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# GEMINI PROGRAM MISSION REPORT

# GEMINI VI-A

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION ☐ MANNED SPACECRAFT CENTER

GEMINI SPACECRAFT FLIGHT HISTORY

| Mission | Description | Launch date | Major accomplishments |
|---|---|---|---|
| GT-1 | Unmanned 64 orbits | Apr. 8, 1964 | Demonstrated structural integrity. |
| GT-2 | Unmanned suborbital | Jan. 19, 1965 | Demonstrated heat protection and systems performance. |
| GT-3 | Manned 3 orbits | Mar. 23, 1965 | Demonstrated manned qualifications of the Gemini spacecraft. |
| Gemini IV | Manned 4 days | June 3, 1965 | Demonstrated EVA and systems performance for 4 days in space. |
| Gemini V | Manned 8 days | Aug. 21, 1965 | Demonstrated long-duration flight, rendezvous radar capability, and rendezvous maneuvers. |
| Gemini VI-A | Manned 2 days | Oct. 25, 1965 | Demonstrated dual countdown procedures (GAATV and GLV-spacecraft), flight performance of TLV and flight readiness of the GATV secondary propulsion system. Mission canceled after GATV failed to achieve orbit. |

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# GEMINI PROGRAM MISSION REPORT

# GEMINI VI-A

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MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

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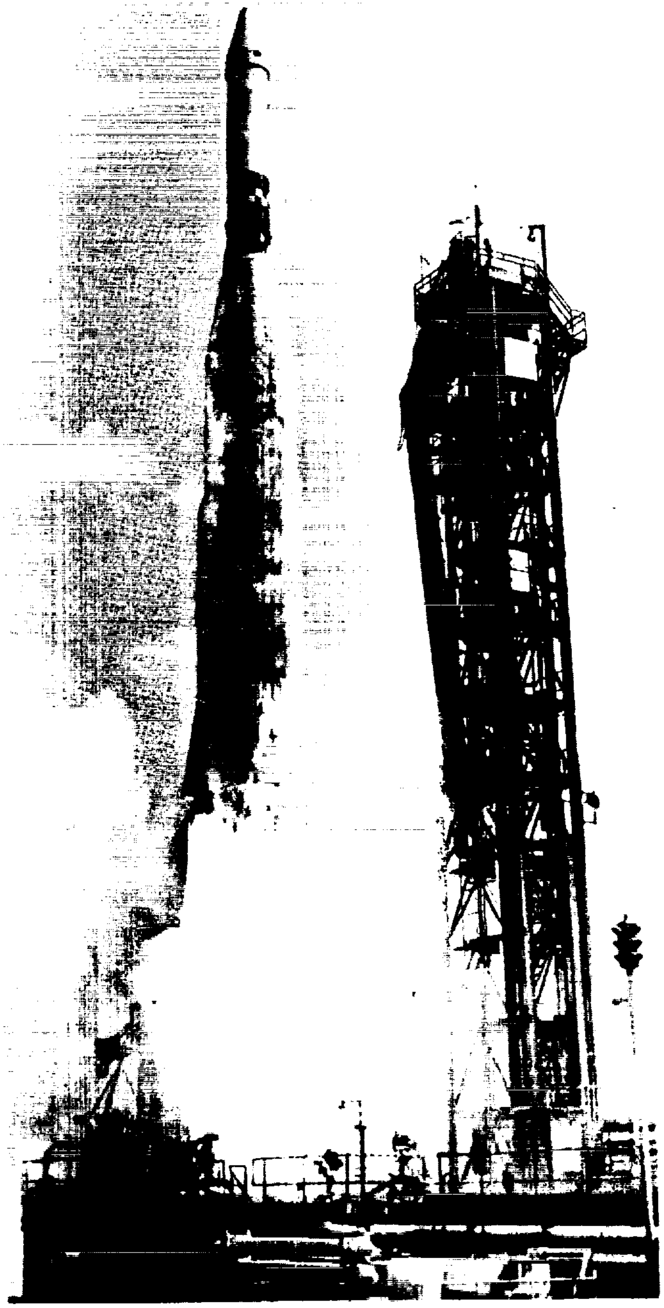

GAATV lift-off.

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## TABLES

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## 1.0 MISSION SUMMARY

The Gemini Atlas Agena target vehicle was launched from Complex 14, Cape Kennedy, Florida, at 9:00:04 a.m. e.s.t., on October 25, 1965. The integrated countdown preceding the launch was satisfactory with no holds, and lift-off occurred approximately 4 seconds after the scheduled time.

The powered-flight phase proceeded normally and all indications were nominal for target launch vehicle booster, sustainer, and vernier engine cut-offs, Gemini Agena target vehicle separation, and secondary propulsion system start until 910 milliseconds after initiation of operation of the primary propulsion system at lift-off (LO) + 367.53 seconds. The primary propulsion system engine shut down at LO + 368.44 seconds, and all telemetry signals, and C-band and S-band radar tracking signals were lost at LO + 375.71 seconds. Although real-time evidence pointed to a propulsion failure and subsequent vehicle breakup, a determination of the exact status of the vehicle could not be made. Consequently, a radar search for the vehicle by the network tracking stations was continued through Carnarvon, Australia. The vehicle was not tracked by Carnarvon and the flight was canceled at approximately 54 minutes ground elapsed time. The Gemini spacecraft was not launched, although the countdown was proceeding normally and the spacecraft and launch vehicle were ready to be launched at the prescribed time to effect the planned rendezvous.

Because of the early termination of this mission and to identify it from other planned missions of the Gemini Program, this mission was designated Gemini VI-A.

All mission objectives established for the Gemini VI mission required the launch of both vehicles; therefore, none of the objectives for the Gemini VI mission were met.

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## 2.0 INTRODUCTION

A description of the Gemini VI-A mission, as well as a discussion of the evaluation results, is contained in this report. The evaluation covers the time from the start of the final countdown of the launch to the end of the mission at approximately 54 minutes ground elapsed time.

This report follows the outline and paragraph numbering system established for all Gemini mission reports; however, areas where no evaluation was conducted because the Gemini spacecraft was not launched are indicated. Detailed discussions are found in the major sections of the report related to each major area of effort. Some redundancy is found in various sections, but this is necessary for a logical discussion of that area.

All available data from both vehicles (target launch vehicle and Gemini Agena target vehicle) were processed. The major emphasis of the evaluation was on the data generated from 367 seconds after lift-off to the loss of telemetry; however, all data were evaluated to verify the nominal performance of the target launch vehicle during the powered-flight phase and the Gemini Agena target vehicle up to 367 seconds after lift-off. Evaluation of the data received during the anomaly was difficult because of the relatively low sample rate of the instrumentation system compared with the dynamic conditions of the vehicle during the few milliseconds in which the anomaly occurred.

Section 6.1, FLIGHT CONTROL, may contain a certain amount of redundancy and some contradictions because the information contained in that section is based upon observations and evaluations made in real time, and consequently the section does not reflect the results obtained from the detailed postflight analysis.

The objectives for the Gemini VI mission, as established by the Gemini VI Mission Directive, are not included in this report because the mission was terminated prior to the launch of the Gemini spacecraft.

The supplemental report listed in section 12.4 will be issued to provide a complete and detailed evaluation of the performance of the Gemini Agena target vehicle. This report will be issued to cover the evaluation of major anomalies which were not resolved at the time of publication of this report.

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# 3.0 VEHICLE DESCRIPTION

The Gemini Atlas Agena target vehicle (GAATV) consisted of the Gemini Agena target vehicle (GATV) and the target launch vehicle (TLV). Figure 3.0-1 shows the major sections of the GAATV and the axis references.

## 3.1 GEMINI SPACECRAFT

This section is not applicable to this report

## 3.2 GEMINI LAUNCH VEHICLE

This section is not applicable to this report

## 3.3 SPACECRAFT WEIGHT AND BALANCE DATA

This section is not applicable to this report

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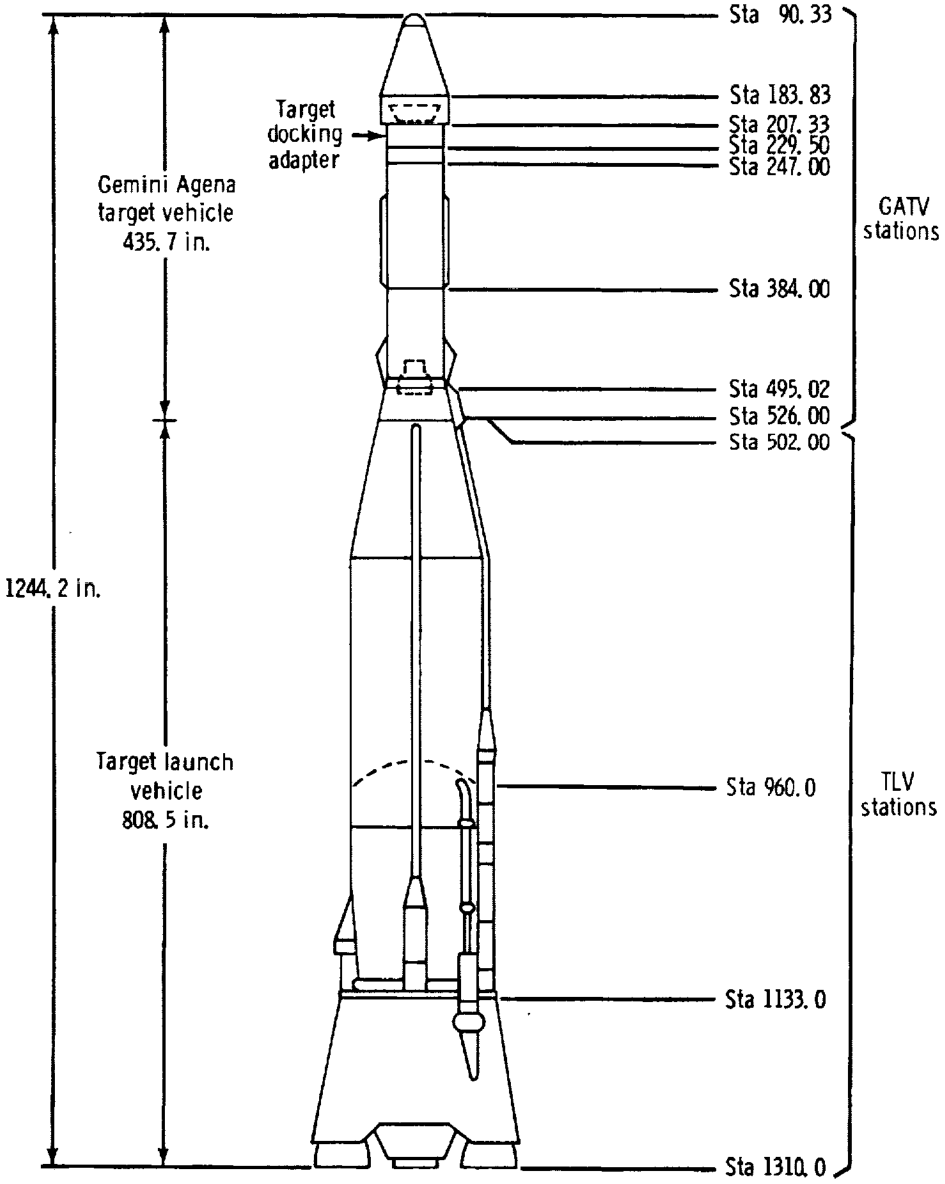
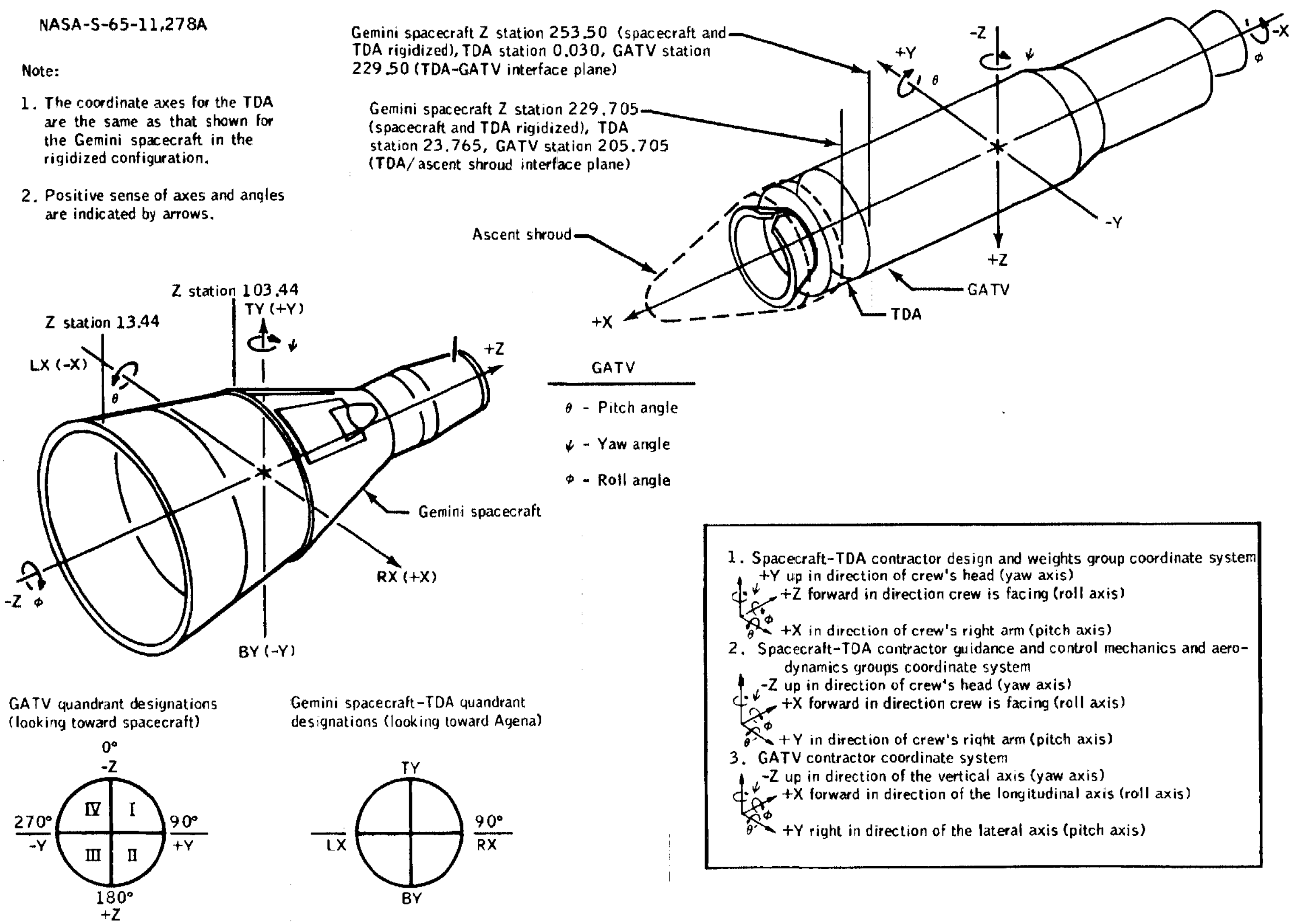


