JOHN F. KENNEDY SPACE CENTER

TR-1237
May 25, 1973

DELTA-95
RAE-B
OPERATIONS SUMMARY

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Prepared by
Spacecraft and Vehicle Support Operations Branch,

TR-1237
May 25, 1973

DELTA-95

RAE-B

OPERATIONS SUMMARY

Approved: D. C. Sheppard
Chief, Spacecraft and Vehicle
Support Operations Branch

Prepared by
Spacecraft and Vehicle Support Operations Branch, KSC-ULO

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MISSION

A. MISSION OBJECTIVE

The purpose of the Radio Astronomy Explorer-B (RAE-B) satellite is to make comprehensive studies of low frequency radio emissions from its planned circular orbit 682 statute miles above the moon. These low-frequency radio emissions are from five prime areas of interest, namely the sun, the moon, the planets and other galactic and extragalactic sources. RAE-B is intended to provide a map of our galaxy by radio frequencies below those of ionospheric cutoff.

The RAE-B program is part of the U.S. Explorer series of scientific satellites, directed by NASA's Office of Space Science, Washington, D.C. The Goddard Space Flight Center, Greenbelt, Md., is responsible for RAE-B project management, design and construction of the satellite.

RAE-B, the second of the Radio Astronomy Explorer satellites, will be launched by a Delta vehicle, model 1913, designated Delta-95.

B. LAUNCH VEHICLE AND SPACECRAFT DESCRIPTION

1. Launch Vehicle. Delta-95, Model DSV-3P-11 research vehicle (figure 1-1), is the third of the new upgraded Delta Straight-Eight vehicles. It consists of a DSV-3P-1 extended long tank first stage with an MB-3 engine, augmented by nine low-drag Castor II solid motors; a DSV-3P-5 second stage within an eight foot mini-skirt adapter; and a TE-364-3 third stage. The prime contractor for the launch vehicle is the McDonnell Douglas Astronautics Company (MDAC). Pertinent vehicle data are presented in table 1-1.

2. Spacecraft. The RAE-B satellite (figure 1-2) is a cylinder-shaped structure 36 inches in diameter and 31 inches in height. The satellite contains subsystems for: telemetry transmission and recording, range and range-rate tracking, command, power, programming, antennas, attitude and control, and experiment instrumentation. It has four fixed solar panels canted 26.5 degrees which will provide an average power of 38.5 watts to a nickel-cadmium battery with a capacity of six-ampere hours.

In terms of physical dimensions, the satellite will be the largest man-made object to orbit the moon with its deployed antennas measuring 1500 feet tip-to-tip. These antennas, as well as the 630 foot damper boom and the 120 foot dipole antenna, are stored flat on motor-driven reels. They are preformed and when deployed on ground command they curl to form rigid tubes one-half inch in diameter. The antenna material is perforated with small holes to equalize energy absorption and provide a more uniform temperature distribution and minimize thermal bending. The radio signal sensing range of the antennas is between 0.02 MHz and 20 MHz.

A lunar insertion motor (LIM) is attached to the upper end of the satellite structure and is fired to slow the spacecraft and allow it to be captured by the lunar gravity. After burnout, the motor is ejected by ground command. A velocity control propulsion subsystem (VCPS) is utilized to provide velocity

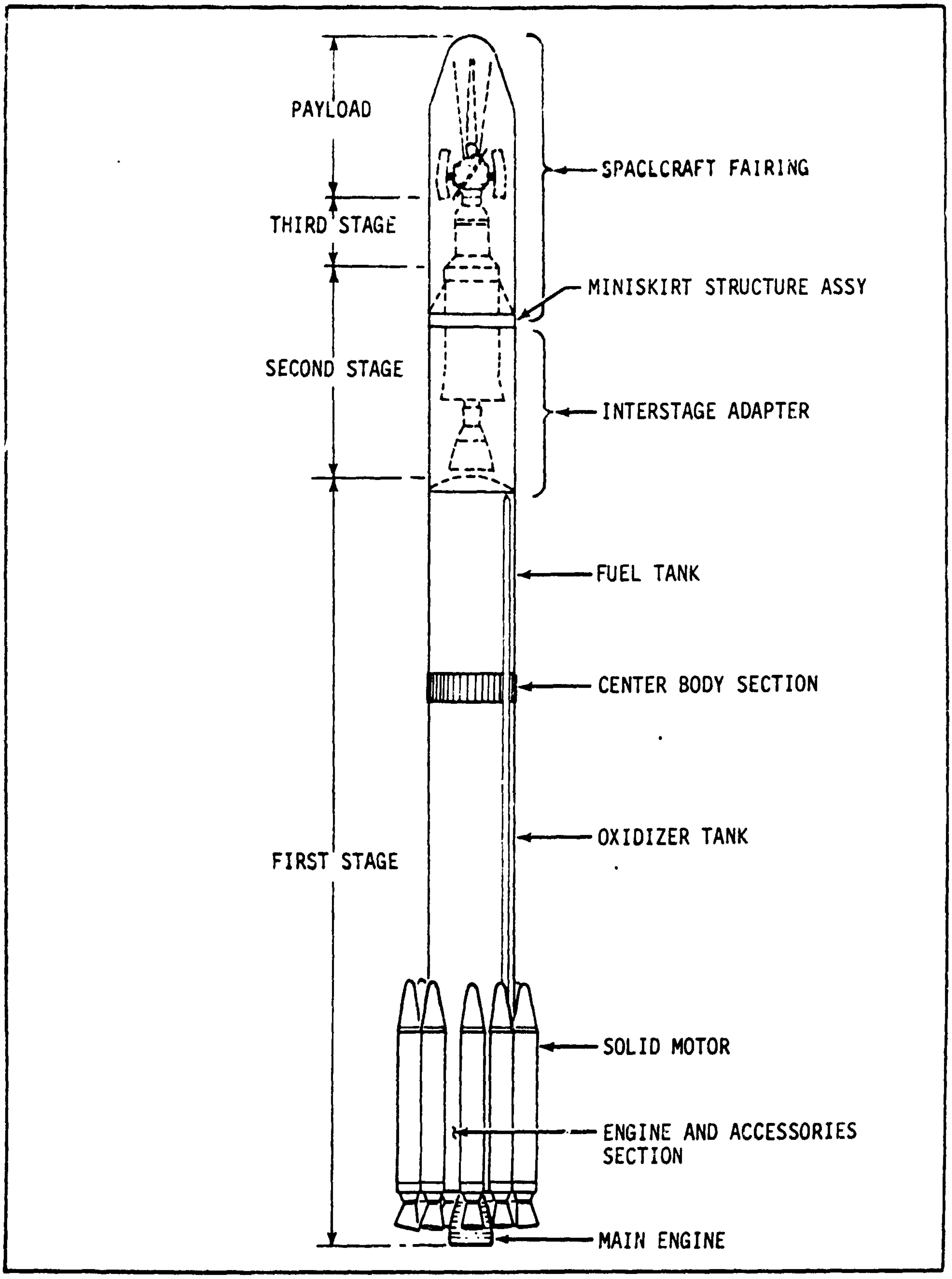

Figure 1-1. Delta-95 Launch Vehicle

corrections after payload separation from the third stage. The VCPS is packaged on the transtage between the spacecraft and third stage adapter and is jettisoned after it has performed its functions.

An attitude control system (ACS) is used to maintain proper satellite attitude by precessing the satellite and by performing spinup and despin maneuvers. Two separate but identical endless-loop tape recorders are onboard and provide a total recording capacity of 225 minutes with a playback time of 45 minutes. Further pertinent spacecraft data are presented in table 1-2.

