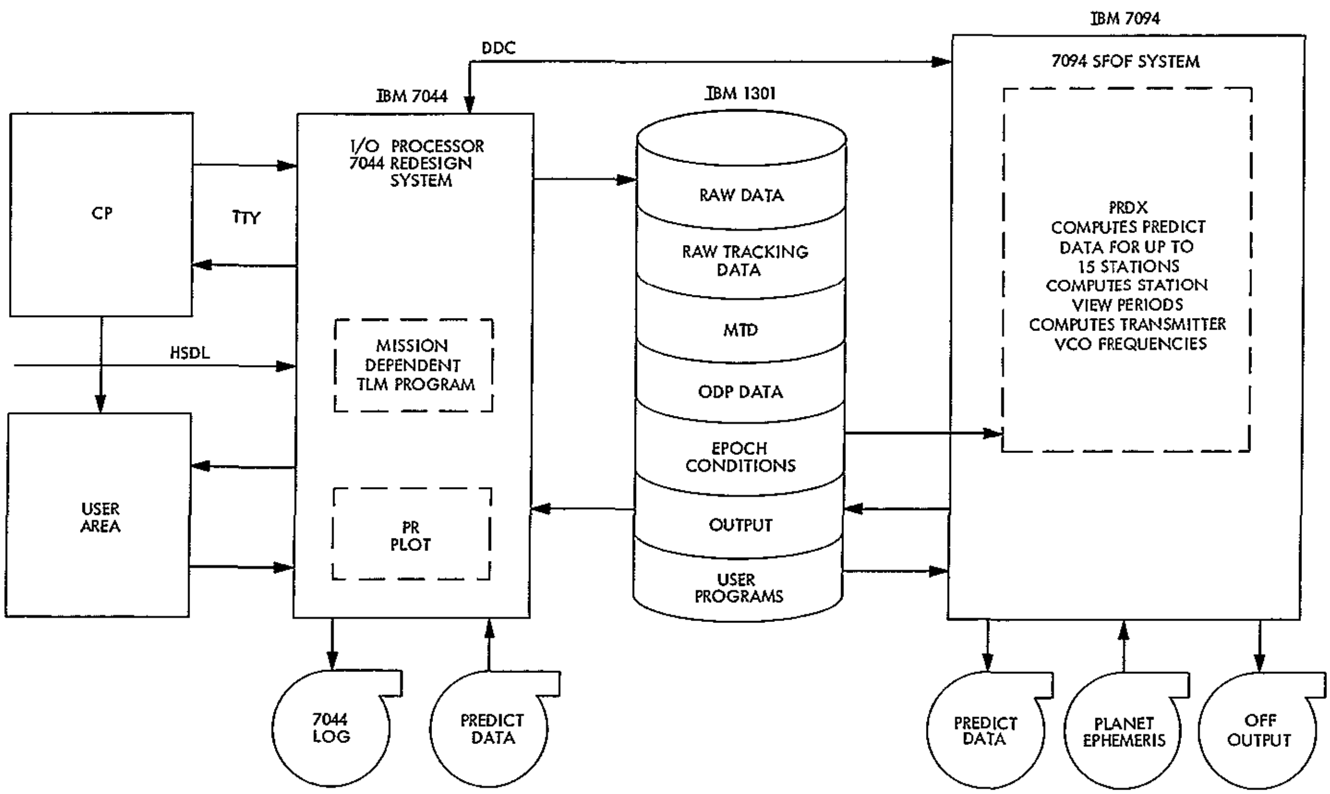


Fig 85 Predicts computation

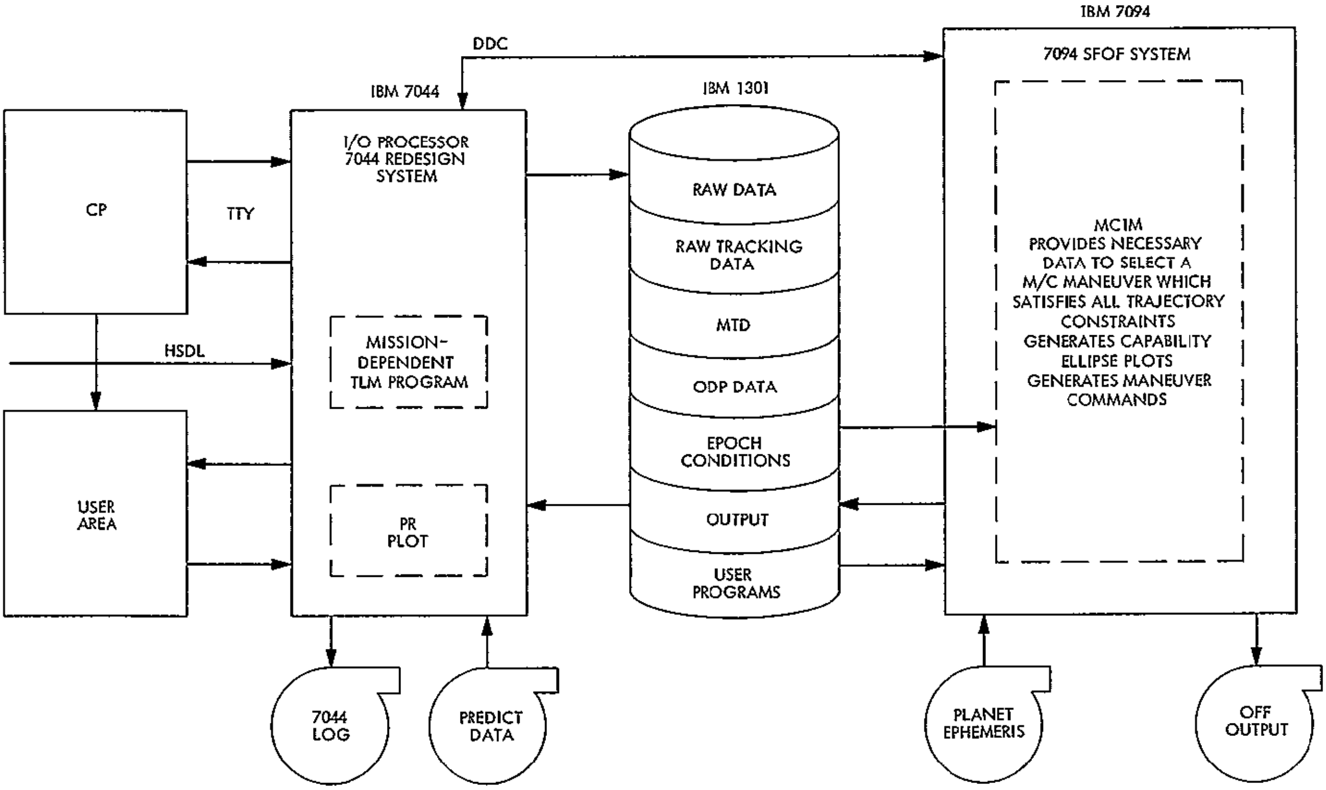


Fig. 86 Midcourse operations program

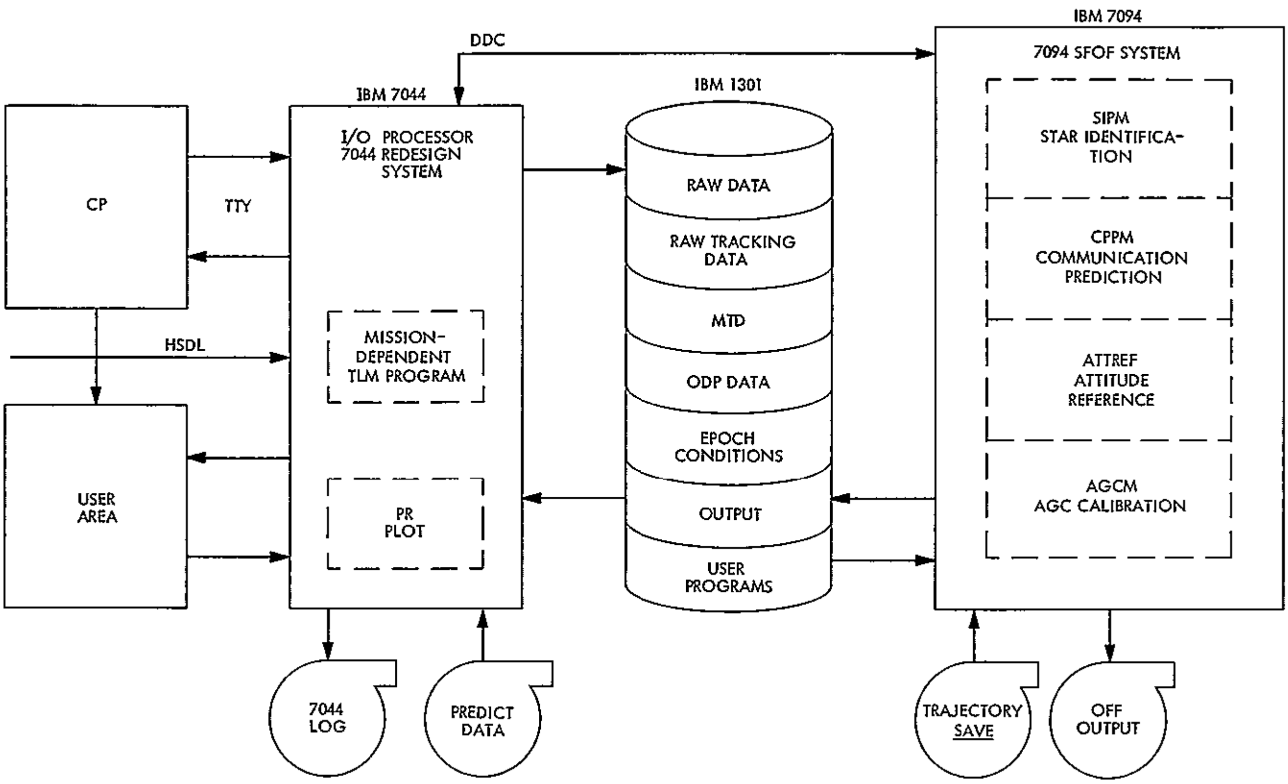


Fig 87. SPAC user programs

There are four TDH and OD programs shown, but only one program operates within the 7094 SFOF system at one time The mission-independent editor acquires raw teletype data from the disk, which contains mixed tracking and telemetry data The mission-independent editor separates the data, extracts the tracking data and stores it on the disk in the raw tracking data file

The tracking data processor program (TDX) retrieves, edits, and reformats these data and places them back on the disk in the master tracking data file (MTDF)

The orbit data generator program (ODGX) uses this file to prepare a block of data for the orbit determination program (ODP) Essentially, the ODGX extracts a subset of the MTD and formats it by using control inputs that are provided to the program

The ODP retrieves the block of ODP data, compiled by the ODGX program, and employs a least-squares curve fit, and an iterative technique, to determine the orbit of the spacecraft The injection, or epoch conditions, are placed on the disk and are available for use by other programs

The area on the disk labeled "User Programs" contains the actual programs callup by the system and brought into the 7094 for operation The normal output of these programs can be accessed by the 7044 from the output area on the disk and sent to the user areas for display

b Trajectory computation Trajectory computations are performed by the programs TJIM (I = 1, 2, and 3) and POWM (Fig 84) The epoch conditions and the planetary ephemeris are used by TJIM to compute the spacecraft ephermeris and generate a trajectory "save" tape This tape consists of tabulated information, regarding the trajectory, computed at specified points along the trajectory

These values are earth–sun–probe angles, clock angles, velocities, etc POWM is essentially a trajectory program which prepares input for PRDX, which generates tracking predictions These predictions are used for early acquisition and are based on predicted or actual liftoff time Various outputs of these programs are displayed in the user areas or are recorded on magnetic tape for subsequent off-line processing *c Predicts computation* This operation is shown in Fig 85, PRDX computes the following

(1) Predict data for up to 15 stations

(2) Station view periods

(3) Transmitter VCO frequencies

This information is formatted for teletype and subsequently transmitted to the DSIF stations to aid in spacecraft acquisition In addition, it produces a predict data tape, which is used as an input to the 7044 for computation of PR plots The PRDX utilizes the Epoch Conditions and the Planetary Ephemeris as inputs Selected outputs are displayed in the user areas or are recorded on magnetic tape for subsequent off-line processing

d Midcourse operations program The M/C maneuver program, shown in Fig 86, performs the following functions

(1) Provides the necessary information to select a midcourse maneuver which satisfies all trajectory constraints

(2) Generates capability ellipse plots

(3) Generates maneuver commands

Again, the inputs are the Epoch Conditions and Planetary Ephemeris, and outputs are recorded for off-line processing

e SPAC user programs The SFOF contains the following technical areas

(1) Flight path analysis and command (FPAC)

(2) Spacecraft performance analysis and command (SPAC)

(3) Space science analysis and command (SSAC)

The user programs previously discussed are primarily FPAC-orientated, but there are also a few SPAC programs (Fig 87) These programs are the star identification program (SIPM), the communication prediction program (CPPM), the attitude reference program (ATTREF), and the AGC calibration program (AGCM)

The SPAC programs receive telemetry data information from the 7044 via a DDC, not from the disk The system capability of the mission-independent editor (to extract the telemetry data stored on the disk, as is done with the tracking data) is not used by *Mariner* Venus 67 Another input for three of the SPAC programs (SIPM, CPPM, and ATTREF) is the trajectory save tape The need for this tape is obvious because these programs require an exact knowledge of the spacecraft's whereabouts in space to accomplish their individual tasks The SPAC program results are available to the user area via the 7044 and the output portion of the disk Selected results are recorded on magnetic tape for subsequent off-line processing

f Mode 3 operation The user programs described in the preceding paragraphs are shown operating in mode 2 Mode 3 (Fig 88) does not use the 7094 computational capabilities, but retains all real-time display capability and processing capability All incoming data are still recorded on the 7044 log tape for subsequent processing

g Mode 4 operation Mode 4 (Fig 89) is essentially the postprocessing mode The 7044 is replaced by a previously recorded 7044 log tape, and control inputs from the user area are replaced by direct card inputs to the 7094 All 7094 programs previously discussed as operating in mode 2 could also operate in mode 4

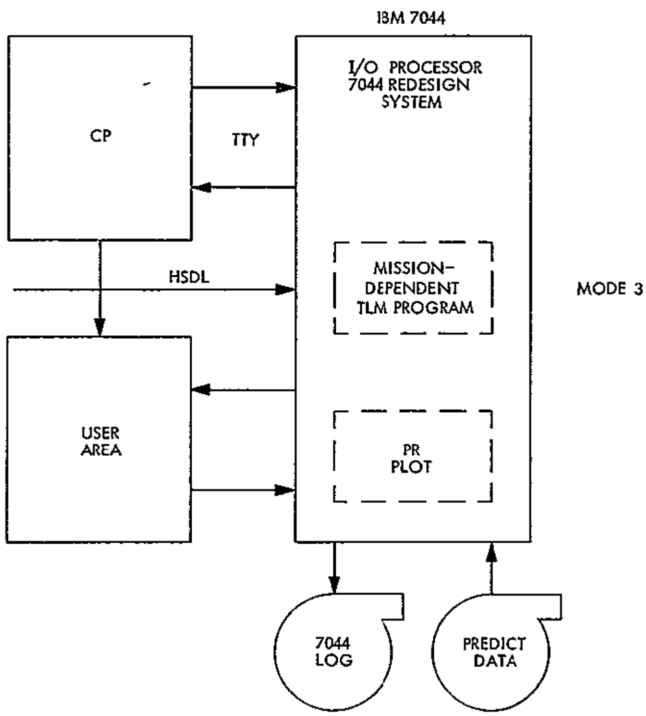


Fig 88. Example of mode 3 operation

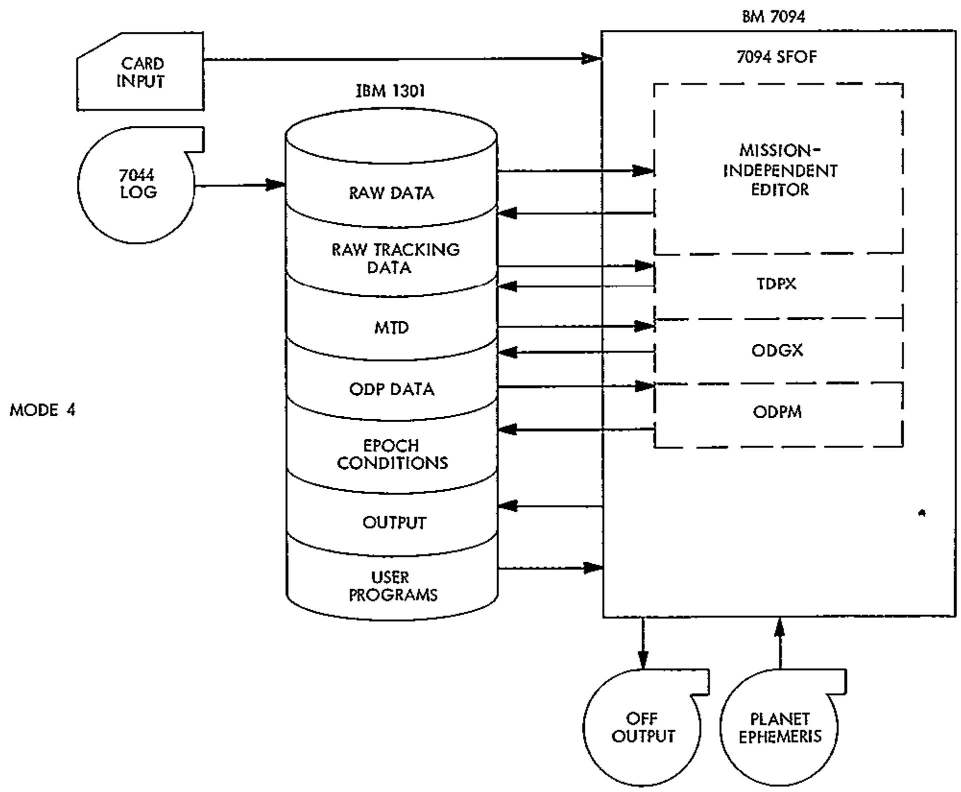


Fig 89. Example of mode 4 operation

h The MDL programs The Master Data Library (MDL) programs (Fig 90) for *Mariner* Venus 67 are identical to those used for *Mariner* Mars 1964, except for two additional input processors (IPs) and the MDL interface user program The MDL programs do not operate in the SFOF software system, but in standard IBM IBSYS system

The purpose of the MDL programs is to generate (in non-real time) a tape containing the most accurate stream of telemetry data possible This tape becomes the basis for analysis by experimenters and spacecraft engineers The processing of various input source tapes into a final tape is done by the three basic software portions of the MDL chain, the edit program, the re-edit program, and the merge program

Inputs Data are recorded in various places and formats in the total data processing system The tapes containing these data are the inputs to the MDL programs The TPS and teletype paper tape inputs are used for *Mariner Mars 1964* Their input capabilities remain, but for *Mariner* Venus 67 they are replaced by two new sources the TCP log tape, which is recorded at the TCP, and the 44 log tape, recorded at the 7044

Each tape input has an associated IP designed to handle a particular format The IPs perform a translation function from the varied input tape formats to a standard format recognizable by the edit program

Edit program The edit program performs frame detection and evaluates the quality of each frame

Included in the telemetry data stream is status information regarding the processing, recording, and receiving equipment, such as receiver in-lock and receiver out-of-lock and demodulator in- and out-of-sync The edit program recognizes this information and uses it in evaluating the data quality during the frame detection process

A spacecraft data frame consists of a certain number of data bits between each science pseudo-noise (PN) sequence The edit program, while performing the frame detection, is able to come to some conclusions regarding the quality of the data stream, based on the proper or improper locations of these science PNs The standard MDL tape generated by the edit program contains not only the time-tagged data, itself, but also information

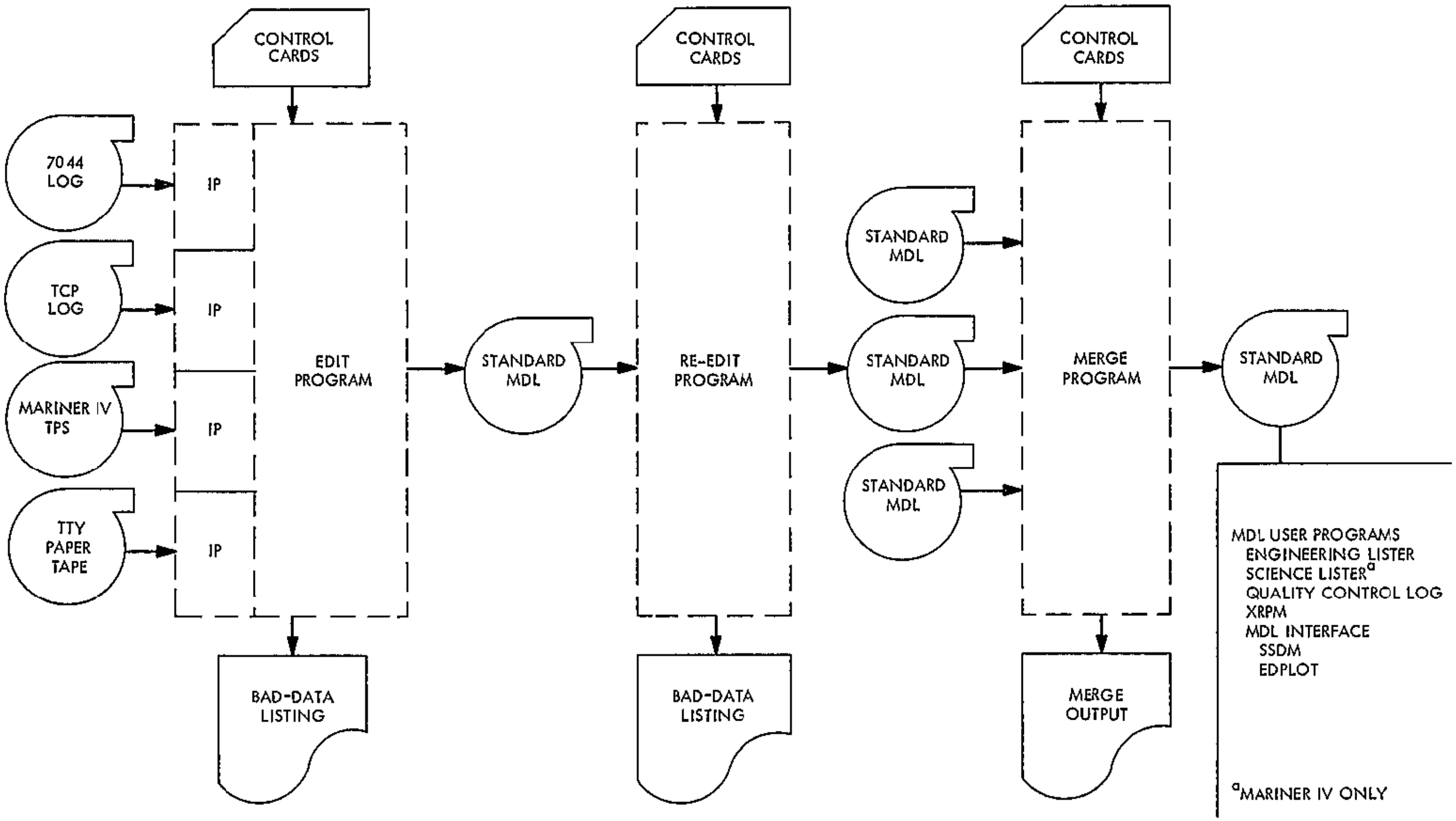


Fig 90 MDL programs

regarding the worth of the data, based on conclusions drawn from the accurate location of the science PNs and the incoming status information contained in the original telemetry stream In addition to the standard MDL tape, a *bad data listing* is recorded on magnetic tape This listing is formatted for subsequent off-line printout

Re-Edit Program The re-edit program allows for time correction of data, deletion of bad data, and deletion of entire data records, while retaining the station function records

The logical files on the edit data tapes are considered sequential, with respect to position on tape A simple search forward is used to locate the file to be processed The appropriate processing is defined by input control cards

The primary function of the re-edit program is to correct times or delete logical files The net times desired for a particular file are transferred to control cards according to specified input formats

Merge program There are two types of merge runs, the *station merge* and the *composite merge*, used by the MDL A station merge is a combination of various data from one station merged into one tape A composite merge is a combination of data from all the stations on one tape The criteria for the program are the quality of work in each frame and the weighting factors on the input cards The objectives of the telemetry merge program are to

(1) Produce DSIF station telemetry master tapes by merging three edited sources (pre-demodulated, post-demodulated, and TCP log tapes) These master tapes also contain information pertaining to the DSIF station instrumentation functions

(2) Produce composite telemetry master tapes by merging three or more station master tapes to provide a continuous spacecraft telemetry record without information pertaining to DSIF station instrumentation functions

(3) Produce a master log containing a summary of all header information from all sources used in producing each telemetry tape and the following information for each internal file

  (a) Internal file number
  (b) Number of pre-demodulated data frames used
  (c) Number of post-demodulated data frames used
  (d) Number of TCP log tape data frames used
  (e) Number of partial data frames used
  (f) Start and stop times (GMT) of the file
  (g) First science frame count within the file
  (h) Last science frame count within the file

(4) Resolve all overlapping data intervals occurring because of the following reasons

  (a) DSIF station A and B recorder data overlaps within each pass
  (b) DSIF station data overlaps
  (c) Composite telemetry master tape data overlaps for consecutive weekly outputs

The functions of the merge program are to

(1) Accept multiple-reel inputs and to output on multiple reels

(2) Select the best data on a frame-by-frame basis in spacecraft modes 2, 2/zero science, and mode 3

(3) Compare data start times of each data source being merged and select the earliest time of start for processing A time comparison (ΔT) window is used and is made controllable by 1-s increments, using control card input

(4) Using specified criteria, identify data frames that (after the program has been initialized on time) should become the prime basis for identifying like-data elements of each data source being merged

11. Monitor system support plans and configurations. The DSN monitor system supports all phases of the *Mariner* Venus 67 mission The DSN has a basic objective to maximize the recovery of data for each flight project that uses the DSN and also to identify defective or lost data, and the reasons for such losses The DSN monitor system was developed to measure and monitor the transfer characteristics of each element in the data stream so that this objective can be achieved

The DSN monitor area, a subsystem of the DSN, houses the DSN monitor team and provides a centralized area within the SFOF to monitor overall DSN system performance Although the DSN monitor system was not fully operational to support the *Mariner* Venus 67 Project, the DSN monitor area was operating and staffed, and the DSN monitor team was prepared to meet requirements for DSN performance monitoring and data validation

a Real-time operations Real-time support consists of data flow analysis with reports to DSN management and DSN system chiefs as soon as an anomaly or malfunction becomes apparent Also, the monitor team gathers statistical data on DSN systems for later analysis and publication Real-time DSN system performance monitoring is accomplished by monitoring the formatted outputs of the TDH, the TCP, and the 7044 computer as they are displayed via printers and plotters in the DSN monitor area Figure 91 shows the monitor real-time data flow

Telemetry data All telemetry data arriving at the SFOF via teletype are displayed in the DSN monitor area via teleprinters and are checked for the following conditions

(1) Correct NASCOM headers

(2) Correct switching preambles at proper intervals

(3) Proper frame sync and science frame count

(4) Correct number of legal characters per teletype line

(5) Alarm conditions (such as receiver and demodulator out-of-lock/sync indicators)

Teleprinters of 100 words/min are used to display selected engineering and science parameters that arrive at the SFOF via HSD and teletype lines and are processed by the DPS A Stromberg-Carlson (SC-3070) bulk printer is used to display formatted raw HSD

Tracking data All AFETR and DSN tracking data are displayed in the DSN monitor area via teleprinters and are checked for the following conditions

(1) Correct preambles at proper times

(2) Proper format

(3) Gross data errors or inconsistencies

An $X-Y$ plotter is used to display the pseudoresidual plots produced by the 7044 computer An I/O console is utilized to request outputs for all display devices in the DSN monitor area

Validation The lack of automatic error detection capabilities limits the real-time validation effort to the detection of only gross errors and data losses in the telemetry and tracking streams The DSN monitor team continually updates a status display board in the DSN monitor area The board displays the following information

(1) DSS number

(2) Pass number

(3) Day

(4) Time of AOS in GMT

(5) Time of LOS in GMT

(6) Number of telemetry frames transmitted

(7) Number of telemetry frames recovered [3]

(8) Percentage of total telemetry data recovered per station

(9) Percentage of total telemetry data recovered per pass

(10) Doppler mode

(11) Total number of tracking data samples

(12) Total number of good samples and percentage of total [4]

(13) Total number of unacceptable samples and percentage of total

b Non-real-time operations The DSN monitor team is the coordinating agency for all non-real-time DSN operations related to the collection and reduction of postflight data The DSN monitor team is responsible for providing validated data records to the DSN project engineer, with associated reports which describe the data's quantity and quality The collection of data and the validation operations performed by the DSN monitor team require support from other elements of the DSN, as shown in Fig 92

DSIF data packages Each station is responsible for preparation of a data package for each pass Data packages are submitted to SFO document control, JPL, which is responsible for logging and storing all DSN flight project data The DSN monitor team has access to all required data package contents to perform its function Data packages are composed of the following

(1) Analog (FR-1400) magnetic data tapes (see Table 25)

(2) The TCP digital tape

(3) A copy of the typewriter output from the interim monitor program (IMP)

(4) The punched paper tape from the TDH

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[3]A telemetry data frame is defined as unacceptable if high-rate engineering sync of science PN code and frame count is not identified or whose associated status bits indicate receiver out-of-lock and/or demodulator out of-sync

[4]A tracking data sample is defined as unacceptable if the data condition code indicates the data are bad or the line containing the sample is lost because of transmission errors

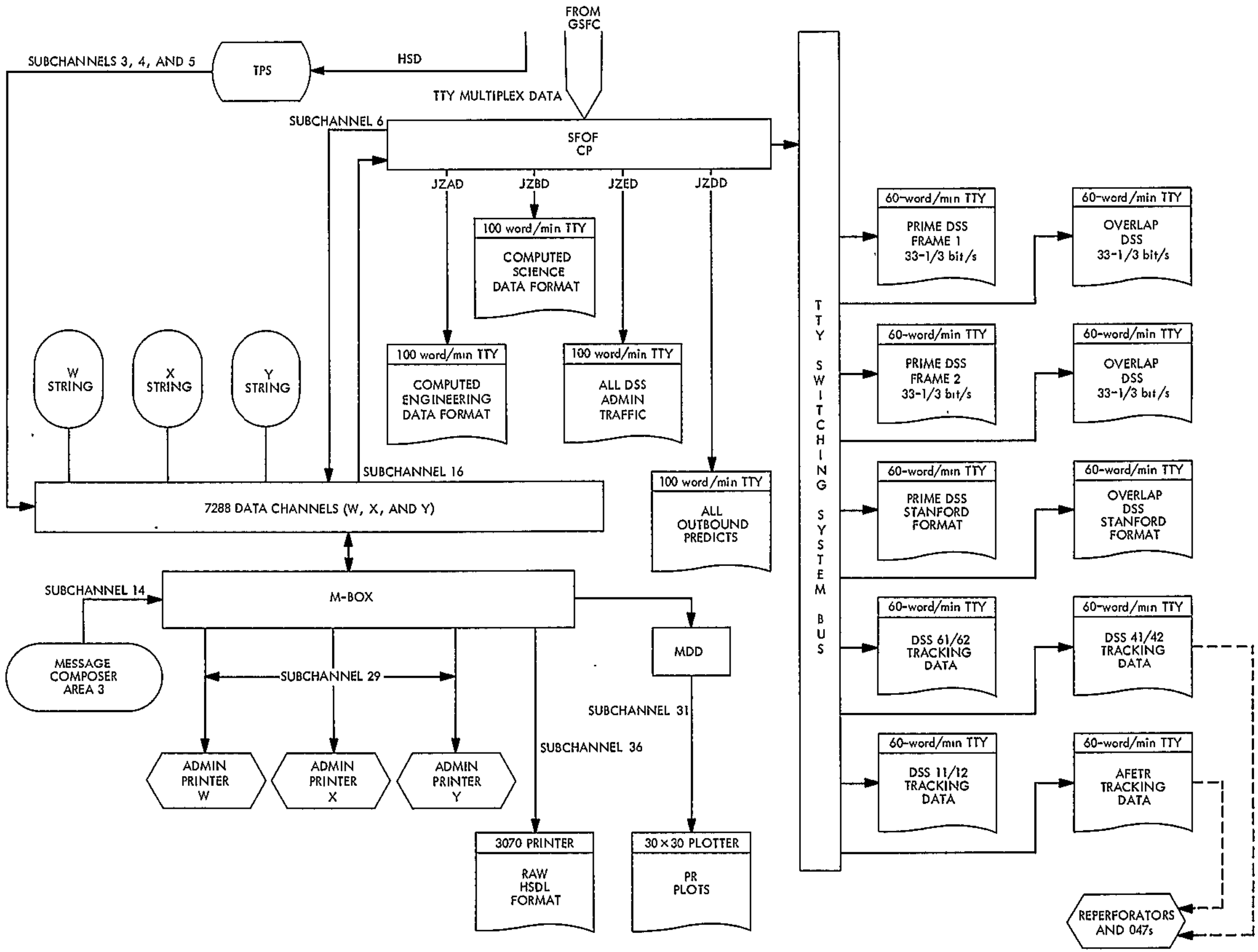

Fig. 91. Monitor real-time data flow diagram

Table 25 Analog magnetic tape format

Track	Description
1	Intercom and voice label
2	Demodulated NRZ data
3	Demodulated-bit sync
4	NASA 36-bit time + CRFS
5	Phase detected telemetry
6	Demodulator word sync
7	DSIF instrumentation + CRFS
IRIG channel	**DSIF instrumentation recordings**
3	Receiver 1 SPE ±100 kHz
4	Receiver 2 SPE ±100 kHz
5	Receiver 1 AGC −90 dbm to threshold
6	Receiver 2 AGC −90 dbm to threshold
7	Receiver 1 DPE ±90 deg
8	Receiver lock signal

(5) TCP typewriter output

(6) Complete pretrack data sheets for MRH

(7) Oscillograph records, which include the following

- (a) Static reference
- (b) Time code
- (c) Antenna mode switch
- (d) Receiver 1 loop bandwidth
- (e) Receiver 1 AGC bandwidth
- (f) Receiver 1 dynamic phase error (DPE)
- (g) Receiver 1 static phase error (SPE)
- (h) Receiver 1 AGC
- (i) Receiver 1 in-lock-data condition indicator
- (j) Receiver 1 dynamic AGC
- (k) Receiver 2 static phase error
- (l) Receiver 2 loop bandwidth
- (m) Receiver 2 AGC bandwidth
- (n) Receiver 2 dynamic phase error
- (o) Receiver 2 AGC
- (p) Receiver 2 in-lock
- (q) Receiver 2 dynamic AGC
- (r) System temperature
- (s) Transmitter power
- (t) Transmitter acq volts
- (u) Telemetry word sync

(8) A copy of the station logs for the time corresponding to the data package

Telemetry processing station The TPS is responsible for the operation of all PDP-7 programs and data processing equipment necessary to process and evaluate the following

(1) Analog tape When requested by the DSN monitor team, the TPS processes the analog tape to ensure proper recording techniques are being complied with by the DSS and to provide data coverage during outages on TCP tapes

(2) TCP digital tape The DSN monitor team requests each TCP tape be processed using the *Mariner* Venus 67 data validation programs (DVP)

(3) Punched paper tape On request, the TPS processes the Baudot format punched-paper tape from the TDH and converts it to a Baudot format digital tape which is used to update the TDP master file

The TPS provides the DSN monitor team with the output listing of the *Mariner* Venus 67 DVPs, the identification number of the TCP format tape copy produced by the *Mariner* Venus 67 DVP, and the identification number of any TCP tape produced by processing the analog tape

Flight support group Tracking data processing and OD are accomplished by a series of 7094 computer programs One of these, the TDP, is run by the flight support group and operates on the raw tracking data, formatting the data for subsequent operations and discarding unusable data The flight support group is required to supply a copy of the output of the TDP to the DSN monitor team This output indicates the quantity of the tracking data recovered by the DSN and also what data are needed from the TDH punched-paper tapes When the tracking data recovery rate falls below a level agreed to by the DSN and the flight project, the DSN monitor team provides the flight support group with these data to update the MTDF

DSN monitor team The DSN monitor team assembles a data package which consists of a digital tape copy of the TCP format tape, the MTDF, a DSN monitor tracking data validation report, and a DSN monitor telemetry data validation report The telemetry data validation report is compiled from station logs, telemetry calibration records, real-time logs maintained by the DSN monitor team, and the output from the *Mariner* Venus 67 DVP The telemetry validation report consists of the following

