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JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

ENGINEERING PLANNING DOCUMENT

NO. 122

SPACE FLIGHT OPERATIONS PLAN

MARINER MARS '64

EPD-122, REVISION 1 17 AUGUST 1964

EPD-122 15 July 1963

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Space Flight Operations
Director

APPROVED BY:

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SFO Systems Manager

J. N. James
Project Manager,
Mariner Mars '64

17 August 1964

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

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FOREWORD

It is the function of the Space Flight Operations Plan (SFOP) for Mariner Mars '64 to define the method by which the space flight operations will be conducted in both the standard case and anticipated departures from the standard case. Space flight operations are defined as the operations necessary to obtain and process spacecraft information and commands required by JPL during the portion of flight from launch to the accomplishment of the mission.

Subsequent revisions will update the SFOP and ensure that the operating procedures followed during the mission will reflect the latest improvements in operational methods and techniques.

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SECTION I

SPACE FLIGHT OPERATIONS FOR MARINER MARS '64

A. MISSION OBJECTIVES

1. Primary Objective

The primary objective of the Mariner Mars '64 Project is to conduct close-up (flyby) scientific observations of the planet Mars during the 1964-65 opportunity and to transmit the results of the observations back to Earth. The planetary observations should, to the greatest practicable extent, provide maximum information about Mars. TV, cosmic dust, and a reasonable complement of fields and particles experiments will be carried. In addition, an Earth occultation experiment will be carried out on spacecraft launched during the Type I trajectory launch period to obtain data relating to the scale height and pressure in the atmosphere of Mars. The project has the option of launching one spacecraft on a Type II trajectory and waiving the occultation experiment on Type II trajectories if, in its judgment, such action maximizes the probability of success of the total mission.

2. Secondary Objectives

There are two secondary objectives of the Mariner Mars '64 Project. The first is to provide experience and knowledge about the performance of the basic engineering equipment of an attitude-stabilized flyby spacecraft during a long duration flight in space further away from the Sun than the Earth. The other secondary objective is to perform certain field and/or particle measurements in interplanetary space and in the vicinity of Mars.

A tertiary objective of the Project is to provide a spacecraft design that is capable of repeating the same (or a similar) flyby mission to Mars during the 1966-1967 Mars opportunity with a minimum of modifications.

3. Space Flight Operations Objectives

The primary objective of Mariner Mars '64 space flight operations is to provide the necessary tracking, data processing and dissemination, mission evaluation, command generation, and command execution functions in support of the primary and secondary mission objectives, and to provide evaluation of the first flight information to assist in the decision as to when to launch the second spacecraft.

On a noninterference basis, space flight operations may also meet the following secondary objectives:

a) Evaluate and compare spacecraft and tracking information received from the spacecraft with information obtained from ground observatories during the flight.

b) Provide information and experience on space flight operations and mission performance for use in future mission planning.

B. LAUNCH VEHICLE AND SPACECRAFT DESCRIPTION

1. General

The Mariner Mars '64 system consists of an Atlas D first stage, an Agena D second stage, and the Mariner C spacecraft. The official designators are as follows:

Project Name	-	Mariner Mars '64
First Launch	-	Mariner C
Second Launch	-	Mariner D
First Mission Success	-	Mariner III
Second Mission Success	-	Mariner IV
Spacecraft Model	-	Mariner C
Spacecraft Serial No.		
MC-2	-	Flight-Qualified Spacecraft
MC-3	-	Flight-Qualified Spacecraft
MC-4	-	Flight-Qualified Spacecraft
MC-5	-	Selected Flight Spares

2. Launch Vehicle

a. Atlas D

The modified SM-65D series Atlas D space-launch booster comprises two main sections, the body or sustainer section and the aft or booster engine section. The booster vehicle is stabilized and controlled by gimbaling the engine thrust chambers. The propulsion system consists of two booster engines with a thrust of 154, 000 pounds each, a sustainer engine with a thrust of 60, 000 pounds, and two vernier engines with 1000 pounds thrust each. The engines use RP-1 and liquid oxygen as propellants. The booster section is connected to the sustainer section thrust ring through a separation system. All five engines are in operation at liftoff and the booster section is jettisoned after approximately 140 seconds of flight. Vehicle attitude control is provided by a preprogrammed autopilot commanded by a ground-based guidance system and a ground computer.

b. Agena D

The Agena D is a multipurpose second-stage launch vehicle used in a variety of NASA and military aerospace applications. It has a 16,000 pound thrust, liquid-fueled engine with in-flight multiple start capability. The engine uses UDMH (Unsymmetrical Dimethylhydrazine) and IRFNA (Inhibited Red Fuming Nitric Acid) 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.

3. Spacecraft

The Mariner C spacecraft (Figures I-1 and I-2), which is fully attitude stabilized, uses the Sun and Canopus as reference objects. The spacecraft derives its power from photovoltaic cells arranged on four panels which have body-fixed orientation and from a battery which is used during launch, trajectory correction maneuvers, and backup. The spacecraft has a two-way communications system that provides: 1) a method of telemetering information to the Earth, 2) command capability to the spacecraft, and 3) doppler and ranging for orbit determination. The spacecraft has a guidance system that permits trajectory correction maneuvers and a propulsion system that is capable of executing two such maneuvers.

Both scientific and engineering experiments will be accomplished by the Mariner C spacecraft. The science portion will be composed of both planetary and interplanetary experiments. A list of the experiments follows:

a) Planetary Experiments

1) TV

2) Earth Occultation

b) Interplanetary Experiments

1) Cosmic Dust Detector

2) Helium Magnetometer

3) Ion Chamber

4) Trapped Radiation Detector

5) Plasma Probe

6) Cosmic Ray Telescope

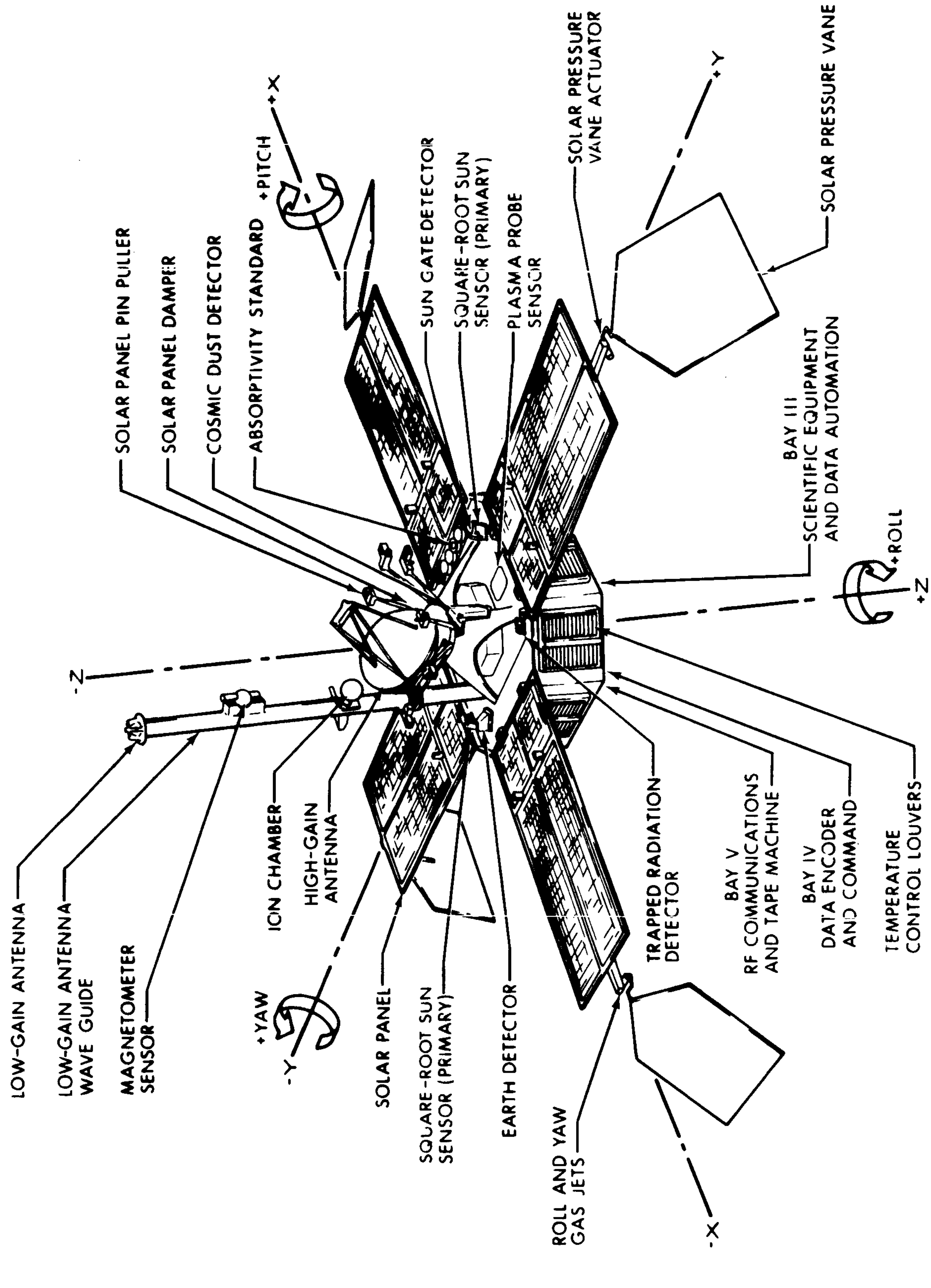

FIGURE I-1. MARINER C SPACECRAFT CONFIGURATION (TOP VIEW)

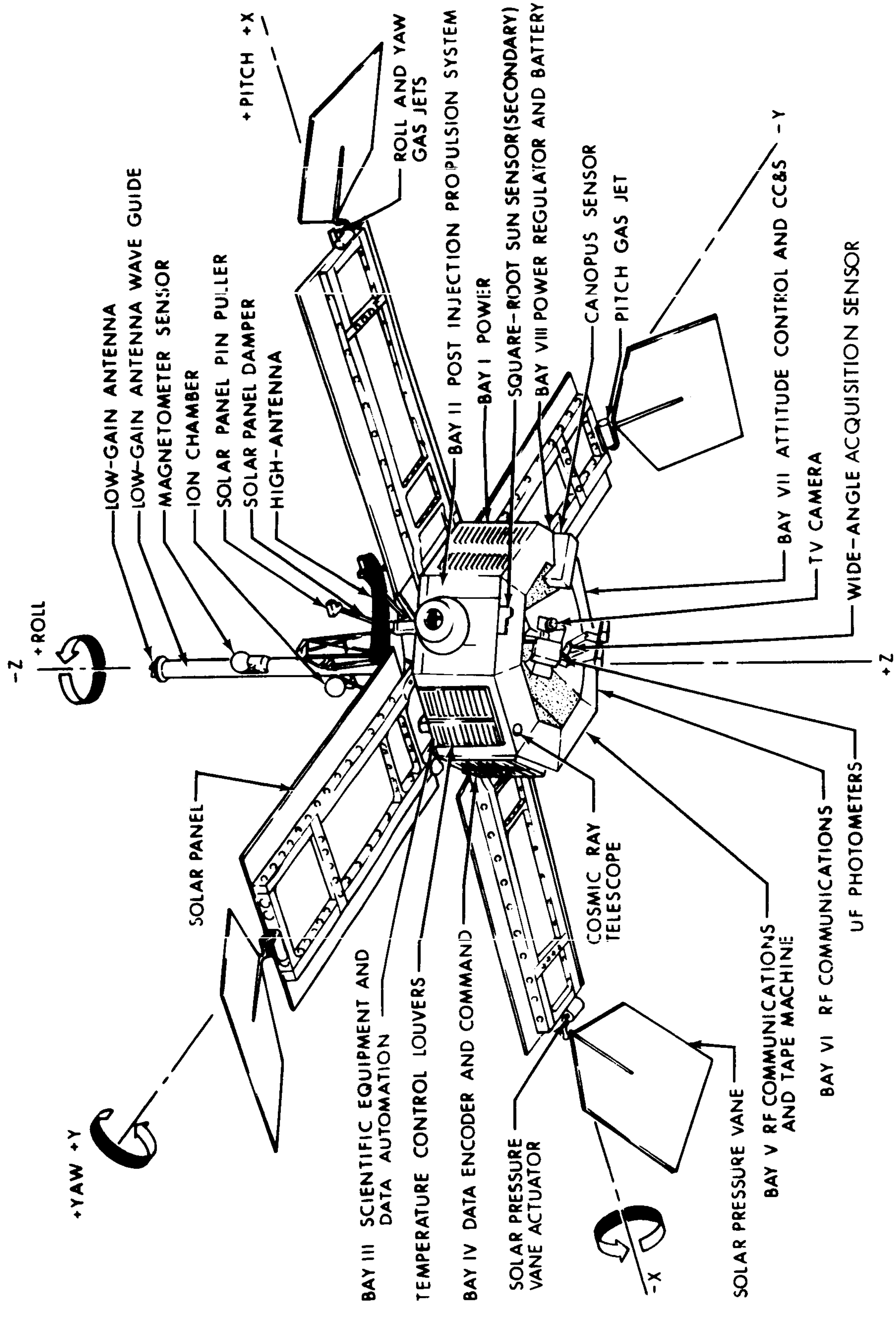

FIGURE I-2. MARINER C SPACECRAFT CONFIGURATION (BOTTOM VIEW)

C. MISSION PROFILE

1. General

Launchings of the Mariner C spacecraft, which take place at the Air Force Eastern Test Range (AFETR), will use Atlas-Agena launch vehicles. The launch period using Type I trajectories* is approximately 17 days. The launch period using Type I and Type II trajectories is approximately 23 days. The launches will take place from two launch pads at AFETR which permits a launch separation interval as short as two days during the Type I portion of the launch period.

2. Mission Launch Plan

AFETR launch Pads No. 12 and No. 13 are to be used for Mariner Mars '64. Until such time as all prior launches have cleared Pads No. 12 and No. 13, the plan shall be to launch Mariner C from Pad No. 13 on Day 5 with a 21-day turn-around. Mariner D will be launched from the same pad.

When and if it is clear that both pads are known to be available, the first launch shall be planned for Day 18, with both space vehicles prepared to support that launch date. A maximum of one launch is planned for the Type II trajectories. Should the first launch occur during the Type II portion of the period, the second launch shall be planned for the early part of the Type I period. If both launches are slipped to the Type I period, the capability of two-day launch separation must be maintained; this would result in both launches occurring prior to a midcourse maneuver.

3. Flight Plan

After launch, prediction data will be provided to the DSIF for initial acquisition. The prediction information is based on nominal launch and parking orbit conditions and on actual conditions supplied by AFETR in near-real time. AFETR will record spacecraft telemetry obtained during the powered flight phases and from spacecraft-Agena separation to DSIF acquisition.

Upon acquisition, the DSIF will transmit near-real time tracking and telemetry data to the Space Flight Operations Facility (SFOF) at JPL. The tracking data will be processed to provide sufficient prediction data to preclude loss of the spacecraft by the DSIF and will be used to establish a trajectory for coarse evaluation of the flight profile. The telemetry data will be analyzed to determine the operating condition of the spacecraft during the Sun and Canopus acquisition processes. The SFO System** will perform any ground command functions and carry out any procedures required.

---

* Type I trajectories, which have transfer angles of less than 180°, produce the shortest flight time and minimum communications distance. The Type II trajectory launch period occurs prior to the Type I period. Type II trajectories have transfer angles greater than 180°.

** The Mariner C SFO System is defined as the Earth-based, mission-independent facilities and personnel of the Deep Space Instrumentation Facility (DSIF), and the SFOF with the addition of the Mariner Mars '64-oriented personnel, equipment, and procedures.

Tracking and telemetry data will continue to be received at the SFOF for exact evaluation of the spacecraft trajectory and the spacecraft engineering and science experiments. When the trajectory has been sufficiently defined, the necessity of performing a maneuver will be evaluated; a maneuver would nominally be performed two to ten days after launch. If a maneuver is necessary, the commands will be generated and transmitted to the DSIF; the DSIF will then transmit the commands to the spacecraft. Tracking and telemetry data will be continuously received and evaluated during and subsequent to the maneuver to determine the necessity of a second maneuver; a second maneuver, however, would normally not be used.

During cruise, the SFO System will continue to receive and evaluate tracking and telemetry data throughout the transit of the spacecraft from Earth to Mars. Predetermined (designed) spacecraft events, as well as the effects of other events, e.g., solar flares and geomagnetic storms, will be monitored. Approximately 3 1/2 months prior to encounter, the 100-kw transmitter (Venus station) at Goldstone will become available for two-way communication and command backup. During the latter part of the cruise period, it is possible that the two Mariner spacecraft may be in the beamwidth of a single antenna; therefore, dual reception by a single station will be available.

During encounter, the spacecraft will be continuously monitored, and tracking and telemetry data will be evaluated to determine the exact encounter conditions. Any necessary commands to the spacecraft will be executed by the normal tracking stations or by the 100-kw transmitter. The spacecraft will also be continuously monitored during the postencounter phase to recover all stored spacecraft TV and encounter data. The spacecraft TV data will be processed into unrefined pictures shortly after the reception of each complete picture at the SFOF. Monitoring of the spacecraft will continue until the combined effects of increasing range and spacecraft antenna pointing error have exceeded the communication threshold.

4. Spacecraft Flight Sequence

The spacecraft flight sequence covers the operations performed by the spacecraft from the period immediately preceding launch until completion of the mission. Figure I-3 shows the flight sequence from launch to Canopus acquisition. Table I-I lists the nominal spacecraft events that occur during the mission. This table is based on a nominal flight of 240 days.

D. OPERATIONAL ORGANIZATION

The organizational structure established to ensure the successful execution of the flight portion of the Mariner Mars '64 Mission is shown in Figure I-4. Primary mission responsibilities and the authority of the individual organizations are also shown.

The following list gives the cognizant personnel of the SFO System:

1) Project Manager - J. N. James

2) Space Flight Operations Director - D. W. Douglas

3) DSIF Operations Manager - C. A. Holritz

4) DSIF Net Control (Project Engineer) - A. T. Burke

5) SFOF Operations Manager - D. B. Sparks

6) SFO Communications Coordinator - J. F. Helms

7) Data Processing Project Engineer - F. G. Curl

8) Flight Path Analysis and Command (FPAC) group - N. R. Haynes

9) Spacecraft Performance Analysis and Command (SPAC) group - A. G. Conrad

10) Space Science Analysis and Command (SSAC) group - R. K. Sloan

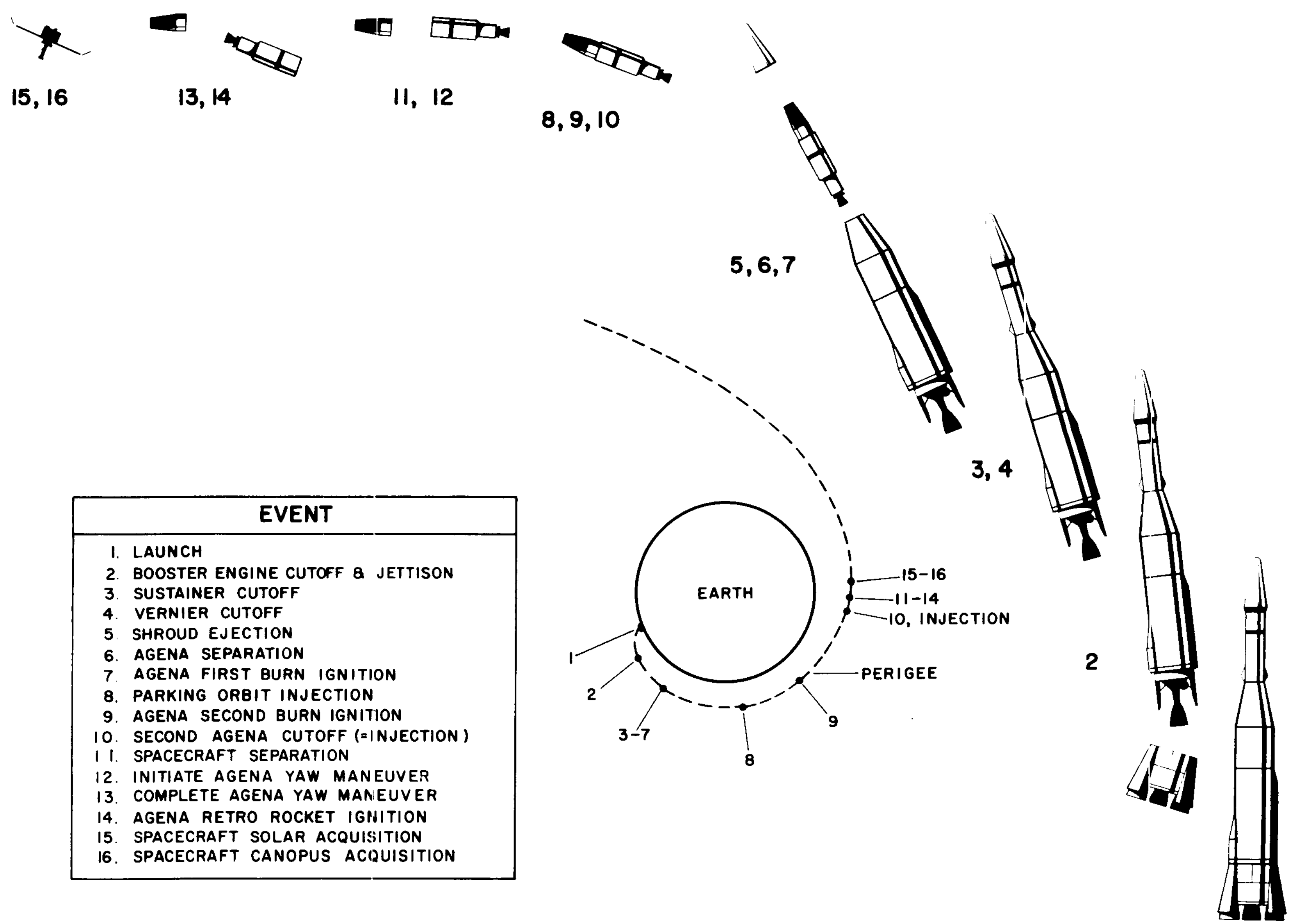

FIGURE I-3. MARINER C FLIGHT SEQUENCE (LAUNCH TO CANOPUS ACQUISITION)

TABLE I-I. MARINER C FLIGHT SEQUENCE

EVENT	TIME
Launch Sequence Started	T -3 min
Liftoff	L=T=0
Booster Cutoff and Jettison	
Sustainer Cutoff	
Vernier Cutoff	
Shroud Ejected	
Atlas-Agena Separation	
Agena 1st Ignition	
Agena 1st Cutoff	
Agena 2nd Ignition	
Agena 2nd Cutoff	
Spacecraft Injection	I=L +29.2 min to 48.0 min
Spacecraft Separation	S=I +2.6 min
RF Power Up and Cruise Science Turned On	
Tape Recorder Turned Off	
Attitude Control System Turned On	
Deploy Solar Panels and Solar Vanes	S +8 sec
Unlatch Scan Platform	
Sun Acquisition Complete	L +33 min 8 sec to 73 min
Solar Vanes and Canopus Sensor Turned On	L +997 min
Initiate Roll Search	

(This table continued on next page.)

TABLE I-I. (CONT'D)

EVENT	TIME
Canopus Acquisition Complete	L +997 min to 1072 min
Tracking Completed and Trajectory Commands Sent*	L +1 day to 10 days
Maneuver Sequence Started (Gyros Turned On for Warm-Up)*	M +0
Begin Maneuver*	M +59 min to 60 min
Midcourse Motor Ignited (Burns for up to 102.3 sec)*	M +103 min to 104 min
References (Sun and Canopus) Automatically Reacquired*	M +109 min to 205 min
Change Telemetry Bit Rate to 8 1/3 bps	E -192 days
Canopus Sensor Cone Angle No. 1 Set	E -137 days
High-Gain Antenna Used for Transmitting, Low-Gain Used for Receiving	E -131 days
Canopus Sensor Cone Angle No. 2 Set	E -103 days
Canopus Sensor Cone Angle No. 3 Set	E -68 days
Canopus Sensor Cone Angle No. 4 Set	E -30 days
Encounter Science Turned On (TV, NRT DAS, Scan, and Tape Recorder get power but do not start sequence)	E -6 2/3 hr
Wide-Angle Acquisition Used (Acquisition System acquires planet, begins tracking, but no data sent to tape recorder because planet is not yet being viewed by TV)	E -70 min to -33 min
Narrow-Angle Acquisition Used (Signals from TV indicate when view is on planet)	E -12 min to -8 min

* These items apply only if a maneuver is necessary.

(This table continued on next page.)

TABLE I-I. (CONT'D)

EVENT	TIME
Recording Begins - planet in view for about 20 min near time of closest approach	E -11 min to -4.6 min
Spacecraft Closest Approach to Mars	E +0
End of Tape in Recorder	E +11.8 min to 18.2 min
Encounter Science Switched Off	E +6 2/3 hr
Tape Playback Begun	E +13 1/3 hr

T - Time Before Liftoff

L - Launch

S - Spacecraft Separation

I - Injection into Transfer Orbit

M - Maneuver Sequence

E - Encounter Sequence. Encounter phase is defined as the 13 1/3-hour period bracketing the time of closest approach to Mars. Encounter is the point of closest approach.

NOTE: Nominal Flight Time to Encounter is 240 days.

SFO FACILITY OPER

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2. COMMITTING AND CONTROLLING THE PREPARATION AND EXECU

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DIRECTING AND COORDINATING DATA PROCESSING OPERATIONS DURING THE PREPARATION AND EXECUTION OF EACH FLIGHT OPERATION

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FLIGHT PATH ANALYSI

1. DETERMINING THE BEST ESTIM TRAJECTORY
2. PERFORMING MANEUVER STUD SPACECRAFT COMMANDS THAT
3. SUPPLYING ACQUISITION PRED DSIF

PROJECT MANAGEMENT

1. ESTABLISHING PROJECT AND MISSION REQUIREMENTS
2. RESOLVING PROJECT INTERFACE CONFLICTS
3. COMMITTING MISSION TO LAUNCH

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SFO DIRECTION

1. INTERPRETING STANDARD OPERATING PROCEDURES
2. PLACING REQUIREMENTS ON OPERATIONAL AND TECHNICAL GROUPS, CONSISTENT WITH SFO PLAN, EPD-122
3. RESOLVING ANY AMBIGUITIES DIRECTLY ASSOCIATED WITH THE SFO PLAN ARISING DURING ITS EXECUTION
4. MAKING APPROPRIATE DECISIONS AND INITIATING EMERGENCY ACTION IF PROJECT MANAGER IS NOT AVAILABLE
5. ENSURING OPERATIONAL READINESS OF SFO SYSTEM
6. COMMITTING SFO SYSTEM TO LAUNCH
7. CONTROLLING AND DIRECTING THE OPERATIONS

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SFO COMMUNICATIONS

1. COORDINATING ALL OPERATIONAL COMMUNICATION ACTIVITIES
2. PROVIDING AND CONTROLLING MISSION-ORIENTED LOCAL AND LONG DISTANCE TELEPHONE CIRCUITS INCLUDING INTERCOMMUNICATIONS SYSTEMS
3. PROVIDING LOCAL CLOSED-CIRCUIT TV VIEWING OF SELECTED OPERATIONAL AREAS AND EQUIPMENT

1. ACTING AS
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2. SUPPLYIN
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SPACECRAFT PERFORMANCE ANALYSIS AND COMMAND (SPAC)

1. EVALUATING AND DETERMINING THE SPACECRAFT ENGINEERING PERFORMANCE
2. ADVISING THE SFO DIRECTOR OF SPACECRAFT PERFORMANCE
3. DETERMINING POSSIBLE CAUSES OF SPACECRAFT ENGINEERING SYSTEM FAILURES AND/OR MALFUNCTIONS AND RECOMMENDING CORRECTIVE ACTION

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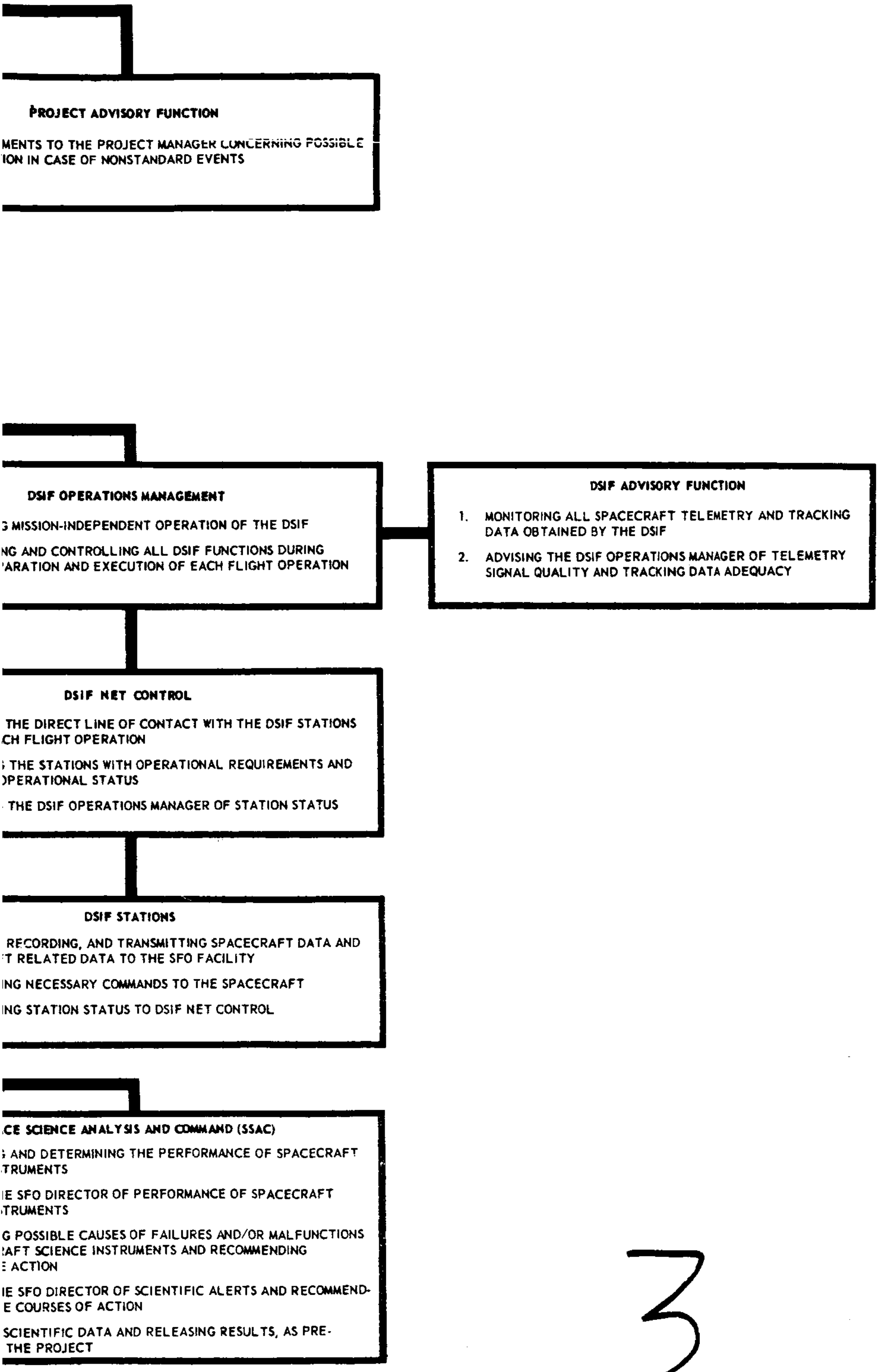

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FIGURE I-4. SPACE FLIGHT OPERATIONS ORGANIZATION, MARINER MARS '64 MISSION

SECTION II

OPERATIONAL FACILITIES

A. GENERAL

This section of the SFOP describes the facilities of the Air Force Eastern Test Range and the Space Flight Operations System that will be committed to support the Mariner Mars '64 Mission. The facilities that are committed are the operational facilities at the Air Force Eastern Test Range (AFETR), the Deep Space Instrumentation Facility (DSIF), the Space Flight Operations Facility (SFOF), and the communications between these facilities.

B. AIR FORCE EASTERN TEST RANGE

The support for the Mariner Mars '64 Mission required of AFETR is fully described in AFETR Program Requirements Document (PRD) No. 4300. The facilities that will be used by AFETR in support of Mariner Mars '64 are described in AFETR Program Support Plan (PSP) No. 4300.

After launch, extensive use of the tracking and telemetry facilities at AFETR will be made in support of the Mariner Mars '64 Mission. These facilities are shown in Figure II-1.

There are two requirements for near-real time data during the preinjection phase of the Mariner C spacecraft:

1) Initial acquisition data for the DSIF is required from AFETR. The raw tracking data obtained from downrange stations will be forwarded to the computing center located in the Impact Predictor Building (IPP) at AFETR and also to the JPL Operations Center at AFETR for relay to the SFOF in Pasadena, California (see Table II-I). This data, in conjunction with pertinent telemetry data, will be used to determine the parking orbit of the spacecraft. The acquisition data shown in Table II-II will be computed and forwarded to the JPL Operations Center at AFETR for relay to the SFOF in Pasadena and thence to the DSIF stations.

2) It is required that AFETR obtain an initial estimate of the spacecraft injection conditions. The orbital elements of the parking orbit and initial estimate of the spacecraft injection conditions will be forwarded by AFETR to the JPL Operations Center at AFETR for relay to the SFOF. Table II-III indicates the form of this data. Table II-III also gives the tracking data nomenclature for AFETR data which will be forwarded to the SFOF in near-real time.

Detailed countdown information will be forwarded to Pasadena from the JPL Operations Center at AFETR during the prelaunch countdown. Additionally, event information from launch through injection will be supplied by AFETR.

Details regarding the handling of this information at AFETR and within the JPL Operations Center, AFETR, will be found in the Mariner C Test and Operations Plan (TOP).

Spacecraft telemetry recorded from the Agena C-band and the spacecraft S-band link covering the injection period of the flight will be available at the JPL Operations Center, AFETR, within 36 hours after the first launch so that the data is available for study prior to the second launch.

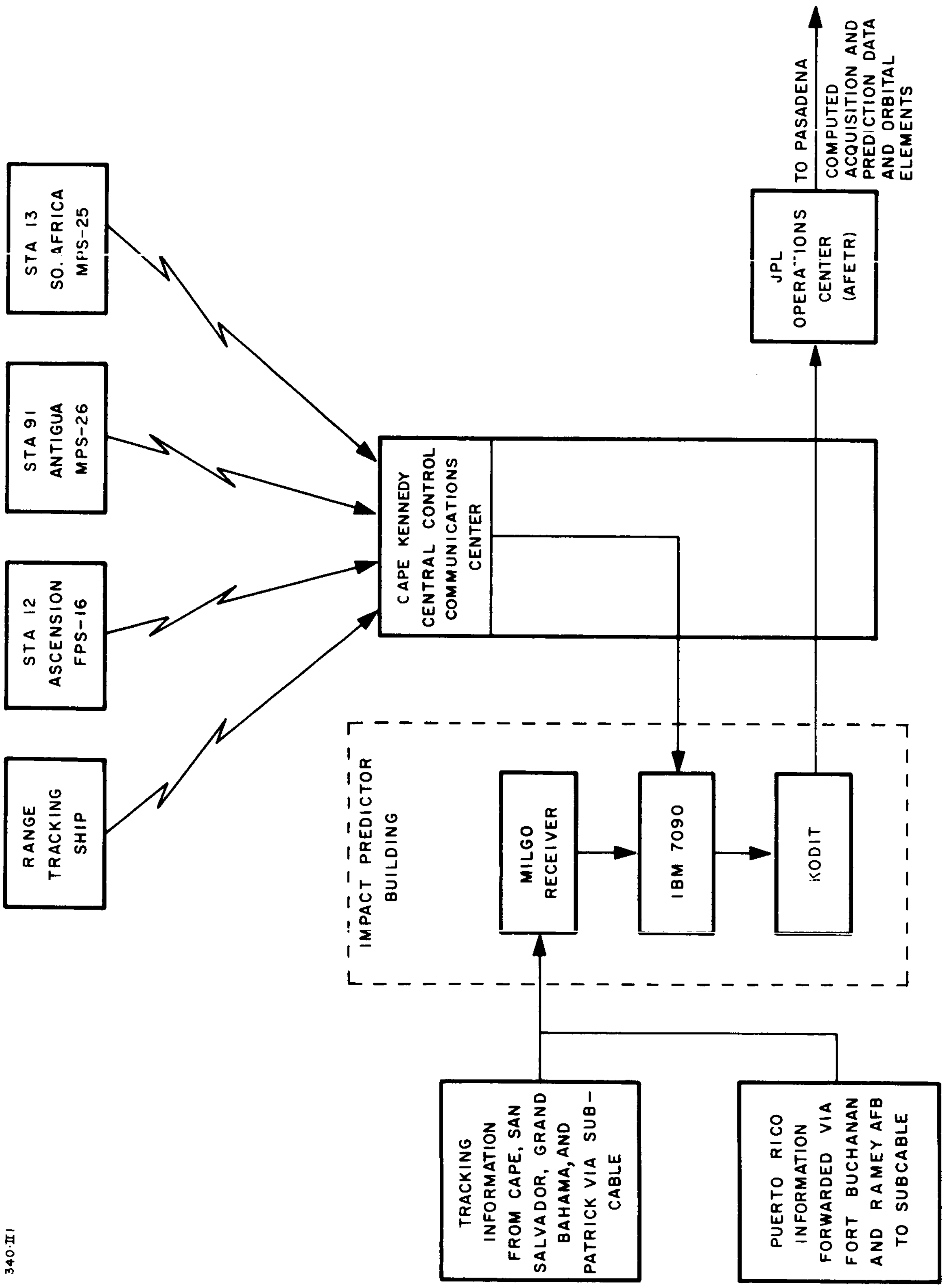


FIGURE II-1. TRACKING FACILITIES SUPPORTING MARINER MARS'64 AT AFETR

TABLE II-I. TRACKING DATA OBTAINED FROM AFETR IN NEAR-REAL TIME

Tracking Data

This will be semi-raw data placed in the following format for TTY transmission:

Character Transmitted	Information	
1	Line Feed	
2	Figure Shift	
3	Figure Shift	
4	Data Type	
5	Station ID	
6	Station ID	
7	Radar Type	
8	On Track - Code 2	
9	Time - H	20, 19
10	Time - H	18, 17, 16, 15
11	Time - M	14, 13, 12
12	Time - M	11, 10, 9, 8
13	Time - Sec	7, 6, 5
14	Time - Sec	4, 3, 2, 1
15	Az	21, 20, 19
16	Az	18, 17, 16
17	Az	15, 14, 13
18	Az	12, 11, 10
19	Az	9, 8, 7
20	Az	6, 5, 4
21	Az	3, 2, 1
22	El	21, 20, 19
23	El	18, 17, 16
24	El	15, 14, 13
25	El	12, 11, 10
26	El	9, 8, 7
27	El	6, 5, 4
28	El	3, 2, 1
29	R	27, 26, 25
30	R	24, 23, 22
31	R	21, 20, 19
32	R	18, 17, 16
33	R	15, 14, 13
34	R	12, 11, 10
35	R	9, 8, 7
36	R	6, 5, 4
37	R	3, 2, 1
38	Carriage Return	

NOTE: See Legend on next page.

