TR-1131
September 20, 1971

NASA **JOHN F. KENNEDY SPACE CENTER**

DELTA-85

ORBITING SOLAR OBSERVATORY-H

(OSO-H)

OPERATIONS SUMMARY

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

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OPERATIONS SUMMARY

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A. MISSION OBJECTIVES

The objective of the Orbiting Solar Observatory (OSO) project is to operate orbiting spacecraft for the purpose of conducting experiments in solar physics above the atmosphere. OSO-H, the eighth OSO spacecraft, will continue the study of solar X-rays, gamma rays, ultraviolet radiation, outer-corona white light, and other phases of solar activity. Specific objectives of the OSO-H mission are as follows:

1. Obtain extreme ultraviolet spectroheliograms tween 170 and 400 Angstroms (A), and obtain spectroheliograms in the 1.75 to 2.1A and the 10 to 22A regions.

2. Study sequentially the solar disc and inner corona in the extreme ultraviolet, and the outer corona in white light.

3. Survey the entire sky for sources of cosmic X-rays in the energy range of 1 to 60 Kev with an angular resolution of about one degree and perform spectral analysis in five broad-energy bands.

4. Perform a sky scan at X-ray energies in the range of 2.0 to 300 Kev.

5. Study hard solar X-ray burst in the energy range of 2.0 to 300 Kev.

6. Monitor intensity and line structure of solar gamma-ray fluxes in the energy range of 0.3 to 9.1 Kev.

The spacecraft will be launched from Cape Kennedy Air Force Station (CKAFS) by a vehicle designated Delta-85.

Delta-85 will also carry a Test and Training (TETR) spacecraft in the second stage engine compartment. It will be designated TETR-D and will be ejected from the second stage after that stage has separated from the OSO-H spacecraft. TETR-D will provide an active target for premission checkout of the Manned Space Flight Network (MSFN) tracking stations, training, of MSFN system personnel, routine mission simulations, and development and verification of acquisition and handover techniques.

B. LAUNCH VEHICLE AND SPACECRAFT DESCRIPTION

1. Launch Vehicle. Delta-85 is a two-stage DSV-3N configured launch vehicle for which the McDonnell Douglas Astronautics Company is the prime contractor. The vehicle is shown in figure 1 and vehicle data is listed in table 1.

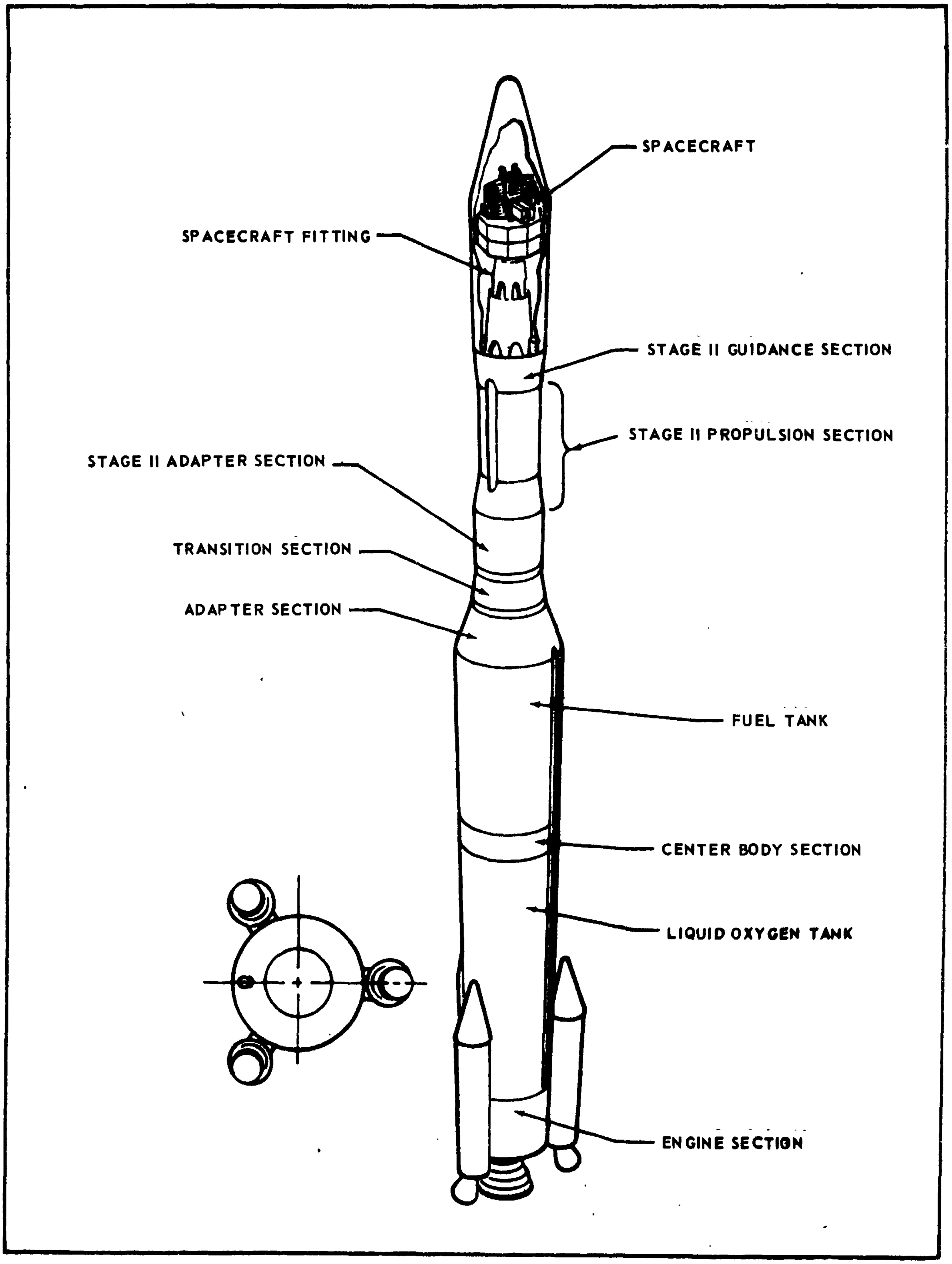

Figure 1. Delta 85 Launch Vehicle

Table 1. Delta Vehicle Data

	Boosters	Stage I	Stage II
Length (feet)	19.7	73.9	16.45
Diameter (inches)	30	96	54.7
Engine propellant type	solid	liquid	liquid
Engine manufacturer	Thiokol	Rocket-dyne	Aeroject
Engine designation	TX354-5	MB3-III	AJ10-118E
Number of engines	3	1+2VEs	1
Specific impulse	237.6	252.4	275
Thrust (pounds/engine)	52,150	170,000	7,750
Burn time (seconds)	37	218.5	380.8
Propellant (solid)	TP-H7036	--	--
Fuel (liquid)	--	RJ-1	UDMH
Oxidizer (liquid)	--	lox	IRFNA
Nitrogen gas (psig)	--	3,000	4,000
Helium gas (psig)	--	--	4,350
Serial number	270, 271, 272	20022	20248

2. OSO-H Spacecraft. The OSO-H spacecraft (figure 2) was built by Ball Brothers Research Corporation (BBRC) under management of the Goddard Space Flight Center (GSFC). The main body of the spacecraft is a wheel of aluminum honeycomb material divided into nine wedge-shaped compartments. Five of these compartments contain the experiments which do not require fixed solar orientation. The remaining four compartments contain electronic controls, batteries, telemetry equipment, and radio command equipment. This part (wheel) of the spacecraft spins and acts as a stable platform for solar-oriented instruments carried on the sail section which is mounted on the spinning wheel by means of a shaft and azimuth drive assembly. The sail section derives its name from a rectangular-shaped solar cell array mounted at right angles to the solar-pointed instruments. OSO-H differs in appearance from previous OSO spacecraft since the arms have been eliminated and the high-pressure gas bottles are now located in the wheel for spin control and in the sail for pitch-control. OSO-H is also much larger and heavier than earlier OSO spacecraft. Table 2 lists dimensions and other spacecraft data.