(a) Launch configuration.

Figure 3.0-1. - TLV - GATV relationships.



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Note:

1. The coordinate axes for the TDA are the same as that shown for the Gemini spacecraft in the rigidized configuration.

2. Positive sense of axes and angles are indicated by arrows.

GATV

θ - Pitch angle

ψ - Yaw angle

φ - Roll angle

1. Spacecraft-TDA contractor design and weights group coordinate system
   - +Y up in direction of crew's head (yaw axis)
   - +Z forward in direction crew is facing (roll axis)
   - +X in direction of crew's right arm (pitch axis)
2. Spacecraft-TDA contractor guidance and control mechanics and aerodynamics groups coordinate system
   - -Z up in direction of crew's head (yaw axis)
   - +X forward in direction crew is facing (roll axis)
   - +Y in direction of crew's right arm (pitch axis)
3. GATV contractor coordinate system
   - -Z up in direction of the vertical axis (yaw axis)
   - +X forward in direction of the longitudinal axis (roll axis)
   - +Y right in direction of the lateral axis (pitch axis)

(b) Dimensional axes and guidance coordinates, GATV-TDA.

Figure 3.0-1. - Continued.

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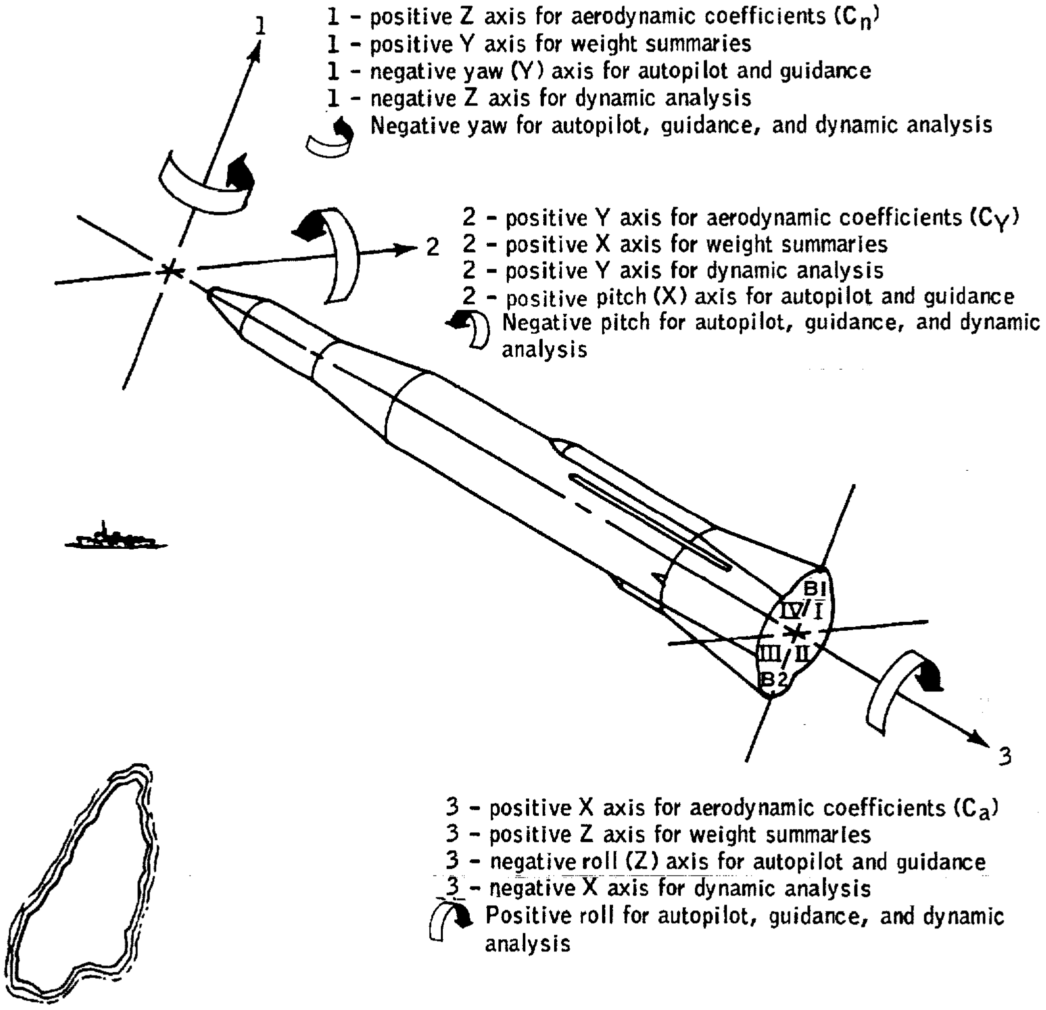

1 - positive Z axis for aerodynamic coefficients ($C_n$)
1 - positive Y axis for weight summaries
1 - negative yaw (Y) axis for autopilot and guidance
1 - negative Z axis for dynamic analysis
Negative yaw for autopilot, guidance, and dynamic analysis

2 - positive Y axis for aerodynamic coefficients ($C_Y$)
2 - positive X axis for weight summaries
2 - positive Y axis for dynamic analysis
2 - positive pitch (X) axis for autopilot and guidance
Negative pitch for autopilot, guidance, and dynamic analysis

3 - positive X axis for aerodynamic coefficients ($C_a$)
3 - positive Z axis for weight summaries
3 - negative roll (Z) axis for autopilot and guidance
3 - negative X axis for dynamic analysis
Positive roll for autopilot, guidance, and dynamic analysis

Vehicle shown in flight attitude

(c) Dimensional axes and guidances coordinates, TLV.

Figure 3.0-1. - Concluded.

## 3.4 GEMINI AGENA TARGET VEHICLE

The Gemini Agena target vehicle (GATV) consists of a basic Agena D vehicle modified to include the additional components required by the Gemini program. (See table 3.4-I.) These components consist essentially of a multistart primary propulsion system (PPS), a secondary propulsion system (SPS), command and communications equipment (C and C), and a target docking adapter (TDA). This section provides a general description of the structure and major systems of GATV, no. 5002. This vehicle was virtually identical to those to be used on future rendezvous missions; therefore, the following description is intended to serve as a reference for subsequent rendezvous mission reports. For a more detailed description of the GATV and TDA, refer to references 1 and 2, respectively.

### 3.4.1 Structure

3.4.1.1 Gemini Agena target vehicle.- The GATV consisted of a semimonocoque structure that housed and supported the various vehicle system components (see fig. 3.4-1). The major structural divisions of the airframe were: aerodynamic shroud, TDA, auxiliary forward equipment rack, forward section, integral skin-propellant tank, aft section, the target launch vehicle (TLV) adapter. The shroud and TLV adapter were not a part of the orbital vehicle. The shroud covers and protects the TDA, and is ejected during the ascent phase of the flight. The GATV separates from the TLV adapter and the adapter remains with the TLV following completion of the powered flight.

3.4.1.1.1 Aerodynamic shroud: The aerodynamic shroud was a weather-tight, RF transparent, jettisonable fairing constructed in two segments with a longitudinal parting plane (fig. 3.4-2). The phenolic fiberglas skin was the main structural member, and it had internal frames to stiffen and maintain the shroud's shape. A nose-cone latch assembly provided positive closure of the two sections. The shroud was 117 inches long and consisted of a cylinder 23.5 inches long by 65 inches in diameter blended to a 15° half-angle cone that was topped by a 12-inch-diameter spherical section. Separation is initiated by a sequence timer signal which initiates the separation by firing the explosive bolts. Also, two spring-loaded separators provide the necessary force to insure positive separation. Pivot brackets restrain the base of the shroud to insure nose-first separation.

3.4.1.1.2 Target docking adapter: The TDA was bolted on the forward face of the auxiliary rack and consisted of an adapter section, docking cone, GATV status-display panel, radar transponder, two L-band antenna systems, acquisition and approach lights, mooring drive system, latching mechanism, and the spacecraft-GATV hardline umbilical connection. The TDA is described in detail in paragraph 3.4.1.2.

3.4.1.1.3 Auxiliary forward rack: The auxiliary forward rack was a 17.5-inch extension of the forward midbody. It was bolted to the midbody and structurally supported the TDA and the shroud. The auxiliary rack housed the equipment shown in figure 3.4-3, and access doors were provided for all components and interface connectors.

3.4.1.1.4 Forward section: The GATV forward section consisted of external skin and access doors held and reinforced by three stiffener rings. Within the forward section, a tubular aluminum frame provided additional strength and mounting locations for equipment. The forward section housed the equipment shown in figure 3.4-4. Hinged doors permitted access to all areas of the forward section, and a removable panel provided access to the battery and electrical equipment area. The guidance module included a panel that was attached to the module structure. Fairings covered each horizon sensor head and are jettisoned during the ascent phase.

3.4.1.1.5 Integral skin-propellant-tank assembly: The GATV propellant tank was both the vehicle cylindrical skin and dual-chamber tank assembly. (See fig. 3.4-1.) The forward tank contained the fuel for the PPS and the aft tank contained the oxidizer for the PPS. The aft hemisphere of the forward tank acted as a bulkhead between the two cavities. The overall length, including the hemispherical ends, was 129.08 inches. The volume of the forward tank was 75.3 cubic feet, and, with baffles installed, the normal capacity was 553.31 gallons. The volume of the aft cell was 98.4 cubic feet, and the normal capacity was 738.0 gallons. Two fairings on the outside of the tank accommodated the electrical wiring and plumbing.

