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ATLAS/AGENA-25

APPLICATIONS TECHNOLOGY

SATELLITE-C

OPERATIONS SUMMARY

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MISSION

A. MISSION OBJECTIVES

The primary objective of the Applications Technology Satellite (ATS) program is to research, develop, and flight test the technology that is a common requirement for several satellite applications. To achieve this objective, a number of technological experiments will be flight-tested on board the ATS satellites. These experiments will consist of both spacecraft-oriented and technology-oriented applications.

The spacecraft-oriented experiments will be conducted as part of a continuing program of spacecraft improvement. The results of these experiments are expected to lead to the development of a satellite that has an accuracy of orbit and attitude control sufficient to meet the demands of any payload.

The technology-oriented experiments will be concerned with advancing existing, and developing new, technological space applications. The results of these experiments are expected to lead directly to hardware and system design information applicable to communications, meteorology, navigation, and related fields.

The ATS-C, a spin-stabilized spacecraft, is the third spacecraft that NASA will launch as part of the ATS program. The spacecraft design and mission of the ATS-C are similar to that of the ATS-1 spacecraft, except that the ATS-C will be placed in a synchronous equatorial orbit over the Atlantic Ocean at approximately 47° west longitude. The spacecraft oriented experiments on-board the ATS-C are expected to provide the following information:

1 Performance and life of the spacecraft power supply and control systems

2 Geodetic data that will improve knowledge of the location of the stable points of a stationary orbit

3 Suitability of low-thrust reaction control systems for stationkeeping

4 Performance and life of a mechanically-despun, earth-oriented antenna system

5 Durability in space of specularly reflective surface materials applicable to the design of spacecraft solar-power supply systems and other reflective optical systems

6 Performance of a self-contained spacecraft navigation system

7 Performance of a sensor for providing three-axis attitude data

The spacecraft is expected to yield the following information from its technology-oriented microwave and VHF communications and meteorology experiments:

1 Performance and life of the communications transponder components

2 Improved range and range rate measurements

3 Multiple-access capabilities of an SSB/FM system

4 Evaluation of data collection and distribution via synchronous spacecraft

5 Communications with aircraft

6 Data on radio propagation through the atmosphere under 10 ghz

7 The nature of short-lived meteorological phenomena from continuous observation of the earth disc

8 The movement, development, time variation and effects of clouds and associated meteorological data

9 Observations from an earth-oriented synchronous spacecraft with higher resolution cameras having three-color capability

10 The performance of a synchronous spacecraft as a signal relay point between a control center and remotely deployed electronic platforms

The experiments on board the spacecraft are as follows:

1 Sylvania Corporation - Mechanical despun antenna

2 Hughes Aircraft - Multicolor spin-scan cloud camera

3 Hughes Aircraft - VHF repeater

4 ITT Industrial Laboratories - Image dissector camera

5 Control Data Corporation - Self-contained navigational system (SCNS)

6 Electro-Optical Systems - Reflectometer

7 Hughes Aircraft - Third harmonic generator

8 Avco Corporation - Resisto jet

The ATS Ground Stations will participate in the following experiments:

1 Ground-to-air communications beyond the station-to-plane line of sight

2 Rosman will participate in the Omega Position Location Equipment (OPLE) experiment

3 VHF propagation experiments

4 Range and range rate

5 Telemetry and command calibration

6 Multiple-access telephone relay systems

7 Color television

TOOMBA will not participate unless the spacecraft is moved within the stations visibility range.

B. LAUNCH VEHICLE AND SPACECRAFT DESCRIPTION

1. Launch Vehicle. The spacecraft will be placed into orbit by a two-stage launch vehicle, ATLAS/AGENA No. 25.

The first stage of the launch vehicle is a General Dynamics/Convair (GD/C) ATLAS booster which is approximately 70 feet in length and 10 feet in diameter. Maximum overall width of the ATLAS across the flared engine nacelles is 16 feet. Propulsion of the ATLAS is provided by an MA-5 Rocketdyne engine group consisting of a booster engine with two thrust chambers, a sustainer engine, and two vernier engines. All are single-start, fixed thrust, liquid propellant engines which provide a combined thrust of 388,340 pounds. Liquid oxygen and RP-1 are used as propellants. Guidance is provided by the ATLAS flight control subsystem and a General Electric (GE) Mod III ground-based radio command system operating in conjunction with a Burroughs ground-based computer. Velocity and position computations performed by the computer provide the necessary vehicle guidance commands.

The second stage is a Lockheed Missiles and Space Company (LMSC) AGENA which is approximately 23 feet in length and 5 feet in diameter. Propulsion for the AGENA is provided by a Bell Aerospace Company liquid propellant engine. The engine uses Unsymmetrical Dimethylhydrazine (UDMH) as fuel and Inhibited Red Fuming Nitric Acid (IRFNA) as the oxidizer to generate a thrust of 16,000 pounds with a burn time of approximately 240 seconds in either one continuous burn or two separate burns. AGENA guidance is provided by a preprogrammed autopilot system using horizon sensors and a velocity meter cutoff.

2. Spacecraft. The Applications Technology Satellite (figure 1) has been designed to provide a relatively large, adaptable payload capable of achieving long life in circular, medium altitude orbit or in synchronous, equatorial orbit. Spin stabilization is used for vehicle orientation in the synchronous orbit.

The primary structure is composed of two main subassemblies, the aft structure assembly and the center structure assembly. The aft assembly is composed of a circular thrust tube, 13 inches long and 29 inches in diameter, an intermediate bulkhead aft ring frame, and eight radial ribs. The center structure includes a sheet metal center thrust tube, 19 inches long and 29 inches in diameter, eight machined hat section longitudinal members, and 16 sheet aluminum longitudinal stiffeners. An annular ring honeycomb shelf attaches by screws to the forward end of the center thrust tube. The shelf provides a mounting surface for electronic units. The outer edge of the shelf is longitudinally supported by eight struts extending from the outboard corner of the ribs.

The following systems are contained in the ATS spacecraft:

a. Thermal Control System. Thermal control of the spacecraft relies completely on the passive balance of energy incident from the sun on the spacecraft and reradiation of IR energy to space.

b. Reaction Control System. Three types of reaction control systems are used to satisfy the mission requirements of ATS-C. A cold gas nitrogen system is used for spinup after separation from the AGENA. A hydrogen peroxide system and a hydrazine system are used for initial longitude positioning, inclination and eccentricity adjustments, and stationkeeping.

(1) Nitrogen System. Freebody spinup of the spacecraft is accomplished through blowdown of a gaseous nitrogen system into a pair of tangentially located nozzles which are placed in a plane near the spacecraft center of gravity. A maximum design system pressure of 3450 psia is available for spinup with a liftoff pressure of approximately 2350 psia currently planned to achieve a spin speed of 90 rpm. Final pressure depends directly on the final roll moment of inertia and will be adjusted accordingly.