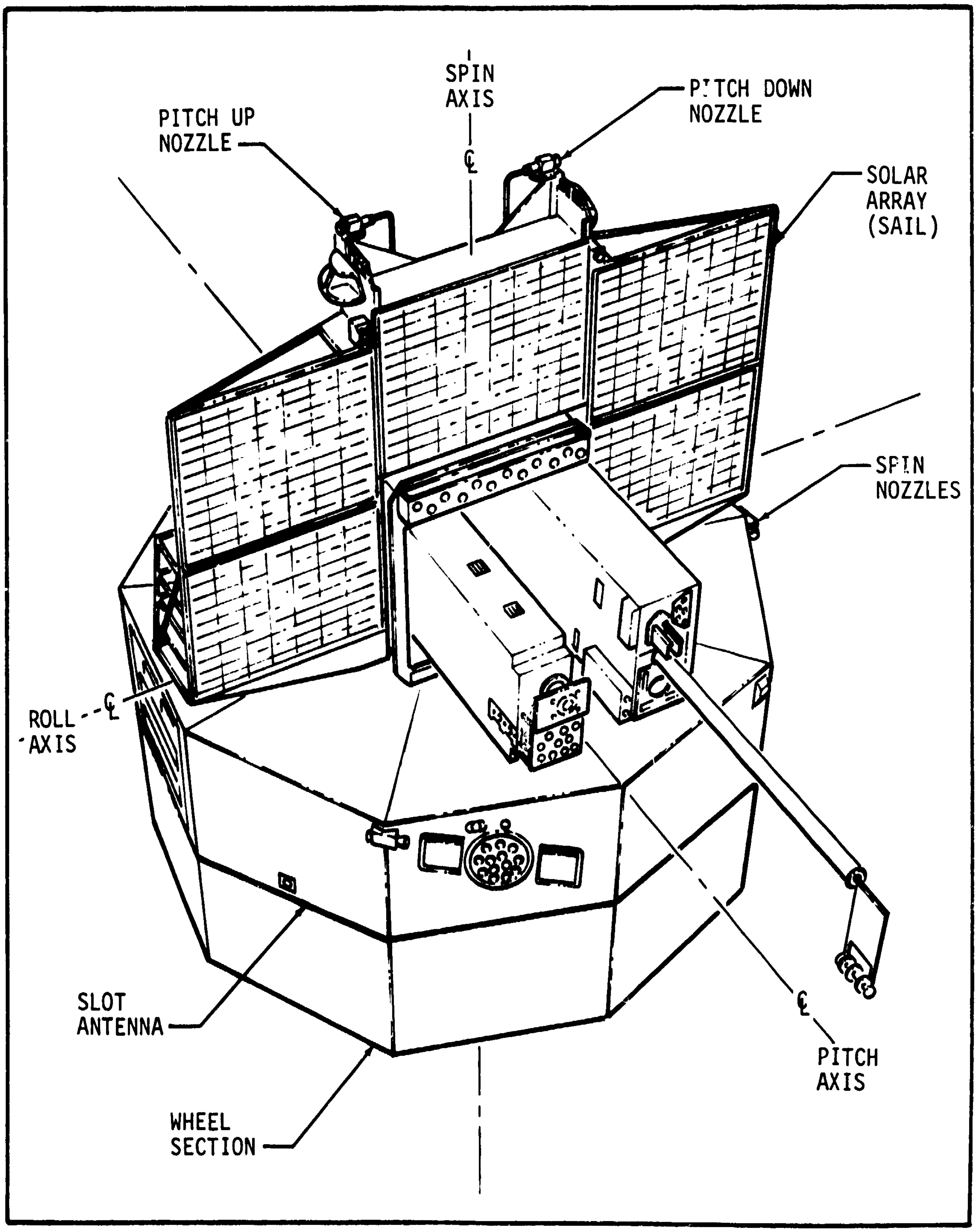

Figure 2 OSO-H Spacecraft

Table 2. OSO-H Spacecraft Data

Height	75 inches
Diameter of Wheel	56 inches
Weight	1400 pounds (app.)
Experiments	6 (2 sail, 4 wheel)
Nitrogen Gas Containers (3000 psi)	2 on sail, 1 on wheel
Power Requirements	65 watts day, 40 watts night
Power Output (from solar cells)	90 watts
Power Storage	56 nickel-cadmium type-F cells arranged in 8 packs of 7 cells. Voltage range from 16.2 (under-voltage) to 22 volts (fully charged)
Supplemental Power	2 squib-firing battery packs in sail to fire nutation damper and elevation lock squibs
Power System Protection	Day/night relay activated by solar detectors. Dummy loads by ground command. Undervoltage switch.
Telemetry System	PCM/PM split-phase binary coded. Simultaneous record and transmit realtime data at 800 bps. Playback once per orbit at 14,400 bps.
Command System	PDM/AM/AM tone digital redundant
Antenna	Progressively-fed turnstile slot

a. Two pointed experiment packages are mounted in the sail section:

(1) Naval Research Laboratories: WL and XUV Coronagraphs. A study of the morphology of the White Light (WL) and extreme ultraviolet (XUV) coronas and of the ultraviolet features on the solar disc such as plages and flares, and to correlate the XUV corona with the WL corona.

(2) Goddard Space Flight Center: XUV/X-ray Spectroheliograph. A study of simultaneous spectroheliograms at several wavelengths, spectra of localized regions, and polarization of X-ray bursts.

b. Four experiments which do not require fixed solar orientation are located in the wheel section of the spacecraft:

(1) Massachusetts Institue of Technology: Celestial X-ray Telescope. This experiment will be a study and analysis of X-ray sources to locate known sources more accurately, to identify and locate new sources, and to measure the intensity and variation of all sources in broad-spectral bands from 1.0 to 60 Kev.

(2) University of California, San Diego: Cosmic X-ray Telescope. A study and analysis of cosmic X-ray sources to locate known sources more accurately, identify and locate new sources, measure intensity, and spectrally analyze these sources over the range of 10 to 550 Kev.

(3) University of California, San Diego: Solar X-ray Telescope. An experiment to measure solar X-ray flux from 1.0 to 300 Kev with good spectral, intensity and time resolutions.

(4) University of New Hampshire: Gamma Ray Spectrometer. To monitor solar high-energy photon spectrum from 0.3 to 9.1 Mev for intensity, time variation, and line spectra.

3. TETR-D Spacecraft. TETR-D (figure 3) is an Orbiting Relay Satellite III (ORS-III) model of the Environmental Research Satellite series. It carries a payload consisting of an S-band transponder which is compatible with the USB systems of the MSFN. In orbit, the spacecraft will provide an active target for ground tracking by the MSFN.

The basic spacecraft is an octahedron with dimensions of 11 inches on a side. Total weight is approximately 44 pounds. The eight triangular sides of the spacecraft are covered with solar cells to provide power to a battery assembly. The battery assembly consist of 10 nickel-cadmium cells and an appropriate charge-regulator system. The batteries are designed to provide 3 hours of continuous S-band transponder operation and will require about 20 hours for recharge after maximum use. A VHF telemetry antenna is mounted with two segments extending on opposite side apexes of the spacecraft. An S-band antenna is mounted at the top spacecraft apex and a command receiver antenna is adjacent to the bottom apex. At the bottom apex is a fitting for mounting and ejecting the spacecraft from its launch canister.

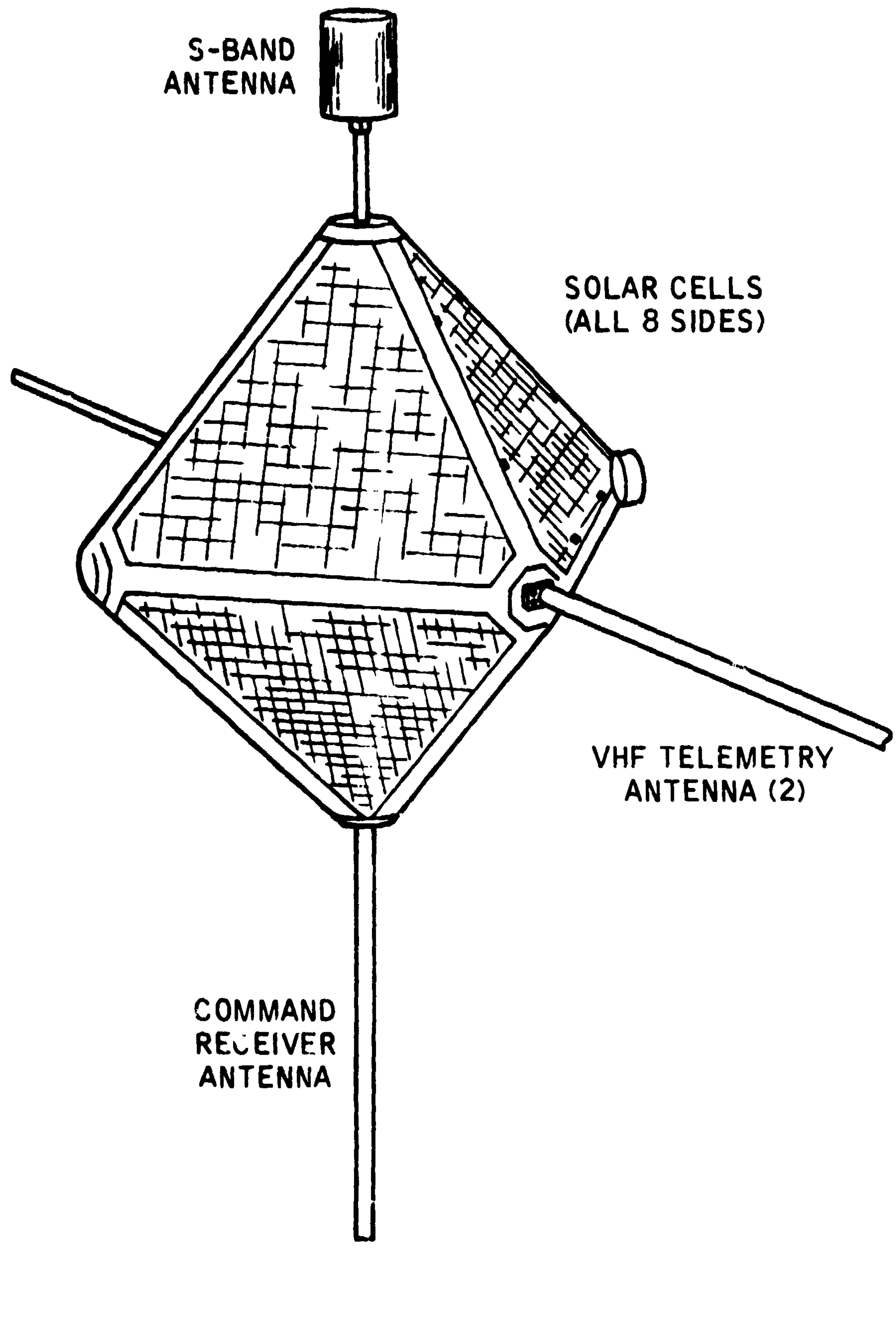

Figure 3. TETR- D Spacecraft

C. MISSION PLAN

1. Launch Constraints.

a. Launch Window. The launch window will open at 0547 EDT on September 23, 1971, and will close at 0601 EDT.