LEGEND

1. Character 4, Data Type:

    2 - Real Time
    3 - Simulated Data
    7 - Last Sample

2. Characters 5 and 6, Station ID:

Grand Turk 7-18	51
Antigua 91-18	91
Bermuda	70
Twin Falls (Corrected)	77
Twin Falls (Uncorrected)	72
Ascension 12-16	75
Pretoria 13-16	76

3. Character 7, Radar Type:

    MPS-26, FPS-16 - 0
    TPQ-18 - 3

4. Character 8, On Track:

    Off Track - 0
    On Track - 2

5. Characters 9 - 14, Time:

    20-Bit Binary Coded Decimal Time Code Character

6. Characters 15 - 21, Azimuth Data in Binary Code:

    FPS-16, MPS-25
    Most Significant Bit - Bit 17 - 180 Degrees
    Least Significant Bit - Bit 1 - 0.0027465 Degrees

    TPQ-18
    Most Significant Bit - Bit 19 - 180 Degrees
    Least Significant Bit - Bit 1 - 0.000686 Degrees

7. Characters 22 - 28, Elevation Data in Binary Code:

    FPS-16, MPS-25
    Most Significant Bit - Bit 17 - 180 Degrees
    Least Significant Bit - Bit 1 - 0.0027465 Degrees

    TPQ-18
    Most Significant Bit - Bit 19 - 180 Degrees
    Least Significant Bit - Bit 1 - 0.000686 Degrees

8. Characters 29 - 37, Range Data in Binary Code:

    FPS-16
    Most Significant Digit - 2^{26} - 67,108,864 Yards
    Least Significant Digit - 2^{0} - 1 Yard

    TPQ-18
    Most Significant Digit - 2^{26} - 67,108,864 Yards
    Least Significant Digit - 2^{0} - 1.953125 Yards

9. Character 38, End of Sample:

    Carriage Return

TABLE II-II. ACQUISITION DATA MESSAGE FORMATS FOR DSIF 41 AND 51, SUPPLIED BY AFETR

A. The acquisition data message for DSIF 41 from AFETR will be in the following formats:

```
JPL LOOK ANGLES FROM ACTUAL P.O AND NOMINAL 2ND BURN                    MA C

XMITTER REF FREQ  XXXXXX    XPONDER FREQ  XXXXXX

HMS XX XX XX.X    RANGE XXXXX.XXX

H M S    HA     DEC    D1.41    D2.41    XA.41      ID

XXXXXX   XXX.X   XXX.X   XXXXXX   XXXXXX   XXXXXX   LMNPQR
                          •
                          •
                          •
HMS XX XX XX.X    RANGE XXXXX.XXX

END OF LOOK ANGLES FROM ACTUAL PARKING ORBIT                            MA C
```

```
JPL LOOK ANGLES FROM ACTUAL TRANSFER ORBIT                              MA C

XMITTER REF FREQ  XXXXXX    XPONDER FREQ  XXXXXX

HMS XX XX XX.X    RANGE XXXXX.XXX

H M S    HA     DEC    D1.41    D2.41    XA.41      ID

XXXXXX   XXX.X   XXX.X   XXXXXX   XXXXXX   XXXXXX   LMAPQR
                          •
                          •
                          •
HMS XX XX XX.X    RANGE XXXXX.XXX

END OF LOOK ANGLES FROM ACTUAL TRANSFER ORBIT                           MA C
```

NOTE: See Legend at end of table.

(This table continued on next page.)

TABLE II-II. (CONT'D)

B. The acquisition data message for DSIF 51 from AFETR will be in the following formats:

```
JPL LOOK ANGLES FROM ACTUAL P.O AND NOMINAL 2ND BURN                 MA C

XMITTER REF FREQ  XXXXXX    XPONDER FREQ  XXXXXX

HMS XX XX XX.X    RANGE XXXXX.XXX

H M S    HA     DEC     D1.51    D2.51    XA.51     ID

XXXXXX  XXX.X  XXX.X  XXXXXX   XXXXXX   XXXXXX  LMNPQR
                         •
                         •
                         •
HMS XX XX XX.X    RANGE XXXXX.XXX

END OF LOOK ANGLES FROM ACTUAL PARKING ORBIT                         MA C
```

```
JPL LOOK ANGLES FROM ACTUAL TRANSFER ORBIT                           MA C

XMITTER REF FREQ  XXXXXX    XPONDER FREQ  XXXXXX

HMS XX XX XX.X    RANGE XXXXX.XXX

H M S    HA     DEC     D1.51    D2.51    XA.51     ID

XXXXXX  XXX.X  XXX.X  XXXXXX   XXXXXX   XXXXXX  LMAPQR
                         •
                         •
                         •
HMS XX XX XX.X    RANGE XXXXX.XXX

END OF LOOK ANGLES FROM ACTUAL TRANSFER ORBIT                        MA C
```

NOTE: See Legend on next page.

LEGEND

H	-	Hours
M	-	Minutes
S	-	Seconds
HA	-	Hour angle
DEC	-	Declination
D1.41	-	One-way doppler detector output frequency for Station 1, Zone 4
D2.41	-	Two-way doppler detector output frequency for Station 1, Zone 4
XA.41	-	Transmitter VCO frequency for spacecraft zero static phase error for Station 1, Zone 4
D1.51	-	One-way doppler detector output frequency for Station 1, Zone 5
D2.51	-	Two-way doppler detector output frequency for Station 1, Zone 5
XA.51	-	Transmitter VCO frequency for spacecraft zero static phase error for Station 1, Zone 5
AZ	-	Azimuth
EL	-	Elevation
ID	-	As listed below:

LM	-	Orbit number, from 01 to 99
N	-	Denotes nominal second burn
A	-	Denotes actual second burn (replaces N)
PQR	-	Day of the year

TABLE II-III. TRAJECTORY DATA SUPPLIED BY AFETR

The trajectory data message from AFETR will be in the following formats:

```
LIFTOFF DAY XXX HMS XX XX XX.X GMT      AZL XXX.XX                   MA C
ELEMENTS AND INJECTION CONDITIONS OF PARKING ORBIT    YYY.YY
HMS XX XX XX.X L PLUS TIME XXXXX.  ALT XXX.XX
SMA XXXXX.X  ECC X.XXXXXX  INC XXX.XXX  C3 XX.XX
LAN XXX.XXX  APF XXX.XXX  TA XXX.XXX
R XXXXX.  LAT XX.XXX  LON XXX.XXX  VE XX.XXX  PTE XX.XXX  AZE XXX.XXX
```

```
INJECT COND OF TRANSFER ORBIT FROM ACT P.O AND NOM 2ND BURN YYY.YY MA C
H M S  XX XX XX.X L PLUS TIME XXXXX.
R XXXXX.  LAT XX.XXX  LON XXX.XXX  VE XX.XXX  PTE XX.XXX  AZE XXX.XXX
```

```
ELEMENTS AND INJECTION COND OF ACTUAL TRANSFER ORBIT    YYY.YY     MA C
H M S  XX XX XX.X L PLUS TIME XXXXX.  ALT XXX.XX
SMA XXXXX.X  ECC X.XXXXXX  INC XXX.XXX  C3 XX.XX
LAN XXX.XXX  APF XXX.XXX  TA XXX.XXX
R XXXXX.  LAT XX.XXX  LON XXX.XXX  VE XX.XXX  PTE XX.XXX  AZE XXX.XXX
```

NOTE: See Legend on next page.

LEGEND

LIFTOFF DAY	Day of the calendar year
HMS (GMT)	Time of launch (GMT)
AZL	Azimuth of launch
YYY. YY	Data source of computations. The number before the decimal is the station ID; the number after the decimal indicates the number of the transmission. (AFETR is to use numbers from 01-09; JPL is to use numbers from 10-99.)
HMS	Epoch - Universal Time (Hours, Minutes, and Seconds); time at which osculating conic is calculated
L + (TIME)	Launch plus ________(time in seconds)
ALT	Distance above Earth's surface in kilometers
SMA	Semimajor axis of conic section. Negative for a hyperbola in kilometers
ECC	Eccentricity of conic section
INC	Inclination - Angle between the orbital plane and the Earth's (instantaneous) equator. Degrees, between 0° (zero) and 360°
C3	Twice the total energy per unit mass or vis viva in km^2/sec^2.
LAN	Right ascension of the ascending node. Degrees, from 0° (zero) to 360°. Measured from the vernal equinox of date in the instantaneous equatorial plane.
APF	Argument of Perigee. Angle, in the orbital plane, eastward from the ascending node to the perigee point. Degrees, from 0° (zero) to 360°.
TA	True anomaly at epoch. The angle measured from perigee to the spacecraft. Measured eastward in degrees.
R	Injection radius in kilometers
LAT	Injection latitude in degrees
LON	Injection longitude in degrees
VE	Inertial velocity in km/sec
PTE	Inertial path angle at injection
AZE	Injection azimuth in degrees
X	Used to indicate number location in message

SECTION II, C. DEEP SPACE INSTRUMENTATION FACILITY

SECTION II, D. SPACE FLIGHT OPERATIONS FACILITY

DEEP SPACE NETWORK

The function of the Deep Space Network (DSN) for the Mariner Mars '64 Mission is to provide the facilities, equipment, and personnel necessary to meet the space flight operations requirements of the Mariner Mars '64 Project. The DSN includes the Deep Space Instrumentation Facility (DSIF), Interstation Communications, and the mission-independent portion of the Space Flight Operations Facility (SFOF).

APPROVED: N. A. Renzetti

N. A. Renzetti
DSN Manager,
Mariner Mars '64

C. DEEP SPACE INSTRUMENTATION FACILITY (DSIF)

The function of the DSIF is to obtain angular position, doppler, and telemetry data from the Mariner C spacecraft during the postinjection phase of the mission. Ranging data will be obtained in addition to two-way doppler at DSIF 11 (Pioneer) only. The DSIF may send ground-computed commands in accordance with the procedures outlined in the Mariner C Tracking Instruction Manual (TIM), EPD-167 (to be published). The Spacecraft Checkout Facility at Cape Kennedy will supply telemetry coverage from launch to local horizon.

Data obtained by the DSIF is transmitted to the SFOF in real time or near-real time by teletype and high-speed data circuits. In addition, the same data is recorded on magnetic tape at each Deep Space Station (DSS) and dispatched to JPL by airmail.

1. DSIF Stations

The following are designated the primary DSS for the Mariner Mars '64 Mission:

DSIF 11	Pioneer Station, Goldstone, California
DSIF 41	Woomera, Australia
DSIF 51	Johannesburg, South Africa

Cape Kennedy (Spacecraft Checkout Facility)

The following are designated the backup DSS for the Mariner Mars '64 Mission:

DSIF 13	Venus Station, Goldstone, California
DSIF 42	Canberra, Australia

The L-band-to-S-band conversion system will be used at DSIF 41 and DSIF 51 during the Mariner Mars'64 Mission. The telemetry system and angle tracking are compatible with either the L-band-to-S-band conversion system or the GSDS S-band system. However, there is a significant difference in the doppler format; use of the ranging subsystem will not be possible with the L-band-to-S-band conversion receiver.

The Mariner Mars '64 Project has a requirement for dual spacecraft coverage. Thus, when two spacecraft are within the beamwidth of a single antenna, the DSIF station will simultaneously transmit near-real time telemetry data from one spacecraft and record and store telemetry data from the other spacecraft for subsequent transmission or transportation to JPL.

Woomera will be a primary station during the early part of the mission. Canberra will supplement Woomera when there is a requirement to provide coverage of two spacecraft, and may become the primary station at that time or sooner, depending on DSN loading and Canberra operational readiness.

Dual spacecraft coverage at DSIF 51 (Johannesburg) will be provided by using the L-band-to-S-band conversion system to cover one spacecraft and by using either a portable telemetry package or a modified angle channel of the S-band receiver to cover the other spacecraft.

The parameters and capabilities of each DSIF station are given in Table II-IV. The operational frequency assignments are listed in Table II-V. It will require approximately two hours to change the operating frequency at a station. Compatible telecommunications modes are listed in Table II-VI. Block diagrams of the stations are presented in Figures II-2 through II-4. The tracking data format is shown in Table II-VII. The ground-encoded telemetry data formats are described in Table II-VIII. Ground modes are listed in Table II-IX.

Acquisition and prediction information required by the DSIF has previously been listed in Table II-II. The sample rate capability for this data is described in Table II-X. Station reports, as detailed in Paragraph C.3, will be periodically transmitted by each DSIF station to the SFOF. These reports will be distributed, as required, within the SFOF.

2. <u>DSIF Coverage</u>

Three DSIF stations are committed to meet the requirements placed on the DSIF by the Mariner Mars '64 Project and are designated as the prime stations; they are Goldstone Pioneer, Johannesburg, and Woomera. Any change in assignment will be coordinated between the DSIF Operations Manager and the Mariner Mars '64 Space Flight Operations Director so that no decrease in coverage will result from a change in prime stations.

The DSIF will provide coverage equivalent to 24 station hours per day, time-shared between the spacecraft, for the duration of the mission. During critical portions of the mission, additional coverage will be provided as follows:

a) <u>Injection</u>

Coverage will be provided by the prime stations up to the full view period of each station.

b) <u>Maneuver</u>

Same as a).

c) <u>Encounter</u>

Same as a); the Goldstone Venus station (100 kw transmitter) will provide command backup.

1.	STATION NAME
2.	STATION ID
3.	RECEIVER CAPABILITY
4.	ANTENNA
5.	MOUNT
6.	MAX. ANGULAR RATE (BOTH AXES)
7.	ANTENNA GAIN RECEIVING TRANSMITTING
8.	ANTENNA BEAMWIDTH
9.	TYPICAL SYSTEM TEMP.
10.	TRANSMITTER POWER
11.	DATA TRANSMISSION (TTY) a) ANGLES b) DOPPLER c) RANGING (TO 800,000 KM) d) TELEMETRY
12.	DEMODULATED TELEMETRY
13.	COMMAND CAPABILITY
14.	DATA PACK AIR SHIPMENT TIME TO JPL

NOTES. 1. Capa

a.
b.
c.

2. Cohe

3. Real

TABLE II-IV. DSIF CAPABILITIES FOR MARINER MARS'64

Goldstone Pioneer GSDS S-Band	Goldstone Venus	Woomera L-to-S Conversion Kit
DSIF 11	DSIF 13	DSIF 41
Two	None	One
85' Parabolic	85' Parabolic	85' Parabolic
Polar (HA-Dec)	Equatorial (Az-El)	Polar (HA-Dec)
0.7 Deg/Sec	1 Deg/Sec	0.7 Deg/Sec
53.0 db $\pm$1 51.0 db $\mp$1	53.0 db $\pm$.5	53.0 db $\pm$1 51.0 db $\mp$1
~ 0.4 deg	~ 0.4 deg	~ 0.4 deg
60 K 10 KW	--- 100 KW	60 K 10 KW
Real Time Real Time Real Time Real & Near-Real Time	None None (2) None None	Real Time Real Time None Real & Near-Real Time
Dual Channel	None	Single Channel
Yes	Yes	Yes
1 Day	1 Day	7 Days

bility difference between L-to-S conversion kit stations and GSD

No ranging.
Doppler format.
Single receiver.

rent two-way doppler when operating at 100 KW with Pioneer Sta

time is defined in the Mariner C SFO System Design Specificati

Canberra GSDS S-Band	Johannesburg L-to-S Conversion Kit
DSIF 42	DSIF 51
Two	One
85' Parabolic	85' Parabolic
Polar (HA-Dec)	Polar (HA-Dec)
0.7 Deg/Sec	0.7 Deg/Sec
53.0 db ± 1 51.0 db ± 1	53.0 db ± 1 51.0 db ± 1
~ 0.4 deg	~ 0.4 deg
60 K 10 KW	60 K 10 KW
Real Time Real Time Real Time Real & Near-Real Time	Real Time Real Time Real & Near-Real Time
Dual Channel	Single Channel
Yes	Yes
6 Days	5 Days

S S-Band stations.

tion.

ons, Section III.

3

TABLE II-V. OPERATIONAL FREQUENCY ASSIGNMENTS

Frequencies to be Employed:

Channel	Receive (mc)	Transmit (mc)
21.	2297.592593	2115.699846
22.	2297.962963	2216.040895
23.	2298.333333	2116.381944
24.	2298.703704	2216.722994

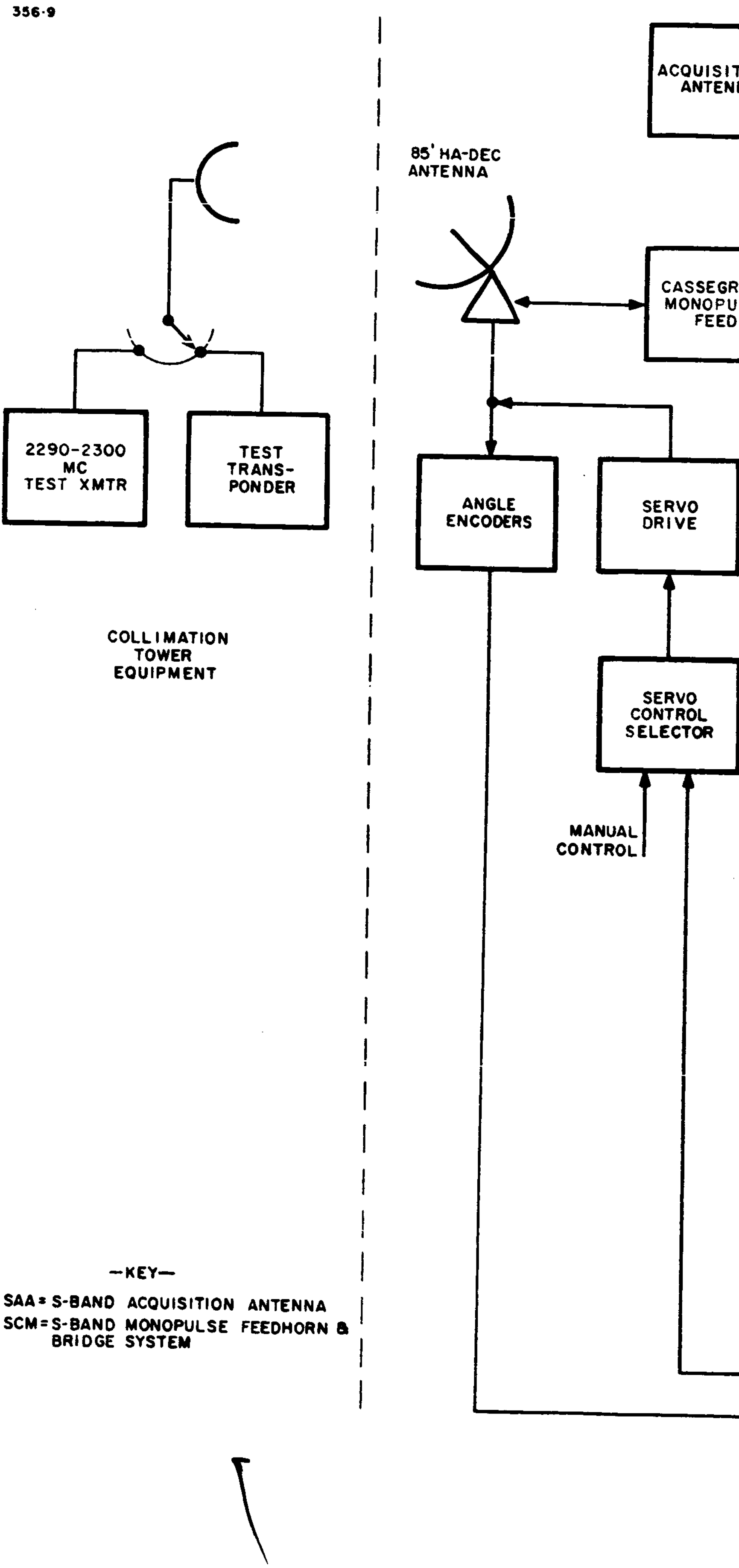
TABLE II-VI. COMPATIBLE TELECOMMUNICATIONS MODES

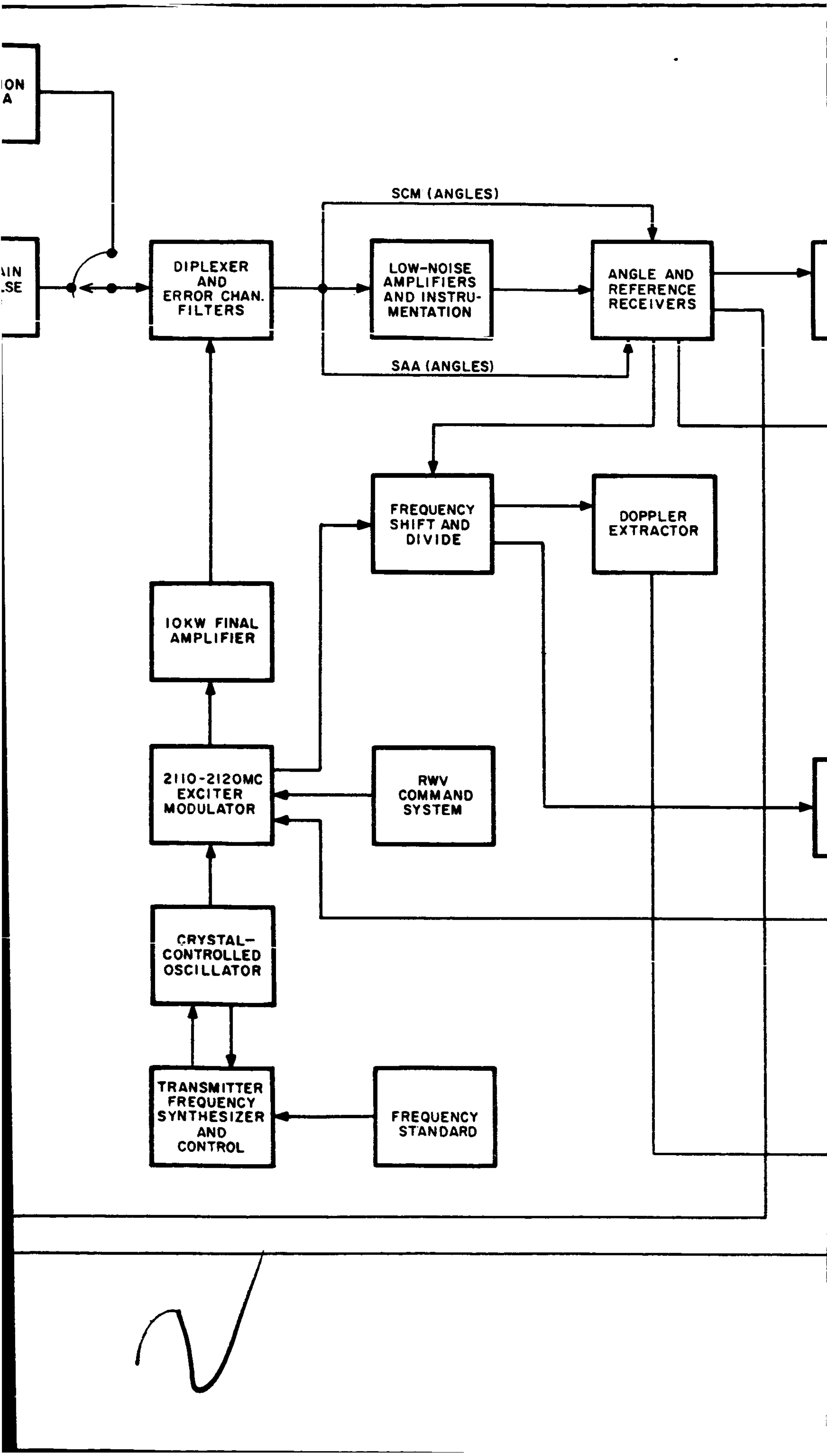
		a ③	b	c	d	e	f	g
a	1-way doppler				X			X
b	2-way doppler				X	X	X	X
c	2-way noncoherent doppler				X ①		X	X ①
d	Angle tracking	X	X	X ①		X	X	X
e	Ranging		X		X			X ②
f	Command		X		X			X
g	Telemetering	X	X	X ①	X	X ②	X	

① Only at receiving station.

② Simultaneous operation not yet demonstrated.

③ Letters on top row are identical with 1st column designation.


356-9
2290-2300
MC
TEST XMTR
TEST
TRANS-
PONDER
COLLIMATION
TOWER
EQUIPMENT
85' HA-DEC
ANTENNA
ACQUISIT
ANTENI
CASSEGR
MONOPU
FEED
ANGLE
ENCODERS
SERVO
DRIVE
SERVO
CONTROL
SELECTOR
MANUAL
CONTROL
—KEY—
SAA = S-BAND ACQUISITION ANTENNA
SCM = S-BAND MONOPULSE FEEDHORN & BRIDGE SYSTEM



ION
A
AIN
LSE
DIPLEXER AND ERROR CHAN. FILTERS
SCM (ANGLES)
SAA (ANGLES)
LOW-NOISE AMPLIFIERS AND INSTRUMENTATION
ANGLE AND REFERENCE RECEIVERS
FREQUENCY SHIFT AND DIVIDE
DOPPLER EXTRACTOR
10KW FINAL AMPLIFIER
2110-2120MC EXCITER MODULATOR
RWV COMMAND SYSTEM
CRYSTAL-CONTROLLED OSCILLATOR
TRANSMITTER FREQUENCY SYNTHESIZER AND CONTROL
FREQUENCY STANDARD

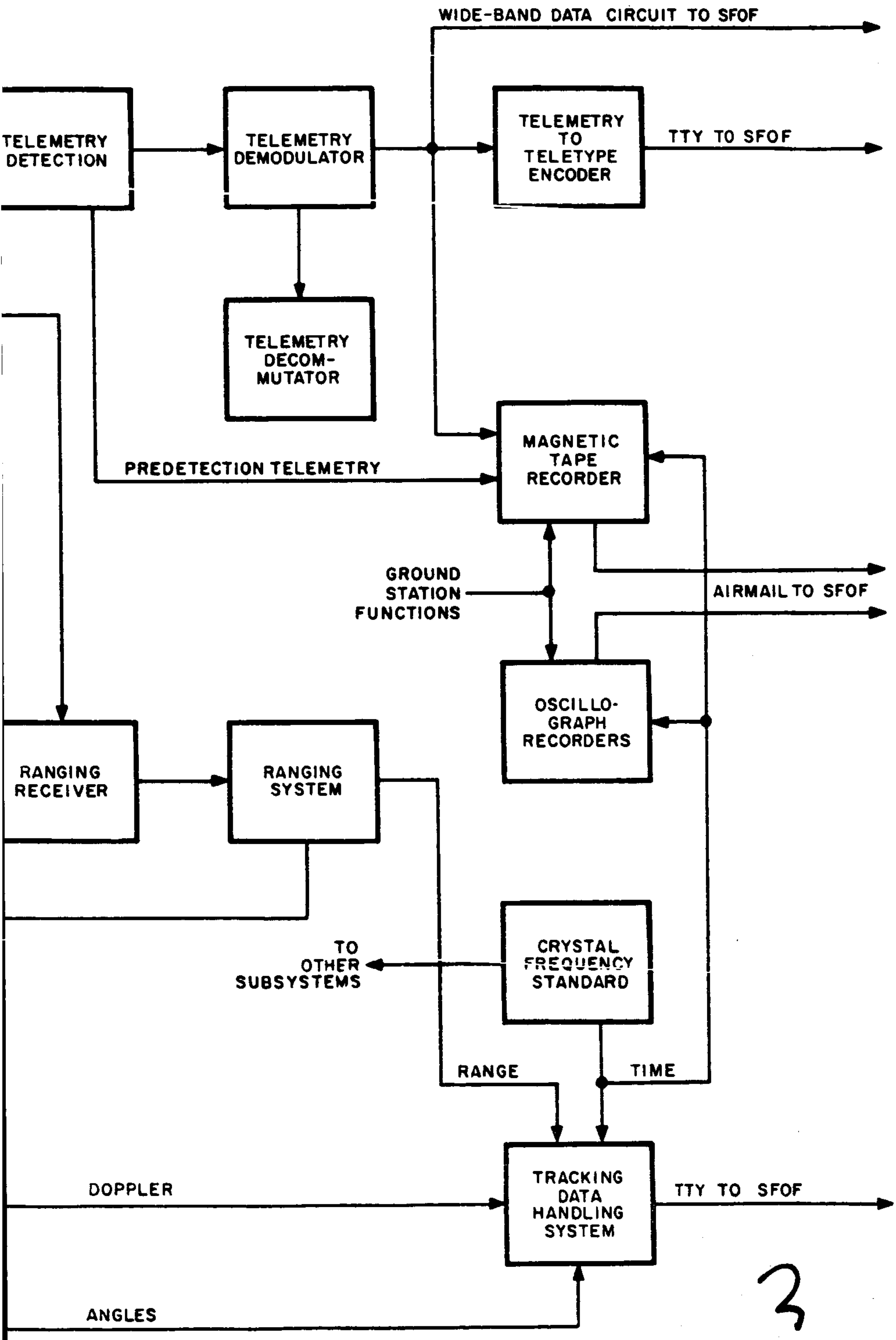
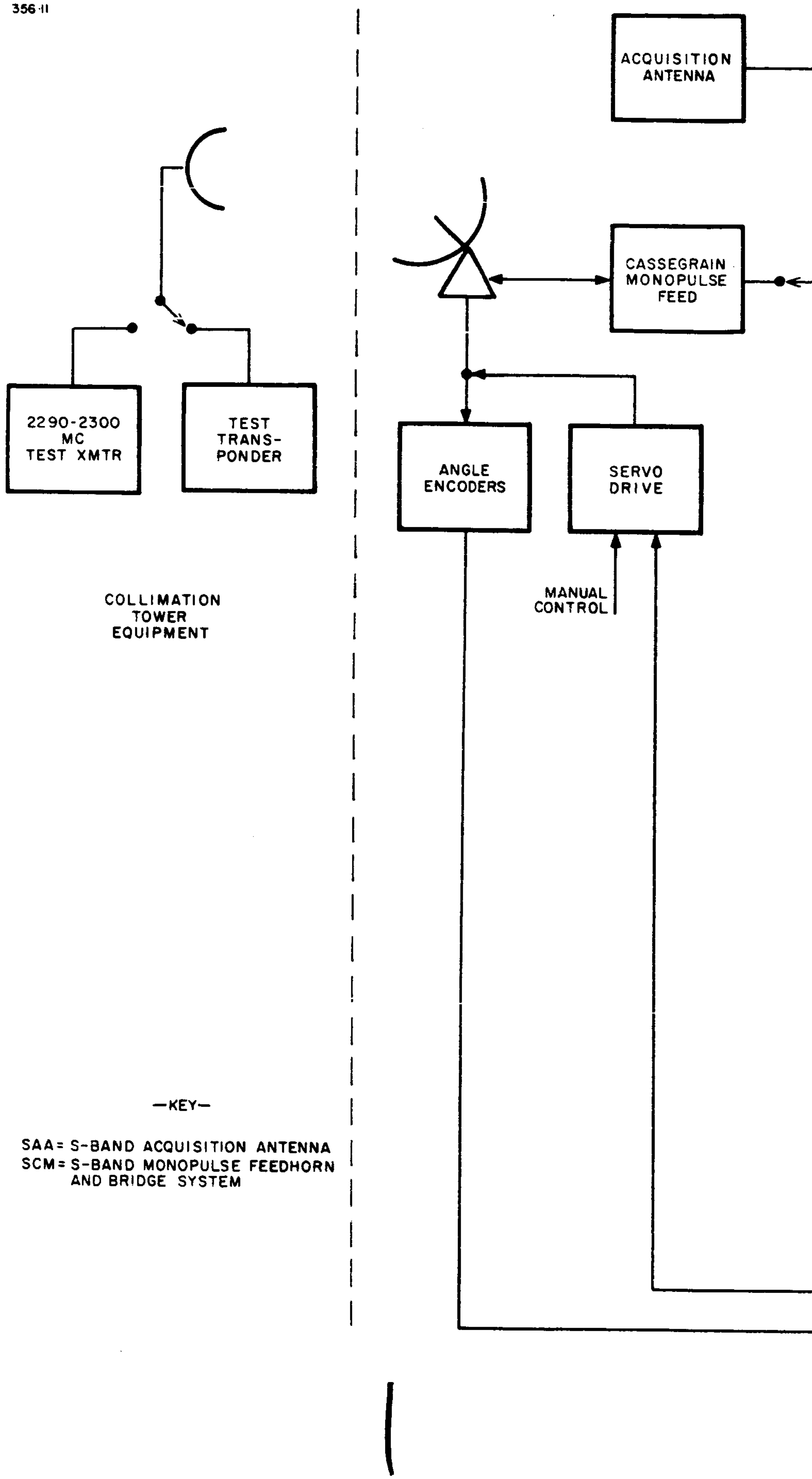
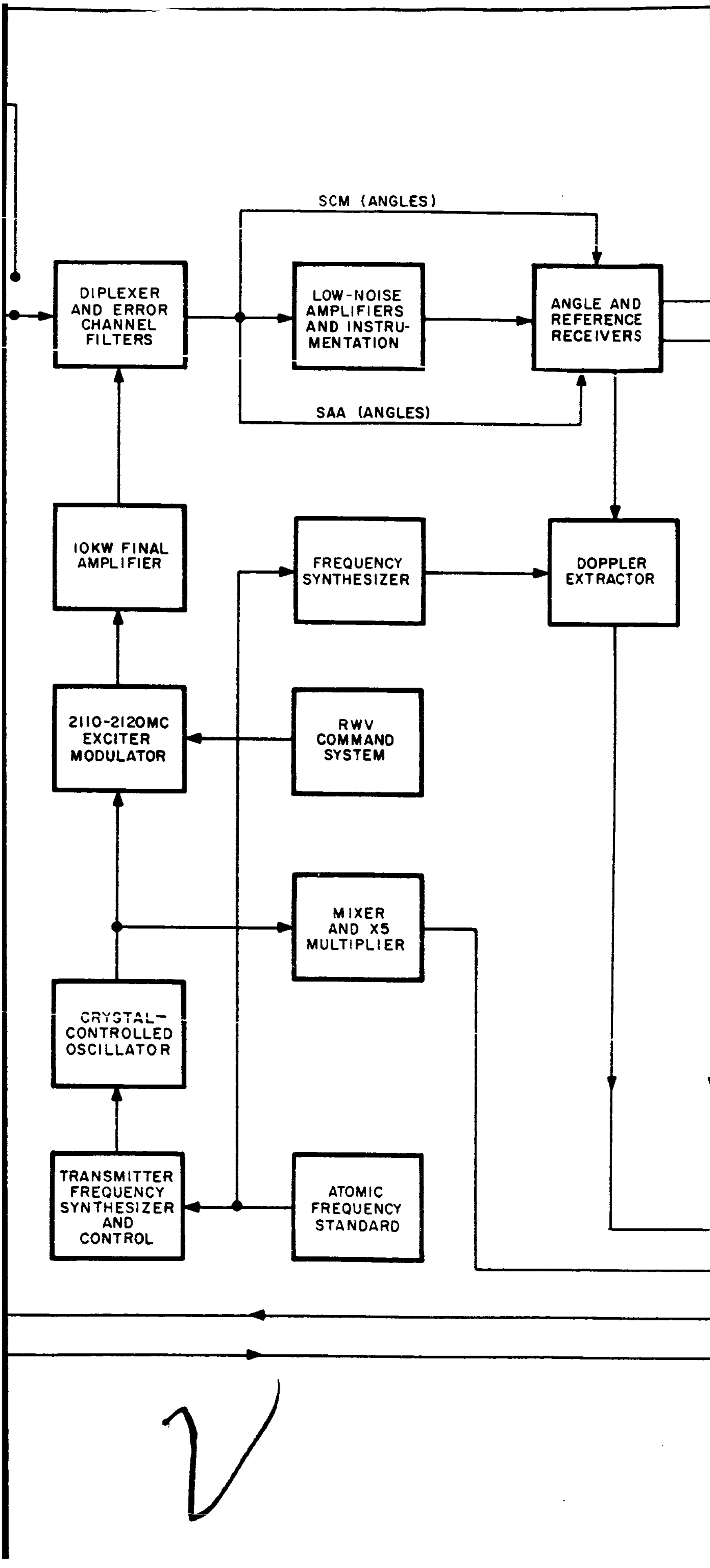


FIGURE II-2. MARINER MARS '64 TYPICAL DEEP SPACE STATION (S-BAND)

356-11


ACQUISITION ANTENNA
CASSEGRAIN MONOPULSE FEED
2290-2300 MC TEST XMTR
TEST TRANS-PONDER
ANGLE ENCODERS
SERVO DRIVE
MANUAL CONTROL
COLLIMATION TOWER EQUIPMENT
—KEY—
SAA= S-BAND ACQUISITION ANTENNA
SCM= S-BAND MONOPULSE FEEDHORN AND BRIDGE SYSTEM


SCM (ANGLES)
DIPLEXER AND ERROR CHANNEL FILTERS
LOW-NOISE AMPLIFIERS AND INSTRU-MENTATION
ANGLE AND REFERENCE RECEIVERS
SAA (ANGLES)
10KW FINAL AMPLIFIER
FREQUENCY SYNTHESIZER
DOPPLER EXTRACTOR
2110-2120MC EXCITER MODULATOR
RWV COMMAND SYSTEM
MIXER AND X5 MULTIPLIER
CRYSTAL-CONTROLLED OSCILLATOR
TRANSMITTER FREQUENCY SYNTHESIZER AND CONTROL
ATOMIC FREQUENCY STANDARD

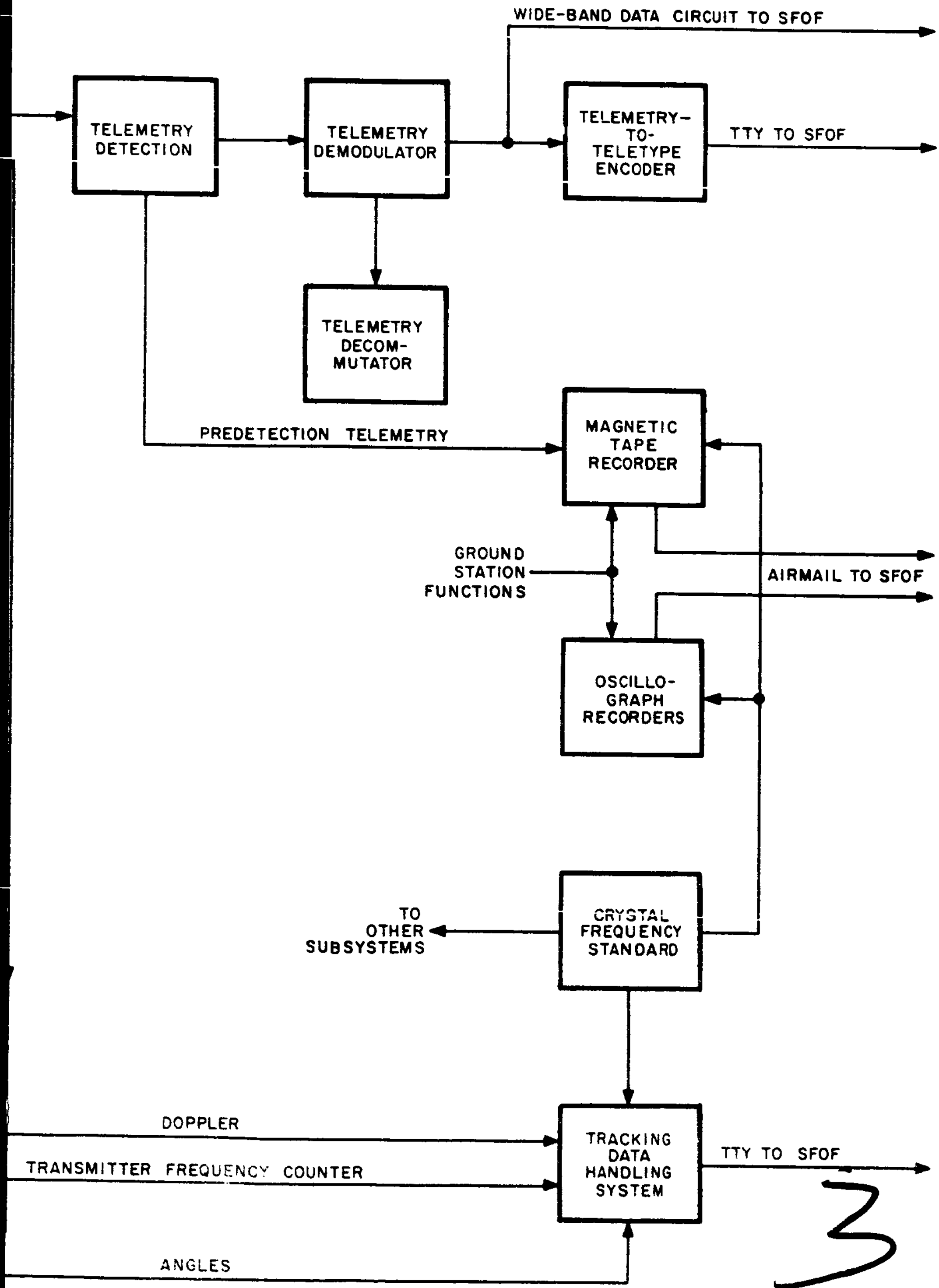


FIGURE II-3. MARINER MARS '64 TYPICAL DEEP SPACE STATION (L- TO S-BAND CONVERSION)

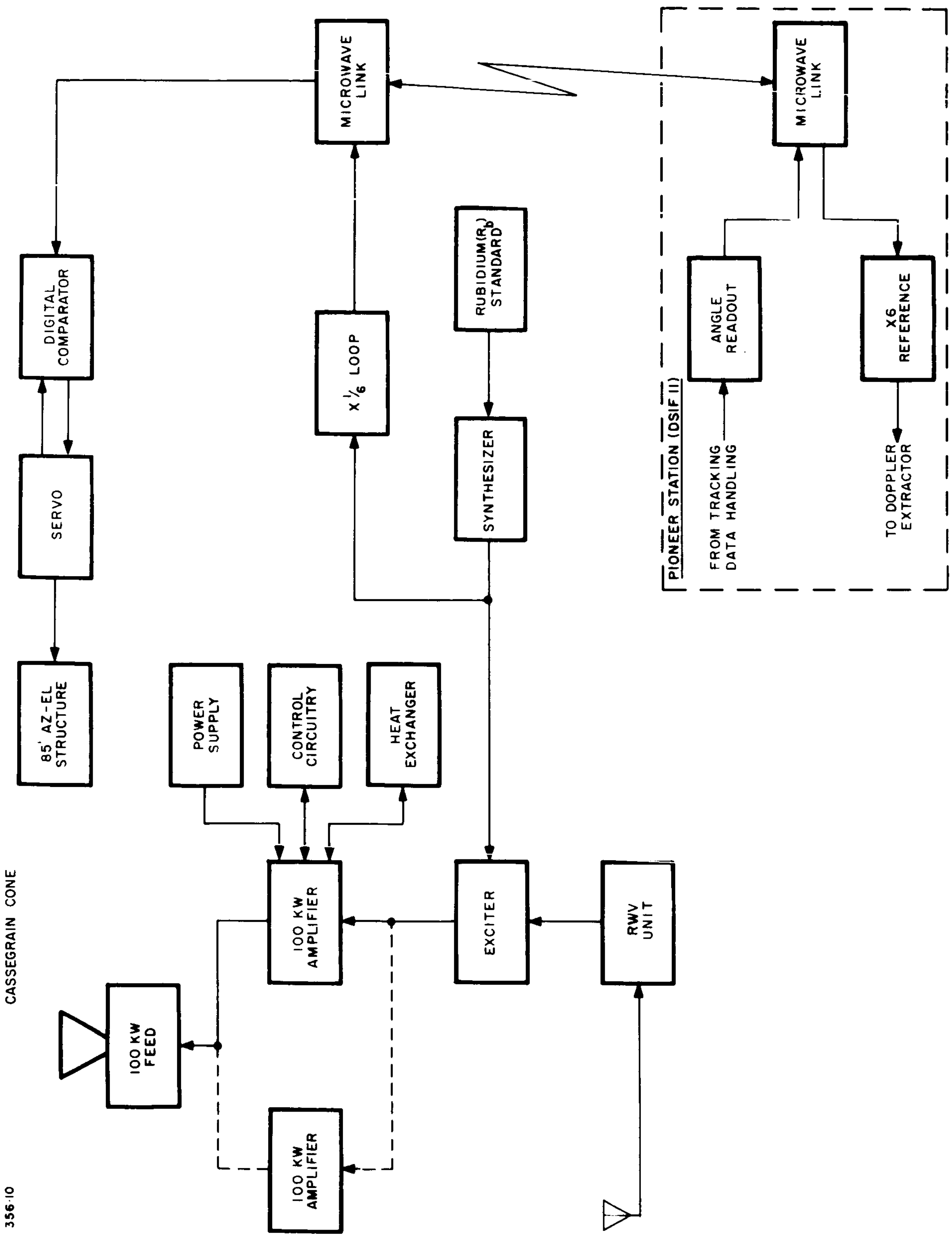


FIGURE II-4. GOLDSTONE VENUS STATION, DSIF 13 (100 KW TRANSMITTER)

TABLE II-VII. TRACKING DATA FROM THE DSIF

Tracking data from the DSIF will be in one of four forms, depending upon the station configuration and the use of the long form or the short form. All transmissions will be preceded by a descriptor as shown below.