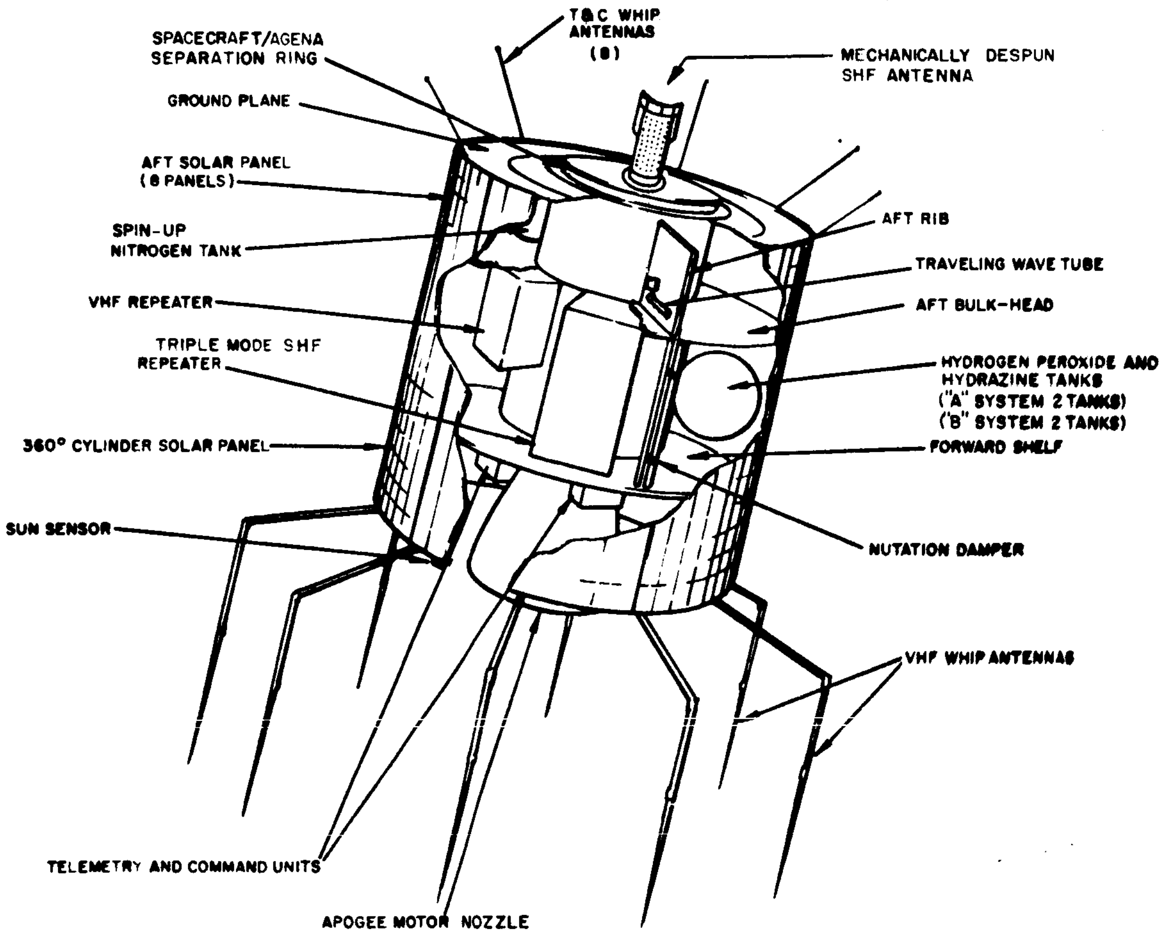


Figure 1. ATS-C Spacecraft

A squib valve opens after the spacecraft separates from the AGENA interstage to start the blowdown mode. The squib firing signal is provided by the spacecraft command regulators through microswitches attached to the spacecraft at the separation plane. Symmetrical plumbing to the nozzles is used to provide a reasonably pure spinup couple. Peak thrust of the system is 60 pounds through a nozzle of about 0.19 inch with blowdown to 5 percent of initial thrust in a nominal 16 seconds.

(2) Hydrogen Peroxide (H_2O_2) System. The H_2O_2 system has four tanks and is capable of providing a velocity increment of approximately 544 fps to a spacecraft weighing 800 pounds initially. Dry weight of the system is 32.5 pounds and the system is loaded with 88 pounds of 90 percent H_2O_2. The tanks, which are approximately 58 percent full of propellant, are then pressurized with nitrogen to 200 psia at 70°F. The system, using jets delivering 5.0 to 2.5 pounds of thrust (at 200 and 100 psia), are expected to control the spacecraft in an orbital environment for at least three years. This system is identical to the one flown on ATS-B.

(3) Hydrazine System. The hydrazine system is actually a reworked configuration of the smaller of the two H_2O_2 systems which were on board the ATS-B spacecraft. The system pressure budget will be identical to the peroxide system. The propellant is lighter than hydrogen peroxide which allows an additional amount of hydrazine to be loaded and still stay within the mechanical design constraints of the tankage. Under these conditions the loaded weight of hydrazine is 36.5 pounds versus 44 for peroxide. (This reworked system utilizes the two tanks of the original smaller H_2O_2 system.) Assuming a 50 percent pulse and 50 percent steady-stage duty cycle for both propellants, the total impulse calculates to be 8000 for hydrazine versus 6670 for peroxide This provides approximately a 328 fps velocity increment for hydrazine compared to 272 fps for peroxide and a weight saving of almost 9 pounds. The basic system operation and command logic are identical to that of the peroxide system. The system is loaded with 97 to 98 percent anhydrous hydrazine and the tanks are pressurized with gaseous nitrogen to 200 psia.

c. Communications System. The communications subsystem is designed to receive frequencies in the 6 ghz band and transmit at frequencies in the 4 ghz band. Receiving and transmitting antennas and traveling wave tube power amplifiers are utilized in conjunction with two triple-mode repeaters. A bandwidth of 25 mhz is available for each repeater output.

d. Telemetry and Command Subsystem. The command portion of the telemetry and command subsystem consists of two command receivers, two command decoders, and two command regulators. The receivers and decoders are cross-strapped so that each receiver can operate with each decoder.

Commands are transmitted to the spacecraft at a frequency of approximately 150 mhz in Goddard Space Flight Center FSK standard format using 8 bits for command address and another 8 bits for the command. The command subsystem provides capability for 255 redundant commands. In addition to the primary FSK mode, a secondary count mode is provided as a backup. In the count mode a command can be sent by pulsing either the one tone or zero tone.

The telemetry portion of the telemetry and command subsystem consists of two transmitters, two Pulse Code Modulation (PCM) encoders, signal conditioning units, and two regulators. One of the transmitters operates at 136.470 mhz and the other operates at 137.350 mhz. The two transmitters are cross strapped with the two PCM encoders.

e. Electrical Power System. In the ATS spacecraft N-on-P silicon solar cells provide the primary source of electrical energy while nickel-cadmium batteries provide power during transient loads and solar eclipse. The solar array and batteries are divided into two solar array battery subsystems which can be combined into one bus on command. Each main solar array directly powers an unregulated spacecraft bus whose voltage range is maintained between -32.5 and -24.5 volts. The upper limit is maintained by the bus voltage limiters and the lower by the battery discharge control circuit. Each battery is charged directly by a small solar cell battery charge array which provides the required charge voltage and also acts as a battery charge current limiter. The bus relay will automatically unparallel the two buses whenever the bus voltage fa ls below a nominal of -22 volts. Current sensors provide the telemetry system with measurements of bus currents and the battery charge/discharge currents. The initial power available in ATS-C is 175 watts.

f. AGENA Adapter. The purpose of the adapter is to provide a physical and functional link between the spacecraft and the booster. Lateral and longitudinal loads, plus bending moments induced by the spacecraft, are transferred by the adapter to the booster structure.

h. Shroud. The standard AGENA clamshell shroud used on ATS-A and B will be used for ATS-C. The shroud consists of a cylindrical section approximately 135 inches long and 65 inches in diameter; a 15-degree, half-angle cone approximately 90 inches long; and 12-inch radius nose dome. The main structural member is the shroud skin, 0.130 inch thick phenolic fiberglass laminate, stiffened with internal rings. The shroud is made of two halves that join and separate along the longitudinal axis. Separation is effected in clamshell fashion to eject the shroud from the vehicle.

C. MISSION PLAN

1. Launch Opportunities. The ATS-C is not confined to a specified number of calendar days and therefore has an indefinite number of launch opportunities. The window for any given day is 90 minutes in duration and will open at approximately 1840 EST during the October/November, 1967 period.