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 prelaunch checkout and postflight data analysis.

The Air Force Eastern Test Range (AFETR) stations supporting Class 1 requirements must be operational or the mission could be delayed.

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

The Go-No Go decision for upper wind conditions is based upon a computer program at MDAC Santa Monica and is a combination of wind shear, velocity, and direction factors.

2. Flight Plan. The launch will be from Complex 17, Pad A, Cape Kennedy Air Force Station (CKAFS), Florida, on September 23, 1971. The pad azimuth will be 115 degrees and the vehicle will roll to 108 degrees shortly after liftoff.

The desired orbital parameters for the OSO-H spacecraft are as follows:

Apogee	300 nautical miles
Perigee	300 nautical miles
Inclination	33 degrees
period	96 minutes

The nominal sequence of flight events from liftoff through separation of both spacecraft is presented in table 3. Times are listed in seconds after liftoff (T+seconds). Those events which occur after Main Engine Cutoff (MECO) are also referenced in seconds after MECO (M+seconds) since most of those events are initiated by the second stage programmer which is started at MECO. The times listed here may be changed if the launch date or window is changed.

Table 3. Sequence of Flight Events

T+Sec	Min:Sec	Event	Initiated By
T+0	00:00	Start stage 1 programmer	Liftoff switch
		Uncage stage 1 gyros	Liftoff switch
		Start solid motor separation timer	Solid motor ignition relays
T+2	00:02	Start stage 1 roll program	CEA
T+9	00:09	End stage 1 roll program	CEA
T+9.3	00:09.3	Start stage 1 pitch program	CEA
T+34.7	00:34.7	End first pitch rate	CEA
T+35	00:35	Start second pitch rate	CEA
T+64.7	01:04.7	End second pitch rate	CEA
T+65	01:05	Begin third pitch rate	CEA
T+75	01:15	Solid motor separation command	Solid motor separation timer
		Roll gain change	Solid motor separation timer
T+80	01:20	Roll gain change (backup)	CEA
		Uncage stage 11 roll gyro	CEA
		Solid motor separation (backup)	CEA
T+103.7	01:43.7	End third pitch rate	CEA
T+104	01:44	Begin fourth pitch rate	CEA
T+140	02:20	Pitch and yaw gain change	CEA
		Enable pitch and yaw vernier engines	CEA
T+197	03:17	Enable stage II ignition and pyrotechnic power	4.75-G switch
T+200	03:20	Enable MECO	CEA

Table 3. Sequence of Flight Events (cont'd)

T+Sec	Min:Sec	Event	Initiated By
T+218.5 (M+0)	03:38.5	MECO	FIP Switch
		Start stage II programmer	Staging relay
		Blow blast band bolts	Staging relay
T+222.5 (M+4)	03:42.5	Sequence 1	Stage II programmer
		Blow stage I/II separation bolts Uncage pitch and yaw gyros Enable stage II roll control Start stage II engine Transfer guidance reference power Roll gyro uncage (backup)	
T+229.5 (M+11)	03:49.5	Start stage II pitch program	Stage II programmer
T+230.5 (M+12)	03:50.5	Sequence 2 Fairing separation Enable stage II restart	Stage II programmer
T+490.5 (M+272)	08:10.5	Initiate VCS channel No.1	WECO
		Sequence 3 Initiate VCS channel No.1 (backup)	Stage II programmer
T+537.5 (M+319)	08:57.5	Arm oxidizer probe	Yaw No. 1 on
		Arm TPS	Yaw No. 1 on
T+596.6 (M+378.1)	9:56.6	SECO No. 1	VCS No. 1 output

Table 3. Sequence of Flight Events (cont'd)

T+Sec	Min:Sec	Event	Initiated By
		Turn off hydraulics	SECOM No. 1 relay
		Switch to coast phase	SECOM No. 1 relay
		End stage II pitch rate	SECOM No. 1 relay
		Enable CDR turnoff	SECOM No. 1 relay
		Reset VCS accumulator	SECOM No. 1 relay
T+618.5	10:18.5	End stage II pitch rate (backup)	Stage II programmer
T+635.5 (M+417)	10:35.5	Begin coast phase pitch program	Stage II programmer
T+660.5 (M+442)	11:00.5	Turn off CDRs	Stage II programmer
T+836.5 (M+618)	13.56.5	End coast phase pitch program	Stage II programmer
T+1653.5 (M+1435)	27:33.5	Sequence 4	Stage II programmer
		Restart conditioning Turn on hydraulics Initiate ullage jet Disarm ox probe and TPS Initiate VCS No. 2 Disable VCS No. 1	
T+1700.5 (M+1482)	28.20.5	Sequence 5	Stage II programmer
		Restart stage II engine Switch to powered phase control	
T+1705.5 (M+1487)	28:25.5	Rearm ox probe	Yaw No. 1 off
		Rearm TPS	Yaw No. 1 off
		Turn off ullage jets	Yaw No. 1 off

Table 3. Sequence of Flight Events (cont'd)

T+Sec	Min:Sec	Event	Initiated By
T+1705.5 (M+1487)	28:25.5	Rearm ox probe	Yaw No. 1 off
		Rearm TPS	Yaw No. 1 off
		Turn off ullage jets	Yaw No. 1 off
T+1707.3 (M+1488.8)	28:27.3	SECO No. 2	VCS No. 2 output
		Turn off hydraulics	VCS No. 2 output
		Switch to coast phase control	
T+1723.5 (M+1505)	28:43.5	Begin coast phase yaw program	Yaw No. 2 on
T+1752.5 (M+1534)	29:12.5	End coast phase yaw program	Yaw No. 2 off
T+1995.5 (M+1777)	33:15.5	Sequence 6	Stage II programmer
		Blow stage II/OSO-H separation bolts Fire retros Start TETR-D separation TDRs	
T+3095.5 (M+2877)	51:35.5	TETR-D separation	TETR-D separation TDRs

D. POST LAUNCH OPERATIONS

When the spacecraft has been successfully separated from the launch vehicle within view of the Johannesburg tracking station (figure 4), control of the spacecraft will be through the OSO Control Center at GSFC. Details of this support may be found in GSFC Operations Plan 10-71 for OSO-H.