DESCRIPTOR	C/R	L/F	F	XX	SF	XX	SF	XX	SF	XXXX	SF	XXXXXX	SF	XXX	SF
				STA ID		FORMAT ID		S/C ID		DATA CONDITION		GMT		DAY	

S-BAND LONG FORM FORMAT ID = 02	DESCRIPTOR	XXXXXXXXXX DOPPLER	SF	XXXXXXXXXXX RANGE AND RANGE DC	SF	XXXXXX LHA	SF	XXXXXX DEC			
S-BAND SHORT FORM FORMAT ID = 03	DESCRIPTOR	XXXXXXXXXX DOPPLER	SF	XXXXXXXXXXX RANGE AND RANGE DC							
L-S BAND LONG FORM FORMAT ID = 04	DESCRIPTOR	XXXXXXXXXX DOPPLER	SF	XXXXX SYN.	SF	XXXXXX LHA	SF	XXXXXX DEC			
L-S BAND SHORT FORM FORMAT ID = 05	DESCRIPTOR	XXXXXXXXXX DOPPLER	SF	XXXXX SYN.							

KEY. LHA = Local Hour Angle
DEC = Declination
SYN = Synthesizer (last 5 digits)

TABLE II-VIII. GROUND-ENCODED TELEMETRY DATA FORMATS

Mode I				
C R	L F	Engrg. Sync Word	19 Engrg. Data Words	P	One Data Frame
C R	L F	Engrg. Sync Word	19 Engrg. Data Words	P	One Data Frame
Mode II				
C R	L F	Engrg. Sync Word	19 Engrg. Data Words	P	
C R	L F		20 Science Words[1]	P	One Data Frame
C R	L F		20 Science Words[1]	P	
Mode III				
C R	L F		20 Science Words[1]	P	
C R	L F		20 Science Words[1]	P	One Data Frame
C R	L F		20 Science Words[1]	P	

TABLE II-VIII. (CONT'D)

<u>Mode IV</u>

Same line length as Mode III except the data frame (video picture line) will consist of 182 data words or 9 page print lines.

Time Tag Format (interjected into data every 5 minutes)

CR	LF	SS	SID	SID	9 Characters of Time	P

NOTE. Seven binary bits per TTY word, actually 10 binary bits constitute most science words. However, science words can be as short as one bit or as long as 15 bits.

CR	=	Carriage return (TTY) character
LF	=	Line feed (TTY) character
P	=	Horizontal line parity character
SS	=	Space
SID	=	Station Identification

TABLE II-IX. GROUND MODES

TRANSMIT/RECEIVE		FEED (CASSEGRAIN MOUNT)	
0.	No Receive (Transmit Only)	0.	Horn
1.	One-Way Doppler (Receive Only)	1.	Horn - Diplexer Combination (Receive and Transmit up to 10 kw)
2.	Two-Way, One Station (Transmit/Receive)	2.	Tracking - Diplexer Combination (Receive and Transmit up to 200 w)
3.	Two-Way, Two Stations Non-coherent (Receive Only)	3.	Acquisition Antenna
4.	Two-Way, Two Stations Coherent (Receive Only with Reference Signal From Transmit Station)	4.	Horn, No Diplexer (Receive Only)
5.	Receive Only. No Doppler		
Example:	GM 21; transmitting to spacecraft and receiving two-way doppler using a horn feed and diplexer.		

NOTE. Telemetry will be available in all receive modes except zero.

TABLE II-X. ACQUISITION AND PREDICTION INFORMATION FOR DSIF

Sample Rate

The sample rate for the earlier part of the initial view period will be one sample per 2 minutes; for the remainder of the view period the rate will be one sample per 5 minutes. One hour of data will be transmitted every hour. For all other view periods, one sample per 5 minutes will be supplied for each pass. The data will be updated each day. Transmission time per day of data is approximately 15 minutes.

Availability of Data

TIME	ORIGIN	FOR DSIF	SAMPLE RATE AND AMOUNT
L +22 m	IPP	51, 59	1 Sample per 2 m, Sta. rise to rise +24 m
L +25 m	IPP	41	1 Sample per 2 m, Sta. rise to rise +24 m
I +30 m	IPP	41, 51	1 Sample per 5 m, Sta. rise to rise +100 m
L +100 m	CCC	41, 51	1 Sample per 5 m, L +90 m to L +4 h
L +220 m	CCC	41, 51	1 Sample per 5 m, L +4 h to L +10 h
L +520 m	CCC	11, 41, 51	1 Sample per 5 m, L +9 h to L +30 h
L +1440 m	CCC	11, 41, 51	1 Sample per 5 m, L +26 h to L +10 days

During the critical portions of other missions, the DSIF may not be able to provide coverage of the Mariner Mars '64 Mission for the full 24-hour-per-day period. The amount of reduced coverage will be negotiated between the DSIF Operations Manager and the Mariner Mars '64 Space Flight Operations Director.

3. DSIF Station Tracking Reports

During a tracking period, tracking reports will be submitted as follows:

1) Every 30 minutes from Launch (L) to Midcourse Maneuver (M).

2) After Midcourse Maneuver, station reports will be transmitted at one-hour intervals.

Each tracking report should be identified with the launch-referenced time (e.g., L plus 60 minutes), and should contain the following information:

1) XXP1 Last five digits of T x VCO frequency (10-second count). GMT, and day of year every five minutes throughout the period covered by the report.

2) Modes.

   a) Start and/or end time of the ground station tracking mode and the actual GM

   b) The spacecraft T/M mode

3) The average signal level in dbm and AGC volts, any variation about this level, and the GMT of the signal level reading.

4) The telemetry condition (in- or out-of-lock condition of each channel, etc.).

5) The transmitter power and the transmitter on and off times.

6) Time (GMT) of significant events. For example:

   a) Time of acquisition

   b) Time of loss of signal

   c) Time of significant changes in the tracking system, e.g., receiver and servo bandwidth changes

   d) Time of abrupt frequency shifts

e) Time of changes in signal level corresponding to spacecraft events or commands

f) Time of command transmission

g) Time of verification of command transmission

h) Equipment failures and time of occurrence

D. SPACE FLIGHT OPERATIONS FACILITY (SFOF)

The role of the SFOF in the Mariner Mars '64 Mission is to provide an area where the premission planning and testing, and the execution of the mission can be conducted. The SFOF provides the technical and operational control areas, operational communications, and the data processing required to support the Mariner Mars '64 space flight operations. A detailed description of the SFOF can be found in the Space Flight Operations Facility System Specifications (SFOF-SS).

1. SFOF Coverage

The SFOF will supply 24-hour-per-day coverage to the Mariner Mars '64 Mission for the operational functions, beginning one week prior to the first flight and extending for the duration of the mission. Technical coverage will be varied in accordance with mission needs; however, technical monitoring coverage will be the same as operational coverage. The detailed coverage plans and procedures for the various groups will be found in Section VII of this document.

2. Operations and Control Areas in the SFOF

All mission flight operations, direction, and control will originate in the SFOF. Mission Control Room (MCR) Number 1 will be the control point during the high-activity (launch, midcourse, encounter, etc.) phases of the flight. The Planetary Operations Room (POR) will be the control point during the low-activity (cruise) phase of the flight. During the high-activity phases, each technical area may have a representative located in the Operations Area. These representatives will inform the SFOD of their respective activities and will also inform the personnel in their respective analysis areas of other activities that might affect performance in those areas.

During the low-activity (cruise) phase of flight, all data monitoring and data analysis will be performed in the POR. Cognizant personnel from the various analysis groups will be situated in the POR during the low-activity phase.

The operations and control areas are described in detail in the SFOF-SS.

3. Technical Areas

The technical areas are provided in the SFOF for the analysis and evaluation of mission data. These areas include the Flight Path Analysis Area (FPAA), the Spacecraft Performance Analysis Area (SPAA), and the Space Science Analysis Area (SSAA). Additionally, a Spacecraft Model Room is located in the SPAA. Computer inquiry stations (input/output) and status displays will be available in the technical areas. These technical areas, supervised by an area director (as outlined in Section I), will operate according to the procedures in Section VII.

4. Operational Communications

The Operational Communications System (OCS), controlled from the Communications Center in the SFOF, serves to provide two basic functions for the Mariner Mars '64 Mission: it controls the connecting of the various operational and technical areas to each other and to external networks, and it routes information in both directions between the DSIF stations and AFETR, and the appropriate areas in the SFOF.

Communication lines between the various DSIF stations and the SFOF are shown in Figure II-5; the AFETR communications are also shown. Although the high-speed data lines are shown as being available, it must be understood that their use should be planned on an engineering basis only, and that they are not fully qualified as operational inasmuch as the reliability and error rates have not been established.

5. Data Processing

The amount of data processing required for the Mariner C will vary as a function of the spacecraft activity; however, it is a Mariner Mars '64 requirement that full data processing be made available within 30 minutes after a request has been initiated by the SFOD or his designated representative.

The various types of data processing available in the SFOF are described in Section III of this document.

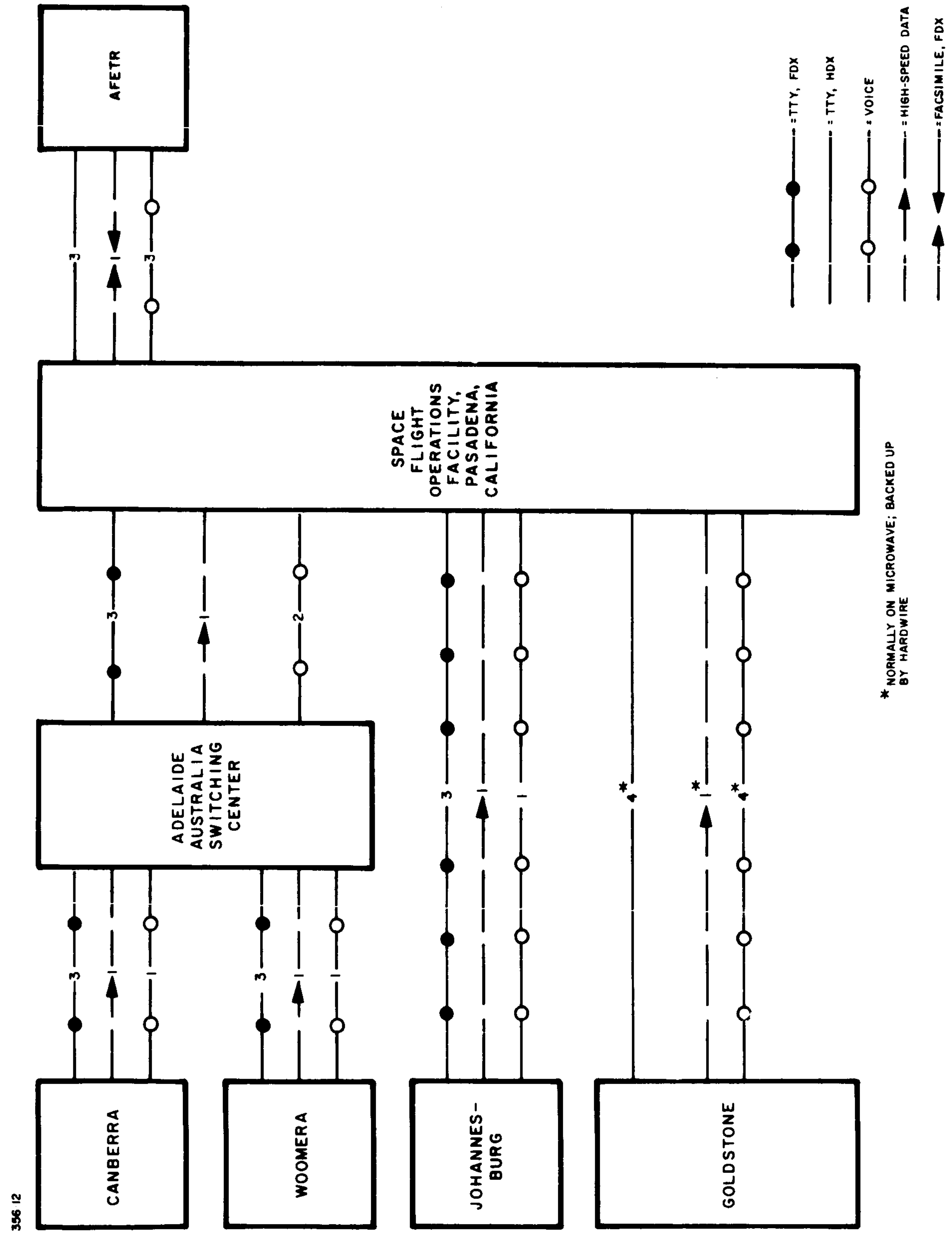


FIGURE II-5. COMMUNICATION LINES (DSN)

SECTION III

DATA FLOW AND PROCESSING

A. GENERAL

This section depicts the data flow paths to, from, and within the facilities that will support the Mariner Mars '64 Mission. The facilities referred to are the Air Force Eastern Test Range (AFETR), the Deep Space Instrumentation Facility (DSIF), and the Space Flight Operations Facility (SFOF). Also discussed in this Section are data flow, raw data flow, the Data Processing System (DPS), and data processing hardware, configurations, and controls. The mode of data processing used at any given time is primarily dictated by the Standard Sequence of Events, Table V-I.

The nature of the space flight operation is such that real time data flow is of prime concern. Control of this flow and of data processing is necessary so that the proper data is received and processed at the proper intervals. The Mariner Mars '64 operation is concerned with real time and nonreal time data.

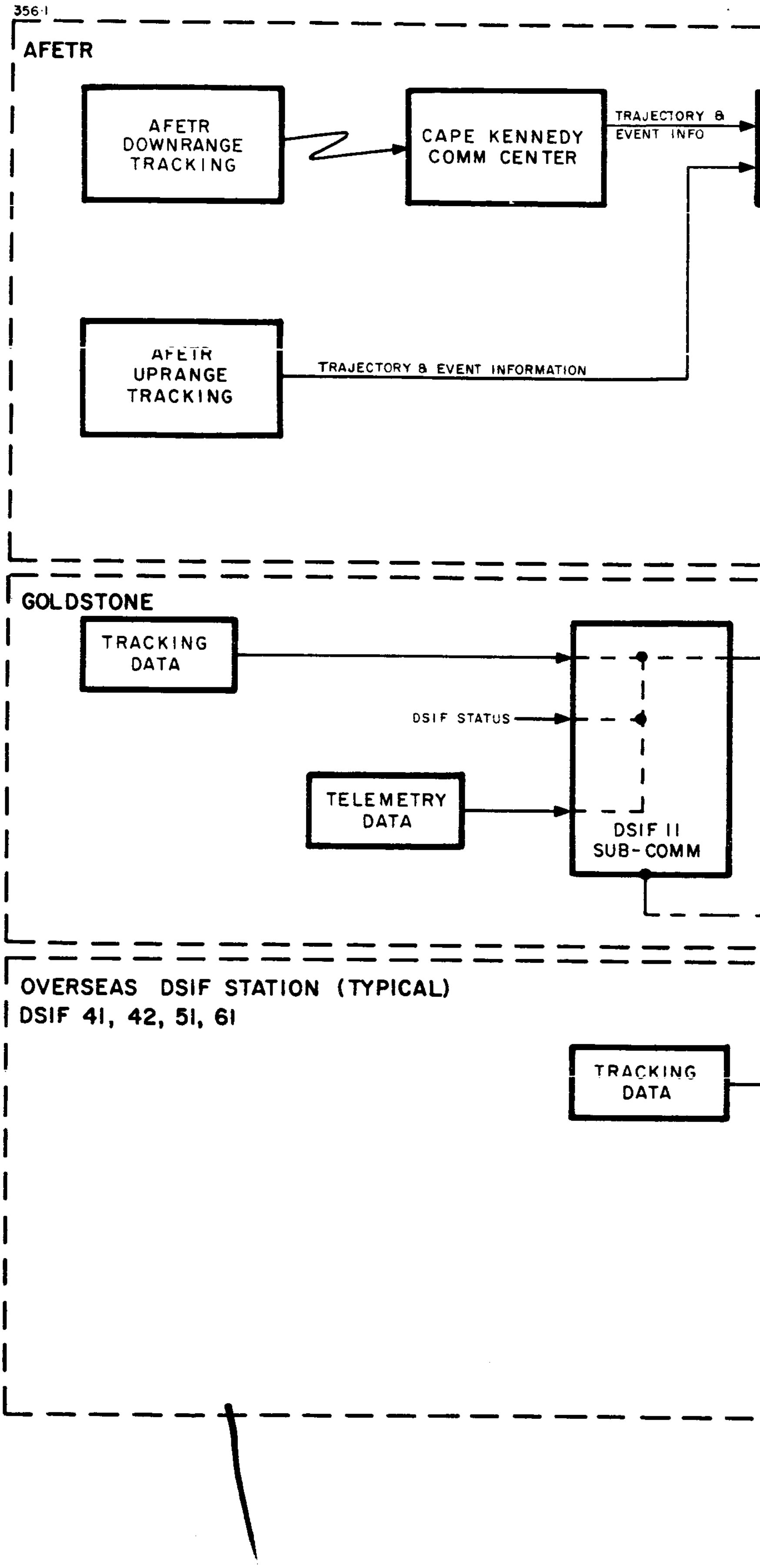
1. Real Time Data

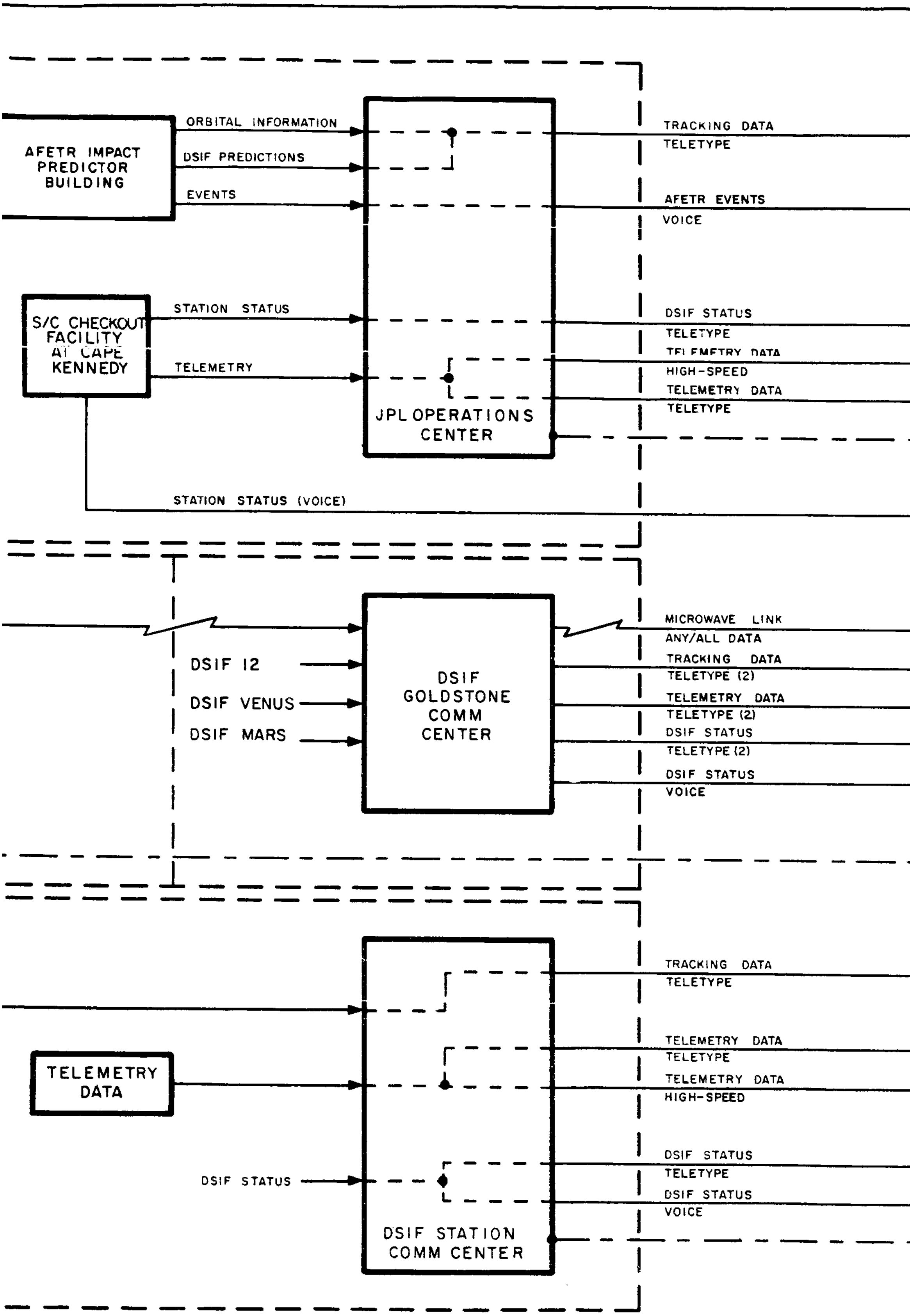
This is data received in real or near-real time via hardline or radio communication link and entered automatically in the DPS. The data is operated upon by the processing system and displayed on-line in the user areas as rapidly as operational priorities and user programs permit. Data is classified as real time if it is transmitted via microwave, phone line, or teletype within five minutes (in the case of Goldstone) or ten minutes (in the case of other DSS) from time of receipt at the DSIF station. If buffered in the link (including the DPS) for more than five but less than thirty minutes, it is classified as near-real time.

2. Nonreal Time Data

This is data received by the DPS either in the form of magnetic tape recordings or of delayed transmissions from a communications link (more than thirty minutes after receipt of data at the DSIF station). Its main characteristic is that the processing is delayed and the results are prepared off-line from the DPS. There is no necessity for a feedback path from the analysis area nor for very rapid throughput and display. Data from the sources is entered, directly or by magnetic tape, in either of the two available 7040s which will perform the same input functions performed on real time data but will record the collected and formatted input data on magnetic tape only. These tapes will then be batch-processed on the 7094 at prescheduled intervals and magnetic tapes will be generated to drive the off-line display devices.

The complete data flow to, within, and from the SFOF is shown in Figures III-1, III-2, and III-3. The flow from the SFOF comprises acquisition


356-1
AFETR
AFETR DOWNRANGE TRACKING
CAPE KENNEDY COMM CENTER
TRAJECTORY & EVENT INFO
AFETR UPRANGE TRACKING
TRAJECTORY & EVENT INFORMATION
GOLDSTONE
TRACKING DATA
DSIF STATUS
TELEMETRY DATA
DSIF 11 SUB-COMM
OVERSEAS DSIF STATION (TYPICAL)
DSIF 41, 42, 51, 61
TRACKING DATA


AFETR IMPACT PREDICTOR BUILDING
ORBITAL INFORMATION
DSIF PREDICTIONS
EVENTS
TRACKING DATA
TELETYPE
AFETR EVENTS
VOICE
S/C CHECKOUT FACILITY AT CAPE KENNEDY
STATION STATUS
TELEMETRY
DSIF STATUS
TELETYPE
TELEMETRY DATA
HIGH-SPEED
TELEMETRY DATA
TELETYPE
JPL OPERATIONS CENTER
STATION STATUS (VOICE)
DSIF 12
DSIF VENUS
DSIF MARS
DSIF GOLDSTONE COMM CENTER
MICROWAVE LINK
ANY/ALL DATA
TRACKING DATA
TELETYPE (2)
TELEMETRY DATA
TELETYPE (2)
DSIF STATUS
TELETYPE (2)
DSIF STATUS
VOICE
TRACKING DATA
TELETYPE
TELEMETRY DATA
TELEMETRY DATA
TELETYPE
TELEMETRY DATA
HIGH-SPEED
DSIF STATUS
DSIF STATUS
TELETYPE
DSIF STATUS
VOICE
DSIF STATION COMM CENTER

2

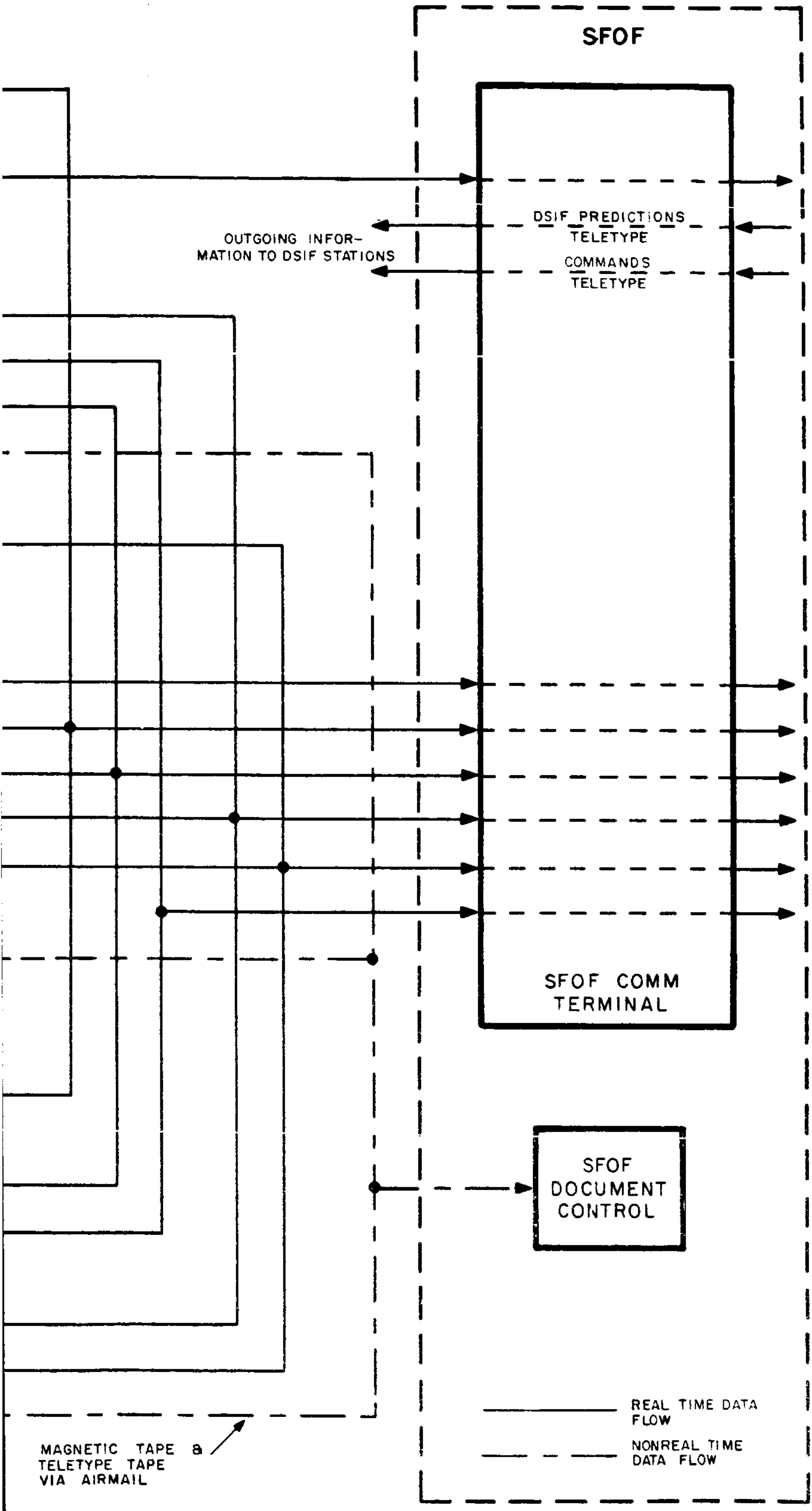
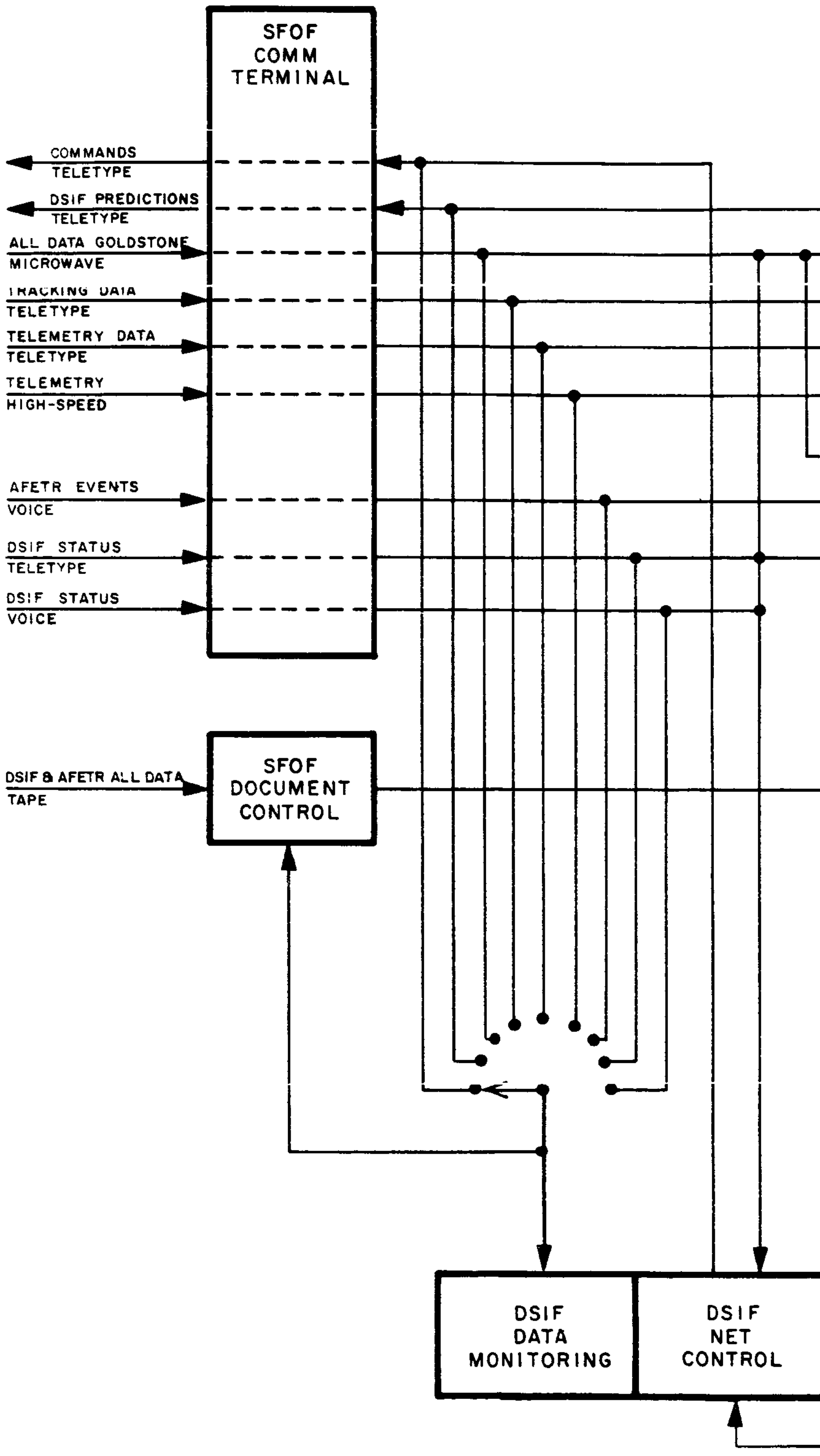
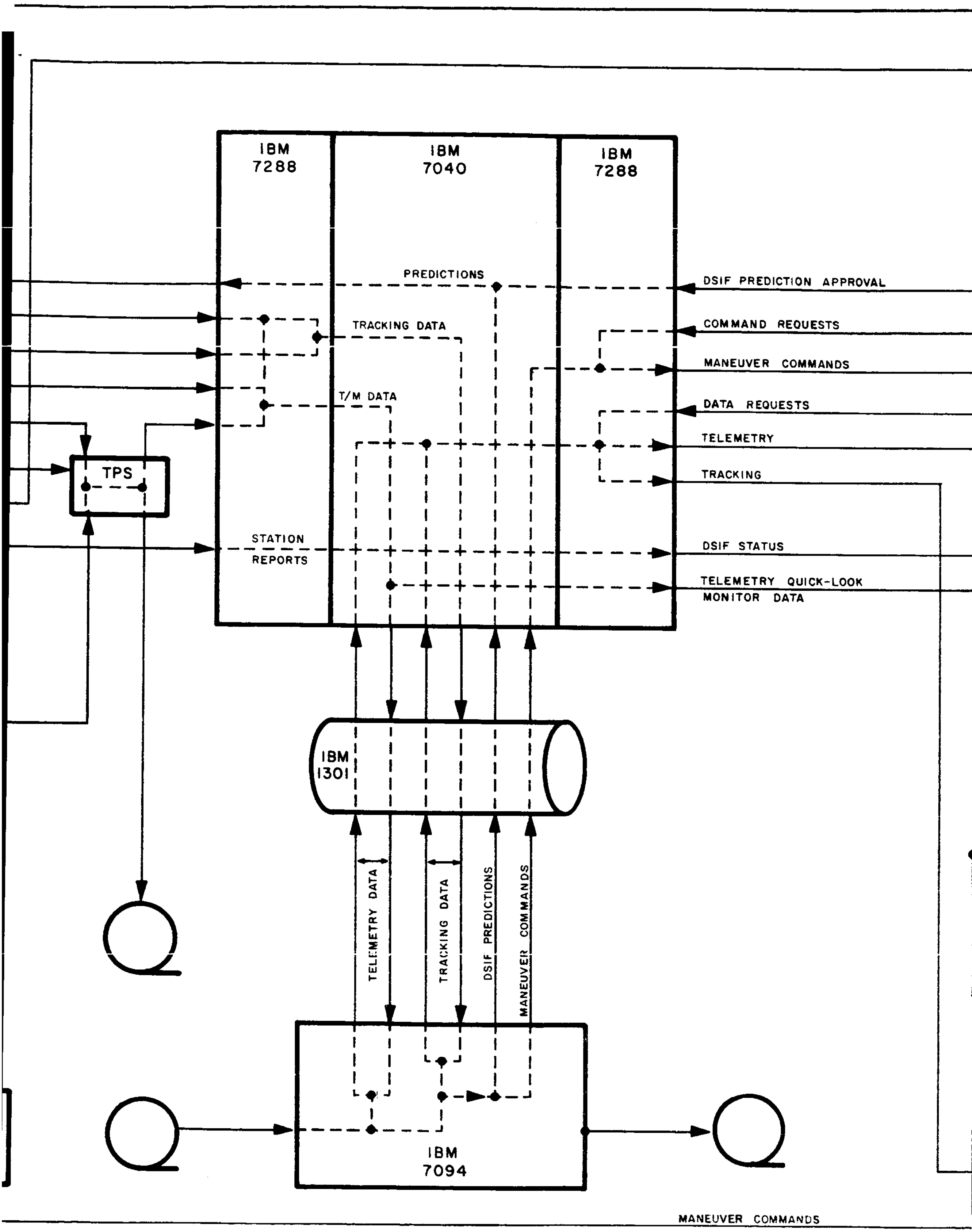