Table 1-1. Delta-95 Vehicle Data

Item	Boosters	Stage I	Stage II	Stage III
Length (feet)	19.7	73.8	17.6	4.5
Diameter (inches)	31	96	54 W/96 adapter	37
Engine type	Solid	Liquid	Liquid	Solid
Engine manufacturer	Thiokol	Rocket-dyne	Aerojet	Thiokol
Designation	TX354-5	MB3-III	AJ10-118F	TE-364-3
Number of engines	9	1 (+2VEs)	1	1
Specific impulse	237.6	252.4	306.3	291.0
Thrust (pounds/engine)	52,150	170,000 & (2 VE @ 1,000 ea)	9,606	9,480 avg. 10,320 max.
Burn time (seconds)	39	265	342	43.1
Propellant	TP-H7036	---	---	TP-H-3062
Fuel	---	RJ-1	A50	---
Oxidizer	---	Lox	N_2O_4	---
Nitrogen gas (psig)	---	3,100	4,000	---
Helium gas (psig)	---	1,150	4,350	---
Serial number	361, 369 365, 376 366, 377 367, 378 368	20002	20004	00024

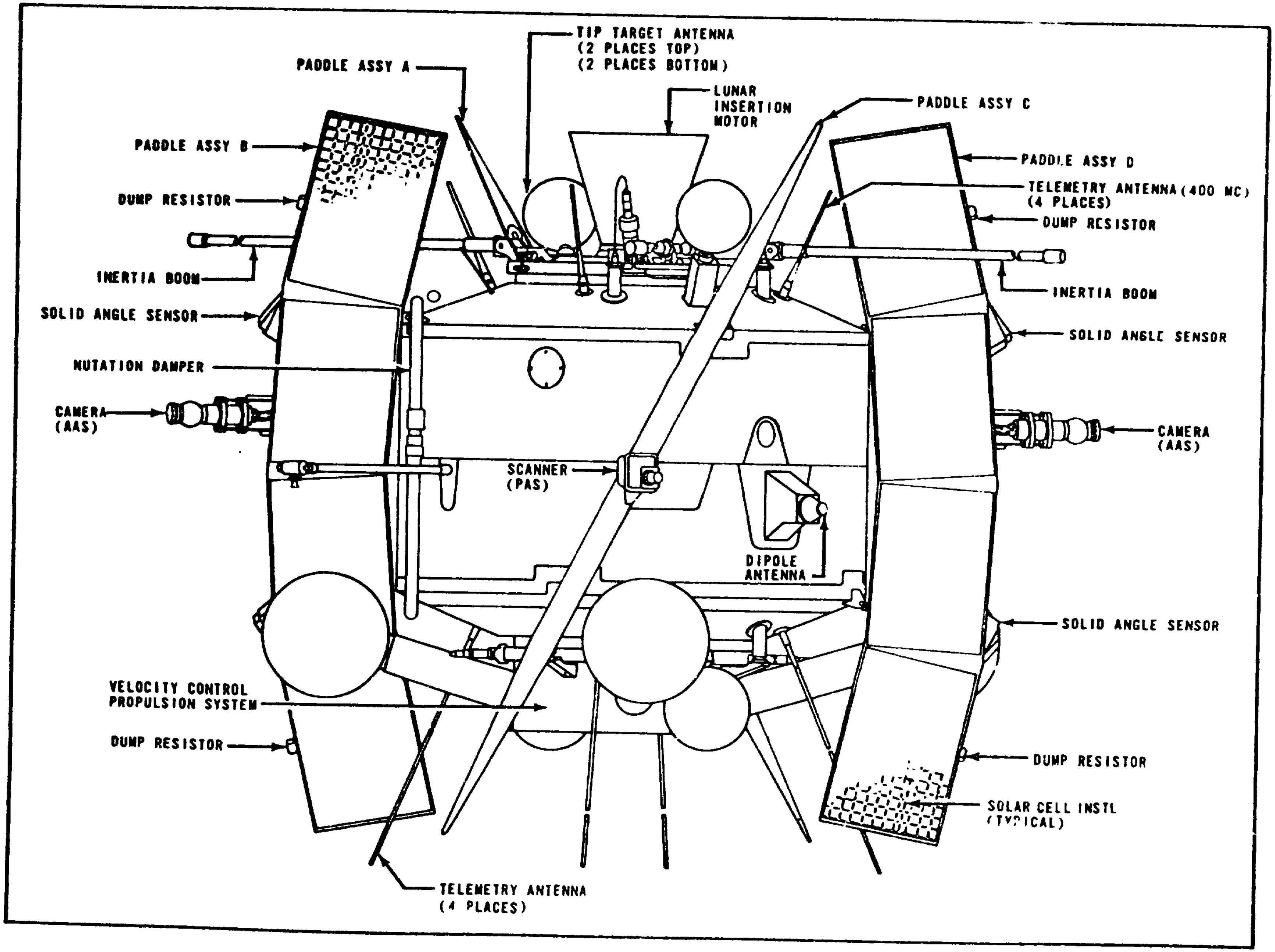

Figure 1-2. RAE-B Spacecraft (Antennas Not Extended)

Table 1-2. RAE-B Spacecraft Data

Weight (pounds) at liftoff	730
Weight (pounds) in lunar orbit	442
Height, body (inches)	31
Diameter (inches)	36
Electrical power (watts)	38.5 (maximum)
Life expectancy (years)	1

C. MISSION PLAN

1. Launch Constraints.

a. Launch Window. The actual time of the launch windows from June 9 thru June 12, 1973, are listed in table 1-3.

Table 1-3. Launch Windows

Date	Opens (Z)	Closes (Z)
June 9	1318:00	1418:00
June 10	1413:00	1513:00
June 11	1448:00	1518:00
June 12	1509:00	1539:00

b. Launch Vehicle. All vehicle in-line subsystems must be operational at launch as required by the operations parameters in the countdown manual. Since all primary test objectives are associated with the spacecraft, there are no vehicle mandatory requirements on telemetry; however, if a telemetry channel carrying critical information becomes inoperative during countdown, it is sufficient cause for a hold to review the effects on vehicle readiness and performance.

c. Allowable Wind Conditions. The maximum allowable wind velocity which the vehicle in any configuration can safely withstand when it is erected on the pad with gantry around it is 64 knots. The maximum wind velocity which the vehicle can safely withstand when it is erected and with gantry removed is 43 knots.

The Go/No-Go decision for upper wind conditions is based on a computer program at MDAC Huntington Beach and is a combination of wind shear, velocity, and direction factors.

2. Flight Plan. The RAE-B spacecraft will be launched from Complex 17, Pad B, Cape Kennedy Air Force Station (CKAFS), Florida, no earlier than June 9, 1973. The pad azimuth will be 115 degrees and the vehicle will roll to 81 degrees shortly after liftoff placing the spin stabilized spacecraft in a lunar transfer trajectory. Details of spacecraft attitude corrections in transfer orbit, lunar insertion motor firing, and lunar orbit adjustments are included in figure 1-3. Lunar orbit parameters are listed in table 1-4.

Table 1-4. RAE-B Lunar Orbit Parameters

Circular orbit	682 statute miles
Inclination	59.0°
Anomalistic period	226 minutes

The nominal sequence of events from liftoff through yo weight release are presented in table 1-5. Times are in seconds after liftoff (T+seconds); those events which occur after Main Engine Cutoff (MECO) and Second Stage Engine Cutoff (SECO) are also referenced as M+seconds and S1+seconds.