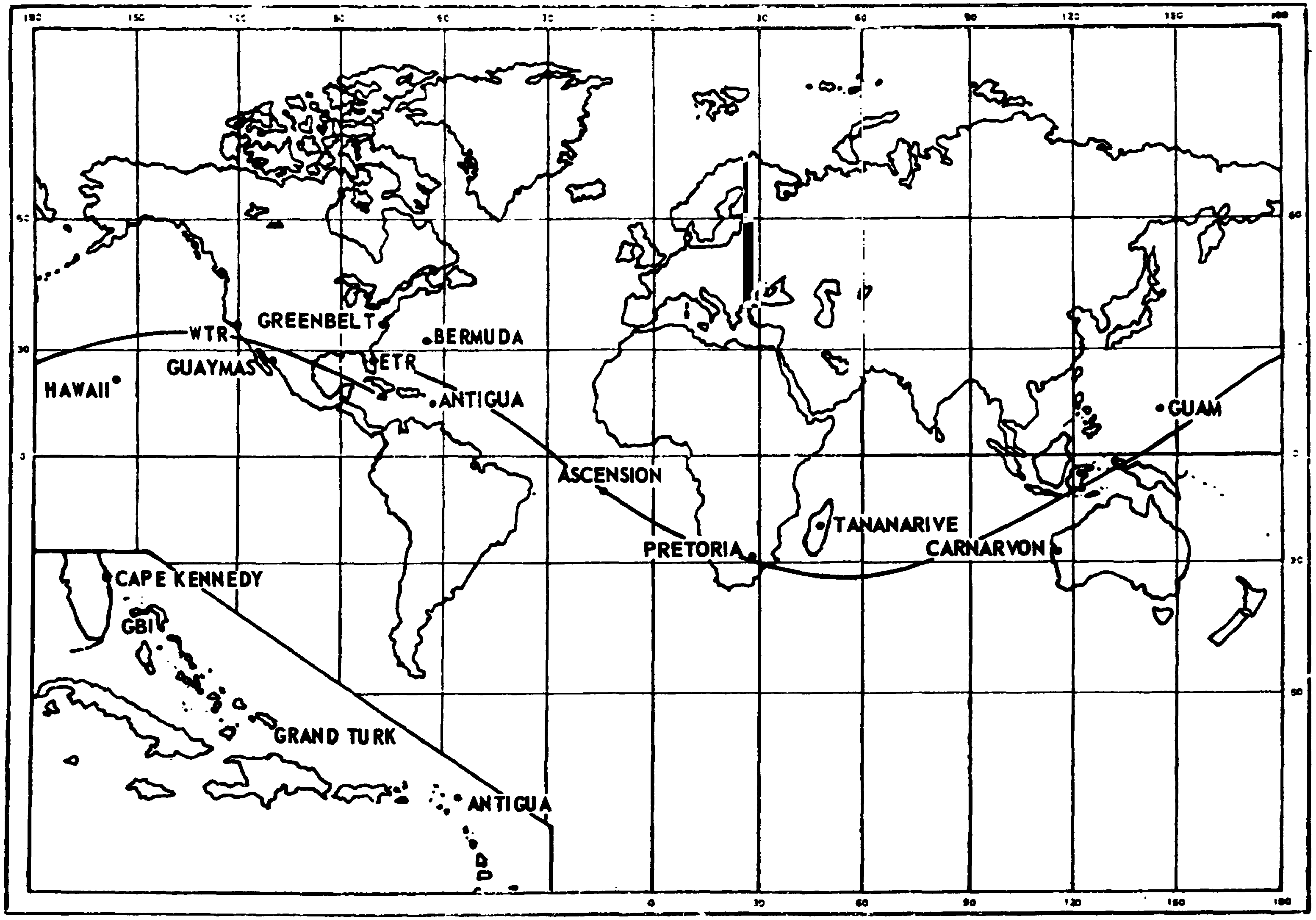

Figure 4. Spacecraft Tracking and Trajectory

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 and Launch Director. 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 AE. The OSO-D mission operational areas are located in Building AE. These are the Mission Director's Center (MDC) and the Launch Vehicle Telemetry Ground Station. In addition, an observation area is provided behind the MDC for observing overall mission progress. Figure 5 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 6) 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 sequence of events after liftoff. Three plotting boards are located at the center of the display and are used to show present position and Instantaneous Impact Prediction (IIP)plots and, in most cases, 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 OSO-H launch operations:

a. TV
b. ETR test number
c. Grennwich Mean Time (GMT) and Eastern Daylight Time (EDT) synchronized to WWV

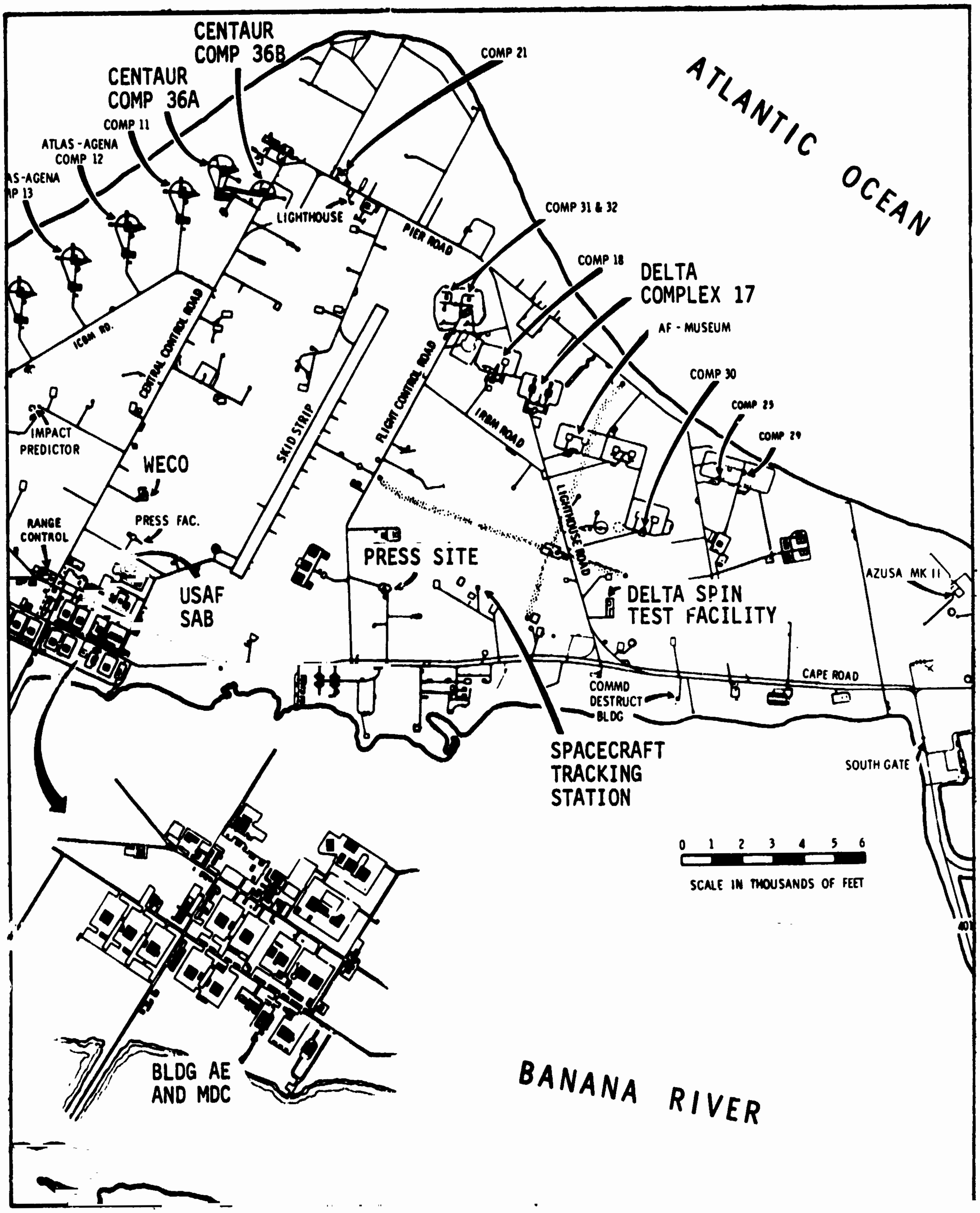

Figure 5. Launch and Operational Areas

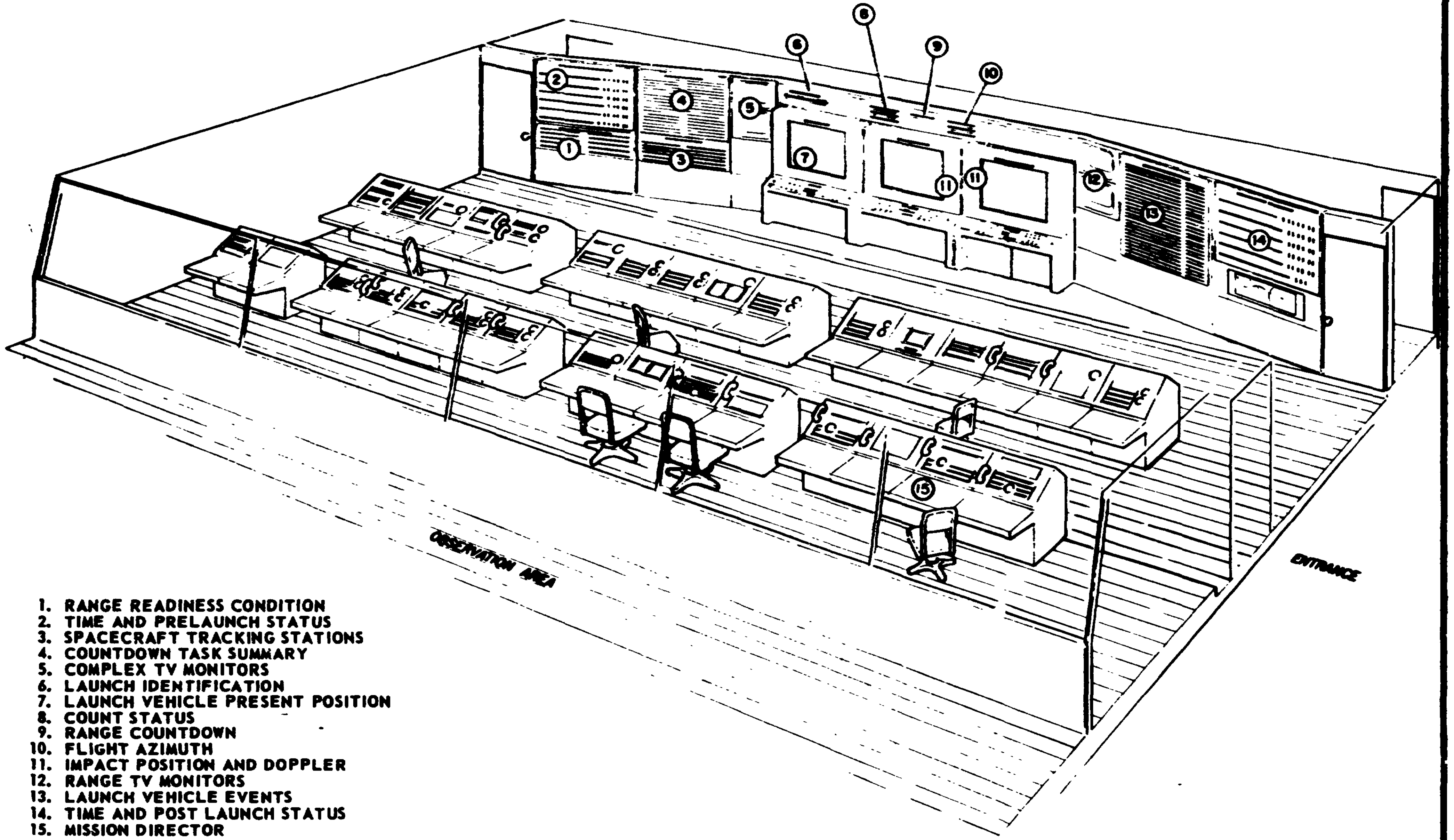

Figure 6. MISSION DIRECTOR'S CENTER

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 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 and raw telemetry data, as requested by the spacecraft checkout team. In addition, launch vehicle telemetry signals will be remoted from the STS to Building AE in realtime.