FIGURE III-1. DATA FLOW FROM AFETR AND THE DSIF TO THE SFOF

3

356-2


SFOF COMM TERMINAL
COMMANDS TELETYPE
DSIF PREDICTIONS TELETYPE
ALL DATA GOLDSTONE MICROWAVE
TRACKING DATA TELETYPE
TELEMETRY DATA TELETYPE
TELEMETRY HIGH-SPEED
AFETR EVENTS VOICE
DSIF STATUS TELETYPE
DSIF STATUS VOICE
DSIF & AFETR ALL DATA TAPE
SFOF DOCUMENT CONTROL
DSIF DATA MONITORING
DSIF NET CONTROL



IBM 7288
IBM 7040
IBM 7288
PREDICTIONS
TRACKING DATA
T/M DATA
STATION REPORTS
TPS
DSIF PREDICTION APPROVAL
COMMAND REQUESTS
MANEUVER COMMANDS
DATA REQUESTS
TELEMETRY
TRACKING
DSIF STATUS
TELEMETRY QUICK-LOOK MONITOR DATA
IBM 1301
TELEMETRY DATA
TRACKING DATA
DSIF PREDICTIONS
MANEUVER COMMANDS
IBM 7094
MANEUVER COMMANDS

2

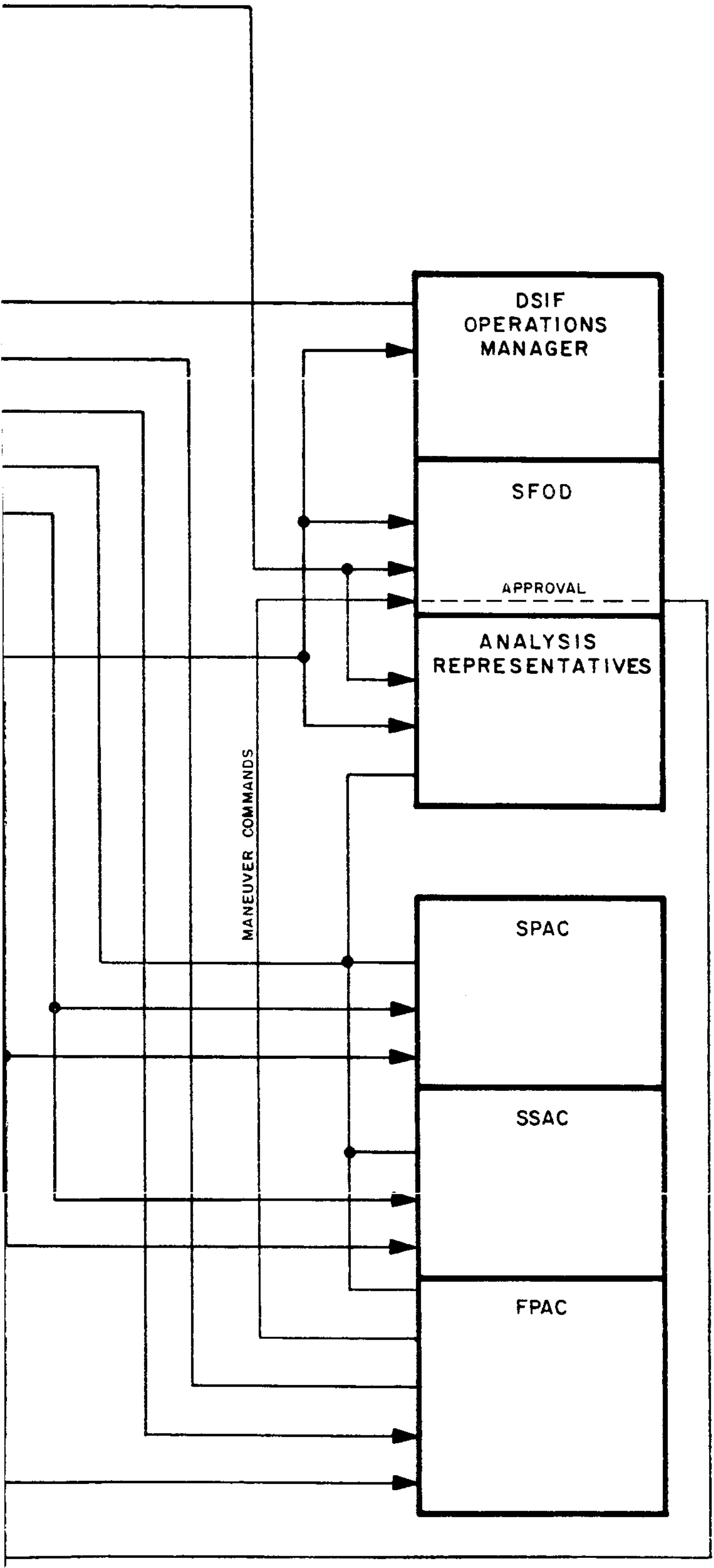


FIGURE III-2. COMPLETE DATA FLOW WITHIN THE SPACE FLIGHT OPERATIONS FACILITY

2

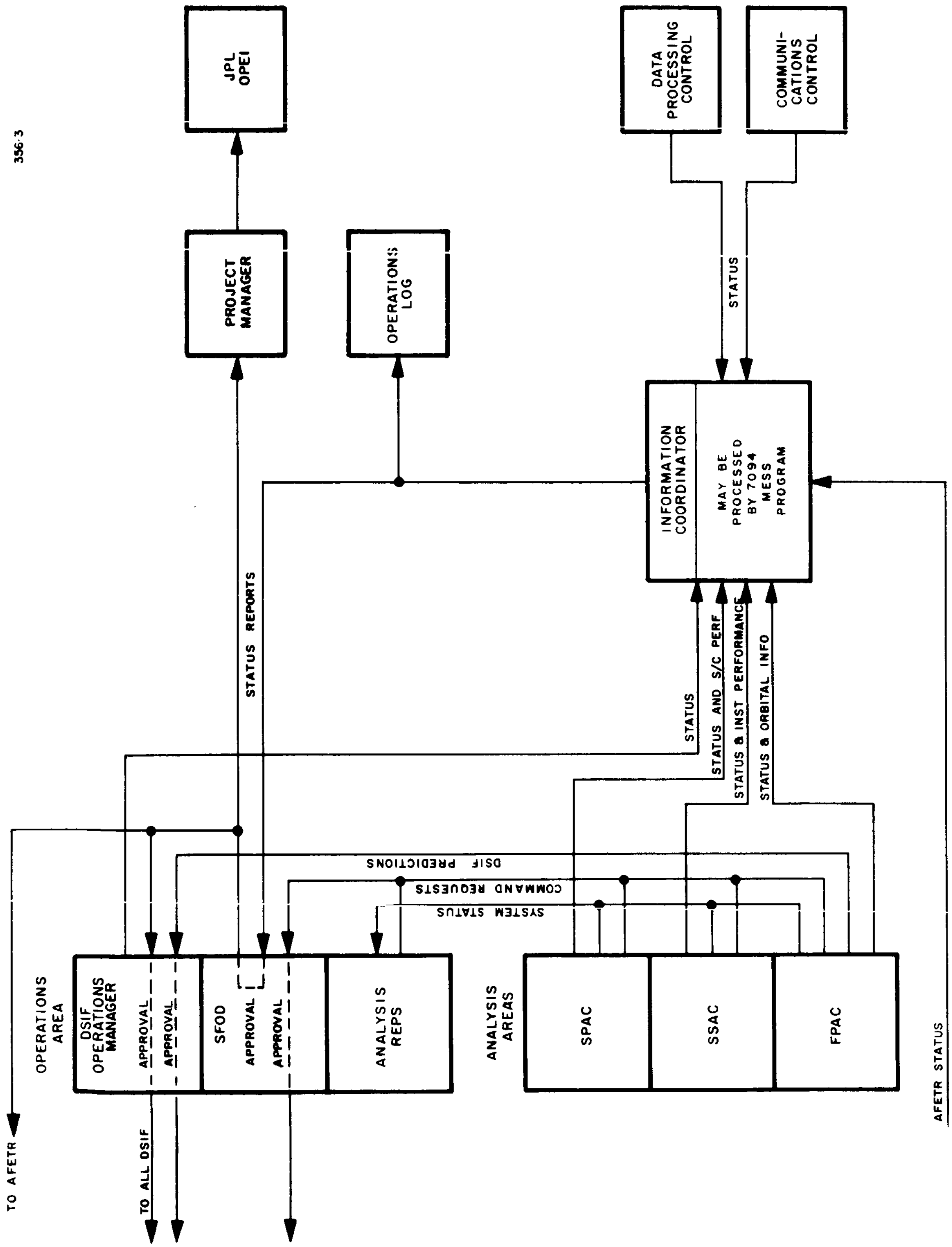


FIGURE III-3. COMPLETE DATA FLOW FROM THE SPACE FLIGHT OPERATIONS FACILITY and tracking information and commands for the DSIF, general status information, and spacecraft performance data. The flow of scientific data from the SFOF is described in Section VII of this document. All DSIF flight data will be forwarded within 48 hours to:

SFOF Document Control
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California, 91003
U. S. A.

The incoming data circuits will be routed through the Communications Center to the 7288 for processing by the 7040. This data will also be available on teletype (TTY) machines and closed-circuit TV (CCTV) in the user areas.

B. DATA PROCESSING SYSTEM

The mathematical processing of incoming data constitutes the major effort in data handling in the SFOF. The type of incoming data (whether telemetry or tracking), as well as the ultimate users, determine the type of computation required. The principal groups using spacecraft or spacecraft-related data and the type of data they use are listed below. It is the responsibility of these groups to interpret, analyze, and evaluate the type of data of which they are cognizant.

GROUP	TYPE OF DATA
Spacecraft Performance Analysis and Command	Engineering telemetry
Space Science Analysis and Command	Science telemetry
Flight Path Analysis and Command	Tracking data
DSIF Net Control	DSIF status
Mission and Operations Control	Summary of all data and status

The SFOF DPS will provide the services described below in support of the above-mentioned operations.

1. The following are fed into the 7040: all data from teletype, phone lines, microwave channels, and from the TPS; also all requests, parameters, and data from the user areas (see Figure III-4) via the inquiry station or the card readers. These inputs are identified and separated by mission number and type of data; the data types include tracking, telemetry, and administrative. All incoming data is written on raw data tape in a sequential mode with proper identification to allow separation and processing in the 7094 in nonreal time.

356-4

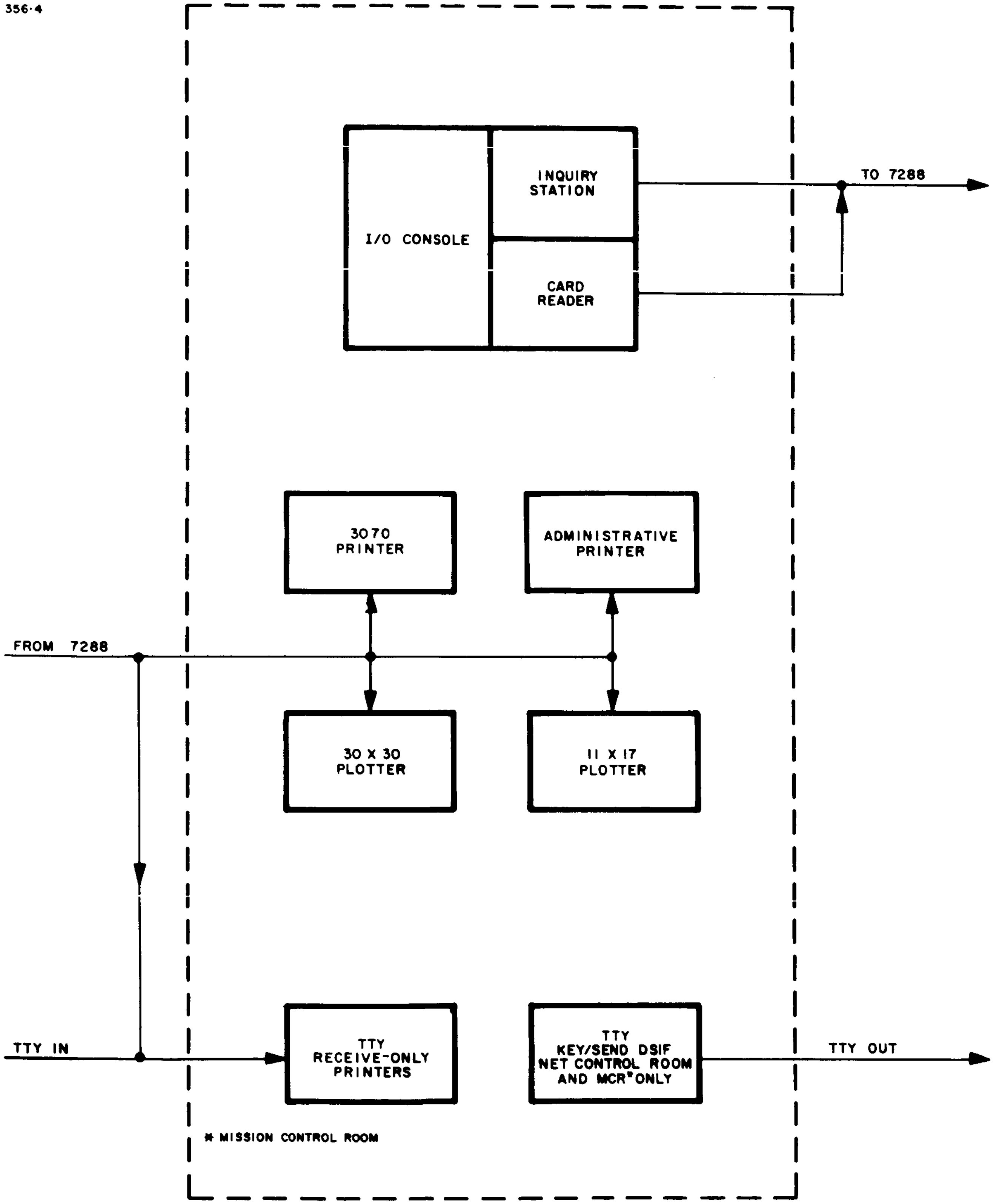


FIGURE III-4. TYPICAL USER AREA EQUIPMENT

If overlaps occur in DSIF coverage and two stations send telemetry data to the SFOF from the same spacecraft, the choice of transmission to be inserted in the 7040 will be determined through the DPCC. The transmission from the rejected station will be recorded but will not be available for further real time processing. Two stations may send data from two different spacecraft. One of the two spacecraft must be designated as active and one as standby. The active mission data will be transferred to disc, while the standby mission data will be placed on tape.

2. The 7094 Complex performs functions in both on-line and off-line modes. By means of it, the Raw Data Table is sorted into a Master Data Table for analysis routines. From these routines final reduced data prints and plots of all data are generated for the Disc, 1401, and 4020. Through the 7094, telemetry data from the TPS and raw data tapes recorded by the 7040 are also processed, and the midcourse maneuver commands and DSIF predictions are computed and generated for transmission to the DSIF.

3. The TPS (Figure III-5) will be used to convert telemetry data received in analog, digital, or composite subcarrier form to a format compatible with a 7288 high-speed subchannel and with 7094-compatible magnetic tape. The conversion process is accomplished either in real time using the High-Speed Data Communications System or in nonreal time using data recorded on magnetic tapes.

During the most critical portions of a mission, it is possible to provide parallel processing through the TPS, thereby providing a backup capability in the event of prime TPS failure. Each TPS is equipped with two parallel output buffers that feed subchannels in two different 7288s. In the event of prime 7040 failure, the two parallel output buffers permit the backup 7040 to be switched into the prime position without disturbing the data flow.

The TPS will operate in four different modes as follows:

a) <u>Mode I - Dual-Thread Mode</u>

When the Computer Subsystem is operating in a backed-up mode (Modes I, IIA, or IIIA), the TPS will provide dual-thread processing (see Figure III-6) of the data inputs, and will provide a simultaneous output from each processing path. Each of these outputs will be patched to a different 7040 Complex.

b) <u>Mode II - Single-Thread Mode</u>

When the Computer Subsystem is operating in a nonbacked-up mode (Modes IIB, IIIB, or IV), the TPS will provide single-thread (see Figure III-6) processing of the data inputs and will provide one output for the mission.

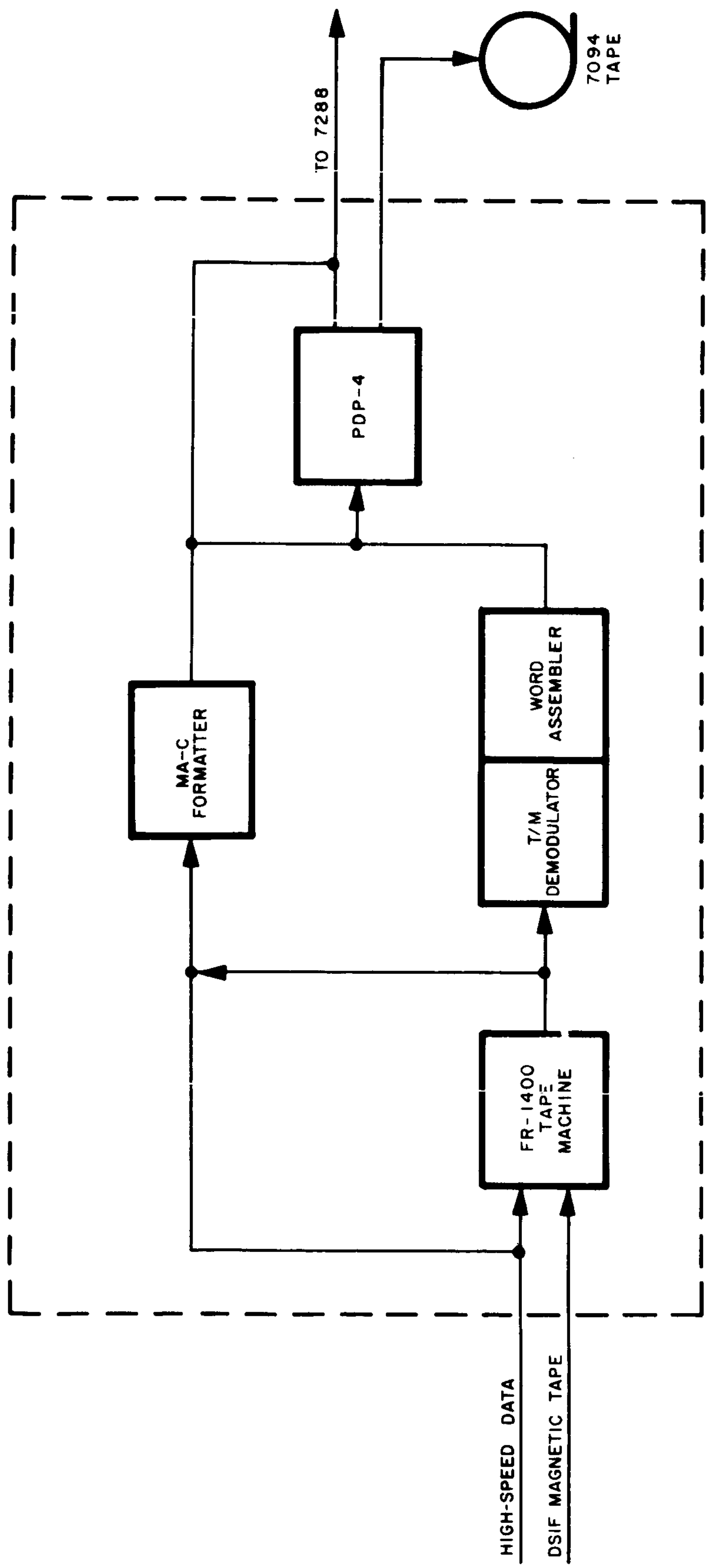
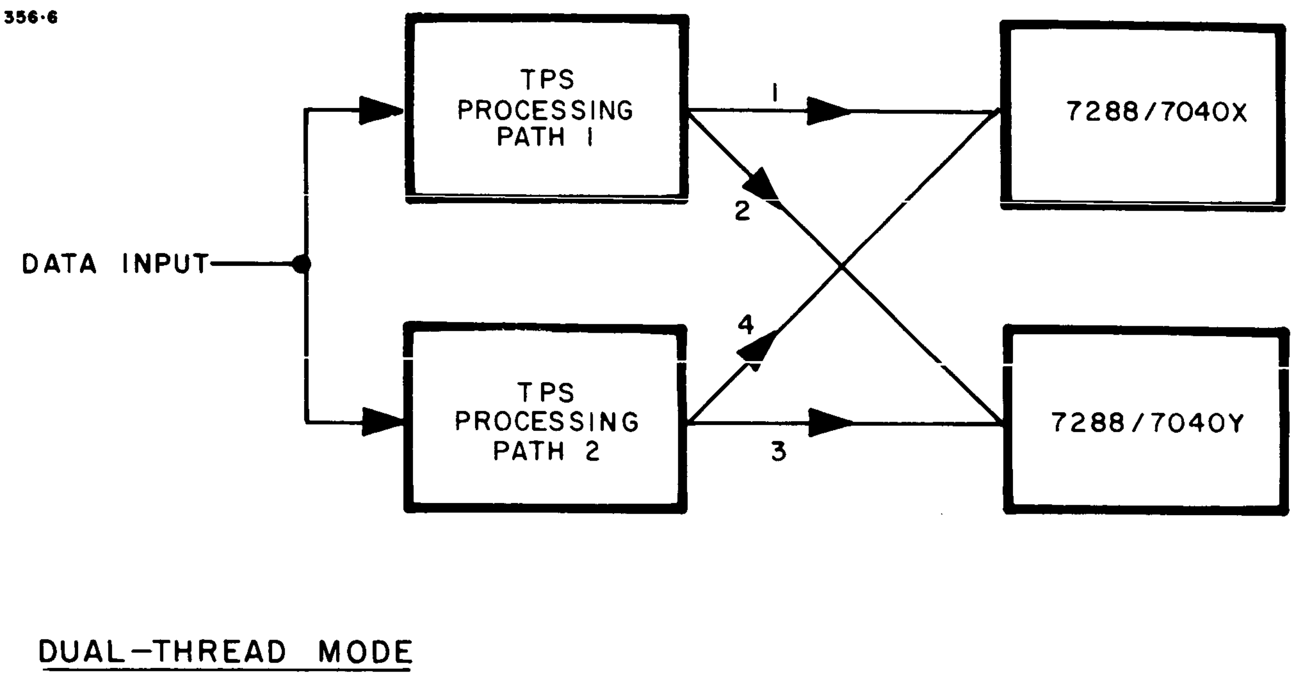
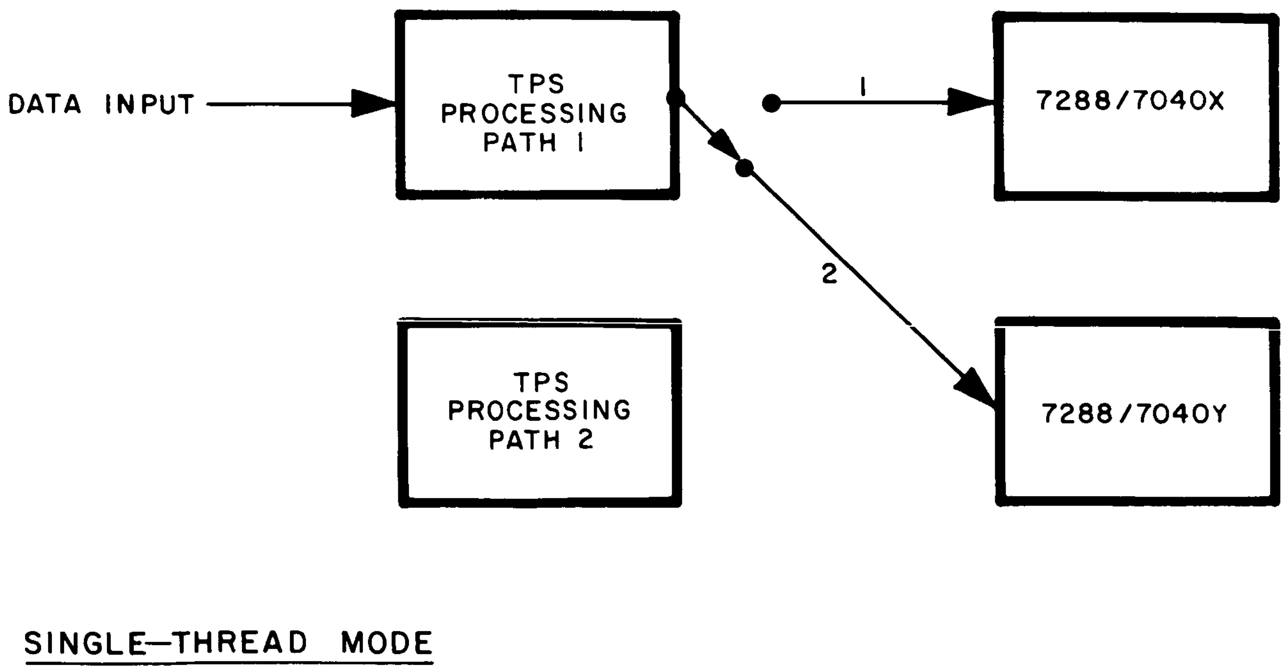


FIGURE III-5. TELEMETRY PROCESSING STATION





NOTE: TPS OUTPUT PATHS 1&3 LABELLED ABOVE ARE NORMAL OUTPUT CABLE PATCHES. OUTPUT PATHS 2&4 CAN BE PATCHED ALSO, IF REQUIRED.

FIGURE III-6. SINGLE- AND DUAL-THREAD TPS PROCESSING MODES

c) Mode III - Logging

When the TPS Subsystem is not sending high-speed data directly to the 7040s, the data will be logged in one or more of the manners described in Table III-I.

d) Mode IV - Analog Tape Playback

Analog tapes recorded at the DSIF and in the SFOF will be processed in the manner described in Table III-I.

TABLE III-I. DATA LOGGING AND PROCESSING CAPABILITIES

Mode	High-Speed Line Input	FR-1400 Recording	IBM Compatible Recording	Strip Chart Recording	High-Speed Output to 7040
I	X	X	X	X	X
II	X	X	X	X	X
III	X	X	X	X	
IV			X	X	

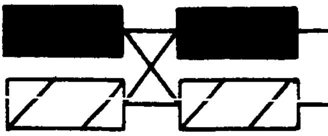
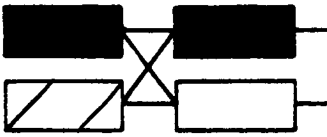
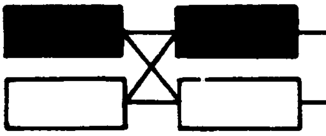
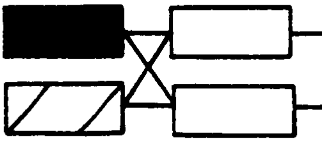
C. DATA PROCESSING CONTROL

Flight status and data type determine the DPS mode of operation and the control programs.

The DPS has six operational modes (see Table III-II). These modes provide different data throughput and failure recovery times as required for various mission conditions. The flow of data through the DPS is controlled from the Data Processing Control Console (DPCC). All switching of Computer Subsystem and I/O equipment, as well as the control of the computer program priorities, is initiated at this console. Control functions at the DPCC are based on equipment performance and on operational requirements specified by the SFOD. The seven user areas in the SFOF contain computer I/O equipment. These areas perform data analysis and/or command/control functions in the Data Processing System.

The Mariner Mars '64 mission-dependent data processing programs are divided into three categories:

1) Real time operational monitoring and processing programs that include all 7040 computer programs.

MODE	EQUIPMENT CONFIGURATIO
I	7040 1301 
IIA	
IIB	
IIIA	

Note. See Legend next page.

TABLE III-II. OPERATIONAL MODES OF THE DATA PR

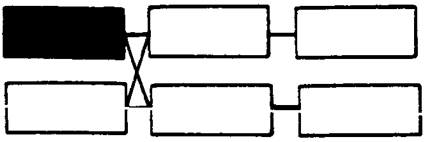
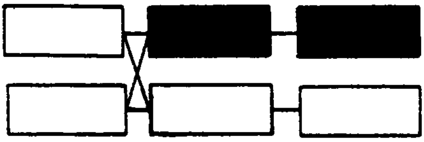
ON	DATA PROCESSING PATHS	
7094		
	Two complete real time parallel processing paths using two each 7040, 1301, and 7094. Failure recovery time: Immediate.	This r portio time c mum syster event
	One complete real time processing path with 7040 backup only. 7040 failure recovery time: Immediate. 7094 failure recovery time: 30 minutes maximum.	This r featur there Compl
	One complete real time processing path with no backup. 7040 failure recovery time: 5 to 50 minutes. 7094 failure recovery time: 30 minutes maximum.	In Mod File C No bac
	Real time processing by two parallel 7040s only. Data for 7094 processing is batched.	Mode either mode, As in parall real ti 7094 i on ma failure Recove will ta also u

(This table continued on next page.)

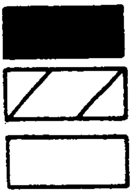
OCESSING SYSTEM

USES
node is designed for use in the most critical ns of a mission when the quickest reaction of the SFOF is required. Mode I takes maxi- advantage of the redundancy built into the n and affords shortest recovery time in the of failure.
node of operation incorporates the 7040 backup e described in the Mode I configuration. However, is no backup available for the Disc and 7094 lexes.
de IIB one complete subsystem (a 7040, a Disc omplex, and a 7094) is assigned to the mission. ckup of input or processing is assigned.
IIIA is used when the throughput time achieved in Mode IIA or Mode IIB is not required. In this all 7094 processing is performed on a batch basis. Mode IIA, all data from remote sites is flowing in el to both 7040s. The active 7040 is used to provide me outputs for user areas and to prepare tapes for nput. The standby 7040 is used to log all input data gnetic tape for use in recovery in the event of a requiring the standby 7040 to become active. ery, in the event of an on-line 7040 Complex failure, ke a maximum of ten seconds. The standby 7040 is sed for testing failing external devices.

3

MODE	EQUIPMENT CONFIGURATION
IIIB	7040 1301 7094 
IV	

LEGEND.



- Primary Data P
- Backup Data Pr
- Available for P

TABLE III-II. (CONT'D)

DATA PROCESSING PATHS	
Real time processing by one 7040 only, with no backup. Data for 7094 processing is batched.	This mode is sin the second 7040 for test purposes capability as Mo significantly lon may, as in Mode
Noncritical, nonreal time 7094 disc processing of batched data. Output is via IBM 1403 and SC 4020.	Mode IV is a non or 7094/Disc op consist of batch Because of the n significant only pended until rec prespecified inte and the IBM 140

rocessing Path for Two Spacecraft

ocessing Path for Same Two Spacecraft

ocessing Data from Additional Spacecraft

2

USES
ɪilar to Mode IIIA with the exception that ɪs not in standby mode and is not available ɪ. This mode provides the same operational ɪe IIIA, but failure recovery time may be ɪer. In the event of a 7040 failure recovery IIB, take up to one hour.
ɪreal time mode that involves only the 7094 ɪration. All operation in this mode will ɪrocessing of previously collected data. ɪncritical nature of this mode, failures are ɪn that they cause the operation to be sus- ɪvery is accomplished. Processing is at ɪrvals in this mode and output is via the 4020 ɪ printers.

3

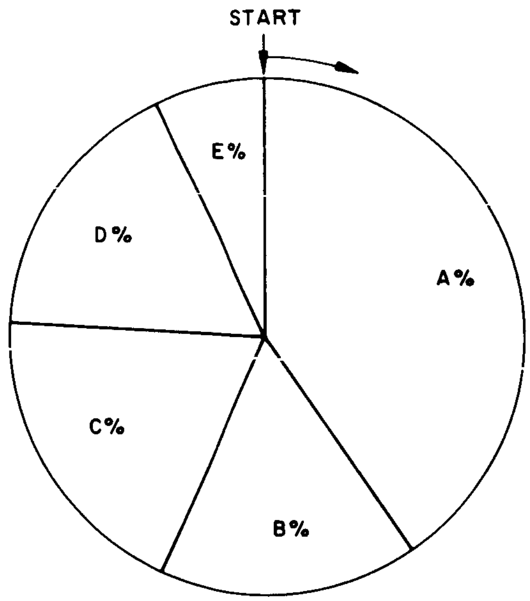
2) Near-real time operational space flight analysis programs that are processed in the 7094 computer for operational flight path analysis and spacecraft and science instrument performance analysis.

3) Nonreal time space flight analysis and research programs that have multiple options and functions.

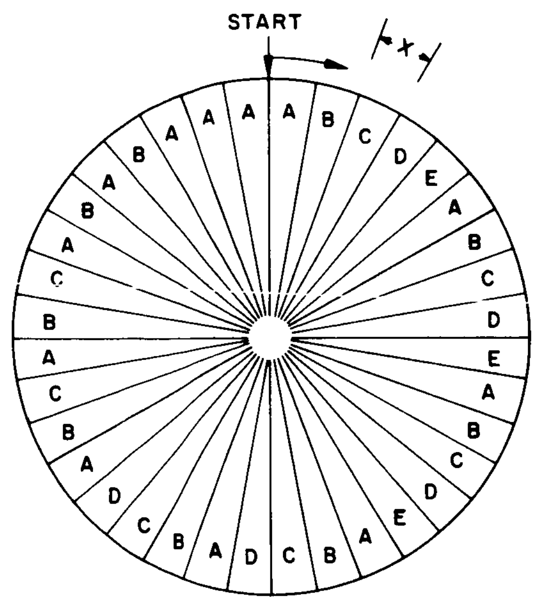
The 7094 computer programs are controlled by a percentage time-sharing scheme (Figure III-7). The percentages are fixed by the SFOD and are based on user preflight requests and the Standard Sequence of Events, Table V-I.

A detailed description of the operation of the 7040 and 7094 control programs will be found in Programming Standards for SFOF User Programs, EPD-125. A more detailed description of the SFOF Data Processing System will be found in EPD-23.

340-III7



a. ALLOWABLE PROGRAM RUN TIME IN PER CENT OF SOME ARBITRARY TOTAL CYCLE TIME



b. PROGRAM RUN SEQUENCE; X = FIXED EXECUTION INTERVAL OF EACH PROGRAM

FIGURE III-7. IBM 7094 PROCESSING CONTROL SCHEME

SECTION IV

SPACECRAFT COMMANDS

A. GENERAL

It is the purpose of this section of the SFOP to describe the operational aspects of the Mariner C command system and to state general control procedures for its use.

There are two major categories of commands: 1) on board and 2) ground. The on-board command sequence and timing are issued by the Central Computer and Sequencer (CC&S) which is preset prior to launch. These on-board spacecraft commands are listed in the Standard Sequence of Events, Section V, as events occurring on the spacecraft. The ground commands are transmitted from the ground to the spacecraft for corrective action in event of nonstandard space flight operation.

B. COMMAND PHILOSOPHY AND CONTROL

The following items constitute the basic ground rules of philosophy and control on the use of ground commands:

1) No ground command will be necessary or will be used in the course of standard space flight operations.

2) Any command or commands deemed necessary for corrective action or for achieving standard space flight operation must be approved by the Space Flight Operations Director. Upon concurrence of the Project Manager, the commands will be transmitted to the DSIF station for execution.

3) Command requests will be made only by the technical and operations teams within the SFOF using approved command decision procedures outlined in Section VI of this document.

4) Although two trajectory correction maneuvers are available, only one maneuver should be necessary to achieve a nominal space flight operation. The second maneuver will be used only if the first maneuver fails to supply the proper or adequate trajectory correction. However, it is possible that the second maneuver may be performed as a propulsion experiment after all mission objectives have been met.

5) The procedure by which commands are transmitted from the SFOF to the DSIF is outlined in paragraph G of this section. The DSIF procedure for transmitting commands to the spacecraft is found in the Tracking Instruction Manual (TIM), EPD-167.

C. GROUND COMMANDS

The ground commands transmitted from the DSIF stations are divided into two types:

1) Direct (execute) Commands (DC) which initiate instant action on board the spacecraft.

2) Quantitative (information) Commands (QC) which are stored in the CC&S for the purpose of timing the length of maneuver events.

A standard ground command word comprises 26 serial bits, as shown in Table IV-I. The first three bits act as the command framing (or start) bits. The remaining bits give the command address, and information to the CC&S in the case of Quantitative Commands. The CC&S information comprises the last 18 bits of the command word. The first five of these bits contain the address of the register to be modified. The sixth bit is adjusted, in QCs, to give odd bit parity for the 18-bit CC&S word. The next 11 bits contain the time value that is to be stored in the specified register. The last bit, bit 18, is the polarity bit. The presence of a "one" in this position calls for a positive turn.

These commands are stored by the CC&S to control the midcourse maneuver. Specifically, they are the following:

1) QC1-1 Pitch Turn Duration

Maximum value	1319 seconds
Resolution	1 second

2) QC1-2 Roll Turn Duration

Maximum value	1319 seconds
Resolution	1 second

3) QC1-3 Motor Burn Time

Maximum value	102. 36 seconds
Resolution	0. 04 to 0. 08 seconds

The command address completely identifies which ground command (whether Quantitative or Direct) has been sent. Although the CC&S information block contains no information in the case of Direct Commands, the bits are transmitted as binary "zeros" to maintain compatibility with the standard word format. All ground command words are transmitted at the rate of one bit per second. The command message is formatted on a five-level teletype paper tape as shown in Figure IV-1. A punched hole corresponds to a "one" and no punch corresponds to a "zero".

TABLE IV-I. GROUND COMMAND WORD STRUCTURE

MARINER C COMMAND WORD FORMAT

COMMAND BIT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
COMMAND BIT IDENTIFICATION	COMMAND DECODER START			COMMAND ADDRESS						ADDRESS PARITY SEE NOTE NO. 1		BITS 12-26 HAVE NO SIGNIFICANCE IN DC'S. IN QC'S THEY FORM PART OF THE CC&S COMMAND. REFER TO QUANTITIVE COMMAND FORMAT.														
COMMAND BIT VALUE	1	1	0	VARIABLE								ZERO FOR DC'S; VARIABLE FOR QC'S														

QUANTITATIVE COMMAND (QC) FORMAT

COMMAND BIT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
CC&S COMMAND BIT NO.									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CC&S COMMAND BIT IDENTIFICATION									CC&S ADDRESS: SEE NOTE NO. 2			CC&S ADDRESS: REGISTER SELECTOR		ODD PARITY	TIME VALUE (SEE NOTE NO. 5)											POLARITY
QC COMMAND BIT VALUES: PITCH TURN	1	1	0	0	1	1	0	0	0	1	1	1	0	SEE NOTE NO. 3	VARIABLE											SEE NOTE NO. 4
QC COMMAND BIT VALUES: ROLL TURN	1	1	0	0	1	1	0	0	0	0	0	0	1		VARIABLE											
QC COMMAND BIT VALUES: MOTOR BURN	1	1	0	0	1	1	0	0	0	1	0	1	1		VARIABLE											

NOTES:

1. COMMAND BIT NOS. 10 AND 11 ARE ADJUSTED TO ENSURE AGAINST SINGLE BIT ERRORS CAUSING AN INCORRECT COMMAND WORD OUTPUT.

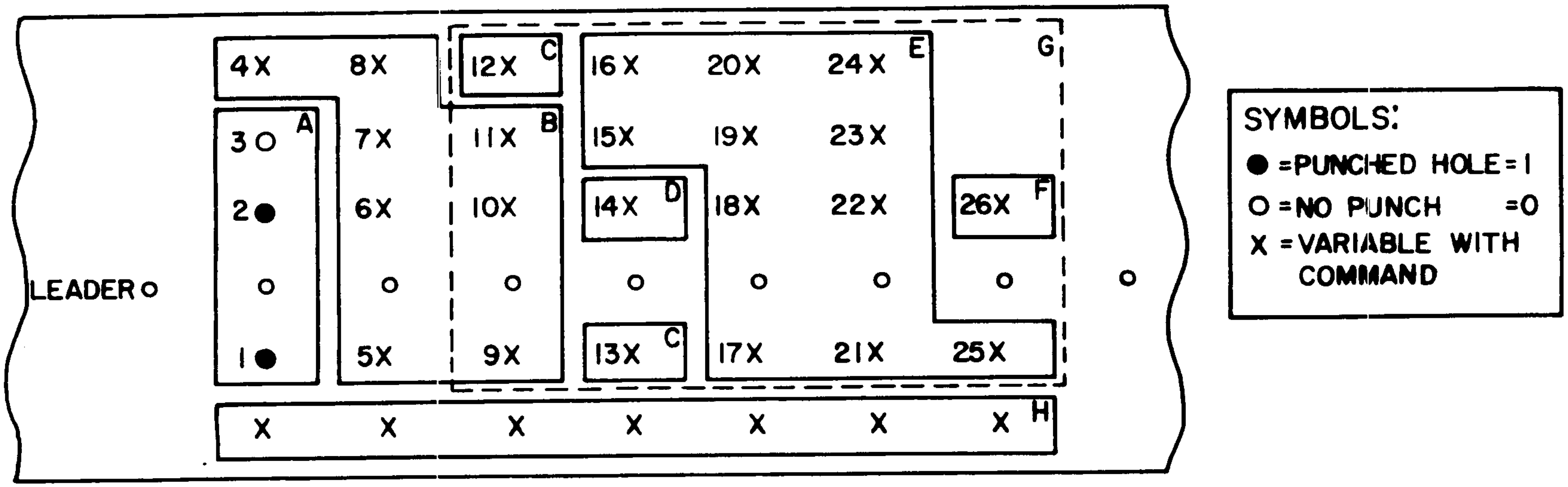
2. COMMAND BIT NOS. 9-11 (CC&S COMMAND BIT NOS. 1-3) ARE NOT USED QUANTITATIVELY BY CC&S BUT ARE USED TO REMAIN COMPATIBLE WITH PREVIOUSLY DESIGNED HARDWARE (MR 62).