(1) DSS number

(2) Pass number

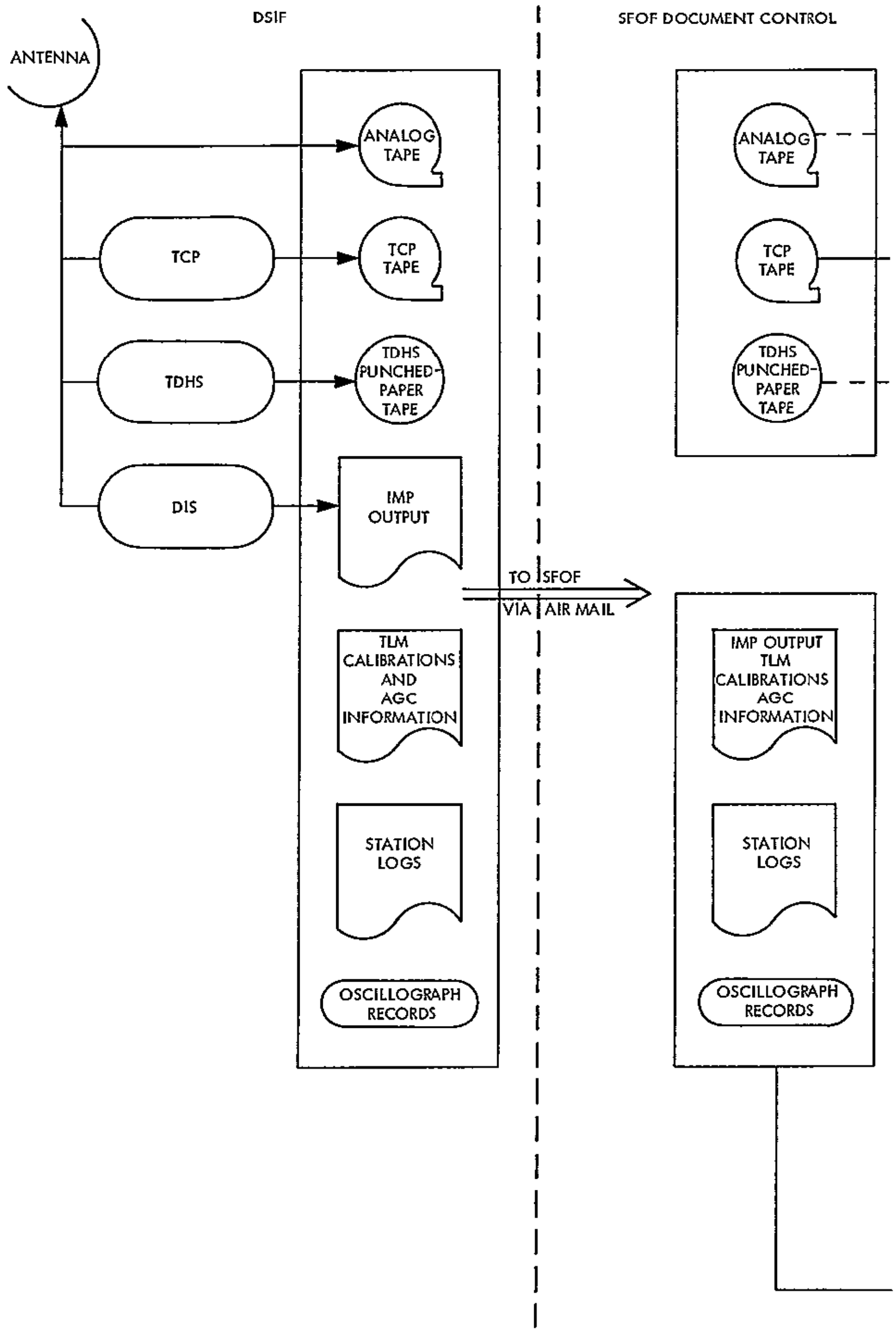

Fig. 92. Non-real-time data flow, *Mariner* Venus 67

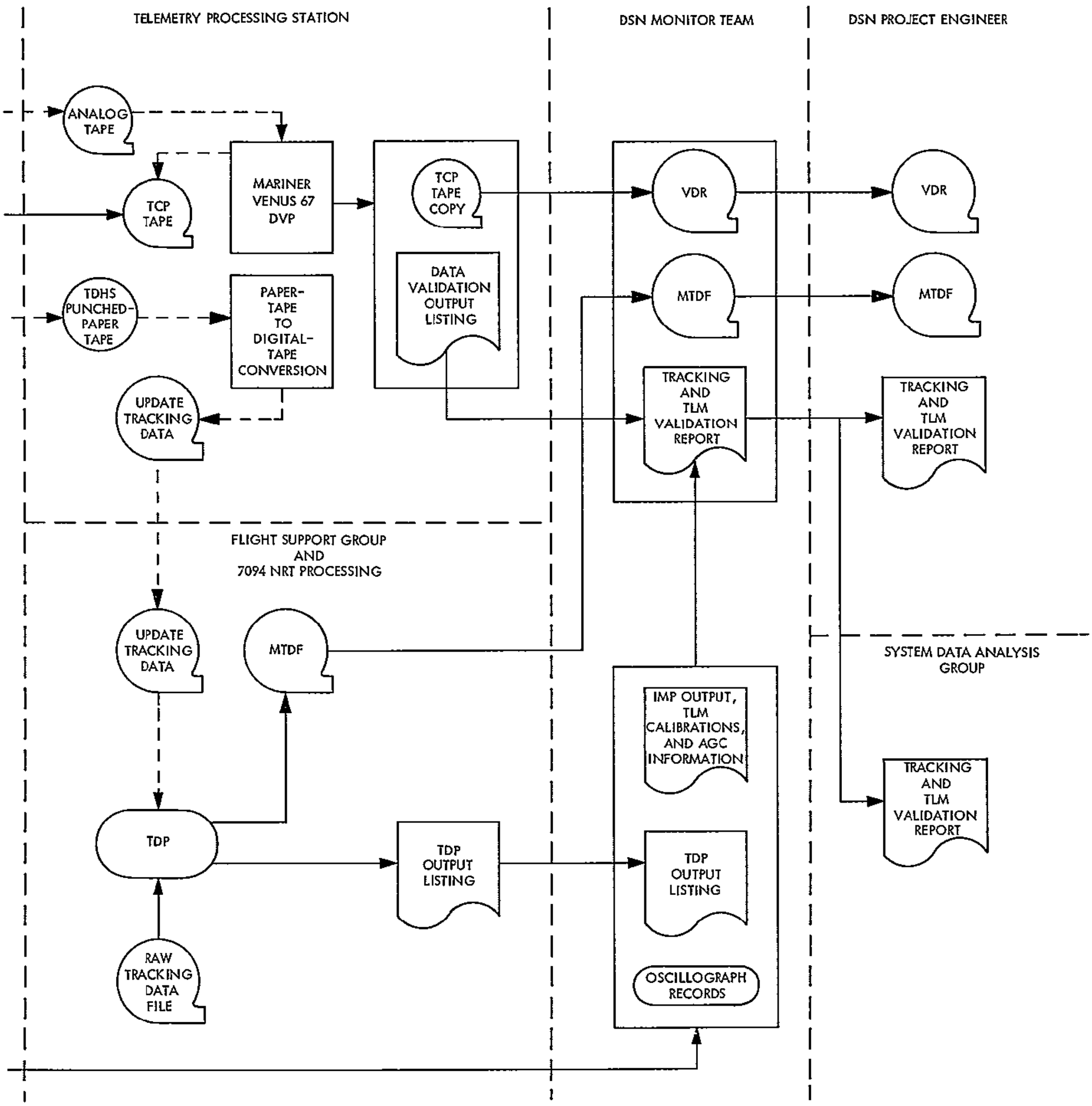
TELEMETRY PROCESSING STATION
DSN MONITOR TEAM
DSN PROJECT ENGINEER
ANALOG TAPE
TCP TAPE
MARINER VENUS 67 DVP
TCP TAPE COPY
DATA VALIDATION OUTPUT LISTING
VDR
VDR
TDHS PUNCHED-PAPER TAPE
PAPER-TAPE TO DIGITAL-TAPE CONVERSION
MTDF
MTDF
UPDATE TRACKING DATA
TRACKING AND TLM VALIDATION REPORT
TRACKING AND TLM VALIDATION REPORT
FLIGHT SUPPORT GROUP AND 7094 NRT PROCESSING
UPDATE TRACKING DATA
MTDF
SYSTEM DATA ANALYSIS GROUP
IMP OUTPUT, TLM CALIBRATIONS, AND AGC INFORMATION
TRACKING AND TLM VALIDATION REPORT
TDP
TDP OUTPUT LISTING
TDP OUTPUT LISTING
RAW TRACKING DATA FILE
OSCILLOGRAPH RECORDS

Fig 92 (contd)

(3) The total time span on the TCP format tape and the time interval recommended for project use

(4) The total number of telemetry data frames transmitted during the recommended time interval

(5) The total number of good frames received during the recommended time interval and the percentage of good frames in the total [5]

(6) The number of questionable frames received during the recommended time interval and the percentage of the total [6]

(7) The number of missing frames, the percentage of the total, and the reason for the loss

(8) A statement of all time discrepancies

(9) A statement of telemetry calibrations and received signal strengths

The tracking validation report is compiled by the DSN monitor team from station logs and reports from the DSIF, real-time logs maintained by the DSN monitor team, output from the IMP and the output of the TDP The report consists of the following

(1) DSS number

(2) Pass number

(3) Total time interval in GMT

(4) Doppler mode

(5) Sampling rate

(6) Total number of tracking data samples

(7) Total number of good tracking data samples and percentage of total

(8) Total number of unacceptable tracking data samples and percentage of total

(9) Station calibrations and configurations

IV. TDS Preflight Test Program

A. TDS Test Philosophy

In keeping with the TDS support of the *Mariner* Venus 67 project being divided into near-earth phase support and deep space phase support, the TDS test philosophy was to divide test activities into near-earth and deep space segments

A TDS near-earth phase test plan was issued and implemented to verify the integrated configurations of the DSN, MSFN, AFETR, and NASCOM This plan is described and the results of the tests conducted under this plan are presented In addition, each agency was responsible for executing its own intra-agency test program as a prerequisite to the interagency testing

The DSN was the only TDS agency which supported the deep space phase Therefore, the DSN prepared a DSN test plan which served as both the TDS deep space phase test plan and the DSN's prerequisite intra-agency test plan for the near-earth phase This plan and test results are described in text and in Tables 26–32

B TDS Near-Earth Phase Test Plan

A TDS near-earth phase test plan was published in February 1967 to verify the planned configurations and the support centers' integrated support plans for near-earth coverage This plan was a comprehensive test program which established, described, scheduled, and controlled those tests required to verify the compatibility and operational readiness of the TDS The testing specified in this plan was limited to joint tests required to verify the systems and interfaces between two or more TDS support centers The tests were conducted in three phases, progressing from the simple interface tests, through the complex system tests, to the operational readiness tests as each phase was completed satisfactorily

Table 26. MRH/DSN integration tests

DSS	Date of completion	Results
11	Set 1, week of February 13 Set 2, week of March 20	Satisfactory Satisfactory
42	Week of March 20	Satisfactory
61	Week of March 27	Satisfactory
12	Week of March 13	Satisfactory (RWV only)
14	Week of March 6	Satisfactory (RWV only)
41	Week of March 27	Satisfactory
51	Week of April 17	Satisfactory
62	Week of March 20	Satisfactory (RWV only)
71	Week of March 13	Satisfactory
72	Week of April 17	Satisfactory

[5]A good frame is considered to be a data frame which is identified by high-rate engineering sync or science PN code and frame count, and contains no more than N bad data words

[6]A questionable frame is considered to be a data frame in which high-rate engineering sync or science PN code and frame count are not identifiable or a data frame which contains more than N bad data words

Table 27 Combined system test sequence of events

Item	Station	Event
1	All	**Pretest preparation**
	Comm	Patch data set from comm to DPLF Initialize CP for *Mariner* preambles Bring up lines Bring up voice nets
	TPS	Patch data set from comm to DPLF Notify data chief of subchannel used Notify data coordinator when ready to accept data
	DPS	Load and start *Mariner* mission 7044 and 7094 computer system programs Select TPS subchannel
	DSS	**Initialization of station equipment** Ensure DSIF station is configured as specified (see Fig 95) Set carrier suppression of test transmitter to 4 12 ±0 05 db Set carrier suppression of DSIF transmitter to 3 17 ±0 05 db Initialize simulation If simulator is to be used, set simulator to S/C mode 1 at bit rate of 33⅓ bits/s Adjust output of test transmitter for DSIF receiver input of −140 dbm Lock GTS demodulator to the received signal Initialize TCP program compatible with simulation source Enable tape write function of TCP Set HSD modem transmitter to operate at 1200 bits/s with word size of 8 bits Notify comm of intent to start data transmission Transmit TLM via TTY and HSD circuit Verify proper formats of TTY data Verify transmission of HSD
2	TC/DSS	**Test procedure** Start data transmission on direction of test conductor (TC) If encoder-simulator is being used, start with mode 1 raw data, AGC-enabled If data package is being used, start tape at beginning, sending raw data with AGC-enabled
3	DSS	Inform TC of TCP output status
	Comm	Inform TC of comm line status and CP status
	Data coordination	Inform TC of 7044 output and TTY output status
4	TC/DSS	Change data mode, rate, and format at direction of TC
	TC/data coordination	Change 7044 output format at direction of TC
5	Data coordination	Inform TC of 7044 output and TTY output status
6	TC/DSS/ data coordination	Repeat items 4 and 5 until all data modes and formats are checked as follows: **Mode — Format — Rate** 1 — Raw — 33 1 — Formatted — 33 2 — Raw — 33 2 — Formatted — 33 2 — Stanford — 33 3 — Raw — 33 3 — Formatted — 33 3 — Stanford — 33 1 — Raw — 8 1 — Formatted — 8 2 — Raw — 8 2 — Formatted — 8 2 — Stanford — 8 2 — Low — 8 3 — Raw — 8 3 — Formatted — 8 3 — Stanford — 8 3 — Low — 8
7	Data coordination	Prepare QC message for transmission
8	TC/DSS coordination	Direct transmission of QC
9	DSS coordination/ data coordination	Verify the proper receipt of QC by DSS
10	All	Repeat items 7, 8, and 9 until confident
11	All	End of test

Table 28. DSN combined systems test summary

DSS	Date	Test results and remarks	Objectives met
11	February 18 and 19	Preliminary tests were run on Feb 18 and 19 to verify testing procedures Proper TCP processing was prevented by lack of operational ms clock Operating procedures created anomalies in data when bit rate was changed from 33⅓ to 8⅓ bits/s Because TCP and 7044 programs were still in developmental stage, complete satisfaction of acceptance criteria was not expected Tests resulted in changes to detailed test procedure (relative to TCP initialization and digital tape write function) and provided DSIF and SFOF personnel with familiarization of new *Mariner* Venus 67 systems and equipment	Not completely
11	March 8	Test was run concurrent with the spacecraft compatibility test at GSCS The equivalent communication system, located in GSCS screen room, was used as data source Two major exceptions to acceptance criteria were (1) No significant data processing was accomplished at SFOF because of nonavailability of operational 7044 program, and (2) all data modes and bit rates were not checked because of lack of time to complete test Some data in modes 1 and 2 at 33⅓ bits/s and mode 2 at 8⅓ bits/s were successfully transmitted from S/C equivalent system through DSS 11 receiver, GTS and TCP, through the JPL CP, and to SFOF TTY in MMSA	Not completely
11	March 28	Start of test was delayed 1 h because of difficulties during pretest activation of lines to and from station During test, it was necessary to use backup CP for proper 100-word/min TTY output It was determined difficulties existed in CP/7044R interface All other systems worked well, with exception of loss of 0 4 V in AGC circuit between isolation amplifier and Dymec voltmeter at DSS Amplitudes at rcvr and out of isolation amplifier were correct (5 74 and 2 87 V, respectively) AGC voltage into Dymec was 2 47 V	Yes, except for station AGC, CP, and SFOF/DPS
11	March 22 and 23	Attempt to play TLM data simulation tape was unsuccessful and encoder simulator had to be used as data source AGC readings were not obtained because of inoperational status of CP/7044 interface, but AGC problem of March 20 test was cleared No data was processed between CP and X and Y computer strings, apparently resulting from hardware problem in patching to CP Data from CP to 7044 was good on W computer string, but 7044 was unable to output to 100-word/min TTY Test was first in which test command message was received from SFOF by the DSS, reperforated, verified on RWV, and retransmitted to SFOF DSS 11 was considered to be in status of operational readiness, but CP/7044 interface required additional testing and corrective measures	Yes, DSS No, CP and SFOF/DPS
71	March 24	In addition to acceptance criteria specified in detailed test procedure, following were checked multiple addressing of Stanford data, looped (QC) message, digital tape playback from TCP, and checking of AGC both with demodulator in-lock and out-of-lock During test, there was no significant data flowing through 7044/CP interface Y computer string was used Up to this point, W computer string seemed to work better than X and Y strings On several occasions, Figures-"H"-letters (signifying EOM) came out of CP when they were not inserted in message transmitted from station, indicating premature CP timeout somewhere in GCF No performance shortcomings from procedures or hardware were noted at DSS DSS qualified from both procedural and hardware standpoints SFOF CP/7044 interface still deemed nonoperable	Yes, DSS No, SFOF/DPS and GCS

Table 28 (contd)

DSS	Date	Test results and remarks	Objectives met
42 and 62	March 25	Test consisted of complete DSN CST with DSS 42 and tracking data transmission test with DSS 62 Only tracking data and a looped QC message were attempted from DSS 62, as station was not scheduled to have TCP until later in mission Tracking data were successfully transmitted, received, and processed SFOF-DSS-SFOF looped QC message was garbled on return to SFOF By comparing QC message with identical message looped with DSS 42, it was discovered garbling was the same on messages from both stations This isolated problem to outbound direction from SFOF As result of test, DSS 62 was considered in status of operational readiness to support mission and no further tests were required Type 60 data were not received by SFOF from DSS 42 until conclusion of all other test segments It was determined type 60 data had been stored in Goddard CP, although station verified data had been addressed with correct preambles No explanation of why data were held by Goddard CP was apparent in critique which followed test and problem was given to comm for resolution Spurious receiver out of-lock indications appeared in DSS 42 data and TCP in/out-of-lock interrupt could not be disabled No AGC data were obtained during test and TTY data became garbled whenever attempt was made to transmit AGC Station personnel requested extension of test to allow them to enable second TCP Same problems occurred with backup TCP in use Internal to SFOF, problems with the Y computer string necessitated switching to the X string at beginning of test It was decided DSS 42 would require further testing before system readiness status could be declared	Yes, DSS No, GCF Partially, DPS Not completely
42	March 27	Problems encountered in enabling AGC and in in/out of-lock functions during first test were not present during second test Both TTY and HSD were processed with only minor problems encountered JPL CP was in down condition for 16 min during portion of test At another point, tracking data were being back-fed to DSS 42 from the CP for no apparent reason This data was also correctly routed simultaneously to SFOF Station successfully played TCP digital tape back through second TCP Only TCP malfunction was in loss of new headers on two occasions when switching from raw to formatted data Station did not use RF portion of test configuration Simulator was run directly into demodulator As in last test, with DSS 42, QC message was unable to be looped end-to end without garbling Garbling was again isolated to SFOF outbound transmission SFOF experienced 7044 problems, this time with Y string drum No problems were experienced with data received after switching to X string DSS 42 was given system readiness status at conclusion of test	Yes

Table 28 (contd)

DSS	Date	Test results and remarks	Objectives met
12, 41, and 62	March 28	Test was first in which JPL CP performed correctly Command and tracking systems for DSS 12 and 62 qualified Stations were not equipped with TM equipment until later in mission Most test objectives were successfully completed from DSS 41, however, it was decided DSS 41 should participate in at least one more test before declared to have status of system readiness AGC problem, which caused program to blow every time AGC was initiated, cleared during test and was considered to be a problem in TCP Commands sent to DSS 41 and DSS 62 were garbled by Goddard CP There were no anomalies with commands looped with DSS 12 All other command functions performed well, after initial 30-min delay in calling up the command circuits DPS used new version of 7044R program All major functions performed well, but all functions had not yet been incorporated into program Some loss of data occurred during test, but malfunction was not deemed of significant importance	DSS 12 and 62 Yes (tracking and commands only) DSS 41, partially GCF, partially DPS, partially
61	March 29	Command problems, especially with TTY lines outside JPL CP, prevented completion of most test objectives Test also used new version of 7044 program, which had many defects to be corrected 7044/7094 was not completely operable until 2 h into test Test was considered near total failure, and two more tests with DSS 61 were scheduled	None
41	April 2	All functions specified in detailed test procedure were completed and DSS 41 was considered to be in condition of system readiness Only major problem encountered during test was in trying to transmit command message to station from SFOF CP blew during first attempt Two other attempts to transmit QC were unsuccessful All three attempts were made on the W computer string A fourth attempt, this time on V string, proved successful Malfunctioning W string was turned over to IBM for checkout and repair Problem was eventually found to be in CP section of 7044/CP hardware interface	DSS, yes GCF/DPS, partially
61	April 3	Line problem between DSS 61 and London caused garbling for the first 3½ h of test Hardware check-out on SFOF V string overloaded JPL CP with restart blocks and caused system to go down three times Except for this, 7044/CP interface performance was acceptable Looped QC message was verified with transmitted message DPS went down three times, twice because of inputs to I/O console and once for unknown cause Test was first in which DPS exercised 7044R 2-S/C simultaneous processing Garbling caused by line distortion between DSS 61 and London prevented completion of most test objectives It was noted DSS 61 personnel were slower responding to test director requests, compared to previously tested situations As result, it was decided additional testing would have to be conducted with DSS 61 before system readiness status could be assigned	No
71 and 51	April 4	TLM portion of detailed test procedure was followed with DSS 71, but only taped tracking data were sent from DSS 51 command center to check communications Command messages were looped with both stations from and to SFOF Acceptance criteria specified in test procedure were met, with the communications and SFOF DP exceptions noted below	DSS, yes GCF, partially DPS, partially

Table 28 (contd)

DSS	Date	Test results and remarks	Objectives met
71 and 51	April 4	All TCP functions worked properly In addition to tasks specified in test procedure, multiple addressing was successfully tested A separate TTY readout machine in SFOF was used for the Stanford format output from the TCP (via GCF) JPL CP operated with no apparent problems GSFC CP was down for approximately 14 min, resulting in lost data Also, Goddard CP stored TTY data, causing non real-time reception at JPL of backed-up data (No explanation was received for this occurrence) The Goddard CPs added blanks and garbled precut command messages sent to stations from JPL SFOF Isolation of malfunction to outbound traffic from JPL through Goddard CPs was verified by having stations retransmit command messages Received messages were identical to those received by and sent by stations During operation with L version of 7044/7094 system, TTY outputs of 7044 (predicts and commands) were garbled Post test evaluation showed this to be DPS hardware problem Other problem noted was that 7044 program blew when processed data source was switched from TTY to HSD Procedure of activating command lines 1 h prior to start of test eliminated start of-test confusion experienced in previous tests and continued to be policy for all subsequent tests SCS 71 was considered to have status of system readiness, with exception of digital tape playback (not essential) NASCOM between JPL and SCS 71, and JPL and DSS 51, was considered to be in operational readiness status, with exception of transmission of QC messages through GSFC CP from SFOF JPL data processing could not be declared ready until after mode 1 system had been properly tested and verified	DSS, yes GCF, partially DPS, partially
61	April 7	In addition to requirements specified in detailed test procedure, DSS 61 was requested to transmit tracking data at 1-min sample rates, loop QC message with SFOF, check AGC with demodulator out-of-lock and verify AGC at station's receiver output and at Dymec voltmeter, and playback digital tape recorded at station during test Playback was mode 1, rate 33⅓ bits/s at normal speed and also mode 1, rate 8⅓ bits/s at × 8 normal speed Acceptance criteria specified in test procedure were not met, primarily because of communication difficulties between DSS TCP and London CP All TCP functions worked properly, however, measurements made at station during test indicated that TCP TTY output contained high distortion Distortion was considered to have been major cause of TM data transmission problem JPL CP performed properly Numerous intercepts of TTY/TLM data occurred as result of erroneous preambles, attributed to distortion in TTY circuits HSD was received and processed satisfactorily by SFOF DPS AGC checks were made Display of TTY data on MSA TTY was sporadic because of mis-patching in communications center Tracking data were transmitted satisfactorily SFOF transmitted command to station Command was verified on RWV and satisfactorily retransmitted to SFOF Station did not satisfactorily transmit TTY/TLM data to SFOF This was attributed to compounded distortions in data transmission system between DSS 61 and London CP The TCP, DSS 61 comm center, and comm lines between Madrid and London contributed to 30% distortion measured at London This resulted in garbled headers, preambles, and data Command problems and delays prevented playback of digital tape Conclusions of test were that neither DSS 61 nor NASCOM between DSS 61 and London were in system readiness condition and further test was necessary to verify DSS 61	No

Table 28 (contd)

DSS	Date	Test results and remarks	Objectives met
51	April 19	Detailed test procedure was not completed because of problems with communications (loss of TTY, voice, HSD circuits, and CP faults) Test was conducted during time when poor propagation conditions existed on RF link from DSS 51 DSIF operations engineering project engineer was at station during this period and verified satisfactory performance of station equipment Test was delayed 90 min at start while attempts were made to activate command lines Throughout test, only sporadic reception at SFOF was made of data transmitted by DSS CP fault caused further delay of test for 30 min Fault was caused by program error in on-line CP Attempt at recovery was not successful CP operator attempted to switch to off-line CP, but pushed wrong button and caused off-line CP to fault Recovery of on-line CP was subsequently completed Very little data were processed by SFOF DPS because of the HSD circuit and CP problems This prevented verification of SFOF data flow interfaces TCP, using version Q9, performed well throughout test On basis of DSIF operations engineering project engineer's on-site observations, DSS 51 was considered to be in ready status NASCOM between DSS 51 and JPL required additional testing	DSS, yes GCF, No DPS, No
51	April 21	All portions of detailed test procedure were accomplished, including additional requirements for command looping and digital tape playback Scheduled test time provided better command propagation conditions than April 19 test, and few data outages occurred as result of propagation conditions Voice circuit was lost twice, once for 10 min and once for 3 min At one point, 15 min of data mysteriously disappeared DPS was unable to process HSD until after digital tape playback This was also after phone line formatters had been switched in TPS During test, it was determined all HSD problems were connected with technical problems arising in PRE, but it was later felt some of trouble was in phone line formatter in the SFOF TPS This pointed to need for means of quickly isolating SFOF HSD problems, i e , SFOF simulation data source of DSS 51 HSD to verify proper operation of TPS/DPS (DSS 51 HSD bit rate is 550 bits/s, compared to 1200 bits/s for all other stations) As DSS 51 had previously been given status of system readiness, final verification of NASCOM between DSS 51 and JPL SFOF was considered complete, with the knowledge that use of lines depended on favorable RF propagation conditions	DSS, yes GCF, partially DPS, partially
12	April 20	Test objectives were thwarted by command problems, lack of experience by personnel engaged in testing, and shortened schedule Only portion of segments of test procedure were able to be thoroughly tested (It should be noted DSS 12 was never completely checked out before *Mariner* Venus 67 launch) Throughout test, when raw data were requested, high-deck sync wandered to different positions on TTY page printout Receiver out of-lock indication did not function properly at start of test During test, it was discovered DSS 12 had not received TWX which instructed them to change two patches on TCP patch panel Change was made and proper indication was transmitted and received	No
72	April 21 and 22	There was initial delay in data transmission because of confusion over line assignments Also, command assigned one circuit which could not be placed in AA mode, which is mode for all *Mariner* Venus 67 TTY transmission Modification to this line at GSFC was made in May, which later enabled its use for *Mariner* Venus 67 data transmission HF circuits were poor during test and lines were down several times Comsat link was not automatically assigned Switch to two Comsat TTY circuits was made for this test Experiment in switching from prime to backup CP and back to prime was successful DPS operated continually throughout test, processing DSS 72 and SDCC data simultaneously DSS TCP program blew once on call for AGC It was suspected to be hardware problem During test, there were only three minor circuit outages Response to TC requests by station personnel, through track chief, was excellent Need for another test was stated, with availability of Comsat circuits	DSS, yes GCF, partially DPS, yes

Table 28 (contd)

DSS	Date	Test results and remarks	Objectives met
72	April 23	Two Comsat TTY circuits and one Comsat HSD circuit were assigned for test Tracking data (via HF link) was garbled during most of test Solid TLM was transmitted and received throughout test Alternate circuits were successfully used both by reassigning message headers and by line swap between station and Goddard It was first test in which capability was verified 7044 blew three times Log tapes and records were turned over to DPS personnel for examination and analysis Station found wire missing in TCP, but was able to successfully output all modes and rates, play back TCP digital tape at × 1 speed and × 8 speed, and multiple-address of Stanford data Station was considered qualified and in operational readiness status	Yes
12	April 24	Hardware malfunctions in SFOF comm center caused large groups of TSS busses and TV monitors to be nonoperative Station was 55 min late in bringing up TM TCP program failed when AGC was requested It was discovered that wire was missing in cable between J-box and TCP Low format could not be transmitted in several attempts Because DSS 12 was not required for L, because successful system had not been run as of this date, and because scheduling problems prevented further testing prior to L, it was decided further testing of DSS 12 would be required after L	No
61	April 26	All segments of detailed test procedure were accomplished without encountering significant problems However, during test there were several TTY line outages Test procedure was augmented with 4 × normal speed playback of TCP digital tape Playback was successful except that SFOF DPS was unable to process all data Station qualified and, since the 4 × normal speed playback was not committed capability, SFOF DPS was also considered operational	Yes
51 and 61	April 27	Station 51 underwent complete combined systems test and DSS 61 was tested for further verification of TCP digital tape playback techniques All segments of detailed test procedure were accomplished with DSS 51 In addition, transmission of predicts and looping of QC message were performed successfully All systems, including the CP, operated without problems, however, RF communications propagation problems with station were encountered as expected With DSS 61, 2 × normal speed TCP digital tape playback, recorded in previous day's testing with station, was attempted All functions, including SFOF data processing, were accomplished without problems This added test qualified 2 × normal speed playback of 33⅓ bits/s data for mission use	Yes

Table 29 OVT results

DSS	Date	Results
71	April 27	Acceptance criteria met
11	May 9	Acceptance criteria met
42	May 11	Acceptance criteria met
61	May 11	Acceptance criteria met with one exception All TDH formats were not on-site at time of test
72	May 13	Acceptance criteria met
51	May 18	Acceptance criteria met
41	June 6	Acceptance criteria met

1. ***Prerequisite tests.*** This term applied to those tests conducted by the AFETR, MSFN, NASCOM, and DSN to verify their respective portions of a system, prior to TDS interface compatibility and system testing The TDS testing commenced only after the cognizant agency completed its prerequisite testing

2 ***Phase I, interface compatibility tests*** These tests were conducted to verify the compatibility between selected portions of the instrumentation of one TDS agency and another The interface compatibility tests were not time-sequenced or related to operational procedures

3. ***Phase II, combined system tests.*** In these tests, previously verified subsystems and interfaces were brought

Table 30 CVT sequence of events

Operation step	Normal indication
1 Ensure DSS station is configured as shown in Fig 97	N/A
2 Initialize encoder simulator to mode 1 at 33⅓ bits/s Set up 0-1 pattern as follows 1–64, 0–32, 1–16, 0–8, 1–4, 0–2, 1–1	N/A
3 Start station magnetic tape recorders	N/A
4 Set carrier suppression of test transmitter	4 12 ± 0 05 db
5 Adjust output of test transmitter	Receiver input of −140 dbm
6 Lock GTS demodulator to received signal	GTS sync lamp lights
7 Initiate TM and command processor activation with *Mariner* Venus 67 program parameters utilizing Q9 tape version	N/A
8 Conduct bit error test for at least 16 min and record results	As specified
9 Allow system to operate for at least 2 min after all systems are locked-up and good data are reported from TCP monitors	Identical data will be received and sync word will remain constant
10 Switch operation of encoder simulator and TCP Repeating steps 9 and 10 until all data modes and formats are checked	N/A

Mode	Format	Rate, bits/s
1	Raw	33
1	Formatted	33
2	Raw	33
2	Formatted	33
2	Stanford	33
3	Raw	33
3	Formatted	33
3	Stanford	33
1	Raw	8
1	Formatted	8
2	Raw	8
2	Formatted	8
2	Stanford	8
2	Low	8
3	Raw	8
3	Formatted	8
3	Stanford	8
3	Low	8

Table 30 (contd)

Operation step	Normal indication
11 Station AGC voltage or simulated signal is fed to Dymec, through TCP interface drawer to TCP Enable HSD at TCP and monitor output to NASCOM transmitter on oscilloscope	N/A
12 Play back last 5 min of tape recorded data through TCP and observe locally that FR-1400 recorder is functioning properly	N/A
13 Station test conductor requests transmission of QC command tape	N/A
14 MRH personnel verify tape and transmit command in auto mode Command transmission is verified by RWV command receiver loop	VERIFICATION lamp on RWV lights
15 Station test conductor prepares report of test results and forwards by TWX within 24 h after completion	N/A

Table 31 CVT results

DSS	Week of completion	Results
11	May 22–28	Satisfactory
42	May 15–21	
61	May 22–28	
12	May 29–June 4	
14	May 22–28	
41	May 29–June 4	
51	May 15–21	
62	May 29–June 4	
71	April 24–30	
72	May 8–14	

together to determine if data flowed as required from the source to the user area These tests were not time-sequenced or tied to strict operational procedures, however, detailed test procedures resembled those procedures expected during actual launch operations

4. Phase III, TDS operational readiness tests TDS operational readiness tests were comprehensive exercises conducted to verify the communication of telemetry and tracking data throughout the entire TDS supporting the near-earth phase of the mission These tests were conducted according to a time-sequence of events and launch operational procedures

Table 32 TDS ORT sequence of events

Time, min	Area	Event
	All	10 min prior to picking up count at $T-180$ min, all SFOF, DSS, and command systems required will be checked out and operational
	All	Each site or area involved in generating, transmitting, receiving, processing, monitoring, or analyzing TLM data will report occurrence of these functions and actions in real time through established channels
	All	DSN status report
$T-180$	AFETR	RIS 1 start transmission of TLM data to DSS 72
	DSS 72	DSS 72 retransmit RIS data to JSFO and Cape Kennedy
	SFOF	Process all data received during − and + counts
	Comm	In addition to SFOF display of data, ensure that processed data are transmitted to Building AO via direct TTY
$T-160$	DSS 72	DSS 72 radiate test TLM data for ASC MSFN USB
	MSFN	ASC USB start transmission of TLM data to DSS 72
	DSS 72	DSS 72 transmit data to JSFO and GKAP
$T-120$	DSS 71 AFETR	Station 91 and SCS 71 start TLM data transmission system calibration. SCS 71 transmit data to JSFO and GKAP
	DSS 72 AFETR	Station 13 start transmission of TLM data to DSS 72, DSS 72 transmit data to JSFO and Cape Kennedy when directed by TC
$T-60$	DSS 71 AFETR	Tel 4 and DSS 71 start TLM data transmission calibration, SCS 71 transmit data to JSFO and Cape Kennedy
	DSS 72 AFETR	RIS 2 start transmission of TLM data to DSS 72, DSS 72 transmit data to JSFO and Cape Kennedy, (RIS 2 may not participate)
$T-30$	DSS 72	DSS 72 generate and transmit 10 min of TLM data to JSFO and Cape Kennedy, using ASC MSFN USB as data source
$T-10$	All	DSN status report
$T-0$		Simulated liftoff
	DSS 71	DSS 71 generate TLM data and transmit to JSFO and Cape Kennedy. Any time before Antigua AOS when there are no data from the SCS 71 antenna-system, SCS 71 has option to go to Tel 4 supplied data −98 kHz/40 kHz links, whichever is available
	DSS 71	When Station 91 reports AOS, SCS 71 switch to this and retransmit to JSFO and Cape Kennedy until LOS
$T+22$	DSS 72	DSS 72 transmit 5 min of data to JSFO and Cape Kennedy, simulate LOS at $T+27$ min
$T+28$	DSS 72	DSS 72 setup to receive playback of TLM data from 2 RISs and Station 13
	DSS 72	RISs and Station 13 will transmit above data at ¼ speed as per coordination with DSS 72 TLM coordinator
Approximated $T+60$		End of first run
$T-60$		Critique
$T-0$		$T-0$ for second run will occur at 18:30 GMT. Sequence above will be repeated, except DSS 72, rather than ASC, will be data source during $T-22$ to $T-27$-min interval

C. Results of TDS Near-Earth Phase Tests (Conducted by JPL/AFETR)

TDS near-earth testing commenced on March 21, after the AFETR and DSN satisfactorily completed the required prerequisite engineering, feasibility, and integration tests. The results of the TDS near-earth phase were as follows.

1. Telemetry (via HF communications) feasibility test. This test was first made by JPL/AFETR on March 31 to verify the feasibility of transmitting *Mariner* Venus 67 telemetry data via HF communications, at 8⅓ bits/s, to establish a workable system for data transmission from RIS AFETR ships. The Antigua/Cape Kennedy telemetry and HF communication systems were arranged to simulate data transmission from an AFETR RIS. The system included use of a 1.68-kHz subcarrier oscillator (SCO), with 40% deviation. During the March 31 test, Tel 2 at Cape Kennedy had problems with the input to the low-frequency discriminator. Tel 2 could achieve phase lock but could not achieve PN lock. As the test was conducted with little advance notice, proper engineering and technical personnel were not available for performing immediate failure analysis.

The test was repeated on April 5 with satisfactory results. Data were transmitted from Antigua via HF communications to DSS 71. All systems performed as required.

2. *Telemetry interface compatibility test 1.* This test was conducted March 21 by JPL/AFETR to verify the TDM system between Tel 4 and SCS 71. A magnetic tape of the composite *Mariner* Venus 67 telemetry signal was used as the data source. Tel 4 transmitted the data to SCS 71 via wideband cable, using a 40-kHz subcarrier oscillator. SCS 71 discriminated the signal and passed the data through the GTS without difficulty. The test results were excellent.

3. *Telemetry interface compatibility test 2.* Simulation problems at Antigua caused the first attempt to conduct this test, on March 22, to end in failure. On March 23, the test was rerun. Antigua successfully played a magnetic tape of the composite *Mariner V* telemetry signal as a source of test data. Using a 40-kHz subcarrier oscillator, data were transmitted via the AFETR submarine cable to SCS 71. The signal was discriminated by SCS 71 and the data were passed through the GTS without difficulty. The verification of compatibility of the real-time telemetry TDH between Tel 4, Antigua, and SCS 71 was considered complete.

4. *Telemetry interface compatibility test 3.* Neither the 2 RIS nor DSS 72 had the DICs and discriminators required to conduct the interface compatibility test. Therefore, Antigua was configured to resemble a RIS and played data to SCS 71 via HF communications to verify the compatibility between RIS and DSS system configurations. The April 25 test was satisfactory.

5. *Telemetry interface compatibility test 4.* This test was conducted on May 13 with the *Agena* link as a data source. Using a 98-kHz subcarrier, on channel F, Building AE transmitted spacecraft data to Building AO with excellent results.

6. *Telemetry interface compatibility test 5.* This test was an internal test within the JPL/AFETR, which reported completely satisfactory results. The test involved telemetry processing between the Ascension MSFN USB site and DSS 72.

7. *Telemetry interface compatibility test 6.* The *Mariner* Venus 67 crystals for the MSFN receiver VCO module were not available until late May, however, from April 28–May 18, numerous interface compatibility tests between Ascension MSFN USB site and DSS 72 were conducted, using *Surveyor* frequencies. Excellent results were obtained in transmitting the *Mariner* Venus 67 signal.

8. *Combined telemetry system test 1.* This test was conducted to verify the telemetry data handling system from Tel 4 and Antigua, through SCS 71, to the SFOF and Building AO. The data source was a magnetic tape. The start of the test was delayed because of difficulties encountered in the data flow tests with voice nets, HSD, and telemetry. All systems performed well at Tel 4 and Antigua. The JPL CP performed satisfactorily, but problems at the GSFC CP interrupted transmission of teletype data to the SFOF. Transmission from SCS 71 to Building AO via the GSFC CP continued without interruption.

When SCS 71 switched to Antigua data, data bar (bit-inverted data) were processed for 2.5 min while attempting to lock up the GTS. Experimentation confirmed the data were coming from Antigua in inverted form. Periods of standard data occurred as a result of the demodulator being 75% PN bit out from the comparing code, cancelling the inversion of Antigua data. Although reception of data was sporadic, sufficient data was received and processed by the SFOF via teletype and HSDL and by Building AO via teletype to verify the configuration of the TDH system.

9. *Combined telemetry system test 2.* The objective of this test was to verify telemetry data flow from a RIS (simulated by Antigua) and MSFN Ascension to the SFOF via DSS 72. Antigua played 8⅓ bits/s data and transmitted them on May 5 to DSS 72 via the HF link. A switch was made to MSFN data at 33⅓ bits/s which was processed at DSS 72 and transmitted to the SFOF. Communications problems between DSS 72 and GSFC delayed the start of the test. The test verified the capability of a RIS to transmit 8⅓-bits/s data to the SFOF.

10. *Combined tracking system test 1.* Data simulating AFETR and MSFN radar tracking and AFETR computer system outputs were transmitted on April 11 from Building AO via the GSFC CP to the SFOF. The data package accurately simulated tracking data expected from a launch on June 12 at an azimuth of 96 deg. Communications and SFOF 7094 computer malfunctions occurred during the test, however, this did not prevent satisfactory verification of the tracking data handling procedures and system which existed between the AFETR and the SFOF.