3.4.1.1.6 Aft section: The aft section consisted primarily of the engine mounting cone and the equipment rack, and was enclosed in the TLV adapter until TLV-GATV separation. A magnesium mating ring was used as an integral part of the engine mounting cone and also as a surface to connect the aft section to the tank and TLV adapter sections. The engine mounting cone consisted of a longitudinal framework of angles and tubular construction which extended from the mating ring to an engine mounting ring.

The aft section provided the mounting structure for the primary and secondary propulsion systems, the attitude-control gas tanks, the thrust valve clusters, and the hydraulic power package. The aft structure and installation details for the SPS modules are shown in figure 3.4-5.

3.4.1.1.7 TLV adapter: The TLV adapter (see fig. 3.4-6) connected the GATV to the TLV. The adapter was permanently attached to the TLV. The GATV separates from the adapter by primacord and a detonator device installed at the forward end of the adapter. Separation retrograde rockets, mounted externally on the adapter, retard the TLV as the GATV moves out of the adapter on the guide rails.

3.4.1.2 Target docking adapter.- The TDA is attached to the forward end of the GATV and is the mechanism used to mate the spacecraft with the GATV during the docking operations. It receives the rendezvous and recovery (R and R) section of the spacecraft, absorbs the contact shock, and forms a rigid structural connection between the spacecraft and the GATV. The TDA consisted of two major subassemblies: the docking cone and the docking adapter. The docking adapter was mounted on the GATV forward auxiliary rack and was the mounting structure for all other components of the TDA (see fig. 3.4-7).

The docking cone section resembled a truncated cone and was mounted to the docking adapter in such a way that the large end faced away from the adapter. A V-shaped notch in the large end of the docking cone is used with the indexing bar on the R and R section during docking operations. The cone structure consisted of leading-edge ring assembly, intermediate ring, docking cone supporting ring, stiffeners, fittings, ribs, and inner and outer skin panels. The surface of the cone which contacts the R and R section was coated with a solid film lubricant.

Three discharge devices were mounted on the docking cone to neutralize any electrical potential differences between the GATV and the spacecraft. The charge is neutralized at a slow rate by three beryllium copper fingers. The 24-inch fingers, connected to the GATV electrical ground through a high resistance, were spaced at equidistant intervals inside the docking cone to insure contact with the R and R section prior to any contact between the TDA and the spacecraft. (See fig. 3.4-7.)

The TDA docking system consisted of the following subsystems: shock attenuation, docking and rigidizing, latch release, radar transponder and associated electronics, GATV acquisition lights, approach lights, and the GATV status display.

3.4.1.2.1 Shock-attenuation system: The shock-attenuation system supports the docking cone on the docking adapter, attenuates initial-contact shock, and stabilizes the spacecraft during docking. During docking, the docking cone provides a circular impact area with a diameter of 58 inches for the 32-inch diameter of the forward end of the spacecraft. The system consisted of seven hydraulic damper assemblies attached to the TDA in three sets that were spaced 120° apart. (See fig. 3.4-7.) Three lateral and four longitudinal damper assemblies were installed. Each of the two lower sets consisted of a lateral and a longitudinal assembly, and the top set consisted of one lateral and two longitudinal damper assemblies. The two longitudinal assemblies were mounted at an angle of 87° to each other to dissipate any rolling forces produced during docking.

3.4.1.2.2 Docking and rigidizing system: The docking and rigidizing system engages the R and R section of the spacecraft and secures the spacecraft firmly against the GATV. During operation of the system, the docking cone retracts into a rigidized position against the docking adapter and provides a rigid connection between the GATV and the spacecraft. The system also moves the docking cone forward to unrigidize the spacecraft and allow GATV–spacecraft separation. The system consisted of a rigidizing drive system, springs, and spring-loaded latches which were equally spaced 120° apart around the circumference of the TDA. The mooring drive system consisted of a power unit, three gear reduction boxes, and the connecting linkage (four flexible drive shafts and an H-drive gear-box).

During docking, the leading edge of the spacecraft R and R section passes over and depresses three latches. When the spacecraft reaches the proper position, the latches seat automatically into the latch receptacles on the R and R section. As each latch seats, an associated limit switch is closed. When all three of the limit switches are closed, the circuit to the mooring drive motor is completed and the motor begins retracting the docking cone. Drive arms apply tension to the rigidizing linkages, the docking cone is pulled toward the TDA main structure, and the umbilical plug extends. When the docking cone bottoms on the adapter pads, the mooring drive mechanism stops, and the rigidizing sequence is complete.

The unrigidize sequence is initiated by a command from the spacecraft or the ground control facilities. The system is mechanically driven to the unrigidized position by reversal of the mooring drive mechanism.

3.4.1.2.3 Latch-release system: The latch-release system automatically releases the latches from the latch receptacles on the spacecraft after the docking cone returns to the unrigidized position. The release system consisted of an electro-mechanical actuator, six cable assemblies, three pulleys, and three bell crank assemblies, which are used in conjunction with the latches mentioned in paragraph 3.4.1.2.2. The latches retract mechanically from the latch receptacles on the R and R section of the spacecraft, as shown in figure 3.4-8, and the spacecraft and TDA are then free to separate. The latches automatically reset 30 seconds later and are ready for another docking operation.

In the event of a malfunction in the normal latch-release sequence, the spacecraft latch receptacles separate from the R and R section by pyrotechnic devices in the spacecraft and remain with the latches. The spacecraft and TDA are then free to separate; however, additional docking operations can not be undertaken.

3.4.1.2.4 GATV acquisition lights: The GATV acquisition lights provide the pilots with a means for visually acquiring and tracking the GATV during the terminal guidance phase of the rendezvous maneuver. The lights were mounted on the docking adapter as shown in figure 3.4-9 and were held in the retracted position by the docking cone during ascent. Upon extending the cone, the lights assume the proper position for acquisition and tracking.

A capacitor-discharge flashing light was installed on the GATV which had a minimum flashing duration of 20 microseconds, a flashing rate of 75 to 90 flashes per minute, and a minimum of 100 candles effective intensity through an included angle of 90° from the longitudinal axis of the lamp. A reflector system is used to increase the effective intensity in order for the light to be visible from 20 nautical miles with the intensity of a third-magnitude star. An independent battery power supply was installed for these lights.

3.4.1.2.5 Approach lights: Two lights were mounted on the docking adapter to illuminate the docking cone as an aid to the flight crew during final approach to the GATV. (See fig. 3.4-9.) Mounted in this position, the lights project a beam envelope on the cone.

3.4.1.2.6 Running lights: Six colored running lights were installed as shown in figure 3.4-9 to provide GATV orientation on the dark side of the orbits. The command system provides control of power to the lights from two 6-volt batteries. In parallel with the command control is an electronic timer which is capable of turning the lights on at any time within 1 year. For the Gemini VI mission, the timer was set to turn the lights on 130 days after launch.

3.4.1.2.7 GATV status display system: The GATV status display panel provides the pilots with a visual indication of the GATV status with respect to propulsion, guidance, the electrical power systems, and the docking system in the TDA. The panel consisted of nine lights, two clocks, one synchro indicator, and the circuitry in the GATV necessary to operate this panel. The panel was separated into three parts, all mounted at the top of the forward end of the docking adapter so that the panel is visible to the flight crew during and after the docking maneuver. (See fig. 3.4-10.)

The functions related to the displays and the lights when lighted were as follows:

(a) DOCK (green light) – Indicates that the docking cone is unrigidized and that all latch hooks are reset.

(b) RIGID (green light) – Indicates that the docking cone is rigidized.

(c) PWR (green light) – Indicates that +28 volts dc unregulated, +28 volts dc regulated, -28 volts dc regulated, 115-volts 400-cps single phase, and 115-volts 400-cps 3-phase power are satisfactory.

(d) MAIN (red light) – Indicates that:

(1) With the main engine firing, the turbine has exceeded 27 000 rpm (1046 cps sensor level), the hydraulic pressure is below 1500 ± 20 psia, or the differential pressure between the fuel and oxidizer tanks is below 3 ± 2 psid (fuel above oxidizer); or

(2) With the main engine not firing, the differential pressure between the fuel and oxidizer tanks is below 3 ± 2 psid (fuel above oxidizer).

(e) MAIN (green light) – Indicates that the main fuel tank is above 15 ± 2 psia, the oxidizer tank is above 15 ± 2 psia, and hydraulic pressure is above 50 ± 5 psia.

(f) ARMED (amber light) – Indicates that the engine control circuits are closed and either the main or secondary engines may be fired by command.

(g) SEC HI (green light) – Indicates that an expulsion gas pressure of more than 1110 ± 20 psia exists in both nitrogen spheres for a 50-second Unit II (200-lb thrust) firing and that more than 170 ± 5 psia regulated pressure exists in both propellant tank gas manifolds.

(h) SEC LO (green light) – Indicates that an expulsion gas pressure of more than 360 ± 20 psia exists in both nitrogen spheres for a 150-second Unit I (16-lb thrust) firing and more than 170 ± 5 psia regulated pressure exists in both propellant tank gas manifolds.

(i) ATT (green light) – Indicates that the GATV attitude control system is active.

(j) MAIN TIME (clock display) – Indicates, by a minute hand and a second hand, the time remaining for main engine burn. The regulated

28-V dc power is applied to the display unit when the main engine is running, causing the display unit to decrease the time-remaining-indication at a rate of 1 sec/sec of burning time.

(k) SEC TIME (clock display) - Indicates, by a minute hand and a second hand, the number of seconds of 200-pound thrust SPS burn time remaining. The regulated 28-V dc power is applied on separate wires for the high and low thrusters of the SPS causing the display unit to decrease the time remaining indication at a rate of 1 sec/sec of burn time for the high consumption, and a rate of $\frac{1}{12}$ sec/sec of burn time for the low consumption rates.

(l) ATT GAS (synchro display) - Indicates the percentage of total pressure remaining in the GATV attitude control system gas spheres.

### 3.4.2 Major Systems

3.4.2.1 Propulsion.- The GATV velocity changes are provided by two rocket engine systems. The PPS provides the capability for boosting the vehicle into the desired orbit after target launch vehicle separation, and it has a multiple restart capability for orbital changes. The SPS provides thrust for ullage orientation and for minor orbital maneuvers.

3.4.2.1.1 Primary propulsion system: The PPS consisted of the propellant and pressurization subsystem and the rocket engine subsystem. (See fig. 3.4.2-1.) A description of these systems is presented in the following paragraphs.

The pressurization subsystem maintains the desired pressures in the propellant tanks and at the engine turbopump inlets from the first burn of the PPS throughout the mission. The initial pressurization applied during the countdown propellant-loading operation maintains proper tank pressures until PPS start.

The rocket engine subsystem consisted of a liquid bipropellant power package with a single combustion chamber. Electrical control equipment, propellant flow components, and the propellant subsystems supported the engine operation. The engine uses unsymmetrical dimethylhydrazine (UDMH) and inhibited red-fuming nitric acid (IRFNA) as propellants. The propellants are fed by turbopumps to the thrust chamber where hypergolic ignition occurs.

The single thrust chamber is regeneratively cooled by the oxidizer, which passes lengthwise through passages in the walls of the thrust chamber before it enters the injector. An electrical control system provides circuits, relays, and control devices to start, operate, and shut down the engine. The engine was mounted on a gimbal ring which permitted vehicle attitude control during engine operation by means of lateral and vertical thrust chamber movements. The engine develops a thrust of approximately 16 000 pounds, and has a total thrust duration of 240 seconds.

The ascent operation is divided into three sequences: the start sequence, the thrust sequence, and the shutdown sequence. Normal operation of these sequences is described in the following paragraphs.

(a) Start sequence – Voltage is applied, through an electronic gate, to energize the pilot-operated solenoid valve and to open the fuel and oxidizer gas generator solenoid valves. This action allows fuel and oxidizer from the start tanks to flow under a pressure of approximately 1000 psi to the gas generator, where they ignite hypergolically. This ignition creates hot gases to drive the turbine wheel in the turbopump assembly which causes the fuel and oxidizer pumps to operate. The increasing output pressure from the fuel and oxidizer pumps opens the fuel and oxidizer valves. As line pressure increases, the fuel and oxidizer flangible discs rupture, and the propellants flow into the thrust chamber where they ignite hypergolically creating the engine thrust. At 1.5 seconds after the initial start signal, two squibs in the pyrotechnic-operated helium control valve are fired, opening the valve and pressurizing the propellant tanks. At the same time, pressurized fuel and oxidizer flow to the fuel and oxidizer pump inlet ports.