3. COMMAND BIT NO. 14 (CC&S COMMAND BIT NO. 6) IS ADJUSTED IN QC'S TO GIVE AN ODD NUMBER OF "ONE" BITS IN COMMAND BIT NOS. 9-26 (CC&S BIT NOS. 1-18).

4. COMMAND BIT NO. 26 (CC&S COMMAND BIT NO. 18) MUST BE A "ONE" TO PRODUCE A CW (POSITIVE) SPACECRAFT ROTATION ABOUT THE SPECIFIED SPACECRAFT AXIS. A "ZERO" IN THIS BIT POSITION WILL RESULT IN A CCW (NEGATIVE) SPACECRAFT ROTATION ABOUT THE SPECIFIED SPACECRAFT AXIS. POLARITY BIT FOR MOTOR BURN COMMAND IS ALWAYS "ONE".

5. COMMAND BIT NOS. 15-25 (CC&S COMMAND BIT NOS. 7-17) ARE A PSEUDO-BINARY CODE REPRESENTATION OF THE TURN OR MOTOR BURN DURATION.

MARINER C RWV COMMAND MESSAGE TAPE FORMAT



A- COMMAND DECODER START BITS (ALL COMMANDS)

B- COMMAND ADDRESS AND ADDRESS PARITY (ALL COMMANDS)

C- CC&S REGISTER SELECTOR BITS (QC'S ONLY)

D- ODD PARITY BIT FOR "G" (QC'S ONLY)

E- CC&S TIME VALUE BITS (QC'S ONLY)

F- CC&S POLARITY BIT (QC'S ONLY)

G- 18 CC&S BITS TO BE CHECKED BY "D"

H- TELETYPE PARITY BITS (ALL COMMANDS); PROVIDES ODD PARITY FOR COLUMNS

NOTES:

1) BITS 11-26 ARE ZERO FOR DC'S
2) PUNCHED HOLE IS EQUIVALENT TO "ONE"
NO PUNCH IS EQUIVALENT TO "ZERO"

FIGURE IV-1. RWV COMMAND MESSAGE TAPE FORMAT

D. SPACECRAFT COMMAND SUBSYSTEM

The Spacecraft Command Subsystem, consisting of a command detector and a command decoder, determines the presence of commands at the output of the spacecraft radio receiver, identifies the received commands, and routes the commands to the designated spacecraft subsystem.

There are two modes of operation: one for Direct Commands (DC) resulting in the single momentary closure of a solid-state switch, and one for Quantitative Commands (QC) where readout switches relay the information to the CC&S. Control of these modes is internal to the command decoder on board the spacecraft and is totally dependent upon the command word received.

The spacecraft will utilize 29 Direct Commands and one (1) Quantitative Command with three addresses. These commands, their functions, and binary and octal formats, are listed in Table IV-II. In addition, the Mariner C polarity convention is shown in Figure IV-2 for further clarification.

E. GROUND COMMAND SUBSYSTEM

The Ground Command Subsystem, which is capable of reading, writing, and verifying (RWV) commands, is a self-checking command processor. It is designed to accept incoming command messages, verify through redundancy the validity of the messages, convert the command into a form suitable for transmission to the spacecraft, read the transmitted signal, verify the signal's validity, and write (punch tape) the transmitted command.

The command message is prepared in the SFOF and transmitted to the appropriate DSIF station via voice and teletype. A prepunched tape or a punched tape received via teletype line at the DSIF station is fed into the RWV subsystem's tape reader, compared, checked, and displayed. For transmission to the spacecraft, the modulator output is connected to the RF transmitter driver. RF energy is fed to the spacecraft receiver and a sample of the transmitted signal is returned to the Ground Command Subsystem by means of a dipole mounted on the DSIF antenna. The returning signal is then checked and displayed as before. If an error is detected, either in the command or in the logic and control circuitry, command transmission will be inhibited. A new tape is punched by the RWV as a permanent record of the transmission.

F. CENTRAL COMPUTER AND SEQUENCER (CC&S)

The CC&S supplies the on-board timing, sequencing, and computing services for the subsystems on the spacecraft. The CC&S contains the preset sequences which include: 1) a launch sequence based on launch time which controls spacecraft events from launch until the cruise mode is established, 2) a maneuver sequence which controls the spacecraft events necessary to perform a trajectory correction maneuver, and 3) a master timer sequence based on nominal encounter time which controls all spacecraft events during cruise, encounter, and postencounter. A frequency reference, accurate to 0.01%, controls the timing in all sequences. The predetermined events in the CC&S are fixed prior to launch and cannot be changed after launch.

COMMAND	EVENT	
DC 1	Command T/M Mode 1.	11
DC 2	Command T/M Mode 2. Turn on Cruise Science.	1
DC 3	Command T/M Mode 3.	1

TABLE IV-II. MARINER C DIRECT AND QUANTITATIVE COMM

BINARY VALUE	OCTAL VALUE	TIME OF USE
0 000 011 00 00 000 000 000 000 0	6030000000	1. Cruise Mode. 2. Following DC 4 (switch to T/M Mode 4 and switch off Cruise Science). 3. After DC 27 (start Midcourse Maneuver). 4. During T/M Mode 4.
.0 011 011 10 00 000 000 000 000 0	6332000000	1. After M +110 min. 2. After DC 1 (switch to T/M Mode 1). 3. On launch pad. 4. Backup after T/M Mode 3.
10 101 011 00 00 000 000 000 000 0	6530000000	1. After nominal wide-angle acquisition time.

(This table continued on next page.)

2

ANDS

CONDITION FOR USE	CONSTRAINTS FOR USE
1. Want to monitor S/C for critical engineering normal S/C power.	1. DC 1 by itself does not turn off science. Must have power available to support cruise science while in T/M Mode 1.
2. Want to monitor S/C for critical engineering phase emergency S/C power condition.	2. DC 1 following DC 4 will get S/C in T/M Mode 1 with science off for power conservation. DC 1 must follow DC 4 to turn science off and get S/C into T/M Mode 1.
3. S/C does not switch to T/M Mode 1 after DC 27.	3. T/M data must verify that midcourse sequence has actually started while in T/M Mode 2. Otherwise, DC 27 will have to be retransmitted.
4. Want to monitor actual or suspected malfunction of S/C T/M Mode 4.	4. The S/C malfunction monitoring must be worth the loss of at least part of one TV picture.
1. S/C not switched to T/M Mode 2 by CC&S release of A/C at end of midcourse maneuver.	1. S/C still in T/M Mode 1 after M +110 min. and conditions 1 and 2 for DC 1 not existing.
2. Desire to return S/C to normal cruise mode.	2. Sufficient S/C power must be available to support cruise science.
3. Desire to return S/C to normal cruise mode.	3.
4. S/C not switched to T/M Mode 2 at completion of T/M Mode 3.	4. To be most effective, DC 2 must be transmitted to coincide with the nominal switchover from T/M Mode 3 to T/M Mode 2. This means that DC 2 will have to be sent before any verification is received of the end of encounter phase.
1. Data encoder does not get a switch to T/M Mode 3 signal from science at nominal wide-angle acquisition time.	1.

3

COMMAND	EVENT
DC 4	Command T/M Mode 4. Switch Cruise Science off.
DC 5	Command Switch Data Rate.
DC 6	Command Switch ADC/PNG.
DC 7	Switch Power Amplifiers.
DC 8	Switch Exciters.
DC 9	Switch Ranging.

TABLE IV-II. (CONT'D)

BINARY VALUE	OCTAL VALUE	TIME OF USE
110 011 101 00 00 000 000 000 000 0	6350000000	1. After E +13 1/3 hours.
110 000 101 00 00 000 000 000 000 0	6050000000	1. While at 33 1/3 bps. 2. While at 8 1/3 bps.
110 000 110 00 00 000 000 000 000 0	6060000000	1. T/M Modes 1, 2, 4.
110 001 001 00 00 000 000 000 000 0	6110000000	
110 110 101 10 00 000 000 000 000 0	6652000000	
110 110 011 10 00 000 000 000 000 0	6632000000	

(This table continued on next page.)

2

CONDITION FOR USE	CONSTRAINTS FOR USE
1. CC&S fails to switch to T/M Mode 4.	1.
1. Received signal strength not sufficient to support 33 1/3 bps data rate.	1.
2. Desire better time resolution on S/C telemetry.	2. Received signal strength must be capable of supporting 33 1/3 bps data rate.
1. Pseudo-noise code is lost from sync channel. Ground stations cannot lock on S/C telemetry data.	1. Check ground stations to make sure trouble is with S/C.
2. Ground station can lock on S/C sync channel but data is nonsense.	2. Check ground station to make sure trouble is with S/C.
1. High-gain drive level or low-gain antenna measurement indicates degraded RF power, substantiated by ground received signal strength, A/C sensors, and gyro measurements.	1. Items 2 for DC 7 and DC 8 (no RF signal for S/C) should be treated as follows: a) Send DC 7. b) If no results are obtained from a), send DC 8. c) If no results are obtained from b), send DC 7.
2. No RF signal from S/C.	2.
1. Exciter power output measurement indicates degraded exciter.	1. This will give all possible combinations of power amplifiers and exciters.
2. No RF signal from S/C.	2.
1. Desire to turn ranging transponder on or off.	1. Earth - S/C distance must not have exceeded ranging operation capability distance of turning ranging transponder on.

3

COMMAND	EVENT
DC 10	Transmit High, Receive Low.
DC 11	Transmit High, Receive High.
DC 12	Transmit Low, Receive Low.
DC 13	Maneuver Inhibit. Turn on Solar Vanes, Canopus Sensor, and Attitude Control Inhibit Prop. Command.
DC 14	Remove Maneuver Inhibit. Remove Propulsion Inhibit.

TABLE IV-II. (CONT'D)

BINARY VALUE	OCTAL VALUE	TIME OF USE
110 110 000 00 00 000 000 000 000 0	6600000000	
110 101 110 00 00 000 000 000 000 0	6560000000	
110 101 101 00 00 000 000 000 000 0	6550000000	
110 010 111 00 00 000 000 000 000 0	6270000000	1. Midcourse Sequence. 2. Sun oriented. 3. L +1 hour.
110 010 100 00 00 000 000 000 000 0	6240000000	1. After DC 13. 2. Prior to DC 27.

(This table continued on next page.)

2

CONDITION FOR USE	CONSTRAINTS FOR USE
1. Nominal performance margin of high-gain antenna exceeds that of low-gain for transmitting.	1.
1. Nominal performance of high-gain antenna exceeds that of low-gain for receiving.	1.
1. Emergency condition in high-gain antenna operation due to radio subsystem malfunction.	1. S/C assumed to be attitude stabilized.
2. Emergency condition in high-gain antenna operation due to loss of roll attitude reference.	2. Receiver is automatically switched to low-gain antenna when roll attitude reference is lost. Must have emergency capability for commanding S/C via low-gain antenna.
1. Trouble in midcourse sequence with CC&S or A/C.	1.
2. Battery needs charging.	2. Sufficient solar power must be available.
3. A/C not turned on.	3. Verification that CC&S L-2 and Pyro Arming Switch failed. (Use of DC 13 for this purpose; obviates a midcourse maneuver.)
4. Backup for CC&S, L -3 min.	4.
1. Desire to perform midcourse maneuver. This command does not affect battery charger or solar vanes.	1.
2. To ensure proper state of pyro relays.	2.

3

COMMAND	EVENT	
DC 15	Canopus Gate Inhibit Override.	11
DC 16	Narrow-Angle Acquisition.	11
DC 17	Cycle Cone Angle.	11
DC 18	Gyros on Inertial Control. Roll Positive Increment.	11
DC 19	Gyros off; Normal Control.	11

TABLE IV-II. (CONT'D)

BINARY VALUE	OCTAL VALUE	TIME OF USE
001 100 00 00 000 000 000 000 0	6140000000	1. During acquisitions or reacquisitions.
101 000 00 00 000 000 000 000 0	6500000000	1. Science Encounter.
010 001 00 00 000 000 000 000 0	6210000000	E -137 days. E -103 days. E -68 days. E -30 days.
100 100 00 00 000 000 000 000 0	6440000000	After DC 18 (Repeat).
100 010 00 00 000 000 000 000 0	6420000000	1. After DC 18, 20, or 15.

(This table continued on next page.)

CONDITION FOR USE	CONSTRAINTS FOR USE
1. Light gate fails or is set wrong for Canopus seeker to acquire Canopus. Desire to get roll stabilized to an object with brightness outside of Canopus sensor brightness gates.	1.
1. Backup for science "Planet In View" narrow-angle sensor signal to DAS.	1. If wide-angle servo system on scan is working properly, must send command so that it will be received at nominal narrow-angle acquisition time.
2. Backup for science "Planet In View" narrow-angle sensor signal to DAS.	2. If wide-angle acquisition has not occurred, must time command to stop scan system so that planetary science instruments see Mars on flyby. NOTE: Procedures for the above two cases will have to be established before encounter.
Backup for CC&S, MT-1. Backup for CC&S, MT-2. Backup for CC&S, MT-3. Backup for CC&S, MT-4.	
1. Desire to place S/C roll axis on inertial controls.	1. Must be Sun oriented.
2. Desire to command positive 2° increment in roll position.	2. DC 18 must have been received from a previous command transmission.
1. Desire to return Z axis to normal cruise mode roll control after one or more of commands DC 15, 18, or 20 have been sent.	1.

3

COMMAND	EVENT
DC 20	Remove Roll Control.
DC 21	Roll Override. Roll Increment Negative.
DC 22	Track Change Command.
DC 23	Arm Second Propulsion Maneuver.
DC 24	Inhibit Scan Search.
DC 25	Turn on Planet Science. a) Unlatch Cover. b) Turn off Battery Charger. c) Turn on Tape Recorder.

TABLE IV-II. (CONT'D)

BINARY VALUE	OCTAL VALUE	TIME OF USE
10 111 100 00 00 000 000 000 000 0	6740000000	
10 111 010 00 00 000 000 000 000 0	6720000000	1. DC 18 not previously sent. 2. DC 18 previously sent. (Gyros on)
10 111 001 00 00 000 000 000 000 0	6710000000	1. During T/M Mode 4.
10 001 111 00 00 000 000 000 000 0	6170000000	1. After first Midcourse Maneuver.
10 100 001 00 00 000 000 000 000 0	6410000000	1. Before planetary Encounter.
110 010 010 00 00 000 000 000 000 0	6220000000	1. After E -6 2/3 hours.

(This table continued on next page.)

2

CONDITION FOR USE	CONSTRAINTS FOR USE
1. Low A/C gas reserve. Desire to conserve A/C gas by removing roll control.	1. Cannot have normal high-gain operation with no roll control. Use only if gas will be depleted before encounter if roll control is left on.
2. Failure of Canopus sensor. Desire to conserve power by turning off gyros and Canopus sensor.	2. Cannot have normal high-gain antenna operation.
1. Object other than Canopus acquired.	1.
2. Desire to command negative 2° increment in roll position.	2. DC 18 must have been received from previous command transmission.
1. Tape electronics does not switch tracks during playback.	1.
1. If a 2nd midcourse maneuver is desired.	1.
1. Scan search not working properly.	1. Try to time command so that scan system is stopped in a position that allows planetary science instruments to see Mars on flyby. If this is not done, the S/C will have to be placed on roll control and pointed at the planet for proper flyby orientation of science instruments.
1. Backup for CC&S event MT-7 to remove science instrument cover. Turn on planet science. Turn off battery charger. Turn on tape recorder electronics.	1.

3

COMMAND	EVENT
DC 26	a) Turn off Planet Science b) Switch off Cruise Science. c) Switch Battery Charger off.
DC 27	Start Midcourse Maneuver.
DC 28	Turn on Battery Charger. Turn off Tape Electronics
DC 29	Arm First Prop. Maneuver.
QC1-1	Pitch Turn.
QC1-2	Roll Turn.
QC1-3	Motor Burn.

x = Quantity (time)

y = Polarity

z - Parity

TABLE IV-II. (CONT'D)

BINARY VALUE	OCTAL VALUE	TIME OF USE
110 011 110 00 00 000 000 000 000 0	6360000000	1. After science Encounter. 2. Cruise.
110 100 111 00 00 000 000 000 000 0	6470000000	
110 110 110 10 00 000 000 000 000 0	6662000000	1. Cruise/Post-encounter. 2. Cruise.
110 001 010 00 00 000 000 000 000 0	6120000000	1. Before first maneuver.
110 011 000 11 10 zxx xxx xxx xxx y	63032xxxxy	
110 011 000 00 01 zxx xxx xxx xxx y	63001xxxxy	
110 011 000 10 11 zxx xxx xxx xxx y	63023xxxxy	

LEGEND

L	-	Launch
M	-	Midcourse
E	-	Encounter
A/C	-	Attitude Control
ADC/PNG	-	Analog to Digital Pseudo Noise Generator
CC&S	-	Central Computer and Sequencer
DAS	-	Data Automation System
DC	-	Direct Command
Prop.	-	Propulsion
QC	-	Quantitative Command
S/C	-	Spacecraft
T/M	-	Telemetry

2

CONDITION FOR USE	CONSTRAINTS FOR USE
1. Backup for CC&S event MT-8. Turn off planet science. Switch off cruise science. Switch battery charger off.	1.
2. Emergency power condition, or battery fully charged.	2.
1. Desire to turn on battery charger following DC 26.	1.
2. Tape electronics on inadvertently.	2.
1. To ensure proper state of pyro relays.	1.

2

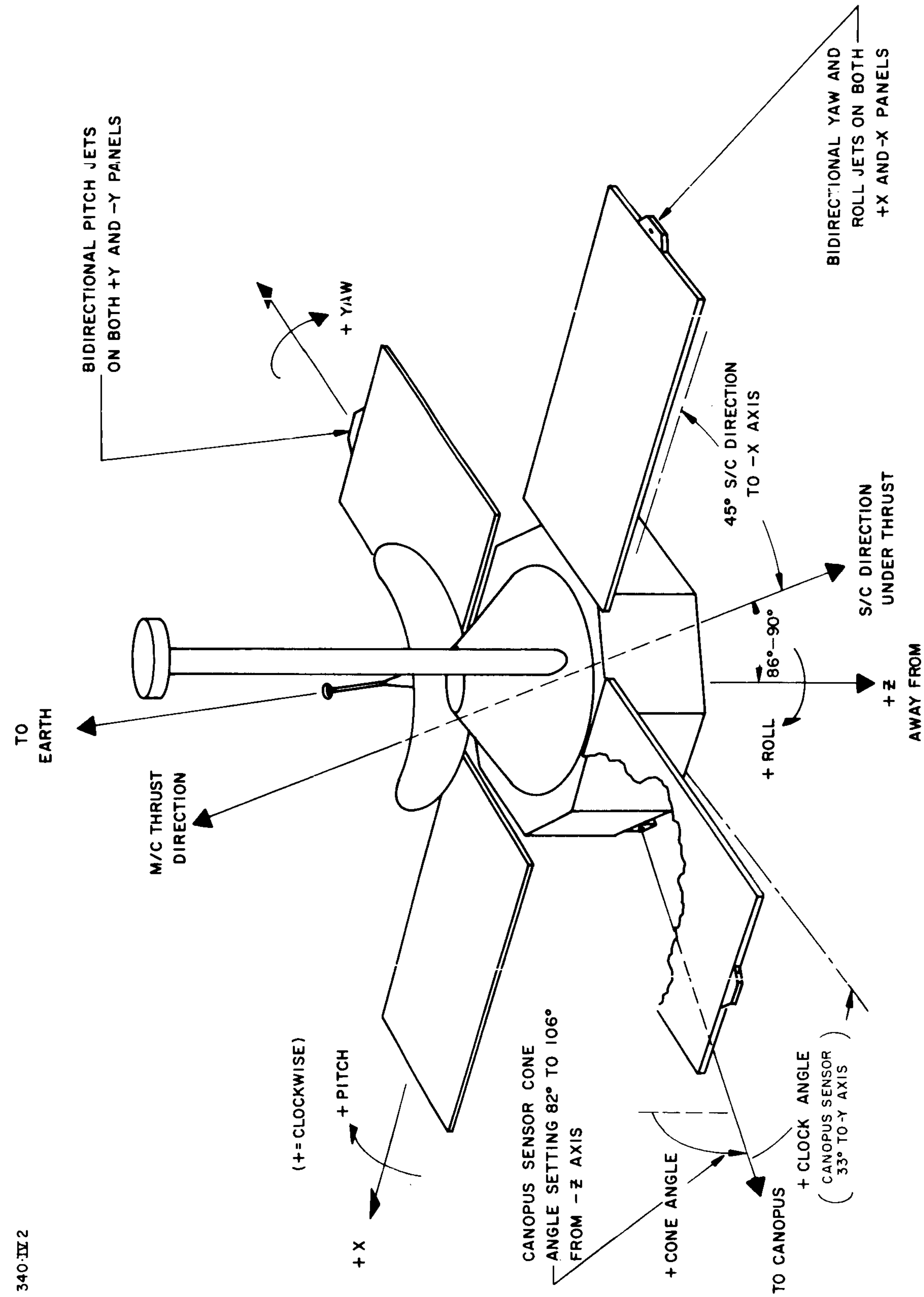


FIGURE IV-2. MARINER C POLARITY CONVENTION

The CC&S receives Direct Commands (DC) and Quantitative Commands (QC) from the spacecraft's radio command decoder for initiation and timing of the maneuver sequence. The outputs of the CC&S actuate spacecraft functions that occur at commanded and predetermined times.

G. COMMAND TRANSMISSION PROCEDURES

The success or failure of the Mariner Mars '64 Mission, which may be dependent on the prudent use of the DC and QC commands, requires careful planning prior to the Mission. Caution in the execution of these commands during the Mission must be exercised. The importance of the midcourse maneuver to a successful encounter requires that every precaution be exercised to ensure that the maneuver actually executed is the maneuver intended to be executed. The time available before the maneuver makes careful planning possible; however, rapid execution of the maneuver may be mandatory.

Consistent with this philosophy, the Quantitative Commands for the maneuvers, after being thoroughly verified before their transmission from the DSIF, will be checked in real time through the spacecraft telemetry prior to execution by observing the CC&S event indications.

The format of the command messages and the transmission and verification procedures follow.

1. Midcourse Maneuver Commands (See Table IV-III)

This message will be generated by the IBM 7094, in a teletype format, and placed on the IBM 1301 disc. The message may then be called up by the Flight Path Analysis Area (FPAA) I/O Console and will be sent out on a predetermined computer teletype circuit. This circuit will be looped in the Communications Center to an SFOF internal teletype circuit; its output will be in the FPAA on a TTY page printer and a reperforator. The message will be verified by the cognizant FPAC engineer, reviewed by the FPAC and SPAC Directors, and personally approved by the SFO Director and the DSIF Operations Manager. The code word will then be inserted and the command message will be transmitted to the appropriate DSIF station from the DSIF Control Room. The correct reception and transmission of the maneuver commands will be verified by use of the following procedures:

a) The DSIF command station will retransmit the command message to DSIF Net Control. The TTY tape output of this message will be compared, hole for hole, with the original command message for verification.

b) The DSIF command station will verify transmission of the command to the spacecraft by a message to DSIF Net Control containing the initiate and verify times of the transmission.

TABLE IV-III. MIDCOURSE MANEUVER COMMAND MESSAGE FORMAT

CODE

MIDCOURSE COMMANDS FOR MA-C S/C NO__________

XMIT AT__________MINUTE INTERVALS STARTING AT

HHMM Z HHMM Z HHMM Z

QC ONE-ONE 63032 XXXXY 63032 XXXXY 63032 XXXXY

QC ONE-TWO 63001 XXXXY 63001 XXXXY 63001 XXXXY

QC ONE-THREE 63023 XXXXY 63023 XXXXY 63023 XXXXY

DC TWENTY SEVEN INITIATE MANEUVER 6470000000

AT HHMMSS Z HHMMSS Z HHMMSS Z

DC TWENTY SEVEN INITIATE MANEUVER (BACKUP)

6470000000 AT HHMMSS Z HHMMSS Z HHMMSS Z

QC1-1 QC1-2 QC1-3 FOLLOW IN CODE IN ORDER

THREE TIMES

XXXXXXX

XXXXXXX

XXXXXXX

XXXXXXX

XXXXXXX

XXXXXXX

XXXXXXX

XXXXXXX

XXXXXXX

c) The command will be verified through the spacecraft by observation of a CC&S event indication on the spacecraft telemetry for each Quantitative Command.

If it is necessary to retransmit one of the Quantitative Commands to the spacecraft, the DSIF command station will be so instructed. The command will not be retransmitted from DSIF Net Control to the DSIF station. The retransmit Quantitative Commands instruction will be in the following format:

CODE
RETRANSMIT TO MA-C S/C NO________
QC ONE - ________ 630 XXXXXXY AT HHMM Z HHMM Z HHMM Z

A separate message will be used for each retransmission required. After the verifications of the Quantitative Commands, the SFO Director will instruct DSIF Net Control to send the following message:

CODE
PROCEED WITH MANEUVER MA-C S/C NO________

This message will be the final approval for the DSIF station to command the start of the maneuver.

2. DC 13 Command Message

The nature of the DC 13 command requires special procedures for its use. This command will normally be used only from DSIF 11 (Goldstone).

The following message will be transmitted to the commanding DSIF station before the start of the maneuver if DC 13 might be required.

CODE
PREPARE TO XMIT DC 13 6270000000
BEFORE HHMMSS Z HHMMSS Z HHMMSS Z

The order to use DC 13 will be given by voice, using the following message:

CODE
TRANSMIT DC 13 TO MA-C S/C NO________

Upon receipt of this order, the commanding DSIF station will immediately transmit DC 13 to the spacecraft. If the command cannot be transmitted before the time indicated in the first message, the command is not to be sent.

3. Spacecraft Command Message

Upon decision to execute a command not included in paragraph IV, G, 1. and 2., the SFO Director will prepare a spacecraft command message as shown below:

```
CODE

XMIT THE FOLLOWING COMMAND(S) TO

      MA-C S/C NO__________

DC-________6XXXXXXXXX AT HHMM Z  HHMM Z  HHMM Z

DC-________6XXXXXXXXX AT HHMM Z  HHMM Z  HHMM Z
```

Note: Times may be replaced with the word "IMMEDIATELY".

DSIF Net Control will transmit the spacecraft command message to the station manager at the proper DSIF station and require verification of receipt of message, command number, and time at which command is to be executed.

Upon receipt of the spacecraft command message, the command will be executed at the time stated in the command message in accordance with the procedures described in the Mariner C TIM, EPD-167.

Upon execution of the commands, the DSIF station manager will notify DSIF Net Control what command was transmitted to the spacecraft and the time of transmission. The DSIF station manager will include the command and time of transmission in the next station report.

Upon notification by DSIF Net Control, the DSIF Operations Manager will inform the SFO Director by voice that the command has been transmitted and the time of its transmission.

4. Command Transmission to the DSIF

a) Prime

The primary communication mode for command messages is to be teletype. All messages and verifications described in the preceding paragraphs will be sent by teletype, if possible, with the exception of the voice order to transmit DC 13.

b) Backup

The backup communication mode for command messages is to be voice. Command messages transmitted by voice are to be in the same format as the teletype messages and will be followed by a teletype verification as soon as possible.

5. Command Message Coding

The word "code" appears in all the command messages. This is a four-letter code used to assure that the message is originating within the DSIF Net Control area. The DSIF stations will be provided with the appropriate code words.

SECTION V

STANDARD SEQUENCE OF EVENTS

A. GENERAL

This section presents the sequence of events planned and expected for standard space flight operations. The anticipated nonstandard sequence of events that describes nonstandard modes of operation will be found in Section VI.

The conditions that establish space flight operations as standard are:

1) Normal operation of the launch vehicle

2) Normal operation of the spacecraft

3) Injection of the spacecraft into a standard design space trajectory wherein the target encounter parameters for which the spacecraft was designed are within the allowable range at encounter.

4) Normal operation of the SFO Complex

Launchings of the Mariner Mars '64 flights will utilize launch azimuths varying from 90° to 114° east of north; this will compensate for launch delays that would otherwise produce errors at the point of closest approach to Mars. Launch time versus launch day for both Type I and Type II trajectories is shown in Figure V-1. The injection corridor falls in the region from the South Atlantic Ocean, through South Africa, into the middle of the Indian Ocean. The launch and injection corridors are shown in Figure V-2. This wide range in the injection corridor produces initial DSIF view periods shown in Figure V-3 and summarized as follows:

1) DSIF 51 (Johannesburg, South Africa) may "see" the spacecraft during its initial pass over the station.

2) The spacecraft will always come into the view of DSIF 41 (Woomera, Australia) not later than 30 minutes after injection.

3) The time indications in the Sequence of Events (Table V-I) are based on a nominal launch azimuth of 104° for Day 38 of the launch period for an early arrival date.