D. DSN Test Plan (TDS Deep Space Phase Test Plan)

The interrelationship of the DSN tests conducted in preparation for *Mariner IV* and *V* operations is shown n Fig 93 The DSN in conjunction with the MOS and spacecraft elements of the *Mariner* Venus 67 Project, established, controlled, and conducted those tests which demonstrated the following

(1) The compatibility between DSN systems and the *Mariner* Venus 67 systems

(2) The operational verification of the DSN on a system, subsystem, and component level This included the acceptance of the *Mariner* Venus 67 MRH and MRS required for both real-time and non-real-time data processing

1 Prerequisite testing. Prior to integration testing, all interfacing systems, subsystems, junction boxes, and interconnecting cables were verified individually through component, subsystem, and system tests by the component DSN facilities

2. Definition of tests

a MRH DSN test A MRH DSN test ensured that the mission-related ground equipment was working properly in the DSN subsystem After demonstrating that the hardware operated properly before interfacing with adjacent equipment, this type of test verified that the requirements of the interface were fulfilled However, a MRH/DSN test did not replace any level of acceptance test that the cognizant DSN agencies required before the integration of MRH into a DSS

b Mission-related software/DSN software integration test A MRS/DSN software integration test ensured that the interface requirements between the *Mariner* Venus 67 software package and the appropriate DSN computer system were met However, a MRS/DSN software integration test did not replace any level of acceptance test which the cognizant DSN agencies may have required before integration into a DSN facility or system, nor did it replace the *Mariner* Venus 67 Project acceptance test of the software package

c Spacecraft/DSN compatibility test A spacecraft/DSN compatibility test verified the interface between the elements of the DSN and the spacecraft This type of test checked RF compatibility and the compatibility of the telemetry, command, and ranging signals The compatibility was established at both AFETR and GDSCC under various operating conditions The two main types of spacecraft/DSN compatibility tests were design compatibility tests and verification compatibility tests The design compatibility test was performed at GDSCC with a spacecraft-equivalent communication subsystem The verification compatibility test was of the type conducted with the spacecraft at AFETR prior to launch

d DSN combined system test A DSN combined system test was a test which combined previously tested DSN systems with previously tested and integrated DSN/project interfaces There were the two following types of CSTs

(1) System test, which combined all elements of the DSN telemetry, tracking, or command system with the project interfaces

(2) System compatibility test, which used live spacecraft data from the *Mariner IV* or the *Mariner* Venus 67 spacecraft to verify the end-to-end ground data system This type of test was conducted at GDSCC or AFETR

e Verification test A DSIF verification test verified the DSIF capability to support *Mariner* Venus 67 operations There were the two following types of verification tests

(1) Operations verification test, which verified the operational compatibility of each DSS with the DSN GCF, and with operational interfaces of the SFOF

(2) Configuration verification test, which verified that the configuration of each DSS was as committed and that all committed interfaces and station components were operational

E Deep Space Phase Testing, Procedures, and Results

The test procedures, objectives, and results of the testing conducted under the DSN test plan to verify the TDS for support of the *Mariner* Venus 67 Mission is presented in the following paragraphs The tests are presented in the incremental order in which they were conducted

1. MRH/DSN integration tests. The MRH/DSN integration tests required several days at each station to complete The testing commenced at DSS 11 during the week of February 13 Table 26 summarizes the dates and the results of these tests at each station The objectives of the six tests conducted at each DSS were as follows

(1) Hardware test 1, frequency and timing

(a) Verify signal levels and correct sequence of binary-coded decimal (BCD)

(b) Verify 1-KHz square-wave voltage and pulse width

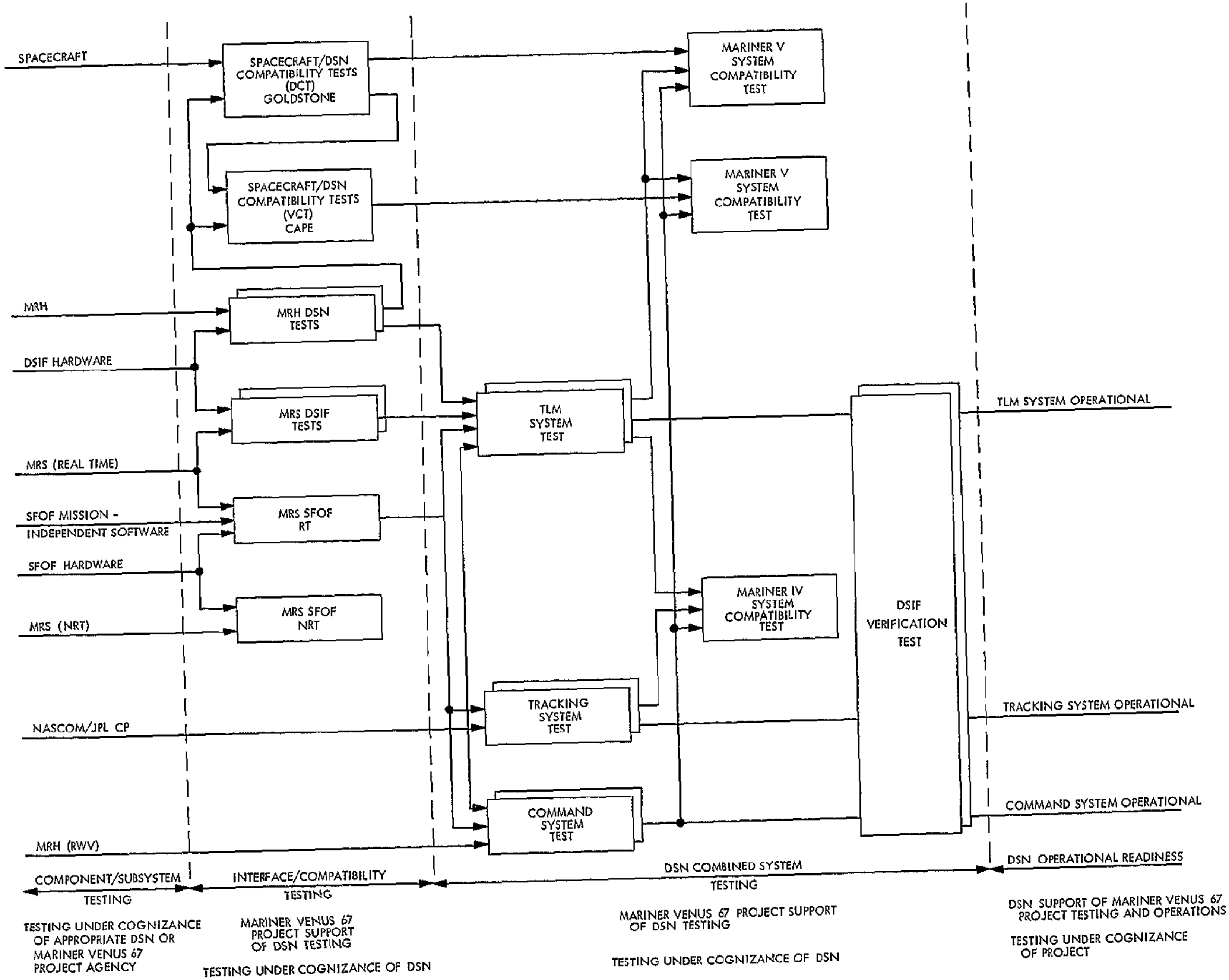

Fig 93 Interrelationships of DSN/*Mariner* Venus 67 tests

(c) Verify GTS printer operation with the 1-kHz square wave with correct time printout

(d) Verify RWV automatic command operation

(e) Verify time displays

(2) Hardware test 2, magnetic recording

(a) Verify outputs from the GTS

(b) Record GTS signals

(c) Verify reproduce signal

(d) Verify playback operation

(3) Hardware test 3, TCP interface

(a) Simulate data through GTS to TCP

(b) Verify processing of station AGC data

(c) Verify processing of receiver out-of-lock signals

(d) Verify AGC and SPE displays

(e) Verify command buffer outputs

(4) Hardware tests 4 and 5, telemetry and ranging

(a) Modulate test transmitter with encoder simulator

(b) Receive signal on receiver 1 through test diplexer

(c) Record detected telemetry on FR-1400 recorder

(d) Verify proper operation of GTS at strong signals

(e) Verify proper operation of GTS at threshold

(f) Add ranging code to test transmitter

(g) Verify proper operation of GTS at strong signals in the presence of ranging

(h) Verify proper operation of GTS at threshold in the presence of ranging

(i) Verify operation of GTS on FR-1400 playback

(5) Hardware test 6, command

(a) Modulate transmitter with RWV output

(b) Radiate 10 kW into dummy load

(c) Lock RWV monitor receiver to signal from klystron 55-db attenuator

(d) Verify the ability of the MRH to transmit manual, automatic, and emergency commands

(e) Verify monitor receiver capability to tune ±142 kHz each side of channel 21 center frequency

2 ***MRS/DSN software integration tests.*** Software integration tests were conducted both at the DSIF stations and at the SFOF

a *MRS/DSIF tests* These tests were conducted at each station in conjunction with MRH integration test 3/TCP interface In these tests, the *Mariner* Venus 67 TCP hardware configuration and the TCP program were checked out as a unified system during the MRH integration tests The tests were completed on the dates shown in Table 26, and the results of all tests were satisfactory The TCP program used in these tests was used with only a few very minor problems and with no changes for all remaining preflight testing It was also used for approximately the first 3 mo of the *Mariner V* Mission

b *MRS/SFOF real-time tests* A series of MRS/SFOF tests was scheduled during March and April Because of program problems, each of the tests was converted into a program check-out To meet a May 1 DSN readiness date, and because the SFOF program was essentially identical for all DSS data sources, it was decided to start CSTs prior to the successful completion of the MRS/SFOF real-time tests The series of CSTs described previously was then used as the vehicle to verify the SFOF software system Successful results were first achieved in the April 21 test with DSS 72

c *MRS/SFOF non-real-time tests* The objectives of these tests were as follows

(1) To verify the analog and TCP digital tape validation programs designed to run on a PDP-7 computer in the TPS within the SFOF

(2) To verify the operability of the *Mariner* Venus 67 MDL programs in the SFOF mode 4 environment

(3) To demonstrate the ability of the *Mariner* Venus 67 7094 user programs to operate in the SFOF mode 4 environment

Satisfactory operation of the digital tape validation and MDL programs was not obtained prior to launch Actual mission data were used to perfect the programs and satisfactory output was first obtained about 7 wks after the *Mariner V* launch

All SFOF mode 4 programs, except the MDL programs, were successfully tested in the MRS/SFOF tests during mid-March to mid-April 1967

3. *Spacecraft compatibility tests*

a Design compatibility test (DCT) This test consisted of a series of subtests conducted between February 20 and March 10 at DSS 11 This series of tests was conducted to pinpoint any incompatibilities or potential problem areas which may have existed between the spacecraft communication system and its DSIF station counterparts The overall objective of these tests was to demonstrate that the spacecraft and GDSCC would work together as designed It was also desired to uncover potential operational problem areas to aid mission planning A secondary objective was to familiarize DSIF personnel with spacecraft characteristics

This test was conducted using the RF test facility at the GDSCC tracking station Figure 94 shows an overall block diagram of the test link The spacecraft and associated OSE (operational support equipment) were set up in the screen room located next to the antenna test facility about 6 mi from DSS 11 An RF link was established from a calibrated antenna at the screen room to a pair of calibrated repeater antennas on the DSS 11 collimation tower and down into the DSS 11 antenna

RF link calibration tests A full calibration of the RF test link was conducted during the first day of the DCT At the start of each following day, a short calibration test was performed to verify the repeatability of the link Daily tests were performed on the downlink and partial calibration tests were conducted only as required on the uplink

RF systems tests One-way lock acquisition (spacecraft to DSIF) was accomplished by using various spacecraft configurations DSIF receiver VCO frequencies were recorded for each configuration Spacecraft power was fixed at 38 6 dbm and the received signal level at −99 8 dbm Downlink receiver VCO best lock frequency was 23 385456 MHz The results of these tests were as follows

S/C RF mode		Rcvr VCO frequency, MHz	Filter, 48-Hz $2B_{L_0}$	Filter, 152 Hz
Exciter	Transmitter			
A	A	23 385309	—	—
A	B	23 385458	23 385456	23 385456
B	B	23 385458	—	—
B	A	23 385308	—	—

One-way lock acquisition (DSIF to spacecraft) was accomplished by varying DSIF transmitter power from 200 W to 10 kW, then noting the spacecraft lock frequencies while tuning from the bottom up and then tuning from top down Uplink exciter VCO best lock frequency was 22 013645 MHz These results were as follows

DSIF transmitter power	S/C lock frequency tuning down, MHz	S/C lock frequency tuning up, MHz
10 kW	22 013648	22 013644
1 kW	22 013646	22 013641
200 W	22 013645	22 013641

Two-way lock acquisition (DSIF to spacecraft to DSIF) functioned successfully without any apparent difficulty in all modes tested

Spacecraft transmitter was checked for spurious radiation signals at signals down to −50 db below carrier level No spurious signals were noted above the −30 db-below-carrier level

Spacecraft receiver threshold was found to be −149 0 dbm, with a screen room temperature of 69°F

One-way (spacecraft to DSIF) residual phase modulations while locked to a strong signal (−100 dbm), using various spacecraft modes of operation, were checked and recorded for later use Similar checks were made of the one-way residual phase modulation at the best lock frequency while varying the DSIF transmitter power, and of the two-way residual phase modulation while the spacecraft was locked to a strong signal (−100 dbm)

Pull range of the spacecraft receiver was checked, starting with the nominal best lock frequency and moving the DSIF transmitter frequency above and below nominal while maintaining lock The receiver held in lock ±1 kHz at the VCO frequency, or ±96 kHz of the transmitted carrier The pull rate was approximately 4 Hz/s

All spacecraft and ground RF systems performed according to specification

Telemetry systems tests Using OSE in the screen room to modulate the spacecraft, a telemetry bit error test was conducted via RF link, at the GTS demodulator threshold

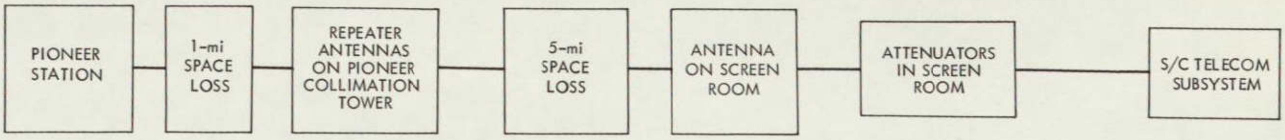

Fig. 94. Block diagram of RF test link for design compatibility test

The GTS system threshold was 0.416 db below the calculated theoretical threshold. Considering the effects of the RF link plus the communications lines, the results exceeded expectations. The modulation index, using the OSE data encoder as a source, did not vary between exciters or ADC/PNG sets. The carrier suppression was 0.3 db less at 8⅓ bits/s than at 33⅓ bits/s. The modulation index of the OSE was 4.1 ± 0.1 db.

Polarity checks were made to determine the correctness of the telemetry phase. Initially, the received telemetry was 180 deg out-of-phase, but operation of the GTS phase-reversal switch corrected the situation, thereby verifying the switch function.

All spacecraft and ground telemetry systems performed according to specification.

Command systems test. The modulation indices were verified by varying the DSIF transmitter power and checking the resultant spacecraft receiver AGC, as follows:

DSIF transmitter power	Spacecraft rcvr input level, dbm[a]	AGC no modulation, db	AGC with modulation, db	Δ db
10 kW	−120	−121.5	−124.2	2.7
1 kW	−120	−121.5	−124.2	2.7
200 W	−120	−121.5	−124.0	2.5
10 kW	−142	−142.7	−145.0	2.3

[a]RF attenuator setting.

The spacecraft receiver command threshold was determined to be −143 dbm.

All spacecraft and ground command systems performed according to specification.

Ranging system tests. The spacecraft/DSIF ranging subsystem was exercised under four general configurations. These were uplink ranging threshold, downlink ranging threshold, ranging acquisition varying uplink power, and ranging acquisition varying downlink power. The ranging acquisition was accomplished using expectant signal level conditions. All spacecraft and ground ranging systems functioned according to specification.

b. Verification compatibility test (VCT). Like the design compatibility test, this test consisted of a series of subtests conducted between May 8–17, 1967. The verification compatibility test constituted the final check by the DSIF that the DSIF was compatible with the spacecraft in its final flight configuration. The verification was made at the spacecraft monitoring station, SCS 71, Cape Kennedy (Fig. 95). For this purpose, an RF link was established between SCS 71 and the spacecraft at various phases of its progress from the assembly building to the launch pad.

The unmodulated spacecraft RF signal was first checked for such properties as frequency stability, tuning range, threshold signal levels, spectrum priority, false lock points, etc. Telemetry, command, and ranging modulations were then applied in succession and each individual spectrum was verified for correct modulation characteristics and correct spacecraft or DSIF response.

The subtests which constituted the VCT are summarized in the paragraphs which follow.

RF tests. The following tests were made to verify compatibility:

(1) Spurious radiation and false lock check. The spurious radiation and threshold data obtained showed that, with the exception of interference from *Surveyor* testing and some *Mariner* Venus 67 testing on the pad, no spurs were observed in any of the modes tested. In addition, the downlink thresholds were consistent for this station with and without the parametric amplifier (−163 dbm and −149 dbm, respectively). It was concluded that there were no spurs in either exciter, and that the jitter attributed to the auxiliary oscillator was not greater than that normally experienced with the DSIF test transmitter.

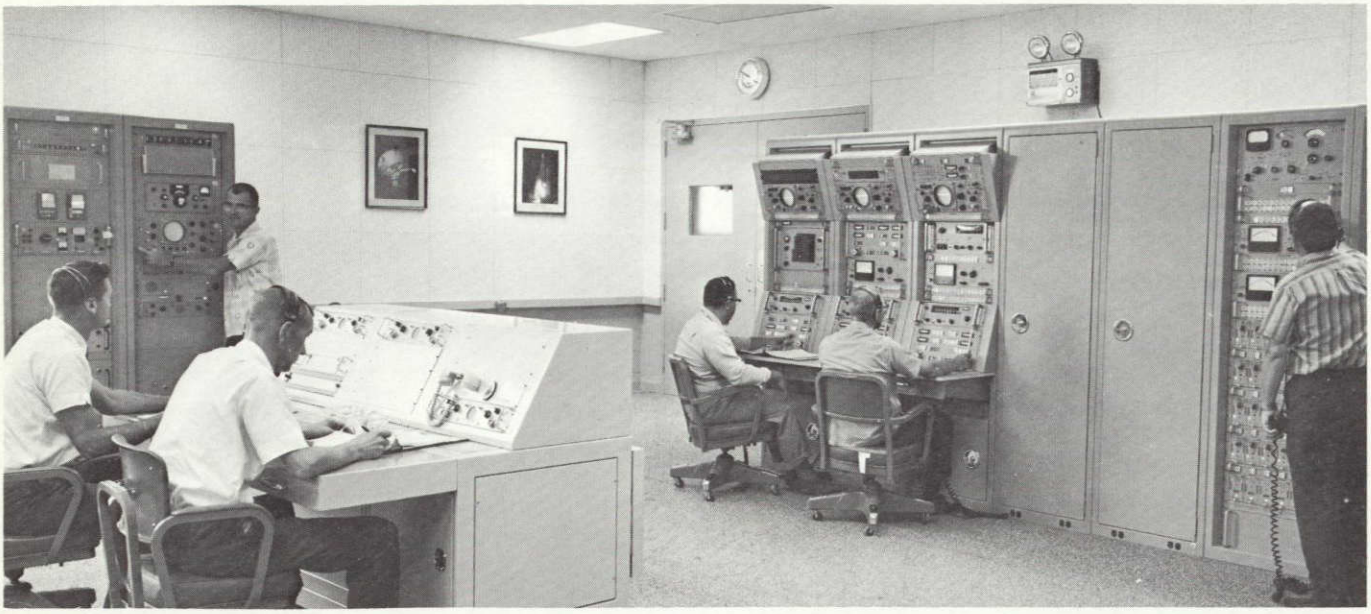

Fig. 95. Control room at DSS 71, Cape Kennedy

(2) Tuning ranges. The tuning range of the spacecraft receiver under strong signal conditions was found to be in excess of the specified value of +65 kHz about the best lock frequency of 2115.697440 MHz.

(3) Tuning rates. It was found that a rate of 100 Hz/s could not be sustained below −135 dbm and that even then the tuning range was reduced to about 35 kHz. Tuning rates of 400 Hz/s could not be tolerated below about −100 dbm.

(4) Best lock frequency. The best lock frequency was measured by approaching the lock point from above and below at 400 Hz/s to minimize the pushing effect. The average value of two measurements resulted in a best lock frequency of 2115.694024 MHz/s at 87.6°K, which was 5.822 kHz below the nominal assigned operating frequency, 2115.699846 MHz/s. The best lock frequency supplied by the Project was 2115.697440 MHz/s. The resulting best lock frequency was considered to be within tolerance when spacecraft temperature and experimental procedures were considered.

(5) Thresholds. The spacecraft receiver threshold was found to vary from −152 dbm at best lock frequency to −135 dbm at the extreme of the tuning range.

Command tests. The three tests made to verify command compatibility were carrier suppression, acquisition time, and command acceptance and verification. Using an average value for $8 \times F_s$ of 4 Hz, the uplink carrier power at the spacecraft was progressively decreased and the acquisition time noted in each case. Acquisition could not be obtained below 140.8 dbm.

Ranging tests. The following tests were made to verify ranging compatibility:

(1) The uplink ranging threshold with constant downlink carrier power data compared very favorably with the data obtained from the DCT run at Goldstone. Comparative figures for uplink acquisition threshold were:

DSS 11, DCT: −132 dbm

DSS 71, VCT: − 132 to −134 dbm

Experimental results agreed with analysis and showed that the requirement for 16-db ratio of ranging power to noise power should result in range acquisition difficulty about −131 dbm.

(2) The comparative figures for downlink ranging threshold with constant uplink carrier power.

DSS 11, DCT: −151 dbm

DSS 71, VCT: −151 dbm

(3) The transponder range delay. Test data showing range delay for various spacecraft configurations was compared with project measurements under the same conditions. The differences varied from −8 to −18 ns. Data from SCS 71 had a standard

deviation of 15 ns, based on 1,000 samples of range data A meaningful comparison with the GDSCC tests could not be made because they were conducted on channel 14 and precise measurements were not attempted

(4) The ranging code polarity tests established that on this particular spacecraft the ranging code was inverted

Telemetry Tests Proper polarity of telemetry signals was verified to be correct with the receiver phase shifter set at 302 5 for both 33⅓ and 8⅓ bits/s SCS 71 did not have the capability of performing spectral density waveform measurements, however, the $4 \times F_s$ sidebands were examined by locking the DSS receiver to the sidebands and noting narrow band AGC measurements The results were as follows

(1) The $4 \times F_s$ sidebands at 33⅓ bits/s were 8 db below the carrier and were approximately ±600 Hz from the carrier

(2) The $4 \times F_s$ sidebands at 8⅓ bits/s were 6 db below the carrier and were approximately ±150 Hz from the carrier

Threshold measurements were conducted by breaking GTS demodulator lock at expected threshold signal levels, observing that the demodulator reacquired phase and PN lock, as follows

(1) At 8⅓ bits/s, exciter A locked at 143 5 db

(2) At 33⅓ bits/s, exciter B locked at 137 5 db

The signal level was varying ±1 db during threshold tests The telemetry channel appeared normal Measured DSS receiver threshold was −150 dbm As a result of the telemetry tests, the following was concluded

(1) The telemetry polarity of *Mariner* Venus 67 spacecraft is identical to the output of the DSIF test transmitter, when modulated by a GTS encoder simulator This is also true for the spectral density of the spacecraft telemetry signal

(2) Normal system performance is obtained at threshold

(3) The telemetry system of the *Mariner* Venus 67 spacecraft was compatible with the DSIF under static conditions

4 DSN combined systems tests The DSN project engineer, or his delegated assistant, acted in the capacity of test conductor and coordinated all DSN combined systems tests from an operations console in the SFOF *Mariner* Venus 67 Mission support area DSN elements involved were the SFOF, GCF, and DSIF (for DSIF station configuration, see Fig 96)

Test objectives The objectives of the DSN combined systems tests (CSTs) were to

(1) Demonstrate the end-to-end operational status of the DSN/*Mariner* Venus 67 telemetry and command systems, including previously checked-out MRH and MRS

(2) Exercise the DSN/*Mariner* Venus 67 TCD systems with simulated spacecraft data

(3) Verify the DSN readiness as a TDS element to support *Mariner* Venus 67 operations

b Requirements The participating personnel in these tests were (1) DSS personnel required to operate the equipment, plus a test conductor, (2) communications personnel at the SFOF and DSS, plus communications representatives to operate and evaluate the performance of the GCF, and (3) SFOF operations personnel to support the configured data system and a test coordinator for the SFOF data system, located in the SFOF with the test conductor Monitor area personnel were also present to monitor and evaluate the incoming data

The equipment requirements imposed upon the DSS were receiver subsystem, transmitter subsystem, test transmitter, frequency and timing subsystem, FR 1200 recorder, FR-1400 recorder, GTS, RWV, TCP (with ms clock), station displays (AGC/SPE), HSD interface, and teletype interface

The GCF line requirements were four TTY lines, one HSD line, and one voice line, each between the SFOF and DSS (full duplex) The NASCOM teletype communications processor (CP) system (including the JPL CP) was used and tested

The SFOF equipment and area requirements were MMSA and computer I/O equipment, DSN monitor area and I/O equipment, DSIF net control area, TPS phone line formatters, 7044/7094 computers in mode 2, internal teletype and OVCS nets

Software required were specified versions of the *Mariner* Venus 67 TCP program and CP program, and software for the 7044/7094 system Command messages,

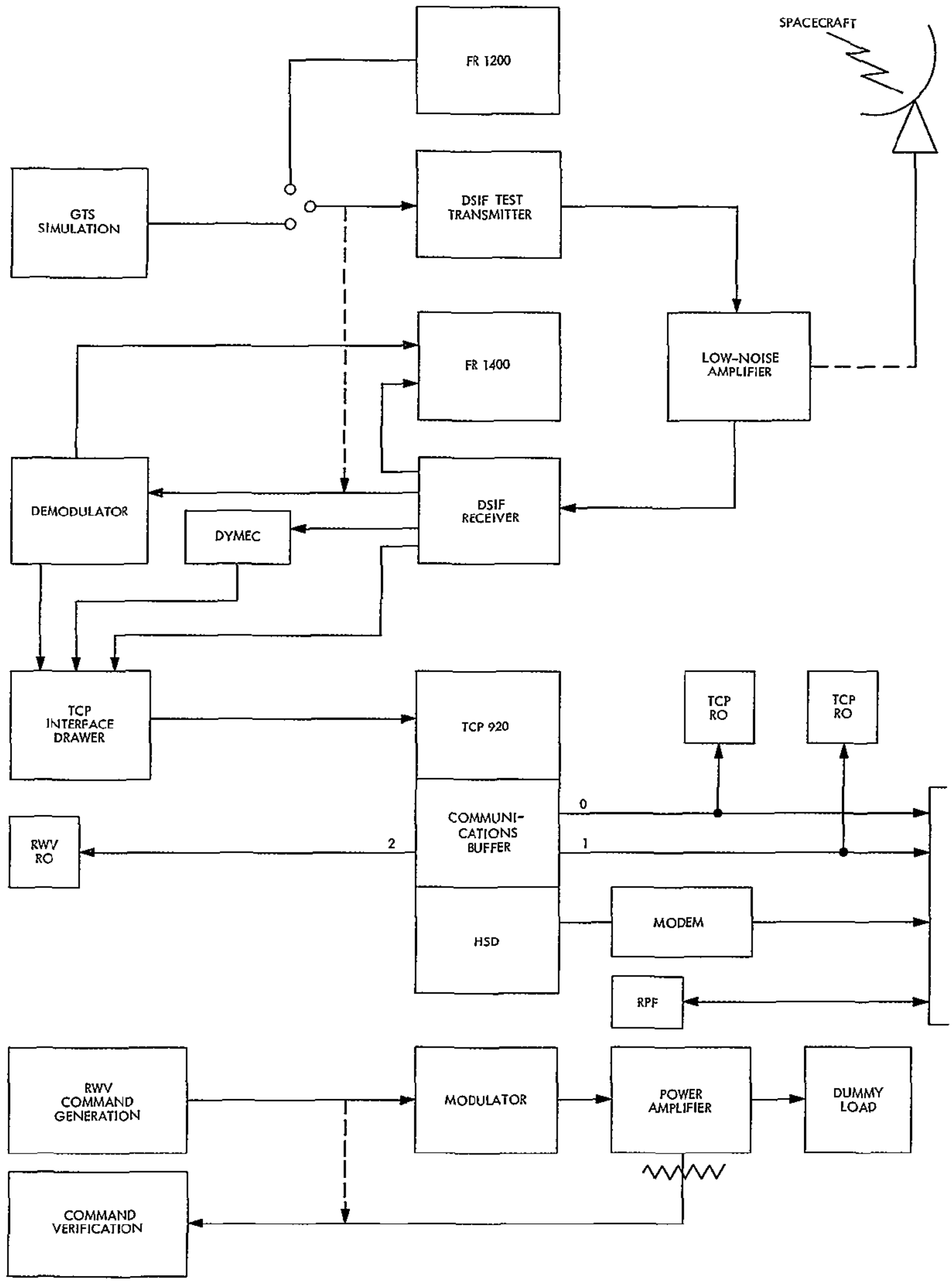

Fig 96. DSIF station configuration for DSN combined systems test

to simulate a realistic maneuver command, were also required

c Pretest activities The DSIF coordinator, directing the activities of the DSS through the track net controller (in liaison with the test conductor, SFOF communications chief, and SFOF data system coordinator), ensured that all teletype, HSD, and voice circuits were activated and that data would flow through the system It was also the responsibility of the DSIF coordinator to ensure that a pretrack countdown on the MRH and a complete set of diagnostics on the TCP were performed The responsibilities for performance of segments of the preflight activities are presented in item 1 of Table 27

d Test procedures and results The detailed test procedure for the DSN CSTs is shown in Table 27 Because those activities listed under item 1 were considered to be pretest activities, the data transmission for actual test purposes did not begin until item 1 had been completed under the cognizance of the DSIF coordinator The test conductor monitored the pretest activities and took command of the test starting at item 2 of the test sequence of events (Table 27)

The results of the CSTs are presented in Table 28, in chronological order As the tests progressed, operational procedures and personnel performance steadily improved Table 28 presents the DSS with which the CSTs were performed, anomalies and problems encountered, and a statement as to whether test objectives were met Tests were considered successful if (1) all the objectives specified previously were met, and (2) any anomalies occurring during the test could be definitely attributed to hardware failure, not of a design nature, or to operator failure, not of a procedural nature

5 DSIF operational verification tests A DSIF OVT was conducted prior to *Mariner V* launch with each DSS that was required for launch support The objectives of the tests were as follows

(1) Demonstrate that the DSS mission-independent and mission-dependent procedures were (1) compatible with the hardware, and (2) adequate to support the mission in the acquisition of data and the transmission of commands

(2) Demonstrate that the DSIF net control procedures, both mission-independent and mission-dependent, were (1) compatible with the DSIF and GCF systems, and (2) adequate to support the mission in the acquisition of data and the transmission of commands

(3) Determine that the DSIF operational interfaces with the GCF and SFOF were correct and adequate to support the mission

(4) Demonstrate that the operational personnel were adequately trained to support the mission

The simulation of an actual track was used to conduct the tests All DSIF operational positions and equipment were included in the tests, including the track chief position, from which the tests were conducted The procedures of the *Tracking Instruction Manual* (TIM) were used throughout the tests, and proper execution of the procedures was the necessary requirement

Each test consisted of the following

(1) A standard pretrack precalibration conducted by the DSS

(2) A standard pretrack data transmission test between the DSS and the SFOF

(3) Simulated one-way and two-way acquisitions

(4) Telemetry and tracking data transmission

(5) Simulated transmission of direct commands and quantitative commands

(6) A standard post-track calibration

(7) Submittal of a post-track report and data package

The dates and results of each OVT are presented in Table 29 No OVT was conducted with DSS 12 or DSS 62 because neither station was required for launch support

6. DSIF configuration verification tests A DSIF CVT was conducted prior to *Mariner V* launch with each DSS that was required for launch support The objectives of the tests were as follows

(1) Verify the configuration status of the DSS/*Mariner* Venus 67 telemetry and command systems, including previously checked-out MRH

(2) Exercise the DSS/*Mariner* Venus 67 telemetry and command ground data systems with simulated spacecraft data

(3) Prove the DSS configuration readiness to support *Mariner* Venus 67 operations

The configuration verification test was the final step in the implementation of the station to support the *Mariner* Venus 67 Mission A simulated telemetry loop through the DSS RF system was established, the bit-error rate checked, and the telemetry and command data transmitted within the DSIF, allowing the verification of the entire system

For the conduct of the tests, the stations were configured as shown in Fig 97 The tests were conducted and controlled entirely at the DSS, with the results sent to JPL/Pasadena The tests were conducted according to the CVT sequence of events shown in Table 30

The results of the CVTs are tabulated in Table 31 All CVTs, including those for the stations not tracking for launch, were successfully completed prior to June 5

7. TDS operational readiness tests The TDS operational readiness tests (ORTs) constituted the final testing required to verify complete operational readiness of the

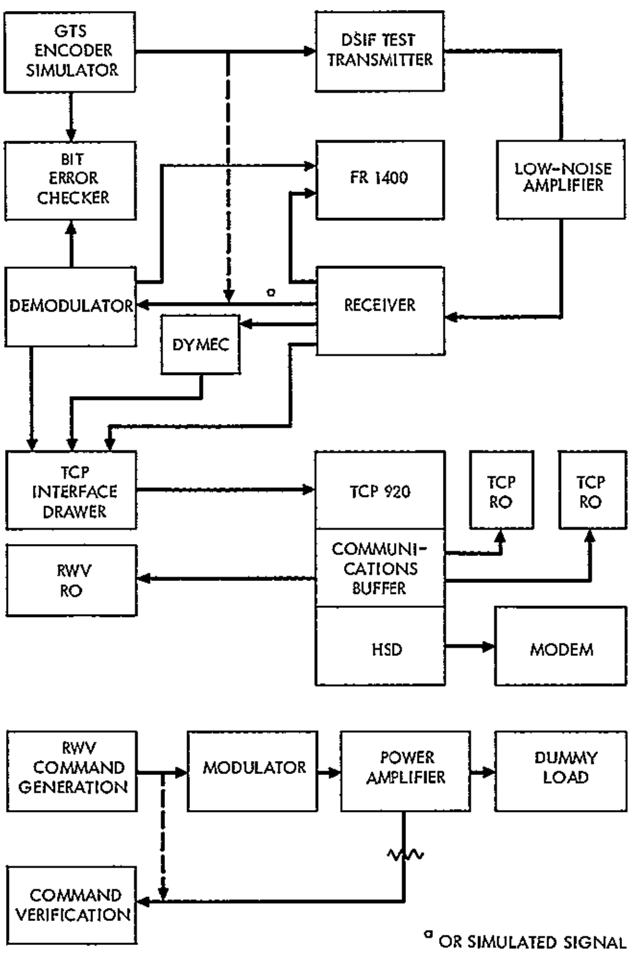

Fig 97 DSIF CVT configuration

TDS (including hardware, software, operational procedures, and personnel within interfacing agencies) to support project ORTs and the near-earth phase of the *Mariner V* Mission Three TDS ORTs were planned tracking, telemetry, and tracking and telemetry The tests were conducted by the JPL/AFETR operations center coordinator, in coordination with the DSN project engineer, from Building AO, AFETR JPL/AFETR elected not to conduct the tracking ORT because the TDH had been successfully proved in earlier missions and tests and also because of its redundancy with the TDS tracking and telemetry ORT

The TDS telemetry ORT was conducted on May 18, involving the SFOF, Building AO, SCS 71, DSS 72, two AFETR RISs, the Ascension MSFN USB site, Antigua (Station 91), Pretoria (Station 13), and Tel 4 The objective of this test was to ensure telemetry data were available in the proper formats at the required place and time Furthermore, timing and sequencing of TDS operations were accurately evaluated through realistic simulation of conditions expected during the actual launch operations The sequence of events shown in Table 32 was followed This test was to exercise for the first time the entire TDS near-earth phase telemetry transmission system The results of the test were successful, as far as the processing of Tel 4, SCS 71, MSFN USB, DSS 72, and Antigua data However, the RISs *Twin Falls* and *Coastal Crusader* and Pretoria had tape playback problems and the portion of the test involving those stations was scheduled to be rerun on May 19

During the rerun, the RIS *Coastal Crusader* was successful in transmitting data to DSS 72, and 72 locked-up on the data However, RIS *Twin Falls* and Pretoria (Station 13) still had problems These difficulties were attributed to the simulation technique of playing back from a simulation tape which was not recorded on the machine from which the tape was played, producing speed-lock problems The problem was corrected by borrowing a *Mariner* encoder simulator from DSS 51 and recording simulation tapes on the machines used for playback The efforts were successful and both stations were checked out and declared operationally ready by May 29

On May 24, a TDS tracking and telemetry ORT was performed All portions of TDS support for the near-earth phase of the mission were exercised (equipment, personnel, computer programs, and procedures) The test also provided a data source for a Project/TDS combined operations test (COT), during which Project/TDS operational interfaces were given a trial run The launch sequence of events (see Appendix A) was used

With regard to system performance, satisfactory results were achieved with the following minor problems

(1) The simulation problems from the downrange stations, previously described, persisted because the new simulation tapes were not on site at the time of this test

(2) Minor communications problems, mostly caused by misaddressing of telemetry data, occurred throughout the test

The TDS tracking and telemetry ORT did uncover the following two salient organizational/procedural problems

(1) Lack of understanding on the part of all concerned on how the JPL/AFETR-SFOF interface should work resulted in a breakdown of communications between the two groups Lengthy discussions following the test resulted in acceptance of a philosophy where a TDS position in the SFOF (SYSAD-staffed by a member of the DSN operations control group and advised by the DSN project engineer) coordinated all prelaunch TDS system checkouts and, at $T-60$ min in the countdown, turned over an operational, checked-out TDS to the Project

(2) The separation of the Project status and TDS status functions did not work, mainly because it was a change from procedures followed on previous launches As a result of the discussions described previously, the TDS and Project status functions were combined after the $T-60$-min point in the countdown Prior to that time, the TDS status function was combined with the TDS checkout coordination, which became extinct at $T-60$ min when an operational TDS was turned over to the Project

The primary objective of the final TDS ORT was met in that the combined tracking and telemetry data acquisition, transmission, and processing system was verified to be operationally ready, Procedural problems, as described, prevented the achievement of all test objectives for verification of operational procedures However, a second run of the test was not considered necessary because workable procedures were developed during, and immediately following, the test

V. TDS Flight Support

A General

This section describes the actual flight support provided by the TDS in areas of tracking, telemetry, command, data transmission, and data processing Major problems which were experienced are also discussed No attempt is made in this section to compare actual support with requirements, estimated coverages, and commitments because this discussion is contained in Section VI The near-earth and deep space phases (through midcourse maneuver) are, again, treated separately

B Near-Earth Phase Support

1 *Launch countdown* Through the operational organization, described in Sections II and III, the TDS coordinators conducted and completed all TDS items as outlined in Appendix A Minus-count telemetry data flow checks between SCS 71, Tel 4, and Antigua were rapidly completed Therefore, SCS 71 was able to start receiving and transmitting actual spacecraft data at $T-3$ h, 20 min, as required This transmission was continued by SCS 71 throughout the count Communications propagation difficulties between DSS 72 and AFETR downrange sites and RISs during the minus-count data flow check were expected and encountered However, conditions improved, permitting completion of checks prior to $T-60$ min The TDS was declared *go* at that time and continued in a *go* condition throughout launch There were problems during this period in various portions of the system which required TDS attention, evaluation, and resolution

Throughout the countdown, the Carnarvon FPQ-6 radar was considered in a RED condition because of an intermittent traveling wave tube (TWT) in the second RF amplifier of the transmitter The system was also RED for transmitter klystron focus coil power supply and the angle encoder power supply Since the problem was intermittent, the radar remained on-line to provide support on a best-obtainable basis

Both the FPQ-6 and FPS-16 radars at Bermuda failed the initial slew checks with GSFC/AFETR The problem was manifested by an intermittent data shift in the azimuth region between 193 and 217 deg This was determined to be a 4101 computer software problem, causing computer *flag minus zero* to be set This problem was remedied by operating the 4101 computer with the parity override switch in the ON position Subsequent slews were satisfactory from both radars