(b) Thrust sequence – During the thrust operation, the burn time is controlled by a velocity meter which applies a signal to remove power from the engine valves when the desired velocity increase has been achieved. (An ascent sequence timer is used as a backup for the velocity meter.) At a discrete time after receipt of the engine start signal, the oxidizer-tank helium-isolation valve is closed, isolating the oxidizer tank from the rest of the pressurization system. Pressure in the fuel tank gradually increases because of the remaining pressurant. Because of this, the bulkhead differential pressure is retained at a positive value.

(c) Shutdown sequence – The PPS is normally shut down by the velocity meter which removes electrical power from the engine. Loss of electrical power to the pilot-operated solenoid valve causes the fuel-valve actuation pressure to decay rapidly. As the pressure decays, the fuel valve closes, shutting off fuel to the thrust chamber which cuts off engine thrust. Removal of electrical power also causes the gas-generator solenoid valves to close. This shuts off propellant flow to the gas generator and results in turbine pump deceleration. This, in turn, causes the oxidizer valve to close.

3.4.2.1.2 Secondary propulsion system: The SPS provides the thrust required to make orbit changes requiring velocity increments less than those available from the PPS. The SPS is also used to provide a small acceleration for orienting propellants in the tanks prior to PPS start. The SPS consisted of two modules mounted on diametrically opposite sides of the GATV aft section.

Each SPS module is a complete, storable-liquid bipropellant propulsion system capable of multiple firings while in orbit. Pressurizing and propellant storage components supply propellants to one 16-pound thrust chamber (Unit I) and one 200-pound thrust chamber (Unit II). The fuel is unsymmetrical dimethylhydrazine (UDMH), the oxidizer is mixed oxides of nitrogen (MON), and the pressurizing gas is nitrogen.

The Unit I and Unit II thrust chambers were mounted on the aft end of each module in a fixed position (see fig. 3.4-11). The Unit I thrusters and the Unit II thrusters are operated as a pair to provide a balanced thrust of either 32 or 400 pounds, respectively.

3.4.2.2 Electrical system.- Power to the 28-V unregulated dc bus is supplied by six 400 A-hr silver-zinc batteries. (See fig. 3.4-12.) Alternating-current power is provided by an inverter which supplies 400-cycle, 115-volt, single-phase and three-phase current to components of the guidance and control system. The dc-dc converters provide regulated 28-V power. One converter supplies the guidance and control system. The other supplies power to the L-band beacon transponder and accelerometers in the TDA, and also the power required for instrumentation and transducer excitation.

3.4.2.3 Guidance and control.- The GATV guidance and control system is not activated during the TLV powered flight. After SECO, the GATV ascent sequence timer is started by a TLV discrete signal. At VECO, the guidance system gyros are uncaged, the horizon sensor fairings jettisoned, and the separation circuitry armed by a TLV discrete signal.

The GATV control system is activated by the GATV separation switches and the cold-gas thrust system stabilizes the vehicle and places it in the proper attitude for SPS thrust.

During the following flight phases, the guidance system provides attitude error signals when the vehicle deviates from the prescribed attitude reference. The guidance system also provides the necessary attitude change signals when an orbital maneuver command is received by the vehicle. In addition, an engine shutdown signal is generated after each desired velocity-to-be-gained increment has been achieved. Primarily, the guidance system consisted of horizon sensors, an inertial reference package (IRP) containing three attitude gyros, rate gyros, a velocity meter, and a sequence timer. The flight control system provides control of the vehicle attitude in response to signals from the guidance system.

3.4.2.3.1 Guidance system: An inertial space attitude reference is provided by the IRP, and an earth reference is provided by the horizon sensor. (See fig. 3.4-13.) Vehicle attitude is changed by applying the appropriate signal to the IRP, and vehicle velocity is changed by firing the appropriate rocket engine and utilizing the velocity meter to terminate thrust after the desired velocity change is achieved. Both of these events are initiated by real-time commands or by stored program commands either of which provide command inputs to the flight command logic package. The guidance junction box provides the interconnects with the major components of the system; in addition, portions of the component circuitry are located in these junction boxes to facilitate program-peculiar modifications. The flight control electronics package receives signals from the IRP, processes these signals, and generates the output signals necessary to actuate the applicable control system.

3.4.2.3.2 Flight control system: The flight control system provides vehicle attitude control in response to attitude error signals received from the IRP in the guidance system. Vehicle attitude control is provided by the cold-gas thrust and hydraulic systems.

The cold-gas thrust system is activated during vehicle ascent and provides pitch, yaw, and roll control prior to ignition of the PPS. At engine ignition, the cold-gas thrust system continues to provide roll control; but the pitch and yaw controls are deactivated and their control transferred to the hydraulic control system. Each time engine operation is discontinued, pitch control and yaw control are returned to the cold-gas thrust system.

(a) Cold-gas thrust system: The cold-gas thrust system consisted of three 2200-cubic-inch storage spheres containing 140 pounds of nitrogen gas, a pressure regulator, and six thrust valves. The pressure regulator reduces the input from the storage spheres (approximately 3600 psia) to a constant gas pressure of 100 psia (high mode) or 5 psia (low mode). One of these two pressures is supplied to the two thruster valve clusters to produce 10-pound and 0.5-pound thrusts, respectively. The thrust valve clusters, each with three thrust valves, were mounted on the Z-axis on opposite sides of the vehicle aft rack so that the thrust nozzles were at right angles to each other. Selection of the thrust valves and the duration and intensity of the pulses is controlled by commands from the flight control electronics unit.

(b) Hydraulic control system: The hydraulic control system consisted of a hydraulic power package, servo actuator, and associated connecting parts. Control of pitch and yaw was accomplished by gimbaling the rocket engine incrementally as much as ±2.5° by means of the pitch or yaw actuators. Attitude error signals are received from the inertial reference package by the flight control electronics unit. This unit converts these signals to electrical commands and routes them to the appropriate actuator.

3.4.2.4 Command and communications.- The GATV command system receives, decodes, and processes command signals from the spacecraft for real-time execution and from the ground stations for real-time and stored-program execution. Specific digital commands are described in reference 3. The GATV telemetry system senses, encodes, records, and transmits vehicle information to telemetry ground stations. The telemetry system is a PCM-FM system consisting of a 128 channel PAM main miltiplexer, a 128 channel PAM submultiplexer, a PAM-PCM encoder, a telemeter control unit, a tape recorder, and an RF section.

3.4.2.4.1 Command system: The command system is the interface between the GATV and the spacecraft or the ground control facilities. (See fig. 3.4-14.) In performing its function, the command system operates in several related modes or conditions of operation. The command sources and modes of operation are:

(a) UHF command: The UHF command system consisted of an antenna, command receiver, programmer, and a command controller.

The UHF antenna is a single quarter-wave monopole antenna mounted on the GATV aft section where it is stored under the TLV adapter section until after GATV separation. The system performed the following functions:

(1) Receives and, through telemetry, verifies acceptance of the commands transmitted from ground-based stations.

(2) Translates command signals into control functions for real-time or delayed actuation of GATV equipment.

(3) Generates timing signals for execution of stored-program commands, sequential operation of telemetry, and sequencing of engine firing.

(b) L-band command: The L-band command system consisted of a 1500-mc L-band transponder (including a command demodulator-decoder) which receives RF signals transmitted from the spacecraft and verifies acceptance of the commands. The L-band components were mounted in the TDA and connected to the GATV programmer.

(c) Hardline command: The hardline command system consisted of continuous wire connections from the docking umbilical of the TDA to the L-band transponder-decoder, and provides control of the GATV from the spacecraft when in a docked condition. Commands from the spacecraft have the same binary forms as the demodulated commands from the L-band transponder and from the command receiver. They are routed through the L-band sub-bit detector to the programmer for validation and execution. These commands are real-time only, and cannot be stored for later execution.

3.4.2.4.2 Telemetry system: The 128-channel telemetry system has two VHF data links which provide information for evalution of vehicle performance and command verification. (See fig. 3.4-15.) Status indications from the TDA are also telemetered via the VHF data links. The telemetry system is a VHF PCM-FM system capable of transmitting data in real time at a rate of 16 384 bits per second. The system also stores the data on an airborne tape recorder and transmits it later upon command at 65 536 bits per second. Real-time data and stored data can be transmitted simultaneously, if required. Table 3.4-II is a listing of the GATV instrumentation parameters discussed in this report.

There are three broad categories of data inputs programed for the telemetry equipment. The first data category, analog, is made up of voltage analogs of such measurements as temperatures, pressures, step functions, currents, et cetera. The magnitude of each of the measurements is represented by a corresponding voltage amplitude. For system compatibility, each of these voltage amplitudes is encoded into a binary format.

The second data category, direct digital, is composed of information which exists in binary coded format as measured, and requires no encoding. This category of data is made up of such information as the programmer memory words, on-off functions (command status functions), the velocity meter word, and the vehicle time word.

The third category of data is pulse analog. There is only one such measurement in the GATV, the gas generator turbine speed measurement. The telemeter counts and totals the number of pulses from the turbine speed transducer. This accumulated total pulse count is transmitted as a binary word.

3.4.2.4.3 Tracking system: Tracking of the GATV by ground stations is accomplished by the interrogation of independently operated S-band and C-band transponders. In addition, the telemetry (RF) signal is used as an acquisition aid. Tracking of the GATV by the spacecraft is accomplished by interrogation of the L-band transponder in the TDA. (See fig. 3.4-9.)

Radar transmitting-receiving antenna systems are provided for tracking functions during the ascent, orbit, and docking phases of flight operations. During ascent, a single linearly polarized C-band antenna is used; during orbit, the C-band antenna and a single linearly polarized S-band antenna are used; and during the docking phase, an L-band antenna system consisting of a loop dipole and two parallel-connected spiral antennas is used. A motor-driven extendible boom is used as the mount for the dipole antenna. Circuitry is also provided to switch the receipt or transmission of signals to either the spiral antennas, which work as a pair, or to the dipole antenna.

3.4.2.5 Range safety.- Range-safety requirements are satisfied by the premature separation self-destruct system.

The premature separation self-destruct system provides two capabilities:

(a) During the period between lift-off and TLV-GATV separation, a destruct signal from range-safety transmitters ignites destruct charges in the TLV and in the TLV adapter that destroy both vehicles.

(b) During the period between lift-off and TLV sustainer engine cut-off, the GATV is automatically destroyed by ignition of a charge in the TLV adapter, if premature separation from the TLV occurs.

After TLV-GATV separation, no explosive charge is aboard the GATV.