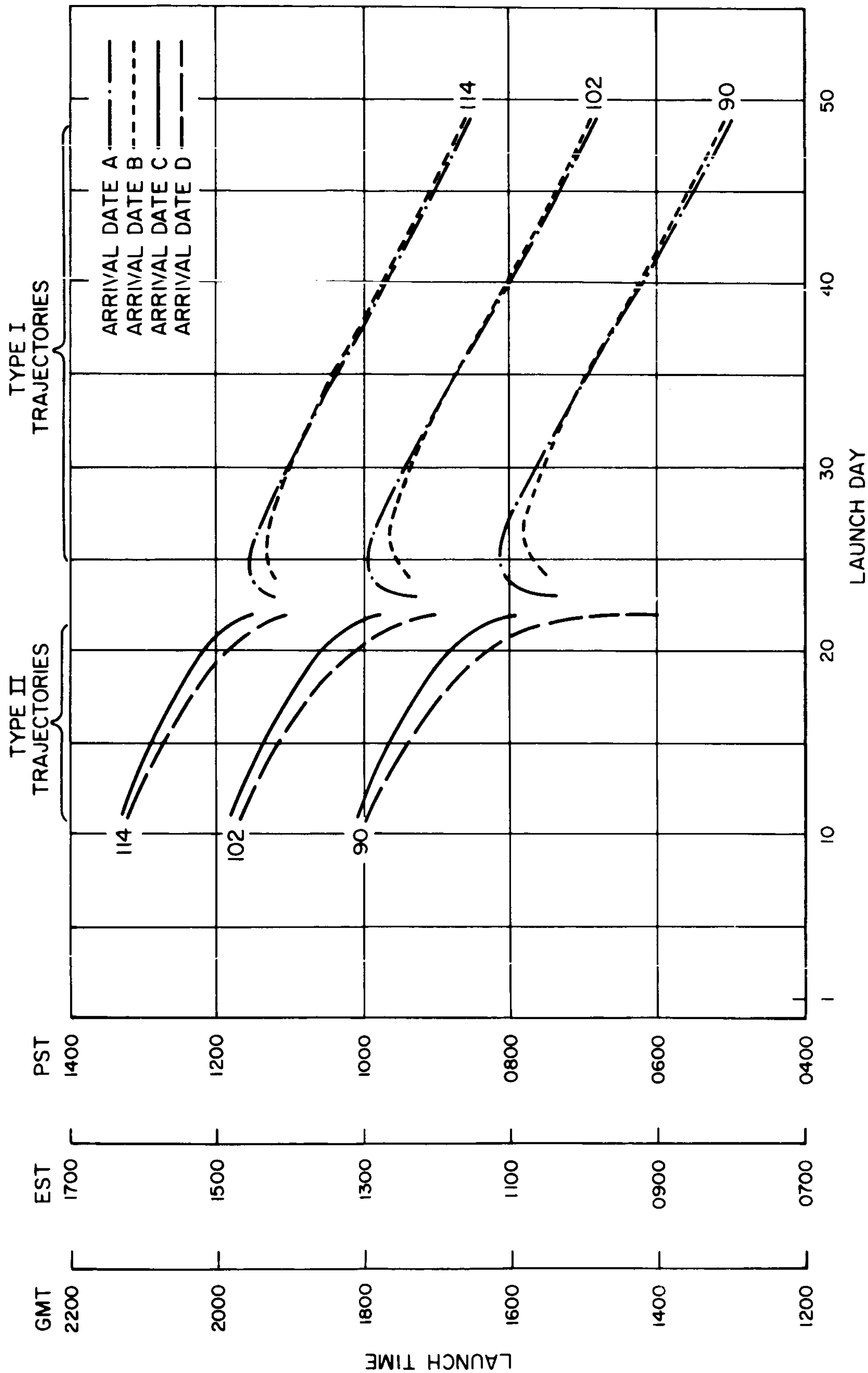


FIGURE V-1. LAUNCH TIME VS. LAUNCH DAY, MARS 1964

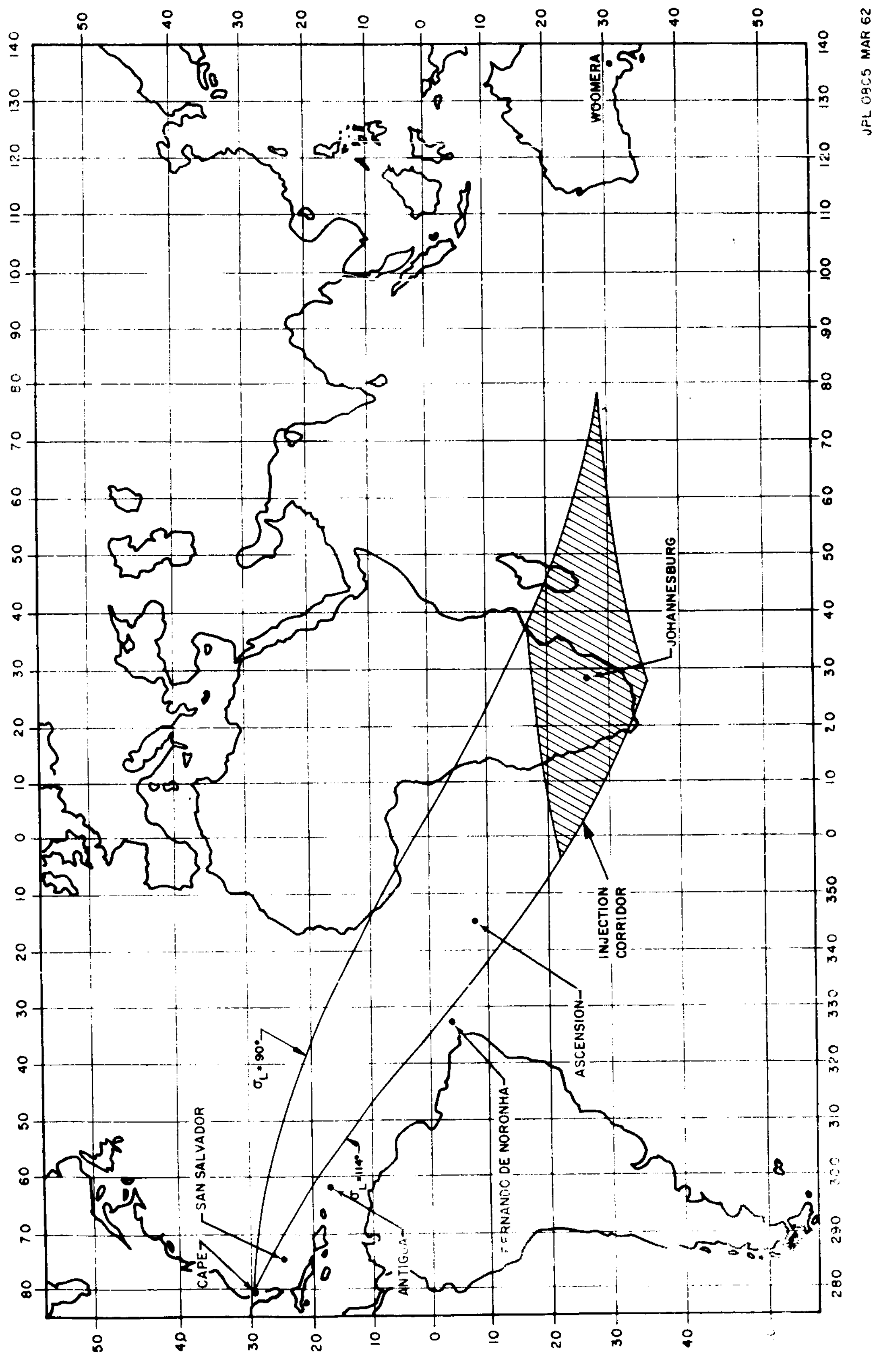
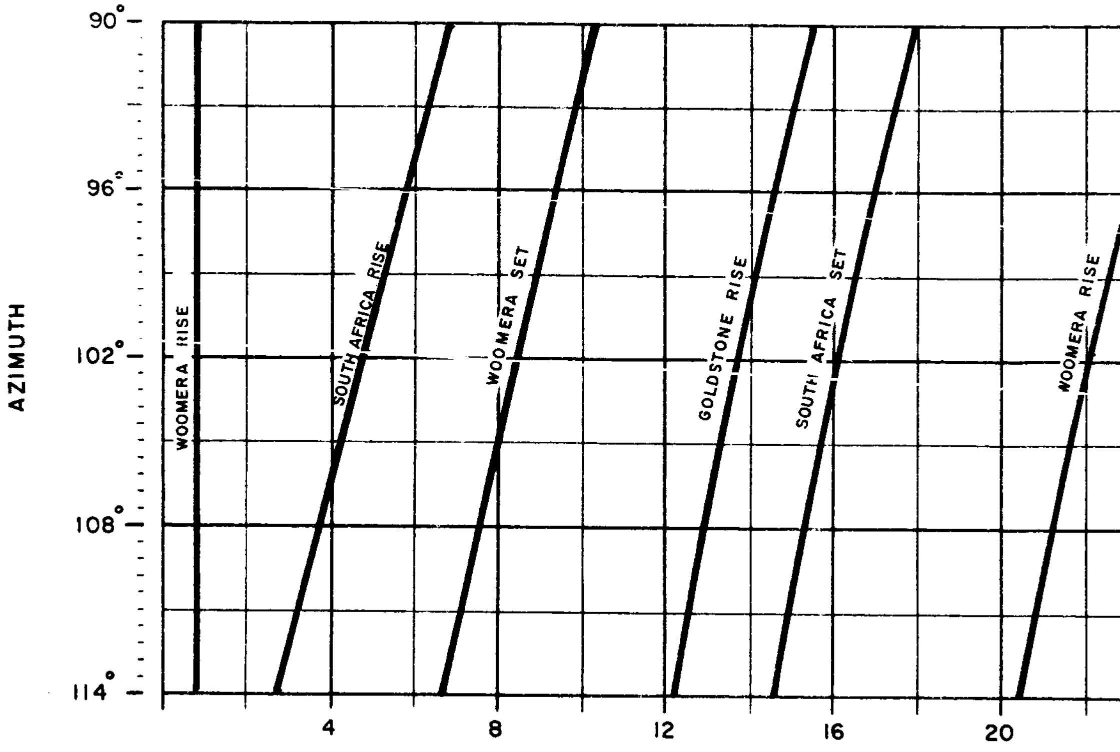
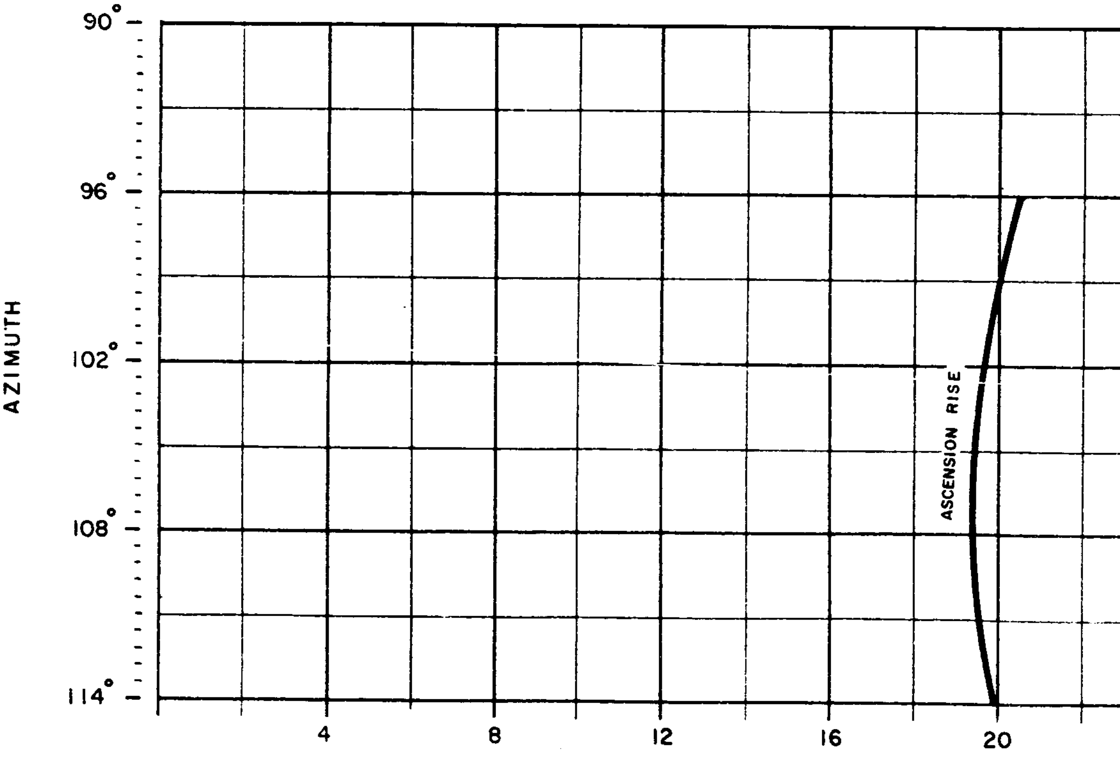
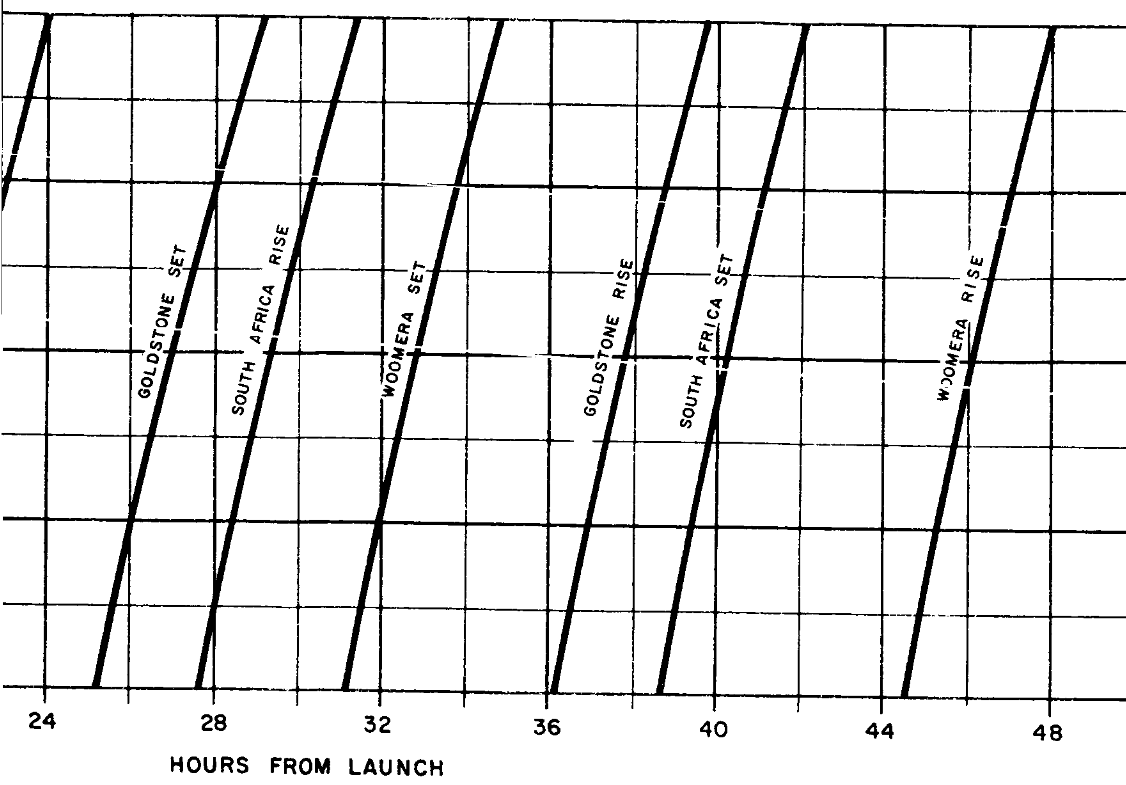


FIGURE V-2. TYPICAL INJECTION LOCI

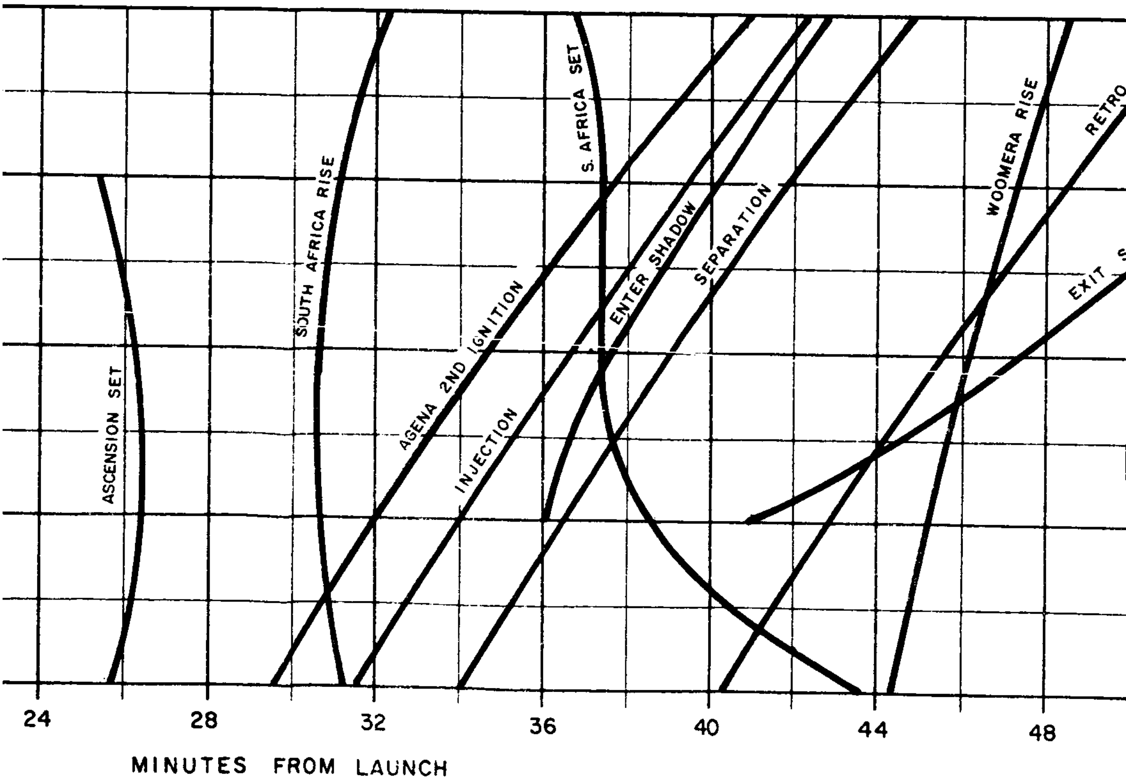
356-15


90°
96°
102°
108°
114°
AZIMUTH
WOOMERA RISE
SOUTH AFRICA RISE
WOOMERA SET
GOLDSTONE RISE
SOUTH AFRICA SET
WOOMERA RISE
4
8
12
16
20


90°
96°
102°
108°
114°
AZIMUTH
ASCENSION RISE
4
8
12
16
20

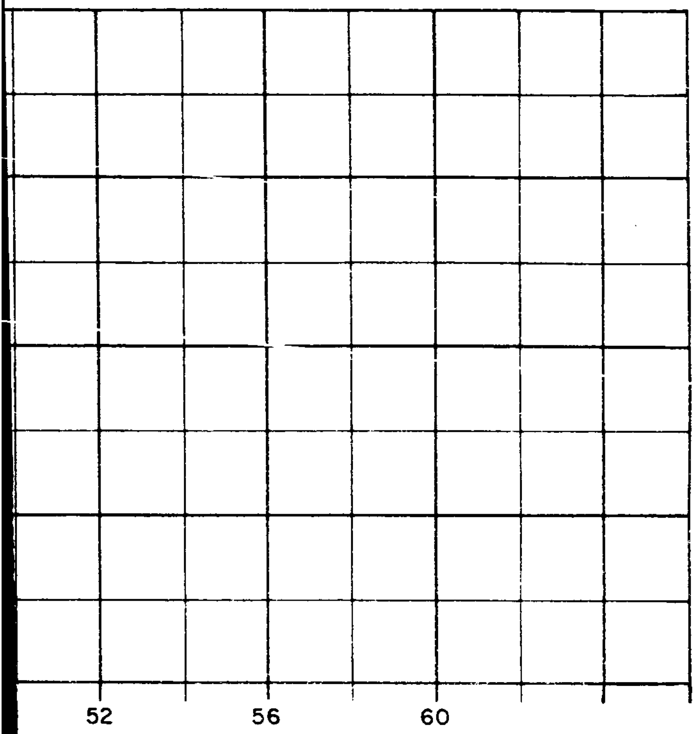


GOLDSTONE SET
SOUTH AFRICA RISE
WOOMERA SET
GOLDSTONE RISE
SOUTH AFRICA SET
WOOMERA RISE
24
28
32
36
40
44
48
HOURS FROM LAUNCH



ASCENSION SET
SOUTH AFRICA RISE
AGENA 2ND IGNITION
INJECTION
S. AFRICA SET
ENTER SHADOW
SEPARATION
WOOMERA RISE
RETRO
EXIT S
24
28
32
36
40
44
48
MINUTES FROM LAUNCH

2



DAY 38

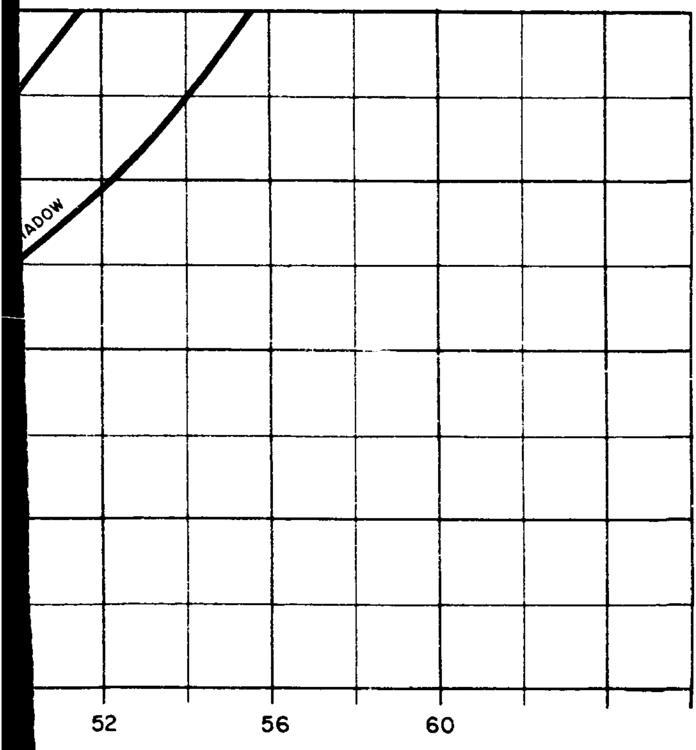


FIGURE V-3. DSIF VIEW PERIODS

Time of Event Column	
T	Countdown Time Before Liftoff
L	Time of Liftoff
I	Time of Injection
E	Encounter (Closest Approach to Mars)
S	Spacecraft/Agena Separation

Station Column	
ACE	Space Flight Operations Facility. Mission Control Room, Building 230, Pasadena
IPP	Impact Predictor Building, Computing Facility at AFETR, Cape Kennedy
COMM	Communications Control, Building 230, Pasadena
DACON	Data Processing System Control, Building 230, Pasadena
EASY	JPL Operations Center at AFETR, Cape Kennedy
FLITE	Flight Path Analysis Area, Building 230, Pasadena
BUSS	Spacecraft Performance Analysis Area, Building 230, Pasadena
SPACE	Space Science Analysis Area, Building 230, Pasadena
SOFT MAN	SFOF Operations Manager, Building 230, Pasadena
NET MAN	DSIF Operations Manager, Building 230, Pasadena
T/M	Telemetry data
S/C	Spacecraft
VEH	Atlas/Agena Launch Vehicle
1.16	AFETR Tracking Station 1, Cape Kennedy (FPS-16)
91	AFETR Tracking Station 91, Antigua (MPS-26)
92	East Island, Puerto Rico (FPS-16)

Station Column (Cont'd)

SHIP	-	AFETR Tracking Ship
75	-	AFETR Tracking Station, Ascension Island (FPS-16)
76	-	AFETR Tracking Station, Pretoria (MPS-25)
71	-	Spacecraft Checkout Facility, Cape Kennedy
11	-	Goldstone Pioneer Station, California (JGLD)
41	-	Woomera, Australia (AOMJ)
42	-	Canberra, Australia (ANBE)
51	-	Johannesburg, South Africa (LJOB)
*	-	Designates events that will be communicated by voice.
CCC	-	Computer Subsystem

TABLE V-I. STANDARD SEQUENCE OF EVENTS

ITEM	TIME OF EVENT	STATION	EVENT
		VEH	1. Atlas/Agena Precount.
CC	T-300M	*COMM	1. Establish Communications between ACE, COMM, DACON, CCC, EASY, and IPP.
			2. Transmit Operational Readiness to ACE.
BB	T-295M (4H55M)	AFETR	1. Start AFETR Support.
AA	T-240M (4H)	11, 41, 51	1. Report Station Readiness to NET MAN by TTY.
Z	T-200M (3H20M)	S/C	1. S/C Countdown Starts.
			2. S/C Power On and RF Checks.
		*ACE	1. Transmit Operational Readiness to EASY.
		*EASY	1. Transmit S/C Status to ACE.
Y	T-155M (2H35M)	VEH	1. Start Agena UDMH 10 Percent Tanking.
X	T-145M (2H25M)	VEH	1. Start Agena UDMH 100 Percent Tanking.
W	T-135M (2H15M)	VEH	1. Agena UDMH Tanking Complete.
V	T-130M (2H10M)	AFETR	1. Start Tower Removal.
U	T-120M (2H)	*IPP, *DACON	1. Start Checkout of Computer and Data Handling Equipment and Report to ACE.
		11, 41, 51, 71	1. Report Station Readiness to ACE by TTY.
		*ACE	1. Report Operational Readiness to EASY.
		*EASY	1. Report S/C Status to ACE.

(This table continued on next page.)

TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
T	T-100M (1H40M)	AFETR	1. Tower Removal Complete.
S	T-90M (1H30M)	VEH	1. Start Agena IRFNA 10 Percent Tanking.
		*IPP	1. Report AFETR Status to ACE.
		*EASY	1. Report Following S/C Frequencies to ACE: a) Transponder Carrier Frequency on Auxiliary Oscillator Drive. b) Ground Transmitter Frequency MC-2 2116.381944 MC-3 2116.722994 c) Transponder Frequency MC-2 2298.333333 MC-3 2298.703704 2. Report S/C Status to ACE.
		*ACE	1. Report Operational Readiness to EASY.
R	T-80M (1H20M)	VEH	1. Start Agena IRFNA 100 Percent Tanking.
Q	T-70M (1H10M)	11, 41, 51, 71	1. Report Station Readiness to ACE by TTY.
P	T-60M (1H)	VEH	1. Complete Agena IRFNA Tanking.
		EASY	1. Start Transmitting S/C Telemetry to DACON.
		DACON	1. Start Processing S/C Telemetry and Reducing on 7094.
---------------- UP TO 70-MINUTE HOLD AT T-60 ----------------			

(This table continued on next page.)

TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
O	T-60M	*ACE	1. Transmit Operational Readiness Report to EASY.
		*EASY	1. Report S/C Status to ACE.
N	T-55M	BUSS	1. Start Evaluation of S/C Telemetry.
M	T-45M	VEH	1. Start Atlas LOX Tanking.
		51, 41	1. Transmit AGC Calibration Data to DACON by TTY.
L	T-30M	11, 41, 51, 71	1. Report Station Readiness to ACE by TTY and Voice.
		*ACE	1. Report Operational Readiness to EASY.
		*EASY	1. Report S/C Status to ACE. 2. Transmit S/C Frequencies and Temperature to ACE: a) Transponder Carrier Frequency on Auxiliary Oscillator Drive. b) Ground Transmitter Frequency c) Transponder Frequency 3. Report Spacecraft Serial Number to ACE.
		*IPP	1. Report AFETR Status to A.
		71	1. Turn Transmitter Off.
		DACON	1. Compute Station AGC Calibrations.

(This table continued on next page.)

TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
K	T-15M	*EASY	1. Transmit Weather Reports to ACE.
J	T-10M	S/C	1. Insert Encounter Update Pulses.
		EASY	1. Report Encounter Parameters to ACE.
I	T-9M	S/C	1. Tape Recorder to Launch Mode.
H	T-5M	*EASY	1. Announce Second Hold.
------------------ UP TO 15 MINUTES HOLD ------------------			
G	T-5M	*EASY	1. Pick Up Time at T-5M.
			2. Announce Launch Plan.
			3. Report S/C Status to ACE.
		*ACE	1. Report Operational Readiness to EASY.
		S/C	1. Switch to Internal Power.
F	T-5M	DACON	1. Start Computation of Standard Trajectory Minimum Print and View Periods for DSN.
E	T-4M	DACON	1. Start Computation of Standard Trajectory and Predictions for DSIF 41, 51, and 11 in that order.
D	T-3M	S/C	1. Release CC&S Inhibit.
C	T-2M	*EASY	1. Report Time of Removal of CC&S Inhibit to ACE.
B	T-1M	S/C	1. Clear Relay Release.
			2. Release Relay Hold.
A	T-30S	VEH	1. Umbilical Release.

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TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
1	L = T-0	*EASY	1. Liftoff. Report to ACE.
		IPP	1. Start Direct Time Range Safety Impact Prediction.
2	L+10S	1.16	1. Acquisition by 1.16.
		EASY	1. Start Transmission of S/C T/M to DACON from DSIF 71.
		S/C	1. Squib Firing Assembly Armed.
3	L+133.5 = MARK 1	*EASY	1. Report Booster Cutoff to ACE.
4	L+ = MARK 2	*EASY	1. Report Booster Jettison to ACE.
5	L+108S (3M)	DACON	1. Transmit Predictions to DSIF 41, 51, and 11 in that order.
6	L+305.6 = MARK 3	*EASY	1. Report Sustainer Cutoff to ACE.
7	L+325.6 = MARK 4	*EASY	1. Report Vernier Cutoff to ACE.
8	L+327.6 = MARK 5	*EASY	1. Report Shroud Separation to ACE.
9	L+330S	91	1. S/C on 91 Horizon.
10	L+333S = MARK 6	*EASY	1. Report Atlas/Agena Separation to ACE.
11	L+379S = MARK 7	*EASY	1. Report Agena First Ignition to ACE.
12	L+438S	1.16, 71	1. Loss of Track by 1.16 and 71.
		EASY	1. Stop Transmission of S/C Telemetry to DACON.
13	L+525.46 = MARK 8	*EASY	1. Report Agena First Cutoff to ACE.
14	L+530S (8M50S)	IPP	1. Complete Direct Time Range Safety Impact Prediction.

(This table continued on next page.)

TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
15	L+550S	IPP	1. Start Computation of Parking Orbit Injection Conditions and Orbit Elements, SHIP, 75, and 76 Acquisition Information.
16	L+750S (12M30S)	91	1. Loss of Track by 91.
17	L+790S (13M10S)	IPP	1. Complete Computation and Injection Conditions and Orbital Elements, SHIP, and 75 Acquisition Information. 2. Transmit Acquisition Information to SHIP and 75. 3. Start Transmission of Elements and Injection Conditions of Parking Orbit to ACE. 4. Compute DSIF 41, 51, and 11 Predictions from Parking Orbit Information and Nominal Second Burn.
18	L+900S (15M)	IPP	1. Stop Transmission (Items 17-2 and 17-3).
19	L+1140S (19M)	IPP	1. Start Transmission of Injection Conditions of Transfer Orbit from Actual Parking Orbit and Nominal Second Burn to DACON.
20	L+1170S (19.5M)	75	1. Spacecraft on 75 Horizon.
21	L+1580S (26M20S)	75	1. Loss of Track by 75.
22	L+1848S (30M48S)	51	1. S/C on 51 Horizon.
23	L+2046S = MARK 9	*EASY	1. Report Agena Second Ignition to ACE.
24	L+2136S = I = MARK 10	*EASY	1. Report Agena Second Cutoff to ACE.
25	L+2241S (37.35M)	51	1. Loss of Track by 51.

(This table continued on next page.)

TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
26	S = I+156S	S/C	1. S/C-Agena Separation. a) RF Power Up and Cruise Science On. b) Enable CC&S. c) End Tape Recorder Launch Mode. d) Remove Plasma 10kv Inhibit. e) Arm Pyrotechnics. f) Agena Isolation Amplifier Turned Off. g) Turn On Attitude Control Subsystem. h) Separation-Initiated Timer Activated.
27	L+2328S	IPP	1. Start Computation of Actual Transfer Orbit Injection Conditions and Orbital Elements.
28	L+ = S+80S	S/C	1. Deploy Solar Panels and Solar Vanes. Unlatch Scan Platform.
29	L+2568S	IPP	1. Complete Computation of Actual Transfer Orbit Injection Conditions and Orbital Elements and Transmit to DACON. 2. Start Computation of DSIF 41, 51, and 11 Acquisition.
30	L+2760S (46M)	41	1. S/C on 41 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and Telemetry Data to DACON.

(This table continued on next page.)

TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
31	L+2868S (47. 8M)	IPP	1. Transmit Acquisition Information to ACE for Relay to DSIF 41, 51, and 11 in that order.
32	L+3180S	S/C	1. Deploy Solar Panels and Solar Vanes. Unlatch Scan Platform. CC&S L-1 Backup.
33	L+57M	S/C	1. Turn On Attitude Control Subsystem. CC&S L-2 Backup.
34	Item 28 or 31 plus 0 to 20M	S/C	1. Sun Acquisition Complete.
35	L+292. 65M	51	1. S/C on 51 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and Telemetry Data to DACON.
36	L+513. 03M	41	1. Loss of Track by 41.
37	L+830. 45M	11	1. S/C on 11 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and T/M Data to DACON.
38	L+969. 96M	51	1. Loss of Track by 51.
39	L+997M (L+16. 6H)	S/C	1. Turn on Solar Vanes and Canopus Sensor. Initiate Roll Search about the S/C Z Axis. CC&S L-3 Backup.
40	Item 38 plus 0 to 75M	S/C	1. Canopus Acquisition Complete.
41	L+1330. 82M	41	1. S/C on 41 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and Telemetry Data to DACON.

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TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
42	L+1623.01M	11	1. Loss of Track by 11.
43	L+1761.78M	51	1. S/C on 51 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and Telemetry Data to DACON.
44	L+1973M	41	1. Loss of Track by 41.
45	L+2269M	11	1. S/C on 11 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and T/M Data to DACON.
46	L+2418M	51	1. Loss of Track by 51.
47	L+2774M	41	1. S/C on 41 Horizon. 2. Report Acquisition to ACE. 3. Transmit Tracking and T/M Data to DACON.
48	E-192 Days	S/C	1. Switch Bit Rate to 8.3 bps. Backup DC-5.
49	E-137 Days	S/C	1. Set Canopus Sensor Cone Angle #1. Backup DC-17.
50	E-131 Days	S/C	1. Transmit Via High-Gain. Receive Via Low-Gain. Backup DC-10.
51	E-103 Days	S/C	1. Set Canopus Sensor Cone Angle #2. Backup DC-17.
52	E-68 Days	S/C	1. Set Canopus Sensor Cone Angle #3. Backup DC-17.

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TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
53	E-30 Days	S/C	1. Set Canopus Sensor Cone Angle #4. Backup DC-17.
54	E-6.66H	S/C	1. Begin Encounter Science. a) Turn On Encounter Science. b) Remove Science Instrument Covers. c) Turn Off Battery Charger. d) Turn On Tape Recorder.
55	E-70 to E-33M	S/C	1. Wide-Angle Planet Acquisition. a) Switch to T/M Data Mode III. Backup DC-3.
56	E-12 to E-8M	S/C	1. Narrow-Angle Planet Acquisition. Backup DC-16. a) Inhibit Scan Motion. Backup DC-24.
57	Item 56 plus 60 to 204S	S/C	1. Release Recording Sequence Inhibit. a) Start Tape Recorder.
58	E = L+	S/C	1. Encounter (Closest Approach to Mars).
59	Item 57 plus 22.8M	S/C	1. End of Tape in Recorder. a) Switch to Data Mode II. Backup DC-2. b) Inhibit Further Start Tape Commands to Tape Recorder.

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TABLE V-I. (CONT'D)

ITEM	TIME OF EVENT	STATION	EVENT
60	E+6.66H	S/C	1. End Encounter Sequence. a) Turn Off Encounter Science. b) Turn Off Scan Platform.
61	E+13.33H	S/C	1. Begin Tape Playback. a) Turn Off Cruise Science. b) Switch to Data Mode IV.
62		S/C	1. Switch to Data Mode II. 2. Turn On Cruise Science.

SECTION VI

NONSTANDARD EVENTS

A. GENERAL

The action to be taken in the event of a departure from the Standard Sequence of Events, Table V-I, is set forth in this section. If a departure from standard space flight operations occurs, the SFOD will approve, subject to the concurrence of the Project Manager, the course of action to be followed. Nonstandard events do not necessarily connote a mission failure. Possible nonstandard events are divided into the four classes described below.

1. Class I

This class includes those nonstandard operations of the launch vehicle, the spacecraft, or the SFO Complex that have been anticipated and for which corrective action has been planned.

2. Class II

Class II nonstandard operations comprise those situations wherein a nonstandard event occurs for which no specific corrective action has been planned, but for which such action is possible.

3. Class III

Class III nonstandard operations are those for which no corrective action is possible. If such events occur, the action to be taken will be decided at the time of occurrence.

4. Class IV

Class IV nonstandard operations do not necessarily involve failure of the spacecraft, or of the SFO Complex. The response to this class of nonstandard event depends on the type of occurrence. Occurrences in this class may necessitate additional coverage by the DSIF and the SFOF. The SFOD will determine the coverage required for the mission and will negotiate for any additional DSIF coverage with the DSIF Operations Manager. Procedures for operations during engineering and scientific alerts are specified in Section VII.

B. OPERATING PROCEDURES

1. Class I

a. Failure of Spacecraft to Achieve Nominal Trajectory Because of Launch Vehicle Design Limitations

A systematic search of possible aiming points is made as described in Section VII, paragraph D. Appropriate commands are sent to the spacecraft and a midcourse maneuver is initiated. Because of the high probability of this occurrence, the steps needed to perform a midcourse maneuver are listed in Table VI-I.

b. <u>Failure of the Attitude Control Subsystem to be Turned On by the Pyro Arming Switch or by the CC&S</u>

The following sequence would be initiated:

1) SPAC determines from spacecraft telemetry that the attitude control subsystem has not been turned on.

2) The SPAC Director recommends to the SFOD that DC-13 be sent after Launch plus 3 hours. DC-13 will cause the Canopus tracker to be turned on immediately upon Sun acquisition.

3) The SFOD initiates transmission of DC-13 by the DSIF.

4) The appropriate DSIF station transmits DC-13.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that the attitude control subsystem has been energized and that the Sun acquisition sequence is in process.

7) The use of DC-13 to accomplish the turn-on of the attitude control subsystem precludes the use of the midcourse maneuver capability.

c. <u>Canopus Tracker Power Not Turned On by CC&S at Launch + 997 Minutes</u>

The following sequence would be initiated:

1) SPAC determines from spacecraft telemetry that Canopus tracker power has not been applied.

2) The SPAC Director recommends to the SFOD that DC-13 be sent.

3) The SFOD initiates the transmission of the DC-13 command by the DSIF.

4) The appropriate DSIF station transmits DC-13.

5) SPAC verifies the receipt of the command by the spacecraft.

TABLE VI-1. TRAJECTORY CORRECTION MANEUVER SEQUENCE

ITEM	TIME	STATION	EVENT
1	M-3H or earlier	ACE, DACON	1. Compute Trajectory Correction Commands A. SCI-1, Pitch Turn Duration and Polarity. B. SCI-2, Roll Turn Dura- and Polarity. C. SCI-3, Motor Burn Duration. D. Time for Initiation Of Maneuver Sequence (Time Of Transmission To S/C Of RTC-27). E. Time For Possible Transmission To S/C of RTC-1 (Switch To Data Mode 1) As Backup.
2	M-2. 5H	DACON	1. Transmit Trajectory Correction Commands To DSIF Station.
3	M-2. 25H	ACE, DSIF	1. Determine Correctness Of Commands Received By DSIF Station.
4	M-2H	ACE, DSIF	1. Run Through Procedure For Transmitting Commands To Spacecraft.
5	M-1H	DSIF	1. Transmit SCI-1, -2, and -3 to Spacecraft A. Pitch Turn Command B. Roll Turn Command C. Motor Burn Command
6	M-45M	ACE	1. Determine Spacecraft Reception of SCI-1, -2, -3.
7	M-30M to M-15M	DSIF	1. Resend SCI-1, -2, or -3 To Spacecraft <u>If</u> Requested by A
8	M- (Space Transmission Time)	DSIF	1. Transmit RTC-27, Initiate Maneuver Sequence To Spacecraft.

TABLE VI-1 (Continued)

ITEM	TIME	STATION	EVENT
9	M	S/C	1. Maneuver Sequence Start A. Turn On Gyros For Warmup. B. Switch To Data Mode #1.
10	M+10M	DSIF	1. Transmit RTC-1, Change To Data Mode 1 If Necessary.
11	M+60M	S/C	1. Begin Maneuver A. S/C To Inertial Control (All Axes). Autopilot On, Star Sensor Off. B. Set Turn Polarity. C. Start Pitch Turn.
12	M+60M to 76.66M (Max.)	S/C	1. End Of Pitch Turn A. Stop Pitch Turn. B. Reset Turn Polarity.
13	M+78M to M+79M	DSIF	1. Transmit RTC-13, Inhibit Maneuver If Requested By A.
14	M+82M	S/C	1. Initiate Roll Turn A. Set Turn Polarity. B. Start Roll Turn.
15	M+82M to M+98.66M (Max.)	S/C	1. End Of Roll Turn A. Stop Roll Turn. B. Reset Turn Polarity.
16	M+100M to M+101M	DSIF	1. Transmit RTC-13, Inhibit Maneuver If Requested By A.
17	M+104M	S/C	1. Ignite Motor.
18	M+104M to M+105.66M (Max.)	S/C	1. Stop Motor Burn.

TABLE VI-1 (Continued)

ITEM	TIME	STATION	EVENT
19	M+110M	S/C	1. Switch To Cruise Mode A. Commence Automatic Reacquisition Of References. B. Switch To Data Mode #2.
20	M+115M	DSIF	1. Transmit RTC-13 and -2 to S/C If Requested By A.
21	M+110M to M+130M (Max.)	S/C	1. Sun Acquisition Complete.
22	M+110M to M+205M (Max.)	S/C	1. Canopus Acquisition Complete.
23	M+199M	S/C	1. Turn Off Maneuver Counter.

6) SPAC verifies that the roll search has started.

7) The use of DC-13 to accomplish the turn-on of the Canopus tracker necessitates the use of a special midcourse maneuver sequence.

d. Data Encoder Not Switched to Data Mode I at the Initiation of the Midcourse Sequence

The following sequence would be initiated:

1) SPAC determines that Data Mode II telemetry still exists and that DC-13 is not in effect.

2) The SPAC Director recommends to the SFOD that DC-1 be sent.

3) The SFOD initiates the transmission of DC-1 by the DSIF.

4) The appropriate DSIF station transmits DC-1.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that the spacecraft is in Data Mode I.

e. A Turn Associated With the Midcourse Maneuver is an Error

1) SPAC determines that errors exist either in polarity or magnitude, in the pitch or roll turn.

2) The SPAC Director recommends to the SFOD that DC-13 be sent.

3) The SFOD initiates the transmission of DC-13 by the DSIF.

4) The appropriate DSIF station transmits DC-13.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that the maneuver sequence has been terminated and that the reacquisition sequence is in process.

f. Canopus Tracker Locked on Wrong Object During Roll Acquisition Sequence

1) SPAC determines that the spacecraft has acquired an object during roll acquisition but is not locked on Canopus.

2) SPAC determines that the cone angle of the Canopus tracker is of the proper value.

3) Prior to midcourse, if the object can be positively identified, the maneuver computations can be accomplished using the object as the roll reference.

4) If the object cannot be positively identified, the SPAC Director will recommend to the SFOD that DC-21 be sent.

5) The SFOD initiates the transmission of DC-21 by the DSIF.

6) The appropriate DSIF station transmits DC-21.

7) SPAC verifies the receipt of the command by the spacecraft.

8) SPAC verifies that the roll acquisition sequence has been initiated and then determines the object next acquired.

g. Canopus Tracker Cone Angle is at the Incorrect Value

1) SPAC determines that the tracker field of view at the present cone angle cannot contain the star Canopus.

2) SPAC determines that the acquisition of the star Canopus is essential to maintain good communications.

3) The SPAC Director recommends that DC-17 be sent to the spacecraft.

4) The SFOD initiates the transmission of DC-17 by the DSIF.

5) The appropriate DSIF station transmits DC-17.

6) SPAC verifies the receipt of the command by the spacecraft.

7) SPAC verifies the new cone angle position and again determines whether the tracker field of view at the new cone angle can contain the star Canopus.

8) Steps 3) through 7) will be repeated until the proper cone angle has been achieved.

h. Data Encoder Not Switched to Data Mode II at the Initiation of the Reacquisition Sequence Following the Midcourse Maneuver

1) SPAC determines that Data Mode I telemetry still exists.

2) The SPAC Director recommends to the SFOD that DC-13 be sent. The use of this command will help isolate the cause of the failure.

3) The SFOD initiates the transmission of DC-13.

4) The appropriate DSIF station transmits DC-13.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC determines whether the data encoder is now in Data Mode II. If it is not, the SPAC Director recommends to the SFOD that DC-2 be sent.

7) The SFOD initiates the transmission of DC-2.

8) The appropriate DSIF station transmits DC-2.

9) SPAC verifies the receipt of the command by the spacecraft.

10) SPAC verifies that the data encoder is now in Data Mode II.

i. <u>The Data Rate is Not Switched to 8 1/3 bps by the CC&S at E-192 Days</u>

1) SPAC determines that the data rate is still 33 1/3 bps.

2) The SPAC Director recommends to the SFOD that DC-5 be sent.

3) The SFOD initiates the transmission of DC-5.

4) The appropriate DSIF station transmits DC-5.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC determines that the spacecraft data rate is at 8 1/3 bps.

j. <u>The Canopus Tracker Cone Angle is Not Reduced by the CC&S at E-137 Days, E-103 Days, E-68 Days, or E-30 Days</u>

1) SPAC determines that the Canopus cone angle is unchanged.

2) The SPAC Director recommends to the SFOD that DC-17 be sent.

3) The SFOD initiates the transmission of DC-17.

4) The appropriate DSIF station transmits DC-17.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that the cone angle has been reduced one step.

k. <u>The Transmitter is Not Switched to the High-Gain Antenna by the CC&S at E-131 Days</u>

1) SPAC determines that the RF signal is still radiating from the low-gain antenna.

2) The SPAC Director recommends to the SFOD that DC-10 be sent.

3) The SFOD initiates the transmission of DC-10.

4) The appropriate DSIF station transmits DC-10.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that the transmitter output has been switched to the high-gain antenna.

l. <u>Encounter Science is Not Turned On by CC&S at E-6 2/3 Hours</u>

1) SPAC determines that the cruise mode of the spacecraft still exists.

2) The SPAC Director recommends to the SFOD that DC-25 be sent.

3) The SFOD initiates the transmission of DC-25.

4) The appropriate DSIF station transmits DC-25.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that encounter science is turned on.

m. <u>Data Encoder Not Switched to Data Mode III at Nominal Time of Wide-Angle Acquisition</u>

1) SPAC determines that Data Mode II still exists.

2) The SPAC Director recommends to the SFOD that DC-3 be sent.

3) The SFOD initiates the transmission of DC-3.

4) The appropriate DSIF station transmits DC-3.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that Data Mode III is present.

n. Data Encoder is Not Switched to Data Mode II at the Nominal Time of Completion of Recording Data

1) SPAC determines that switch to Data Mode II should have occurred, but has not.

2) The SPAC Director recommends to the SFOD that DC-2 be sent.

3) The SFOD initiates the transmission of DC-2.

4) The appropriate DSIF station transmits DC-2.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that Data Mode II has been reinstituted.

o. Encounter Science Has Not Been Switched Off at E+6 2/3 Hours

1) SPAC determines that encounter science instruments are still on.

2) SPAC analyzes the capability of the power system to support the load. If there is sufficient margin, no action is taken.

3) Should it be determined that the power system is marginal, the SPAC Director recommends to the SFOD that DC-26 be sent.

4) The SFOD initiates the transmission of DC-26.

5) The appropriate DSIF station transmits DC-26.

6) SPAC verifies the receipt of the command by the spacecraft.

7) SPAC verifies that the load on the power supply has decreased and that this signifies a turn-off of all science instruments.

8) SSAC verifies a change in the science data format caused by the turn-off of all science instruments.

9) The SSAC Director recommends to the SFOD that DC-2 be sent.

10) The SFOD initiates the transmission of DC-2.

11) The appropriate DSIF station transmits DC-2.

12) SPAC verifies the receipt of the command by the spacecraft.

13) SPAC verifies that the increase in the power load is indicative of cruise science instruments being turned on.

14) SSAC verifies the science format is indicative of only the cruise science instruments being energized.

p. Data Encoder is Not Switched to Data Mode IV by CC&S at E+13 1/3 Hours

1) SPAC verifies that Data Mode II still exists.

2) The SPAC Director recommends to the SFOD that DC-4 be sent.