The FPS-16 radar at Bermuda was RED during the minus count from 0339Z to 0335Z because of an elevation digital data problem The coarse data word showed all ones in the set condition Replacement of a module corrected the situation

At $T - 180$ min, the 3 18 radar at GBI was declared not operationally ready (NOR) by AFETR because of a problem in the electrical power system to the pedestal Meanwhile, the 3 16 radar at Grand Bahama remained in a *go* condition The 3 18 radar was repaired at $T - 108$ min

The first RF propagation forecast for $T - 0$ was received at $T - 360$ min This report forecast a condition 3 for all downrange circuits Radio frequency propagation conditions are defined as follows Condition 5 excellent, 4 good, 3 fair, 2 unusable, 1 circuit out At $T - 80$, the forecast for circuits from RIS *Twin Falls* was changed to condition 2 During the built-in hold at $T - 60$, the forecast for RIS *Coastal Crusader* circuits was changed to condition 2

At $T - 143$ min, the Grand Turk 7 18 radar failed its slew checks and was declared NOR for approximately 30 min The problem was in the elevation encoder system The radar was declared operational at $T - 50$ min

The Bermuda FPS-16 was again RED at $T - 64$ min The GBI 3 16 was NOR at $T - 62$ min because of brush-block assembly problems Both radars were GREEN 20 min later

After resuming the count at the end of the 50-min built-in hold, all operations progressed normally until $T - 30$ min, when the TAA-2 telemetry antenna at GBI failed Failure was caused by a wet connector, resulting from a heavy rainstorm Loss of this resource was not considered critical because of other overlapping coverage

Excessive nutation (10 Hz) was noted when Tel 4 receivers were in-lock with the spacecraft telemetry during the minus count The level fluctuated to the extent that it was unusable Tel 4 also reported that the S-band signal strength at their preamplifier was -115 dBm during most of the minus count, as compared to -80 dBm when the receivers reacquired the S-band signal at $T - 20$ min

At approximately $T - 10$ min, the TDS analyst in the MOC recommended slipping from launch plan 14F to launch plan 14G This was based on several factors, all pivoting on the prevailing downrange propagation conditions and improved coverage from DSS 72, DSS 51, and RIS *Twin Falls* The poor RF propagation conditions expected at $T - 0$ on launch plan 14F were predicted to improve after 30 to 60 min and then to deteriorate again Moreover, launch plan 14F provided only single-station coverage of certain critical telemetry data, whereas redundancy was gained on launch plans 14G and 14H The launch phase mission analyst concurred in the recommendation, and the mission director extended the $T - 7$ min built-in hold by 14 min to slip to launch plan 14G

The RTCS operations went smoothly in the minus count All static points were transmitted and were acceptable The predict constants were received in a timely manner The launch azimuth was such that Antigua data were prime for parking orbit computations There were three sources of data for the actual transfer orbit (preposigrade) computations Pretoria, Ascension, and RIS *Twin Falls*

Following the countdown, which included the 14-min unscheduled built-in hold, liftoff occurred at 06 01 00 176 GMT, June 14, on an azimuth of 101 deg

2. Metric coverage. Extensive metric coverage was provided by the AFETR and MSFN C-band radars, as shown in Table 33 and Fig 98 It should be noted that data coverage intervals reflect that period of time a site tracked a signal and did not necessarily indicate the presence of high-quality data The same is even more applicable to telemetry coverages

Table 33 Launch vehicle metric coverage intervals (C-band radar)

Station	Actual interval, $L + s$
Cape Kennedy (1 16)	10–265
KSC (19 18)	12–365
PAFB (0 18)	15–480
GBI (3 18)	48–450
(3 16)	69–467
GT (7 18)	199–610
BDA (FPQ 6)	282–642
ANT (91 18)	368–768
ASC (12 18)	1232–1515
(12 16)	1245–1474
RIS *Twin Falls* (FPS-16)	1414–1912
PRE (13 16)	1667–3046 3078–4967
CRO (FPQ 6)	2342–5178

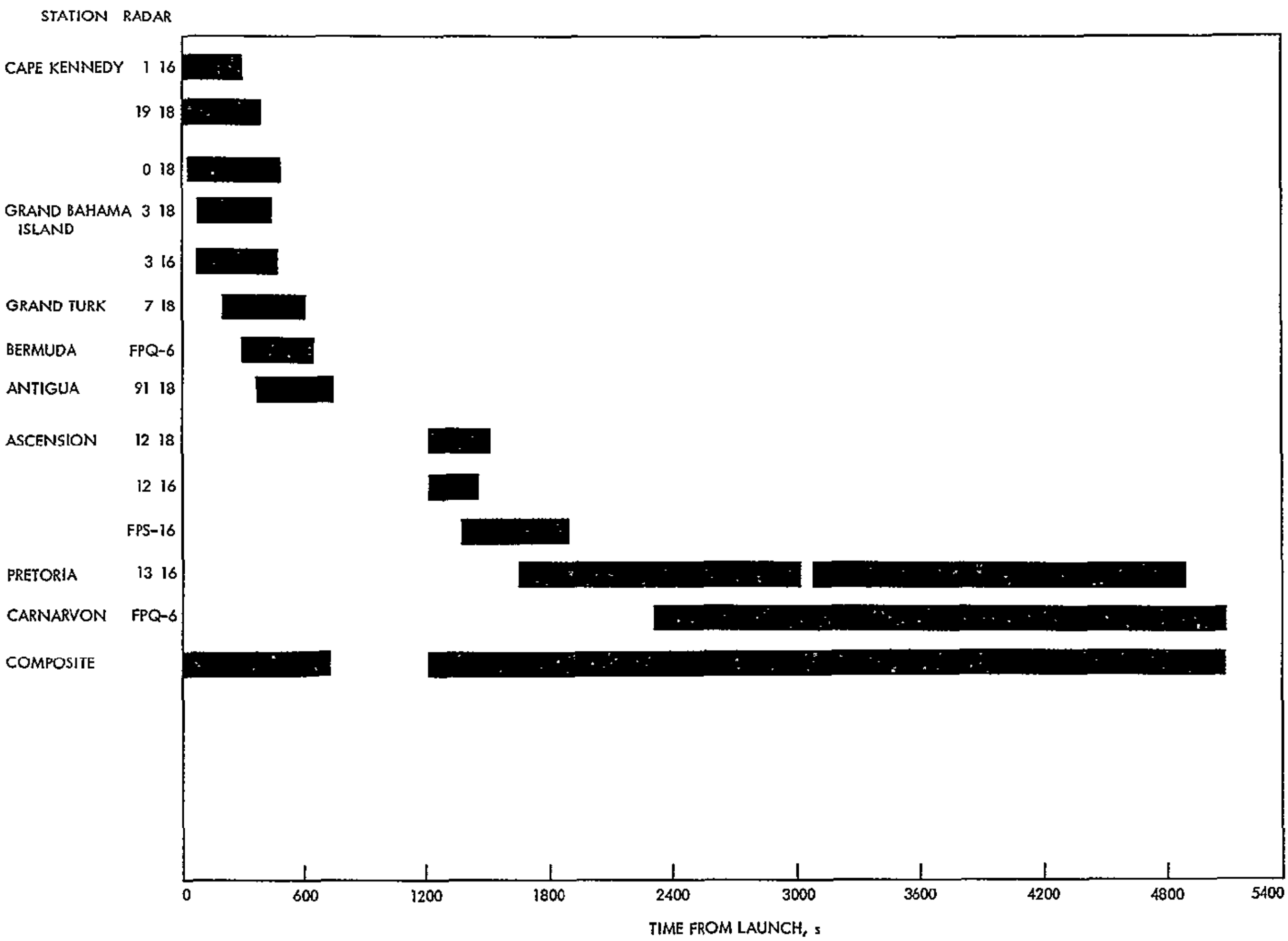

Fig 98 Launch vehicle metric actual coverage intervals (C-band radar)

3. *Telemetry coverage*

a Launch vehicle Launch vehicle telemetry data coverage provided by AFETR and MSFN sites was as shown in Table 34 and Fig 99 Note that AFETR telemetry aircraft obtained data during the flight, this is further explained in Section VI AFETR, MSFN, and launch vehicle personnel confirmed and reported all mark events The nominal and actual mark event times are shown in Table 35 All differences between nominal and actual times were within tolerances Table 36 lists the GMT of mark events as they were reported in near-real time

b Spacecraft telemetry Extensive S-band spacecraft telemetry coverage was provided by AFETR, MSFN, and DSN sites, as shown in Table 37 and Fig 100 Also, spacecraft data available via the *Agena* 98-kHz channel were covered as shown in the launch vehicle telemetry summary

c Data transmission and processing

Metric Uprange sites transmitted metric data to the RTCF in real time The RTCF used these data to compare the actual parking orbit, IRV, SOPM, and JPL elements, as well as the theoretical transfer orbit, Carnarvon and Tananarive look angles and DSN predicts (based on the theoretical transfer orbit) Table 38 contains a log of metric operations reflecting activities at the RTCF and between the RTCF, GSFC, and Building AO SFOF Table 39 lists the orbital computations performed by the RTCF and the source of data used in the OD

Because of poor RF propagation conditions, Ascension and Pretoria metric data were not transmitted to the RTCS in real time The RIS *Twin Falls* metric data were not transmitted in real time because of a combination of propagation and shipboard communications patching problems In effect, the RTCS had no data for computation of the actual transfer and postposigrade orbits Since no data were available, the RTCS was requested to deviate from the standard sequence of events as reflected in Table 38

Although the RTCS was not receiving C-band radar metric data, DSS 51 tracking data were available, and DSS 42 would acquire a few minutes later and provide additional tracking data In prelaunch planning meetings, RTCS personnel had been informed that DSS 42 would be the first station to go to two-way track They were not aware that DSS 51 had been instructed to go two-way at approximately $L + 60$ min This unfortunate communication deficiency led to further delays in the orbit determination

Table 34. Launch vehicle telemetry coverage intervals (*Agena* link VHF)

Station	Actual interval, $L +$ s
Tel 2	0–483
Tel 4	0–483
GBI	18–525
BDA	237–633
ANT	330–773
ASC	1158–1640
RIS *Coastal Crusader*	1270–1380
PRE	1615–5040
RIS *Twin Falls*	1341–2065
TAN	1756–3036
CRO	2375–3990
Aircraft	
Audit 1 TAA-4	945–1497
Audit 2 TAA-4	994–1591

When RTCS personnel observed DSS 51 tracking data coded two-way, they thought this was an error and waited for DSS 42 data Shortly, DSS 42 tracking data were received at the RTCS and the data were also coded two-way The RTCS started using this data Unfortunately, DSS 42 personnel had misidentified their data, and RTCS personnel spent approximately 40 min attempting to generate an orbit

Finally, the RTCS learned the correct situation, however, at that time, propagation conditions had improved and downrange sites were retransmitting their C-band metric data The RTCS personnel continued their orbit computations, using Ascension, Pretoria, and Carnarvon data, as shown in Tables 38 and 39 The RTCS then used DSS 51 data and combinations of DSS 51/AFETR data to make additional computations However, when DSS 51 data were used in the system, a good orbit fit could not be obtained It appeared to RTCS personnel that DSS 51

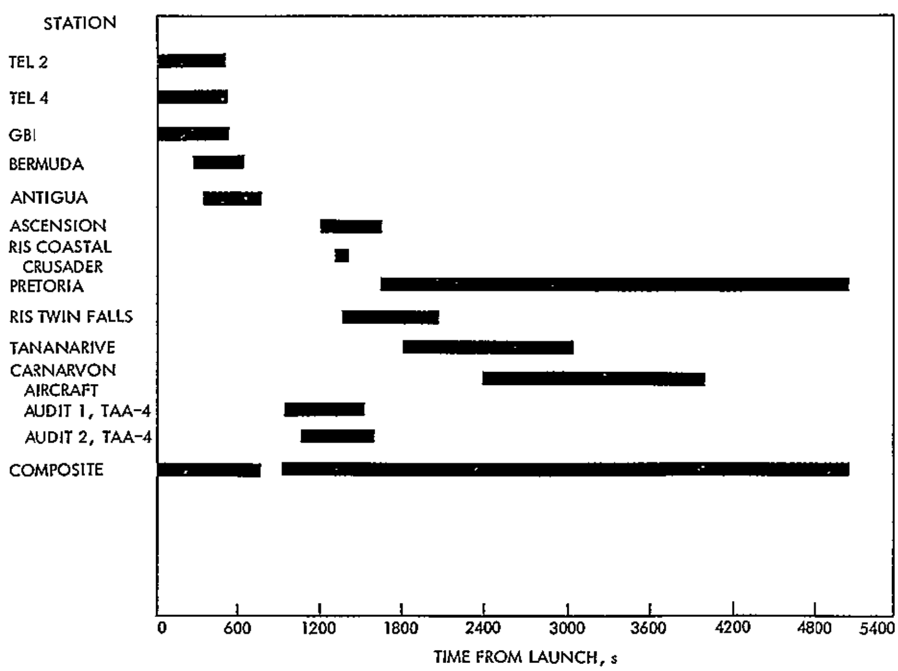

Fig 99 Launch vehicle telemetry coverage intervals (*Agena* link VHF)

Table 35 *Mariner V* mark event times (time from launch)

Mark	Event	Nominal time, s	Actual time, s	Source
1	*Atlas* BECO	128 4	128 67	Cape Kennedy
2	*Atlas* booster engine jettison	131 4	131 57	Cape Kennedy
3	Start *Agena* secondary timer	280 8	281 72	Cape Kennedy
4	*Atlas* SECO	295 5	296 66	Cape Kennedy
5	Start *Agena* primary timer	297 9	308 39	Cape Kennedy
6	*Atlas* VECO	315 4	317 75	Cape Kennedy
7	Shroud separation	317 5	320 06	Cape Kennedy
8	*Atlas/Agena* separation	319.5	322 10	Cape Kennedy
9	*Agena* first ignition	371 1	381 62 381 82	Cape Kennedy BDA
10	*Agena* first cutoff	514 4	525 18 524 32	 BDA
11	*Agena* second ignition	1320 0	1321 02 1321 02 1320 92	ANT ASC RIS *Coastal Crusader*
12	*Agena* second cutoff	1415 6	1415 32 1415 42 1415 42	ASC RIS *Twin Falls* RIS *Coastal Crusader*
13	*Agena*–S/C separation	1575 8	1576 72 1576 82	ASC RIS *Twin Falls*
14	Begin *Agena* yaw	1578 8	1579 92 1580 72	ASC RIS *Twin Falls*
15	End *Agena* yaw	1587 8	1588 72 1588 82	ASC RIS *Twin Falls*
16	Begin *Agena* posigrade	1875 8	1876 72 1876 82 1876 92	PRE RIS *Twin Falls* TAN

Table 36 GMT of *Mariner V* mark events

Mark	Time, s	Source
Liftoff	06 01 00 176	Cape Kennedy
1	06 03 08 85	Cape Kennedy
2	06 03 11 75	Cape Kennedy
3	06 05 41 90	Cape Kennedy
4	06 05 56 84	Cape Kennedy
5	06 06 08 57	Cape Kennedy
6	06 06 17 93	Cape Kennedy
7	06 06 20 24	Cape Kennedy
8	06 06 22 28	Cape Kennedy
9	06 07 21 80	Cape Kennedy
	06 07 22 0	BDA
10	06 09 45 34	Cape Kennedy
	06 09 44 5	BDA
11	06 23 01 2	ANT
	06 23 01 2	ASC
	06 23 01 1	RIS *Coastal Crusader*
12	06 24 35 5	ASC
	06 24 35 6	RIS *Twin Falls*
	06 24 35 6	RIS *Coastal Crusader*
13	06 27 16 9	ASC
	06 27 17 0	RIS *Twin Falls*
14	06 27 20 1	ASC
	06 27 20 9	RIS *Twin Falls*
15	06 27 28 9	ASC
	06 27 29 0	RIS *Twin Falls*
16	06 32 16 9	PRE
	06 32 17 0	RIS *Twin Falls*
	06 32 17 1	TAN

was probably tracking a side lobe (Tables 40 and 41) This is supported by the fact that the SFOF flight path analysis and command (FPAC) group also had some difficulty in converging on an orbit The RTCS and SFOF efforts in providing Venus encounter computations are further defined in Table 41 and Fig 101

The RTCS was considered to be prime until $L + 3\ 5$ h, at which time FPAC had sufficient confidence in the several orbits generated As reflected in the data above, the first good mapping to planetary encounter was not available until approximately $L + 2$ h

4 Telemetry data

a Launch vehicle Continuous launch vehicle telemetry data were transmitted to user areas in real time through Antigua LOS The submarine cable was used with less than good results The data on VCOs 15 and 16 were quite noisy (spikes), resulting in continuous short dropouts in the data Real-time velocity meter and chamber pressure data were transmitted by downrange sites (Ascension, RISs *Twin Falls* and *Coastal Crusader*) to user areas, as reflected in Table 42 The MSFN station at Tananarive also provided velocity meter information during the posigrade maneuver

b Spacecraft telemetry DSS 71 transmitted spacecraft data to Building AO and the SFOF in real time throughout the minus count At liftoff, the received signal strength was −99 dbm SCS 71 continued receiving and transmitting data through $L + 7$ min At this time, the signal level was −150 dbm, at 06 08 09 GMT, SCS 71 switched to Antigua data, which were being transmitted to SCS 71 in real time via the submarine cable Antigua was using the *Agena* channel F, 98 kHz, as the source of spacecraft telemetry data Transmission continued until Antigua LOS Antigua data were received in good condition, but were inverted (data bar) No change in the GTS polarity was requested, because inverted data caused no significant difficulties Tel 4, channel F, data were available in real time at SCS 71 and were of excellent quality This

Table 37. Spacecraft telemetry coverage intervals (S-band)

Station	Actual interval, s
SCS 71	0–428
Tel 4	0–364
GBI	None
BDA	None
ANT	390–715
	Phase locked
ASC USB	1184–1629
ASC	1183–1500
	1575–1593
	1625–1643
DSS 72	1308–1500
	1560–1620
RIS *Coastal Crusader*	1270–1380
PRE	1633–5040
DSS 51	1718–(SCM auto-track at − 95 dbm)
	3720–(2-way doppler)
RIS *Twin Falls*	1361–2065
DSS 42	3120–8940–(2 way doppler)
DSS 41	2940

data stream could have been used for real-time transmission if SCS 71 had LOS before AOS by Antigua Tel 4 S-band data were also available at SCS 71 in real time

DSS 72 received the IRV at $L + 15$ min, 30 s The station acquired the spacecraft signal at $L + 22$ min, 14 s Signal strength was −126 dbm DSS 72 processed and transmitted the received data to Building AO and the SFOF in real time MSFN Ascension USB data were transmitted to DSS 72 and were available if DSS 72 had lost track At $L + 26$ min, all S-band sites at Ascension reported an unexpected LOS Although DSS 72 did not reacquire, the MSFN USB site was back on track in about 10 s DSS 72 switched to this source of data and continued to transmit data to the SFOF and Building AO via teletype and HSD circuits until the MSFN USB LOS at $L + 27$ min, 9 s

Shortly after LOS, DSS 72 was ready to receive AFETR's near-real-time playback of RIS *Twin Falls* data However, poor propagation conditions prevented data transmission at that time Data from RIS *Twin Falls* were transmitted to the SFOF via DSS 72 at about $L + 2$ h, 40 min The ¼-speed playback continued until approximately $L + 3$ h, 4 min

At $L + 28$ min, DSS 51 acquired the spacecraft signal and had demodulator lock at $L + 28$ min, 45 s Real-time

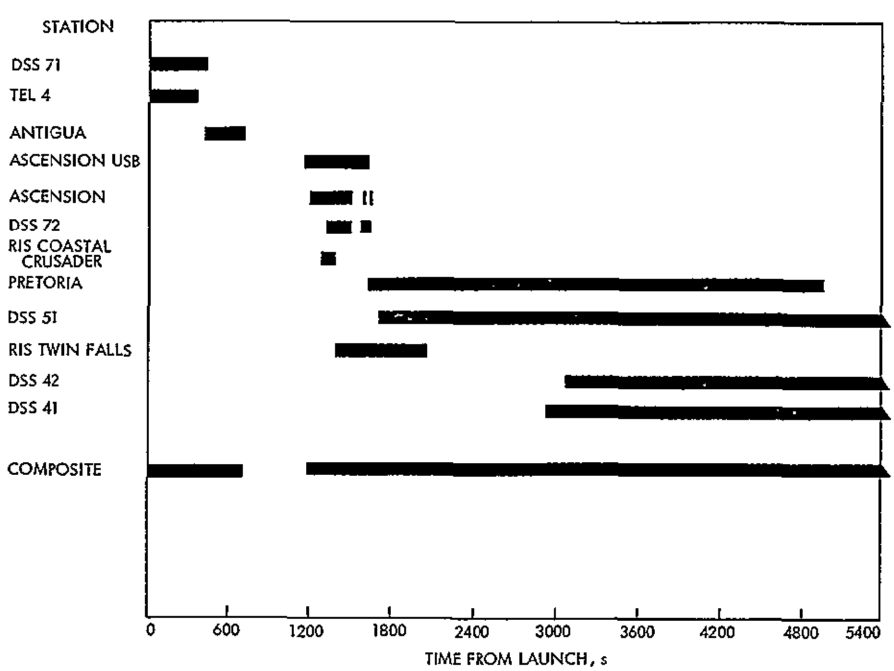

Fig 100. Spacecraft telemetry coverage intervals (S-band)

Table 38 RTCS operations log

Real time	Occurrences
00 15	Static point 3, radars 7 18, 91 18, 12 18, 13 16, and RIS *Twin Falls* to Building AO and GSFC operable
00 34	Quick brown fox test message from RIS *Twin Falls* 3X to 5X
01 57	Static points completed with 0 18, 3 18 and 19 18
02 18	JPL and RTCS used RIS *Twin Falls* data at ⅓ speed without problems
02 35	Static point 3 from 91 18 to Building AO octal
03 11	GSFC computer confirms accepted RIS *Twin Falls* at ⅓ speed, theoretical trajectory to GSFC rough during switchover, radars 1 16, 19 18, and 3 18 operable
03 40	Static point 3 CRO Building AO
05 12	Verbal DSN predicts received
06 01 (*T*—0)	First motion 06001 00 176Z, 101 1-deg flight azimuth 19 18 octal to GSFC 3 18 octal to GSFC 67 18 decimal to Building AO 67 16 passive role 7 18 octal to GSFC decimal to Building AO 91 18 octal to GSFC, decimal to Building AO
06 14	Transmit parking orbit IRV to RIS *Twin Falls, Coastal Crusader*, Building AO, AFETR 12, 13, and DSS 72 SOPM to Building AO Elements to Building AO
06 28	TAN look angles
06 45	CRO look angles Transmit parking orbit DSN 72 predicts to Building AO DSN 51 predicts to Building AO DSN 42 predicts to Building AO
06 45	CRO AOS decimal to Building AO DSN 42 format 15, 3 way, unable to compute DSN 51 format 13, 2-way data satisfactory Items delayed, no data for preposigrade transfer orbit JPL requests deletion of preposigrade transfer orbit DSS 51, 42, and 41 predicts CRO look angles deleted, as no data available for computation
07 30	RIS *Twin Falls* and 12 18 replay completed, including decimal to Building AO
07 43	Replay 13 16 completed, including to Building AO
08 05	Transmit preposigrade transfer orbit based on station 12/13 recursive IRV, SOPM, elements to Building AO RIS final position A, RIS *Twin Falls* B, 0624 34-Z C, 3 deg 59 2′ S D, 1 deg 48 1′ E E, 2 5 F, 026 G, 0406Z/brn[3] H, none
08 14	Transmit preposigrade transfer orbit based on 12/13 planetary map to Building AO
08 24	Transmit postposigrade transfer orbit based on CRO recursive, IRV elements, SOPM to Building AO
08 27	Transmit postposigrade transfer orbit planetary map to Building AO, based on CRO
08 33	Transmit preposigrade transfer orbit I-matrix to Building AO, based on 12/13
08 36	Transmit postposigrade transfer orbit I-matrix to Building AO, based on CRO
08 38	Complete replay of CRO decimal data to Building AO
09 05	Transmit preposigrade transfer orbit IRV elements, SOPM to Building AO, based on DSS 51
09 18	Transmit preposigrade transfer orbit DSS 51, 42 and 41 to Building AO, based on 12/13, special JPL request
09 35	Transmit preposigrade transfer orbit planetary map to Building AO, based on 51, P/O recursive deleted per JPL request
09 41	Transmit preposigrade transfer orbit planetary map to Building AO, based on 13/51, special JPL request
09 54	Released from test support

Table 39. Actual AFETR RTCS support

Actual, L + min	Computation	Source
13	Actual P/O, IRV, SOPM, JPL elements	91 18
20	Theoretical transfer orbit—IRV, SOPM, and JPL elements	
27	CRO, and TAN look angles	
34	DSN predicts based on theoretical transfer orbit	
124	Preposigrade transfer orbit, IRV, SOPM, and JPL elements	12 18 and 13 16 (recursive)
133	Preposigrade transfer orbit, planetary map	12 18 and 13 16 (recursive)
143	Postposigrade transfer orbit, IRV, elements, and SOPM	CRO (recursive)
147	Postposigrade, planetary map	CRO (recursive)
153	Preposigrade I matrix	12 18 and 13 16 (recursive)
156	Postposigrade I matrix	CRO (recursive)
173	AFETR selected as prime computer	
185	Preposigrade transfer orbit, IRV, SOPM, and JPL elements	DSS 51
195	AFETR computer status returned to normal	
197	DSN predicts for DSS 41, 42, and 51	12 18 and 13 16
211	Preposigrade transfer orbit, IRV, SOPM, and JPL elements	DSS 51 and 13 16
215	Preposigrade transfer orbit, planetary map	DSS 51
221	Preposigrade transfer orbit, planetary map	DSS 51 and 13 16

Table 40. RTCS orbit generation

Orbit	Epoch, GMT	Time of computation, GMT	Data source
Agena/S/C parking orbit	06 10 04 8	06 13	ANT
Transfer orbit[a] based on actual parking orbit and nominal second burn	06 24 37 1	06 17	ANT
Actual transfer orbit (from Agena)	06 29 50 9 07 15 10 1 07 15 10 1	08 05 09 03 09 30	PRE/ASC DSS 51 PRE/DSS 51
Postposigrade Agena orbit, actual S/C orbit	06 45 17 9	08 21	CRO

[a]RTCS generated predicts from this orbit

telemetry and tracking data were transmitted to Building AO and the SFOF DSS 51 went to two-way tracking at L + 61 min

DSS 42 acquired the spacecraft at L + 52 min, 27 s, marking the end of the near-earth phase

All data received at the SFOF were processed and displayed in real time SFOF-processed telemetry data were also transmitted to Building AO via the eight special 100-word/min teletype circuits There were no significant problems in the TDS telemetry support during the near-earth phase other than the previously discussed communication difficulties resulting from poor propagation conditions

5 *Communications* The NASCOM network provided 26 teletype, 11 voice, and 6 HSD circuits to the DSN and 9 teletype, 6 voice, and 1 HSD circuit to the MSFN in support of the early portion of the mission Circuit assignments are shown in Table 43

In addition, eight 100-word/min simplex teletype circuits were provided for backfeed of data from the SFOF to Building AO One 60-word/min teletype circuit was furnished for the transmission of telemetry data from JPL to Stanford

Because of the criticality of the DSS 51 site, one teletype and one voice circuit were called up through AFETR facilities to serve as backup These circuits were to be routed through Pretoria and Ascension to Goddard via Comsat or via communications control at Cape Kennedy The voice circuit was not available during the mission because of an antenna shortage at Ascension,

Table 41 Venus encounter computation

Facility	Data source	Time of computation, GMT	Day	B[a], km	B • T, km	B • R, km	Encounter time and date, GMT
SFOF	51	07 41 00	165	8,608 983	722,810 360	467,644 180	Nov 1, 01 58 43 4
RTCS	12/13	08 05 00	165	97,853 897	79,224 786	52,435 342	Oct 19, 09 05:30 8
SFOF	51	08 42 00	165	553,321 700	452,429 880	−318,546 850	Oct 15, 15 57 36 6
SFOF	51	08 56 00	165	92,462 993	63,398 130	− 67,305 878	Oct 19, 02 27:56 0
RTCS	51	09 03 00	165	133,697 420	128,488 290	− 36,956 169	Oct 19, 16 39 18 3
RTCS	13/51	09 30 00	165	107,348 800	104,587 210	224,192 606	Oct 19, 22 14 52 7
SFOF	42	10 08 00	165	103,665 060	86,031 496	− 57,836 193	Oct 19, 06 32 28 6
LAMCI SFOF		23 51 00	169	104,447 01	81,483 270	− 65,342 59	Oct 19, 03 53:14 9

[a]B is the vector from center of Venus to the incoming asymptote of the approach hyperbole R S and T form an orthogonal coordinate system at Venus B • R and B • T equal the products of magnitude of the two vectors X the cosine of angle between them

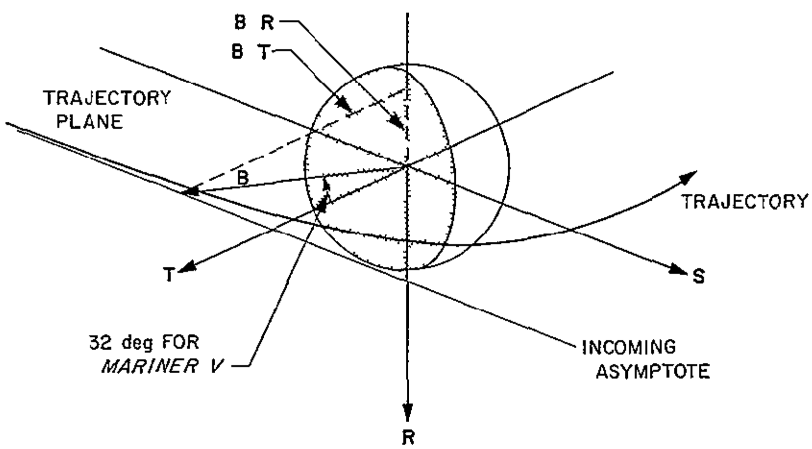

Table 42. Real-time transmission of launch vehicle data

Event	ASC	RIS stations	
		Twin Falls	*Coastal Crusader*
Transfer VM number	X	–	X
Second burn ignition	X	–	X
Chamber pressure	X	–	X
Shutdown	X	X	X
Tailoff	X	X	X
VM read out	X	X	X

however, the normal voice circuits through London held up unusually well and no backup path was required The teletype circuit was available for backup to DSS 51 but was not used because of the exceptional quality of the circuits via London and Tangiers

Table 43 Communications circuit assignments

Station	TTY circuits	Voice circuits	HSD circuits
DSS 41	4	1	1
DSS 42	4	1	1
DSS 51	4	1	1
DSS 61	4	1	1
SCS 71	3	1	1
DSS 72	4	1	1
AFETR/Building AO	3	5	0
BDA	2	3	1
TAN	1	1	–
CRO	2	1	–
RTCF	4	1	–

Problems encountered early in the minus count were as follows

(1) The London 418 system had to be switched because of a loss of power while going from commercial to

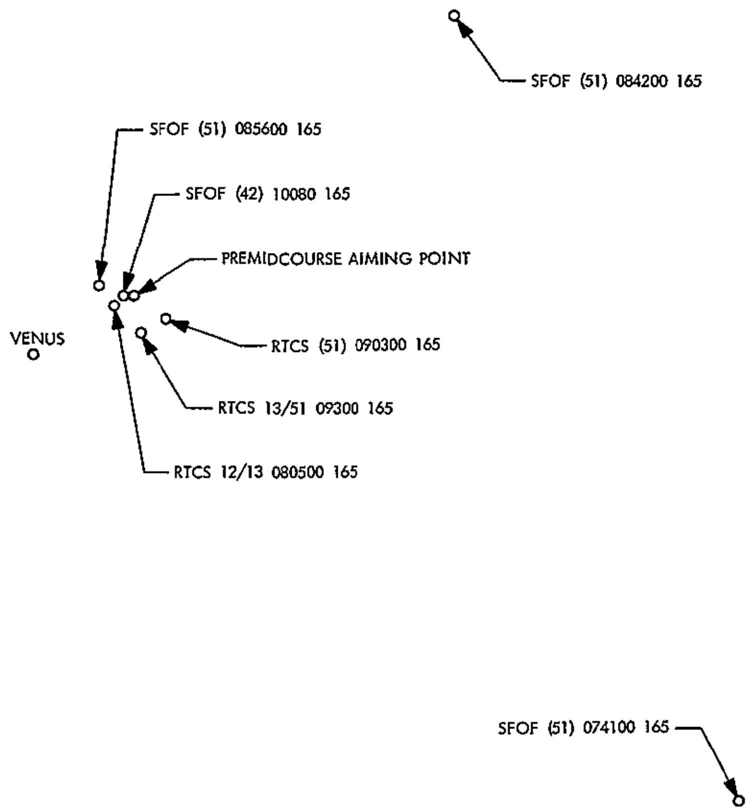

Fig 101. Plot of key data in Table 41

diesel power This caused an outage of approximately 4 min

(2) JPL messages in the AA mode outbound to the JPL sites were intermittently closed out The location of this problem was not pinpointed until after launch An operating procedure was devised to clear this condition when it occurred, and the problem did not interfere with mission progress The problem was found to be originating from the JPL CP system This difficulty was subsequently cleared

As a precautionary measure, TTY circuits were provided around the CP from the prime sites to permit instant alternate paths in case of a CP failure

Special NASCOM network circuit coverage was implemented with commercial carriers and switching centers at $L - 2$ h

C. Deep Space Phase Support

1. Summary of critical periods

a First DSIF AOS through acquisition-of-Canopus by spacecraft The AOS of the spacecraft signal by the DSIF was accomplished on schedule by DSS 42 on Day 165 at 06 53 05 GMT DSS 42 went two-way at 07 03 00, without problems DSS 41 tracked one-way from 06 48 to 12 11 as a backup to DSS 42 Successful two-way transfers were completed between DSS 42 and DSS 61, and between DSS 61 and DSS 11 Two DC-V21 commands were transmitted successfully during the DSS 11 first pass at 00 30 and 00 34 on Day 166, and the spacecraft acquired Canopus at 01 10 No failures or anomalies were noted during this phase

The GCF provided a standard configuration of one voice, one HSD, and four teletype lines to each station Special engineering personnel coverage was also provided No significant failures or anomalies were experienced

b Midcourse maneuver The following commands were transmitted successfully by DSS 11 at the times indicated on Days 170 and 171, pass 6

QC-V1-1	at	20 18 00
QC-V1-2	at	20 23 00
DC-V1-3	at	20 28 00
DC-V29	at	20 38 00

DC-V14	at	20 48 00
DC-V27	at	21 23 57
DC-V21	at	23 33 15
DC-V21	at	00 25 00
DC-V21	at	01 17 50
QC-V1-1	at	02 19 00
QC-V1-2	at	02 24 00
QC-V1-3	at	02 29 00
QC-V-9	at	02 39 00

DSS 61 tracked two-way prior to the command sequence and was backed up by DSS 62 tracking one-way DSS 61 tracked until 20 34, DSS 62 tracked until 20 49, therefore overlapping coverage was provided for the first five commands of the sequence

DSS 42 acquired at 23 49 The track was terminated at 01 27 because of failure of the second maser DSS 41, switching from the backup to the prime role, acquired at 01 44 Therefore, overlapping coverage was also provided for the last six commands of the sequence

Backup coverage to DSS 11 was provided by DSS 14 from 18 25 to 03 00 At 00 06, the received signal strength experienced a rapid increase of 3 db and then slowly decreased to normal The anomaly did not recur and could not be reproduced No other anomaly or failure occurred during the midcourse phase

The standard GCF line configuration was provided to each of the prime stations during the midcourse phase Special engineering personnel coverage was provided on the Goldstone lines No significant anomalies or failures were experienced

The SFOF was in the same configuration as for launch All operations were performed without problems

c *First use of lunar ranging* The Mark I lunar ranging system was first used by DSS 61 on Pass 7, Day 171 Ranging modulation was applied at 11 32 58 GMT and the first range code was acquired at 12 10 GMT When ranging modulation was activated, the spacecraft received signal strength increased 3 db No explanation for this anomaly has been found No other problems were encountered

The Mark I ranging data were not immediately processed by the SFOF DPS because of program problems These problems were eliminated within 24 h

2 *Logs* In Table 44 appears a log of all significant DSN events in the *Mariner V* mission (and the *Mariner IV* mission after *Mariner V* launch) The log is chronological, ordered by station pass number, with *Mariner IV* passes inserted at appropriate points in time (see Table 44)

The following information is contained in the log

(1) Pass number Pass 1 started with the first acquisition by the Australian tracking stations, DSS 41 and DSS 42, and ended with the Goldstone (DSS 11) track

(2) Station numerical identification of DSIF tracking station

(3) Day of Year Day 001 equals January 1, 1967

(4) Acquisition time and end of track time, GMT

(5) Average received signal strength (in dbm), a time average of hourly readings taken during the track

(6) DSN performance the following three percentage values which provide indicators to the real-time performance of the various DSN systems,

  (a) Teletype telemetry For a given station pass, this percentage is the total number of errorless telemetry frames received over teletype at teletype page printers in the SFOF, divided by the maximum possible number of frames This figure provided a performance index for the GTS, TCP, and GCF (including CPs)

  (b) HSD telemetry For a given station pass, this percentage is the total number of errorless telemetry frames printed on a 3070 HSD printer in the SFOF, divided by the maximum possible number of frames This figure provides a performance index for the GTS, TCP, GCF (HSD lines only), and the SFOF DPS

  (c) Teletype tracking For a given station pass, this percentage is the total number of errorless tracking data samples (lines) printed on a teletype page printer in the SFOF, divided by the maximum possible number of good samples The maximum possible number is dictated by the periods when the receiver was in lock This figure provides an index to the performance of the TDH and GCF (including CPs)

Table 44 *Mariner* Venus 67 DSN log

Pass	DSS	Day, GMT	Acquisition, GMT	End of track, GMT	Average received signal level, dbm	DSN performance, %			Failures and anomalies	Configuration	Significant events
						TTY TLM	TTY TK	HSD TLM			
1	42	165	06 53	11:20	107.0	95 00	67 40	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	—
	41	165	08:18	12:11	107 1	99 35	76 38	N/A	—	DSS 1-way GCF Standard SFOF Mode 2	—
	61	165	11 13	20:22	115 6	84 82	80 85	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	—
	11	165/ 166	18:52	04 38	−127	92 33	92 22	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	DC-V21 transmitted at 00 30 DC V21 transmitted at 00 34
2	42	165/ 166	23:52	11 54	−126	91 89	85 59	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	Canopus acquired at 01 10 GMT
	61	166	11 13	20 38	−127	51 72	94 57 (retransmission)	N/A	GCF JPL CP failed repeatedly during pass, problem attributed to program problem Program modified on Day 167	DSS 2-way GCF Standard SFOF Mode 2	—
	11	166/ 167	18:37	04 50	−131 3	97 41	94 50	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	—
3	42	166/ 167	23 58	11:56	−131 3	98 74	96 52	N/A	GCF HSDL to DSS 42 down from 07 03 to 07:24; unknown cause, 21 min loss of HSD	DSS 2 way GCF Standard SFOF Mode 3	—

Table 44 (contd)