TABLE 3.4-I.- GEMINI-PECULIAR CHANGES TO AGENA D VEHICLE

| System | Major changes | Reason for changes |
|---|---|---|
| Structure | Forward auxiliary rack | Add space and mounting structure for new electrical components and wiring. |
| | Aft section | Add SPS and modify PPS. |
| | Shroud | Add TDA and increase confidence in separation. |
| Propulsion | Multiple restart PPS | Provide capability for space maneuvering. |
| | Deletion of oxidizer manifold pressure switch for fuel injection | Provide more repeatable start and shut-down transients and conserve propellants after shut-down. |
| | Addition of SPS | Provide minor velocity changes, backup for PPS, and for propellant orientation prior to PPS start. |
| Electrical | Addition of four batteries | Provide necessary power for 5-day mission. |
| Flight control | Increased ACS gas supply | Required for 5-day GATV mission and docked maneuvers. |
| Command and telemetry | Addition of new command systems and modification of telemetry | Provide a command control capability and telemetry to monitor vehicle functions. |
| Range safety | Deletion of engine shut-down system | Delete system which could endanger mission. |

TABLE 3.4-II.- GATV INSTRUMENTATION MEASUREMENTS

| Measurement | Description | Instrumentation range | Type of data |
|---|---|---|---|
| A-4 | Accelerometer Y no. 1 (TDA) | -1.5g to +1.5g | Real-time |
| A-5 | Accelerometer Z no. 1 (TDA) | -1.5g to +1.5g | Real-time |
| A-9 | Accelerometer X no. 1 (TDA) | -3.0g to +3.0g | Real-time |
| A-14 | TLV-GATV separation | 0 to 5 V | Real-time |
| A-20 | Forward compartment pressure | 0 to 15 psia | Real-time |
| A-21 | Aft compartment pressure | 0 to 15 psia | Real-time |
| A-52 | Shroud separation | 0 to 5 V | Real-time |
| A-150 | Shear-panel temperature no. 1 | -10° F to +120° F | Real-time |
| A-151 | Shear-panel temperature no. 2 | -10° F to +120° F | Real-time |
| A-152 | Shear-panel temperature no. 3 | -10° F to +120° F | Real-time |
| A-153 | Shear-panel temperature no. 4 | -10° F to +120° F | Real-time |
| A-154 | +Z aft-bulkhead temperature | -30° F to +250° F | Real-time |
| A-155 | -Z aft-bulkhead temperature | -30° F to +250° F | Real-time |
| A-156 | +Y SPS bulkhead temperature | -20° F to +300° F | Real-time |
| A-157 | -Y SPS bulkhead temperature | -20° F to +300° F | Real-time |
| A-158 | +Y radiation shield temperature | -100° F to +200° F | Real-time |
| A-159 | -Y radiation shield temperature | -100° F to +200° F | Real-time |
| A-388 | TDA skin temperature no. 1 | -100° F to 500° F | Real-time |
| A-389 | TDA skin temperature no. 2 | -100° F to 500° F | Real-time |
| A-390 | TDA skin temperature no. 3 | -100° F to 500° F | Real-time |
| A-391 | TDA skin temperature no. 4 | -100° F to 500° F | Real-time |
| A-522 | Accelerometer Y no. 2 (aft) | -1.5g to +1.5g | Real-time |
| A-523 | Accelerometer Z no. 1 (TDA) | -1.5g to +1.5g | Real-time |
| B-1 | Fuel pump inlet pressure | 0 to 100 psig | Real-time |
| B-2 | Oxidizer pump inlet pressure | 0 to 100 psig | Real-time |
| B-3 | Turbine manifold pressure no. 1 | 0 to 750 psig | Real-time |
| B-6 | Combustion chamber pressure | 0 to 700 psig | Real-time |
| B-8 | Oxidizer tank pressure | 0 to 60 psig | Real-time |
| B-9 | Fuel tank pressure | 0 to 60 psig | Real-time |
| B-11 | Oxidizer venturi inlet pressure | 0 to 1500 psig | Real-time |
| B-12 | Fuel venturi inlet pressure | 0 to 1500 psig | Real-time |
| B-82 | Fuel valve actuation pressure | 0 to 1500 psig | Real-time |
| B-132 | Turbine manifold pressure no. 2 | 0 to 120 psig | Real-time |
| B-139 | Engine switch group signal | 0 to 5 V | Real-time |
| B-148 | Oxidizer injector pressure | 0 to 1000 psig | Real-time |
| B-201 | -Y gas sphere pressure | 0 to 4500 psia | Real-time |
| C-13 | Battery case temperature no. 2 | 0° F to 200° F | Real-time |

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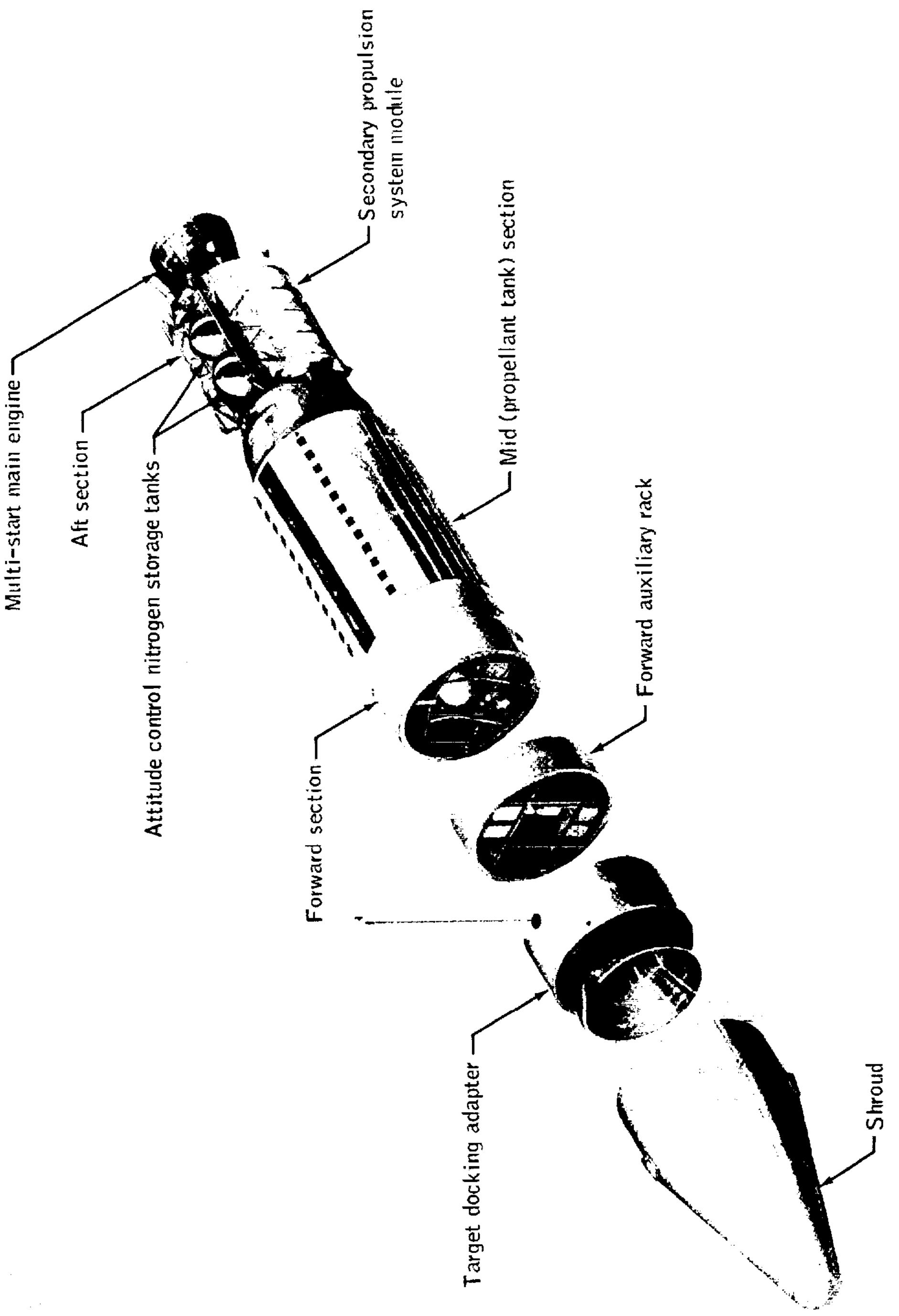

Figure 3.4-1. - Gemini Agena target vehicle.

NASA-S-65-11,237A

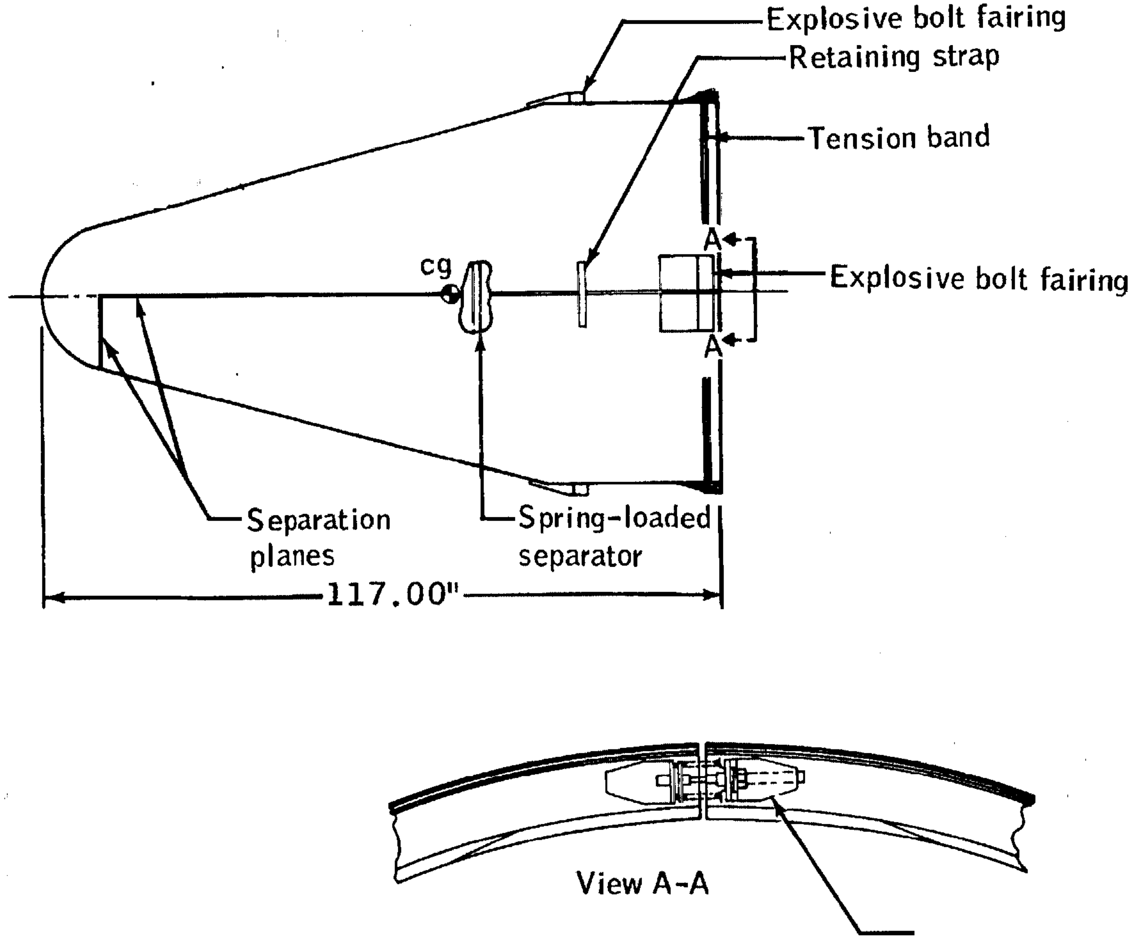

Figure 3.4-2. - GATV shroud configuration.

NASA-S-65-11,240A

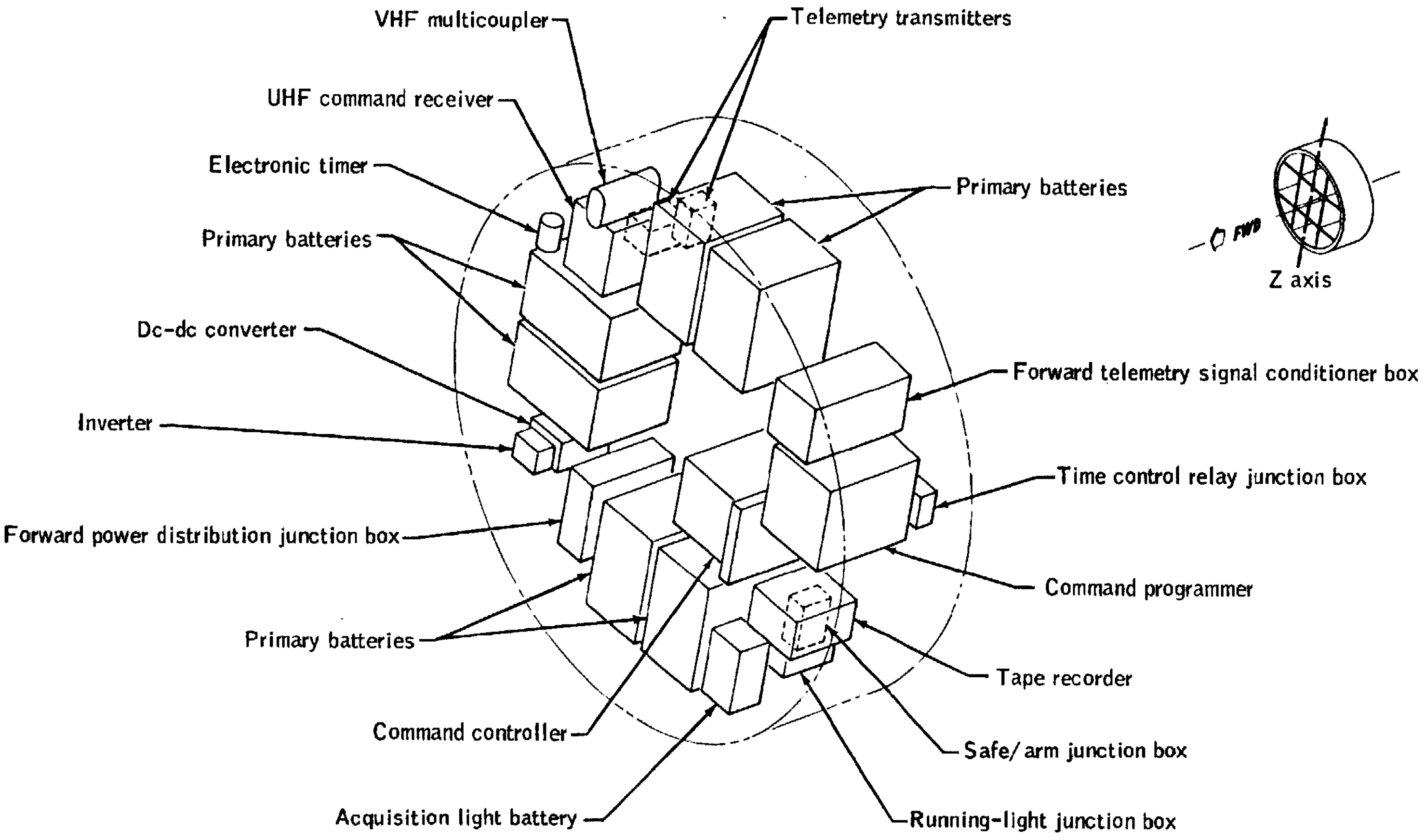

Figure 3.4-3. - Auxiliary forward rack equipment.