D. POST LAUNCH OPERATIONS

Following insertion into the transfer orbit, the spacecraft will be controlled from the Spacecraft Control Center at GSFC. Two midcourse corrections are planned during the transfer orbit. The LIM will be fired approximately 100 to 120 hours after launch. The LIM will be jettisoned following this burn. Following additional spacecraft attitude and orbit corrections, the VCPS will also be jettisoned. Experiments will then be turned on and antennas deployed.

Table 1-5. Sequence of Flight Events*

T+Sec	Min:Sec	Event
T-0.2	-00:00.2	Pitch & yaw vernier engi[illegible] lockout
		Solid motors (4, 5, 6, 7, 8, 9) ignition
T+0	00:00.0	Liftoff
T+2.0	00:02	Begin first roll program
T+7.0	00:07.0	End first roll program
		Begin first pitch rate
T+11.0	00:11.0	End first pitch rate
		Begin second pitch rate
T+12.0	00:12.0	End second pitch rate
		Begin third pitch rate
T+25.0	00:25.0	End third pitch rate
		Begin fourth pitch rate
T+37.0	00:37.0	Gain change - pitch, yaw, roll
T+38.2	00:38.2	Solid motor burnout (4, 5, 6, 7, 8, 9)
T+39.0	00:39.0	Solid motors (1, 2, 3) ignition
T+40.0	00:40.0	End fourth pitch rate
		Begin fifth pitch rate
T+50.0	00:50.0	End fifth pitch rate
		Begin sixth pitch rate
T+70.0	01:10.0	End sixth pitch rate
		Begin seventh pitch rate

Table 1-5. Sequence of Flight Events (Cont'd)

T+Sec	Min:Sec	Event
T+77.4	01:17.4	Solid motor (1, 2, 3) burnout
T+85.0	01:25.0	Solid motors (1 thru 9) separation command
		Lox acc purge
		Gain change - roll
T+87.0	01:27.0	End seventh pitch rate
		Begin eighth pitch rate
T+100.0	01:40.0	Gain change - pitch, yaw
T+120.0	02:00.0	Start guidance
T+140.0	02:20.0	Feedback - gain change pitch, yaw
T+200.0	03:20.0	Gain change - pitch, yaw
T+240.0	04:00.0	Enable MECO
T+247.7	04:07.7	Switch to velocity only steering
T+262.7	04:22.7	Stop computing guidance steering corrections
T+263.0	04:23.0	End eighth pitch rate
T+267.7 (M+0)	04:27.7	MECO
		VE enable
		Stage II hydraulic pump on (back-up)
		Arm stage II
		Filter gain change - pitch and yaw

Table 1-5. Sequence of Flight Events (Cont'd)

T+Sec	Min:Sec	Event
T+269.7 (M+2.0)	04:29.7	Pressurize tanks
T+272.7 (M+5.0)	04:32.7	Close tank pressurization valve
		Remove tank pressurization discrete
T+273.7 (M+6.0)	04:33.7	VECO
T+275.7 (M+8.0)	04:35.7	Stage I/II separation
		Remove SECO discrete
T+276.7 (M+9.0)	04:36.7	Remove stage I discretes
		Filter gain change - pitch, yaw, roll
T+279.7 (M+12.0)	04:39.7	Remove separation discretes
		Pressurize tanks
T+280.7 (M+13.0)	04:40.7	Start stage II engine
		Filter gain change - pitch, yaw
		Roll gas jet coarse mode
T+281.0 (M+13.3)	04:41.0	Start steady burn
T+281.7 (M+14.0	04:41.7	Remove tank pressurization
T+283.5 (M+15.8)	04:43.5	Begin ninth pitch rate

Table 1-5. Sequence of Flight Events (Cont'd)

T+Sec	Min:Sec	Event
T+293.5 (M+25.8)	04:53.5	End ninth pitch rate
		Begin tenth pitch rate
T+294.0 (M+26.3)	04:54.0	Fairing unlatch
T+295.0 (M+27.3)	04:55.0	Fairing separation
T+297.0 (M+29.3)	04:57.0	Remove fairing separation discrete
T+298.0 (M+30.3)	04:58.0	Start guidance
T+450.0 (M+182.3)	07:30.0	Gain change - pitch, yaw
T+521.6 (M+253.9)	08:41.6	Velocity only steering
T+568.6 (M+300.9)	09:28.6	Stop guidance corrections
T+570.6 (M+302.9)	09:30.6	Stop guidance
T+571.6 (S1+0)	09:31.6	SECO No. 1
		End tenth pitch rate
		Initiate TPS check
		Turn off hydraulic pump
		Pitch/yaw gas jet fine control
T+600.0 (S1+28.4)	10:00.0	Begin eleventh pitch rate

Table 1-5. Sequence of Flight Events (Cont'd)

T+Sec	Min:Sec	Event
T+631.6 (S1+60.0)	10:31.6	Enable CDR off
T+632.6 (S1+61.0)	10:32.6	CDR off
T+700.0 (S1+128.4)	11:40.0	End eleventh pitch rate
T+760.0 (S1+188.4)	12:40.0	Begin first coast guidance
T+800.0 (S1+223.4)	13:20.0	End first coast guidance
T+802.8 (S1+226.2)	13:22.8	Initiate ullage jets
T+809.8 (S1+233.2)	13:29.8	Turn on hydraulic pump
T+836.8 (S1+260.2)	13:56.8	Stage II engine restart
		Filter gain change - pitch, yaw
T+837.1 (S1+260.5)	13:57.1	Engine steady burn
T+837.8 (S1+261.2	13:57.8	Ullage jets off
T+838.8 (S1+262.2	13:58.8	Initiate stage II restart guidance
		Reactivate TPS logic
T+866.2 (S1+288.6	14:26.2	Stop guidance steering corr
T+867.2 (S1+289.6)	14:27.2	Stop stage II restart guidance

Table 1-5. Sequence of Flight Events (Cont'd)

T+Sec	Min:Sec	Event
T+868.2 (S2+0)	14:28.2	SECO No. 2 Filter gain change - pitch, yaw Pitch and yaw jet to fine control
T+869.2 (S2+1.0)	14:29.2	Hydraulic pump off
T+870.0 (S2+1.8)	14:30.0	Start guidance No. 2
T+900.0 (S2+31.8)	15:00.0	Stop guidance No. 2
T+902.9) (S2+34.7)	15:02.9	Fire spin rockets Start stage III ignition TD Start stage III timer
T+903.9 (S2+35.7)	15:03.9	Fire stage III wire cutter Remove spin rocket discrete
T+904.9 (S2+36.7)	15:04.9	Blow stage III/II separation bolts Fire retros
T+917.9 (S2+49.7)	15:17.9	Stage III ignition
T+962.7 (S2+99.7)	16:02.7	Stage III burnout
T+1062.9 (S2+199.9)	17:42.9	Payload separation
T+1064.9 (S2+201.9)	17:44.9	Release yo weight

*Times listed are for launch June 9, 1973. All times after Coast Guidance No. 1 change as follows: Day 2 - subtract 15 seconds
Day 3 - add 35 seconds
Day 4 - add 133 seconds

Legend:

1. (T-0) Launch.
2. (T+0.25 hours) Separate from third stage, spinning at 50 rpm.
3. (T+10 hours) First trajectory correction, adjust spin rate to 12 rpm, adjust ΔV, reorient for thermal and power constraints.
4. (Retro fire minus 20 hours) Second trajectory correction.
5. (Retro fire minus 10 hours) Adjust spin axis and spin rate to 50 rpm.
6. (T+115 hours) Lunar insertion (LI) and separation.
7. (LI+) Adjust spacecraft orbit to lower it from the orbit of the LI motor and decrease its eccentricity 0.005.