2. Winds.

a. Surface Winds. The maximum allowable recorded surface winds for the ATS vehicle with the service tower removed are listed in table 1. Maximum winds indicated are for an anemometer height of approximately 90 feet above ground and will vary with lox tank ullage pressure. Gantry tower replacement must be performed if ground winds exceed the limits listed.

Table 1. Maximum Allowable Surface Winds

Tank Conditions		Wind Velocity Redline (mph)
Fill	Lox Tank Pressure (psig)	
SLV-3 and AGENA empty	4.0	40.0
SLV-3 fueled and AGENA empty	4.0	40.0
SLV-3 full and AGENA empty	4.0	40.0
SLV-3 and AGENA fueled	4.0	40.0
SLV-3 fueled AGENA full	4.0 4.3 min	38.5 40.0

b. Upper-Air Wind Shear. The ATS launch vehicle has upper-air wind shear limitations which are complicated by factors dependent upon amplitude, rate of shear, duration of shear, and air density. LMSC-Sunnyvale (SV) uses a digital computer program that can evaluate these shear limitations versus vehicle bending moment and control capabilities. The computer response serves as the basis for the determination of the GO/NO GO recommendation required for launch. The launch -2 and launch -1 day forecasts, acquired by Rawinsonde technique for the interval from 0-80,000 feet in 2,000-foot increments, will be relayed from Detachment 11, 4th Weather Group, Patrick AFB to the LMSC Off Site Building (OSB) where the data is key punched and transmitted via Type 103A dataphone to the computer operations center, LMSC/SV. FPS-16/Jimsphere wind data balloon soundings will also be taken for the interval, surface to 15.3 km in 25-meter increments with the balloon releases at T-10, T-4.5 and T-3 hours with an additional sounding at T-0. These data will be transmitted from KSC Central Instrumentation Facility (CIF) to the LMSC/SV computer operations center via Type 202A dataphone. The resultant recommendation derived from the computer process is relayed to the flight operations center (SV) and transmitted by datafax and hotline to LMSC Hangar E operations center for relay to the LMSC test conductor and the LeRC launch vehicle system manager. Rawinsonde soundings will also be made on the launch day as backup procedure. Computer recommendations are completed only when requested. The procedure to be used which outlines the data transmission times and sequence of operations should be in accordance with LMSC-A084887-E, NASA Program-ETR Launch Wind Shear Recommendation Procedure, dated March 31, 1967.

3. Launch Vehicle Requirements.

a. ATLAS. The following constraints and criteria apply to the ATLAS vehicle. All subsystems must be certified as flight ready. The MOD III guidance system must be operational at launch. Hold capabilities and redline criteria must be in accordance with the latest revision to GD/C document GDC-69-00717-1, Redline Requirements SLV-3. The telemetry system must be operational in accordance with telemetry ground rules delineated in GD/C document GDC-BKE65-017, Flight Plan and Instrumentation Summary for the ATLAS SLV-3 used for the ATS Program at ETR.

b. AGENA. Landline measurements of subsystem operating parameters will be monitored during the countdown. Deviations from the limits, as stated in the latest revision of LMSC document A832826, NASA/AGENA Program Launch and Hold Limitations for ATS Program AGENA Vehicles, will be cause for holding the countdown to investigate the discrepancy.

4. Spacecraft Requirements. All spacecraft subsystems must be functioning properly prior to launch as required by the operational parameters of the F-0 day countdown. In addition, spacecraft telemetry required for the conduct of inflight operations must be in an operational status at the time of launch.

5. Tracking and Telemetry Coverage Requirements for Launch. Verification of mandatory tracking and telemetry coverage and Range station capability is required before liftoff, to verify achievement of the primary flight objectives. The requirements outlined in this section, in accordance with the class categories presented below, define the conditions necessary to prepare a launch decision.

Class I requirements reflect the minimum essential needs to assure accomplishment of primary test objectives. These mandatory requirements, if not met, may result in a decision to delay the launch attempt. Class II requirements define the needs to accomplish and/or verify all stated test objectives.

a. Class I Range Tracking Coverage

1 AGENA C-band radar tracking from liftoff to AGENA first burn cutoff plus 10 seconds and 60 seconds of continuous tracking between AGENA first cutoff and second ignition (performance)

2 GE guidance radar tracking data from liftoff to ATLAS/AGENA separation (real time guidance and Range safety)

3 Any 60 seconds of continuous tracking between AGENA second cutoff and ATS separation

4 Any 60 seconds of continuous tracking after completion of AGENA second yaw maneuver

b. Class II Range Tracking Coverage. From 60 seconds prior to AGENA second ignition to battery depletion.

c. Class I Range Telemetry Coverage.

1 ATLAS telemetry from T-7 minutes through ATLAS/AGENA separation

2 AGENA telemetry from T-7 minutes to AGENA first cutoff plus 25 seconds

3 AGENA telemetry from AGENA second ignition minus 20 seconds to completion of AGENA second yaw maneuver plus 10 seconds

d. Class II Range Telemetry Coverage. Recordings are desired from AOS to LOS by the stations supporting the class I coverage requirements. However, the launch vehicle system does not require support, nor should the vehicle requirements be used as justification for support of any other station over which the AGENA may pass.

6. Flight Plan. The ATLAS/AGENA No. 25 launch vehicle will be launched from Complex 12 of the ETR on a fixed launch azimuth of 90 degrees and will place the AGENA and the ATS spacecraft into a 100 nautical mile circular parking orbit. After the correct coast period, the AGENA second burn will inject the ATS spacecraft into the desired trajectory. After cut-off of the second AGENA burn, the AGENA guidance

package will program a pitch-up maneuver of approximately 10 degrees and a yaw maneuver of approximately 53 degrees to the left of the flight path. These two maneuvers will prealign the apogee motor thrust axis (spacecraft spin axis) prior to spacecraft separation from the expended AGENA stage. The spacecraft will be separated and spun up to approximately 90-rpm approximately 1.5 seconds after separation.

As it traverses the transfer orbit, the spacecraft will maintain the spin-axis attitude established by the AGENA guidance system prior to separation. This should be the correct attitude for an apogee motor thrust that will simultaneously accelerate the spacecraft to circular synchronous velocity and remove the spacecraft inclination when the spacecraft reaches apogee at the stationary orbit radius. A near real time attitude determination will be made prior to the apogee motor firing. If the spacecraft attitude is in error for the proper apogee motor velocity vector, the reaction control system will be exercised by ground control to correct this error.

The apogee motor will be fired at second apogee which nominally will occur approximately 16 hours after liftoff. A nominal sequence of flight events is listed in table 2.

D. POST INJECTION OPERATIONS

Following spacecraft injection Tananarive, Republic of Malagasy (MADGAR) will read spacecraft telemetry and determine if spin-up has occurred. If spin-up has not occurred, Toowoomba, Australia, (TOOMBA) will be advised to command spin-up.

TOOMBA, MOJAVE (California), and ROSMAN (North Carolina) will read telemetry and determine spin axis orientation and command any necessary reorientation for apogee motor firing.

GSFC ATS Operations Control Center (ATSOCC) will compute the orbit and determine apogee motor firing time. GSFC ATSOCC will command apogee motor firing from the ATS network.

GSFC will determine the spacecraft orbit and make necessary adjustments for a synchronous orbit. GSFC will then reorient the spacecraft spin axis perpendicular to the orbital plane.