3) The SFOD initiates the transmission of DC-4.

4) The appropriate DSIF station transmits DC-4.

5) SPAC verifies the receipt of the command by the spacecraft.

6) SPAC verifies that the data transmitted from the spacecraft is Mode IV data.

SECTION VII

OPERATING PROCEDURES

The purpose of this section is to formalize certain procedures by means of which the various operational groups will function during the Mariner Mars '64 Mission. These procedures provide for commitments of, and requirements on and between the groups involved in the mission.

A. MISSION AND OPERATIONS CONTROL

1. Organizational Responsibilities

The Project Manager has the responsibility and authority for the execution to completion of the development and operation of the Mariner Mars '64 Mission. Accountable to him is the Space Flight Operations Director (SFOD). The SFOD will advise the Project Manager prior to the implementation of a course of action and will obtain his approval prior to all sequences involving commands sent to the spacecraft, except that the SFOD is authorized to make appropriate decisions requiring action to assure success of the mission if the Project Manager is not available.

In case of nonstandard events, whether Class I, II, III, or IV, a conference will be held between the Directors of the technical analysis groups, the Project Manager, and the SFOD to determine the best course of action. The operating procedures to be used will then be initiated by the SFOD, will have the concurrence of the Project Manager, and will be based on analyses by the technical groups.

During high-activity phases (Launch, Midcourse, Encounter, and major nonstandard events), full support of a maximum SFO staff for the performance of all functions will be required. During the cruise phase, the performance of the Mariner C spacecraft will be monitored 24 hours per day by the DSIF and all data received from the spacecraft will be transmitted to the SFOF. Personnel responsible for quick-look and alarm monitoring will be required to be on duty during these hours.

Procedural instructions required by the DSIF for support of the flight operation will be coordinated verbally between the DSIF Operations Manager and the SFOD. The DSIF Operations Manager directs and controls the DSIF through DSIF Net Control. Additionally, he will report to the SFOD all significant events as well as any difficulties that may occur and their possible effect on the mission.

The SFOF Operations Manager is responsible for the control of the procedures and functions of mission-independent personnel and equipment in the SFOF during the Mariner Mars '64 space flight operations. This responsibility includes the Data Processing System (DPS), the Deep Space Network Ground Communications System (DSN GCS), and the Facility Support System.

The Data Processing Project Engineer (DPPE) will provide operational control of the Data Processing System. The SFOD will communicate directly with the DPPE in determining the use of computer facilities during critical periods of flight.

It will be the responsibility of the DPPE to control the processing of data and its distribution, via the DPCC, to the various user areas for analysis and display.

The DPPE will notify the SFOF Operations Manager of any problems encountered in the area of data processing, and will supply an estimate of the time required to eliminate any difficulty. The DPPE will notify both the SFOF Operations Manager and the SFOD upon completion of all significant steps in each computer program.

The Communications Coordinator will control the use of JPL internal and external communication lines and will route data over the appropriate line. In case of conflicting requirements, the Communications Coordinator will obtain information on data and communication priorities from the SFOF Operations Manager. The Communications Coordinator will report all communication difficulties by remote display, if possible, or verbally if not. The nature of any failure shall be reported to the SFOF Operations Manager.

Facility support functions are under the direction of the SFOF Operations Manager. It will be his responsibility to ensure that:

1) All SFOF support functions are being performed

2) Equipment maintenance problems are reported to accountable personnel

3) The correction of any failure in a support function is expedited

4) Supplies required during the mission are provided in all areas

During a mission, failure reports concerning any system supporting the mission shall be made directly to the SFOF Operations Manager.

The FPAC Director will direct the flight operation support for which his group is responsible. He will maintain the required computing operations schedule within the FPAC function. For specific phases of the operation and with the knowledge of the FPAC Director, the SFOD may coordinate activities directly with the head of a specific function within the FPAC.

The FPAC Director will be required to submit a verbal report, upon request, to the SFOD on the status of his functions. Further, it is the responsibility of the FPAC Director to report any significant or anticipated deviations from the scheduled operation. The head of each function within the FPAC shall advise the FPAC Director of any input that is significant to the mission.

The SPAC Director will supervise and coordinate the planned analysis of telemetry data by the subsystem representatives. He will accept special requests for analysis only from the SFOD. The SPAC Director will be required to submit a verbal report, upon request, to the SFOD concerning the status of his area of responsibility. The SPAC Director will also report any spacecraft anomaly or data recovery problems to the SFOD and will describe the expected effect on the spacecraft and any known effects on the mission.

The SSAC Director will coordinate the scientific support of the flight operations. He will be required to submit a verbal report, on request, to the SFOD concerning the status of experiments. The SSAC Director will be prepared at all times to confer with the SFOD on the scientific trade-offs of various mission possibilities.

2. Maneuver Policy

The guidelines delineated below and illustrated in Figures VII-1 and VII-2 shall be followed in determining the necessity for, and the choice of maneuvers during space flight operations. The Project Manager may revise or waive any or all of these guidelines at any time if it is in the best interest of the project to do so.

The maneuver aiming points are defined in Table VII-I for nominal maneuver conditions. The Goldstone time-of-day for encounter events will be supplied in a future revision.

TABLE VII-I. MANEUVER AIMING POINT

TYPE I TRAJECTORY	TYPE II TRAJECTORY
1) Arrival Day: 15 July 1965 $B = 13{,}000$ km $\pm$ 2000 km $\theta = 60° \pm 2°$	1) Arrival Day: 17 July 1965 $B = 13{,}000$ km $\pm$ 2000 km $\theta = 80° \pm 2°$
2) Arrival Day: 17 July 1965 $B = 13{,}000$ km $\pm$ 2000 km $\theta = 70° \pm 2°$	2) Arrival Day: 19 July 1965 $B = 13{,}000$ km $\pm$ 2000 km $\theta = 80° \pm 2°$

The encounter area in the vicinity of the planet is divided into three zones:

a. Zone 1

The greatest returns of planetary information from all experiments will be available if encounter occurs in this area.

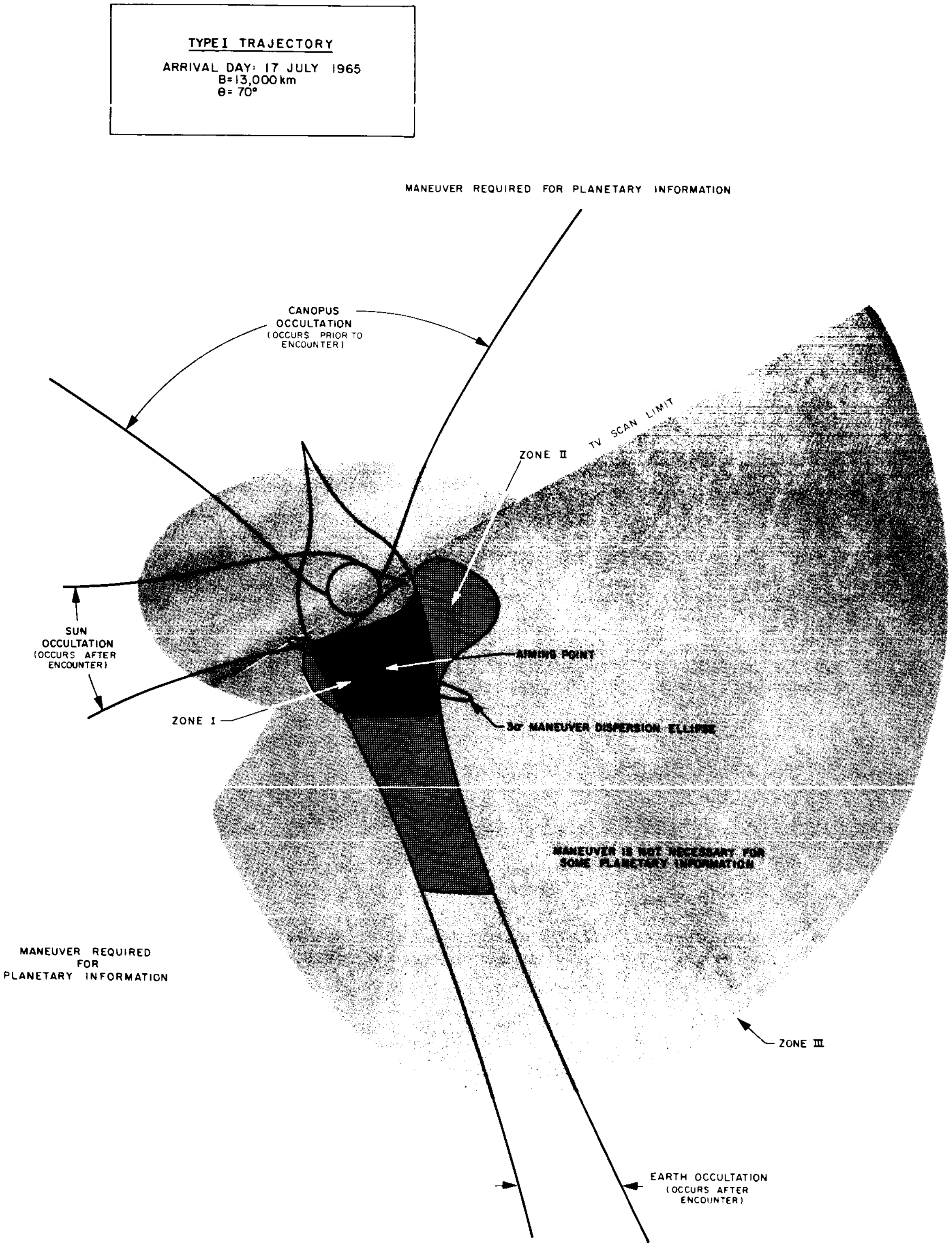

FIGURE VII-1. AIMING POINT PLANE, TYPE I TRAJECTORY

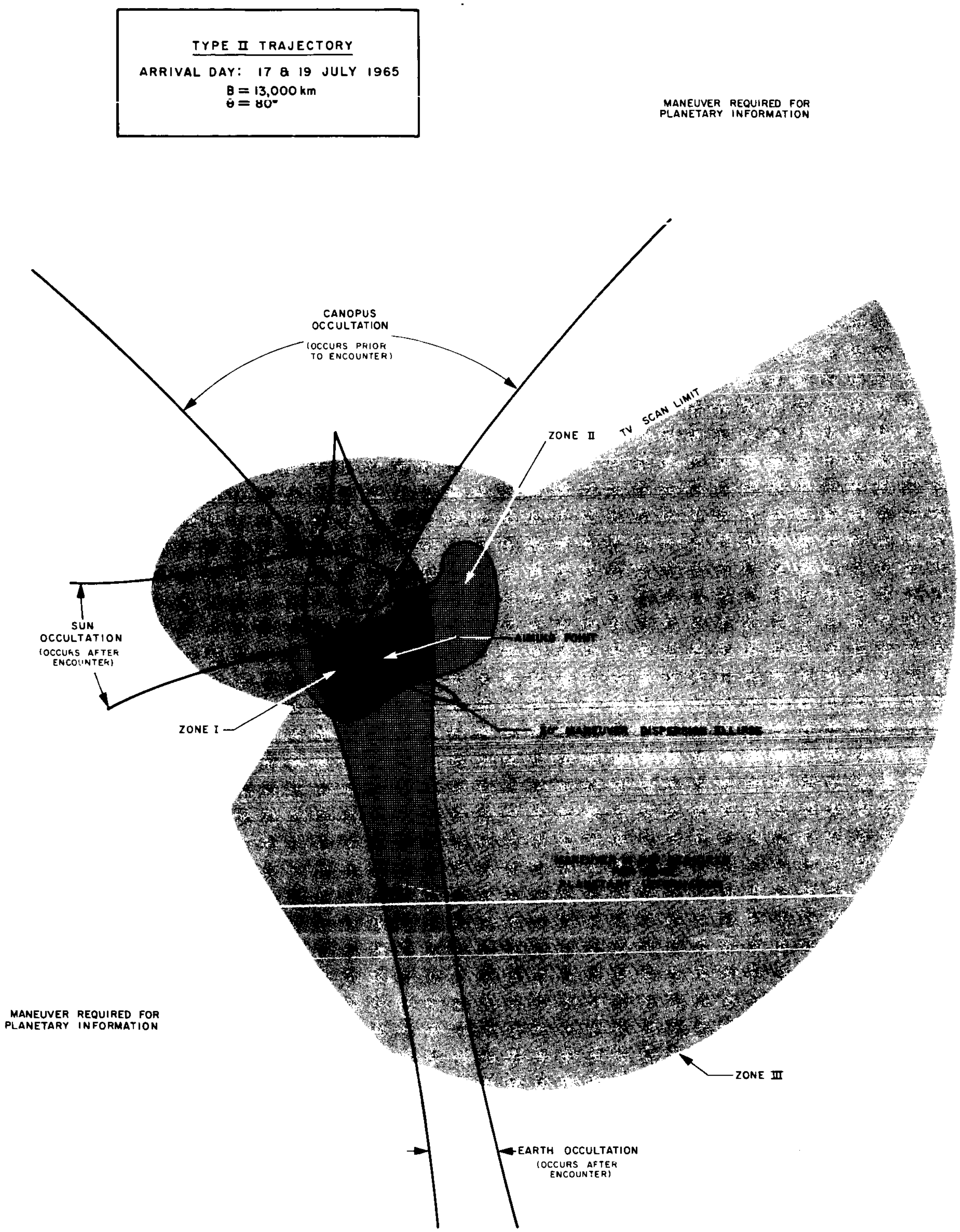

FIGURE VII-2. AIMING POINT PLANE, TYPE II TRAJECTORY

(1) No maneuver will be performed if the launch vehicle injects the spacecraft into a trajectory that results in an encounter in Zone 1. Conversely, at least one maneuver will be performed if the launch vehicle injects the spacecraft into a trajectory that results in an encounter in any area other than Zone 1.

(2) If a first maneuver is performed that injects the spacecraft into a new trajectory resulting in an encounter in Zone 1, no second maneuver will be performed.

(3) The perimeter of Zone 1 is the approximate boundary within which an encounter, resulting from and indicated during the performance of a maneuver, should occur. Specifically, if data received during the performance of a maneuver indicates that an encounter outside this boundary will result, DC 13 (MANEUVER INHIBIT) shall be used.

b. Zone 2

Encounter in this area will provide high returns from either the TV and occultation experiments or the TV and fields and particles experiments, but not the highest returns from all experiments.

(1) If the first maneuver establishes a trajectory that fails to result in an encounter in Zone 1 but that does result in an encounter in an area in Zone 2 from which both TV and occultation data will be available, a second maneuver may not be performed.

(2) If the result of the first maneuver is an encounter in Zone 2 wherein only TV and fields and particles information is available, the Project Manager may waive the occultation experiment (and the performance of a second maneuver). However, it is presently planned that a second maneuver will be performed to obtain TV and occultation information.

c. Zone 3

An encounter in Zone 3 will not provide information from all experiments and, in some cases, will provide information from only one experiment. Combinations of experiments from which information will be available are:

1) TV only

2) Fields and particles only

3) Occultation only (possibly)

4) TV and fields and particles

5) TV and occultation

Any trajectory that might result in an encounter in any area other than Zones 1 or 2 will be corrected by the performance of one or both maneuvers in an attempt to obtain an encounter in Zones 1 or 2.

B. DSIF CONTROL AND OPERATIONS

1. Organizational Responsibilities

a. DSIF Operations Manager

The DSIF Operations Manager is responsible for the operation of the DSIF in support of the Mariner Mars '64 Mission in accordance with commitments made by the DSN office. He will coordinate DSIF activities, as directed by the SFOD, and will provide support to the SFOD in establishing procedures for nonstandard situations.

b. DSIF Project Engineer

The DSIF Project Engineer is responsible for the preparation and distribution of the Tracking Instruction Manual (TIM), the Tracking Operations Memorandum (TOM), and instructions and test schedules for the DSIF stations. He will assist the DSIF Operations Manager and the SFOD in establishing the tracking schedule for the mission. He will also ascertain that committed DSIF stations are properly equipped with mission-dependent equipment and are operationally ready for a mission at a time specified by the DSIF Operations Manager. Lastly, he is responsible for the instruction of the Net Control personnel as to duties and responsibilities for the mission.

c. DSIF Net Control

DSIF Net Control will establish and maintain communications with the DSIF stations as dictated by test and mission schedules. It will coordinate the activities of these stations during actual operational periods by providing a Net Controller for each station.

d. DSIF Advisory Staff

The DSIF Advisory Staff comprises systems engineers for the Ground Radio System, the Tracking Data System, and the Telemetry Data System. The responsibilities of these engineers are to provide full-time coverage during critical periods, and to serve as technical advisors to the DSIF Operations Manager and the Project Engineer. They will also be available during noncritical periods to assist in resolving problems that may arise within the DSIF.

2. Information Required From Other Areas

The DSIF Operations Manager and the Project Engineer shall be periodically advised of the quality of the tracking and telemetry data by a representative of the appropriate analysis area.

Personnel from the appropriate areas will give advance notice of the transmission of predictions to the DSIF and changes in communications commitments to the DSIF Operations Manager and to the Project Engineer.

3. Information Supplied to Other Areas

DSIF Net Control will report, in real time, spacecraft events as reported by the DSIF stations.

DSIF reports (tracking summary, etc.) will be supplied according to a schedule and to a distribution established by the SFOD and the DSIF Project Engineer.

C. SFOF CONTROL AND OPERATIONS

1. Organizational Responsibilities

Refer to Figures VII-3 and VII-4 for the line of authority of the personnel and/or functions described below.

a. SFOF Operations Manager

The SFOF Operations Manager is responsible for the direction of SFOF functions during the Mariner Mars '64 Mission. The duties include committing and controlling the procedures and functions of the mission-independent personnel and equipment in the SFOF. In particular, he is responsible for ensuring that:

1) All SFOF support functions are performed

2) Equipment maintenance problems are reported to accountable personnel

3) The correction of any failure in a support function is expedited. Failure reports of any supporting SFOF system shall be submitted directly to the SFOF Operations Manager.

b. SFOF Project Engineer

The SFOF Project Engineer is responsible for:

1) Coordinating Mariner Mars '64 Mission requirements with SFOF capabilities

2) Disseminating, among the various systems of the SFOF, the information required to support the Project

3) Ensuring that the configuration of the SFOF for the support of the Project is implemented as agreed upon between the Project and the SFOF

4) Participating in SFOF tests and operations when deemed necessary by the SFOF Operations Manager

5) Supplying the Mariner Mars '64 Project with preflight and postflight SFOF reports and schedules

6) Documenting the commitments of the SFOF to the Mariner Mars '64 Project. This documentation consists of contributions to the SFO System Design Specifications, the DSN Support Plan, the SFOF Standard Operating Procedures, and the SFOF Postflight Summary.

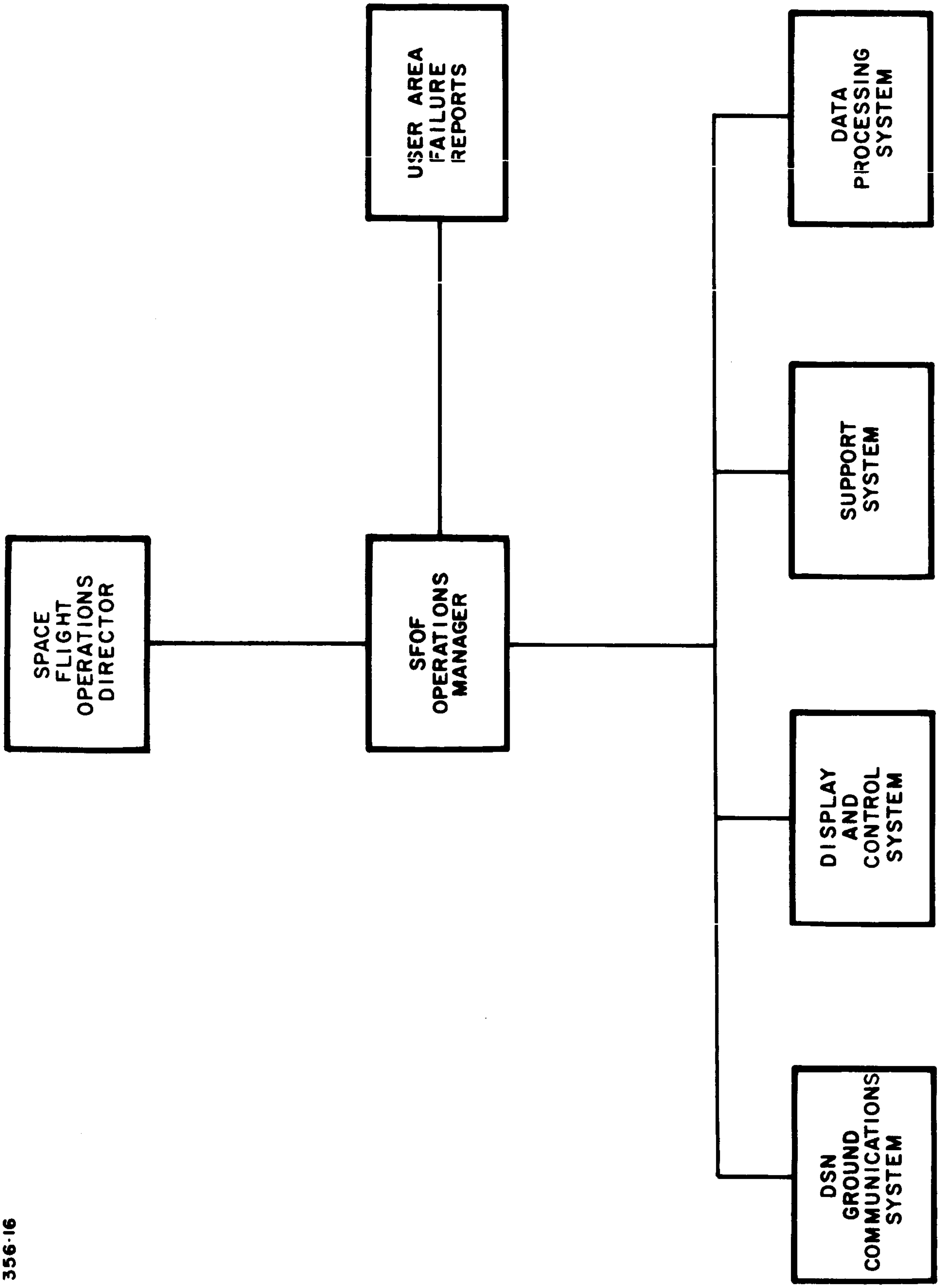

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FIGURE VII-3. HIGH-ACTIVITY (CRITICAL) FLIGHT PHASE

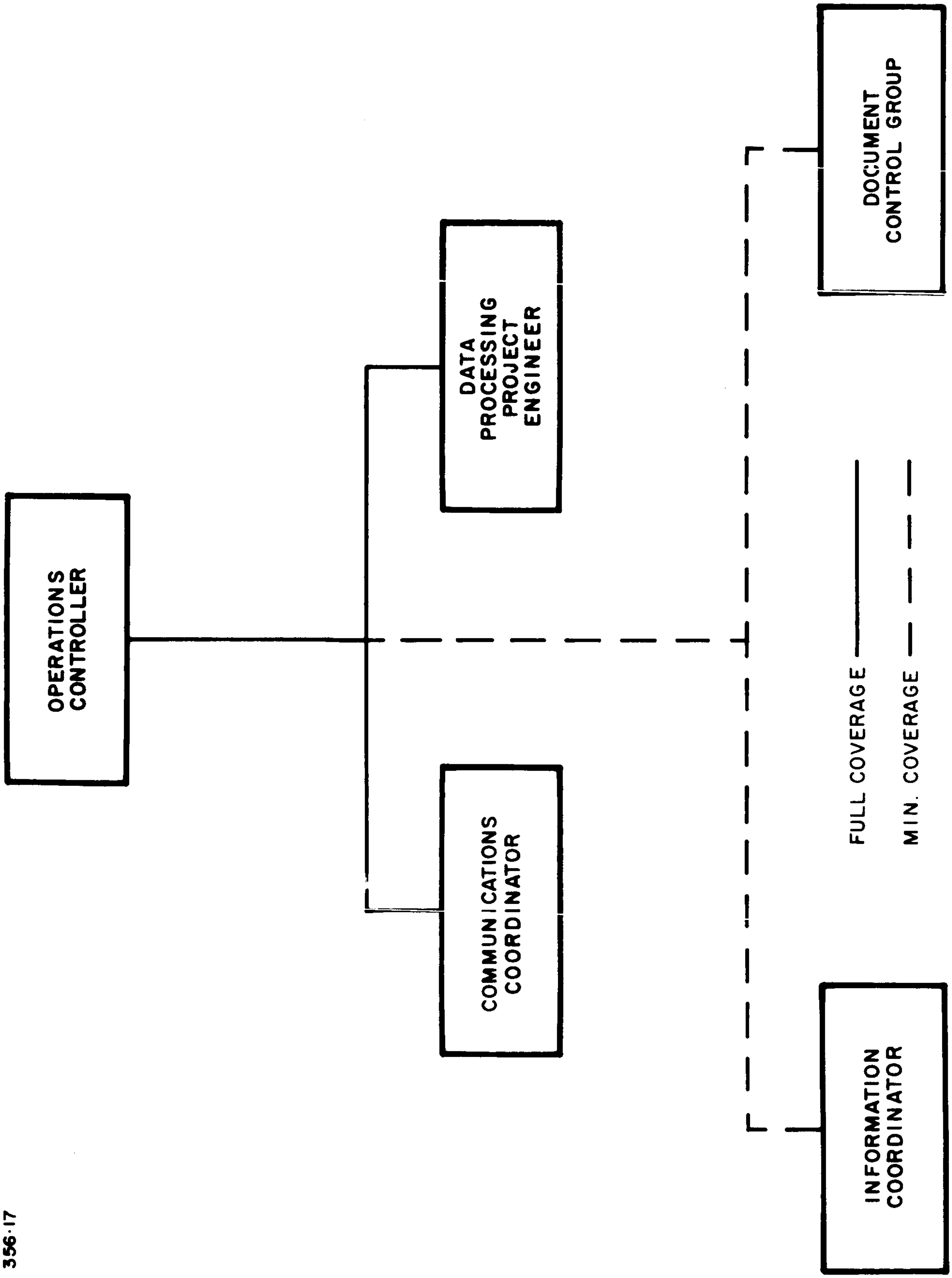

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FIGURE VII-4. LOW-ACTIVITY (CRUISE) FLIGHT PHASE

c. Communications Coordinator

The Communications Coordinator is responsible to the SFOF Operations Manager for operation of the SFOF Internal Communications System. He is responsible for coordination of the ground and SFOF communication network. The Communications Operations Team Leader will provide him with support plans and a sequence of events for the particular operation at hand. He will direct the operation of the Communications Center through the Technical Coordinator and the Data Distributor, and will supervise their activities and areas of responsibilities. In case of conflicting requirements, the Communications Coordinator will obtain information on data and communication priorities from the SFOF Operations Manager.

The Communications Coordinator is responsible for making a continuing review and evaluation of those communications personnel and facilities made available to him under appropriate support plans and schedules. He will enter data on the SFOF status boards relative to these facilities. He will have access to, and continue a historical record of all significant communication events including items such as circuit outages, subsystem failures, user area failures, subsequent repair and/or replacement notations, and general message and/or conference information.

d. Data Processing Project Engineer

The Data Processing Project Engineer (DPPE) will coordinate and control the SFOF Data Processing System (DPS). He will maintain control over the Data Processing Control Console (DPCC) operators, the TPS and Computer Subsystem operators, and the programmers assigned to the SFOF analysis areas. Control functions implemented at the DPCC will be based on the requirements of the SFOD and the SFOF Operations Manager.

It will be his responsibility to control the processing of data and its distribution to the various user areas for analysis and display. He will also notify the SFOF Operations Manager of any problems encountered in the area of data processing, and will supply an estimate of the time required to solve them. He will notify both the SFOF Operations Manager and the SFOD upon completion of all significant steps in each computer program. Further, he will maintain a log of DPCC operations and an operations handbook of Computer Subsystem control.

e. Information Coordinator

The Information Coordinator will obtain and maintain status information from all elements of the SFO Complex as required by MC/SFO-4-202. His responsibilities include:

1) Coordinating the preparation, dissemination, and display, via the SFOF Display and Control System, of operational status information in the operational areas

2) Collecting the information required to compile the Mariner C status reports

3) Reporting malfunctions in displays to the responsible technicians

During the flight, the Information Coordinator is responsible first to the SFOF Operations Manager and, secondly, to the Mariner Mars '64 SFOD. Those areas with which the Information Coordinator comes in contact are:

1) Spacecraft Performance Analysis and Command (SPAC)

2) Space Science Analysis and Command (SSAC)

3) Flight Path Analysis and Command (FPAC)

4) Deep Space Instrumentation Facility (DSIF) Control

5) Data Processing Area (DPA)

6) Communications Control

7) Office of Public Education and Information (OPEI)

8) Operations Control

f. Document Control Group

The SFOF Document Control Group has responsibility for the physical receipt of all flight data from the DSIF, the AFETR, and the SFOF and for storing a complete record of this data in the form of microfilm, teletype paper tape, and/or magnetic tape. The Document Control Group has the capability of rapidly retrieving all flight data, by means of an indexing method, from the stored microfilm or the data library. In addition, the group reproduces and disseminates the off-line bulk data originating in the Data Processing Area (DPA) as required for support of the Mariner Mars '64 Mission.

D. FLIGHT PATH ANALYSIS AND COMMAND (FPAC)

1. FPAC Director

The FPAC Director is responsible for the proper execution of FPAC functions. His real time mission responsibilities include scheduling and disseminating information within his group to ensure that outputs of the FPAC function are made available to the appropriate areas. The scheduling responsibility includes placing personnel requirements on the FPAC Operations Heads and arbitrating FPAC computing conflicts in a manner consistent with the desires of the SFOD.

It is the FPAC Director's responsibility to ensure that pertinent FPAC personnel are at all times cognizant of all changes in mission status and/or of all real time decisions, and that appropriate action will be taken when required.

Each FPAC Operations Head is responsible for personally presenting to the SPAC Director the technical inputs that are concerned with the former's area of responsibility, and that are necessary for real time decisions by the SFOD. The SPAC Director will be responsible for presenting this information to the SFOD.

The FPAC Operations Heads will make available to the FPAC Director copies of those portions of their outputs that are significant and will keep the FPAC Director advised as to the status of their respective areas. The FPAC Director will, in turn, as a service to the Operations Heads, explain to the appropriate personnel the contents of any FPAC output and/or the status of the FPAC at any given time.

2. Maneuver Commands

a. General

The commands for which procedures are given in this paragraph are:

DC-13	Maneuver Inhibit
DC-14	Remove Maneuver Inhibit
DC-23	Arm Second Maneuver
DC-27	Initiate Maneuver
QC1-1	Pitch Turn Duration
QC1-2	Roll Turn Duration
QC1-3	Motor Burn Duration

b. Description of Operations Program

The primary function of the Midcourse and Terminal Guidance Operations Program, described in detail in JPL RFP 312-174 and addenda, is to formulate the midcourse maneuver commands required to achieve standard operation. Each maneuver requires three stored quantitative commands (QC) and one direct command (DC). The three stored quantitative commands, when transmitted to the spacecraft, are stored in the memory of the CC&S prior to performance of the maneuver. The one direct command initiates the maneuver sequence.

If optimum utilization of spacecraft resources for this function will not permit achievement of standard operation, the program permits determination of the feasibility of certain nonstandard modes of operation. In such an event, the decision as to which mode shall be adopted will be made by the SFOD during the flight and, subject to the approval of the Project Manager, executed.

(1) Sequence of Guidance Operations. The sequence of events in computing and executing the midcourse maneuvers follows.

(a) The spacecraft is tracked from launch. After the spacecraft has been tracked for at least two days, a definitive orbit from which the maneuver will be computed is determined.

(b) The midcourse velocity impulse required to modify the trajectory of the spacecraft so that encounter occurs with the desired geometry at a favorable time is computed. Certain constraints must be satisfied:

1) The velocity impulse may not be applied in certain directions without loss of the telemetry used to record the performance of the midcourse system, because there are nulls in the pattern of the low-gain antenna used to transmit the data.

2) The velocity impulse delivered cannot exceed the maximum value set by the amount of propellant available.

3) The velocity impulse cannot be applied in certain directions within a cone about the initial pitch axis. This cone is inaccessible because of the pitch-roll turning sequence and the motor mounting.

The antenna constraint will not be violated unless the mission cannot otherwise succeed. If a maneuver resulting in encounter with the desired geometry and satisfying the other constraints cannot be found, a failure situation exists. If the spacecraft is operating properly and is following a trajectory that takes it sufficiently close to Mars, an attempt will be made to determine a midcourse maneuver that places the spacecraft on the most advantageous trajectory available. The trajectory evaluation features of the Guidance Operations Program enable the operations personnel to choose a revised aiming point quickly. Once a suitable aiming point has been chosen, the midcourse maneuver is computed.

(c) The vector impulse is converted to the appropriate coordinates: pitch turn angle, roll turn angle, and magnitude of impulse. The two angles and the magnitude are then converted to the binary-coded form acceptable to the spacecraft.

(d) The three binary-coded commands are converted to TTY format and transmitted to a page printer and reperforator in the FPAC area. The punched paper tape is checked for validity against the computer printouts and is then given to the SFOD for approval. After proper approvals have been obtained, the command message is transmitted to the appropriate DSIF station where the command is again checked and is then transmitted to the spacecraft using the Read-Write-Verify (RWV) System. The commands are stored in the registers of the CC&S.

(e) DC-27 is transmitted and the spacecraft begins the midcourse maneuver. After completing the midcourse maneuver the spacecraft returns to the cruise mode, orienting itself by means of the Sun and Canopus sensors.

(f) The orbit is recomputed and the necessity of a second maneuver is determined. If required, the second maneuver is executed in the same manner as the first.

c. Considerations Determining the Optimum Choice of Maneuvers

A large number of constraints and experimental requirements affect the choice of an optimum flyby trajectory. The nominal trajectory was chosen to satisfy all these constraints in an optimum manner. The constraints that have been considered are:

(1) Experimental Requirements.

(a) Television Experiment. The following restrictions are imposed by the television experiment:

1) The area being photographed must not move too rapidly across the field of view or the picture will be blurred.

2) The area being photographed must include contrasting regions recognizable from Earth observations.

(b) Field and Particle Experiments. The spacecraft must pass sufficiently close to the planet to detect the associated fields and any trapped radiation.

(c) The flyby geometry should enable an improved estimate to be made of the Martian atmosphere and of its mass.

(2) Engineering Subsystem Requirements. There are several hardware constraints imposed by the various subsystems:

(a) Attitude Control. The following restrictions are imposed by the attitude control subsystem:

1) The spacecraft must be able to see the Sun and the star Canopus, otherwise attitude reference will be lost.

2) The encounter geometry must not allow Mars or its satellites to come into the field of view of the Canopus sensor.

(b) Communications. The following restrictions are imposed by communications requirements:

1) If at all possible, the orientation of the spacecraft during the midcourse maneuver must permit the transmission of telemetry over the low-gain antenna.

2) The high-gain antenna must be pointed at the Earth during the encounter sequence while planet scan is in progress, and until the data is relayed back to the Earth.

(c) Propulsion. The midcourse impulse cannot exceed the maximum provided.

The satisfication of all these constraints, other than the low-gain antenna constraint, is guaranteed if encounter occurs in the nominal location. If a standard encounter is not indicated, a trajectory that satisfies these constraints will be chosen during the operation.

d. Input to the Guidance Operations Program

The input to this program has been divided into three classifications.

1) Input from the Tracking Program

The basic inputs from the tracking program are the best estimate of the six injection coordinates and the injection time and a measure of the orbit uncertainty.

2) Prelaunch Input

The prelaunch input consists, in general, of items that can be considered constants of the spacecraft system and thus are not subject to variation during changing or unexpected operating conditions.

3) Postlaunch Input

Items in the postlaunch input fall into two classifications: items that are subject to change during changing or unexpected operating conditions, and control commands for the program.

e. Functional Blocks

Figure VII-5 is a functional block diagram of the Guidance Operations Program. There are seven independent blocks that have been built around the JPL planetary trajectory program. Functional blocks 1 through 5 in this figure are required for standard operation and nonstandard operation. Functional blocks 6 and 7 have been designed to assist in making operational decisions during nonstandard operation. A brief description of each functional block is given below.

Block 1 Midcourse Maneuver Program Introductory Printout

The information presented on the introductory printout is based on the orbit determination process, gives an initial estimate of the quality of the orbit obtained, and serves to relate the Orbit Determination Program to the guidance program. All

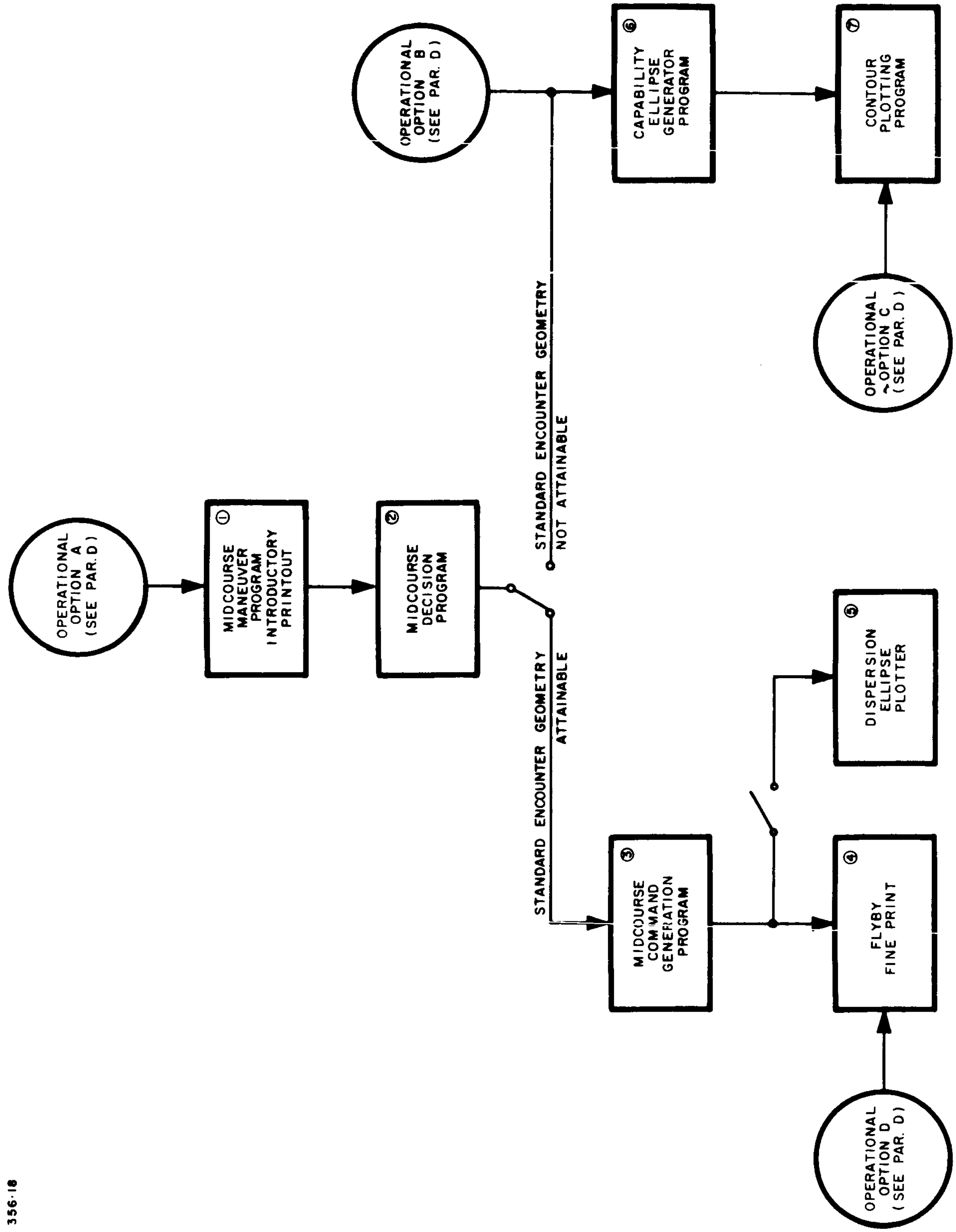

FIGURE VII-5. MIDCOURSE GUIDANCE OPERATIONS PROGRAM input quantities from the Orbit Determination Program will be included in the introductory printout. The trajectory program will be utilized to obtain an initial estimate of the miss distance and time-of-flight error that exist between the best fit trajectory and the terminal conditions specified in the program output.