Pass	DSS	Day, GMT	Acquisition, GMT	End of track, GMT	Average received signal level, dbm	DSN performance, %			Failures and anomalies	Configuration	Significant events
						TTY TLM	TTY TK	HSD TLM			
	61	167	11:09	20 46	−130 3	78 59	81 79	N/A	DSIF: At 14 41, Z receiver signal strength gradually dropped from −131 4 dbm to −140 3 dbm Signal increased to −130 3 by 15 07, anomaly could not be reproduced under test conditioning or on later passes GCF: GSFC CP down from 14 42 to 16 10 CP was bypassed at 15 30 48 min real time TTY data loss DSIF TCP-A would not transmit AGC data, TCP B used, problem repaired after pass	DSS 2-way GCF Standard SFOF Mode 3	— — —
	11	167/ 168	18:32	04:46	134 4	73 58	95 30	N/A	GCF: JPL CP failure at 20 28 Data restored by bypassing CP at 20 58, distortion on one TTY TLM line, lines switched during pass DSIF: TCP failure resulted in 3-h loss of data on log tape, no real-time logs	DSS 2-way GCF Standard SFOF Mode 2	— —
4	42	167/ 168	23 56	11:53	134 5	75 06	95 09	N/A	—	DSS 2-way GCF Standard SFOF Mode 3	—
	61	168	11 02	20 41	133 1	94 96	91 60	N/A	—	DSS 2 way GCF Standard SFOF Mode 3	—
	11	168/ 169	18:29	04 45	136 2	97 37	99 03	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	—

Table 44 (contd)

Pass	DSS	Day, GMT	Acquisition, GMT	End of track, GMT	Average received signal level, dbm	DSN performance, %			Failures and anomalies	Configuration	Significant events
						TTY TLM	TTY TK	HSD TLM			
5	42	168/ 169	23:53	11:49	136 4	97 66	95 65	N/A	DSIF: Maser 1 failed prior to pass, maser 2 used without problem	DSS 2-way GCF Standard SFOF Mode 3	—
	61	169	10 57	20 36	136 9	88 94	93 92	N/A	—	DSS 2-way GCF Standard SFOF Mode 3	—
	11	169/ 170	18:25	04:42	−138 7	99 18	92 73	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	—
6	42	169/ 170	23 52	11:46	−138 0	93 39	84 50	N/A	DSIF: Pass interrupted three times for total of 32 min for maser checks	DSS 2-way GCF Standard SFOF Mode 3	—
	61	170	11:00	20:34	−139 2	95 57	93 50	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	DSS 62 simultaneously tracked from 10:51 to 20 49 as a DSIF premidcourse backup
	11	170/ 171	18 23	04:38	−140 7	98 19	96 27	N/A	DSIF At 00 06, received signal strength experienced a rapid increase of 3 db and then decreased to normal, anomaly could not be reproduced	DSS 2-way GCF Standard SFOF Mode 2	Transmitted following commands: QC-V1-1 at 20:18 00 QC-V1-2 at 20:23 00 DC-V1-3 at 20 28:00 DC-V29 at 20:38 00 DC-V14 at 20 48:00 DC-V27 at 21:23:57 DC-V21 at 23 33:15 DC-V21 at 00:25:00 DC-V21 at 01:17:50 QC-V1-1 at 02:19:00 QC-V1-2 at 02:24:00 QC-V1-3 at 02 29 00 QC-V-9 at 02 39:00 DSS 14 tracked as BU to DSS 11 from 18:25-03:00

Table 44 (contd)

Pass	DSS	Day, GMT	Acquisition, GMT	End of track, GMT	Average received signal level, dbm	DSN performance, %			Failures and anomalies	Configuration	Significant events
						TTY TLM	TTY TK	HSD TLM			
7	42	170/171	23:49	01:27	−139 7	95 68	96 94	N/A	DSIF Track cut short due to failure of second maser	DSS 2-way GCF Standard SFOF Mode 2	—
	41	171	01 44	11 15	−140 1	94 90	86 08	N/A	—	DSS 2-way GCF Standard SFOF Mode 2	— —
	61	171	10:50	20 30	−139 3	96 27	89 18	N/A	DSIF: S/C AGC increased 3 db when ranging modulation was turned on	DSS Lunar ranging GCF Standard SFOF Mode 2	—
	11	171/172	19 58	04:35	−140 6	97 20	93 31	89 02	—	DSS Lunar ranging GCF Standard SFOF Mode 2	

(7) Failures and anomalies All failures which significantly interrupted the flow of real-time tracking or telemetry data to the Project, or resulted in a permanent loss of spacecraft data, are listed by facility (DSIF, GCF, and SFOF) Any anomalies in the system performance with a potential jeopardy to operations are also listed

(8) Configuration A general configuration is listed for the tracking DSS, the GCF, and the SFOF If more than one configuration was used during a pass, the most complex configuration is listed, as follows

(a) DSS

One-way receive only

Two-way transmit and receive

Ranging transmit with ranging modulation on and receive

Pioneer a special one-way configuration at DSS 51 originally devised for the *Pioneer* Project which improves threshold conditions by removing the diplexer and using a 3-Hz bandwidth

Record only no data transmission to the SFOF

XX/YY MMSA DSS XX RF system and antenna used, DSS YY GTS and TCP used

(b) GCF

Standard one voice, one HSD, and four teletype lines

XX/YY MMSA one voice and two teletype lines to DSS XX, two teletype and one HSD line to DSS YY, one teletype line between DSS XX and DSS YY, voice line bridged from DSS XX to DSS YY

(c) SFOF

Mode 3 7044 only, with MMSA and mission-independent areas (DPS, track, communications, and monitor)

Mode 2 7044 and 7094, with the areas in the paragraph above plus an FPAA

No DPS no computers, but MMSA, track, communications, and monitor areas

(9) Significant events commands transmitted, mission milestones, or DSN milestones

Table 45 Launch vehicle tracking coverage intervals (C-band radar)

Required intervals of class I coverage[a]		
Continuous coverage from L to $T + 604$ s Any continuous 60 s between $T + 1415$ s and $T + 1875$ s Any continuous 60 s after $T + 1882$ s		
Expected and actual intervals of coverage[b]		
Station	**Expected interval, s**	**Actual interval, s**
Cape (1 16)		10–265
KSC (19 18)	18–390	12–365
PAFB (0 18)	20–445	15–480
GBI (3 18)	104–429	48–450
		69–467
GT (7 18)	221–593	199–610
BDA (FPQ-6)	290–562	282–642
ANT (91 18)	390–755	368–768
ASC (12 18)	1180–1590	1232–1515
(12 16)		1245–1474
RIS *Twin Falls* (FPS-16)	1350–2040	1414–1912
PRE (13 16)	1610	1667–3046
		3078–4967
CRO (FPQ-6)	2390–5130	2342–5178

[a]Based on nominal mark times
[b]Based on 101 deg launch azimuth

VI. TDS Performance Evaluation

A General

In this section, Project requirements, TDS plans, commitments, and actual performance are compared to provide quantitative and qualitative comments about TDS performance Certain elements may exhibit less than expected performance, however, failure of a subsystem does not necessarily mean that the TDS failed to meet commitments, because a reasonable degree of redundancy was planned into the operations Of primary concern was the determination of how well the overall TDS did in meeting commitments and requirements

B Evaluation of TDS Performance, Near-Earth Phase

Figure 102 shows the location of TDS supporting sites in relation to the actual flight azimuth and location and time of major mark events which are generally associated with class I TDA requirements in the near-earth phase This figure is an aid to relating and visualizing the information contained in the tables, figures, and commitments which are presented in the pages which follow

1 Metric system performance evaluation. Tables 45 and 46 and Figs 103–105 show the metric requirements, expected coverages, and actual coverages Composite metric coverage is illustrated in Fig 106

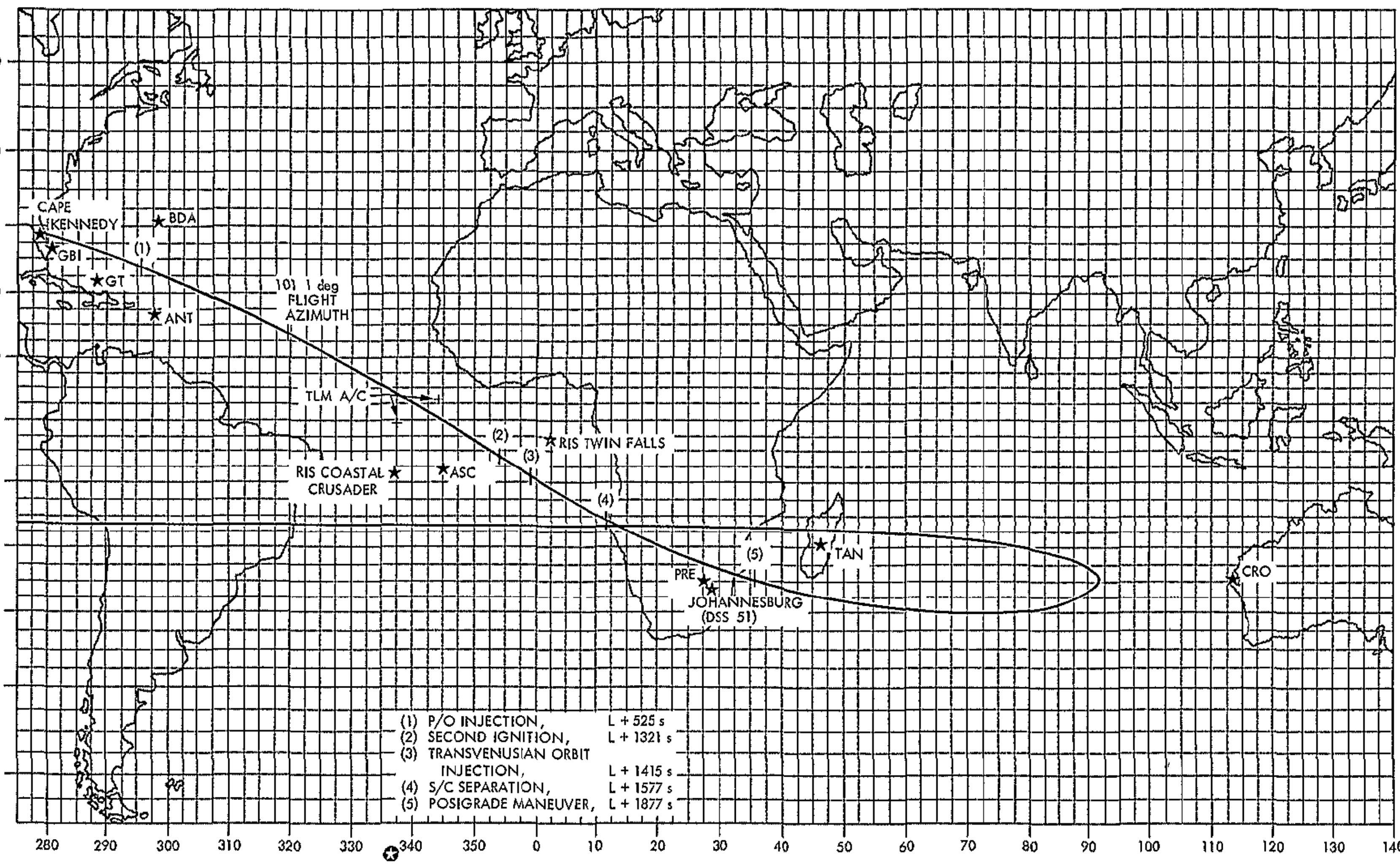

Fig. 102. *Mariner* Venus 67 TDS support stations

In general, all stations obtained and recorded metric data in excess of the estimated coverages Except for a 412-s gap in metric data between Antigua and Ascension view, continuous radar tracking of the launch vehicle was provided during the near-earth phase This gap was expected and was nominal Coverage exceeded the Project's class I and class II requirements The data quality was good, providing accurate information for acquisition and OD purposes

Table 46 Radar coverage

Station	Radar	AOS, GMT		LOS, GMT		Total track, s
		Predicted	Actual	Predicted	Actual	
BDA	FPQ-6	06 05 50	06 05 42	06 10 22	06 11 42	360
BDA[a]	FPS-16	—	—	—	—	—
CRO	FPQ 6	06 41 36	06 41 42	07 19 00	07 28 18	2568

[a]Backup only

Although the Carnarvon radar was RED at launch and could not be committed, it provided excellent support Difficulties with this radar did not pose a serious problem to the TDS since Pretoria and Carnarvon provided redundant coverage of postposigrade tracking requirements during the early part of the launch period

RTCS activities were nominal up through computation of the theoretical transfer orbit based on conditions of

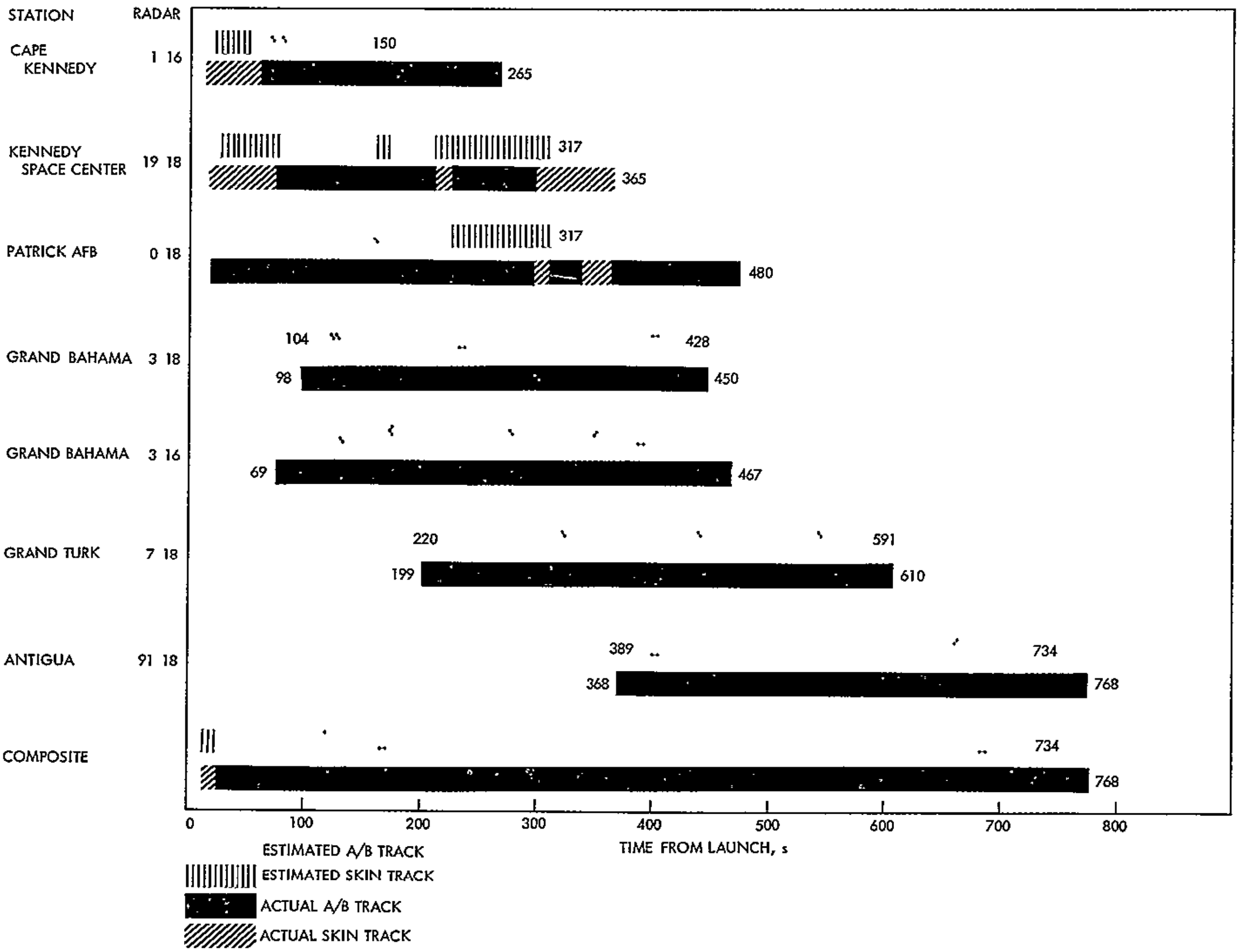

Fig. 103 *Mariner V* AFETR uprange radar coverage

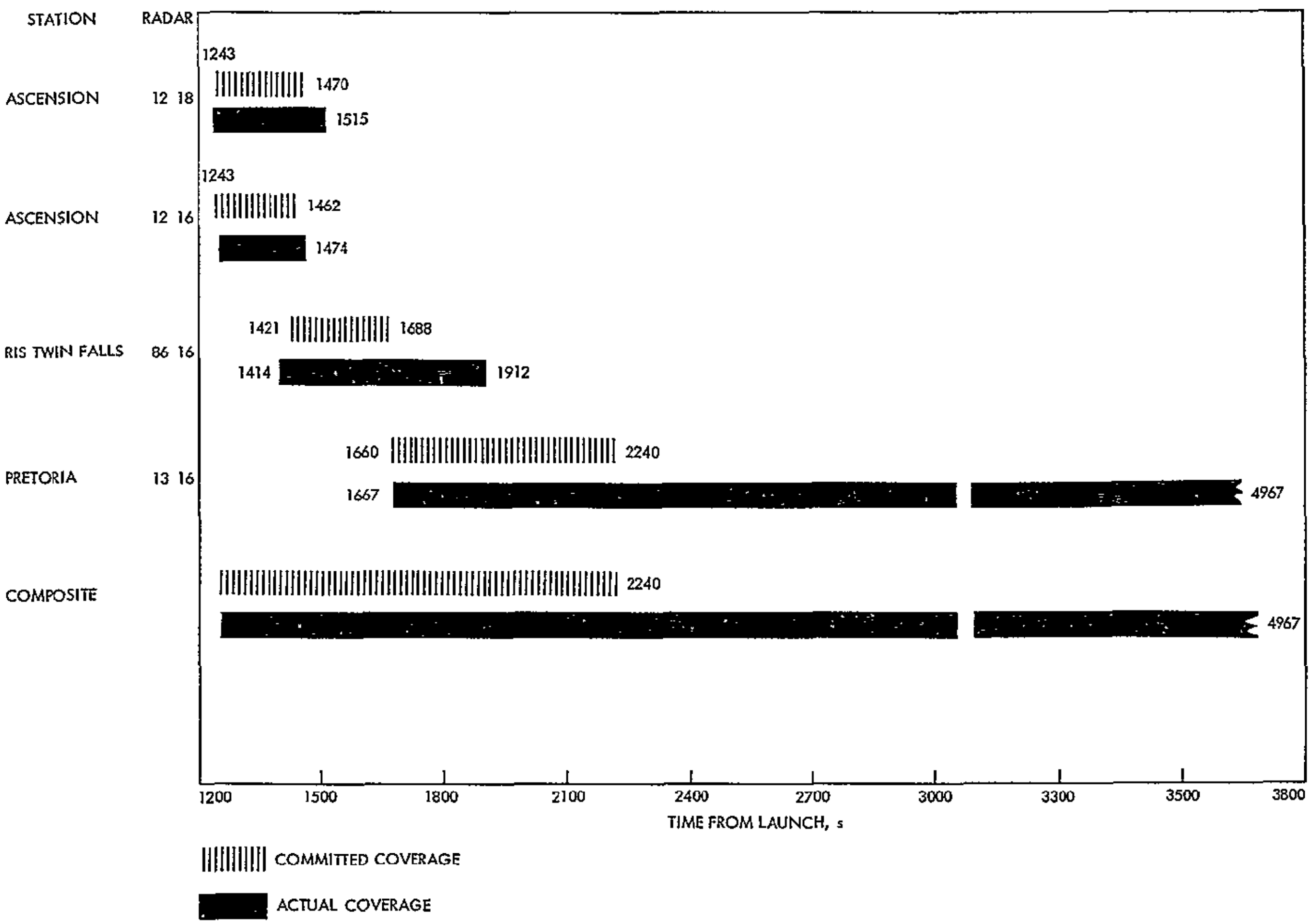

Fig 104 *Mariner V* AFETR downrange radar coverage

the actual parking orbit and nominal second burn Table 47 lists the nominal and actual times of the various computations and reflects the delays resulting from the lack of real-time metric data

The TDS did not meet requirements for real-time transmission of post-*Agena* second-burn metric data Subsequently, the TDS did not meet the Project's requirement for early determination of the actual transfer orbit, i e , by $L + 1$ h This early definition of the transfer orbit was of prime importance because it provided information for determining if there was a need for a very early spacecraft course correction maneuver Since LV performance was such that the spacecraft was injected into a very nominal transfer orbit, the delays produced little or no lasting effects However, the situation had the potential for producing very serious consequences, and, for this reason, the TDS was obligated to take action to avoid similar circumstances in the future

Prelaunch tests and past experience indicated a high probability of radio communications difficulties with downrange RIS and sites because of the location of the terminator in the South Atlantic area at the time of launch The anticipation of this problem by the TDS prompted the requests for DSS 72 circuits through the Comsat, for backup circuits to DSS 51, and for special coverage of these circuits The previously described instances of patching and data identification errors, plus poor coordination, further compounded the effects and seriousness of this problem

Concerning the problem with the RIS *Twin Falls*, postflight reviews pointed out that the ship actually had good communications with Cape Kennedy during its tracking pass However, because of the patching error, the ship's navigational data which were used to remove ship motion from the tracking data were transmitted to the RTCS instead of the metric data The problem was

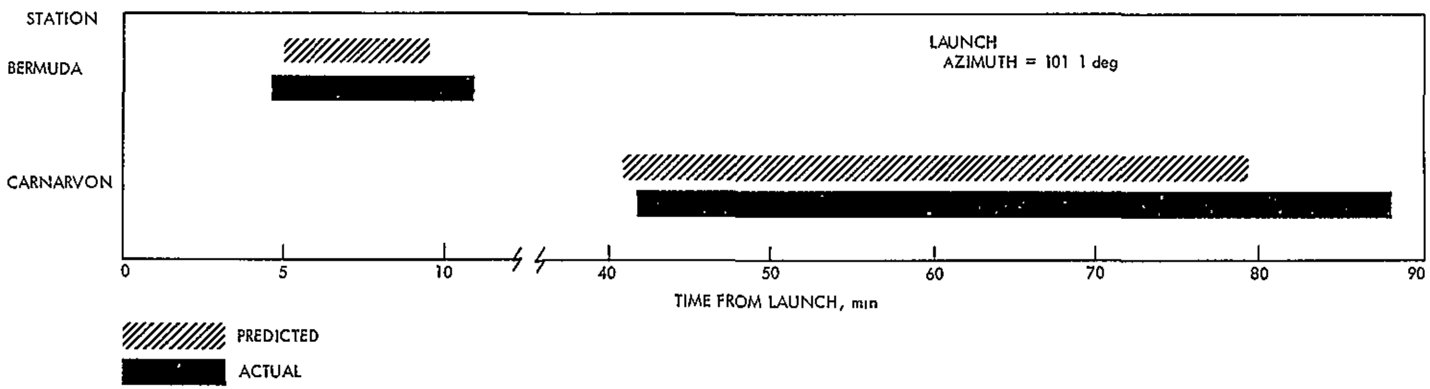

Fig 105 Radar coverage, predicted vs actual

Table 47 Nominal vs actual AFETR RTCS support

Nominal, L + min	Actual, L + min	Computation	Source
15	13	Actual parking orbit IRV, SOPM, JPL elements	ANT
20	20	Theoretical transfer orbit IRV, SOPM, and JPL elements	
25	27	CRO, TAN look angles	
28	34	DSN predicts based on theoretical transfer orbit	
50	124	Preposigrade transfer orbit, IRV, SOPM, and JPL elements	ASC, PRE (recursive)
70	133	Preposigrade transfer orbit planetary map	
67	143	Postposigrade transfer orbit—IRV, elements, and SOPM	CRO (recursive)
110	147	Postposigrade planetary map	CRO (recursive)
80	153	Preposigrade I matrix	12 18 and 13 16 (recursive)
120	156	Postposigrade I matrix	CRO (recursive)
	173	AFETR selected as prime computer	
135	185	Preposigrade transfer orbit—IRV, SOPM, and JPL elements	DSS 51
	195	AFETR computer status returned to normal	
Added	197	DSN predicts for DSS 41, 42, and 51	12 18 and 13 16
Added	211	Preposigrade transfer orbit IRV, SOPM, and JPL elements	DSS 51 and 13 16
160	215	Preposigrade transfer orbit planetary map	DSS 51
Added	221	Preposigrade transfer orbit planetary map	DSS 51 and 13 16

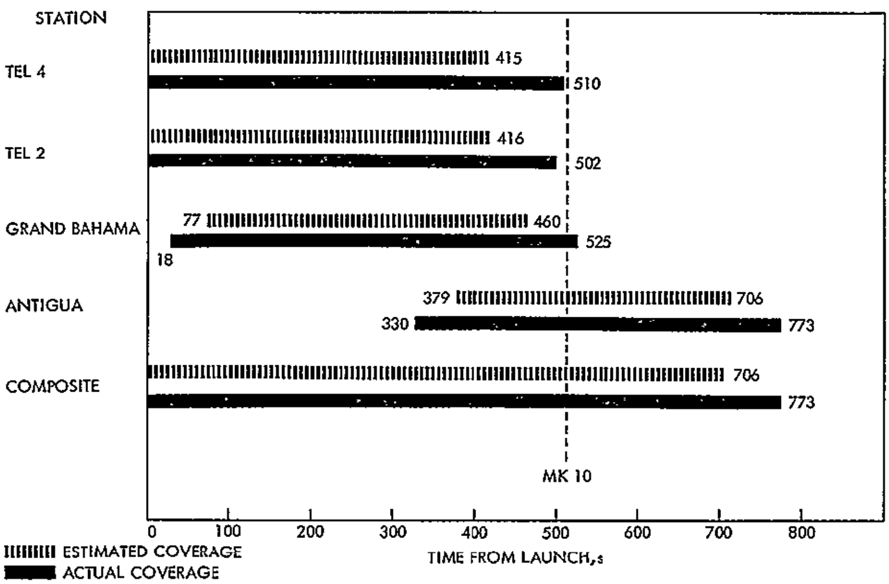

Fig 106. *Mariner V* AFETR uprange VHF telemetry coverage

identified and corrected, and the RIS *Twin Falls* started a tape playback of data Unfortunately, at the same time, communications conditions deteriorated and prevented data transmission

The RIS *Twin Falls*' patching error was not revealed during the operational readiness tests because the ship did not actually transmit metric data during the tests The RIS tracking was simulated by playing RTCS-generated punched tape The practice of simulating station participation helps avoid scheduling problems while permitting other TDS elements to conduct valid tests, but there was a consensus that the TDS, and the AFETR in particular, had too much of this type of simulation during tests As a result, action was taken to improve the capability of establishing site test configurations which resemble as closely as possible that which will be used to support the mission and to require all planned support sites to actually participate in ORTs

The lack of pertinent information at the RTCS prevented timely selection and use of the proper DSN tracking data for orbital determinations FPAC personnel knew that DSS 51 planned, and actually went to, two-way tracking and that DSS 42 data were misidentified as being two-way The fact that this information did not reach the RTCS can only be attributed to a lapse of coordination between the two areas The FPAC-RTCS point-to-point voice circuit was continually operational during the near-earth phase This was a well-exercised interface and normally operated smoothly to provide the required exchange of information

RTCS recovery and performance under these circumstances were very good The multiple-station solution at 08 05 GMT, using Ascension and Pretoria radar data, was of good quality and gave the first indication from tracking data that the spacecraft was on a nominal trajectory (see Table 41 and Fig 101)

There is no short-range technical solution to the overall radio communications difficulties The eventual availability of additional submarine cables or Comsat terminals will provide for more reliable circuits from those areas which relied on radio communications

It should be noted that the near-earth phase communications difficulties which have been discussed primarily involved the AFETR-controlled circuits The communications support provided by NASCOM was highly satisfactory

Table 48 Launch vehicle telemetry coverage intervals (Agena link VHF)

Required[a] intervals of class I coverage		
Continuous coverage from $T - 420$ s to $T + 544$ s		
Continuous coverage from $T + 1300$ s to $T + 1435$ s		
Continuous coverage from $T + 1565$ s to $T + 1597$ s		
Continuous coverage from $T + 1865$ s to $T + 1895$ s		
Expected[b] and actual intervals of coverage		
Station	**Expected intervals, s**	**Actual intervals, s**
Tel 2	−420–415	0–483
Tel 4	420–415	0–483
GBI	72–456	18–525
BDA	228–590	237–633
ANT	390–708	330–773
ASC	1240–1490	1158–1640
RIS *Coastal Crusader*	1240–1350	1270–1380
PRE	1640–3780	1615–5040
RIS *Twin Falls*	1410–2110	1341–2065
TAN	1760–2930	1756–3036
CRO	2370–2820	2375–3990
Aircraft		
Audit 1 TAA-4	—	945–1497
Audit 2 TAA-4	—	994–1591

[a]Based on nominal mark times
[b]Based on 101 deg launch azimuth

2. *Telemetry system performance evaluation*

a Launch vehicle telemetry Figure 106 contains a composite summary Tables 48 and 49 and Figs 107, 108, and 109 illustrate the requirements, expected and actual coverages, for the near-earth phase LV telemetry

In general, all stations obtained LV data in excess of class I requirements and estimated coverages Except for a gap of 172 s between Antigua and Audit 2 (AFETR telemetry aircraft 629), the TDS provided continuous LV coverage during the near-earth phase It should be noted that support by AFETR telemetry circuit (Audit 1 and Audit 2) was not a part of the official TDS support plan AFETR scheduled this support to further evaluate the capabilities of their airborne telemetry receiving systems Launch vehicle representatives from Le RC examined the aircraft data and reported they were of good quality The aircraft were not positioned to obtain an optimum amount of coverage, however, the data received did significantly reduce the coverage gap between Antigua and Ascension

Table 49 Telemetry coverage

Station	Frequency, MHz	Actual AOS and LOS, GMT: Decom lock	Actual AOS and LOS, GMT: Decom unlock	Predicted AOS and LOS, GMT: Decom lock	Predicted AOS and LOS, GMT: Decom unlock	Total track, s
BDA	249 9	06 04 57	06 11 33	06 05 30	06 10 40	396
BDA	244 3	06 04 57	06 11 33	06 05 30	06 10 40	396
TAN	244 3	06 30 16	06 51 36	06 30 00	06 38 30	1280
CRO	244 3	06 40 35	07 07 30	—	—	1620

Station	Mark event	Time, GMT
BDA	4	06 05 56
BDA	8	06 06 20
BDA	9	06 07 22
BDA	10	06 09 44
TAN	11	06 32 13

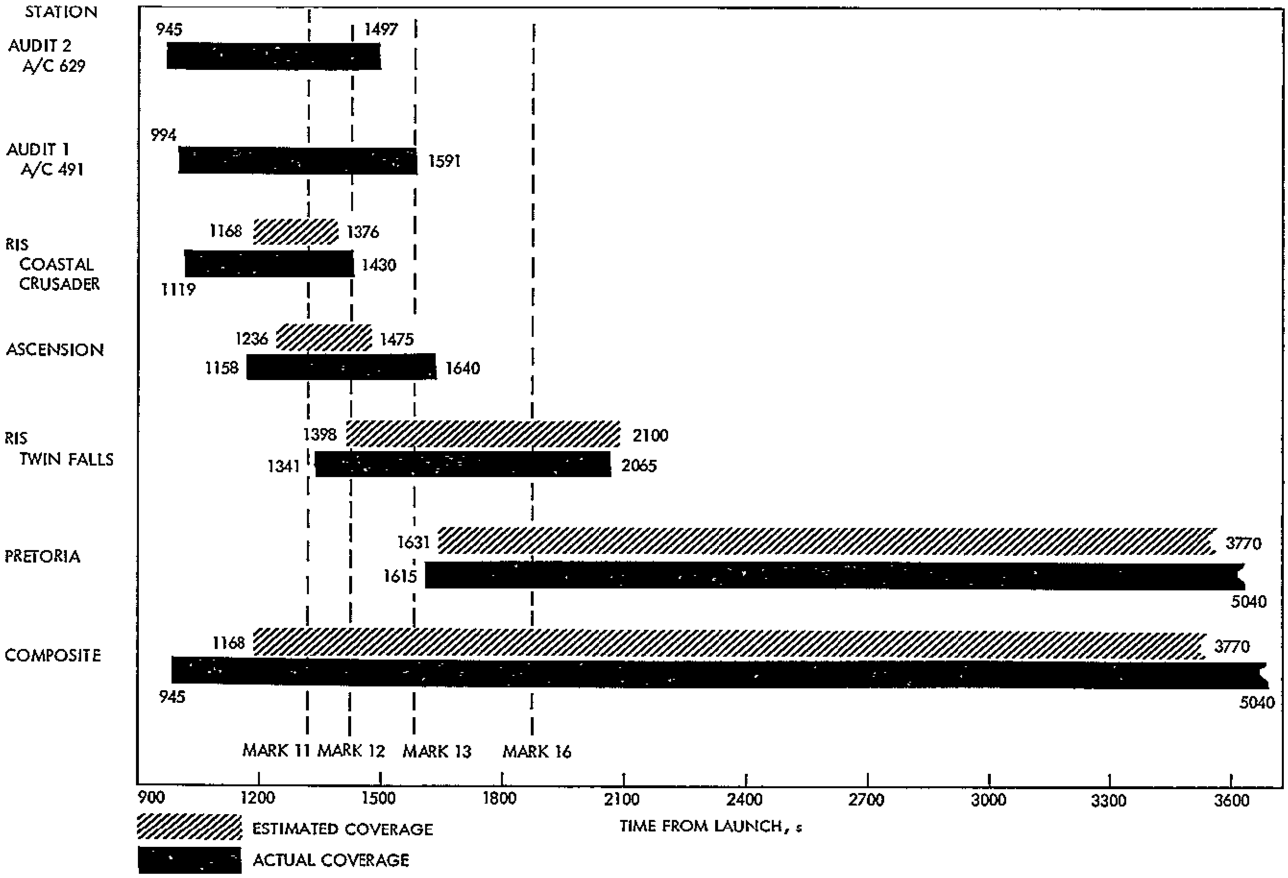

Fig 107 ***Mariner V*** **AFETR downrange VHF telemetry coverage**

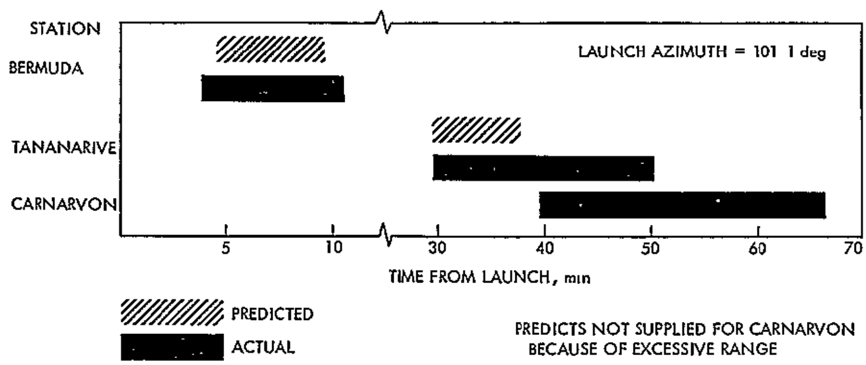

Fig 108 Telemetry coverage, predicted vs actual

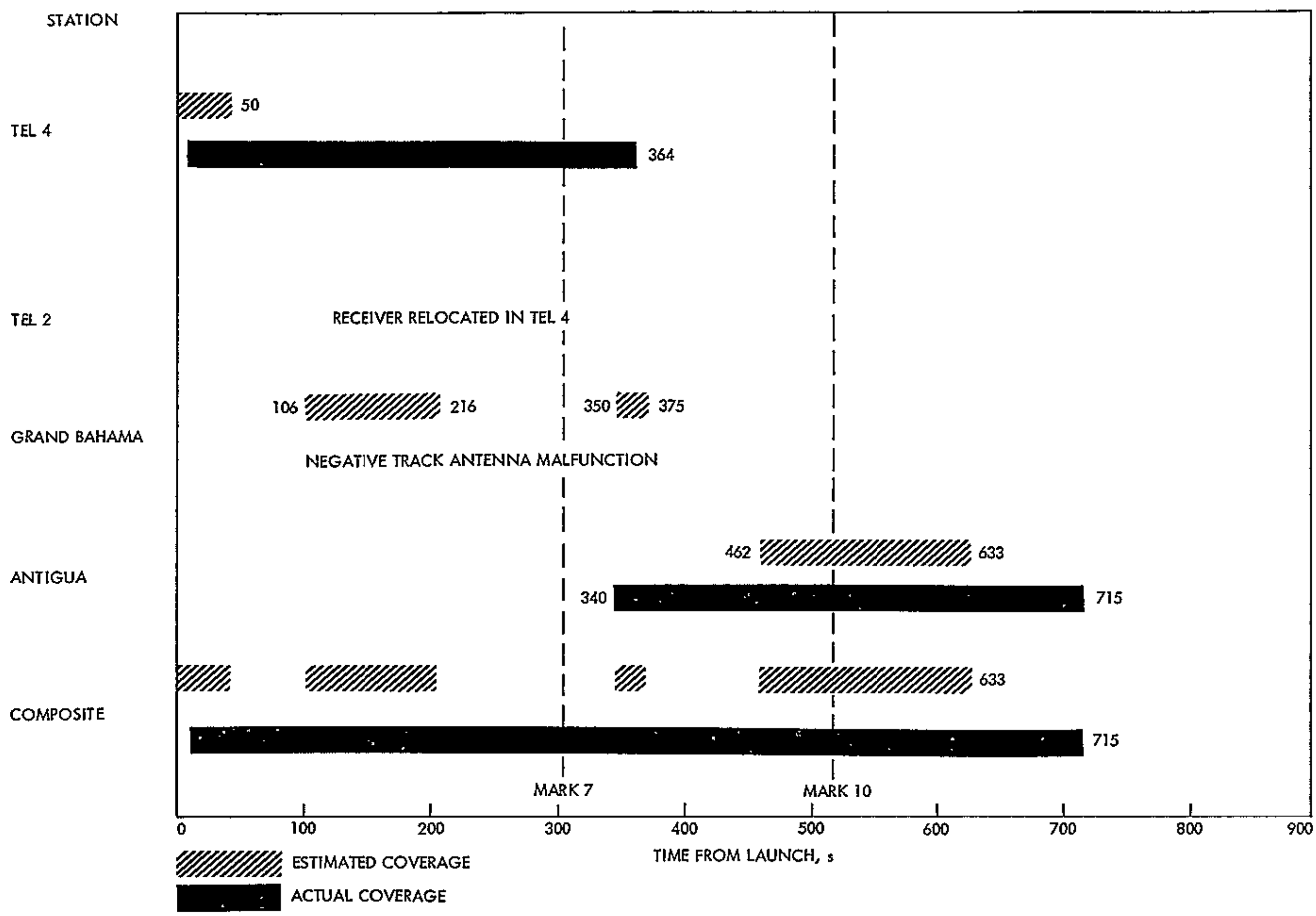

Fig 109 *Mariner V* AFETR uprange S-band telemetry coverage

The predicted MSFN expected coverage reflected in Fig 108 was based on the following criteria 2 deg elevation rise and set, −100 dbm input to the receiver, receiving antenna gain, 18 db The range of expected coverage was 4000 kyds based on a −105 dbm power level to the receiver Some of the factors contributing to the extended coverage are as follows (1) achievement of telemetry lock at elevations less than 2 deg, (2) high elevation angles at Tananarive and Carnarvon LOS, and (3) favorable LV attitude

Real-time transmission of LV data occurred as required Continuous real-time data were provided to LV analysts from launch area sites and through Antigua LOS via the submarine cable Downrange sites met the requirements for transmission of selected *Agena* parameters with the data quality reflected in Table 50 Tananarive also provided real-time velocity meter information during the posigrade maneuver with excellent results