Figure 1-3. Simplified Trajectory Profile From Earth to Moon

SECTION II
LAUNCH OPERATIONS PLAN

A. OPERATIONAL AREAS

1. Complex 17. All launch and pad operations during final countdown are conducted from the blockhouse at Complex 17 by the MDAC Test Conductor. Countdown readiness and status of the booster and spacecraft stages are the responsibility of the appropriate contractor test conductors. Overall management of launch operation is the responsibility of the Unmanned Launch Operations (ULO) Directorate. The ULO Test Controller functions as the official contact between test personnel and the ETR. The ULO Spacecraft Operations Engineer in the blockhouse coordinates spacecraft activities and reports spacecraft status to the test conductor.

2. Building S/Building AE. The spacecraft checkout area is located in Building S, but the remaining operational areas are located in Building AE. Spacecraft checkout activities in Building S are connected by data circuits and voice communications to the Multisat Control Center at GSFC and the MDC in Building AE. The mission operational areas consist of the Mission Director's Center (MDC), including an observation area located behind the MDC for observing overall mission progress, and the Launch Vehicle Telemetry Ground Station. Figure 2-1 shows the location of the launch and operational areas.

The launch operations and overall mission activities are monitored by the Mission Director in the MDC (figure 2-2) where he is informed of launch vehicle, spacecraft, and tracking network flight readiness. From the information presented, the Mission Director will determine whether or not the mission will be attempted. Appropriate prelaunch and realtime launch data are displayed to provide a presentation of vehicle launch and flight progress. The MDC also functions as an operational communications center during launch operations.

The front of the MDC consists of large illuminated displays including a list of tracking stations, Range stations in use, plotting boards, and a sequence of events after liftoff.

Three plotting boards are located at the center of the displays and are used to show present position, Instantaneous Impact Prediction (IIP) plots and doppler information. These displays, when plotted with the theoretical plots, give an overall representation of the launch performance.

The following information will be displayed in the MDC during RAE-B launch operations:

a. TV

b. ETR test number

c. Greenwich Mean Time (GMT) and Eastern Daylight Time (EDT) synchronized to WWV

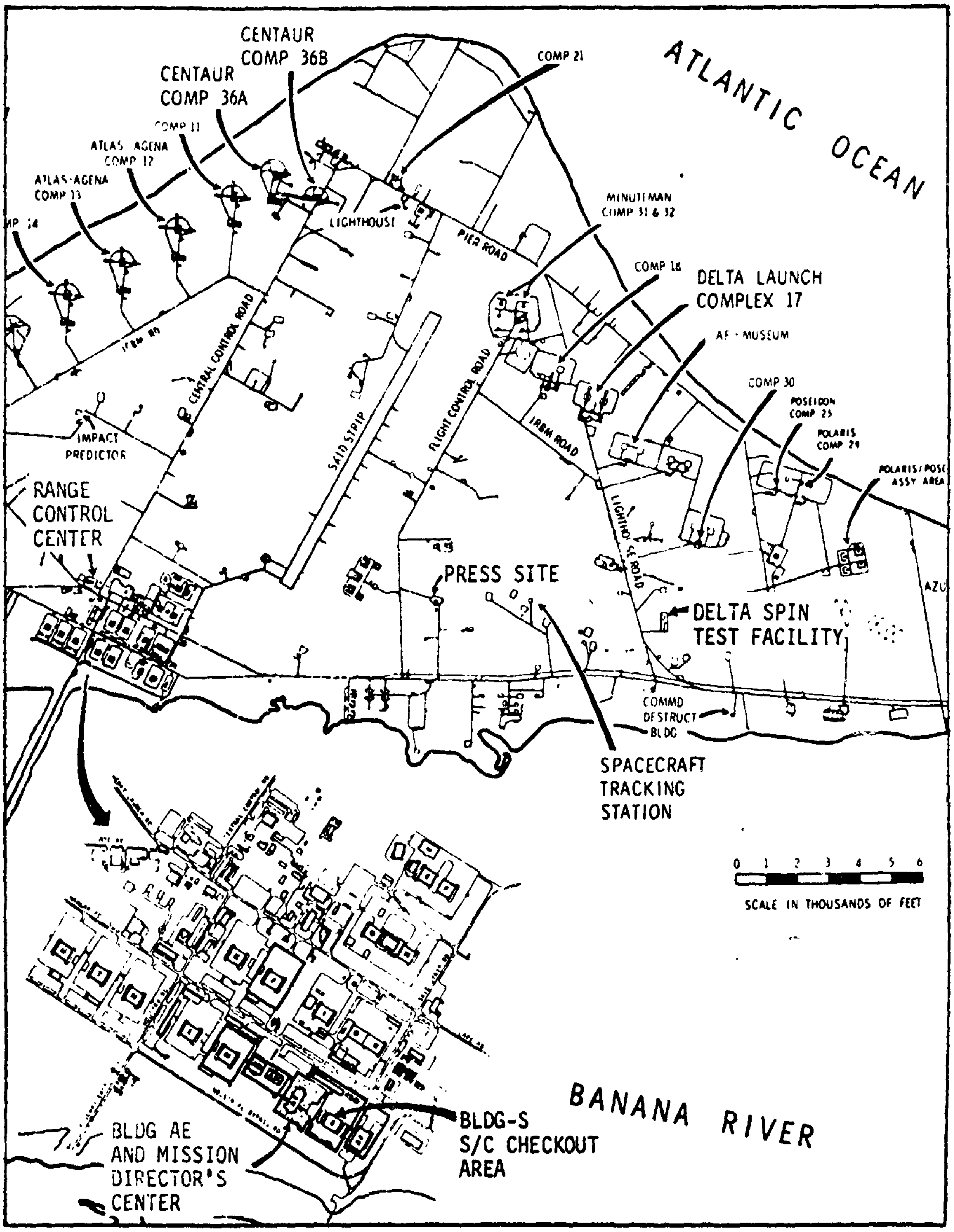

Figure 2-1. Launch and Operational Areas

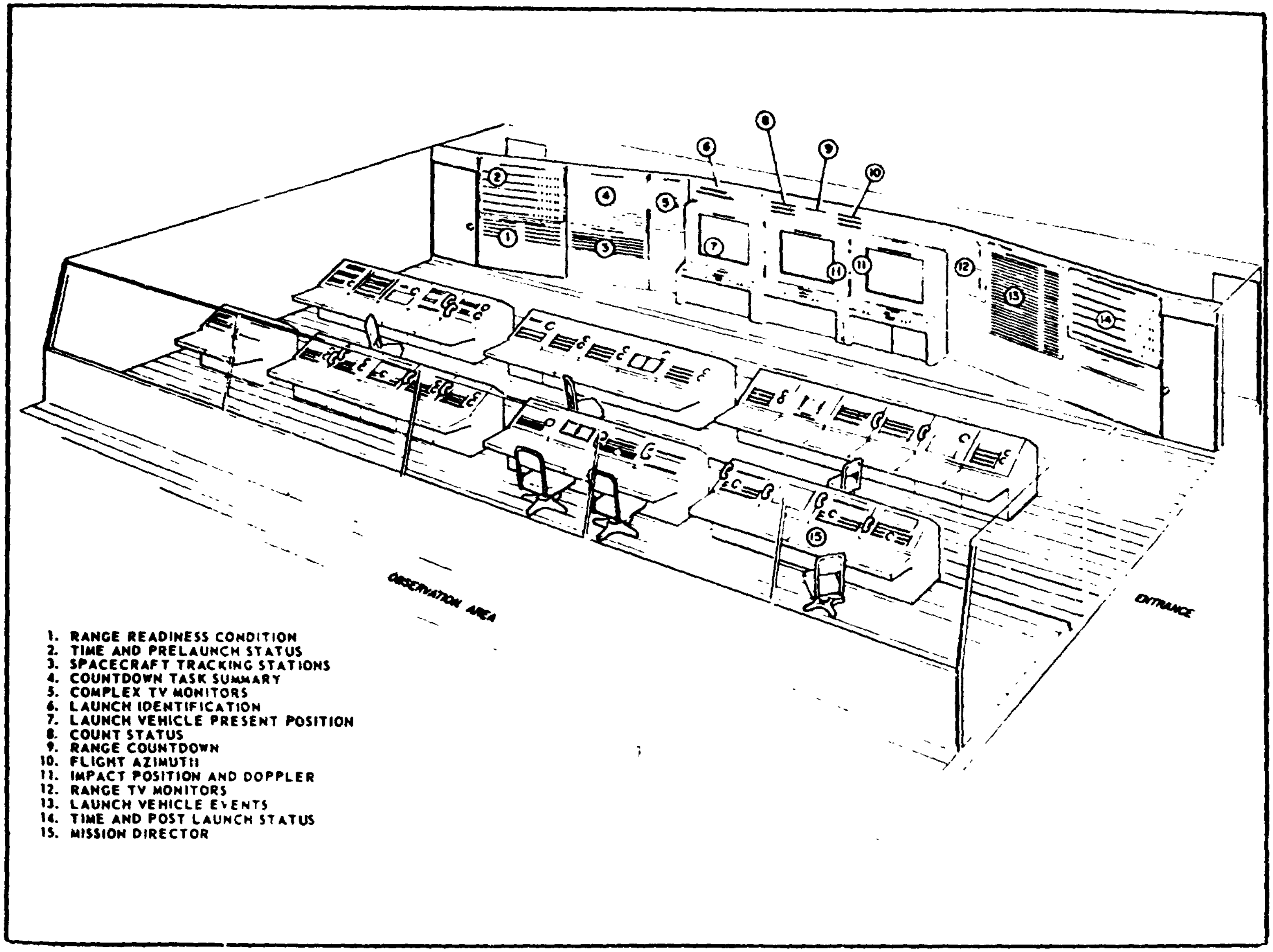

Figure 2-2. Mission Director's Center

d. Time remaining in launch window

e. Predicted liftoff time

f. Built-in hold time

g. Countdown progress

h. Range readiness

i. Countdown task summary

j. Spacecraft stations readiness

k. Impact prediction

l. Doppler

m. Launch azimuth

n. Post liftoff vehicle events

o. Present position

The ULO Launch Vehicle Telemetry Ground Station (Building AE) receives, monitors, and records launch vehicle telemetry signals during prelaunch checkout to assist in determining vehicle launch readiness. After liftoff, realtime analysis of telemetry data will be used to determine vehicle performance for display in the MDC.

3. Spacecraft Tracking Station (STS). The STS will provide prelaunch spacecraft checkout support, consisting of frequency and power measurements, as requested by the spacecraft checkout team. In addition, launch vehicle telemetry signals will be remoted from the STS to Building AE, and spacecraft telemetry signals will be remoted from STS to Building S in realtime.

B. DATA ACQUISITION

Telemetry, optical, and radar data will be supplied by a composite of ETR, GSFC, and KSC stations. The support requirements of various stations are described in the following paragraphs; the geographical location of the various stations are presented in figure 2-4.

1. Vehicle Telemetry.

a. Uprange Telemetry. During the prelaunch operations, the checkout data will be received, recorded, and displayed in realtime at both the Complex 17 station, operated by MDAC, and the Building AE station, operated by KSC/ULO. The Building AE station will display all channels telemetered and the Complex 17 station will display as many measurements as recorders permit. System engineers will observe the data at both sites to determine flight readiness of the vehicle. Both stations will display the realtime data post-test for flight evaluation prior to the post-flight critique. The Building AE Computer System (DRAM) will process all vehicle data and will display processed DIGS data on CRT displays in Building AE and at Complex 17.

Data will be received at both sites through their respective local antennas until just prior to liftoff, with switches after liftoff to other stations made as required to optimize the coverage. STS and CIF will provide early launch phase data to Building AE. Building AE will send the best of AE, CIF, or STS data to Complex 17. Complex 17 will therefore have the best data available. One hundred percent coverage is anticipated through the switch to Antigua data at about T+450 seconds.

b. Downrange Telemetry (STDN).

(1) MILA/USB, Bermuda, and Canary Islands stations will remote selected data to GSFC for GSFC displays. This data will also be routed to Building AE for display and retransmission to Complex 17. See tables 2-1 through 2-6.

Table 2-1. Merritt Island USB [illegible] to GSFC Retransmissions

VCO	Vehicle Channel	Data
1	2-E-20	Control Battery Voltage
2	1-E-35	Event Group 5
3	2-E-27	Nitrogen Regulator Pressure
4	2-E-23	Hydraulic System Pressure
5	1-11	Main Engine Chamber Pressure
6	2-9	Stage 2 Engine Chamber Pressure
7	2-A	Thrust Axis Acceleration
8		Time (SCDT)

Table 2-2. Bermuda to GSFC/AE Retransmission (Group I)

VCO	T/M	Function
7	2G4	Pitch Attitude Error
6	2E9	Pitch Position
5	2E27	N_2 Regulator Pressure
4	3-18	Thrust Acceleration
3	2E23	Hydraulic Pressure
2	2E11	IMU Temperature
1	2-A	Triax Acceleration
8	Timing	

Table 2-3. Bermuda to GSFC/AE Retransmissions (Group II)

VCO	T/M	Function
7	2-9	Chamber Pressure
6	2G6	Yaw Attitude Error
5	2E13	Yaw Position
4	2G2	Roll Attitude Error
3	2E38	He Regulator Pressure
2	2E20	Control Battery Voltage
1	2E43	Engine Battery Voltage
8	Timing	

(2) Antigua (ETR station 9.1) is a prime downrange station for early launch even though the look angles show a very low elevation. A composite of stage II and III data (see table 2-4) will be remoted to the Cape via the two subcable circuits. The PCM will be on the higher frequency subcable circuit re-modulated on an IBM data modem. This data will be demodulated at Tel-4 and sent

to Building AE for display and relay to Complex 17. The other channels will be directly placed on the lower frequency circuit. This data will be sent to Building AE and Complex 17 for realtime flight analysis and to Tel-4 for the Range safety display. Antigua should be the best data source for SECO.

Table 2-4. Antigua Retransmission

Transmit System	Vehicle VCO	Data
	High Freq Subcable	
IBM Modem	2-G	PCM
	Low Freq Subcable	
VCO	2-E	PDM
14	3-16	Pitch Acceleration
13	3-17	Yaw Acceleration
12	3-14	Battery Monitor
11	3-15	Engine Chamber Pressure
10	3-18	Thrust Acceleration
9	2-9	Engine Chamber Pressure
8	2-8	Roll Jets
7	2-7	Pitch Jets
6	2-6	Yaw Jets
5	2-10	Yaw Control Signal
4	2-11	Pitch Control Signal
Note: 2 indicates link 2241.5 MHz 3 indicates link 2250.5 MHz		

(3) See tables 2-5 and 2-6 for Canary Islands STDN site realtime data.