NASA-S-65-11,230A

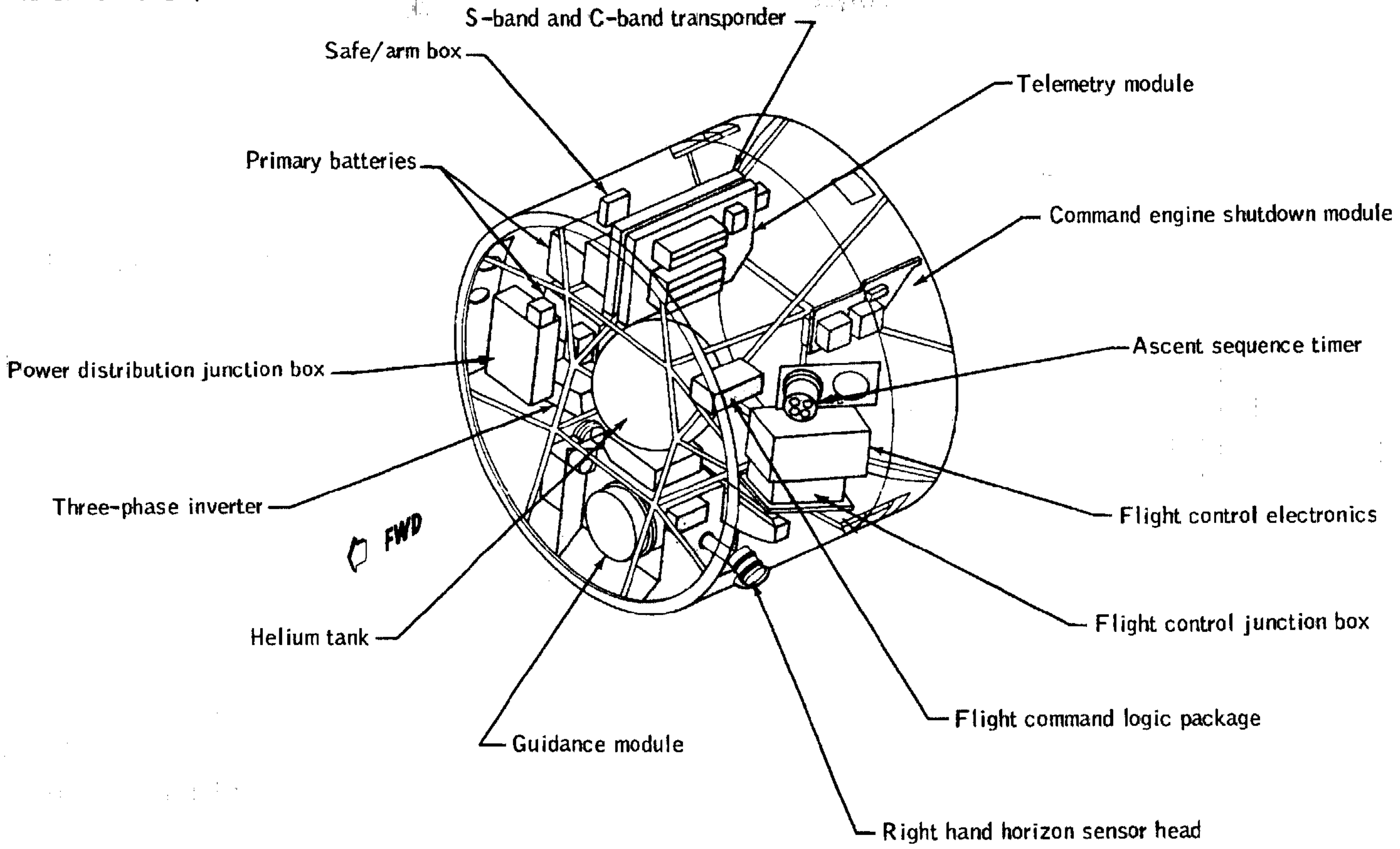

Figure 3.4-4. - Forward section equipment installation.

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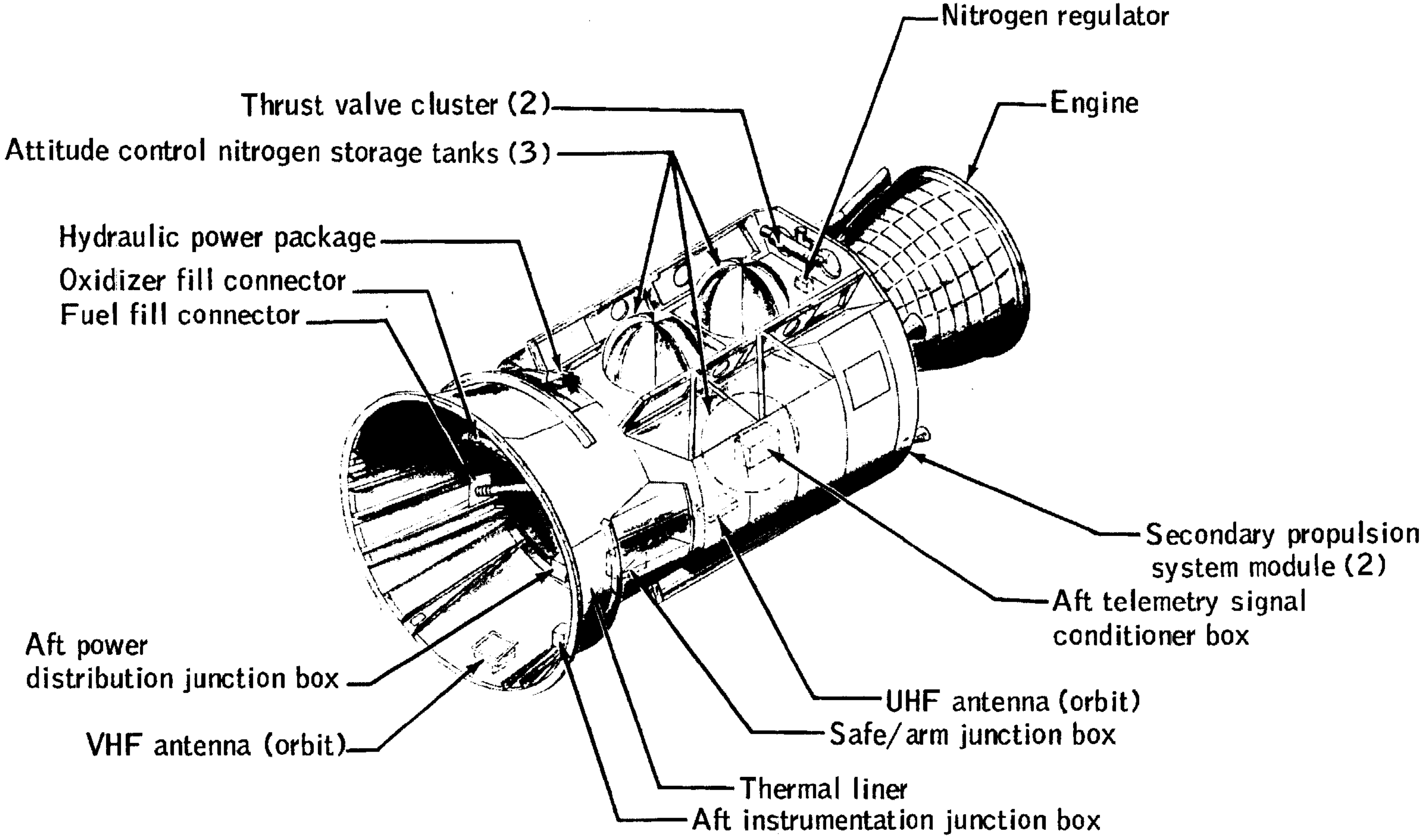

Figure 3.4-5. - GATV aft section.

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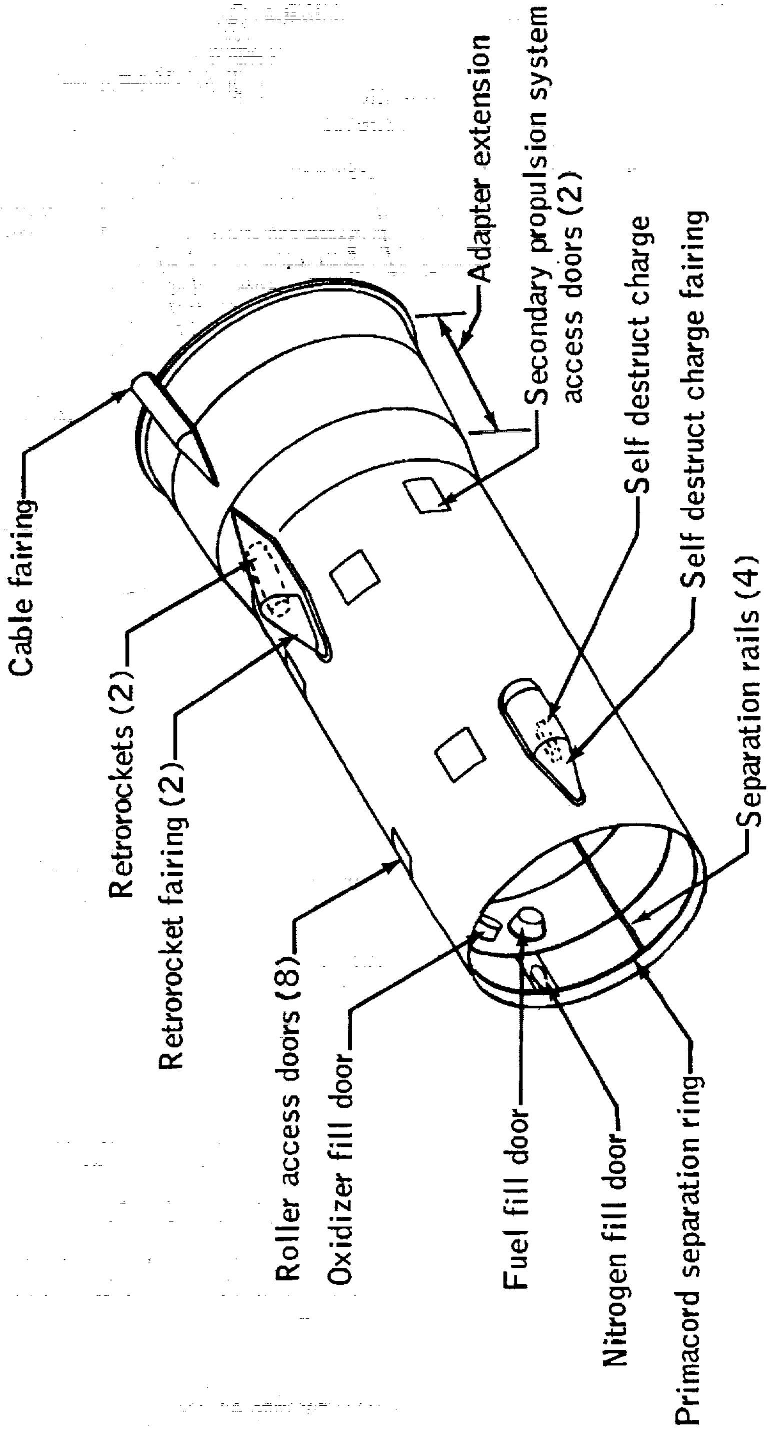


Figure 3.4-6. - TLV adapter.