Table 2. Nominal Sequence of Flight Events

Event	T+Sec	Min:Sec	Initiated by
Liftoff	T+0	00:00	2-inch rise switch
Start roll program	T+2	00:02	ATLAS programmer
Start booster pitch program	T+15	00:15	ATLAS programmer
Enable guidance steering	T+80	01:20	ATLAS guidance discrete
BECO	T+129.5	02:09.5	ATLAS programmer
Jettison booster	T+132.5	02:12.5	ATLAS programmer
GE steering enable	T+138.5	02:18.5	ATLAS guidance discrete
SECO	T+291.22	04:51.22	ATLAS guidance discrete
Start AGENA sequence timer*	T+295.4	04:95.4	ATLAS guidance discrete
VECO	T+311.01	05:11.01	ATLAS guidance discrete
ATLAS/AGENA separation	T+315.5	05:15.5	ATLAS guidance discrete
AGENA first burn ignition*	T+367.5	06:07.5	AGENA D-timer
Jettison nose shroud*	T+376.4	06:16.4	AGENA D-timer
AGENA first burn cutoff*	T+527.77	08:47.77	Velocity meter
Start auxiliary timer*	T+758.4	12:38.4	AGENA D-timer
Stop sequence timer, TLM and beacon OFF*	T+760.4	12:40.4	AGENA auxiliary timer
Restart sequence timer, TLM OFF, beacon ON*	T+1327.4	22:07.4	AGENA auxiliary timer
TLM ON*	T+1332.4	22:12.4	AGENA D-timer
AGENA second burn ignition*	T+1500.5	25:00.5	AGENA D-timer
AGENA second burn cutoff*	T+1578.7	26:18.7	Velocity meter
Pitch maneuver*	T+1666.4	27:46.4	AGENA auxiliary timer
Yaw maneuver*	T+1705.4	28:25.4	AGENA auxiliary timer
Payload separation*	T+1743.4	29:03.4	AGENA D-timer
Remove all power from vehicle except C-band*	T+2118.4	35:18.4	AGENA auxiliary timer

*Times for these events are variable.

SECTION II
LAUNCH OPERATIONS PLAN

A. OPERATIONAL AREAS

1. Blockhouse. All ATS launch vehicle and pad operations during the launch countdown are conducted from the blockhouse at Complex 12 by the launch conductor. Countdown readiness and status of the ATLAS and AGENA stages are the responsibility of the appropriate contractor test conductors. The spacecraft controller in the blockhouse controls spacecraft activities and reports on the countdown readiness and status of the spacecraft to the launch conductor. Overall management of launch operations is the responsibility of the operations and launch director. The test controller functions as the official contact between test personnel and the ETR.

2. Buildings AE and AM. For the ATS mission, major operational areas are located at Building AE (figure 2) and Building AM (figure 3). These operational areas are the Mission Director Center (MDC) (figures 4 and 5), launch vehicle telemetry ground station, and the Systems Test ATS (STATS in Building AM).

a. Mission Director Center. During ATS launch operations launch vehicle activities are monitored by the vehicle project manager in the MDC. From this monitor post he is informed and monitors flight readiness of the vehicle and spacecraft. Appropriate prelaunch and real time launch data are displayed to provide a presentation of vehicle launch and flight progress. The MDC also functions as an operation communications center during the final launch countdown.

The front of the center consists of large illuminated displays. The center of the display contains three plotting boards for displaying doppler, present position, and Instantaneous Impact Plots (IIP). The doppler plot is a real time graph of the (STS). This display when plotted with the theoretical plot gives an excellent overall picture of the launch vehicle's velocity performance.

Other displays include a personnel locator, a list of tracking stations, Range radars used, and a sequence of events after liftoff. Fourteen of the twenty-three consoles in the MDC provide two-way communications with any area associated with the launch.

The following information will be displayed in the MDC during ATS launch operations:

1 Real time vehicle progress (this information is derived from vehicle telemetry)

2 Doppler plot and present position plot

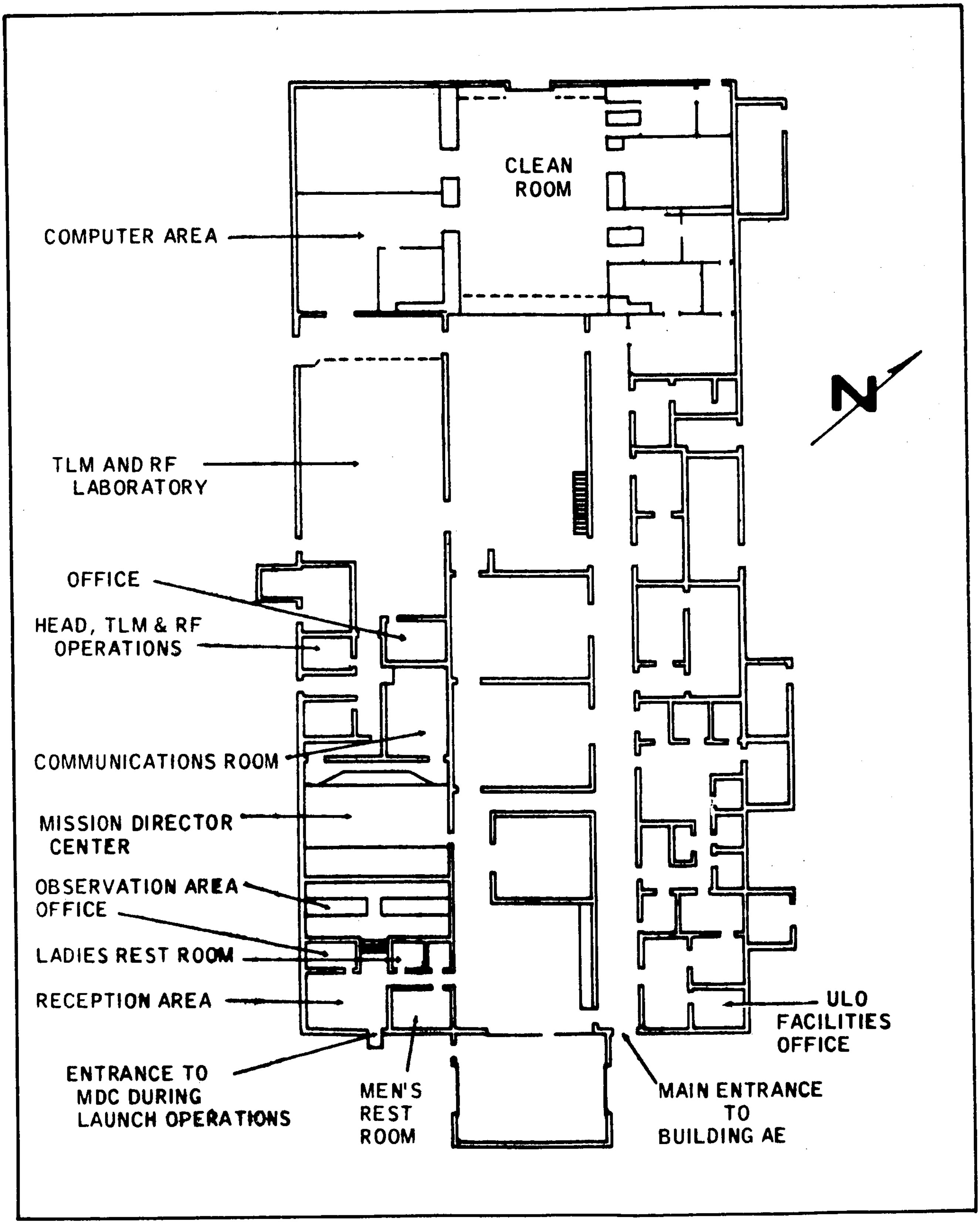
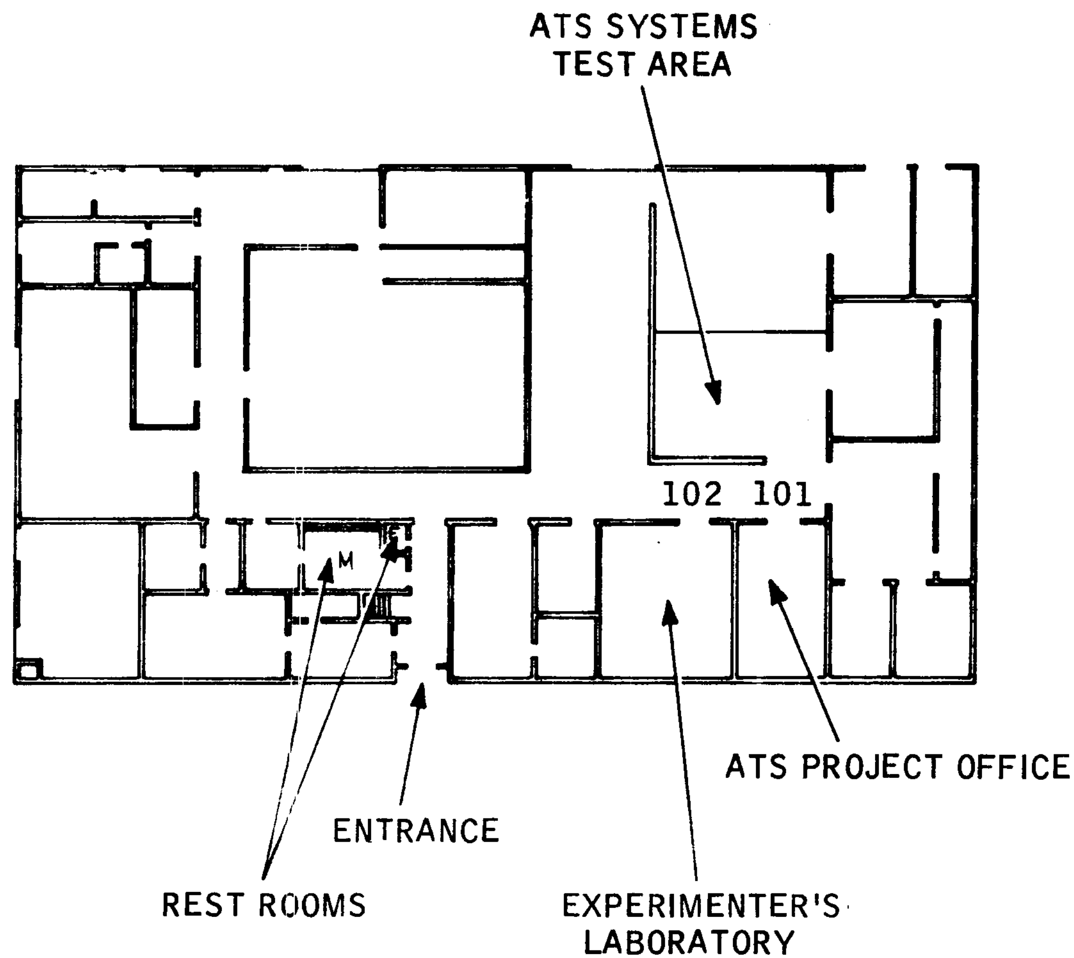