B. DATA ACQUISITION

Telemetry, optical, and radar data will be supplied by a composite of ETR, GSFC, and KSC stations. Details of support from various stations follows:

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. Both stations will display all or most of the channels telemetered, and systems engineers will observe the data at both sites to determine the flight readiness of the vehicle. Both stations will display the realtime data post-test for flight evaluation prior to the post-flight critique.

Data will be received at both sites through their respective local antennas, with switches to other stations made as required to optimize the coverage. STS will provide early launch phase data to AE. Building AE will send the best of

AE and STS data to Complex 17. Complex 17 will use the best data available. The stations will use their local antennas whenever possible to increase reliability. Coverage is anticipated to be 100 percent through the switch to Antigua data at about T+400 seconds.

b. Downrange Telemetry. Antigua (ETR station 9.1) is the prime downrange station for early launch. The entire stage II link except for VCO-C will be remoted to the Cape via the two subcable circuits. The PDM will be on the higher frequency subcable circuit remodulated on a 75 kHz±10 percent subcarrier. 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. This will probably be the only station viewing SECO No. 1.

Tananarive (MSFN), Carnarvon, Guam, Hawaii, and ULO/WTR will receive and record only, and the tape will be used post-test for coast-phase performance information.

Both the ETR and MSFN sites on Ascension will provide more extensive support because the stage II second burn and spacecraft separation will occur within view. Each Ascension site will remote 14 channels of information, plus timing, to AE for analysis of second stage events and general vehicle condition. This data will also be remoted to Complex 17 for analysis. A list of these channels is in table 4.

2. Spacecraft Telemetry.

a. Uprange. The spacecraft 136 MHz signal (PCM/PM) will be received and recorded in Building AE using the AF antenna system up until late terminal count. At that time, the spacecraft station will switch to STS video data and will stay with STS until switching to Antigua. It is anticipated that 100 percent coverage will be obtained. AE will back up STS with a redundant high-gain antenna system.

b. Downrange. Antigua will receive and record the spacecraft signal and will remote the signal to Building AE over a 202-D data modem on the subcable. AE telemetry will demodulate this signal and send it to the OSO ground station.

All data beyond this point will be transmitted directly from MSFN or STADAN sites to GSFC.

c. DTS Operations. The DTS systems in Building AE, utilizing a 203 data modem, will remote all data as seen at the OSO ground station to GSFC. This includes all minus count operations through Antigua LOS. In addition, this data will be sent to Ball Brothers, Boulder, Colorado, via 205 modem during all Cape checkout. Command signals from Ball Brothers in Boulder will be sent to the spacecraft via a 205 modem for spacecraft checkout. After liftoff, the best data at GSFC (Ascension, Johannesburg, Carnarvon, etc.) will be remoted to the AE station for several days for backup systems analysis by the checkout team using the 203 modem set.

3. Tracking. Radars 1.16, 19.18, 0.18, 3.13, 7.18, and 91.18 will provide realtime position information for Range Safety and input to the Realtime Computer System (RTCS). Radar 19.18, 0.18, 7.18, and 91.18 will record metric data for post-test analysis. Radars 67.16 and 67.18 will provide Range Safety input to the RTCS. Radar 12.16 will provide realtime input to the RTCS.

STS will doppler track the spacecraft signal through approximately first SECO. Antigua will also support and verify first SECO. Ascension will doppler track through stage II second burn. Data from STS, Antigua, and Ascension will be remoted to the MDC and to GSFC in realtime. Detailed data will be available for post-test analysis should the need arise.

4. Miscellaneous Other Support.

a. STS will send the countdown to GSFC on the digital doppler.

b. AE will remote mark events to GSFC using eight VCOs (IRIG-1-8).

c. The MILA USB site will track the vehicle as a target of opportunity and will supply data tapes if requested.

d. NORAD will provide early orbital parameters (24 hours) to the OSO Control Center.

5. Optics. Twenty-two fixed engineering sequential cameras will provide coverage from T-4 minutes to T+30 seconds. The Cocoa Beach, Vero Beach, and Melbourne Beach long range tracking cameras will track from acquisition to Loss of Vision (LOV). Six tracking engineering sequential cameras will provide photographic coverage from liftoff to LOV. Twenty-six documentary cameras are assigned to the mission.

Table 4. Realtime Data Retransmissions

VCO Number on the Cable	Function	Stage II Instrumentation Assignment
	Circuit No. 1 Ascension	
1	Pitch Engine	2-E-9
2	Pitch Gyro	2-E-7
3	Yaw Gyro	2-E-11
4	Yaw Engine	2-E-13
5	Roll Gyro	2-E-2
6	Engine Battery	2-E-19
7	Control Battery	2-E-20
8	Time	(Deviate 0 to 25%)
	Circuit No. 2 Ascension	
1	Helium Reg	2-E-38
2	Pc	2-9
3	Nitrogen Reg	2-E-27
4	Ox Probe/TPS SECO	2-E-5
5	Start S/C Sep	2-E-14
6	Restart Conditioning	2-E-26
7	VCS SECO No. 2	2-8
8	Time	(Deviate 0 to 25%)

C. METEOROLOGICAL PLAN

Cape Kennedy Forecast Facility (CKFF) will provide Weather Warning (WW) services from the time the vehicle is erected on the pad until launch. WW notifications will be issued whenever 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 Delta Missions Office 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 the test termination.

Minimum ceiling and visibility requirements will be as described by Range Safety. Upper air limitations, wind shears and wind speeds, will be determined by computer evaluation at MDAC Santa Monica from the latest forecasts.

SECTION III
COMMUNICATIONS

A. GENERAL

The operation communications facilities which will be available for support of the OSO-H launch are described in this section. These facilities will be available for prelaunch checkout and early post flight communications. 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 6) 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 telephone 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 real-time on OIS Channel 2. All personnel may switch to channel 2 on a listen only basis.

4. Operations Conducted on OIS. The operations to be conducted on OIS channels during the OSO-H launch are listed in table 5.

5. Long-Line Operations. In addition to the local circuits, twelve long-lines (SCAMA) will be utilized during the OSO-H prelaunch, launch, and post-launch phases. These lines are listed in table 6.

Table 5. OIS Prelaunch Operations Channel Assignments

Complex 17 Channels	Complex 17 Channel Title	MDC and TLM Lab Channels	Operation
1	Facilities 1	1	Countdown, including terminal count
2	Facilities 2	2	Post liftoff oral account of flight events
5	Missile Test B	3	Doppler coordination
6	Missile Test A	4	Ordnance and RF system destruct checks
11	Instrumentation	6	Realtime telemetry use
12	Payload 1	7	Spacecraft checks
13	Payload 2	8	Post liftoff, project officer to MDC (eyeball)
17	NASA Project	10	Project official's use

Table 6. Long-Line Communications

Sĉama	Title	Operation	Mode
1	Mission Director	Mission Director ETR to Mission Director GSFC	Voice
2	Project Conference	All S/C management for project use	Voice
3	BBRC Project Mgr	Contractor Mgr ETR to contractor rep GSFC	Voice
4	BBRC Conference	All S/C contractors for general S/C use	Voice
5	Delta Launch Vehicle	Delta Project rep ETR to Delta rep GSFC	Voice
6	NASA Hq Rep	Hq Mgt. discussion	Voice
7	Project Johannes-burg	Voice coord to station	Voice
8	Mission Operations	NASCOM S/C Opera-tion	Voice
9	Computer Coord	Radar data coord	Voice
10	ETR Asc. Data	202 data	Data
11	GSFC 1	203 data	Data
12	GSFC 2	203 data	Data

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 7 and 8.

Table 7. Spacecraft Prelaunch Milestones

Event	Location	Date
Spacecraft ETR arrival	Hanger AM	9/16/71
Spacecraft performance checks	Hanger AM	9/17 through 9/20/71
Mated to launch vehicle	Complex 17A	9/21/71 (F-2 Day)

Table 8. Vehicle Prelaunch Milestones

Event	Location	Date
Stage I ETR arrival	Hanger M	7/14/71
Stage II ETR arrival	Hanger M	7/16/71
Stage I erection	Complex 17A	7/22/71
Stage II erection	Complex 17A	8/10/71
Simulated Flight Test	Complex 17A	9/13/71

A total of 34 separate vehicle tasks are performed during F-3 Day, F-2 Day, F-1 Day, and F-0 Day operations to prepare the vehicle and spacecraft for launch. A summary of the tasks and the sequence of events through the terminal count are presented in this section. Four of the tasks are performed preliminary to the countdown operations and are described below.

1. Task 1. This designation has been assigned to the first part of the countdown manual which contains the introduction, table of contents, task leader instructions, operating parameters, emergency warning system description, the milestone countdowns, and schematics.

2. Task 2. This task involves a walkaround inspection prior to countdown initiation on F-3, F-2, F-1, and F-0 Days to determine that proper equipment is available and that necessary safety measures are being observed. Responsibility: Test Conductor.

3. Task 4. The S and A units are tested and prepared for transfer to the launch complex. This task is performed in the PAA ordnance area.

4. Task 8. This task is preliminary to ordnance installation and hookup and provides safety information for tasks 10, 11, 22, and 26.

B. F-3 DAY

Countdown tasks 3, 5, 6, 7, 9, 10, and 11 are performed on F-3 Day to verify flight readiness and compatibility of the launch vehicle and Range systems for launch. Performance of the F-3 Day tasks in relation to countdown time is presented graphically in figure 7. Major items accomplished during the F-3 Day countdown are listed sequentially in table 9.