NASA-S-65-11,236A

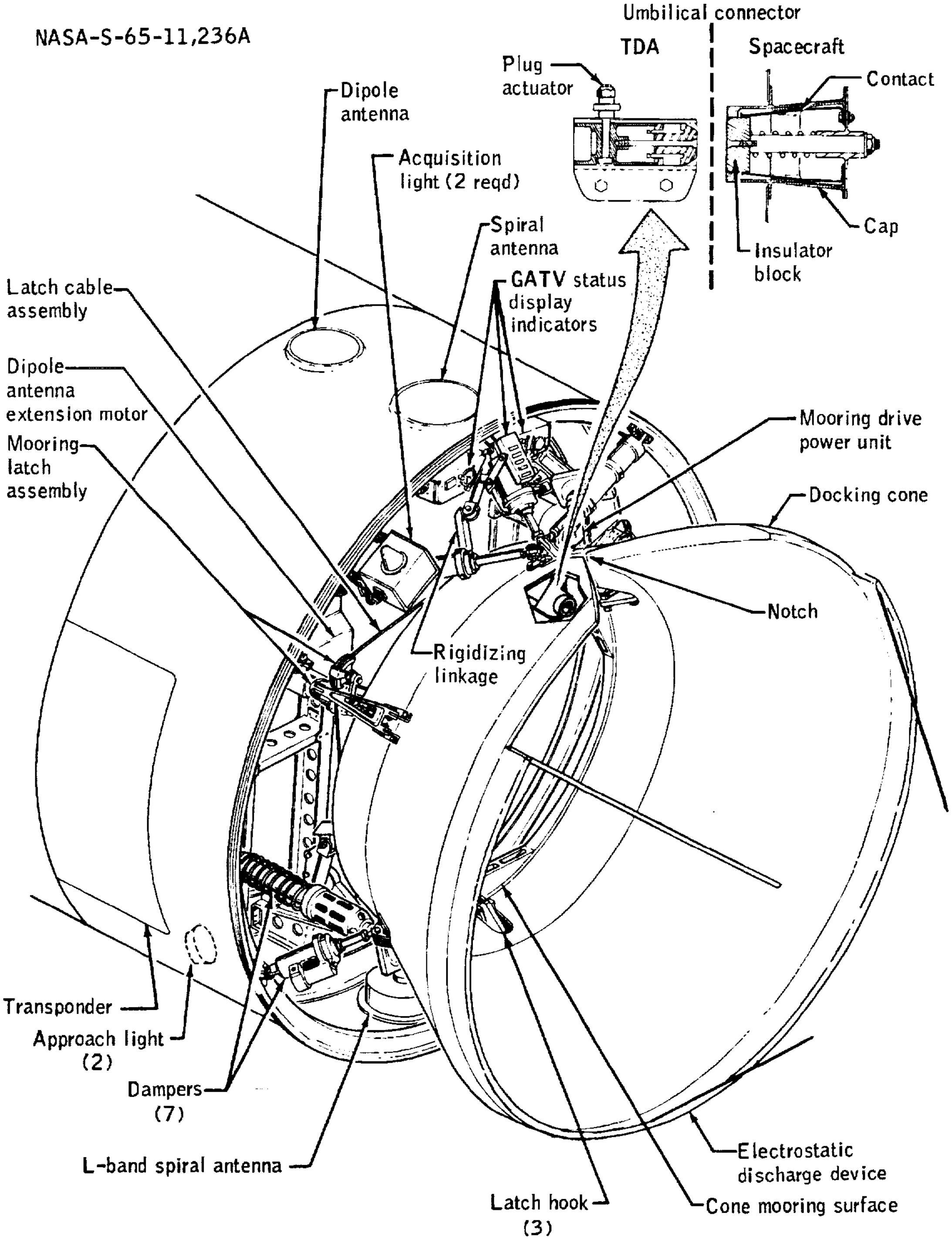
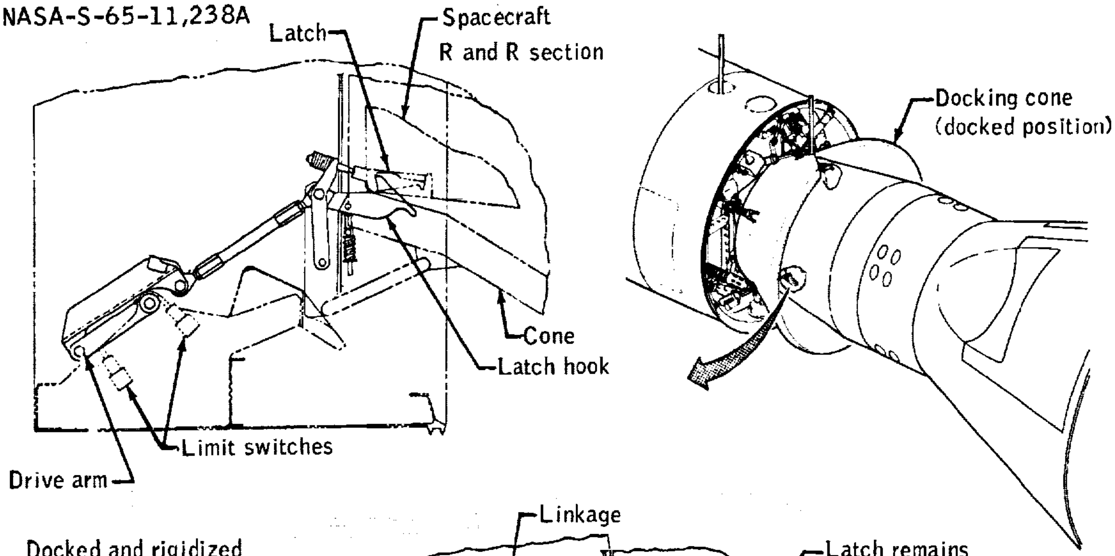
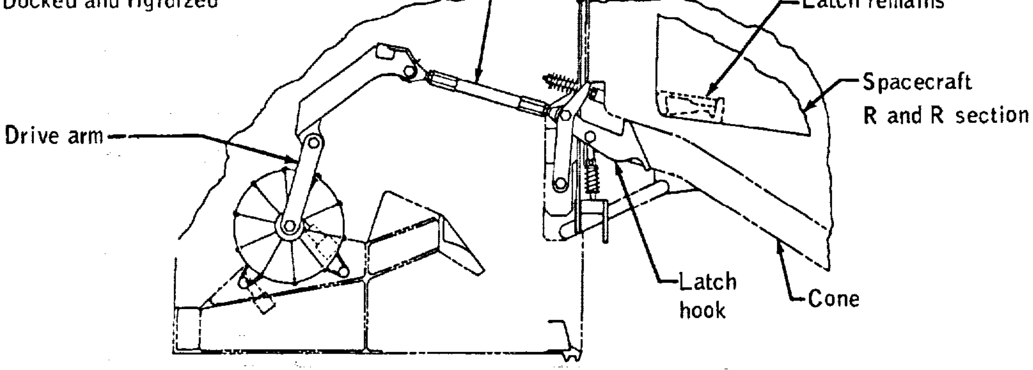


Figure 3.4-7. - Target docking adapter.

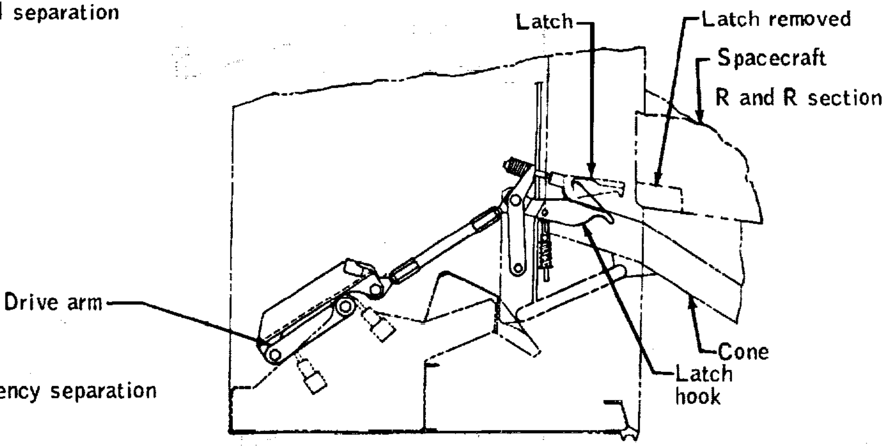
NASA-S-65-11,238A



Docked and rigidized



Normal separation



Emergency separation

Figure 3.4-8. - Spacecraft - TDA seperation sequence.

NASA-S-65-11,232A

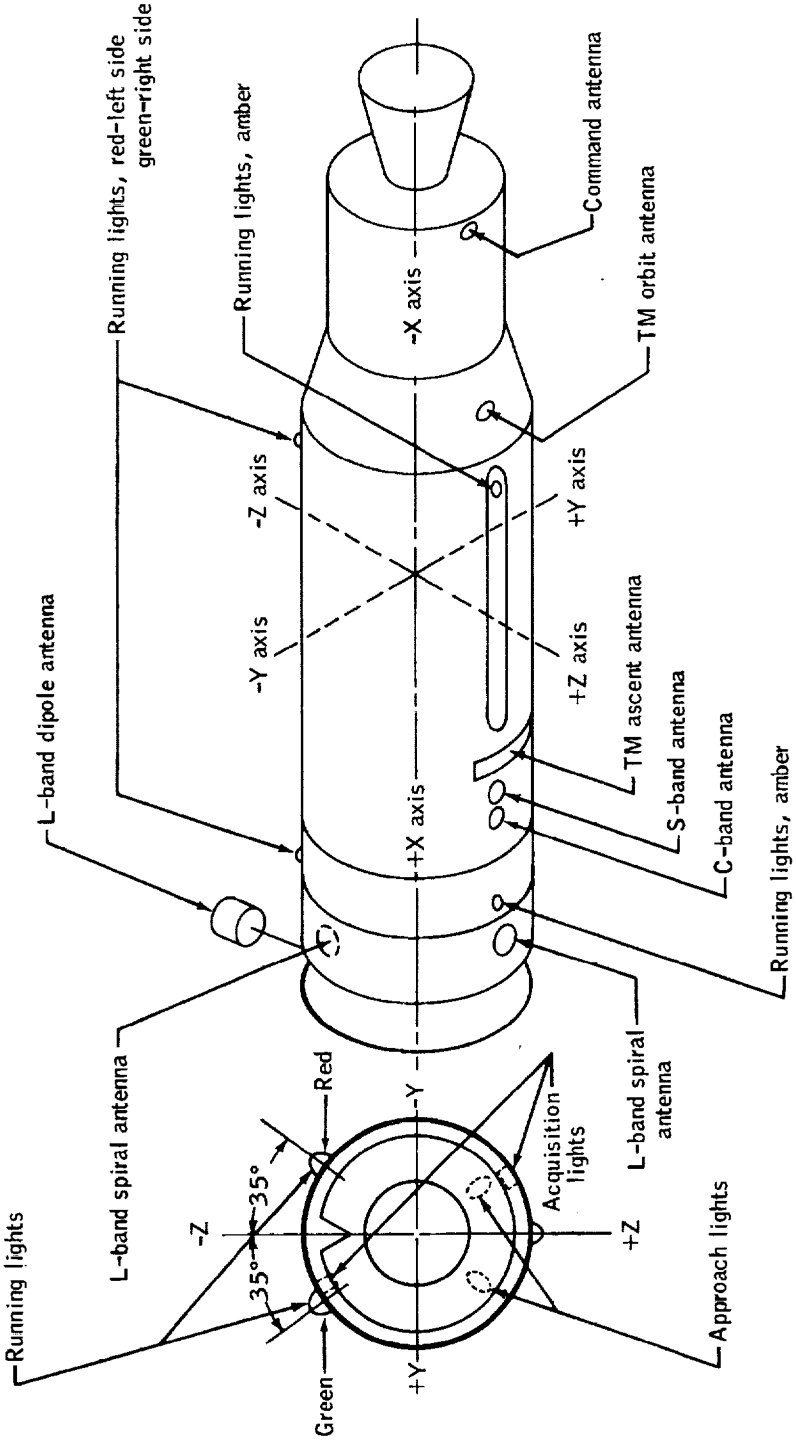


Figure 3.4-9. - GATV lights and antenna locations.