Figure 2. Building AE



BUILDING AM FIRST FLOOR

Figure 3. Building AM

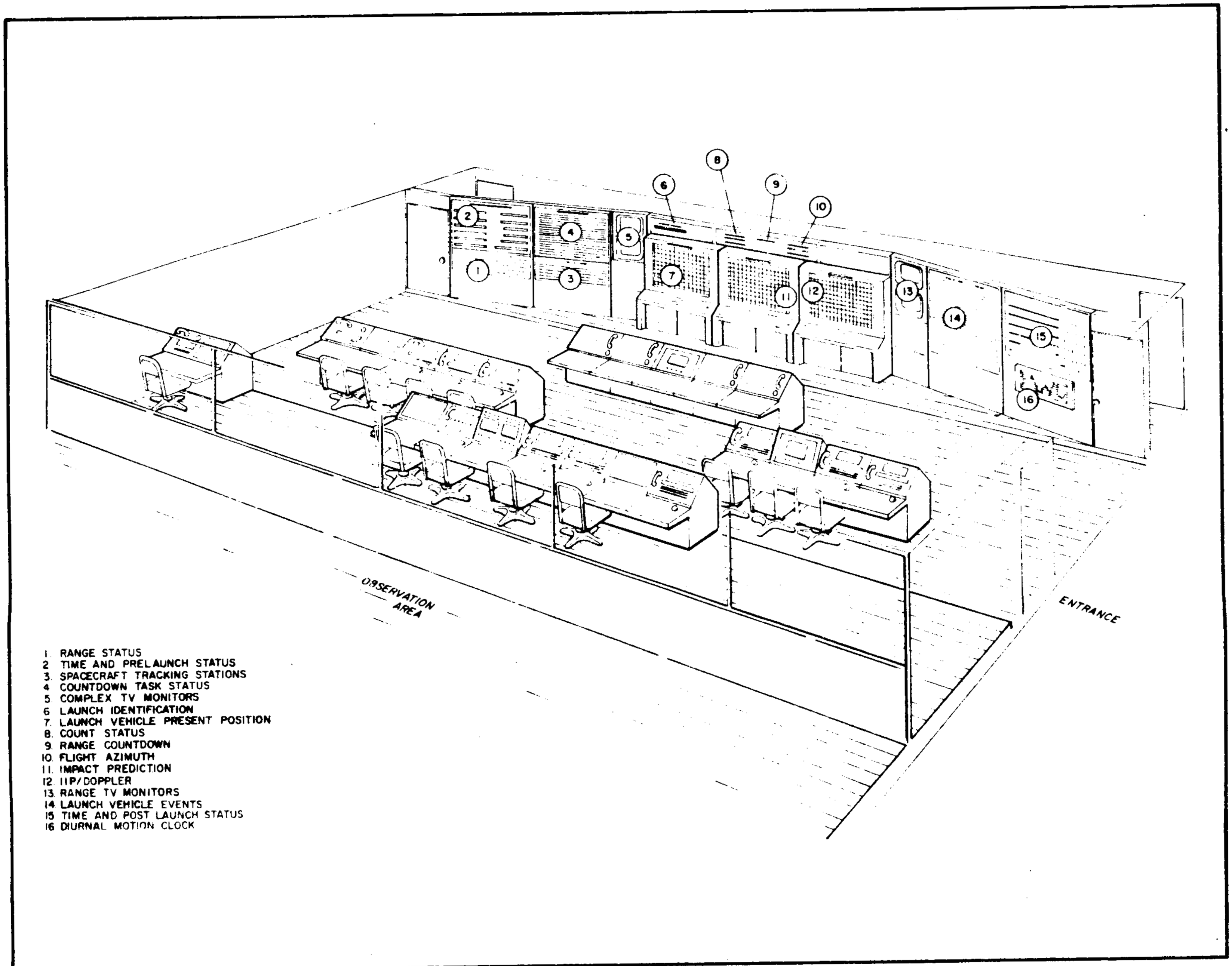
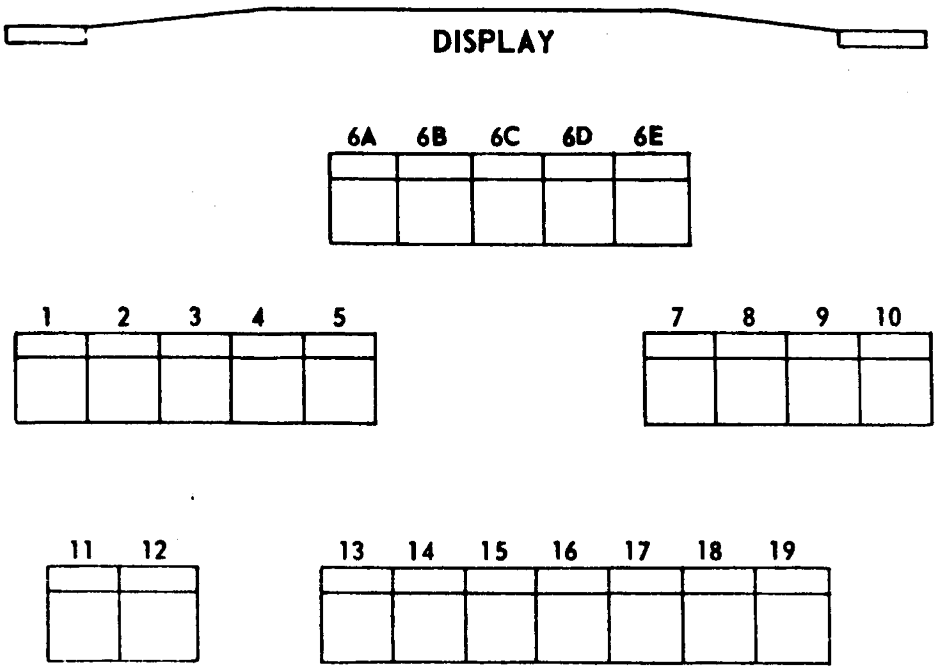