1. Task 3 - Countdown Initiation. This task is the start of the countdown. Clearance to start the countdown is obtained from all systems, a communications check of all required stations is made, the necessary power is turned on, and any changes to the countdown are announced. Responsibility: Test Conductor.

2. Task 5 - Engine Checks. Checks are made to verify that engine sequencing and cutoff circuits are functioning properly, vehicle tanks and bottles are pressurized, and the lubricating-oil tank is filled. Responsibility: Propulsion Control.

3. Task 6 - Electrical System Checks. All facility systems are operational during this check. Vehicle electrical systems are checked and the RF systems receive an open loop composite test, first on external power and then on internal power, using the applicable Range ground transmitting and receiving systems. The flight batteries are connected and secured prior to the internal power check. Responsibility: Vehicle Control.

4. Task 7 - Engine Flush. Trichlorethylene is used to flush and purge the main engine Lox dome and injector to remove any possible contaminants. This flush is performed immediately after the final engine valve sequencing. Responsibility: Propulsion Control.

5. Task 9 - Stray Voltage Checks. All electrical power is turned on and the complete ordnance wiring circuitry is checked for stray voltage. Personnel on the pad are kept to a minimum during these checks. The personnel making the stray voltage checks must wear nonstatic-producing clothing and must be properly grounded at all times. Responsibility: Vehicle Control.

6. Task 10 - Category B Ordnance Installation and Hookup. This task involves installation and electrical connection of all category B ordnance not previously installed. Stray voltage checks are made prior to electrical connection. During this task, personnel on the pad are kept to a minimum, and a no switching - no radiation period is in effect. Those personnel working with ordnance must wear nonstatic-producing clothing and must be properly grounded at all times. Responsibility: Vehicle Control.

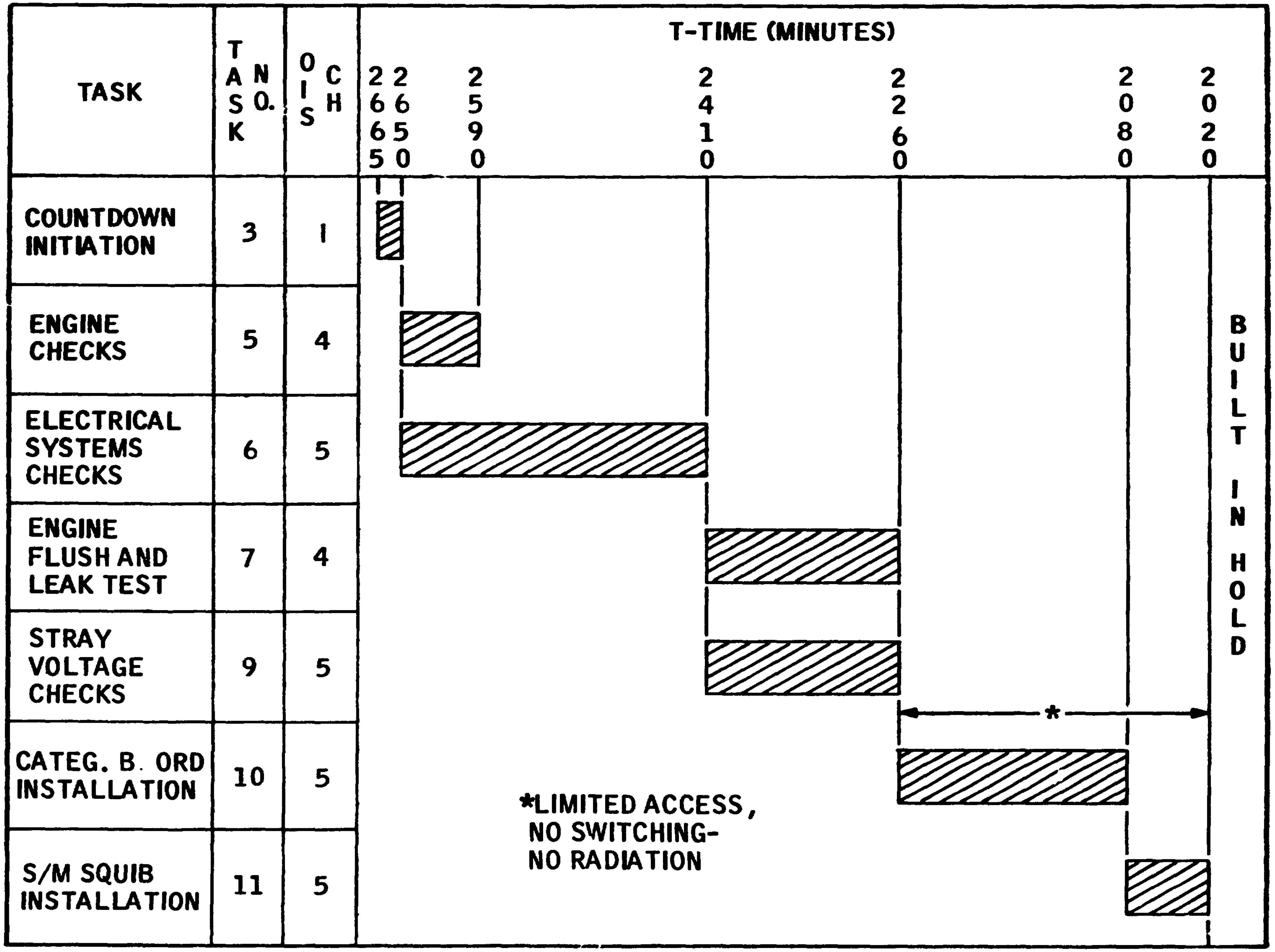

Figure 7. F-3 Day Countdown Tasks

7. <u>Task 11</u> - <u>Solid Motor Squib Installation</u>. The three first stage solid motor initiator assemblies are installed. A no switching-no radiation period is in effect during this operation. Responsibility: Vehicle Control.

Table 9. F-3 Day Milestone Countdown

Count (Min)	Time (EDT)	Event
T-3665	0745	Contractor countdown initiation
		<u>High pressure nitrogen storage bottles on line</u>
		NOTE: All <u>underlined</u> items in this and the following tables require Range support
T-3650	0800	Engine checks begin Electrical systems test setup begins
T-2590	0900	Engine checks complete
		Electrical systems checks begin
T-2410	1200	Electrical systems checks complete
		Engine flush begins
		Stray voltage checks begin
T-2260	1430	Engine flush complete
		Stray voltage checks complete
		<u>No switching - no radiation period begins</u>
		Category B ordnance installation and hookup begins
T-2080	1730	Category B ordnance installation and hookup complete
		S/M squib installation begins
T-2020	1830	S/M squib installation complete
		<u>No switching - no radiation period ends</u>
		Built-in hold begins (5 hours 30 minutes)

C. F-2 DAY

Countdown tasks 12 through 18 and spacecraft preparations are performed and task 10 is completed on F-2 Day. Task 12 is essentially the same as task 3 to initiate the F-2 Day countdown. Performance of F-2 Day tasks in relation to countdown time is presented graphically in figure 8. The major items accomplished during F-2 Day are listed sequentially in table 10.

1. Task 13 - Second Stage Final Preparations. Final work is accomplished to prepare the second stage for flight. Test cables are removed, final safety wiring is accomplished, connector matings are verified, and access doors are closed and sealed. Responsibility: Propulsion Control.

2. Task 14 - Second Stage Servicing Setup. Preparations are made for oxidizer and propellant flow and loading of the second stage. Fuel and oxidizer fill lines are leak checked, and fuel and oxidizer ullage tank filling is accomplished. Responsibility: Propulsion Control.

3. Task 15 - Second Stage Propellant Servicing. Fuel and oxidizer are loaded into the vehicle. Pad access is limited to those necessary for performance of the second stage servicing, and protective clothing must be worn. Responsibility: Propulsion Control.

4. Task 16 - Blast Band Installation. The blast band is installed but ordnance installation is part of task 22 performed on F-1 Day. Responsibility: Mechanical Engineer.

5. Task 17 - First Stage Fuel Circulation and Setup. First stage fuel is ciculated for 30 minutes or until a stabilized fuel temperature is reached, and preparations are made for fueling the vehicle. Responsibility: Propulsion Control.

6. Task 18 - First Stage Fueling. The first stage is loaded with fuel and checked for leakage. Responsibility: Propulsion Control.

7. Spacecraft Operations. The spacecraft, fairing, and environmental control system are erected at the beginning of F-2 Day. Final cleaning of the spacecraft area commences immediately after second stage servicing and continues until the beginning of F-1 Day.