Table 2-5. Canary Islands, STDN, Realtime Data (Group I)

VCO	T/M	Function
7	2G4	Pitch Attitude Error
6	2-9	Chamber Pressure
5	2E27	N_2 Regulator Pressure
4	2G2	Roll Attitude Error
3	2E23	Hydraulic Pressure
2	2E11	IMU Temperature
1	2-A	Triax Acceleration
8	Timing	

Table 2-6. Canary Islands, STDN, Realtime Data (Group II)

VCO	T/M	Function
7	3-15	Chamber Pressure
6	3-18	Thrust Acceleration
5	3-17	Yaw Acceleration
4	3-16	Pitch Acceleration
3	2-6	Spin Rate
2	2G6	Yaw Attitude Error
1	2E20	Control Battery Voltage
8	Timing	

(4) An ARIA aircraft will provide prime coverage of the second burn of stage II, spinup, separation, ignition and burnout of stage III, and spacecraft separation. An ARIA with realtime retransmission capabilities has been requested, and realtime data should be received at Building AE from the aircraft. The ARIA retransmission format is presented in table 2-7.

Table 2-7. ARIA Retransmission Format

VCO	T/M	Function
1	3-16	Pitch Acceleration
2	3-17	Yaw Acceleration
3	3-18	Thrust Acceleration
4	3-15	Chamber Pressure
5	2-5	Control Battery Current
6	2-6	Yaw Jets/Spin Rate
7	2-7	Pitch Jets/Eng St Bus
8	2-8	Roll Jets
9	2-9	Chamber Pressure
10	2-10	Yaw Control Signal
11	2-11	Pitch Control Signal

2. Spacecraft Telemetry.

The spacecraft will be radiating link 400.95 MHz during the launch phase. The STS and the CIF will be providing receive, record, and retransmission services during the early launch phase. STDN stations will provide the remainder of the launch phase spacecraft data.

3. Tracking. ETR radars will track through SECO No. 1 and will provide Range safety and orbital parameters based on this data. Radars 0.18, 1.16, 19.18, and 3.18 may be used for this purpose. In addition, STDN radars will be used to provide final stage II orbital parameters.

The only tracking of the final orbit after stage III burn will be through use of the STDN stations using the spacecraft 136 MHz band range and range rate signals. Accurate final orbits from GSFC should be available within a few hours of launch.

STS will Doppler track the spacecraft signal through T+450 seconds and the resulting data will be remoted to the MDC and GSFC for display in realtime.

4. Miscellaneous Other Support.

a. STS will send the coundown to GSFC on the Digital Doppler System.

b. Stage III channel assignments are presented in table 2-8.

c. Building AE will remote mark events to GSFC using 8 VCO's (1 set of IRIG 1-8). (See table 2-9.)

d. The MILA USB site will track the vehicle and will supply data tapes if requested.

e. A block diagram of the overall data flow is presented in figure 2-3. Table 2-10 presents the wide band multiplexer assignments associated with this figure.

Table 2-8. Stage III Channel Assignments

VCO	Information
14	Battery Monitor
15	Engine Chamber Pressure
16	Pitch Radial Acceleration
17	Yaw Radial Acceleration
18	Thrust Acceleration
19	Acoustic Microphone

Table 2-9. Building AE to GSFC Realtime Relay

VCO	Vehicle Channel	Data
1	2G2	Roll Attitude Error
2	2G4	Pitch Attitude Error
3	2G6	Yaw Attitude Error
4	2E14	Fairing Sep, etc.
5	1-11	Chamber Pressure
6	2-A	Thrust Acceleration
7	2-9	Chamber Pressure
8		Time (IPPS EMR B-1)

Table 2-10. Wide Band Multiplexer Assignments

MUX No. 1 - Complex 17 to Building AE	
1	2244.5 MHz Video
2	Spare
3	2241.5 MHz Video
4	PCM Direct
5	Vets
MUX No. 2 - Building AE to Complex 17	
1	CIF 2244.5 MHz/Canary Island STDN No. 1
2	CIF 2241.5 MHz/Canary Island STDN No. 2
3	Antigua Lo
4	Antigua Hi (PCM)
5	Spare
MUX No. 3 - STS to Building AE	
1	2244.5 MHz Video
2	2241.5 MHz Video
3	2250.5 MHz Video
4	400.95 MHz Video
5	Spare
MUX No. 4 - CIF to Building AE	
1	2244.5 MHz Video
2	2241.5 MHz Video
3	2250.5 MHz Video
4	400.95 MHz Video
5	Spare

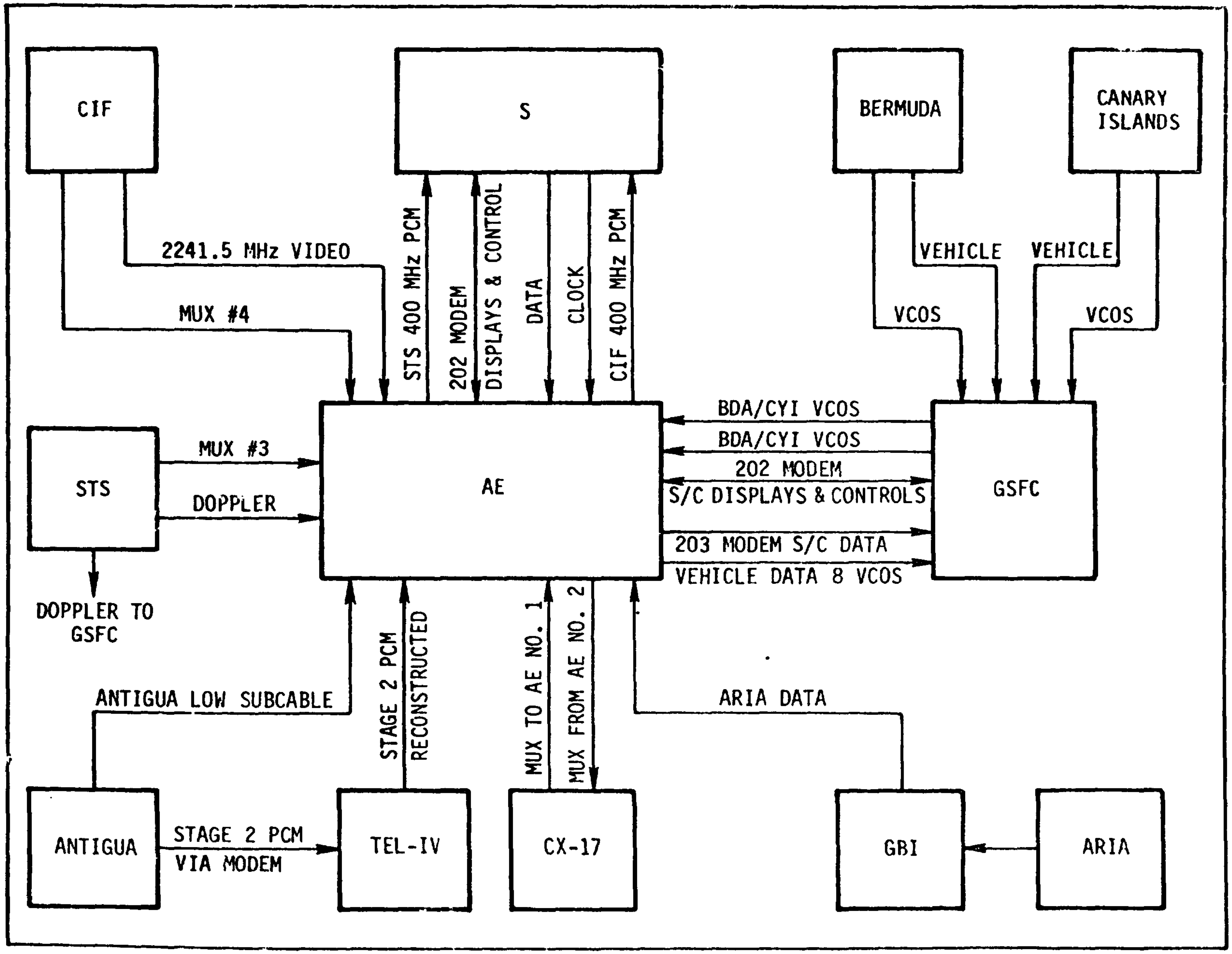

Figure 2-3. RAE-B Data Flow

5. Optics. Thirty-one engineering sequential cameras will provide coverage from T-4 minutes to T+30 seconds. The Melbourne Beach long range tracking camera will track from acquisition to loss of vision (LOV). Seven tracking engineering sequential cameras will provide photographic coverage from liftoff to LOV. Twenty-four documentary cameras are assigned to the mission.