Figure 4. Mission Director Center



1, 2, 3 LAUNCH HISTORIAN
4 OPSCON COMMUNICATOR
5 RANGE COORDINATOR
6A, 6B, 6C, 6D, 6E LeRC PERSONNEL
7 HEADQUARTERS SPACECRAFT MANAGER
8 OPEN
9 HEADQUARTERS VEHICLE MANAGER
10 SPACECRAFT ADVISOR
11 PIO
12 PIO
13 TECHNICAL SUPPORT OPERATIONS MANAGER
14 CENTER MANAGER
15 OPEN
16 MISSION DIRECTOR
17 ASSISTANT MISSION DIRECTOR
18 ULO DEPUTY DIRECTOR
19 LeRC VEHICLE REPRESENTATIVE

Figure 5. Mission Director Center Seating Arrangement

3 Tracking station readiness

4 Range readiness

5 Guidance readiness

6 Flight line and program television

7 Range count

8 Eastern standard time (synchronized to WWV)

9 Greenwich mean time (synchronized to WWV).

The display coordinator monitors communication circuits from outlying data stations in order to display events as they occur.

b. Launch Vehicle Telemetry Ground Station. The launch vehicle telemetry ground station receives, monitors, and records launch vehicle signals during prelaunch checkout to assist in determining vehicle launch readiness. After liftoff, real time analysis of telemetry data will be used to aid in displaying vehicle performance in the MDC.

c. STATS Area. The ATS-C spacecraft countdown will be conducted from the STATS area located in Building AM (room 100) by the spacecraft test conductor and the ATS-C crew. Spacecraft data, received in response to program functions generated by the STATS area, is stored and analyzed to determine the launch readiness and status of the spacecraft.

3. Satellite Tracking Station. The Satellite Tracking Station (STS) will doppler-track the ATS-C launch vehicle from liftoff through loss of signal. The doppler data will be transmitted to Building AE for display and to GSFC in realtime for display in the Operations Control Center (OPSCON). In addition, spacecraft tracking equipment on board a tracking ship will doppler-track the launch vehicle during AGENA second burn and spacecraft separation.

The countdown (Range count) to T-0 minutes will also be transmitted via data phone to GSFC.

4. Range Control Center. Overall management of ETR range support is provided by the Superintendent of Range Operations (SRO) the Range Control Center (RCC). ETR personnel stationed in this facility coordinate Range activities and instrumentation operations required to support ATS launch operations. A ULO project official is stationed at the RCC throughout the launch operation to maintain liaison with range personnel. The ETR Range Safety Officer (RSO) is also located in the RCC.

5. Guided Missile Control Facility No. 1. Prelaunch checkout of the ATLAS radio command guidance system is conducted by the guidance test conductor at Guided Missile Control Facility No. 1 (GMCF 1). After liftoff, during portions of the ATLAS powered flight, present position and velocity information from the GE Mod III Ground Station is compared with programmed trajectory data stored in the Burroughs guidance computer at GMCF 1. If the vehicle is not traveling the desired course, the computer generates guidance commands which are transmitted to the vehicle via the GE Mod III Ground Station.

B. DATA ACQUISITION

Telemetry optical and radar data will be provided by equipment located at Cape Kennedy (ETR Station 1), by ETR downrange instrumentation sites (refer to figure 6), and by the Manned Space Flight Net (MSFN) instrumentation stations during the prelaunch, and injection phases of the ATS mission.

1. Telemetry. During launch operations airborne telemetry data will be acquired by four Cape ground stations in real time and on magnetic tape. During flight, telemetry will be recorded by ETR downrange stations, ships, aircraft, and MSFN stations.

2. Optics.

a. Land Bases.

(1) Metric. Two fixed ribbon frame cameras located on Complex 12 and one on Complex 11 will provide position and time derivatives from liftoff to T+8 seconds. Six cinetheodolites at Station 1 will provide position data and time derivatives from T+8 seconds to T+120 seconds. The cinetheodolites will track from first acquisition to Loss of Vision (LOV). One metric tracking camera will provide relative roll during daylight only from liftoff to T+15 seconds.

(2) Engineering Sequential. Twenty-one fixed engineering sequential cameras will provide coverage from T-4 minutes to T+10 seconds. Five long focal length cameras (ROTI and IGOR) will be tracking from acquisition through LOV. Five tracking engineering sequential cameras will provide coverage from liftoff until LOV.

3. Tracking.

a. AFETR Radar. ETR C-band radars 0.18 Patrick AF Base, 1.16 CKAFS, 19.18 KSC, 3.18 Grand Bahama, 7.18 Grand Turk, 91.18 Antigua, and 13.16 Pretoria, will use beacon and/or skin track to provide vehicle position and