Table 10. F-2 Day Milestone Countdown

Count (Min)	Time (EDT)	Event
T-2020	0400	Built-in hold ends
		S/C and fairing erection and environmental fixture setup begin

Table 10. F-2 Day Milestone Countdown (cont'd)

Count (Min)	Time (EDT)	Event
T-1780	0800	Stage II final preps begin
T-1720	0900	Stage II final preps complete
		Stage II servicing setup begins
T-1540	1200	Limited access period begins
		Category B ordnance installation begins
T-1480	1300	Stage II servicing setup complete
		Category B ordnance installation complete
		S/C and fairing erection and environmental fixture setup complete
		Stage II servicing begins
T-1270	1630	Stage II servicing complete
		Limited access period ends
		Spacecraft operations begin
		Blast band installation begins
		Fuel circulation and setup begins
T-1210	1730	Blast band installation complete
T-1180	1800	Fuel circulation and setup complete
		Spacecraft operations stop
		Limited access period begins
		Stage I fueling begins
T-1090	1930	Stage I fueling complete
		Limited access period ends
		Spacecraft operations begins
		Built-in hold begins (10 hours 30 minutes)

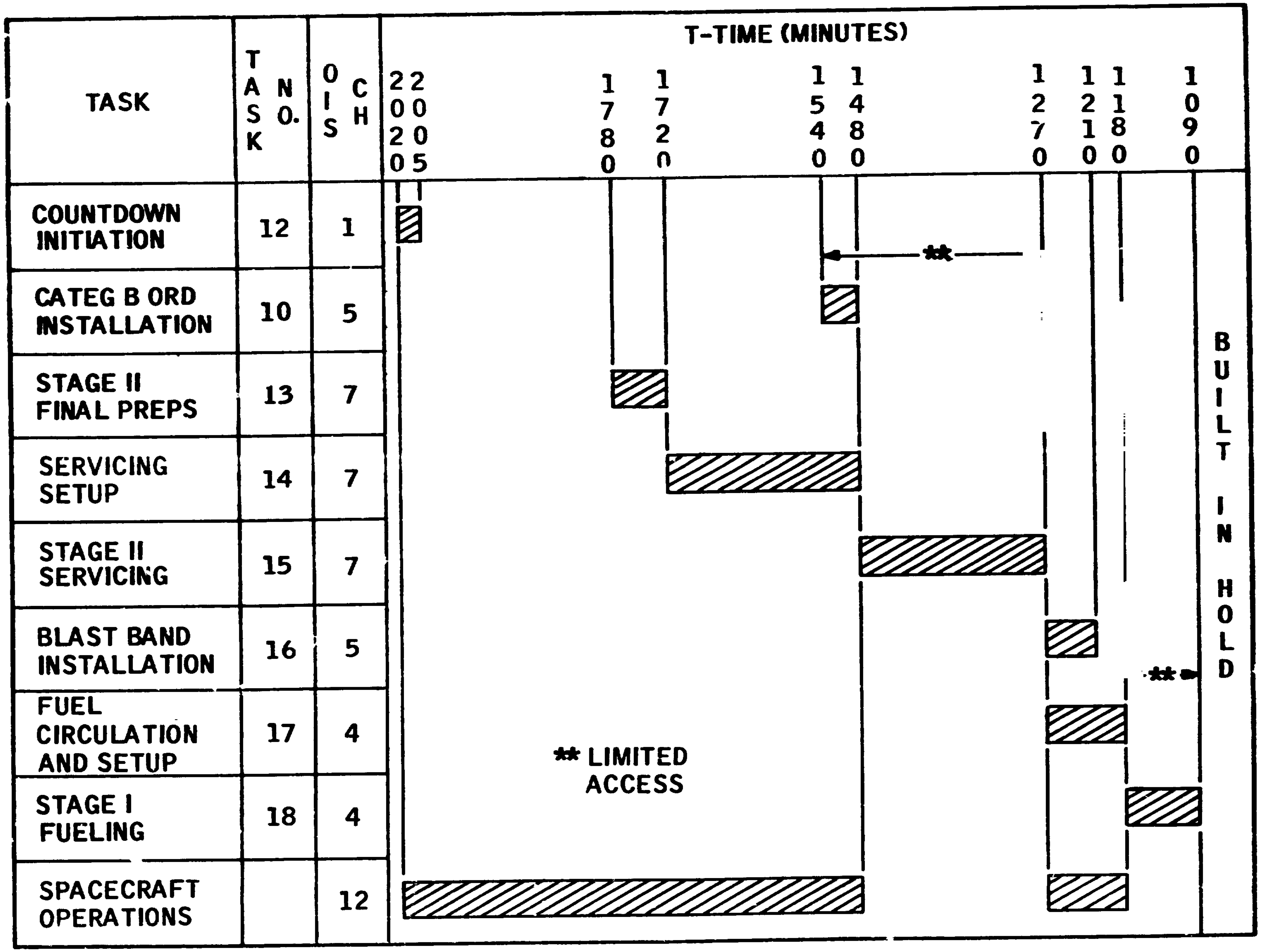

Figure 8. F-2 Day Countdown Tasks

D. F-1 DAY

Countdown tasks 20, 21, 22, and spacecraft operations are performed on F-1 Day. Task 20 is simply countdown initiation and helium sphere pressurization. Performance of the F-1 Day tasks in relation to countdown time is presented graphically in figure 9 and the major items are listed sequentially in table 11.

1. Task 21 - Fairing Closure. The fairing is unbagged and installed in close coordination with spacecraft personnel. Responsibility: Mechanical Engineer.

2. Task 22 - Blast Band and Fairing Ordnance Installation and Hookup. A no switching - no radiation period is in effect during this task. Stray voltage checks are conducted, blast band cartridges are installed, and fairing separation bolt cartridges are installed. Responsibility: Vehicle Control.

3. Spacecraft Operations. The spacecraft is unbagged prior to fairing installation. Spacecraft checks are conducted after fairing and blast band ordnance installation and hookup are completed.

Table 11. F-1 Day Milestone Countdown

Count (Min)	Time (EDT)	Event
T-1090	0600	Built-in hold ends
		Spacecraft unbagging begins
		Fairing closure begins
T-970	0800	Spacecraft unbagging complete
		Heilum sphere pressurization begins
T-910	0900	Helium sphere pressurization complete
T-730	1200	Fairing closure complete
		Limited access - no switching, no radiation begins
		Fairing and blast band ordnance installation begin
T-640	1330	Fairing and blast band ordnance installation complete
		Limited access - no switching, no radiation ends
		Spacecraft checks begin

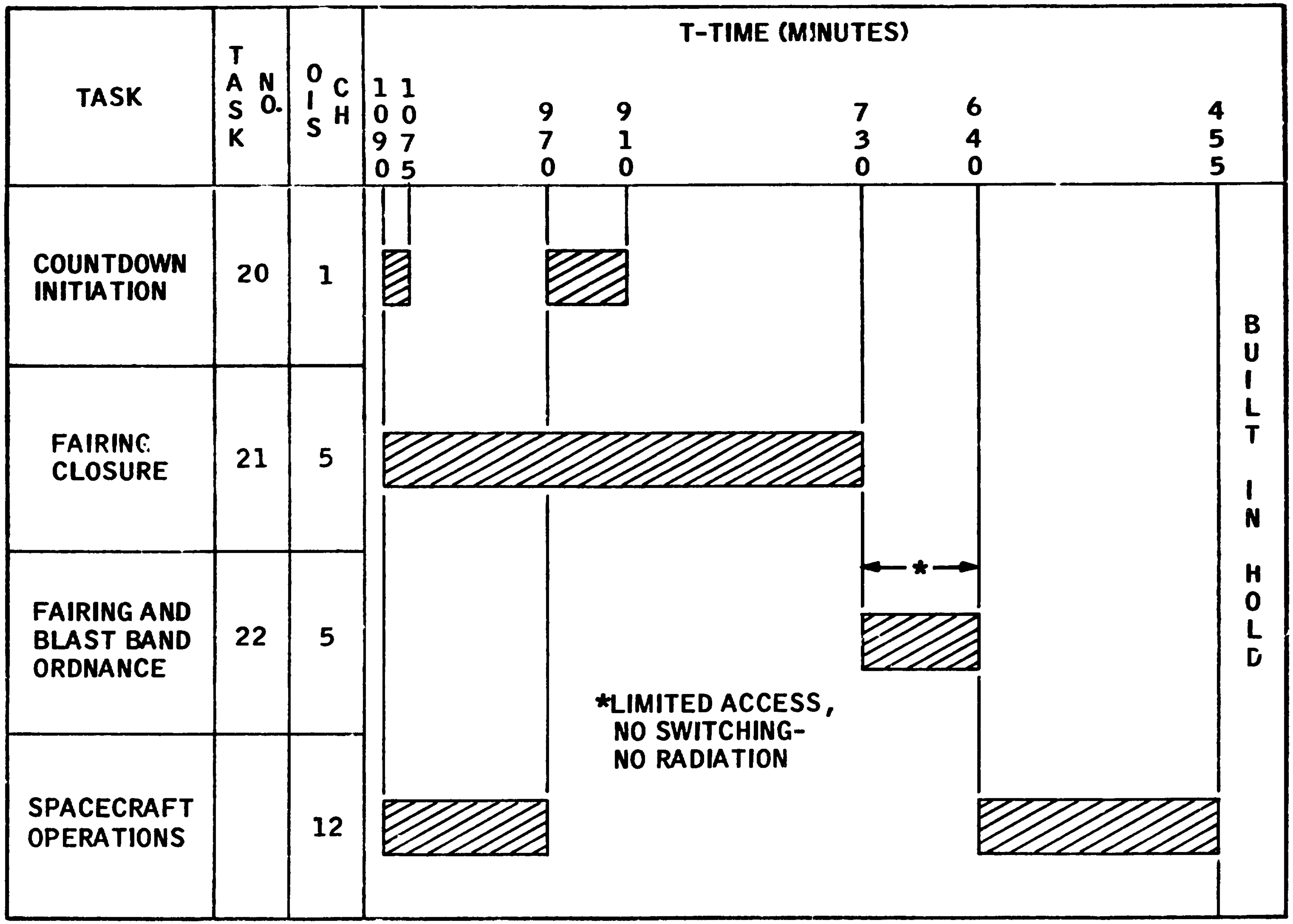

Figure 9. F-1 Day Countdown Tasks

Table 11. F-1 Day Milestone Countdown (cont'd)

Count (Min)	Time (EDT)	Event
T-455	1635	Spacecraft checks complete Built-in hold begins (3 hours 25 minutes)

E. F-0 DAY

Tasks 23 through 34 and spacecraft operations are performed during the F-0 countdown. Task 23 is the countdown initiation and is essentially the same as task 3. Performance of the tasks in relation to the F-0 Day countdown is presented graphically in figure 10. The sequence of major events during the launch countdown through task 37 is presented in table 12. Task 34, the terminal count, begins at T-35 minutes after a 120-minute built-in hold and continues until a 5- minute built-in hold at T-5 minutes, then continues to liftoff. Those items accomplished during the terminal count are listed in table 13.