Table 50 Quality of launch vehicle data transmitted in real time

Event	ASC	RIS *Twin Falls*	RIS *Coastal Crusader*
Transfer VM number	Fair	None	Good
Second-burn ignition	Good	None	Good
Chamber pressure	Good	None	Good
Shutdown	Good	Good	Good
Tailoff	Good	Good	Good
VM readout	Good	Good	Good

The quality of real-time LV telemetry data provided via the submarine cable was not as good as it had been on past missions The data on VCOs 15 and 16 contained noise spikes, resulting in continuous short dropouts in data at viewing areas During prelaunch tests, the data were noise-free and the problem could not be repeated after launch The cause was not determined

Almost all of the downrange data-tape packages were returned to the Cape Kennedy area within 4 days after launch via AFETR and commercial aircraft The AFETR aircraft used air-snatch techniques to pick up data packages from ships at sea This permitted early evaluation of the quality of recorded data, and LV analysts reported the over-all quantity and quality of data were excellent Taped *Agena* data received from the RIS *Coastal Crusader* was too noisy to be of use, but this caused no concern as the telemetry aircraft and Ascension provided good-quality data through the RIS *Coastal Crusader* interval The cause of the noisy data has not been determined It was reported the RIS *Twin Falls* data contained some dropouts but were generally of good quality

b Spacecraft telemetry Tables 51 and 52 and Figs 110–113 show the class I requirements, the expected coverages, and actual coverages Figure 106 reflects the composite S-band telemetry support provided

In general, the TDS obtained spacecraft telemetry data which exceeded the expected coverage and the class II requirements Except for a 468-s gap between Antigua and Ascension, the TDS provided continuous spacecraft telemetry coverage throughout the near-earth phase

Tel 4 and SCS 71 actual coverage greatly exceeded the estimates The effects of spacecraft shroud attenuation on S-band antenna patterns and signal strengths were not known precisely, therefore, coverage estimates were based on worst-case parameters Furthermore, the improvement in DSS 71 performance resulting from the newly installed parametric amplifier could not be evaluated precisely because of lack of operational experience Coverage greater than estimated was anticipated but could not technically be committed

Coverage by AFETR downrange sites also exceeded estimates Estimates were based on the more unfavorable portions of the spacecraft antenna patterns, because the spacecraft was not immediately roll-attitude stabilized and was not randomly orientated for some time after separation Obviously, ground stations actually viewed favorable antenna patterns and provided extended coverage

The GBI S-band telemetry antenna (TAA 2) failed to acquire the S-band signal As stated earlier, this was attributed to a wet connector This difficulty caused a short in the feed unit power connector resulting in no

Table 51. Spacecraft telemetry coverage intervals (S-band)

Required[a] intervals of class I coverage in seconds		
Continuous coverage from L to $T + 544$ s		
Continuous coverage from $T + 1575$ s to $T + 1875$ s		
Continuous coverage from $T + 3060$ s to $T + 3540$ s		
Expected[b] and actual intervals[c] of coverage		
Station	Expected intervals, s	Actual intervals, s
SCS 71	0–50/80–180	0–428
Tel 4	0–50	0–364
GBI	115–218/351–376	None
BDA	Not committed	None
ANT	462–632	390–715 phase-locked
ASC USB	1240–1510	1184–1629
ASC	1260–1593	1183–1500 1575–1593 1625–1643
DSS 72	1280–1590	1308–1500 1560–1620
RIS *Coastal Crusader*	1260–1320	1270–1380
PRE	1640–2150	1633–5040
DSS 51	1640	1718– (SCM auto track at −95 dbm) 3720–(2-way doppler)
RIS *Twin Falls*	1410–1660/1730–1980/ 2070–2130	1361–2065
DSS 42	2880	3120– 8940–(2-way doppler)
DSS 41	2680	2940

[a]Based on nominal mark times
[b]Based on 101 deg launch azimuth
[c]Based on phase locked coverage

Table 52 USB coverage

Station	AOS, GMT		LOS, GMT		Signal strength	
	Predicted	Actual	Predicted	Actual	AOS, dbm	LOS, dbm
ASC	06 21 36	06 22 21	06 21 25	06 28 09	−125	−142

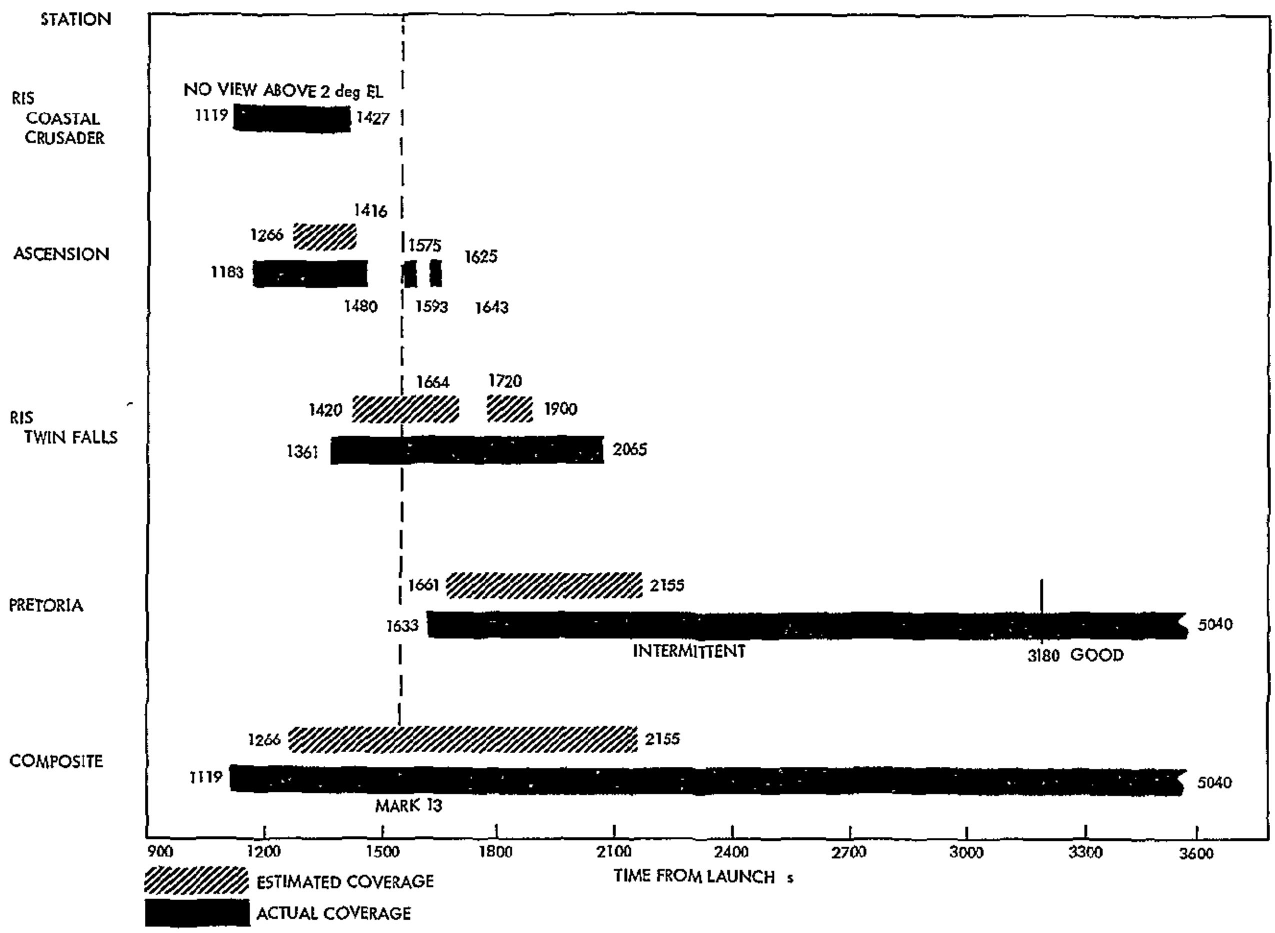

Fig 110 *Mariner V* AFETR downrange S-band telemetry coverage

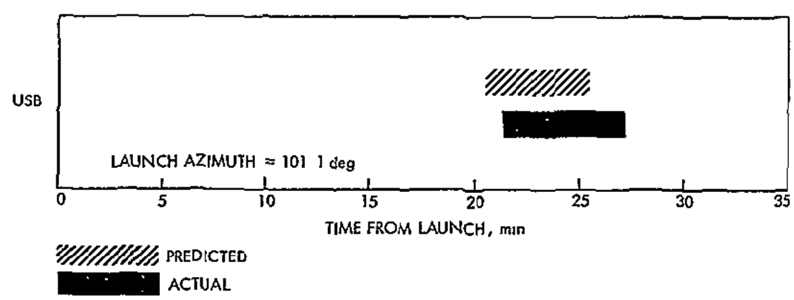

Fig 111. USB coverage, predicted vs actual

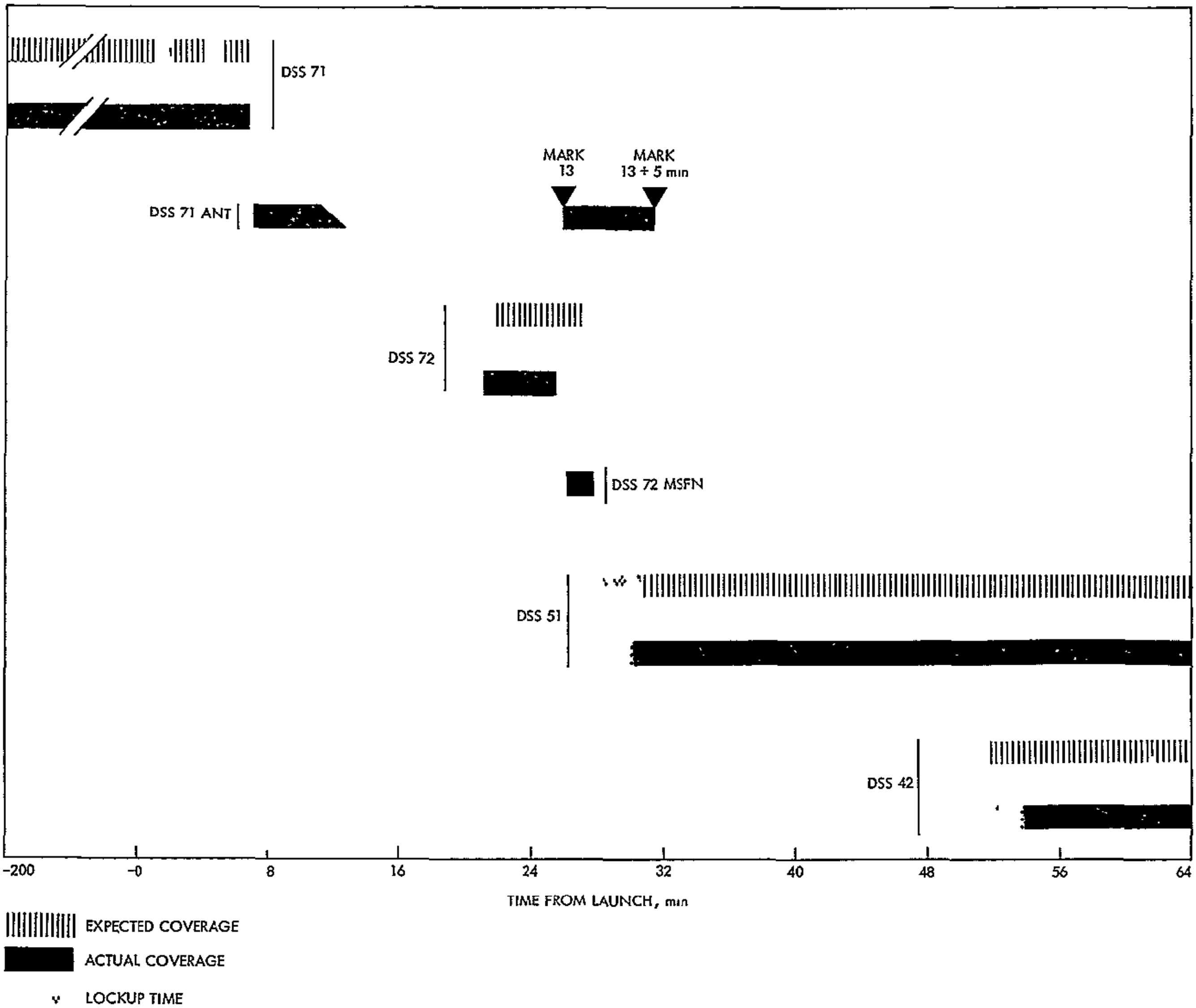

Fig 112 *Mariner V* DSN near-earth S-band telemetry coverage

power to the feed unit preamplifier and autotrack spin motor However, because of overlapping coverage between Cape Kennedy sites (Tel 4 and SCS 71) and Antigua, no spacecraft data were lost

Although Antigua received spacecraft telemetry data via the S-band and *Agena* links, spacecraft telemetry data transmitted to SCS 71 in real time were from the 98-kHz channel of the *Agena* link The S-band source could have been transmitted and the project's preference satisfied, but the 98-Hz data signal appeared to be of better quality and reliability This caused no concern, because the extensive coverage of the S-band link by SCS 71 permitted verification of the proper performance of the spacecraft's telecommunication system after shroud ejection

The MSFN USB site at Ascension experienced a 1-min, 45-s delay in AOS Although the receiver locked up on a strong signal, it has been determined that this was a spurious signal originating at the *Saturn IV*-B receiver The MSFN corrected the problem Late lockup by the MSFN site was not significant from a data coverage standpoint since other Ascension sites were providing coverage at that time

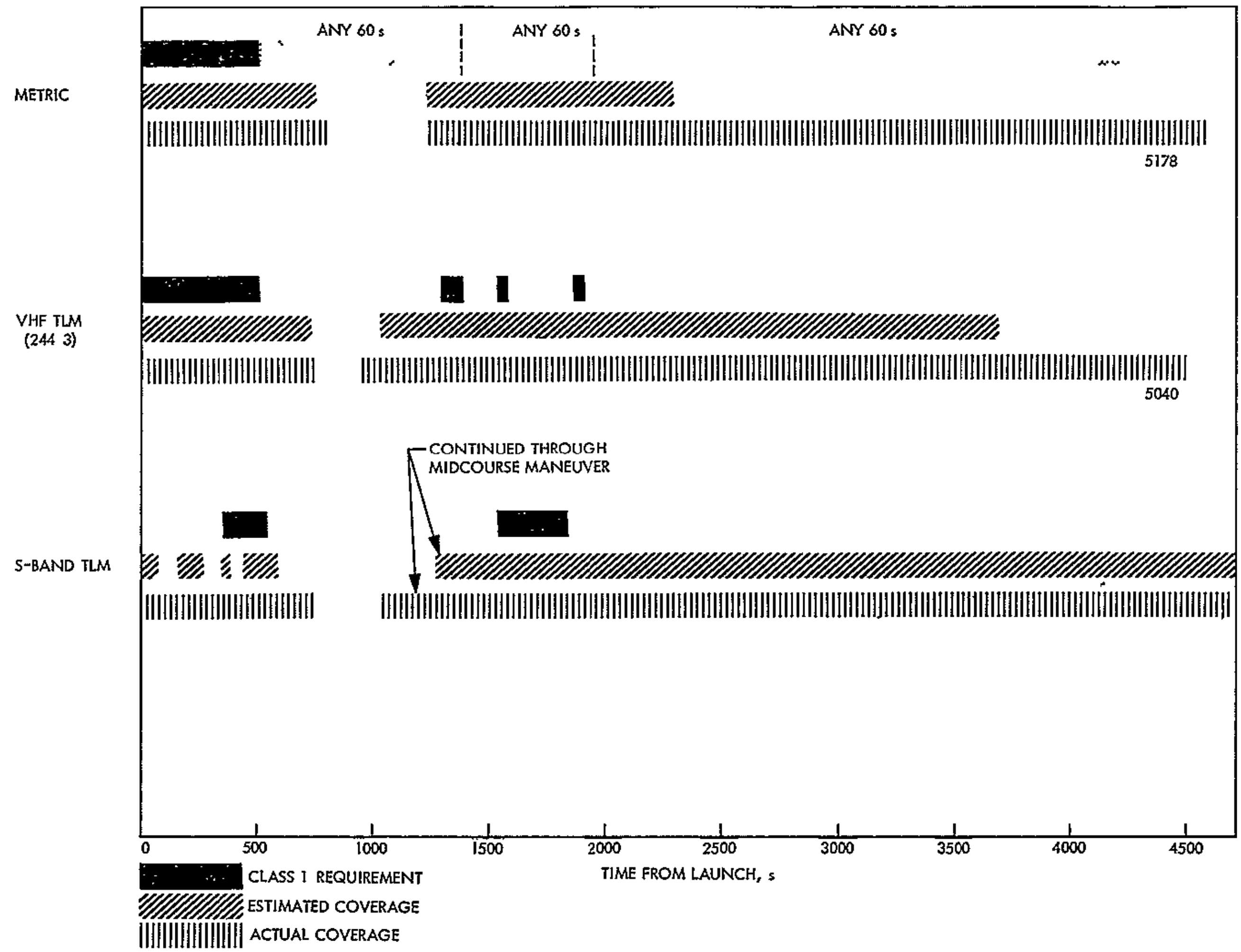

Fig 113 *Mariner V* TDS support summary

When DSS 72 could not reacquire after the early dropout, the plan to switch to the MSFN USB source of real-time data was smoothly executed, resulting in a minimum data flow outage Rapid lockup at DSS 51 minimized the coverage gap between DSS 72 and DSS 51 Although small, this gap occurred during the critical class I spacecraft separation-to-separation +5 min interval However, the RIS *Twin Falls* had recorded the entire interval and began playback within the 7-min time limit required by the Project Unfortunately, poor radio propagation conditions prevented lockup at the DSS 72 demodulator Successful playback of this data occurred much later than required The delayed playback caused no immediate concern, as there was only a small amount of missing data, and DSS 51 was providing real-time data which verified the spacecraft was performing normally

Analysis of RIS *Twin Falls* data confirmed that the class I separation interval had been completely covered as required Good data began shortly before science frame *zero*, which occurred at separation, and continued for 24 consecutive frames The data teletype printout received at the SFOF was in inverted form (data bar) and partly alphabetic, rather than numeric This presented no problem, as conversion could be made with little difficulty

3 *Evaluation of TDS operational organization* As mentioned previously, the TDS encountered some difficulty in establishing an operational coordination configuration required to meet the increased responsibilities described in Section III These difficulties were resolved through understandings and agreements developed

during prelaunch tests The previously mentioned coordination lapse cannot be attributed to the design of the TDS operational organization Overall, the system provided for very satisfactory direction of activities, real-time monitoring and evaluation of TDS performance, and near-real-time reporting of pertinent information and major events to TDS decision-responsibility centers

4. Other areas. Apart from the problems attributed to poor propagation conditions, the total TDS communication network provided excellent support throughout the near-earth phase Central facility telemetry data processing, distribution, and display performance was excellent and all requirements were met All operations and facility support functions were routinely performed as specified An evaluation of the NASCOM performance is presented in Table 53

Table 53 NASCOM performance evaluation, near-earth phase

DSS	Communication type	Hours up	Outages, min	Mean duration, min	Reliability percentage, %
70	TTY	80 83	—	—	100
Building AO	Voice	63 05	6 0	6 0	99 84
71	TTY	55 83	17 0	8 5	99 49
	Voice	10 53	—	—	100
	HSD	14 03	—	—	100
72	TTY	52 0	66 0	66 0	97 88
	Voice	11 95	—	—	100
	HSD	11 95	—	—	100
51*	TTY	85 93	124 0	17 7	97 59
	Voice	22 72	90 0	22 5	93 39
	HSD	22 72	—	—	100

*DSS 51 was actually considered as part of the near earth phase for only first hour of DSS 51 tracking, however for the purpose of this table all DSS 51 tracking is included

C Evaluation of TDS Performance First DSIF Acquisition Through Midcourse

The DSN provided continuous tracking and data processing coverage from first DSIF acquisition on June 14 through the completion of the midcourse maneuver sequence on June 20 The prime tracking stations for this period were DSS 11, DSS 42, and DSS 61 Significant spacecraft events during this period are listed in Table 54 A log of all DSN activity during the period and a summary of each critical phase is presented in Section V

Table 54 Significant spacecraft events, first acquisition through midcourse

Event	Date, June	Time, GMT
Earth acquired	14	22 47 01
Canopus acquired	15	01 09 02
Pitch maneuver	19	22 24 11 to 22 29 17
Roll maneuver	19	22 46 14 to 22 52 32
Burn maneuver	19	23 08 11 26 to 23 08 28 92 Duration of burn 17 66 s
Sun acquired	19	23 21 29 5
Canopus acquired	19	23 32 27
	20	00 24 05 8
	20	01 17 20
	20	02 06 40

In Section VI, a comparison is made between the requirements and the actual TDS performance Discrepancies between the two are explained

1. Tracking requirements and performance. A comparison of the class I (minimum) tracking requirements and the actual performance is presented in Table 55 A maser failure during the DSS 42 pass immediately following the midcourse maneuver sequence resulted in a 17-min gap in the Australian tracking coverage before DSS 41 could be brought on-line DSS 41 completed the tracking pass without any problems The 17-min gap was during an overlap period with DSS 11, so there was continuous coverage and Project minimum requirements were met

The requirements for *Mariner IV* tracking during this period ranged from one per day (class III) to one pass per week (class I) Because of the low signal strength from the spacecraft, tracking was not possible from a standard DSIF 85-ft antenna station, and the Project elected to forgo all coverage of *Mariner IV* during this period

2. Data transmission requirements and performance No quantitative requirements were placed on the GCF other than the line quantity requirements shown in Fig 19 These requirements were met without problems The basic requirement was to transmit data from the tracking station to the SFOF This was accomplished with a high degree of reliability, as presented in Table 56 and described below

a High-speed data lines This portion of the communications system performed exceptionally well during the

Table 55 Tracking coverage comparison, first acquisition through midcourse

Time distance coverage	Data required	Coverage and data provided
Continuous coverage Track S/C from separation to first $M - 1$ h	Angular position, doppler (2-way) 1-min sample rate (from initial DSIF acquisition to $L + 1$ h at 5-s sample rate)	As required, + BU coverage on the first pass As required
Data stream 1 Continuous coverage from first M/C − 1 h to sun reacquisition	10-s sampling rate	Coverage as required, 10-s data from $M - 48$ min at SFOD request
Data stream 2 (first M/C) Pitch − 1 min to pitch + 1 min Roll − 1 min to roll + 1 min Motor burn − 5 min to motor burn + 5 min	1-s sampling rate	As required
Motor burn + 5 min to sun reacquisition	10 s sampling rate	
Continuous coverage Sun reacquisition to first $M + 2$ days	60-s sampling interval	As required

Table 56 NASCOM performance evaluation, deep space phase[a]

DSS	Communication type	Hours up	Outages, min	Mean outage duration, min	Reliability percentage, %
42	TTY	361 80	105 0	17 5	99 51
	Voice	91 28	—	—	100
	HSD	90 48	23 0	11 5	99 57
41	TTY	106 13	—	—	100
	Voice	28 22	—	—	100
	HSD	28 00	—	—	100
61	TTY	380 20	185 20	6 4	99 18
	Voice	98 87	10 0	5 0	99 83
	HSD	102 88	20 0	10 0	99 67
11	TTY	373 27	—	—	100
	Voice	93 13	—	—	100
	HSD	93 83	—	—	100

[a]See Table 53 for DSS 51 NASCOM performance evaluation

tests and mission phases with virtually 100% reliability, with 99 57% to DSS 42 being the lowest The transmit side of the lines was used during the launch phase to backfeed the status net to the DSS stations

b Teletype circuits The teletype circuits were also exceptionally reliable The three prime stations during this phase of the mission (DSS 11, 42, and 61) showed better than 99% reliability

c Voice circuits The NASCOM voice circuits provided for the *Mariner* Venus 67 mission and tests performed well within expectations The DSS 51 circuit was the weakest, with approximately 93 39% reliability As previously stated, RF propagation problems with DSS 51 were anticipated The prime stations (DSS 11, 42, and 61) showed better than 99% reliability during all tests and the mission

d JPL/Goldstone microwave system The GDSCC-SFOF microwave system, operated by the Western Union Company, provided excellent communications service with 100% reliability

e Communications processor After the launch phase of the mission, some CP software problems became apparent with predict transmission causing a large part of the difficulties Numerous errata changes were made after these problems came to light and the system thereafter operated with a high degree of reliability The performance of the NASA communications network used to support *Mariner* Venus 67 was considered excellent, demonstrating its high degree of reliability GSFC circuit and CP restoration support was also highly satisfactory

3 Data processing requirements and performance

a On-site data processing The Project supplied a program to the DSN to process telemetry data in the TCP at each DSS This program performed without flaw during the period of concern, processing all received telemetry and transmitting the data to the SFOF over HSD and teletype data lines

b SFOF data processing A comparison of the computer time requirements and the actual computer time provided is presented in Table 57 All computer time requirements were more than met Substantially more mode 2 time was provided than was originally required Additional requests were made to, and honored by, the DSN to run additional orbits over those originally anticipated

SFOF data processing performance was satisfactory Some problems were encountered with the 7044/CP interface These problems were fixed (as soon as a fix was known) in real time, where possible Minor problem fixes were incorporated in versions of the 7044 and CP system programs that were used later in the mission

4. Command system performance. The basic requirement on the DSN command system for *Mariner V* was to correctly transmit commands to the spacecraft This was accomplished as required From first AOS through midcourse, 15 commands were transmitted correctly to the spacecraft, all by DSS 11 These commands are listed in Table 58

5. Prediction performance Predictions were sent to all DSS in a timely manner No tracking of the spacecraft was lost because of lack of antenna pointing or frequency information One measure of the accuracy of the predicts was to compare predicted view periods with actual AOS and LOS times (Note This measure had flaws in that scheduling or station problems may affect the AOS and LOS times) This comparison is made in Table 59, which shows that in most cases the predicts were only a few minutes different than the actuals

6. Summary The performance of the TDS during the period from first DSIF AOS through midcourse in all cases met or exceeded the requirements placed by the Project The coverage which was provided represented an extraordinary effort on the part of all elements of the DSN during a period when the requirements of three other projects were taxing the systems

Table 57 Computer requirements and actual provisions

Configuration	Required	Provided
Dual mode 2	$L - 6$ h to $L + 36$ h	$L - 12$ h to $L + 36$ h
Mode 2/mode 3	$M/C - 12$ h to $M + 12$ h	$M/C - 15$ h to $M + 30$ h
Mode 2	$L + 36$ h to $L + 48$ h	$L + 36$ h to $L + 48$ h, + approx 8 h/day between L and M/C
Mode 3	All other periods	All other periods

Table 58 Commands sent (first DSIF AOS through M/C)

Command sent	Day	Time, GMT
	Canopus acquisition	
DC-V21	166	00 30 00
DV-V21	166	00 34 00
	Midcourse maneuver (pre-M/C)	
QC V1-1	170	20 18 00
QC-V1-2	170	20 23 00
QC-V1-3	170	20 28 00
DC-V29	170	20 38 00
DC-V14	170	20 48 00
DC-V27	170	21 23 57
DC-V21	170	23 33 15
DC-V21	171	00 25 00
DC-V21	171	01 17 50
QC-V1-1	171	02 19 00
QC-V1-2	171	02 24 00
QC-V1-3	171	02 29 00
DC-V9	171	02 39 00

Table 59. Predicted view periods vs actual tracking at DSIF stations

Pass	Day	DSS	Predicted rise, GMT	Predicted set, GMT	Predicted view period, GMT	AOS, GMT	LOS, GMT	Actual view period, h, min and s	Observed — predicted (min, s)
1	165	41	06 50 58	11 50 45	04 59 47	06 53 22	12 11 02	05 23 40	+33 53
		42	06 53 25	11 18 19	04 24 54	06 58 42	11 20 02	04 21 20	− 3 34
		61	11 15 03	20 21 40	09 09 37	11 13 02	20 23 02	09 10 00	+ 3 23
		11	18 34 26	04 30 26	09 56 00	18 35 02	04 38 02	10 03 00	+ 0 07
2	166	42	23 56 09	11 54 43	11 58 34	00 05 32	11 55 02	11 49 30	− 9 04
		61	11 05 43	20 41 15	09 34 32	11 10 02	20 38 02	09 28 00	− 7 32
		11	18 34 35	04 40 48	10 06 13	18 32 02	04 46 02	10 14 00	+ 7 37
3	167	42	23 55 19	11 52 46	11 57 27	00 02 02	11 56 02	11 54 00	− 3 27
		61	11 01 22	20 43 36	09 42 14	11 06 02	20 35 02	09 29 00	−13 14
		11	18 31 55	04 41 54	10 09 59	18 32 02	04 47 02	10 15 00	+ 5 01
4	168	42	23 54 52	11 49 48	11 56 54	00 00 02	11 53 02	11 53 00	− 3 54
		61	10 57 12	20 42 39	09 45 27	11 01 02	20 41 02	09 40 00	− 5 27
		11	18 28 31	04 40 33	10 12 02	18 28 02	04 45 02	10 17 00	+ 4 58
5	169	42	23 49 49	11 46 22	11 56 33	23 55 02	11 50 02	11 55 00	− 1 33
		61	10 53 01	20 40 27	09 47 26	10 57 02	20 37 02	09 40 00	− 7 26
		11	18 24 48	04 38 08	10 13 20	18 25 02	04 42 02	10 17 00	+ 3 40
6	170	42	23 46 24	11 42 46	11 56 22	23 52 02	11 47 02	11 55 00	− 1 22
		61	10 48 48	20 37 35	09 48 47	11 04 02	20 32 02	09 28 00	−20 47
		11	18 20 54	04 35 12	10 14 18	18 26 02	04 39 02	10 13 00	− 1 18

Glossary

AA computer instruction for teletype noninterrupt mode

A/B autobeacon

A/C attitude control

ADC/PNG analog-to-digital converter/pseudonoise generator

AFETR Air Force Eastern Test Range

AGC automatic gain control

AGCM AGC calibration program

AMES Ames Research Center

ANT Station 91, Antigua Island

AOS acquisition of signal

ASC Ascension Island, MSFN/USB site

ATTREF attitude reference program

az azimuth

BDA Bermuda Island station, MSFN

BECO booster engine cutoff

BU backup

CADDAC Central Analog Data Distribution and Computer System

CATS an area in the SFOF where visiting scientists observe mission proceedings

CB Cocoa Beach

CCC Central Computing Complex

CCS Command Control System

CC&S central computer and sequencer

CGF communication guidance facility

ch channel

comm communications

Comsat Communications Satellite

CP communications processor

CPPM communication prediction program

CRO Carnarvon MSFN/USB site

CRFS Combined Reference Frequency System

CST combined systems test

CVT configuration verification test

DACON Data Control (operational position)

DAS data automation subsystem

dbm decibel referred to 1 milliwatt

DC direct command

DCT design compatibility test

DDC direct data channel

decom decommutator

demod demodulator

DFR dual frequency receiver

DIC data insertion converter

DIS Digital Instrumentation Subsystem

DPA Data Processing Area

DPCC data processing control console

DPE dynamic phase error

DPLF Digital Phone Line Formatter

DOD Department of Defense

DPS data processing system

DSCC Deep Space Communications Complex

DSN Deep Space Network

DSIF Deep Space Instrumentation Facility

DSS Deep Space Station

DSS 11 Pioneer Deep Space Station, Goldstone, California

DSS 12 Echo Deep Space Station, Goldstone, California

DSS 13 Venus Deep Space Station, Goldstone, California

DSS 14 Mars Deep Space Station, Goldstone, California

DSS 41 Woomera Deep Space Station, Island Lagoon, Australia

DSS 42 Tidbinbilla Deep Space Station, Canberra, Australia

Glossary (contd)

DSS 51	Johannesburg Deep Space Station, Johannesburg, South Africa
DSS 61	Robledo Deep Space Station, Madrid, Spain
DSS 62	Cebreros Deep Space Station, Madrid, Spain
DSS 72	Ascension Deep Space Station, Ascension Island
DVP	data validation program
Dymec	digital voltmeter
E	time of encounter
EAT	engineering analysis team
el	elevation
EOM	end of message
EOPS	AFETR Operations
EOT	end of test
FC	false cape
FDX	full duplex, two-way
FM	frequency modulated
FPAA	Flight Path Analysis Area
FPAC	Flight Path Analysis and Command
FR-100 FR	Ampex tape recorders
FPQ6	C-band monopulse tracking radar
FTS	Federal Telecommunications System
GBI	Grand Bahama Island
GCF	Ground Communications Facility
GDSCC	Goldstone Deep Space Communications Complex
GET	ground elapsed time
GMCF	Guided Missile Control Facility
GMT	Greenwich mean time
GSFC	Goddard Space Flight Center
GTS	Ground Telemetry System
HAC	Hughes Aircraft Company
HA-DEC	hour angle–declination
HF	high frequency
HSD	high-speed data
HSDL	high-speed data line
ID	identification
IBM	International Business Machines
IF	intermediate frequency
IGOR	Intercept Ground Optical Recorder
IMP	interim monitor program
I/O	input/output
IP	input processor
IRIG	Inter-range Instrument Group
IRV	inter-range vector message
KSC	Kennedy Space Center (NASA, Cape Kennedy, Fla)
KSR	keyboard send–receive
L	time of launch
LOS	loss of signal
LeRC	Lewis Research Center (NASA, Cleveland, Ohio)
LPA	launch phase analyst
LV	launch vehicle
M	time of maneuver
MA&E	Mission Analysis and Engineering
MB	Melbourne Beach
M/C	midcourse
MDE	mission-dependent equipment
MDL	master data library
MDTF	master tracking data file
MECO	main engine cutoff
MEIG	main engine ignition
MIE	mission-independent editor
MMSA	*Mariner* Mission Support Area
MOC	Mission Operations Center

Glossary (contd)

MODEM	modulator–demodulator
MRH	mission-related hardware
MRS	mission-related software
MS	millisecond clock
MSA	Mission Support Area
MSFN	Manned Space Flight Network
MTD	master tracking data
MTDF	master tracking data file
N/A	not applicable
NASCOM	NASA Communications Network
NOR	not operationally ready
NRT	non-real-time
NRZ	non-return-to-zero
OCC	Operations Control Chief
OD	orbit determination
ODGX	orbital data generator
ODP	orbit determination program
OPS	operations
ORT	operational readiness test
OSDP	on-site data processing
OSE	operational support equipment
OSSA	Office of Space Science and Applications (NASA)
OTDA	Office of Tracking and Data Acquisition (NASA)
OVCS	Operational Voice Communications System
OVT	operations verification test
PAFB	Patrick Air Force Base
PAM	pulse-amplitude modulation
PCM	pulse-code modulation
PE	project engineer
PIO	Public Information Office
PM	phase modulation
PN	pseudonoise
P/O	parking orbit
POWM	a trajectory computer program
PR	pseudoresidual
PRDX	predicts computer program
PRE	Pretoria
PRPP	pseudoresidual plot program
PSK	phase-shift-keyed
QC	quantitative command, quality control
RCVR	receiver
RCC	Range Control Center
R&D	research and development
RIS	Range Instrumentation Ship
RO	receive only
ROTI	recording optical tracking instrument
RPF	reperforator
RTCC	real-time computer complex
RTCS	real-time computer system
RWV	read-write-verify
S	start
SAF	Spacecraft Assembly Facility
SC	stored command
S/C	spacecraft
SCAMA	signaling, conferencing, and monitoring arrangement
SCO	subcarrier oscillator
SCS 71	Spacecraft Compatibility Station, Cape Kennedy, Fla
SDCC	SFOF Simulation Data Conversion Center
SECO	sustainer engine cutoff
SFO	Space Flight Operations
SFOD	Space Flight Operations Director
SFOF	Space Flight Operations Facility
SIPM	star identification program

Glossary (contd)

SNR	signal-to-noise ratio
SOPM	standard orbital parameter message
SPAC	Spacecraft Performance Analysis and Command
SPE	static phase error
SRI	Stanford Research Institute
SRO	Supervisor of Range Operations
SSAC	Space Science Analysis and Command
STC	System Test Complex
sync	synchronization
SYSAD	systems adviser (operational position)
T	interruptible time count referenced to an event
TAER	time, azimuth, elevation, range
TAN	Tananarive site, Malagasy
TC	test conductor
TCP	telemetry and command processor
TDA	tracking and data acquisition
TDH	tracking data handling
TDP	tracking data processor
TDPX	tracking data processor program
TDS	Tracking and Data System
Tel 2, 4	AFETR stations
TIM	Tracking Instruction Manual
TJIM	a trajectory computer program
TLM	telemetry
TPQ 18	transportable version of FPQ-6 radar
TPS	Telemetry Processing Subsystem
TRW	TRW Systems Group
TTY	teletype
TSP	test support position
TSS	teletype switching system
TV	television
UHF	ultrahigh frequency
ULO	Unmanned Launch Office
UNI	Uniform (call name for RIS *Twin Falls*)
USB	unified S-band
VCO	voltage-controlled oscillator
VCT	verification compatibility test
VDR	validated data record
VECO	vernier engine cutoff
WHI	Whiskey (call name for RIS *Coastal Crusader*)

Appendix

Standard Sequence of Events

Mariner V Launch, June 14, 1967

MOS/T+DS MERGED SEQUENCE FOR MV-67

PAGE 1

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
1.0.	T- 28D	MARCHF	MCHF SC		1. ADVISE SUPPORT CHIEF OF ACCESS CONTROL		1.
					REQUIREMENTS.		2.
2.0.		COMM	CC OPC		1. ORDER NECESSARY PAPER, TAPE, RIBBON, AND		3.
					AUDIO RECORDING TAPE.		4.
3.0.		SUPT	SC OPC		1. TECHNICAL AREA ASSISTANTS CHECK SUPPLIES AND		5.
					ORDER ALL NEW SUPPLIES REQUIRED.		6.
4.0.		SUPT			1. CHECK COFFEE SUPPLIES ON HAND AND ORDER ITEMS		7.
					REQUIRED.		8.
5.0.	T- 15D	MARCHF	MCHF OPC		1. SUBMIT ALL COMMUNICATIONS REQUIREMENTS TO		9.
					THE SCHEDULING OFFICE PER SFOF SOP 12-010.		10.
6.0.	T- 14D	COMM	CC OPC		1. SUBMIT NASCOM CIRCUIT FORECAST MESSAGE TO		11.
					GSFC.		12.
							13.
					2. REQUEST JPL PBX MANNING AND SPECIAL COVERAGE		14.
					FOR SFOF AND GTS MICROWAVE LINK.		15.
7.0.	T- 12D	COMM	CC OPC		1. COMMENCE SFOF COMMUNICATIONS PLANT CHECKOUT,		16.
					ALL SYSTEMS.		17.
8.0.	T- 10D	SUPT	SSPE ALL		1. PUBLISH IOM TO SECTION 713 SPECIFYING DATES		18.
					AND TIMES OF STANDBY GENERATOR COVERAGE.		19.
							20.
					2. PUBLISH IOM TO EMPLOYEE SERVICES DEFINING		21.
					CAFETERIA SUPPORT REQUIRED.		22.
							23.
					3. REQUEST ADDITIONAL GUARDS FOR ACCESS CONTROL		24.
					FROM OPERATIONS SUPPORT.		25.
							26.
					4. SPECIAL TRANSPORTATION, IF REQUIRED, HAS BEEN		27.
					ARRANGED.		28.
9.0.		MARCHF	MCHF CC		1. PREPARE AND DELIVER T-10D MESSAGE TO		29.
					COMMUNICATIONS FOR TRANSMISSION TO GSFC.		30.
							31.
			MCHF OPC		2. CONFIRM COMMUNICATIONS REQUIREMENTS WITH THE		32.
					SCHEDULING OFFICE PER SFOF SOP 12-010.		33.
10.0.		COMM	CC OPC		1. ORDER ALL REQUIRED VOICE, TTY, AND DATA		34.
					CIRCUITS FROM NNSG/GSFC.		35.
							36.
					2. REQUEST SPECIAL COVERAGE FROM NNSG/GSFC.		37.
							38.
					3. REQUEST PROPAGATION FORECASTS FROM		39.
					NETREV/GSFC.		40.