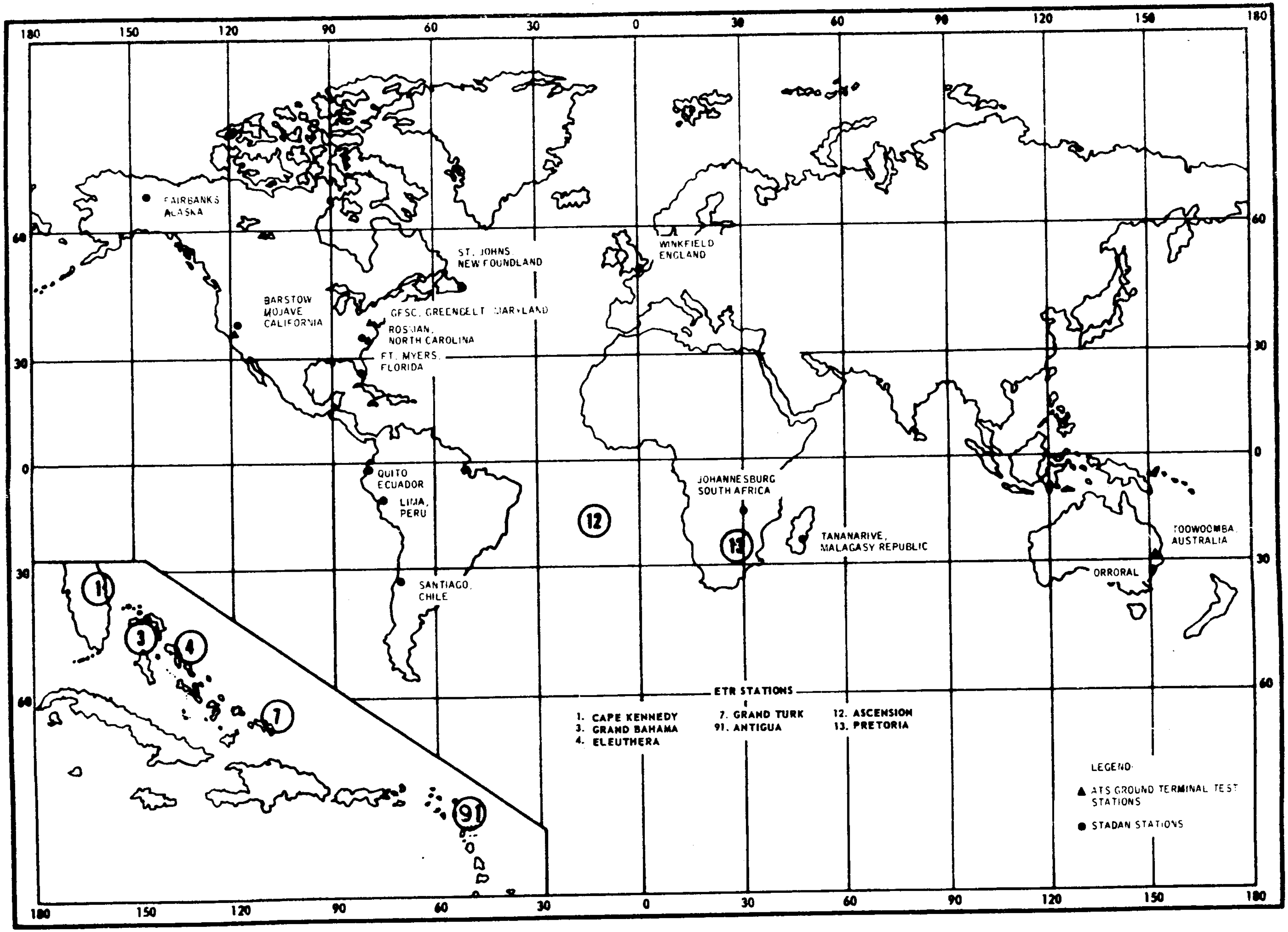


Figure 6. Tracking and Control Stations

velocity information for range safety inputs to the RTCS for determination of powered flight impact prediction and post-test determination of the trajectory. One C-band radar must be in operation at each of the downrange stations and two of the three mainland radars must be in operation. The XX.18 type radars are preferred for those stations having the capability; but the backup XX.16 type radars are acceptable where the station is so equipped.

TheClass I requirement for ETR radars is from AOS through AGENA first burn cutoff plus 10 seconds, any 60 seconds of continuous tracking between AGENA first burn cutoff and second ignition, any 60 seconds of continuous tracking between AGENA second cutoff and ATS separation. In addition, ETR is to provide information during the parking orbit, pre-separation AGENA ignition orbit, and radar tracking data in real time, to the MSFN. In addition, computed acquisition data for selected MSFN stations are provided.

b. Satellite Tracking Station. The ULO STS will track the spacecraft telemetry and provide doppler information for display in the MDC.

c. MSFN Radar. MSFN stations at Bermuda (BDA), Tananarive (TAN), and Carnarvon (CRO) will support the launch. Radar data from ETR stations will be transmitted to Goddard Space Flight Center (GSFC) for computation of acquisition messages to BDA, TAN, and CRO. Bermuda will track the C-band radar beacon from Acquisition of Signal (AOS) to LOS, record, and transmit radar data to GSFC and CKAFS, TAN and CRO will track the beacon from AOS until released by the MSFN network controller and will record and transmit real time radar data to GSFC for computation of orbital parameters of the AGENA. Tananarive is to obtain any 60 seconds of continuous tracking data after AGENA second yaw maneuver.

4. Other Data. A Preliminary Test Report (PTR) will be prepared by the range within 2 hours after test termination.

5. Range Safety. Two video skyscreens will provide flight line and program deviation information to the Range Safety Officer (RSO) at his console. These presentations are also remoted to the MDC. A wire skyscreen will be used to obtain program deviations. The electronic mobile telemetry receiving vans (Tel-ELSSE) will operate using the 244.3 mc AGENA telemetry link. A chart presentation of flight deviation will be provided to the RSO.

C. METEOROLOGICAL PLAN

Arrangements have been made for LMSC-ETR to receive forecast and upper-wind data directly from CKAFS Weather Station for transmittal to LMSC-SV and LeRC. The AGENA Missions Office (AMO) will provide forecast and upper-air wind data on F-3, F-2, and F-1 days to the Manager, ATLAS/AGENA Operations. The AMO representative will provide weather information to project and operations personnel on OIS Channel 17 or green phone as received.

1. Forecasts. Weather Warning (WW) notifications will be made when surface winds are forecast to exceed 35 knots steady state or in gusts, or electrical storm activity is expected within 5 nautical miles of Complex 12. All WW forecasts will be telephoned to the blockhouse monitor.

2. Long Range. A forecast will be provided by 1600Z on F-3 day of the general surface conditions for the Cape Kennedy area, valid for T-0.

3. Planning. A forecast will be provided by 1600Z on F-2 day of surface conditions and upper-air winds for the Cape Kennedy area, valid for T-0. The forecast of surface conditions will include wind direction and speed, pressure, temperature, humidity, cloud cover, ceiling visibility, and precipitation. The upper-air wind forecast will predict the direction and speed for each 2,000 feet from the surface to 80,000 feet.

4. Operational. By 1600Z on F-1 day, the forecast issued on F-2 day will be modified or confirmed. At T-8.5, -3.5, and -1.5 hours, the Assistant Staff Meteorologist (ASM) will provide to the AMO representative comments on any conditions that might affect the launch.

5. Observations. Routine surface observations will be made at hourly intervals from T-12 hours to T+1 hour, and the wind speed and direction at Complex 12 will be recorded from T-6 hours through T-0.

a. Tabulated upper-air wind data from the ETR Rawinsonde system will be provided LMSC-ETR at T-8.5, T-3.0, T-1.5, and T+1.5 hours. These data will be transferred to cards and transmitted via data phone from the LMSC off-site building to LMSC-SV for computation of shear and bending moment information.

b. At T-10, T-4.5, T-3, and T-0 hours, a C-band radar will track a Jimsphere balloon to approximately a 15.3 kilometer altitude. Data from the radar will be transmitted to the CIF Building at KSC for reduction to card format. Data phone circuits will be used to transmit card data to LMSC-SV and Lewis Research Center (LeRC). This data will also be used to compute the shear and bending moment information. Computers at LeRC and LMSC-SV will provide information from which a GO/NO-GO determination can be made based on the shear and bending moment analysis. The GO/NO-GO data will be provided to LeRC representatives in the MDC by telephone and datafax.

6. Minima. Ceiling and visibility minima will be as prescribed by range safety. Upper-air wind shear limitations which depend on shear amplitude, rate, duration, and air density will be evaluated as indicated above.

7. Consultation Services. The ETR weather station will provide consultation services as requested by the AMO representative in the RCC.

SECTION III
COMMUNICATIONS

A. GENERAL

The ATS communications facilities which will be available for support of this mission are described in this section. These facilities will be used for prelaunch operations and early postflight intercommunications. The communications center will be located in the MDC, Building AE.

B. MISSION DIRECTOR CENTER

The consoles in the MDC provide the assigned MDC personnel with the communications systems required to monitor and participate in vehicle and mission progress. The center's communications facilities provide the means for communicating with Cape stations (blockhouse, STS, range central control), downrange stations, NASA Headquarters, GSFC, and the worldwide tracking stations. Communications systems available at the consoles in the MDC are described below.

1. Administrative. The black telephones used in this system are special dial phones installed in the consoles and enable MDC personnel to place or receive local and long distance calls. Individuals assigned to consoles may establish, listen to, or participate in conference calls on the black telephone system.

2. Green Telephone System. The ETR green phone system utilizes manually operated key panels at each console, limiting the number of users. This provides rapid, direct communications between all sites participating in this launch operation. The key cabinets provided for this system have both visual and audible signaling. The system has standby batteries to prevent its becoming incapacitated by commercial power failure. Table 3 shows the green telephone network for ATS launch operations.