1. Task 24 - Vehicle Shake Test. First and second stage gyros are uncaged and personnel gradually shake the vehicle in varying directions. Responsibility: Vehicle Control.

2. Task 25 - Liquid Nitrogen Storage Tank Fill. The PAA liquid nitrogen tanker truck is positioned adjacent to the storage tank and the tank is filled. Responsibility: Propulsion Control.

3. Task 26 - Class A Ordnance Installation and Hookup. The main and vernier engine hypergolic igniters are installed, the first and second stage S and A devices are installed and connected, the ignition detector assembly is installed and the solid motor initiator squibs are connected. Responsibility: Vehicle Control.

4. Task 27 - Final Preparation. Final preparations prior to clearing personnel from the area are accomplished. This includes capping or connecting all open lines, installation of access doors, final inspections, and general cleanup of the pad area. Responsibility: Pad Control.

5. Task 28 - Tower Removal. Tower removal preparations and actual moving of the tower are performed. Responsibility: Ground Handling Engineer.

6. Task 29 - Second Stage Pressurization Setup. The second stage propulsion console is set up to support pressurization for the second stage helium and nitrogen systems. Responsibility: Second Stage Propulsion Control.

7. Task 30 - Lox Setup. The first stage lox supply system is checked and prepared for fill. Responsibility: Propulsion Control.

8. Task 31 - Beacon Checks. Beacon interrogating radars are slewed to the vehicle and final RF checks are conducted. Responsibility: Vehicle Control.

9. Task 32 - Lox Loading. The pad area is cleared and the first stage lox system is filled. Responsibility: Propulsion Control.

10. Task 33 - Second Stage Pressurization. Helium and nitrogen spheres are first partially filled, then pressurized to capacity remotely during the terminal count. Responsibility: Second Stage Propulsion Control.

11. Spacecraft Operations. Spacecraft final preparations are performed during tower removal preparations and spacecraft RFI checks are conducted after the tower is back.

12. Task 34 - Terminal Count. The complex area is cleared, all non-essential personnel and equipment are evacuated, the blockhouse is sealed, all systems are armed, and final checks are made to verify vehicle and spacecraft readiness. Responsibility: Test Conductor.

Table 12. F-0 Day Milestone Countdown

Count (Min)	Time (EDT)	Event
T-455	2000	Built-in hold ends
		Contractor countdown initiation
		High pressure nitrogen and helium storage bottles on line
		Both 2250 psig nitrogen storage banks on line
		Complex fire water system pressure at 125 psig
		Fire and medical support required
		PAA complex guard still on station
T-445	2010	RF and shake test begins

Table 12. F-0 Day Milestone Countdown (cont'd)

Count (Min)	Time (EDT)	Event
		Liquid nitrogen fill begins
T-385	2110	RF and shake test complete
		Liquid nitrogen fill complete
		Limited access - no switching, no radiation begins
		Category A ordnance task begins
T-205	0010	Category A ordnance task complete
		Limited access - no switching, no radiation ends
		Final preparations begin
		Pressure setup task begins
		Tower removal preparations begin
T-115	0140	S/C final preps begin
		Pressure setup complete
		S/C final preps complete
		Lox setup begins
T-55	0240	Loxing setup complete
		Final preparations complete
		Tower removal complete
		Beacon checks begin
		Pressurization fill begins
		S/C RFI checks begin

Table 12. F-0 Day Milestone Countdown (cont'd)

Count (Min)	Time (EDT)	Event
T-35	0300	Beacon checks complete
		Pressurization fill complete
		S/C RFI checks complete
		127-minute built-in hold begins

Table 13. Terminal Countdown

Count (Min)	Time (EDT)	Event
T-35	--	Lox loading and second stage pressurization begin after the pad is cleared but before the end of the 127-minute built-in hold.
T-35	0507	Terminal Countdown begins
T-30	0512	Beacon on
T-28	0514	Guidance on
T-26	0516	CEA on
		Guidance checks
T-23	0519	Second stage slew checks
T-18	0524	Command carrier on
T-16	0526	Second stage pressurization complete
T-15	0527	Range Safety arm checks
		First stage slew checks
T-8	0534	Gyro drift check

Table 13. Terminal Countdown (cont'd)

Count (Min)	Time (EDT)	Event
T-5	0537	Begin 5-minute built-in hold
T-5	0542	Built-in hold ended
T-4	0543	Close lox tank vent. Lox loading complete
T-2	0545	Spacecraft status report
		Clear to launch report
T-90 sec		CEA internal
T-50 sec		Arm
T-30 sec		Charts high speed
T-15 sec		Lox topping report
T-10 sec		Enable engine control
T-0	0547	Engine start
T+2.3 sec		Liftoff
	0601	Latest possible liftoff in window

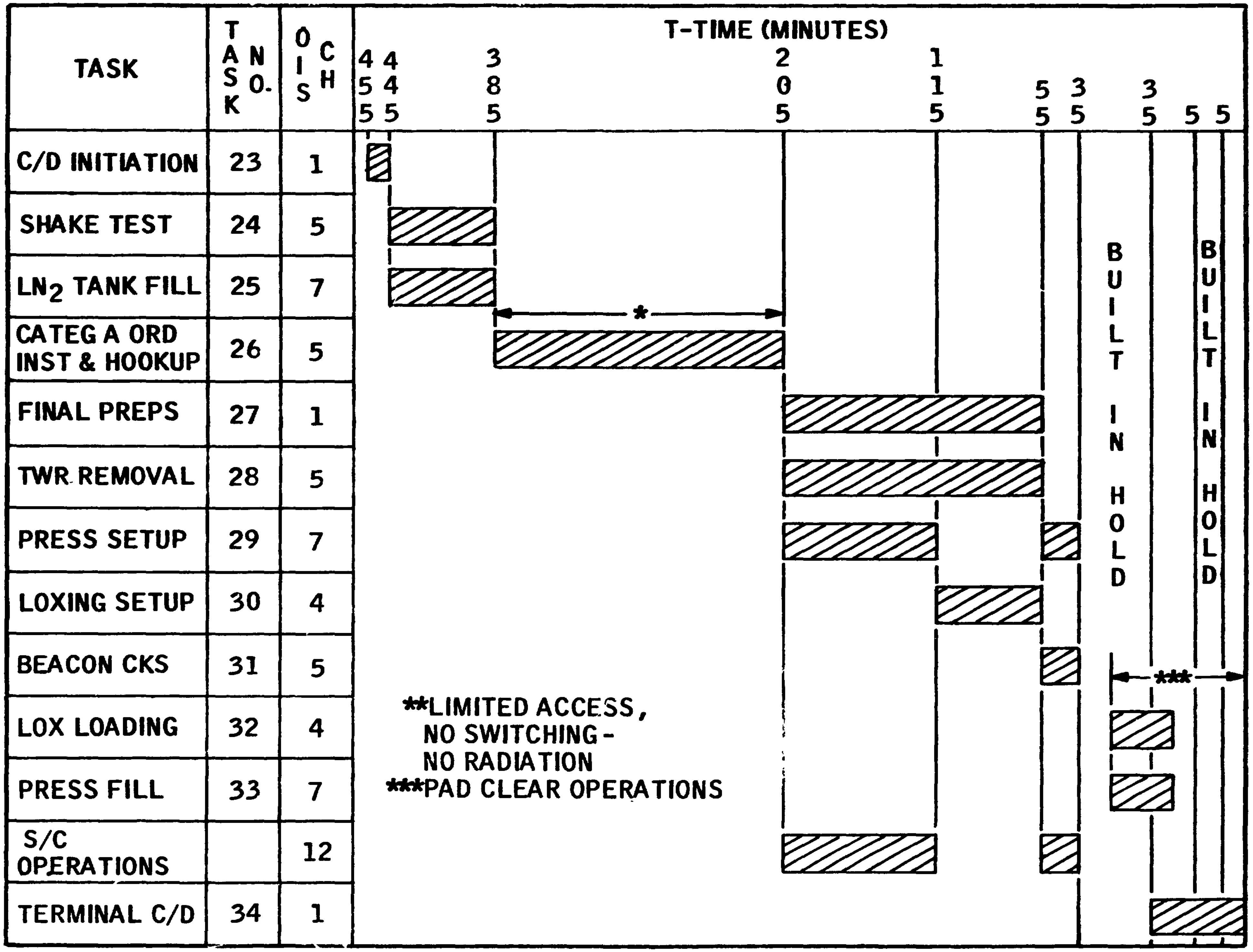

Figure 10. F-0 Day Countdown Tasks