C. METEOROLOGICAL PLAN

Cape Kennedy Forecast Facility (CKFF) will provide Weather Warning (WW) services from the time the booster is erected on the pad until launch. WW notifications will be issued when surface winds are forecast to exceed 34 knots and/or electrical storm activity is expected within 5 nautical miles of Complex 17. F-5 Day forecasts of general surface and upper air conditions will be made available to the Test Requirements and Scheduling Office (TS-NTS-1) upon request. An upper winds forecast to 60,000 feet in 1,000-foot increments will be provided on F-2 Day. This forecast will include predictions of cloud cover, ceiling, visibility, surface winds, precipitation, and temperature. On F-1 Day, a forecast containing the same elements as on F-2 Day will be made. At T-10 hours, the F-1 Day forecast will be confirmed or modified and this will again be done at T-4 hours. In addition, the Assistant Staff Meteorologist will be available at the CKFF from T-4 hours until test termination.

The minimum criteria allowed by the Range Safety Officer for launch is zero feet altitude and zero feet visibility based on the two of three radars capable of auto beacon track. DIGS telemetry impact prediction could provide an alternate source. The altitude increases to 1,600 feet for transfer from optical tracking to auto-skin track (for 1.16 and 19.18) using the beam intercept mode when the Delta C-band beacon becomes inoperative. The specific's of such alternatives would be evaluated in the latter stages of the countdown. Upper air limitations, wind shears, and wind speeds will be determined by computer evaluation at MDAC Santa Monica from the latest observations available.

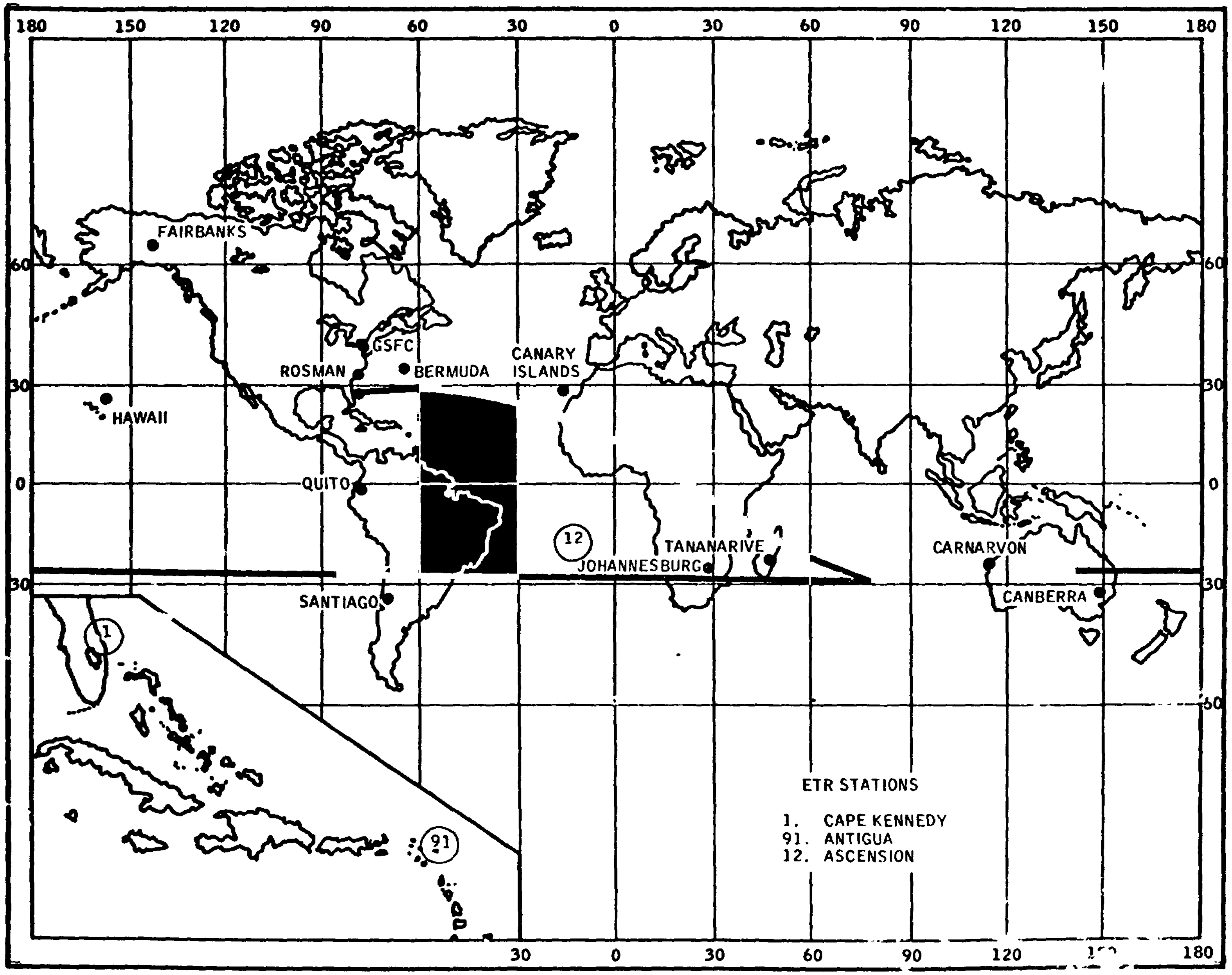

Figure 2-4. Spacecraft Tracking and Trajectory

SECTION III
COMMUNICATIONS

A. GENERAL

The operational communications facilities which will be available for support of the RAE-B launch are described in this section. These facilities will be available for prelaunch checkout and early post-flight intercommunications. The ULO MDC located in Building AE is the principal center of communications for launch activities.

B. MISSION DIRECTOR'S CENTER COMMUNICATIONS

Consoles in the MDC (figure 2-2) provide the Mission Director and assigned MDC personnel with all the communications systems required to monitor and participate in vehicle and mission progress. The communications facilities provide the means for communicating with Cape stations (Blockhouse 17, STS, and Range Control Center), downrange stations, NASA Headquarters, GSFC, and other NASA centers, and the worldwide tracking stations.

1. <u>Black Telephones</u>. The telephones used in this system are special dial telephones installed in the consoles. The black telephones enable MDC personnel to place or receive local and long distance calls. Each individual assigned to a console may listen to or participate in more than one call if required.

2. <u>Green Telephones</u>. The ETR green phone system utilizes individual phones on key panels with a limited number of users. It provides rapid, direct communications between all sites participating in the launch operation. The system has standby batteries and cannot be incapacitated by commercial power failure.