3. Station Conferencing and Monitor Arrangement (SCAMA) Telephone System. The SCAMA telephones provide direct dialing contact with the GSFC SCAMA switchboard at Greenbelt, Maryland, for instantaneous long distance communications with the NASA global satellite tracking networks. SCAMA, originally designed to support the manned spacecraft network, has been extended to include the STADAN network (formerly called Minitrack), and the Deep Space Instrumentation Facilities (DSIF). SCAMA can now link any combination of 51 communications points in NASA's global satellite tracking networks.

4. Operational Intercommunications System (OIS). The OIS is a range intercom system which operates on a channel select basis rather than on an individual station-to-station basis. (This system was formerly called the MOPS network and most consoles still display that designation. The designation MOPS and OIS are synonymous.) All related operating positions, such as those for telemetry, are connected in parallel and

Table 3. Green Telephone Network

	Building AE, Room 125	Building AE, Room 109A	Hangar J, TLM Lab.	BH 12 Water Panel	Pumphouse 4	BH 12 Advisor Console	SRO	GMCF 1, ULO Rep.	GMCF 1, GE TC	Burroughs TC	CKAFS Coord. (GSFC) RCC	ULO Proj. Console RCC	Hangar E, Room 107	AF Weather Off. RCC	Hangar E, TLM Room 108	STS	RCC, 098D Proj. Cons.	RCC, Dir. Range Opns.	RCC, CNC Cons.	RCC, RCO Cons.
Building AE, Room 125		x	x			x						x			x					
Building AE, Room 109A	x					x					x	x	x			x				
Hangar J, TLM Lab.	x																			
BH 12 Water Panel					x															
Pumphouse 4				x																
BH 12 Advisor Console	x	x					x	x				x				x				
SRO						x			x			x				x				
GMCF 1, ULO Rep.						x														
GMCF 1, GE TC							x			x										
Burroughs TC									x											
CKAFS Coord.(GSFC)RCC												x								
ULO Proj. Console RCC	x	x				x	x				x		x	x		x		x		
Hangar E, Room 107		x										x					x			
AF Weather Off. RCC												x								
Hangar E, TLM Room 108	x																			
STS		x				x	x					x								
RCC, 098D Proj. Cons.													x							
RCC, Dir. Range Opns.												x								
RCC, CNC Cons.																				x
RCC, RCO Cons.																			x	

the end instruments may communicate only with the channels to which connected. Rotary selector switches are used to select the desired channel on all end instruments except those on consoles which use key switches. 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 that same channel.

During the ATS launches, various operations are assigned specific OIS channels. 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. Table 4 shows the OIS system.

Additional range user OIS circuits for the ATS launch are as follows:

MSFN conf. net	-CNC (monitor only)
MSFN status net	-CNC

5. Leased Voice Circuits. Eight NASCOM voice circuits are used for voice communications in support of launch operations. The leased voice circuits are as follows:

1 SCAMA - Launch status

2 LL-1 - Project manager

3 LL-2 - Mission control

4 LL-3 - Spacecraft operations

5 LL-4 - Launch vehicle

6 LL-5 - Project scientist

7 260 - Headquarters launch vehicle loop

8 261 - Headquarters spacecraft loop

6. Post Liftoff Channels.

a. Channel 1. After liftoff, flight performance data will be summarized in real time at the MDC on this channel.

b. Channel 5. This channel will be used for a telemetry commentary from Building AE.

Table 4. OIS System

Blockhouse 12 Channel Assignment		Blockhouse 12	Service Structure	Umbilical Tower	Pad Area	Launch Pad Bldg.	Hangar E	Tel-4	Hangar J	Hangar H	GMCF 1	RCC-SRO	RCC Proj. Rep.	RCC IIP Board	Hangar AE Rm. 109	NASA Tlr. Complex 12	Hangar K	RCC-CNC	Burroughs	DCT E and A Bldg.	Building AM
		Console and Location																			
Launch Conductor	1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
GD/C TC	2	x	x	x	x	x	x		x	x	x				x	x	x			x	x
GD/C Propulsion	3	x	x		x										x	x				x	
SRO	4	x										x	x		x						
GD/C RF System	5	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x		x	x
GD/C Autopilot	6	x	x		x										x	x				x	
GD/C Guidance	7	x	x		x	x	x		x		x	x			x	x				x	x
LMSC TC	8	x	x	x	x	x	x	x							x	x					x
GD/C Landline	9	x	x		x										x	x					
Complex Facilities	10	x	x	x	x	x									x	x					
Test Stand Operations	11	x	x		x	x									x	x					
LMSC Test Operations	12	x	x	x	x	x	x	x							x	x					
LMSC Propulsion	13	x	x	x	x	x	x								x	x					
LMSC Electrical	14	x	x	x	x	x	x								x	x					
LMSC Guidance	15	x	x	x	x	x	x	x							x	x					
LMSC TLM and Beacon	16	x	x	x	x	x	x	x				x	x		x	x		x			
NASA Engineering	17	x	x		x		x	x			x		x	x	x	x					x
SC TC	18	x	x		x	x									x				x		x
SC Test Operations	19	x	x		x	x									x				x		x
SC Net A	20	x	x		x	x							x		x						x
SC Net B	21	x	x		x	x							x		x						
NTC	22	x											x		x			x			
SC Net C	23	x	x		x	x									x						
Mission Director	24	x											x	x	x	x		x			

c. Channel 16. Liftoff time and mark event times will be called out on this channel by LMSC, SRO, and GSFC.

d. Channel 17. This channel will be used by the range safety monitor for IIP commentary.

SECTION IV
TEST OPERATIONS

The ATLAS/AGENA and spacecraft operations to be performed during the launch countdown are summarized in table 5.

Table 5. F-0 Day Operations

Time (EST)*	Count (Min)	Event
0826	T-550	Spacecraft countdown starts
1026	T-430	Man countdown stations
1031	T-425	Start countdown
1056	T-400	Radiation clearance required Spacecraft checks complete
1116	T-380	AGENA PIV test (L-5)
1121	T-375	AGENA ordnance delivered to pad
1131	T-365	Local RF silence until T-315 Start mechanical installation of vehicle pyrotechnics
1221	T-315	Range countdown starts Ordnance installation complete. RF silence released Start AGENA TLM and beacon checkout
1301	T-275	Range safety command test
1316	T-260	Local RF silence until T-245 Start electrical hookup of pyrotechnics (ATLAS and AGENA)
1331	T-245	Spacecraft ordnance hookup complete
1436	T-180	ATLAS TLM warmup
1440	T-176	Guidance command test No. 1
1451	T-165	All personnel not involved in AGENA tanking clear the pad area and retire to roadblock
1501	T-155	Start AGENA fuel (UDMH) tanking
1521	T-135	AGENA fuel tanking complete Pad area clear for essential work

Table 5. F-0 Day Operations (Cont'd)

Time (EST)*	Count (Min)	Event
1531	T-125	Remove service tower
1556	T-100	Range T-0 pulse checks
1606	T-90	Start AGENA oxidizer (IRFNA) tanking AGENA beacon range calibration check
1631	T-65	AGENA oxidizer tanking complete
1636	T-60	Built-in hold (50 minutes nominal) Clear all private vehicles and nonessential support vehicles from parking and pad area
1726	T-60	Built-in hold ends Start spacecraft terminal countdown VHF TLM systems 1 and 2 ON
1735	T-51	Start guidance command test No. 2
1746	T-40	Start lox tanking
1804	T-22	Start final Range safety committment
1806	T-20	Spacecraft launch configuration is established
1819	T-7	Built-in 10 minute hold
1829	T-7	Built-in hold ends AGENA to internal power Apogee motor squibs are armed
1834	T-2	ATLAS commands to internal
1836	T-0	Launch

*EST times are valid only for expected opening of launch window on November 3, 1967.