Block 2 Midcourse Decision Program

The purpose of this program is to calculate the midcourse maneuver subject to various constraints. The constraints that must be evaluated are the propulsion constraint, the time-of-flight constraint, and the low-gain antenna constraint. The propulsion constraint and the time-of-flight constraint are absolute. If it is not possible to attain the encounter geometry requested without violating an absolute constraint, the Midcourse Decision Program will switch automatically to the Capability Ellipse Generator Program. If it is possible to attain the encounter geometry requested without violating an absolute constraint, the output of the Midcourse Decision Program will be fed directly to the Midcourse Command Generation Program.

The output from the Midcourse Decision Program falls into three groups. The first group specifies the trajectory conditions (i. e., position, velocity, and time) at which the midcourse rocket motor ignites. The second group consists of a set of brief statements that will be printed out, if called for, by the decision sequence that formulates the midcourse maneuver. The third group contains detailed numerical information related to the test for the antenna constraint.

Block 3 Midcourse Command Generation Program

The purpose of this program is to convert the velocity vector correction, determined in the Midcourse Decision Program, into a pitch turn, a roll turn, and a velocity magnitude, all expressed in binary form and adjusted to a form usable by the CC&S. The commands will be punched out on cards in binary form on command. The Midcourse Command Generation Program will also calculate a noise moment matrix of midcourse injection errors.

Block 4 Flyby Fine Print Program

The purpose of the Flyby Fine Print Program is to generate detailed information concerning the trajectory during the encounter sequence. The program is automatically run after the Midcourse Command Generation Program.

Block 5 Dispersion Ellipse Plotting Program

The covariance matrices of the orbit determination and of the midcourse execution are mapped to dispersion ellipses in the R·T plane.

Block 6 Capability Ellipse Generator Program

The Capability Ellipse Generator Program will generate the maximum capability ellipse in the R·T plane by assuming that maximum maneuvers are applied in the critical plane. By drawing a contour through the points found in this way, the attainable area in the R·T plane can be defined.

Block 7 Contour Plotting Program

Contours of the various constraints will be plotted in the R·T plane. This is done primarily as an aid in selecting new aiming points in nonstandard situations.

f. Operational Options

The various functional blocks described in paragraph e., immediately preceding, are combined to form four operational options. These options are:

Operational Option A - Midcourse Maneuver Program

Operational Option B - Mission Capability Study Program

Operational Option C - Spacecraft and Trajectory Constraint Evaluation Program

Operational Option D - Flyby Trajectory Fine Print Program

In general, all operational options will be used before the midcourse maneuver to select the midcourse maneuver; Operational Option D will be used after the midcourse maneuver to monitor the trajectory obtained. All four operational options require access to the prelaunch input and the input from the tracking program. Each option requires the trajectory program. The postlaunch input is specified by options.

Operational Option A, the Midcourse Maneuver Program can, under various circumstances, use five of the seven functional blocks. The postlaunch input provides considerable additional flexibility. The following alternatives are provided:

1) Operational Option B will be used when it is desired to make a mission capability study.

2) Operational Option C will be used when the standard encounter conditions are unattainable and an alternate aiming point must be chosen.

3) Operational Option D will be used, in general, after the midcourse maneuver, on flyby missions, to obtain better trajectory information following an improvement in the orbit determination.

3. Orbit Determination

a. General

The determination of the spacecraft orbit is described herewith. The portions of the Atlas/Agena, Mariner C vehicle trajectory to which this part of the procedure applies are the parking orbit of the Mariner C/Agena and the space trajectory of the Mariner C spacecraft. Knowledge of the parking orbit is required by JPL to provide:

1) Initial acquisition and prediction information for the DSIF

2) An estimate of the injection conditions of the spacecraft

Knowledge of the space trajectory of the Mariner C spacecraft after injection is required to provide:

1) The path of the spacecraft in space

2) Successive acquisition and prediction information for the DSIF

3) Spatial orientation to assist the evaluation of spacecraft performance

4) Inputs to the maneuver program.

b. Determination of the Parking Orbit

The parking orbit of the Mariner C/Agena vehicle is an Earth satellite orbit into which the vehicle, under standard conditions, is injected at the end of the first Agena burning period. After a coast period, the Agena stage is reignited and permitted to burn until sufficient velocity has been attained to place the spacecraft in the desired Mars flyby trajectory. The vehicle will be tracked during the parking orbit by the AFETR tracking stations shown in Figure II-1. The prime responsibility for the real time determination of the parking orbit will be discharged by AFETR. The orbital elements of the parking orbit and initial acquisition information will be supplied to JPL by AFETR as shown in the Standard Sequence of Events (Table V-I).

Prior to entry into the parking orbit, AFETR will fulfill its range safety function under the direction of the Superintendent of Range Operations. During, and for a short period after entry into the parking orbit, the vehicle will be tracked by the San Salvador, Grand Turk, Antigua, and Bermuda radars. At the conclusion of its range safety function at approximately L +500 seconds, AFETR will use this tracking data, with a modified least squares technique, to determine the injection conditions of the parking orbit. The time of injection, i. e., cutoff of the first Agena burning period, will be obtained from Antigua in real time by telemetry from the Agena vehicle.

While the Mariner C/Agena vehicle is coasting in the parking orbit, AFETR will use these injection conditions and time, assume a nominal second Agena burn, and commence computation of initial acquisition information for DSIF 41 and 51. The orbital elements of the parking orbit and initial acquisition information will be transmitted in real time to JPL at Cape Kennedy for relay to the SFOF and DSIF 41 and 51.

To ensure the capability of providing this initial acquisition information for the DSIF, JPL will back up the AFETR computations at the SFOF. Reformatted raw tracking data from Antigua, Ascension, Pretoria, and the tracking ship, as well as the telemetered event times, will be transmitted to JPL at Cape Kennedy for relay to the SFOF for this purpose. JPL will parallel the computations at AFETR and will use the orbital elements supplied by AFETR as they become available. The initial computations at AFETR will be based on more data from more stations than those at the SFOF thereby providing a better estimate of the parking orbit injection conditions.

At the conclusion of the AFETR postinjection orbit determination process, AFETR will transmit the injection conditions of the spacecraft to JPL. If trouble should develop with the IBM 7094 at the IPP, these injection conditions will be used by JPL to compute the required initial acquisition information for DSIF 41 and 51.

c. Determination of the Spacecraft Orbit

After initial acquisition by the DSIF, all postinjection tracking data will be supplied by the DSIF for the determination of the orbit of the spacecraft.

(1) The Mathematical Method and Computational Options

The spacecraft orbit will be determined by finding the set of initial conditions at injection epoch that causes the weighted sum of the squares of the differences between actual observations and the computed values of the observables to be minimized. The method is called modified weighted least squares because of the method employed in obtaining the weights. In the usual least squares method, the data points are weighted, independently, inversely proportionally to their expected (or measured) variances. In modified least squares, the independent weighting values are determined by the expected (or measured) effective variances. In arriving at the effective variance for each data type at each station, consideration is given to the correlation width of all recognized noise sources, the sampling rates, counting times, elevation angles, range to the spacecraft, and computational errors.

A final premaneuver orbit will be computed using all data prior to the maneuver point. The best estimate of the initial conditions and the covariance matrix of its errors at the new epoch will be computed in the midcourse guidance program from data supplied by the Orbit Determination Program (ODP) plus the statistical description of nominal guidance execution errors provided before launch and verified after launch by the SDAT. The ODP will statistically combine the premaneuver orbit estimate with the postmaneuver tracking data to provide the combined postmaneuver estimate.

Operationally, the tracking data will be placed on magnetic tapes directly from the teletype lines and on the disc files. The normal mode of operation of the Tracking Data Editing Program (TDEP) will use tracking data from the disc; the data on tape serves as a backup. The TDEP processes the incoming tracking data at regular intervals so that data not meeting certain tests for data format, range of measured quantities, and data condition codes may be eliminated and the remainder of the data may be made available for use by the ODP. The Orbit Determination Group will control the data admitted to the ODP from the disc file containing the edited data. Blunder points not caught by the TDEP are normally rejected by the ODP using a semiautomatic, three-sigma test. The main exception is the OD first postinjection orbit that will require nonautomatic hand editing because of inaccuracies in the initial conditions. It is anticipated that after two hours of data have been processed, no significant convergence problems will be present. AFETR estimates of injection conditions will normally be used to start the iterative process. An independent check of these initial conditions will be made using DSIF data with a recently developed starter method.

(2) Key Events

a) Parking orbit estimation (backup to AFETR).

b) Orbit calculation number one. This gives a preliminary indication of the maneuver required to hit the desired aiming point.

c) Nominal maneuver orbit. This orbit is computed a few hours before midcourse and is used as a basis for the initial calculation of the midcourse maneuver before it is performed.

d) First postmaneuver orbit. This orbit provides the first opportunity to compute the actual postmaneuver target parameters and to gain a preliminary estimate as to the necessity of a second maneuver.

E. SPACECRAFT PERFORMANCE ANALYSIS AND COMMAND (SPAC)

1. Organizational Responsibilities

SPAC support of the Mariner Mars '64 Mission will be described as a function of mission phases. The primary mission phases are:

a) Launch to Canopus Acquisition

b) Canopus Acquisition to Midcourse Maneuver

c) Midcourse to Reacquisition

d) Cruise

e) Encounter

A central core of SPAC personnel, hereafter referred to as the nucleus, will consist of the SPAC Director, the SPAC Division Representatives, the Data Processing and Operations Advisor, and the Computer Programming Advisor(s). The SPAC Director will place much responsibility for the successful discharge of the SPAC effort on the other members of this nucleus. Additional personnel from the technical divisions will augment this nucleus during the various mission phases. The schedule which follows will indicate how the various mission phases will be supported.

a. Launch to Canopus Acquisition Phase

Full support from all major subsystems will be provided during this phase from Launch minus one (1) hour until Canopus Acquisition plus four (4) hours.

b. Canopus Acquisition to Midcourse Maneuver Phase

The minimum support during each 24-hour interval will be the SPAC Division Representatives or their alternates. This support will commence at Canopus Acquisition plus four (4) hours and will terminate at Midcourse Maneuver minus six (6) hours.

c. Midcourse Maneuver to Reacquisition Phase

Full support from all major subsystems will be provided during this phase from Midcourse Maneuver minus six (6) hours to Canopus Reacquisition plus four (4) hours.

d. Cruise Phase

During this phase, SPAC support will consist of a) monitoring the spacecraft data output on a day-to-day basis, b) daily convening of the SPAC nucleus to discuss spacecraft performance and provide current computer alarm limits. Telemetry analysis by SPAC will be conducted in nonreal time during the cruise mode, except in the following situations:

1) Individual SPAC members may review the bulk data output in the Planetary Operations Room at their convenience.

2) The SPAC Director may periodically decide to run an exercise in the SPAA at a time when that room can be made available.

3) An emergency (alarm) situation arises in the spacecraft performance and some corrective action must be decided upon.

During the cruise phase, detailed plans for staffing and operation during the encounter sequence will be worked out. This effort will require periodic meetings to evolve these plans.

e. Encounter Phase

The tentative schedule during the encounter phase will be real time, 24-hour personnel support from all major subsystems, beginning about one day prior to the estimated encounter time and extending through the period of tape recorded data playback. As mentioned previously, the details of the encounter phase operation will be generated during the cruise phase.

2. Operational Procedures

a. Launch to Canopus Acquisition Phase

Although the state of the spacecraft at time of launch is not the responsibility of SPAC, SPAC personnel will be available at least one hour prior to scheduled launch time to review the spacecraft telemetry generated in the prelaunch configuration; thus these personnel will be able to anticipate the spacecraft telemetry output following launch. The spacecraft telemetry will be transmitted to the SFOF from Cape Kennedy during the prelaunch phase to assist SPAC in its subsequent analysis of the spacecraft after launch.

All data acquired at the JPL station at Cape Kennedy will be transmitted to the SFOF for evaluation by SPAC. Similarly, data acquired at the SFOF during the initial stages will be transmitted, as desired, to the JPL station at Cape Kennedy for perusal by the launch team.

The first scheduled spacecraft events will occur, in most cases, over an area of the Indian Ocean. Telemetry of these events will not be available in real time. Telemetry data acquired in real time by DSIF 41 will have to be used to determine that the following actions have occurred (primary indicators are also noted):

Action	Indicator
Solar Panels Open	#115, #116
Scan Platform Unlatch	#116
Sun Acquisition In Process	#105, #106, #112, #113
Radio Transmitting High Power	#204, #214 (DSIF received signal strength)
Cruise Science On	#227 (Telemetry contains science data)
Tape Recorder Shut Off	#116, #221

When the spacecraft is over DSIF 41, the CC&S will initiate backup commands for unlatching the solar panels and scan platform and for initiating the Sun acquisition process. The generation of these two commands will be indicated on Telemetry Channel 115.

The completion of the Sun acquisition process should be indicated on Telemetry Channels 112, 113, and 116. Verification of the fact that the solar panels will supply the total spacecraft power requirement will be indicated by observing Telemetry Channels 109, 207, 216, 222, 223, 224, 225, and 226. Sun acquisition can also be verified by the fact that the magnetometer calibration roll rate will be imparted to the spacecraft. Telemetry Channels 107 and 114 are used to monitor this condition.

The spacecraft should continue rolling for magnetometer calibration purposes until L +997 minutes when the CC&S initiates the roll acquisition sequence of energizing the Canopus tracker and imparting the roll search rate to the spacecraft. The CC&S event is observable on Telemetry Channel 115; the roll acquisition process may be monitored on Telemetry Channels 107, 108, and 114.

Subsequent to the completion of the roll acquisition process it must be determined that the celestial object at which the Canopus tracker is pointed is actually the star Canopus. Receipt of telemetry on Channel 107 is indicative of the Canopus tracker pointing at Canopus. A more rigorous identification of the celestial body acquired will be established with the aid of a computer program that matches the time history of the Canopus tracker output with the star field viewed by the Canopus tracker during the roll search. The spacecraft and/or ground AGC time history, and the magnetometer output during the roll search should also aid in determining the attitude of the spacecraft after completion of the roll search.

The execution of the midcourse maneuver is dependent on the spacecraft being stabilized about the roll axis at the initiation of the maneuver. Its attitude in space must be known, but there is no basic requirement that the spacecraft be oriented so that the Canopus tracker points at Canopus this early in the flight. In the situation where the acquired star is not Canopus, a ground command is available that will cause the roll search to be initiated once more. A more thorough discussion of this situation will be found in Section VI.

3. Midcourse Maneuver to Reacquisition Phase

Should a trajectory correction be necessary, SPAC will review the suggested corrections to verify their effect upon the spacecraft and will be capable of monitoring spacecraft performance during the execution of the trajectory correction. The correction will be accomplished by orienting the thrust axis of the postinjection propulsion system in space so that the impulse to be applied to the spacecraft will be the proper vector quantity. Subsequent to orientation of the motor axis, the motor will be commanded to burn for a sufficient period to permit the required impulse to be supplied to the spacecraft.

Orientation of the thrust axis is accomplished by causing the spacecraft to pitch a prescribed number of degrees, and then causing it to roll a prescribed number of degrees. These maneuvers are likely to orient the spacecraft away from its Sun acquired state thereby placing a perturbation upon the thermal balance of the spacecraft. Communication margins will also vary as the spacecraft/Earth angular relationships are altered. These are some of the factors SPAC must consider in determining the capability of the spacecraft to execute a given maneuver.

Computation of the required turn durations and the motor burn duration is accomplished by FPAC. An output of the program is the listing of the three quantitative commands (QC) to be sent to the spacecraft. After these commands have been checked, they will be transmitted to the spacecraft. Event register indications will confirm that the commands have been properly received. The command subsystem will generate two event pulses on Channel 116, register 4, to confirm a) that the QC address has been recognized, and b) that the eighteen CC&S bits have been transmitted to the CC&S. The CC&S will generate one event pulse on Channel 115, register 2, when odd parity on the eighteen CC&S command bits has been observed.

The next step of the maneuver sequence is to transmit ground commands to assure that the pyrotechnic subsystem is in the proper state for the maneuver. These two commands, DC-14 and DC-29, will result in one event pulse each on Channel 116, register 4.

Activation of the maneuver clock in the CC&S occurs upon receipt of DC-27 by the CC&S at which time a pulse is issued on Channel 115, register 2. The flight command subsystem issues one pulse on Channel 116, register 4, upon recognition of the DC-27 command address. The gyros are energized and the data encoder is switched to Data Mode I by the CC&S upon activation of the maneuver clock. In the following discussion, the times listed for initiation of functions by the CC&S may be as much as one minute earlier and still be considered nominal. All maneuver commands should then be initiated early by this same increment.

One hour after DC-27, the CC&S initiates the pitch turn. Evidence of this is seen on Channels 105, 112, and 115. It is possible to verify that this turn was of the proper duration by monitoring Channel 220. The turn is terminated by the CC&S at the preset time and an event pulse is issued on Channel 115, register 2.

At 82 minutes after DC-27, the roll turn is initiated. Evidence of this is seen on Channels 107 and 115. Verification of the duration of the roll turn is monitored on Channel 220. Telemetry Channel 115, register 2, will record one pulse when the CC&S terminates the roll turn at the preset time.

The postinjection propulsion system ignition will be initiated by the CC&S at DC-27 plus 104 minutes. The CC&S register will indicate one pulse when the command is given. Event registers 1 and 3 will record one event each when the pyrotechnic subsystem supplies firing current to the first burn start squibs. The duration of the motor burn can be monitored on Channel 220. Termination of the motor burn will be commanded by the CC&S at the preset time; the CC&S will also issue an event pulse on Channel 115, register 2. After receipt of the CC&S command, the pyrotechnic subsystem will supply firing current to the first burn stop squibs; this generates event pulses on Channel 115, register 1, and on Channel 116, register 3.

Reacquisition of celestial references will commence 110 minutes after DC-27; this will be evidenced by an event on Channel 115, register 2, and a switch to Data Mode II by the data encoder. This acquisition sequence will not contain a delay between Sun acquisition and the initiation of roll acquisition. Acquisition of the star Canopus will be verified by an output of the Earth detector on Telemetry Channel 107.

An event pulse will be recorded on Channel 115, register 2, at DC-27 plus 199 minutes, independently of the state of the attitude control subsystem. This pulse indicates that the CC&S maneuver clock has reset itself and again is in a proper premaneuver state ready for a second trajectory correction if one is deemed necessary.

4. Cruise Phase

The spacecraft is in the cruise phase until just before closest approach to the planet. Specific events are scheduled to occur by means of on-board command which will permit the long-range communications required for this mission. All these events are commanded from the CC&S, and each will result in an event pulse being added to Channel 115, register 2.

At Encounter minus 192 (E -192) days, the data encoder will be commanded to switch the telemetry data rate to 8 1/3 bps. This will increase the time interval of a Data Mode II data frame from 12.6 to 50.4 seconds. This altered data rate will be maintained for the duration of the mission.

The angular relationship between the Sun-oriented spacecraft and the star Canopus changes as the spacecraft revolves about the Sun. As a consequence, the cone angle of the Canopus tracker must be changed periodically in order to permit Canopus to remain within the field of view of the tracker. Four commands are issued during the course of the mission. These will occur at E -137 days, E -103 days, E -68 days, and E -30 days. Maintenance of proper lock on Canopus is imperative for long-range communications, as is the use of the high-gain antenna for the final portion of the mission.

The radio transmitter output is switched from the low-gain to the high-gain antenna which will be used for radiating the spacecraft RF signal for the remainder of the mission.

Another type of CC&S command is generated regularly throughout the flight and an event pulse is sent each time it is given. The cyclic command occurs every 66 2/3 hours and is used for automatic switching of radio exciters or power amplifiers if their output falls below a preset value. Also, by internal logic, the radio subsystem will switch the spacecraft receiver from one antenna to the other if two-way RF lock has not occurred between two consecutive cyclic commands.

5. Encounter Phase

The CC&S will initiate the encounter sequence approximately 6 2/3 hours before closest approach to the planet; this will be evidenced by an event pulse on Channel 115, register 2. Encounter science power will be turned on which should be evidenced on Telemetry Channels 222, 223, 224, 225, and 227. The science cover will be released, causing the telemetry value of Channel 414 to change. Release of the science cover is the result of the pyrotechnic subsystem activating a solenoid; this pyro event causes an event pulse to be recorded on Channel 115, register 1.

Motion of the scan platform will begin, and data within the Display and Analysis Support (DAS) Subsystem format will indicate where it is pointing. While the scan process continues, the Wide-Angle Sensor will be searching for the planet. Upon acquiring the planet within its field of view, a signal to the data encoder, via the DAS logic, will command the data encoder to switch to Data Mode III. No engineering telemetry will be transmitted when the data encoder is in Data Mode III.

The data encoder will continue in Data Mode III until the DAS has switched it to Data Mode II at the termination of the TV picture recording sequence. Upon return to Data Mode II, Telemetry Channel 116, register 3, should contain two additional counts caused by the two end-of-tape (EOT) signals generated while the tape recorder was running.

Another event pulse will be registered on Channel 115, register 2, at 13 1/3 hours following the turn-on of encounter science. This pulse coincides with the turn-off of the encounter science instruments. Examination of Telemetry Channels 222, 223, 224, 225, and 227 will verify that this has occurred, as will the change of the last several words of the real time DAS telemetry format.

Examination of engineering data will be possible for the next 6 2/3 hours, at which time the CC&S will switch the data encoder into Data Mode IV to play back the previously recorded data. A CC&S event pulse will occur also. The playback of one TV picture and associated data will take approximately 8 1/2 hours, at which time the Data Mode IV/I logic of the tape recorder will switch the data encoder to Data Mode I. Data Mode I will last approximately 1 1/2 hours and will be followed by a switch to the recorded data playback mode for the next TV picture and associated data. This alternation between recorded data and the all-engineering Data Mode I will continue indefinitely, or until interrupted by radio command. Each time the end-of-tape strip is passed, another event pulse will be issued on Channel 116, register 3.

F. SPACE SCIENCE ANALYSIS AND COMMAND (SSAC)

1. Organizational Responsibilities

Space Science Analysis and Command (SSAC) is composed of cognizant personnel from the Space Science Division and off-Laboratory experimenters, and is headed by the Project Scientist. Figure VII-6 shows the Mariner Mars '64 SSAC organization which consists of Group A and Group B.

For operational purposes, SSAC Group A has been defined as consisting of:

a) Project Scientist

b) Cognizant Scientist for Ground Data Handling

c) Data Representative

d) Data Monitors

e) Assistant Project Scientist

f) Deputy Project Engineer

SSAC Group A will be able to provide routine support during space flight operations tests and during flight. SSAC Group B will be available to provide additional support during critical periods and for consultation when required. SSAC Group B will be composed of SSAC Group A plus the following:

a) Consultants (Project Representative, Division 32 Section Chiefs, Project Engineer, etc.)

b) Systems Engineers

c) Cognizant Engineers

d) Experimenters

e) Cognizant Scientists

Additional support from within the Space Science Division may be required if necessary.

2. Analysis of Scientific Data

a. Cruise Science Analysis

SSAC will provide 24-hour-per-day mission coverage beginning approximately one week prior to the first launch and continuing for the duration of the mission. Real time data monitoring and analysis programs must be adequate to permit the reaction time

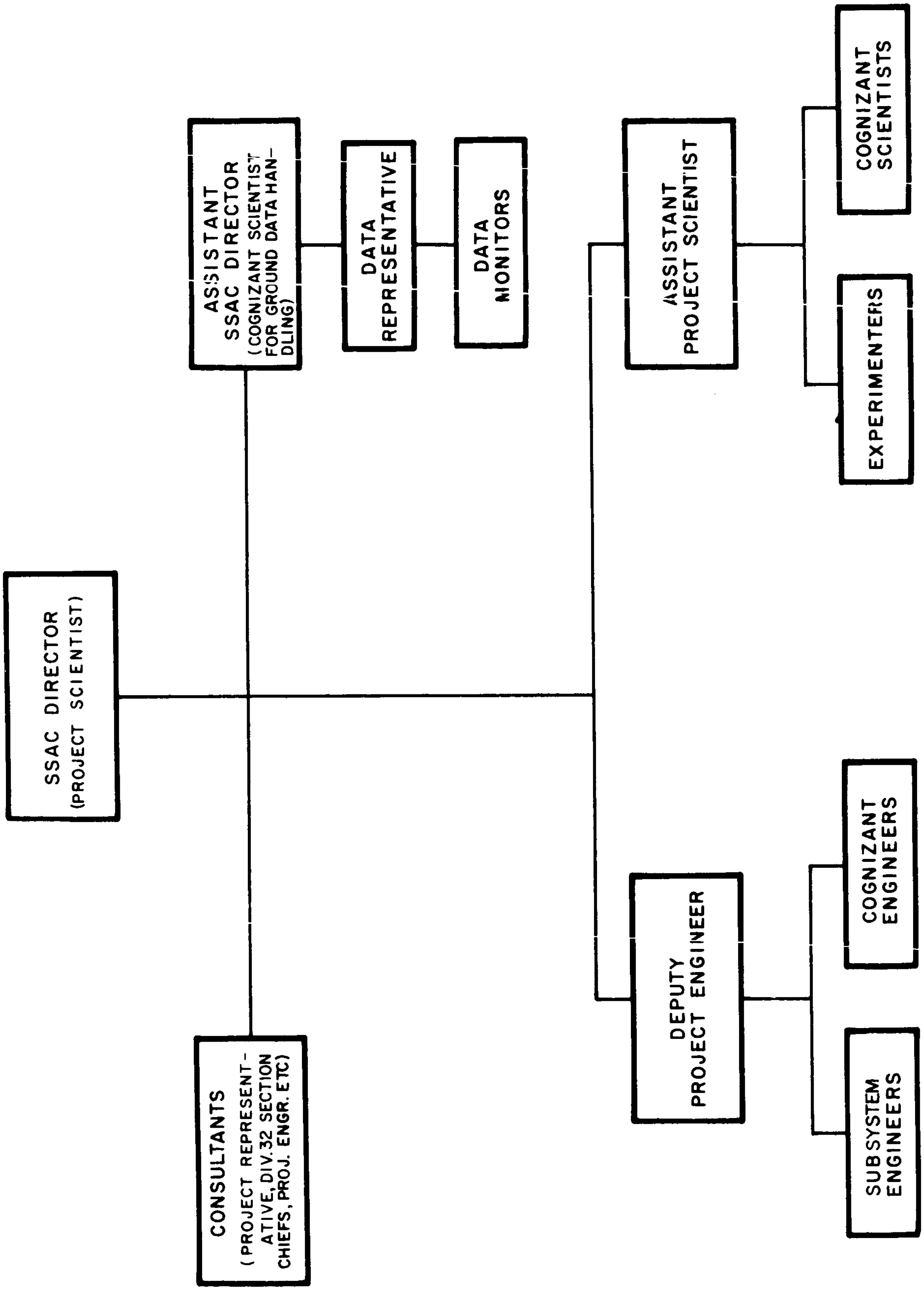

FIGURE VII-6. MARINER MARS '64 SSAC ORGANIZATION to a spacecraft nonstandard or emergency situation to be not greater than ten minutes during the launch to initial acquisition period and during maneuvers, and not greater than one hour during the cruise period.

Data obtained during the initial spacecraft roll period should yield positive calibration information about the magnetometer X and Y axes.

The following cruise instruments should have been calibrated at least twice by the time of Canopus acquisition:

1) Magnetometer

2) Cosmic Dust Detector

3) Cosmic Ray Telescope

4) Plasma Probe

The first three are calibrated once every 7.175 hours at a spacecraft data transmission rate of 33.3 bps, and once every 28.787 hours at a spacecraft data transmission rate of 8.3 bps. The plasma instrument completes one cycle, including calibration, every 36 data frames, which is ~ 8 minutes at the 33.3 bps data rate and ~ 31 minutes at the 8.3 bps rate, respectively.

These instruments and the following ones will be continuously alarm-monitored on the IBM 7040:

1) Ion Chamber

2) Trapped-Radiation Detectors

3) Data Automation System

4) Wide- and Narrow-Angle Acquisition Gates

5) Encounter Instrument Power-On Indicator

6) Spacecraft Serial Number Indicator

The processed tabulations and plots will be available through the IBM 7094 at least once daily. The TV, a planet-oriented instrument, cannot be monitored during cruise since no power turn-on is planned prior to planet encounter. Full data processing on the IBM 7094 is required on one-half-hour notice in the event of a spacecraft nonstandard condition or a science alarm.

b. Planetary Science Analysis

SSAC will provide 24-hour-per-day mission coverage through planetary encounter and through Telemetry Mode IV tape playback. Real time data monitoring and analysis programs must be adequate to permit the reaction time to a spacecraft non-standard or emergency situation to be not greater than ten minutes during planetary encounter and during the postencounter period when stored encounter data is being played back.

Power-on to encounter instruments will be monitored at the nominal time. Provision will exist to recommend the execution of a backup real time command from the DSIF. During Telemetry Mode III, all scientific instruments will be monitored to determine the spacecraft's detection of the planet; real time TV engineering data will also be monitored.

During Mode III and Mode IV, SSAC will maintain close liaison with the DSIF stations through DSIF Net Control to ensure that the data quality meets established standards. This is necessary to determine the necessity of repeating the stored data playback. Each complete picture will be displayed in unrefined form, both as a digital matrix and as an analog print, one-half hour after its reception at the SFOF.

In addition to the SFOF computing services, the requirement exists for priority use of the Link Video Film Converter. Mode IV decommutators are required at the DSIF stations so that detailed monitoring of the data can be accomplished by the station.

3. Release of Scientific Data

The real time computer provides, as outputs, single copy tabulations on the SSAA SC 3070 printer, single copy plots on the 11" x 17" and 30" x 30" plotters, and comments on the administrative printer. This data concerning the performance of the scientific instruments on board the spacecraft is intended for SSAC use and will be the basis for SSAC inputs to the Mission Evaluation and Status Summary. In addition, the SSAA Engineering Sensor Display Module, the Mission Space Science Status Display Module, and the science portion of the Mission Spacecraft Performance Status Display Module will be kept current by the SSAC Group A members. All other release of scientific data will require individual approval in person by the SSAC Director. The Assistant SSAC Director will supervise the distribution of the computer output in the form of tabulations, and the distribution of SC 4020 plots, photographs, microfilm, and magnetic tape to the off-Laboratory experimenters.

Sufficient programming and display capability will exist to permit the continuous and complete monitoring of science telemetry to assure cognizance. It is not the function of SSAC, as such, to announce scientific discoveries.

Logistic and personnel support may be required from the SFOF Support Group to distribute and mail data, etc.

G. DISSEMINATION OF INFORMATION

1. General

In order to maintain consistency, accuracy, and proper control of the information to be released during the Mariner Mars '64 Mission, the policies detailed herein will be observed.

Detailed information concerning countdown and launch-to-injection status will be available to the Information Coordinator as it is reported to the SFO Talker by the AFETR Talker over the Operational Voice Communication System (OVCS). Information detailing mission progress will be furnished by the Mission Evaluation and Status Summary (MESS) program.

2. MESS Program

The MESS program is an operations computer program that furnishes abstracted values from the detailed user area listings in the common environment (COMENT) region of the 1301 disc file. The functions of the real time MESS in the 7094 Complex are to receive information from the 7094 user areas and to deposit this information in the COMENT of the 1301 disc file in the appropriate regions.

The requirements of the program are:

a) MESS must operate in the 7094 at edit time.

b) A simplified mission status report must be available to the SFOD from the 7094 at his request.

c) The numerical contents of COMENT, with identifying symbols in tabular form, must be available at all times.

d) MESS must permit inputs to be stored in COMENT from any user area, provided these real time messages are properly identified for transmission to COMENT.

e) Output must be suitable for microfilming.

MESS will order, number, place in the 1301 disc file, and will provide as an output to the SFOD the information that follows.

a. Flight Path Analysis Area (FPAA)

FPAA information will include:

1) Orbital elements in Cartesian coordinates

2) Epoch at which orbital elements are computed

3) Miss parameters associated with this converged orbit

4) Encounter conditions predicted by this orbit

5) Position of spacecraft at time of update

6) Predicted flight time to encounter

7) Distance from Earth's surface at time of update

8) Station view periods for next five days

9) Information about condition of tracking data

10) Merit figure for the quality of predictions that will be based on the standard deviation, and rms error in the differences between observed and predicted data

11) Midcourse maneuver velocity increment and midcourse commands

12) Predicted B · T and B · R and time of flight as a result of a midcourse correction, and the time associated with this information

13) Midcourse covariance matrix resulting from midcourse execution errors

14) Aerographic point at which closest approach occurs

15) 300 words of comment and explanation by FPAC Director

16) Formats from DSIF and AFETR for use of the Tracking Data Editor

b. Engineering Telemetry

Engineering telemetry will consist of 90 discrete measurements, each of which will contain:

1) Time of update

2) Number

3) Encoder address

4) Telemetry mode

5) Bit rate for that mode

6) High (DN)

7) Low (DN)

8) Current (DN)

9) Average (DN)

10) Six BCD characters identifying the measurement

11) High (Engineering Units)

12) Low (Engineering Units)

13) Average (Engineering Units)

14) Current (Engineering Units)

15) Day number

c. Science Telemetry

Science telemetry will include 35 quantities specified by the Space Science Division.

d. Significant Flight Events

Significant flight events will be transmitted to MESS from all user areas. MESS arranges this information by time, and numbers it sequentially.

e. DSIF Station Reports

DSIF station reports, comprising 120 words of comment per pass per station, will consist of:

1) Actual station acquisition and loss times for each pass

2) Time at which the DSIF is taking telemetry and tracking data

3) Times that the DSIF is out of lock

4) Signal strength and transmitter power throughout the pass, as a function of time

5) Ground mode of operation and the time periods for each ground mode

f. Communications Status Summary

The Communications Status Summary of 100 lines per day will provide the following information:

1) In and out times for all lines

2) One BCD word comment about their quality

3) One word for usage (science, telemetry, etc.)

g. Computer Status Reports

The Computer Status Reports will be in the following format:

UNIT #, TIME, (UP OR DOWN)

FUNCTION*, TIME, USAGE**

DATA***, TIME START, TIME END

h. Log of Flight

The log of the flight, providing special comments from the Operations Area at a maximum rate of 500 lines per day, will consist of:

1) Time

2) 54 BCD characters (9 BCD words)

3. Source of Operational Information

Operational information is collected from the following sources:

a) Operations logs

b) DSIF station logs

c) Reports from analysis groups (SPAC, SSAC, and FPAC)

d) SFOF Operations Reports

e) Spacecraft Data Reports

f) Status Displays

4. Dissemination of Operational Information

Assembled operational information is disseminated as follows:

a. Operations Log

Distributed to operations personnel in near-real time, the Operations Log is a real time record of events that are

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* where FUNCTION is monitor, full data processing, etc.
** where USAGE is given in percent of full day, 0000 GMT to 2400 GMT
*** where DATA is type, such as telemetry or tracking

transmitted verbally between SFOF operational information personnel and AFETR, and of events that are heard over the JPL internal communications system.

b. Daily Operations Reports

These reports provide NASA, the Project, and the DSIF stations with a short summary of daily operations as well as summarized information regarding spacecraft status and operational status. The information for this report will be derived from the MESS program output.

Off-Laboratory distribution will be as follows:

G. A. Reiff	NASA/HQ
O. W. Nicks	NASA/HQ
E. C. Buckley	NASA/HQ
D. E. Forney	LMSC, Sunnyvale
J. L. Shoenhair	LMSC, Sunnyvale
S. C. Himmel	Lewis Research Center
W. F. Kindt	AG/SSD, LA
L. Von Derwische	GDA
DSIF 11 and 13	JETGLD
DSIF 41 and 42	OOMJET
DSIF 51	JOBJET
AFETR	CAPJET

The following will receive copies of the Daily Operations Report through normal JPL distribution channels:

J. N. James
T. H. Parker
W. A. Collier
D. W. Douglas
T. S. Bilbo
F. J. Colella
F. Felberg
R. A. Hall
C. A. Holritz
A. R. Luedecke
R. J. Parks
W. H. Pickering
E. Rechtin
N. A. Renzetti
D. Schneiderman
D. B. Sparks

c. Technical Progress Reports

These reports consist of a detailed technical summary of spacecraft and operational status based on MESS outputs. The reports are to be released every 15 days for the first six weeks of the mission, and thereafter on a monthly basis until mission termination. The distribution list will be the same as that for the Daily Operations Report.

d. Technical Bulletins

Technical Bulletins, compiled and released weekly throughout the mission, are a compilation of spacecraft and operational performance that are classified "JPL Discreet". These bulletins are disseminated to the Daily Operations Report off-Laboratory distribution list, to JPL administrative personnel through the Section Chiefs, and to SFO personnel.

e. JPL Announcements

Announcements of mission status will be read over the JPL public address (PA) system every 20 minutes from Launch minus two hours through Launch plus 12 hours if launch occurs during normal working hours. Announcements will be read thereafter when deemed important (e. g., during midcourse maneuver), for the remainder of the mission. These announcements will be sent in written form to the DSIF stations.

f. Press, Radio, and Television Releases

Press, radio, and television releases will be handled by the Office of Public Education and Information (OPEI). Copies of these releases will be sent to operational personnel and the DSIF stations.

g. OPEI Data Messages

The OPEI data messages consist of approximately six-hour increments of spacecraft trajectory information. These messages are provided by FPAC and are sent to NASA, AFETR, and OPEI.

h. Displays

A display system will be maintained in the SFOF to provide operations personnel with a summary of support equipment and spacecraft status. These displays will contain information from SPAC, SSAC, FPAC, DSIF, AFETR, and Communications Control, and also a time-oriented sequence of operational and spacecraft events, GMT time, and appropriate local time conversion.

i. Postmission Reports

The following reports will be released within 30 days following mission completion:

1) Space Flight Operations Memorandum

2) DSIF Tracking Operations Memorandum

3) SFOF Operations Memorandum

These will be the final reporting documents to the Project from Space Flight Operations.

5. Information Control

All operational information is subject to approval prior to release. The SFO Director must approve the release of any information pertaining to space flight operations, with the exception of scientific data releases. The Mariner C Project Manager must approve the release of all information for dissemination off the Laboratory, with the exception of scientific data.

The DSIF Operations Manager must approve the release of any information about the DSIF and any information going to DSIF stations.

6. Capabilities and Limitations

The dissemination of information function is limited to the collection, assembly, and distribution of technical and sometimes discreet information concerning mission status. Release of status information to the public (through press, radio, and television) will be handled by the OPEI. When information is made available to the OPEI, it will be the responsibility of the OPEI to ensure that all such information has been cleared with the Project Office prior to its release to the public.

7. Requirements

In order that information may be disseminated as indicated above, the cooperation of the information input areas will be necessary.

8. Interfaces

Interfaces between areas exist as regards the operational information that is collected or disseminated. These interfaces are shown in Table VII-II.

TABLE VII-II. INTERFACES BETWEEN SOURCES AND DISSEMINATION OF OPERATIONAL INFORMATION

AREA	INFORMATION FROM AREA	INFORMATION TO AREA
SPAC	Spacecraft Performance	SFO Status
SSAC	Science Instrument Performance	SFO Status
FPAC	Trajectory Characteristics	SFO Status
DSIF	Tracking Status	SFO Status
Communications Control	Communications Status	SFO Status
OPEI	Information Requirements	SFO Status Summary
Operations Control (SFO, SFOF Communications, and DSIF)	Instructions and Requirements	SFO Status