MOS/T+OS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
11.0		MARCHF	MCHF PE		1. SUBMIT MSB REQUIREMENTS TO DSN P.E.		41
12.0	T- 10D	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		42
					DSS 11 DSS 61 DSS 41 DSS 62		43
					DSS 42 DSS 71 DSS 12		44
					DSS 51 DSS 72 DSS 14		45
13.0	T- 10D	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		46
							47
14.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		48
15.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		49
16.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		50
17.0		DSN	OPC TDS		1. REPORT DSN STATUS.		51
18.0		AO	EOPS TDS		1. REPORT AFETR AND MSFN STATUS.		52
19.0		TDS	TDS TDSM		1. REPORT TDS STATUS.		53
20.0	T- 9D	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		54
					DSS 11 DSS 61 DSS 41 DSS 62		55
					DSS 42 DSS 71 DSS 12		56
					DSS 51 DSS 72 DSS 14		57
21.0	T- 9D	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		58
							59
22.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		60
23.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		61
24.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		62
25.0		DSN	OPC TDS		1. REPORT DSN STATUS.		63
26.0		AO	EOPS TDS		1. REPORT AFETR AND MSFN STATUS.		64
27.0		TDS	TDS TDSM		1. REPORT TDS STATUS.		65
28.0	T- 8D	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		66
					DSS 11 DSS 61 DSS 41 DSS 62		67
					DSS 42 DSS 71 DSS 12		68
					DSS 51 DSS 72 DSS 14		69
29.0	T- 8D	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		70
							71

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY	REPORT TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
30.0.		COMM	CC	OPC.	DSN	1. REPORT COMM STATUS.		72.
31.0.		DPS	DC	OPC.	DSN	1. REPORT DPS STATUS.		73.
32.0.		SUPT	SC	OPC.	DSN	1. REPORT FACILITY STATUS.		74.
33.0.		DSN	OPC	TDS.		1. REPORT DSN STATUS.		75.
34.0.		AO	EOPS	TDS.		1. REPORT AFETR AND MSFN STATUS.		76.
35.0.		TDS	TDS	TDSM.		1. REPORT TDS STATUS.		77.
36.0.	T- 7D	MARCHF	MCHC	SC.		1. SUBMIT ACCESS LISTS FOR ALL MISSION DEPENDENT		78.
						PERSONNEL TO SUPPORT CHIEF.		79.
37.0.		SFOF	MGR	ALL.		1. PUBLISH SFOF FREEZE DATES AND HOURS.		80.
38.0.	T- 7D	DSIF	MGR	ALL.		1. PUBLISH DSIF FREEZE DATES AND HOURS.		81.
		..						82.
39.0.	T- 7D	DSIF	STA	TC.		1. TRANSMIT DAILY STATION STATUS MESSAGE.		83.
		..				DSS 11 DSS 61 DSS 41 DSS 62		84.
						DSS 42 DSS 71 DSS 12		85.
						DSS 51 DSS 72 DSS 14		86.
40.0.	T- 7D	DSIF	TC	OPC.	DSN	1. REPORT DSIF STATUS.		87.
		..						88.
41.0.		COMM	CC	OPC.	DSN	1. REPORT COMM STATUS.		89.
42.0.		DPS	DC	OPC.	DSN	1. REPORT DPS STATUS.		90.
43.0.		SUPT	SC	OPC.	DSN	1. REPORT FACILITY STATUS.		91.
44.0.		DSN	OPC	TDS.		1. REPORT DSN STATUS.		92.
45.0.		AO	EOPS	TDS.		1. REPORT AFETR AND MSFN STATUS.		93.
46.0.		TDS	TDS	TDSM.		1. REPORT TDS STATUS.		94.
47.0.		COMM	CC	OPC.		1. RUN SYSTEM TEST ON GTS MICROWAVE LINK.		95.
								96.
						2. TEST AND VERIFY COMMUNICATIONS LINES AND		97.
						WIDEBAND CHANNELS BETWEEN THE COMM CENTER		98.
						AND TPS/DPS.		99.

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
48.0.	T- 6D	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		100.
					DSS 11 DSS 61 DSS 41 DSS 62		101.
					DSS 42 DSS 71 DSS 12		102.
					DSS 51 DSS 72 DSS 14		103.
49.0.	T- 6D	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		104.
							105.
50.0.		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		106.
51.0.		DPS	DC OPC	DSN	1. REPORT DPS STATUS		107.
52.0.		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		108.
53.0.		DSN	OPC TDS		1. REPORT DSN STATUS.		109.
54.0.		AO	EOPS TDS		1. REPORT AFETR AND MSFN STATUS.		110.
55.0.		TDS	TDS TDSM		1. REPORT TDS STATUS.		111.
56.0.		PLANT	PLT SC		1. START SFOF PLANT INSPECTION AND MAINTENANCE.		112.
57.0.		DSN PE	PE SC		1. SUBMIT MSB DISPLAY REQUIREMENTS TO SUPPORT		113.
					CHIEF.		114.
58.0.	T- 5D	COMM	CC OPC		1. RECEIVE NNSQ/GSFC CONFIRMATION OF		115.
					COMMUNICATIONS CIRCUITS AND SPECIAL COVERAGE.		116.
							117.
					2. TWX LAUNCH CIRCUIT SCHEDULE MESSAGE TO		118.
					SUPPORTING DSS.		119.
59.0.	T- 5D	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		120.
					DSS 11 DSS 61 DSS 41 DSS 62		121.
					DSS 42 DSS 71 DSS 12		122.
					DSS 51 DSS 72 DSS 14		123.
60.0.	T- 5D	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		124.
							125.
61.0.		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		126.
62.0.		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		127.
63.0.		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		128.
64.0.		DSN	OPC TDS		1. REPORT DSN STATUS.		129.
65.0.		AO	EOPS TDS		1. REPORT AFETR AND MSFN STATUS.		130.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
66.0		TDS	TDS TDSM		1. REPORT TDS STATUS.		131.
67.0	T- 40	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		132.
					DSS 11 DSS 61 DSS 41 DSS 62		133.
					DSS 42 DSS 71 DSS 12		134.
					DSS 51 DSS 72 DSS 14		135.
68.0	T- 40	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		136.
							137.
69.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		138.
70.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		139.
71.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		140.
72.0		DSN	OPC TDS		1. REPORT DSN STATUS.		141.
73.0		AO	EOPS TDS		1. REPORT AFETR AND MSFN STATUS.		142.
74.0		TDS	TDS TDSM		1. REPORT TDS STATUS.		143.
75.0	T- 30	PLANT	PLT SC		1. COMPLETE SFOF PLANT INSPECTION AND		144.
					MAINTENANCE.		145.
76.0	T- 30	DSIF	STA TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		146.
					DSS 11 DSS 61 DSS 41 DSS 62		147.
					DSS 42 DSS 71 DSS 12		148.
					DSS 51 DSS 72 DSS 14		149.
77.0	T- 30	DSIF	TC OPC	DSN	1. REPORT DSIF STATUS.		150.
							151.
78.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		152.
79.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		153.
80.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		154.
81.0		DSN	OPC TDS		1. REPORT DSN STATUS.		155.
82.0		AO	EOPS TDS		1. REPORT AFETR AND MSFN STATUS.		156.
83.0		TDS	TDS TDSM		1. REPORT TDS STATUS.		157.
84.0		SUPT	SC OPC		1. CHECK MSB FOR CORRECT INFORMATION.		158.
85.0	T- 20	MARCHF	DCN		1. FINAL COEFFICIENTS FOR 7044 DELIVERED TO		159.
					DACON.		160.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY	REPORT TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
86.0	T- 2D	COMM	CC	OPC	DSN	1. COMPLETE COMMUNICATIONS PLANT CHECKOUT, ALL		161
						SYSTEM.		162
87.0	T- 2D	DSIF	STA	TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		163
						DSS 11 DSS 61 DSS 41 DSS 62		164
						DSS 42 DSS 71 DSS 12		165
						DSS 51 DSS 72 DSS 14		166
88.0	T- 2D	DSIF	TC	OPC	DSN	1. REPORT DSIF STATUS.		167
								168
89.0		COMM	CC	OPC	DSN	1. REPORT COMM STATUS.		169
90.0		DPS	DC	OPC	DSN	1. REPORT DPS STATUS.		170
91.0		SUPT	SC	OPC	DSN	1. REPORT FACILITY STATUS.		171
92.0		DSN	OPC	TDS		1. REPORT DSN STATUS.		172
93.0		AO	EOPS	TDS		1. REPORT AFETR AND MSFN STATUS.		173
94.0		TDS	TDS	TDSM		1. REPORT TDS STATUS.		174
95.0	T- 1D15H	DPS	DC	OPC	DSN	1. PROJECT USING THE COMPUTERS.		175
96.0	T- 1D11H	DPS	DC	OPC	DSN	1. PROJECT RELEASING THE COMPUTERS.		176
								177
						2. START DPS/FSD SYSTEM DIAGNOSTICS.		178
97.0		DACON	DCN	MCHF		1. REPORT DPS STATUS.		179
98.0	T- 1D 7H	DPS	DC	OPC		1. COMPLETE DPS/FSD SYSTEM DIAGNOSTICS.		180
								181
						2. START IBM PM.		182
								183
						3. START TPS PM.		184
								185
						4. START I/O PM.		186

ITEM	TIME	STA.	REPORT BY	REPORT TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
99.0	T- 1D	SUPT	SC	OPC	DSN	1. CHECK ALL FIRST FLOOR DISPLAYS INCORPORATING		187.
						DDU FOR CORRECT OPERATION.		188.
								189.
						2. CHECKOUT AND VERIFY THE OPERATION OF		190.
						A. EIDOPHOR PROJECTOR		191.
						B. MISSION EVENTS PROJECTOR		192.
						C. TELEPROMPTER PROJECTORS.		193.
								194.
						3. RECEIVE STANDBY ELECTRICIANS NAMES AND WORK		195.
						SCHEDULES.		196.
								197.
						4. RECEIVE VERIFICATION FROM FACILITY SUPPORT		198.
						THAT THE DIESELS ARE READY FOR LAUNCH.		199.
100.0		MARCHF	MCHF	CC		1. PREPARE AND DELIVER T-1 DAY ALERT MESSAGE TO		200.
						COMMUNICATIONS FOR TRANSMITTAL TO GSFC.		201.
101.0		COMM	CC	OPC	DSN	1. VERIFY XMISSION OF ALERT MESSAGE TO GSFC.		202.
102.0	T- 1D	DSIF	STA	TC		1. TRANSMIT DAILY STATION STATUS MESSAGE.		203.
						DSS 11 DSS 61 DSS 41 DSS 62		204.
						DSS 42 DSS 71 DSS 12		205.
						DSS 51 DSS 72 DSS 14		206.
103.0	T- 1D	DSIF	TC	OPC	DSN	1. REPORT DSIF STATUS.		207.
								208.
104.0		COMM	CC	OPC	DSN	1. REPORT COMM STATUS.		209.
105.0		OPS	DC	OPC	DSN	1. REPORT OPS STATUS.		210.
106.0		SUPT	SC	OPC	DSN	1. REPORT FACILITY STATUS.		211.
107.0		DSN	OPC	TDS		1. REPORT DSN STATUS.		212.
108.0		AO	EOPS	TDS		1. REPORT AFETR AND MSFN STATUS.		213.
109.0		TDS	TDS	TDSM		1. REPORT TDS STATUS.		214.
110.0	T- 21H	OPS	DC	OPC	DSN	1. IBM PM COMPLETE.		215.
								216.
						2. TPS PM COMPLETE.		217.
								218.
						3. I/O PM COMPLETE.		219.
								220.
						4. START FINAL OPS/FSD SYSTEM DIAGNOSTICS.		221.
111.0	T- 1 H	COMM	CC	OPC	DSN	1. COMMENCE GO, NO/GO, TESTS ON VRS, PA, OVCS,		222.
						CCTV, AND TTY.		223.

ITEM	TIME	STA.	REPORT BY-TO		NET	EVENT	CHECK WHEN COMPLETE	LINE
112.0.	T- 13H15M	DSIF				1. COMMENCE STANDARD CLASS A COUNTDOWN		224.
						DSS 71 AND DSS 72		225.
113.0.	T- 12H	AFETR		EOPS.		1. TRANSMIT PROPAGATION FORECAST.		226.
114.0.	T- 12H	DSIF				1. COMMENCE STANDARD CLASS A COUNTDOWN.		227.
						DSS 11 DSS 51		228.
						DSS 41 DSS 61		229.
						DSS 42		230.
115.0.	T- 11H	COMM	CC	OPC.	DSN	1. REPORT COMM STATUS.		231.
116.0.		DPS	DC	OPC.	DSN	1. REPORT DPS STATUS.		232.
117.0.		SUPT	SC	OPC.	DSN	1. REPORT FACILITY STATUS.		233.
118.0.		COMM	CC	OPC.	DSN	1. STAFF UNIVAC MAINTENANCE.		234.
								235.
						2. COMMENCE CP GO, NO/GO TEST.		236.
119.0.	T- 11H	DPS	DC	OPC.	DSN	1. DPS SYSTEM CHECKOUT COMPLETE.		237.
								238.
						2. ONE STRING RELEASE TO DACON FOR PROJECT USE.		239.
								240.
						3. ONE STRING RELEASE TO DACON FOR TCS USE.		241.
120.0.	T- 11H	DACON	DCN	ACE5.		1. REPORT OPERATIONAL READINESS TO ACE 5.		242.
121.0.	T- 10H	COMM	CC	OPC.	DSN	1. COMPLETE GO, NO/GO TESTS ON VRS, PA, DVCS,		243.
						CCTV, AND TTY.		244.
								245.
						2. CLEAN AND SERVICE 1004.		246.
								247.
						3. LOAD PAPER IN ALL CPCC MACHINES.		248.
122.0.	T- 9H	COMM	CC	OPC.	DSN	1. COMPLETE GO, NO/GO, TEST ON CP.		249.
123.0.	T- 7H20M	SUPT	SC	OPC.	DSN	1. STARTING GENERATORS.		250.
124.0.	T- 7H	SUPT	SC	OPC.	DSN	1. FACILITY WILL BE SWITCHED TO GENERATOR POWER		251.
				CC.		IN 10 MINUTES.		252.
				DC.				253.
125.0.	T- 6H50M	SUPT	SC	OPC.	DSN	1. FACILITY SWITCHED TO GENERATOR POWER.		254.
				CC.				255.
				DC.				256.
126.0.	T- 6H45M	COMM	CC	TC.	DSN	1. DSS 71 AND 72 VOICE UP.		257.

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ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
127.0	T- 6H30M	PE	SYSD OPC	DSN	1. SYSAD POSITION STAFFED.		258
128.0	T- 6H30M	DSIF	NM OPC	DSN	1. TRACK CHIEF AND NETMAN POSITIONS STAFFED.		259
							260
					2. ONE NET CONTROLLER ON DUTY.		261
129.0	T- 6H30M	COMM	CC OPC	DSN	1. VOICE CIRCUITS JPL/ETR ARE UP.		262
130.0	T- 6H20M	COMM	CC OPC	DSN	1. ALL REAL TIME ENTRIES HAVE BEEN MADE TO THE		263
					CP.		264
131.0	T- 6H15M	COMM	CC OPC	DSN	1. ESTABLISH ALL DSS 71 AND 72 CIRCUITS.		265
							266
					2. START VOICE RECORDING REQUIREMENTS REQUESTED		267
					NETS.		268
132.0	T- 6H	MARCHF	MCHF CC		1. PREPARE AN DELIVER L-6 HOUR ALERT MSG TO COMM.		269
					FOR TRANSMITTAL TO GSFC.		270
133.0	T- 5H50M	COMM	CC OPC	DSN	1. ESTABLISH 2 VOICE CIRCUITS JPL/ETR STATUS		271
					AND ETR NETS. (FPAC-RTCC2)		272
							273
					2. REPORT COMM STATUS.		274
134.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		275
135.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		276
136.0	T- 5H45M	COMM	CC MCHF	FAC-PRIME	1. VERIFY XMISSION OF ALERT MESSAGE TO GSFC.		277
137.0	T-	VEH			1. ATLAS AGENA PRECOUNT.		278
138.0	T- 5H45M	COMM	CC OPC	DSN	1. DSS 71 AND 72 CIRCUITS UP.		279
			DC	DPA 1			280
139.0	T- 5H45M	COMM	CM TC	FAC-PRIME	1. DSS 71 AND 72 CIRCUITS UP.		281
			SYSD				282
					2. FIRST COMM OPERATOR TO NET CONTROL.		283
140.0		OPSCON	OPC	FAC PRIME	1. JPL/ETR FPAC/RTCC NET UP.		284
			SYSD				285
					2. COMM MAN POSITION IS STAFFED.		286
							287
					3. THE DSN STATUS IS GO-NO/GO.		288

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
141.0	T- 5H15M	DSIF	TC DSS	DSS	1. START PRETRACK DATA XMISSION TEST WITH		289.
					DSS 71, DSS 72		290.
							291.
					1. DSS 71 AND 72 TRANSMIT PRETRACK REPORT		292.
					BY TTY.		293.
142.0	T- 5H	FTR			1. RANGE COUNT STARTED.		294.
143.0	T- 5H	COMM	CC OPC	DSN	1. ESTABLISH COMMUNICATIONS WITH DSS 11, 41, 42,		295.
					51, AND 61.		296.
							297.
					1. VOICE WITH DSS 11, 41, 42, 51, AND 61 UP		298.
144.0	T- 4H35M	COMM	CC OPC	DSN	1. ACTIVATE ALL TTY CIRCUITS AND HSD AND		299.
					REMAINING ETR VOICE.		300.
					SPAC-AD TRW (MAC)		301.
					PROJECT HOT LINE HSD/BUSS		302.
					STATUS		303.
145.0	T- 4H30M	COMM	CC OPC	DSN	1. COMMUNICATIONS TO ALL PARTICIPATING DSS UP		304.
			CM TC	FAC-PRIME	AND PROGRAMMED.		305.
146.0		DACON	DCN SYSD	FAC PRIME	1. BOTH DPS STRINGS INITIALIZED.		306.
147.0	T- 4H20M	DSIF	ALL TC	DSS	1. REPORT STATION STATUS.		307.
							308.
148.0	T- 4H15M	COMM	CC OPC	DSN	1. REPORT COMM STATUS.		309.
							310.
		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		311.
							312.
		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		313.
							314.
		DSIF	NM OPC	DSN	1. REPORT DSIF STATUS.		315.
149.0		DSN	OPC SYSD	FAC PRIME	1. REPORT DSN STATUS.		316.
150.0	T- 4H 8M	PE	SYSD EOPS	ETR	1. REPORT DSN STATUS.		317.
151.0		AO	EOPS SYSD	ETR	1. REPORT AFETR AND MSFN READINESS TO CONDUCT		318.
					DATA FLOW TESTS.		319.
152.0		AO	EOPS TDSM		1. REPORT TDS STATUS.		320.
153.0		PE	SYSD TDS		1. REPORT TDS STATUS.		321.
154.0	T- 4H 5M	COMM	CC OPC	DSN	1. REMAINING COMMUNICATIONS TO AFETR UP AND		322.
					PROGRAMMED.		323.

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
155.0		DSN	OPC SYSD	FAC PRIME	1. ALL AFETR CIRCUITS UP AND PROGRAMMED FOR		324
					YOUR USE.		325
156.0		MON	MC OPC	DSN	1. MONITOR AREA STAFFED AND READY.		326
157.0	T- 4H	DSIF	DSS TC		1. DSS 11, 42, 41, 51, AND 61 TRANSMIT PRETRACK		327
					REPORT BY TTY.		328
158.0	T- 4H	DSIF	TC DSS	DSS	1. START PRETRACK DATA XMISSION TEST WITH DSS 11		329
					DSS 41,42,51,61		330
159.0	T- 4H	MSFN			************** NOTE ****************		331
		ETR			************** DATA FLOW CHECKS ****************		332
		DSIF					333
		SFOF			BETWEEN T-4H AND T-60M DATA FLOW TESTS FROM		334
					MSFN, ETR, AND DSIF STATIONS TO THE SFOF WILL		335
					BE CONDUCTED. THERE IS NO PARTICULAR ORDER		336
					THAT THESE TESTS MUST FOLLOW. THE READINESS		337
					TO SUPPORT EACH OF THE DATA FLOW TESTS WILL		338
					BE COORDINATED AT DSS 71 AND DSS 72 BY THE		339
					RESPECTIVE STATION MANAGERS AND T + DS		340
					TELEMETRY COORDINATORS. SYSAD WILL DIRECT		341
					THE START AND DURATION OF EACH TEST, BASED		342
					ON INFORMATION AND RECOMMENDATIONS FROM THE		343
					T + DS COORDINATORS. SYSAD WILL DIRECT		344
					MULTIPLE ADDRESSING OF DATA TO AO AS REQUIRED		345
					DURING THIS PORTION OF THE COUNT.		346
							347
					1. ASCENSION MSFN TM THRU DSS 72 TO SFOF		348
					AND AO		349
					2. SHIP 1,1/4 SPEED TM PLAYBACK THRU DSS 72		350
					TO SFOF AND AO		351
					3. SHIP 2,1/4 SPEED TM PLAYBACK THRU DSS 72		352
					TO SFOF AND AO		353
					4. ANTIGUA TM VIA 40KC CARRIER THRU DSS 71		354
					TO SFOF AND AO		355
					5. PRETORIA TM THRU DSS 72 TO SFOF AND AO		356
					6. TEL 4 TM THRU DSS 71 TO SFOF AND AO		357
					7. DSS 51 TM AND TK TO SFOF AND AO		358
					8. DSS 42 TM AND TK TO SFOF AND AC		359
					9. DSS 61 TM AND TK TO SFOF AND AC		360
							361
					THE FOLLOWING REPORTS, AS APPROPRIATE, WILL BE		362
					MADE FOR EACH TEST-		363
160.0		PE	SYSD EOPS	ETR	1. DSS TRANSMITTING TO AO		364
161.0		AO	EOPS SYSD	ETR	1. AO RECEIVING TM FROM (SOURCE).		365

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
162.0		MON	MC SYSD	FAC-PRIME	1. SFOF RECEIVING DATA		366
163.0		DACON	DCN SYSD	FAC-PRIME	1. PROCESSING AND OUTPUTTING 100 WPM PROCESSED		367
					DATA		368
164.0		PE	SYSD EOPS	ETR	1. TRANSMITTING PROCESSED TTY		369
165.0		AO	EOPS SYSD	ETR	1. AO RECEIVING PROCESSED TTY		370
166.0		MON	MC SYSD	FAC-PRIME	1. VALIDATE DATA		371
167.0		SYSAD	SYSD PRIM	FAC-PRIME	1. ---DATA FLOW TEST COMPLETED.		372
168.0		MARCHF	PRIM ETR	STATUS	1. ---DATA FLOW TEST COMPLETED.		373
					**		374
169.0	T- 3H50M	DACON	DCN ACE5	VAL-PRIME	1. REPORT DATA PROCESSING SYSTEM READINESS TO		375
					ACE 5.		376
170.0	T- 3H50M	VOPS	VOPS I/O		1. REQUEST T/M OUTPUT FORMATS FROM DPS.		377
171.0	T- 3H40M	S/C			1. S/C COUNTDOWN STARTS.		378
172.0		AO	ETR PRIM	STATUS	1. PRIME/ETR BEGIN STATUS REPORTING.		379
							380
					2. S/C POWER ON AND RF POWER CHECKS.		381
173.0	T- 3H20M	DSIF	71 TC	DSS	1. START XMITTING S/C T/M TO SFOF VIA HSD AND		382
					TTY		383
174.0	T- 3H20M	DSIF	TC SYSD	FAC-PRIME	1. RECEIVING S/C T/M FROM DSS 71		384
							385
175.0		MARCHF	PRIM ETR	STATUS	1. TRANSMIT OPERATION READINESS REPORT TO ETR BY		386
					VOICE.		387
176.0		DACON	DCN ACE5	VAL-PRIME	1. START PROCESSING DSS 71 S/C T/M		388
177.0		AO	ETR PRIM	STATUS	1. TRANSMIT S/C STATUS REPORT TO PRIME 5 BY		389
					VOICE		390
178.0	T- 3H 5M	DACON	DCN ACE5	VAL-PRIME	1. REPORT SFO STATUS TO ACE 5.		391
		SPAC	BC				392
		SSAC	SC				393
		FPAC	FC				394
179.0		MARCHF	PRIM ETR	STATUS	1. REPORT SFO READINESS TO ETR BY VOICE		395
180.0	T- 3H 5M	COMM	LC OPC	DSN	1. ACTIVATE AND PATCH SPECIAL AUDIO CIRCUITS.		396

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
181.0.	T- 2H35M	AO	ETR PRIM.	STATUS	1. START AGENA UDMH 100 PERCENT TANKING.		397.
182.0.	T- 2H30M	MARCHF	MCHF CC.		1. PREPARE AND DELIVER T-2H30M ALERT MESSAGE TO		398.
					COMM FOR TRANSMISSION TO GSFC.		399.
183.0.	T- 2H15M	AO	ETR PRIM.	STATUS	1. AGENA UDMH TANKING COMPLETE.		400.
184.0.	T- 2H15M	COMM	CC ACE5.	FAC-PRIME	1. VERIFY TRANSMISSION OF T-150M ALERT		401.
					MESSAGE TO GSFC.		402.
185.0.	T- 2H 5M	AO	ETR PRIM.	STATUS	1. START TOWER REMOVAL.		403.
186.0.	T- 2H 5M	DACON	DCN ACE5.	VAL-PRIME	1. REPORT SFO STATUS TO ACE 5.		404.
		SPAC	BC				405.
		SSAC	SC				406.
		FPAC	FC				407.
187.0.	T- 2H	MARCHF	PRIM ETR.	STATUS	1. TRANSMIT OPERATIONAL READINESS REPORT TO ETR		408.
					BY VOICE.		409.
188.0.		FPAC	FC ACE5.	VAL-PRIME	1. RUN PREDICT CHECK CASE ON BOTH COMPUTER		410.
					STRINGS (PRDX).		411.
189.0.		DACON	DCN ACE5.	VAL-PRIME	1. REPORT RECEPTION AND PROCESSING OF ETR S/C		412.
					DATA TO ACE 5.		413.
190.0.	T- 2H	AO	ETR PRIM.	STATUS	1. REPORT UPDATE OF NOMINAL MARK EVENTS		414.
					WHEN AVAILABLE.		415.
191.0.	T- 1H45M	DSIF	ALL TC.	DSS	1. ALL STATIONS REPORT STATUS.		416.
							417.
192.0.	T- 1H45M	COMM	CC OPC.	DSN	1. REPORT COMM STATUS.		418.
							419.
		DPS	DC OPC.	DSN	1. REPORT DPS STATUS.		420.
							421.
		SUPT	SC OPC.	DSN	1. REPORT FACILITY STATUS.		422.
							423.
		DSIF	NM OPC.	DSN	1. REPORT DSIF STATUS.		424.
193.0.	T- 1H40M	VOPS	VOPS ACE5.	VAL-PRIME	1. REPORT STATUS OF COMPUTER OUTPUT TO ACE 5 AND		425.
					DACON.		426.
194.0.	T- 1H35M	AO	ETR PRIM.	STATUS	1. TOWER REMOVAL COMPLETE.		427.
195.0.	T- 1H35M	SYSAD	SYSD EOPS.	ETR	1. DSS 51 AND 42 STATIC POINTS HAVE BEEN		428.
					TRANSMITTED TO AO.		429.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
196.0	T- 1H30M	AO	ETR PRIM	STATUS	1. START AGENA IRFNA 10 PERCENT TANKING.		430
							431
					2. REPORT ETR AND MSFN STATUS TO PRIME 5.		432
							433
					3. REPORT THE FOLLOWING S/C FREQUENCIES AND		434
					TEMPERATURES TO PRIME.		435
					A. BAY V TEMPERATURE.........DN (CH404)		436
							437
					B. BAY VI TEMPERATURE.........DN (CH405)		438
							439
					C. VCO TEMPERATURE.........DN		440
							441
					D. AUXILIARY OSCILATOR		442
							443
					NO. 1 TEMPERATURE.........DN		444
							445
					E. AUXILIARY OSCILATOR		446
							447
					NO. 2 TEMPERATURE.........DN		448
							449
					F. TRANSPONDER CARRIER FREQUENCY		450
					ON AUXILIARY OSCILIARY DRIVE		451
							452
					G. GROUND TRANSMITTER FREQUENCY		453
							454
					H. TRANSPONDER FREQUENCY		455
							456
					4. REPORT S/C STATUS TO PRIME 5.		457
							458
					5. TRANSMIT STATIC POINTS TO SFOF.		459
197.0		MARCHF	PRIM ETR	STATUS	1. REPORT SFO STATUS TO ETR BY VOICE.		460
198.0	T- 1H30M	AO	ETR 71		1. TRANSMIT T-1H15M TRANSPONDER FREQ AND		461
					TEMP REPORTS BY VOICE.		462
199.0		AO	ETR PRIM	STATUS	1. START AGENA 100 PERCENT IRFNA TANKING		463
200.0	T- 1H30M	COMM	CC OPC	DSN	1. START BACKFEEDING MISSION COMMENTARY PER		464
					COMM PLAN.		465
							466
					2. ADD SECOND COMM OPERATOR TO TRACK.		467
201.0	T- 1H15M	DSIF	71 TC	DSS	1. TRANSMIT T-1H15M FREQUENCY AND TEMPERATURE		468
					REPORTS BY VOICE AND TTY.		469

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE.
202.0.	T- 1H 5M	DACON	DCN ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		470.
		SPAC	BC				471.
		SSAC	SC				472.
		FPAC	FC				473.
203.0.	T- 1H 5M	DSIF	ALL TC.	DSS	1. REPORT STATION STATUS.		474.
							475.
204.0.		COMM	CC OPC.	DSN	1. REPORT COMM STATUS.		476.
205.0.		DPS	DC OPC.	DSN	1. REPORT DPS STATUS.		477.
206.0.	T- 1H 5M	DSIF	NM OPC.	DSN	1. REPORT DSIF STATUS.		478.
							479.
207.0.		SUPT	SC OPC.	DSN	1. REPORT FACILITY STATUS.		480.
208.0.		DSN	OPC SYSD.	FAC-PRIME	1. REPORT DSN STATUS		481.
209.0.	T- 1H 5M	AO	ETR PRIM.	STATUS	1. COMPLETE AGENA IRFNA TANKING		482.
210.0.	T- 1H 3M	PE	SYSD EOPS.	ETR	1. REPORT DSN STATUS.		483.
211.0.		AO	EOPS SYSD.	ETR	1. REPORT AFETR AND MSFN STATUS.		484.
212.0.		FPAC	FC EOPS.		1. TRANSMIT DSN ACQUISITION CONSTANTS TO AO		485.
					FOR RETRANSMISSION TO RTCS.		486.
213.0.		AO	EOPS TDSM.		1. REPORT TDS STATUS.		487.
214.0.		PL	SYSD TDS.	FAC PRIME	1. REPORT TDS STATUS.		488.
215.0.		PF	SYSD ACE5.	FAC-PRIME	1. TDS DATA FLOW CHECK COMPLETE		489.
							490.
					2. TDS IS GO/NO GO		491.
216.0.		MARCHF	PRIM ETR.	STATUS	1. REPORT SFO READINESS TO ETR BY VOICE		492.
							493.
217.0.	T- 60M				------------START 50 MIN BUILT IN HOLD------------		494.
							495.
							496.
					------------END 50 MIN BUILT IN HOLD------------		497.
							498.
218.0.	T- 60M	PC	SYSD CC.	FAC PRIME	1. BRIDGE BETWEEN ETR AND FPAC-RTCC2 NETS		499.
					BROKEN AT THIS TIME		500.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
219.0	T- 1H	SPAC	BC ACE5	VAL-PRIME	1. ALL SPAC STATIONS MANNED.		501
							502
					2. START EVALUATION OF S/C T/M RECEIVED FROM		503
					T- 200M TO PRESENT		504
220.0		MARCHF	MCHF CC		1. PREPARE AND DELIVER T- 60M ALERT MESSAGE TO		505
					COMM FOR TRANSMISSION TO GSFC		506
221.0	T- 1H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		507
		DACUN	DCN				508
		SPAC	SC				509
		SSAC	SC				510
		FPAC	FC				511
							512
222.0	T- 60M	AO	ETR PRIM	STATUS	1. TRANSMIT S/C TEMPERATURES TO PRIME 5		513
							514
					A. BAY V TEMPERATURE.........DN (CH404)		515
							516
					B. BAY VI TEMPERATURE.........DN (CH405)		517
							518
					C. VCO TEMPERATURE.........DN		519
							520
					D. AUXILIARY OSCILATOR		521
							522
					NO. 1 TEMPERATURE.........DN		523
							524
					E. AUXILIARY OSCILATOR		525
							526
					NO. 2 TEMPFRATURE.........DN		527
							528
					F. TRANSPONDER CARRIER FREQUENCY		529
					ON AUXILIARY OSCILIARY DRIVE		530
							531
					G. GROUND TRANSMITTER FREQUENCY		532
							533
					H. TRANSPONDFR FREQUENCY		534
223.0	T- 60M	AO	ETR 71		1. TRANSMIT T-45M TRANSPONDER FREQ AND		535
					TEMP REPORTS BY VOICE.		536
224.0	T- 60M	DSIF	ALL TC	DSS	1. REPORT STATION STATUS.		537
							538
225.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		539
226.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		540

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
227.0	T- 60M	DSIF	NM OPC	DSN	1. REPORT DSIF STATUS.		541
							542
228.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		543
229.0	T- 57M	DSN	OPC PRIM	FAC-PRIME	1. REPORT DSN STATUS		544
230.0		AO	ETR PRIM	STATUS	1. REPORT OPERATIONAL READINESS TO PRIME 5 BY		545
					VOICE		546
231.0	T- 55M	MARCHF	PRIM ETR	STATUS	1. REPORT SFO READINESS TO ETR BY VOICE.		547
232.0	T- 55M	AO	EOPS TDSM		1. REPORT TDS STATUS.		548
233.0		PE	SYSD TDS		1. REPORT TDS STATUS.		549
234.0	T- 45M	DSIF	42		1. TRANSMIT PRETRACK REPORT TO SFOF BY TTY.		550
			51				551
			72				552
							553
235.0	T- 45M	DSIF	71 TC	DSS	1. TRANSMIT T-45M FREQUENCY REPORT BY VOICE		554
					AND TTY.		555
236.0	T- 40M	AO	ETR PRIM	STATUS	1. START ATLAS LOX TANKING		556
237.0	T- 40M	COMM	CC ACE5	FAC-PRIME	1. VERIFY TRANSMISSION OF ALERT MESSAGE TO GSFC		557
238.0		FPAC	FC ACE5	VAL-PRIME	1. RUN POWM BASED ON EXPECTED LIFTOFF TIME.		558
239.0	T- 30M	FPAC	FC ETRC		1. VERIFY OR UPDATE DSN ACQUISITION CONSTANTS.		559
240.0		COMM	CC OPC	DSN	1. PATCH PA SPEAKERS TO STATUS NET AS CALLED		560
					OUT IN THE COMM PLAN.		561
241.0	T- 30M	DSIF	ALL TC	DSS	1. REPORT STATION STATUS.		562
							563
242.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		564
243.0		OPS	DC OPC	DSN	1. REPORT OPS STATUS.		565
244.0	T- 30M	DSIF	NM OPC	DSN	1. REPORT DSIF STATUS.		566
							567
245.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		568

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
246.0.	T- 30M	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFC STATUS TO ACE 5.		569.
		DACON	DCN				570.
		SPAC	BC				571.
		SSAC	SC				572.
		FPAC	FC				573.
		..					574.
247.0.	T- 28M	DSN	OPC PRIM.	FAC-PRIME	1. REPORT DSN STATUS.		575.
248.0.		MARCHF	PRIM ETR.	STATUS	1. REPORT SFO STATUS TO ETR BY VOICE		576.
249.0.		AO	ETR PRIM.	STATUS	1. REPORT S/C,AFETR,MSFN STATUS TO PRIME 5 BY		577.
					VOICE		578.
250.0.	T- 27M	AO	EOPS TDSM.		1. REPORT TDS STATUS.		579.
251.0.		PE	SYSU TDS.		1. REPORT TDS STATUS.		580.
252.0.	T- 25M	MARCHF	MCHF CC.		1. DELIVER T-30M FREQUENCY MESSAGE TO COMM FOR		581.
					TRANSMISSION TO GSFC		582.
253.0.		DPS			1. COMPUTE STATION AGC.		583.
254.0.	T- 25M	FPAC	FC ACE5.	VAL-PRIME	1. GENERATE PREDICTS BASED ON EXPECTED LAUNCH UP		584.
		..			TO L+ 4H (BOTH COMPUTER STRINGS)(PROX) FOR		585.
					DSS 72, 51, 42, AND 41		586.
255.0.	T- 20M	AO	ETR PRIM.	STATUS	1. REPORT STATUS OF S/C,AFETR,AND MSFN TO		587.
					PRIME 5 BY VOICE		588.
256.0.	T- 15M	AO	ETR PRIM.	STATUS	1. VERIFY NUMBER OF ENCOUNTER UPDATE PULSES TO		589.
					BE INSERTED AT L-7 MIN.		590.
257.0.		COMM	CC ACE5.	FAC-PRIME	1. VERIFY TRANSMISSION OF FREQUENCY MESSAGE TO		591.
					GSFC		592.
258.0.	T- 15M	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		593.
		DACON	DCN				594.
		SPAC	BC				595.
		SSAC	SC				596.
		FPAC	FC				597.
		..					598.
259.0.	T- 12M	DACON	DCN ACE5.	VAL PRIME	1. PROCESSED TM DATA IS BEING TRANSMITTED TO		599.
					AO ETR.		600.
260.0.		AO	ETR PRIM.	STATUS	1. RAW AND PROCESSED DATA BEING RECEIVED BY AO		601.