3. <u>Operational Intercommunication System (OIS)</u>. The OIS is a Range intercom system which operates on a channel-select basis rather than on an individual station-to-station basis. All end instruments in the same working area are connected in parallel. Access to individual channels may be limited to certain operators. When an operator selects a channel and talks, all other operators who have previously selected the same channel will hear him, conversely, he will hear all other operators talking on the same channel.

During launches, various operations are assigned a specific OIS channel. Because of this assignment system and the limited number of channels available at some of the outlying stations, it is mandatory that only assigned channels be used. After vehicle liftoff, flight performance will be summarized in realtime on OIS Channel 2. All personnel may switch to channel 2 on a listen only basis.

4. <u>Operations Conducted on OIS</u>. The operations to be conducted on OIS channels during the RAE-B launch are listed in table 3-1.

Table 3-1. OIS Prelaunch Operations Channel Assignments

Complex 17 Channels	Complex 17 Channel Title	Operations
1	Test Conductor	Countdown, including terminal count
2	Chatter 1	Post liftoff oral account of flight events
3	Paging	
4	Chatter 2	
5	General Test	Doppler Coordination
6	First Stage	Ordnance and RF systems destruct checks
7	Second Stage	
8	Tower Removal	
9	Digs Alignment	
10	Spare-1	
11	AE TLM	AE TLM post liftoff oral account of flight events
12	Spacecraft-1	Spacecraft checks
13	Spacecraft-2	
14	Eyeball	Post liftoff, Project Officer to MDC
15	SRO	
16	NASA TC	
17	NASA Project	Project Official's use
18	Spare-2	
19	Spacecraft-3	
20	NASA Chatter	

5. Special Circuits. The following special circuits will be utilized as designated in table 3-2.

Table 3-2. Special Circuits

	From	To	Name	Use
1	MDC	GSFC	Mission Director	Project Coordination
2	Bldgs AE and S	GSFC	Spacecraft Operator	Spacecraft Data Coordination
3	Bldg AE-TLM	GSFC	Launch Vehicle	Delta Project Use
4	MDC	GSFC	Mission Scientist	Experimenter Coordination
5	MDC	GSFC	Launch Status	Flight Commentary
6	Bldg S	GSFC	202 Data	Spacecraft Crt Displays
7	Bldgs S and AE	GSFC	203 Data	Spacecraft Telemetry

SECTION IV
TEST OPERATIONS

A. GENERAL

Prior to F-3 Day, significant spacecraft and vehicle milestones are accomplished preliminary to final prelaunch operations. These events are presented in tables 4-1 and 4-2.

Table 4-1. Spacecraft Prelaunch Milestones

Event	Location	Date
Spacecraft ETR arrival	Building S	5-6-73
Spacecraft buildup and checkout	Building S	5-7-73 5-16-73
Spacecraft moved to ESF-60A	ESF-60A	5-16-73
Spacecraft mated to third stage	ESF-60A	5-24-73
Mated to launch vehicle	Complex 17B	5-25-73

Table 4-2. Vehicle Prelaunch Milestones

Event	Location	Date
Stage I ETR arrival	Hangar M	4-16-73
Interstage ETR arrival	Hangar M	4-19-73
Stage II ETR arrival	Hangar M	4-19-73
Stage III arrival	ETR	4-9-73
Stage I erection	Complex 17B	4-24-73
Interstage erection	Complex 17B	4-25-73
Stage II erection	Complex 17B	4-30-73
Simulated Flight Test	Complex 17B	5-29-73

B. F-3 Day

The milestone activities accomplished during F-3 day are listed in table 4-3.

Table 4-3. F-3 Day Milestone Countdown

Time (EDT)	Event
0600	Spacecraft final preps
	Fairing installation preps
0730	Fairing installation
	Stage II propellant servicing preps
1400	Strongback removal and shimming
1600	Solid motor initiator installation
	Fairing ordnance installation and hookup
1800	Solid motor ordnance hookup

C. F-2 Day

The milestone activities accomplished during F-2 day are listed in table 4-4.

Table 4-4. F-2 Day Milestone Countdown

Time (EDT)	Event
0000	Oxidizer and fuel propellant chilling
0630	Final propellant servicing preps
0830	Stage II propellant servicing
1400	Stage II propellant servicing securing
	Stage I fuel preps

Table 4-4. F-2 Day Milestone Countdown (Cont'd)

Time (EDT)	Event
1500	Stage I fueling
1700	Stage I leak check and securing
1730	Stage I engine preps
	Propellant and pneumatic watch

D. F-1 Day

The milestone activities accomplished during F-1 day are listed in table 4-5.

Table 4-5. F-1 Day Milestone Countdown

Time (EDT)	Event
0530	Telemetry and IMU on and warmup
0600	Guidance and Range Safety Test
	0715 Stage II turn on
	0845 Azimuth determination
	0930 Communications check
	0940 Guidance system test
	1030 Securing
	Fold unused platforms
1100	Spacecraft ordnance arming
	Class A ordnance hookup
1300	Final spacecraft preps
	Final preps
	Gantry removal preps

E. F-0 Day

The milestone activities accomplished during F-0 day are listed in table 4-6.

Table 4-6. F-0 Day Milestone Countdown

Count (min)	Time (EDT)	Event
T-330	0218	Pressurize stage II oxidizer tank
		LN_2 storage tank fill
		Solid motor S/V checks
T-260	0328	LCE warmup
		Remove MST
		Lanyard connect
T-200	0428	Solid motor single point arming
T-140	0528	Terminal countdown

F. TERMINAL COUNTDOWN

The terminal countdown starts at T-140 minutes and includes two build-in holds totaling 90 minutes. The first hold (60 minutes) occurs at T-60 minutes, the second hold (30 minutes) occurs at T-7 minutes. After completion of the second hold the countdown picks up at T-7 minutes and continues thru liftoff.

The milestone activities accomplished during the terminal countdown are listed in table 4-7.

Table 4-7. Terminal Countdown

Count (min)	Time (EDT)	Event
T-140	0528	Start terminal count
		Guidance system turn-on
		Beacon checks

Table 4-7. Terminal Countdown (Cont'd)

Count (min)	Time (EDT)	Event
T-70	0638	Pad securing
T-60	0648	Built-in hold (60 minutes)
T-60	0708	Warning horn
T-60	0738	Roll call
		Air Conditioning adjust
T-60	0748	Built-in hold ends
		Initiate terminal count
T-50	0758	TC Briefing
T-40	0808	Status check
		Pressurize vehicle bottles
T-30	0818	First stage lox loading
		Final beacon checks
T-27	0821	C-Band beacon interrogation
T-25	0823	Auto slews
T-20	0828	CDR's on (both stages)
T-10	0838	Pad Safety launch enable
		Range ready on
T-7	0841	Built-in hold (30 minutes)
T-7	0911	Built-in hold ends
		Stage III telemetry external
T-5	0913	Stage I fuel tank pressurized
		Stage III ignition S&A received

Table 4-7. Terminal Countdown (Cont'd)

Count (min)	Time (EDT)	Event
T-4	0914	Stage I telemetry internal
		Stage I E-package internal
		Stage I solid motor power internal
		Pressurize stage I Lox tank
		Stage II hydraulics on external
T-3	0915	All stage II systems on internal
T-2	0916	SRO clear to launch
T-90 sec		Spacecraft final report
T-60 sec	0917	Eng recorders to high speed
T-15 sec		Final topping report
T-10 sec		Arm igniters
		Enable engine control
T-5 sec		Open solo vent valve
T-0	0918	Engine start
		Liftoff