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
261.0	T- 12M	DSIF	ALL TC	DSS	1. REPORT STATION STATUS.		602
							603
262.0		COMM	CC OPC	DSN	1. REPORT COMM STATUS.		604
263.0		DPS	DC OPC	DSN	1. REPORT DPS STATUS.		605
264.0	T- 12M	DSIF	NM OPC	DSN	1. REPORT DSIF STATUS.		606
							607
265.0		SUPT	SC OPC	DSN	1. REPORT FACILITY STATUS.		608
266.0		DSN	OPC PRIM	FAC-PRIME	1. REPORT DSN STATUS.		609
267.0		AO	ETR PRIM	STATUS	1. REPORT AFETR AND MSFN STATUS.		610
268.0		AO	EOPS TDSM		1. REPORT TDS STATUS.		611
269.0		PE	SYSD TDS		1. REPORT TDS STATUS.		612
270.0	T- 10M	MARCHF	PRIM ETR	STATUS	1. REPORT SFO STATUS TO ETR BY VOICE		613
271.0	T- 10M	AO	EOPS FC	FPAC/RTCC	1. GIVE VERBAL SHIP POSITION REPORT.		614
272.0		AO	ETR PRIM	STATUS	1. ANNOUNCE SECOND PLANNED HOLD UP TO 10 MIN.		615
							616
					------------UP TO 10 MIN HOLD AT T-7M------------		617
							618
273.0	T- 7M	AO	ETR PRIM	STATUS	-----------------DURING HOLD-----------------		619
							620
					1. ANNOUNCE GMT OF L-7 MIN ....H ....M ....S		621
							622
					2. ANNOUNCE LAUNCH PLAN.		623
							624
					3. VERIFY NUMBER OF ENCOUNTER UPDATE PULSES		625
					TO BE INSERTED AT T-7 IF A RECYCLE HAS		626
					OCCURED.		627
							628
					------------END 10 MIN BUILT IN HOLD------------		629
274.0	T- 7M	S/C			1. SWITCH TO INTERNAL POWER		630
							631
					2. INSERT ENCOUNTER UPDATE PULSES		632

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
275.0	T- 7M	AO	ETR PRIM.	STATUS	1. REPORT GMT OF SWITCH AND NUMBER OF UPDATE		633.
					PULSES WHEN AVAILABLE.		634.
							635.
					2. REPORT ANY SIGNIFICANT CHANGE OF S/C		636.
					FREQUENCY AND TEMPERATURE.		637.
276.0	T- 7M	AO	ETR 71.		1. TRANSMIT T-5M TRANSPONDER FREQ AND TEMP		638.
					REPORTS BY VOICE.		639.
277.0		COMM	CC OPC.	DSN	1. ACTIVATE COMMERCIAL BACKUP CIRCUITS TO ETR.		640.
278.0	T- 6M	DSN	OPC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE5.		641.
		DSIF	TC				642.
		DACON	DCN				643.
		SPAC	BC				644.
		SSAC	SC				645.
		FPAC	FC				646.
							647.
279.0		AO	ETR PRIM.	STATUS	1. REPORT S/C STATUS TO PRIME 5 BY VOICE		648.
280.0	T- 5M	S/C			1. RELEASE LCE RELAY HOLD		649.
281.0	T- 5M	AO	ETR PRIM.	STATUS	1. REPORT GMT OF RELEASE LCE RELAY HOLD		650.
					WHEN AVAILABLE.		651.
282.0	T- 5M	DSIF	71 TC.	DSS	1. TRANSMIT T-5M FREQUENCY REPORT BY VOICE		652.
					AND TTY.		653.
283.0	T- 4M	S/C			1. TURN TAPE RECORDER LAUNCH MODE ON.		654.
284.0	T- 4M	AO	ETR PRIM.	STATUS	1. REPORT TAPE RECORDER LAUNCH MODE ON GMT		655.
					TIME WHEN AVAILABLE.		656.
							657.
					....H ....M ....S		658.
285.0	T- 3M	S/C			1. RELEASE CC+S REAL TIME INHIBIT.		659.
286.0	T- 3M	AO	ETR PRIM.	STATUS	1. REPORT GMT OF CC+S REAL TIME INHIBIT		660.
					RELEASE WHEN AVAILABLE.		661.
287.0	T- 1M	S/C		STATUS	1. CLEAR RELAY RELEASE		662.
288.0	T- 1M	AO	ETR PRIM.	STATUS	1. REPORT GMT OF CLEAR RELAY RELEASE		663.
					WHEN AVAILABLE.		664.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
289.0		AO	ETR PRIM	STATUS	--------------------LIFTOFF--------------------		665
							666
					T = L		667
							668
							669
					1. REPORT GMT OF LIFTOFF AND LAUNCH AZIMUTH.		670
							671
					LIFTOFF ....H ....M ....S		672
					2. REPORT CH 115 AND CH 116 LAST READING TO		673
					PRIME 5 BY VOICE		674
							675
					3. TRANSMIT RAW TTY TRACKING DATA ON LINE A AND		676
					COMPUTED DATA ON LINE B		677
290.0		MARCHF	MCHF CC		1. PREPARE AND DELIVER LIFTOFF MESSAGE TO COMM		678
					FOR TRANSMISSION TO GSFC		679
291.0		DSIF	TC ALL	DSS	1. XMIT LIFTOFF MSG		680
							681
292.0					***		682
					NOTE--PLUS TIMES GIVEN AS L+ ARE NOMINAL		683
					BASED ON A LAUNCH AZIMUTH OF 96 DEG ON		684
					DAY 163.		685
					***		686
293.0	L+ 1M	FPAC	FC ACE5	VAL-PRIME	1. POWM/PRDX RUN PREDICTS BASED ON ACTUAL LAUNCH		687
					TIME UP TO L+ 4H (BOTH COMPUTER STRINGS)		688
					IF REQUIRED		689
294.0	L+ 2M 9S	AO	ETR PRIM	STATUS	--------------------MARK 1--------------------		690
							691
					1. REPORT BOOSTER CUTOFF AND TIME IN GMT TO		692
					PRIME 5 BY VOICE		693
							694
					MARK 1 ....S		695
295.0	L+ 2M11S	AO	ETR PRIM	STATUS	--------------------MARK 2--------------------		696
							697
					1. REPORT BOOSTER JETTISON AND TIME TO PRIME 5		698
							699
					MARK 2 ....S		700
296.0	L+ 3M	FPAC	FC ACE5	VAL-PRIME	1. VERIFY PREDICTS AND SET NO.'S FOR DSS 72,51,		701
					42,41,61		702
297.0	L+ 3M	FPAC	TDA FC	FPAC-3	1. RUN PREDICTS BASED ON ACTUAL LAUNCH TIME.		703
							704
					2. TRANSMIT PREDICTS TO DSS IF REQUIRED.		705

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
298.0	L+ 4M	AO			1. AO TRANSMIT LIFTOFF MESSAGE TO JPL.		706
299.0		AO	ETR PRIM.	STATUS	1. BERMUDA AOS-DATA DESIG 84 (TPQ-6), DATA		707
					DESIG 82 (FPS-16).		708
300.0	L+ 4M 5S	AO	ETR PRIM.	STATUS	-------------MARK 3 AT L+ 4M 05.1S-------------		709
							710
					1. REPORT START OF AGENA AUX. TIME		711
							712
					MARK 3 ....S		713
301.0	L+ 4M50S	AO	ETR PRIM.	STATUS	-------------MARK 4 AT L+ 4M 50.7S-------------		714
							715
					1. REPORT SUSTAINER CUTOFF TO PRIME 5 BY VOICE		716
							717
					MARK 4 ....S		718
302.0	L+ 4M54S	AO	ETR PRIM.	STATUS	-------------MARK 5 AT L+ 4M 54.7S-------------		719
							720
					1. REPORT START OF AGENA STANDARD TIMER		721
							722
					MARK 5 ....S		723
303.0	L+ 5M	MARCHF	ACE5 DCN.	VAL-PRIME	1. TRANSMIT PREDICTS TO DSS 41, DSS 42 and DSS 51		724
304.0	L+ 5M10S	AO	ETR PRIM.	STATUS	-------------MAPK 6 AT L+ 5M 10.3S-------------		725
							726
					1. REPORT VERNIER CUTOFF TO PRIME 5 BY VOICE		727
							728
					MARK 6 ....S		729
305.0	L+ 5M12S	AO	ETR PRIM.	STATUS	-------------MARK 7 AT L+ 5M 12.8S-------------		730
							731
					1. REPORT SHROUD EJECTION TO PRIME 5 BY VOICE		732
							733
					MARK 7 ....S		734
306.0		AO	ETR PRIM.	STATUS	1. REPORT STATION AGC INCREASE IN VALUE TO		735
					PRIME 5		736
307.0	L+ 5M17S	AO	ETR PRIM.	STATUS	-------------MAPK 8 AT L+ 5M 17.3S-------------		737
							738
					1. REPORT ATLAS AGENA SEPARATION TO PRIME 5 BY		739
					VOICE		740
							741
					MARK 8 ....S		742
308.0	L+ 5M25S	IPP	RTCC FC.	FPAC-RTCC2	1. COMPLETE REAL TIME RANGE SAFETY IMPACT		743
					PREDICTION		744

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
309.0.		FPAC	FC BC.	VAL-PRIME	1. REPORT PREDICTED TIME OF EXIT SHADOW TO BUSS		745.
					CHIEF		746.
310.0.		AO	ETR PRIM.	STATUS	1. AOS ANTIGUA-DATA DESIG 74		747.
311.0.	L+ 6M 9S	AO	ETR PRIM.	STATUS	------------MARK 9 AT L+ 6M 09.0S------------		748.
							749.
					1. REPORT FIRST AGENA IGNITION TO PRIME 5 BY		750.
					VOICE		751.
							752.
					MARK 9 ....S		753.
312.0.		AO	ETR PRIM.	STATUS	1. TEL 4 LOS.		754.
313.0.	L+ 8M30S	DSIF	71 TC.	DSS	1. DSS 71 LOS.		755.
							756.
					2. SWITCH TO ANTIGUA S/C TM SOURCE.		757.
314.0.	L+ 8M30S	DSIF	TC ACE5.	FAC-PRIME	1. DSS 71 LOS.		758.
							759.
315.0.		MARCHF	PRIM ETR.	STATUS	1. DSS 71 LOS.		760.
316.0.		AO	ETR PRIM.	STATUS	1. GRAND TURK AOS.		761.
317.0.	L+ 8M30S	DSIF	71 TC.	DSS	1. ANTIGUA TM BEING PROCESSED AND TRANSMITTED		762.
					TO SFOF AND AO.		763.
318.0.	L+ 8M30S	DSIF	TC ACE5.	FAC-PRIME	1. TRANSMITTING ANTIGUA DATA.		764.
							765.
319.0.		MON	MC SYSD.	ETR	1. RECEIVING ANTIGUA DATA.		766.
							767.
					2. VALIDATE ANTIGUA DATA.		768.
320.0.	L+ 8M33S	S/C			1. PARKING ORBIT INJECTION.		769.
321.0.		AO	ETR PRIM.	STATUS	1. BERMUDA LOS.		770.
322.0.	L+ 8M39S	AO	ETR PRIM.	STATUS	------------MARK 10 AT L+ 8M 39.7S------------		771.
							772.
					1. REPORT FIRST AGENA CUTOFF TO PRIME 5 BY VOICE.		773.
							774.
					MARK 10 ....S		775.
323.0.	L+ 8M39S	DSIF	TC ACE5.	FAC-PRIME	1. REPORT COMPLETION OF TRANSMISSION OF PREDICTS		776.
					TO DSS 41, DSS 42 and DSS 51		777.

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
324.0	L+ 10M	CONM	CC ACE5	FAC-PRIME	1. VERIFY TRANSMISSION OF LIFTOFF MESSAGE TO		778.
					GSFC		779.
325.0		AO	ETR PRIM	STATUS	1. REPORT ESTIMATED TIME OF S/C AGENA		780.
					SEPARATION		781.
326.0	L+ 10M	MARCHF	MCHF CC		1. PREPARE AND DELIVER POST LAUNCH MESSAGE TO		782.
					COMM FOR TRANSMISSION TO GSFC.		783.
327.0		AO	ETR PRIM	STATUS	1. GRAND TURK LOS.		784.
328.0	L+ 13M	AO	ETR PRIM	STATUS	1. TRANSMIT ELEMENTS AND INJECTION CONDITIONS		785.
					OF PARKING ORBIT TO SFOF		786.
329.0	L+ 14M	AO	ETR PRIM	STATUS	1. TRANSMIT ETR IRV AND PREDICTS BASED ON		787.
					P.O. DATA TO SFOF, DSS 41, DSS 42 and DSS 51		788.
330.0		DACON	DCN ACE5	VAL-PRIME	1. TURN ON ODPM (BACKUP STRING)		789.
331.0		AO	ETR PRIM	STATUS	1. ANTIGUA LOS.		790.
332.0	L+ 15M	FPAC	FC ACE5	VAL-PRIME	1. RUN PRDX BASE ON ETR P.O. INJECTION CONDITION		791.
					IF REQUIRED (PRIME COMPUTER STRING).		792.
333.0	L+ 17M24S	AO	ETR PRIM	STATUS	-------------------MARK 11-------------------		793.
	L+ 33M30S				---------VARIABLE (L+17.4M TO L+33.5M)---------		794.
							795.
					1. REPORT SECOND AGENA IGNITION TO PRIME 5 BY		796.
					VOICE		797.
							798.
					MARK 11 ....S		799.
334.0	L+ 19M	AO	ETR PRIM	STATUS	1. TRANSMIT INJECTION CONDITIONS OF TRANSFER		800.
					ORBIT FROM ACTUAL PARKING ORBIT AND NOMINAL		801.
					SECOND BURN TO SFOF.		802.
							803.
					2. TRANSMIT TARGET PARAMETERS BASED ON NOMINAL		804.
					SECOND BURN IF TIME PERMITS.		805.
335.0		FPAC	FC RTCC	FPAC-RTCC	1. VOICE CHECK EARTH SPHERICALS OF INJECTION		806.
					BASED ON NOMINAL SECOND BURN		807.
336.0	L+ 19M 6S	AO	ETR PRIM	STATUS	-------------------MARK 12-------------------		808.
	L+ 35M				---------------MARK 11 + 1M 36S---------------		809.
							810.
					1. REPORT SECOND AGENA CUTOFF TO PRIME 5 BY		811.
					VOICE		812.
							813.
					MARK 12 ....S		814.

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
337.0.	L+ 20M	FPAC	FC ACE5.	VAL-PRIME	1. PROCESS ETR RAW P.O. DATA AND GENERATE		815.
					PREDICTS IF REQUIRED TDPX/ODGX/ODPM/PRDX		816.
					(BACKUP COMPUTER STRING)		817.
338.0.	L+ 20M	COMM	CC OPC.	DSN	1. DEACTIVATE COMMERCIAL CIRCUITS TO ETR.		818.
339.0.	L+ 20M	DACON	DCN ACE5.	VAL-PRIME	1. SWITCH TO PROCESSING DSS 72 DATA.		819.
340.0.	L+ 21M	AO	ETR PRIM.	STATUS	1. ASCENSION AOS-DATA DESIG 75 (FPS-16), DATA		820.
					DESIG 79 (TPQ-18).		821.
341.0.	L+ 21M	DSIF	72 TC.	DSS	1. DSS 72 AOS.		822.
							823.
					2. DEMODULATE AND TRANSMIT TM AND TK TO SFOF		824.
					AND AO.		825.
							826.
					3. DEMODULATE AND TRANSMIT ASCENSION MSFN TM		827.
					ONLY IN CASE OF LOS.		828.
342.0.	L+ 21M	DSIF	TC ACE5.	FAC-PRIME	1. DSS 72 AOS		829.
							830.
343.0.		MARCHF	PRIM ETR.	STATUS	1. DSS 72 AOS		831.
344.0.		MON	MC SYSD.	ETR	1. RECEIVING DSS 72 DATA.		832.
							833.
					2. VALIDATE DSS 72 DATA.		834.
345.0.	L+ 21M35S	AO	ETR PRIM.	STATUS	-------------------MARK 13-------------------		835.
	L+ 37M41S				---------------MARK 11 + 4M 10.7S---------------		836.
							837.
					1. REPORT SPACECRAFT AGENA SEPARATION		838.
							839.
					MARK 13 ....S		840.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
346.0.	I+ 2M36S	S/C			1. RF POWER UP.		841.
							842.
					2. CRUISE SCIENCE ON.		843.
							844.
					3. CC+S RELAY HOLD OFF.		845.
							846.
					4. END TAPE RECORDER LAUNCH MODE.		847.
							848.
					5. ARM PYROTECHNICS.		849.
							850.
					6. REMOVE PLASMA 10KV INHIBIT.		851.
							852.
					7. AGENA ISOLATION AMPLIFIER TURNED OFF.		853.
							854.
					8. TURN ON A/C SUBSYSTEM.		855.
							856.
					9. SEPERATION INITIATED TIMER ACTIVATED.		857.
					A. ARM PYROTECHNICS.		858.
					B. PYRO ARMED INDICATION.		859.
					C. DEPLOY SOLAR PANELS AND SUNSHADE.		860.
347.0.		AO	ETR PRIM.	STATUS	1. REPORT PAYLOAD INTERFACE CONNECTOR SEPERATION.		861.
					TO PRIME 5.		862.
348.0.	I+ 3M	S/C			1. UNFOLD SOLAR PANELS.		863.
349.0.	L+ 21M 1S	AO	ETR PRIM.		--------------------MARK 14--------------------		864.
					----------------MARK 11 + 4M 13.7S------------		865.
							866.
					1. REPORT START OF AGENA YAW MANEUVER.		867.
							868.
					MARK 14 ....S		869.
350.0.	L+ 24M31S	AO	ETR PRIM.	STATUS	1. SHIP 1 AOS.		870.
351.0.	L+ 25M	AO	ETR PRIM.	STATUS	1. ASCENSION LOS		871.
352.0.	L+ 25M	DSIF	72 TC.	DSS	1. DSS 72 LOS.		872.
							873.
353.0.	L+ 25M	DSIF	TC ACES.	FAC PRIME	1. DSS 72 LOS.		874.
							875.
354.0.		MARCHF	PRIM ETR.	STATUS	1. DSS 72 LOS.		876.
355.0.	L+ 27M	AO	ETR PRIM.	STATUS	1. PRETORIA AOS-DATA DESIG 76.		877.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
356.0.	L+ 27M	DSIF	51 TC.	DSS	1. DSS 51 AOS.		878.
							879.
					2. DEMODULATE AND TRANSMIT TM AND TK TO SFOF		880.
357.0.	L+ 27M	DSIF	TC ACE5.	FAC PRIME	1. DSS 51 AOS		881.
							882.
358.0.		MARCHF	PRIM ETR.	STATUS	1. DSS 51 AOS.		883.
359.0.		MON	MC SYSD.	ETR	1. RECEIVING DSS 51 DATA.		884.
							885.
					2. VALIDATE DSS 51 DATA.		886.
360.0.	L+ 30M30S	AO	ETR PRIM.	STATUS	1. PRETORIA LOS.		887.
							888.
					2. SHIP 1 LOS.		889.
361.0.	L+ 30M30S	DSIF			1. S/C SEPERATION + 5M--RIS1, RIS2, AND STATION		890.
					13 WILL STOP RECORDERS USED FOR NEAR-REAL		891.
					TIME TRANSMISSION AND REWIND TO START POINT.		892.
					PLAYBACK AT 1/4 SPEED AS PER ARRANGEMENTS		893.
					WITH DSS 72 TM COORDINATOR.		894.
362.0.	L+ 30M30S	DSIF	72 TC.	DSS	1. START 1/4 SPEED PLAYBACK		895.
							896.
363.0.	L+ 30M30S	DSIF	TC ACE5.	FAC-PRIME	1. START 1/4 SPEED PLAYBACK FROM DSS 72		897.
							898.
364.0.		MARCHF	PRIM ETR.	STATUS	1. DSS 72 1/4 SPEED PLAYBACK STARTED		899.
365.0.		AO	ETR PRIM.	STATUS	1. TANANARIVE AOS.		900.
366.0.	L+ 33M	MSFN			1. TANANARIVE START TRANSMISSION OF VELOCITY		901.
					METER AND CHAMBER PRESSURE DATA TO AE AND E.		902.
367.0.	L+ 37M23S	AO	ETR PRIM.	STATUS	--------------------MARK 15--------------------		903.
					---------------MARK 11 + 5M 13.7S------------		904.
							905.
					1. REPORT END OF AGENA YAW MANEUVER.		906.
							907.
					MARK 15 ....S		908.
368.0.	L+ 40M	AO	ETR PRIM.	STATUS	1. CARNARVON AOS-DATA DESIG 83.		909.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
369.0.	L+ 42M10S	AO	ETR PRIM.	STATUS	----------------------MARK 16----------------------		910.
					------------------MARK 11 + 9M 10.7S-------------		911.
							912.
					1. REPORT AGENA POSIGRADE IGNITION TC PRIME 5		913.
					BY VOICE.		914.
							915.
					MARK 16 ....S		916.
370.0.	I+ 10M	AO	ETR PRIM.	STATUS	1. TRANSMIT ELEMENTS AND INJECTION CONDITION		917.
					OF ACTUAL TRANSFER ORBIT TO SFOF (DSS 51 AND		918.
					DSS 42.		919.
							920.
					2. TRANSMIT DSS 42 AND 51 PREDICTIONS AND IRV		921.
					TO SFOF AND DSS.		922.
371.0.	I+ 15M	AO	ETR FC.	FPAC-RTCC2	1. VOICE CHECK EARTH FIXED SPHERICALS OF		923.
					TRANSFER ORBIT.		924.
372.0.	I+ 17M	FPAC	FC ACE5.	VAL-PRIME	1. MAP TO TARGET AND BE PREPARED TO GENERATE		925.
					PREDICTS BASED ON ETR TRANSFER ORBIT		926.
					INJECTION CONDITIONS UP TO L+ 4H (PRIME		927.
					COMPUTER STRING).		928.
373.0.	I+ 20M	FPAC	FC ACE5.	VAL-PRIME	1. PROCESS ETR RAW DATA, FIRST PORTION OF		929.
					DSS 51 DATA, AND IF REQUIRED GENERATE		930.
					PREDICTS (BACKUP COMPUTER STRING).		931.
374.0.	L+ 51M	DSIF	42 TC.	DSS	1. DSS 42 AOS.		932.
							933.
					2. DEMODULATE AND TRANSMIT TM AND TK TO SFOF		934.
375.0.	L+ 51M	DSIF	TC ACE5.	FAC PRIME	1. DSS 42 AOS		935.
							936.
376.0.		MON	MC SYSD.	ETR	1. RECEIVING DSS 42 DATA.		937.
							938.
					2. VALIDATE DSS 42 DATA.		939.
377.0.	L+ 53M	S/C			1. DEPLOY SOLAR PANELS (CC+S L-1 BACKUP TO		940.
					SEPERATION INITIATED TIMER).		941.
378.0.	L+ 55M	AO			1. RETRANSMIT DSS 42 TK TO RTCS.		942.
379.0.	L+ 57M	S/C			1. TURN ON ATTITUDE CONTROL SYSTEM (CC+S L-2		943.
					BACKUP TO THE PYROTECHNIC ARMING SWITCH).		944.
380.0.	L+ 57M	S/C			1. SUN ACQUISITION COMPLETE.		945.
	L+ 77M						946.
					2. BEGIN MAGNETOMETER, CALIBRATE ROLL RATE.		947.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
381.0.	L+ 1H	MARCHF.	ACE5 CM.	FAC-PRIME	1. TERMINATE MAC NET TO AO AND REPLACE WITH		948.
					SPACE NET (LISTEN ONLY).		949.
382.0.	I+ 40M	FPAC	FC ACE5.	VAL-PRIME	1. PROCESS DSS 51 DATA AND GENERATE PREDICTS		950.
					UP TO L+ 6H (PRIME STRING)		951.
					TDPX/ODGX/ODPM/PRDX		952.
383.0.		AO	ETR PRIM.	STATUS	1. TRANSMIT COPY OF GMT MARK TIMES TC SFOF		953.
					BY FAX		954.
384.0.	L+ 2H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		955.
		DACON	DCN				956.
		SPAC	BC				957.
		SSAC	SC				958.
		FPAC	FC				959.
		..					960.
385.0.		FPAC	FC ACE5.	VAL-PRIME	1. FINISH FIRST ORBIT (ODPM).		961.
							962.
					2. TURN ON TJIM.		963.
							964.
					3. REPORT RESULTS OF FIRST ORBIT TO ACE 5.		965.
386.0.		AO	ETR PRIM.	STATUS	1. TRANSMIT ORBIT BASED ON DSS DATA TO SFOF.		966.
387.0.	L+ 2H 5M	FPAC	FC ACE5.	VAL-PRIME	1. VERIFY PREDICTS AND SET NUMBERS FOR DSS.		967.
388.0.	L+ 2H 7M	MARCHF.	ACE5 DCN.	VAL-PRIME	1. TRANSMIT PREDICTS TO DSS 51, DSS 61, DSS 42,		968.
		..			AND DSS 41		969.
389.0.	L+ 3H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		970.
		DACON	DCN				971.
		SPAC	BC				972.
		SSAC	SC				973.
		FPAC	FC				974.
		..					975.
390.0.		FPAC	FC ACE5.	VAL-PRIME	1. PROCESS DSS 51 AND DSS 42 DATA AND GENERATE		976.
					PREDICTS UP TO L+ 16H (PRIME STRING).		977.
							978.
					2. PROCESS ETR DSS 51 AND DSS 42 DATA (UP TO		979.
					S/C SEPERATION) AND GENERATE PREDICTS UP TO		980.
					L+ 16H (BACKUP COMPUTER STRING).		981.
391.0.	L+ 3H45M	DSIF	61 TC.	DSS	1. XMIT VERBAL PRETRACK REPORT		982.
		..					983.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
392.0.	L+ 3H50M	MARCHF	MCHF CC.		1. PREPARE AND DELIVER ORBITAL PARAMETERS		984.
					MESSAGE TO COMM FOR TRANSMISSION TO GSFC		985.
					FOR MISSION CONTROL.		986.
393.0.	L+ 4H	VOPS			1. RUN AGCM.		987.
394.0.	L+ 4H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		988.
		DACON	DCN				989.
		SPAC	BC				990.
		SSAC	SC				991.
		FPAC	FC				992.
		..					993.
395.0.		DACON			1. TRANSMIT PREDICTS TO DSS.(UPON APPROVAL)		994.
396.0.		FPAC	FC ACE5.	VAL-PRIME	1. RUN TJIM.		995.
397.0.		COMM	CC ACE5.	FAC PRIME	1. VERIFY TRANSMISSION OF ORBITAL PARAMETERS		996.
					MESSAGE TO GSFC.		997.
398.0.	L+ 4H57M	DSIF	61 TC.	DSS	1. DSS 61 AOS.		998.
		..					999.
					2. TRANSMIT TRACKING AND T/M DATA TO SFOF.		1000.
399.0.			TC ACE5.	FAC PRIME	1. REPORT 61 AOS		1001.
400.0.	L+ 5H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1002.
		DACON	DCN				1003.
		SPAC	BC				1004.
		SSAC	SC				1005.
		FPAC	FC				1006.
		..					1007.
401.0.		VOPS			1. TURN ON ATT. REF.		1008.
							1009.
					2. TURN ON SIPM.		1010.
402.0.	L+ 5H56M	DSIF	42 TC.	DSS	1. DSS 42 LOS.		1011.
		..					1012.
403.0.	L+ 5H56M	DSIF	TC ACE5.	FAC-PRIME	1. REPORT 42 LOS		1013.
		..					1014.
404.0.	L+ 6H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1015.
		DACON	DCN				1016.
		SPAC	BC				1017.
		SSAC	SC				1018.
		FPAC	FC				1019.
		..					1020.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
405.0.		FPAC	FC ACE5.	VAL-PRIME	1. PROCESS DSS 51 AND DSS 42 DATA AND GENERATE		1021.
					PREDICTS UP TO L+ 48H.		1022.
							1023.
					2. RUN FIRST STANFORD PREDICTS AND SEND ASAP		1024.
					TO SRI BY TTY.		1025.
406.0.	L+ 7H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1026.
		SPAC	BC				1027.
		DACON	DCN				1028.
		SSAC	SC				1029.
		FPAC	FC				1030.
							1031.
407.0.	L+ 8H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1032.
		DACON	DCN				1033.
		SPAC	BC				1034.
		SSAC	SC				1035.
		FPAC	FC				1036.
							1037.
408.0.	L+ 9H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1038.
		DACON	DCN				1039.
		SPAC	BC				1040.
		SSAC	SC				1041.
		FPAC	FC				1042.
							1043.
409.0.	L+ 10H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1044.
		DACON	DCN				1045.
		SPAC	BC				1046.
		SSAC	SC				1047.
		FPAC	FC				1048.
							1049.
410.0.		VOPS			1. TURN ON COMM PREDICTS.		1050.
411.0.	L+ 10H50M	COMM			1. ESTABLISH HSD, TTY, AND VOICE LINES TO		1051.
					DSS 11.		1052.
412.0.	L+ 11H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1053.
		DACON	DCN				1054.
		SPAC	BC				1055.
		SSAC	SC				1056.
		FPAC	FC				1057.
							1058.
413.0.	L+ 11H	DSIF	11 TC.	DSS	1. XMIT VERBAL PRETRACK REPORT		1059.
							1060.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
414.0	L+ 11H15M	COMM			1. PROGRAM AND VERIFY TTY AND HSD TO COMPUTER		1061
					FROM DSIF 11.		1062
415.0	L+ 12H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1063
		DACON	DCN				1064
		SPAC	BC				1065
		SSAC	SC				1066
		FPAC	FC				1067
							1068
416.0	L+ 12H19M	DSIF	11 TC	DSS	1. DSS 11 AOS.		1069
							1070
					2. TRANSMIT TRACKING AND T/M DATA TO SFOF.		1071
417.0	L+ 12H19M	DSIF	TC ACE5	FAC PRIME	1. REPORT DSS 11 AOS TO ACE 5.		1072
							1073
418.0	L+ 13H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1074
		DACON	DCN				1075
		SPAC	BC				1076
		SSAC	SC				1077
		FPAC	FC				1078
							1079
419.0	L+ 13H54M	DSIF	51 TC	DSS	1. DSS 51 LOS.		1080
							1081
420.0	L+ 13H54M	DSIF	TC ACE5	FAC-PRIME	1. DSS 51 LOS		1082
							1083
421.0	L+ 14H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1084
		DACON	DCN				1085
		SPAC	BC				1086
		SSAC	SC				1087
		FPAC	FC				1088
							1089
422.0	L+ 15H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1090
		DACON	DCN				1091
		SPAC	BC				1092
		SSAC	SC				1093
		FPAC	FC				1094
							1095
423.0	L+ 15H22M	DSIF	61 TC	DSS	1. DSS 61 LOS.		1096
							1097
424.0	L+ 15H22M	DSIF	TC ACE5	FAC-PRIME	1. DSS-61 LOS		1098
							1099

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
425.0	L+ 16H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1100
		DACON	DCN				1101
		SPAC	BC				1102
		SSAC	SC				1103
		FPAC	FC				1104
							1105
426.0	L+ 16H37M	S/C			1. TURN ON CANOPUS SENSOR AND		1106
					INITIATE ROLL SEARCH ABOUT THE Z AXIS		1107
					(CC+S L-3).		1108
427.0	L+ 16H37M	S/C			1. CANOPUS ACQUISITION COMPLETE.		1109
	L+ 16H38M						1110
428.0	L+ 17H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1111
		DACON	DCN				1112
		SPAC	BC				1113
		SSAC	SC				1114
		FPAC	FC				1115
							1116
429.0	L+ 17H34M	DSIF	42 TC	DSS	1. DSS 42 AOS.		1117
							1118
430.0	L+ 17H34M	DSIF	TC ACE5	FAC PRIME	1. REPORT DSS 42 AOS TO ACE 5.		1119
							1120
431.0	L+ 18H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1121
		DACON	DCN				1122
		SPAC	BC				1123
		SSAC	SC				1124
		FPAC	FC				1125
							1126
432.0		VOPS			1. TURN ON SIPM.		1127
433.0	L+ 19H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1128
		DACON	DCN				1129
		SPAC	BC				1130
		SSAC	SC				1131
		FPAC	FC				1132
							1133
434.0	L+ 20H	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1134
		DACON	DCN				1135
		SPAC	BC				1136
		SSAC	SC				1137
		FPAC	FC				1138
							1139

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
435.0.	L+ 21H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1140.
		DACON	DCN				1141.
		SPAC	BC				1142.
		SSAC	SC				1143.
		FPAC	FC				1144.
							1145.
436.0.	L+ 22H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1146.
		DACON	DCN				1147.
		SPAC	BC				1148.
		SSAC	SC				1149.
		FPAC	FC				1150.
							1151.
437.0.	L+ 23H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1152.
		DACON	DCN				1153.
		SPAC	BC				1154.
		SSAC	SC				1155.
		FPAC	FC				1156.
							1157.
438.0.	L+ 23H 8M	DSIF	11 TC.	DSS	1. DSS 11 LOS.		1158.
							1159.
439.0.	L+ 23H 8M	DSIF	TC ACE5.	FAC-PRIME	1. DSS 11 LOS		1160.
							1161.
440.0.	L+ 1D	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1162.
		DACON	DCN				1163.
		SPAC	BC				1164.
		SSAC	SC				1165.
		FPAC	FC				1166.
							1167.
441.0.	L+ 1D 2H54M	DSIF	61 TC.	DSS	1. DSS 61 AOS.		1168.
							1169.
					2. TRANSMIT TRACKING AND T/M DATA TO SFOF.		1170.
442.0.	L+ 1D 2H54M	DSIF	TC ACE5.	FAC PRIME	1. REPORT DSS 61 AOS TO ACE 5.		1171.
							1172.
443.0.	L+ 1D 4H	MARCHF	MCHF CC.		1. TRANSMIT FLIGT PATH REPORT TO MISSION		1173.
					DIRECTOR BY FAX.		1174.
444.0.	L+ 1D 4H26M	DSIF	42 TC.	DSS	1. DSS 42 LOS.		1175.
							1176.
445.0.	L+ 1D 4H26M	DSIF	TC ACE5.	FAC-PRIME	1. DSS 42 LOS		1177.
							1178.

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
446.0.	M- 6H	SPAC			1. REVIEW MANEUVER CORRECTION CAPABILITY		1179.
					WITH FPAC.		1180.
447.0.	M- 3H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1181.
		DACON	DCN				1182.
		SPAC	BC				1183.
		SSAC	SC				1184.
		FPAC	FC				1185.
		..					1186.
448.0.	M- 2H50M	COMM			1. ESTABLISH TTY COMMAND LINE TO DSS 11.		1187.
449.0.	M- 2H30M	MARCHF	MCHF CC.		1. TRANSMIT TRAJECTORY CORRECTION COMMANDS		1188.
					TO DSS.		1189.
450.0.	M- 2H15M	MARCHF			1. DETERMINE CORRECTNESS OF COMMANDS RECEIVED		1190.
		ACE 5			BY DSIF.		1191.
		DSIF					1192.
		..					1193.
451.0.	M- 2H	MARCHF			1. REVIEW PROCEDURES FOR TRANSMITTING COMMANDS		1194.
		DSIF			TO S/C.		1195.
		..					1196.
452.0.	M- 2H	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1197.
		DACON	DCN				1198.
		SPAC	BC				1199.
		SSAC	SC				1200.
		FPAC	FC				1201.
		..					1202.
453.0.	M- 1H10M	SPAC	BC ACE5.	VAL-PRIME	1. REPORT S/C READY TO ACCEPT COMMANDS TO ACE 5.		1203.
454.0.	M- 1H10M	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1204.
		DACON	DCN				1205.
		SPAC	BC				1206.
		SSAC	SC				1207.
		FPAC	FC				1208.
		..					1209.
455.0.	M- 1H 5M	DSIF	11 TC.	DSS	1. REPORT ANY CHANGE IN CH 115 OR CH 116 TO		1210.
		..			TRACK CHIEF AT ONCF DURING ANY COMMAND		1211.
					TRANSMISSION.		1212.
456.0.	M- 1H	DSIF			1. TRANSMIT QC V1-1, V1-2, AND V1-3 TO THE		1213.
		..			SPACECRAFT.		1214.
					A. PITCH TURN.		1215.
					B. ROLL TURN.		1216.
					C. MOTOR BURN.		1217.

MOS/T+DS MERGED SEQUENCE FOR MV-67

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
457.0	M- 45M	SPAC	BC ACE5	VAL-PRIME	1. VERIFY S/C RECEPTION OF QC V1-1, V1-2, AND		1218
					V1-3. REPORT TO ACE 5.		1219
458.0	M- 30M	DSIF			1. RESEND QC V1-1, V1-2, OR V1-3 TO S/C IF		1220
	M- 15M				REQUESTED BY SFOD.		1221
							1222
					2. TRANSMIT DC-V29 PER SEQUENCE.		1223
							1224
					3. TRANSMIT DC-V14 PER SEQUENCE.		1225
459.0	M- 30M	SPAC	BC ACE5	VAL-PRIME	1. REPORT S/C STATUS TO ACE 5.		1226
460.0	M- 10M	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1227
		DACON	DCN				1228
		SPAC	BC				1229
		SSAC	SC				1230
		FPAC	FC				1231
							1232
461.0	M-	S/C			1. MANEUVER SEQUENCE START. (DC-V27)		1233
					A. TURN GYROS ON FOR WARM UP.		1234
					B. SWITCH TO DATA MODE 1.		1235
462.0	M-	DSIF	TC ACE5	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1236
		DACON	DCN				1237
		SPAC	BC				1238
		SSAC	SC				1239
		FPAC	FC				1240
							1241
463.0	M+ 55M	DSS			1. LOAD DC-V13 AND REPORT TO SFOD.		1242
464.0		SPAC	BC ACE5	VAL-PRIME	1. REPORT STATUS OF S/C TO ACE 5.		1243
465.0	M+ 1H	S/C			1. BEGIN MANEUVER.		1244
					A. S/C TO INERTIAL CONTROL (ALL AXIS).		1245
					B. AUTOPILOT ON.		1246
					C. STAR SENSOR OFF.		1247
					D. SET TURN POLARITY.		1248
					E. START PITCH TURN.		1249
466.0		S/C			1. END OF PITCH TURN--M+ 76.66 MIN (MAX).		1250
					A. STOP PITCH TURN.		1251
					B. RESET TURN POLARITY.		1252
467.0		SPAC	BC ACE5	VAL-PRIME	1. REPORT END OF PITCH TURN TO ACE 5.		1253

ITEM	TIME	STA.	REPORT BY-TO	NET	EVENT	CHECK WHEN COMPLETE	LINE
468.0.	M+ 1H22M	S/C			1. INITIATE ROLL TURN.		1254.
					A. SET TURN POLARITY.		1255.
					B. START ROLL TURN.		1256.
469.0.		S/C			1. END OF ROLL TURN.		1257.
					A. STOP ROLL TURN.		1258.
					B. RESET TURN POLARITY.		1259.
470.0.		SPAC	BC ACE5.	VAL-PRIME	1. REPORT END OF ROLL TURN TO ACE 5.		1260.
471.0.	M+ 1H42M	DSIF			1. REMOVE DC-V13 FROM COMMAND SUBSYSTEM.		1261.
		..			(AS DIRECTED)		1262.
472.0.	M+ 1H44M	S/C			1. IGNITE MOTOR.		1263.
473.0.		S/C			1. STOP MOTOR BURN--102.36 SEC.		1264.
474.0.	M+ 1H50M	S/C			1. SWITCH TO CRUISE MODE.		1265.
					A. SWITCH TO DATA MODE 2.		1266.
					B. COMMENCE AUTOMATIC REACQUISITION OF		1267.
					REFERENCE.		1268.
475.0.	M+ 1H50M	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1269.
		DACON	DCN				1270.
		SPAC	BC				1271.
		SSAC	SC				1272.
		FPAC	FC				1273.
		..					1274.
476.0.	M+ 1H50M	S/C			1. SUN ACQUISITION COMPLETE--M+ 130 MIN (MAX).		1275.
	M+ 2H10M						1276.
477.0.	M+ 1H50M	S/C			1. CANOPUS ACQUISITION COMPLETE-- M+ 205 MIN		1277.
	M+ 3H25M				(MAX).		1278.
478.0.	M+ 3H25M	DSIF	TC ACE5.	FAC-PRIME	1. REPORT SFO STATUS TO ACE 5.		1279.
		DACON	DCN				1280.
		SPAC	BC				1281.
		SSAC	SC				1282.
		FPAC	FC				1283.
		..					1284.
479.0.	M+ 3H19M	S/C			1. TURN OFF MANEUVER COUNTER.		1285.
480.0.	M+ 3H25M	ALL			1. RETURN TO STANDARD CRUISE OPERATIONS.		1286.