NASA-S-65-11,239A

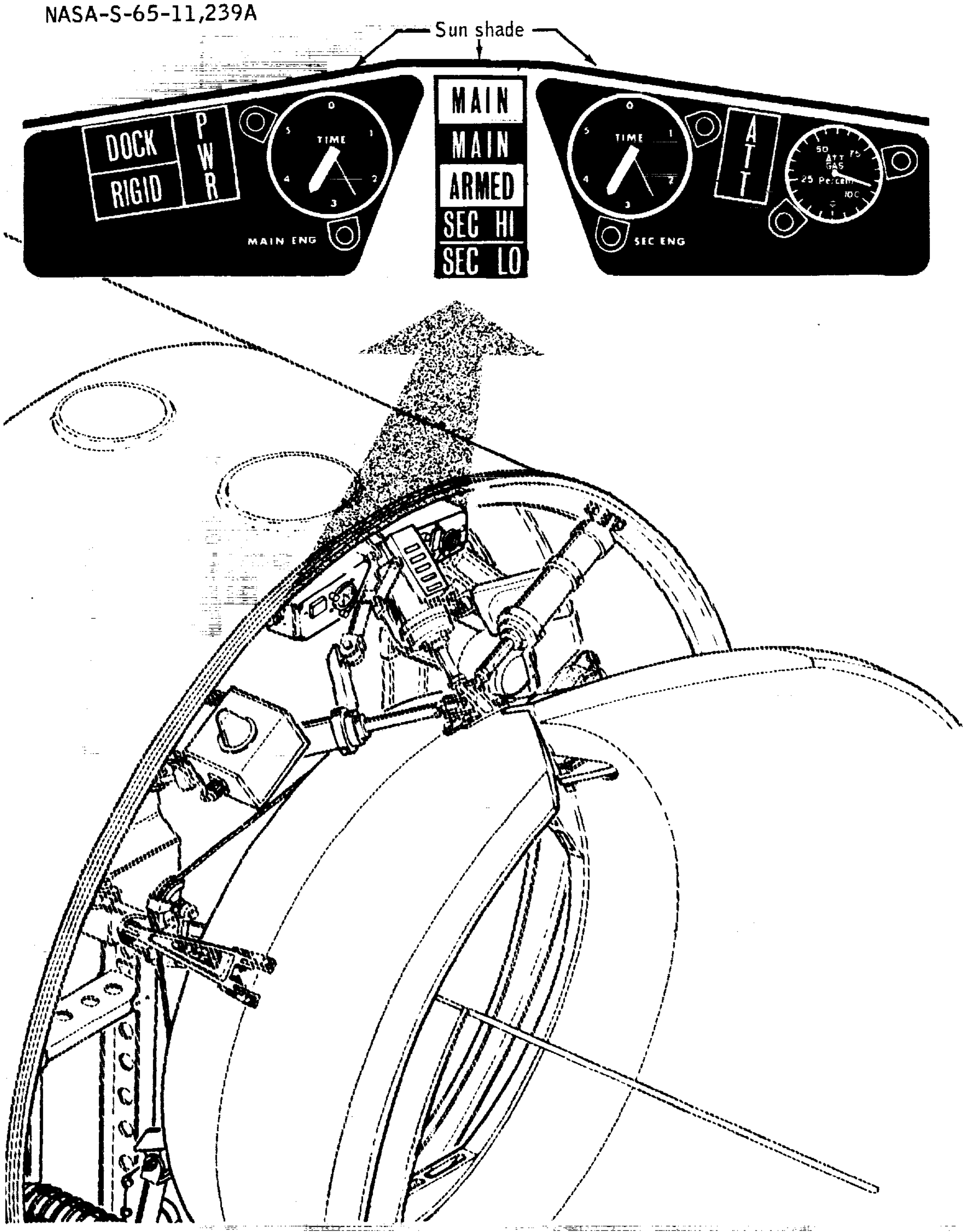


Figure 3.4-10. - Status display panel.

NASA-S-65-11,219A

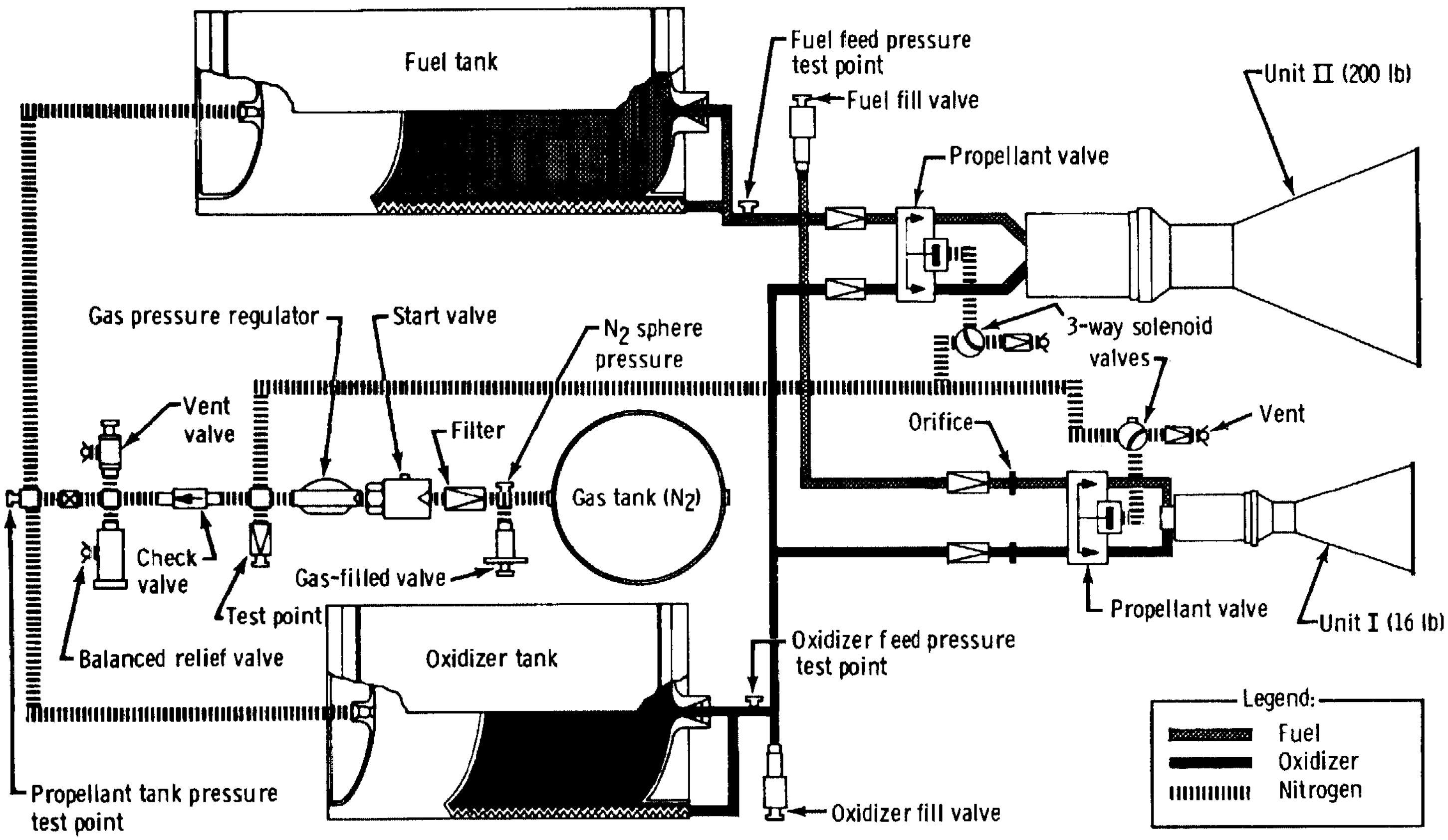


Figure 3.4-11. - Secondary propulsion system schematic.

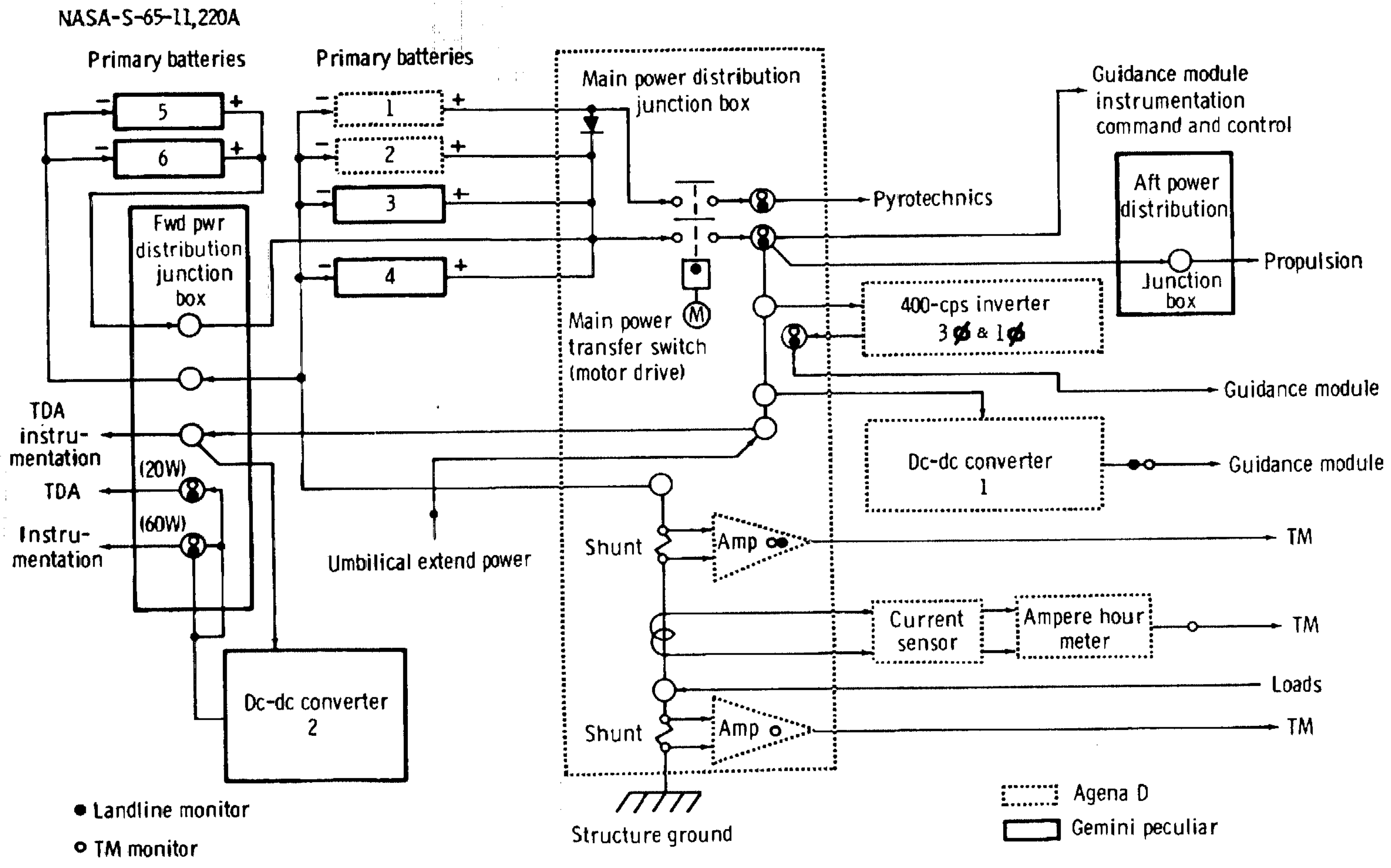


Figure 3.4-12. - GATV electrical system block diagram.

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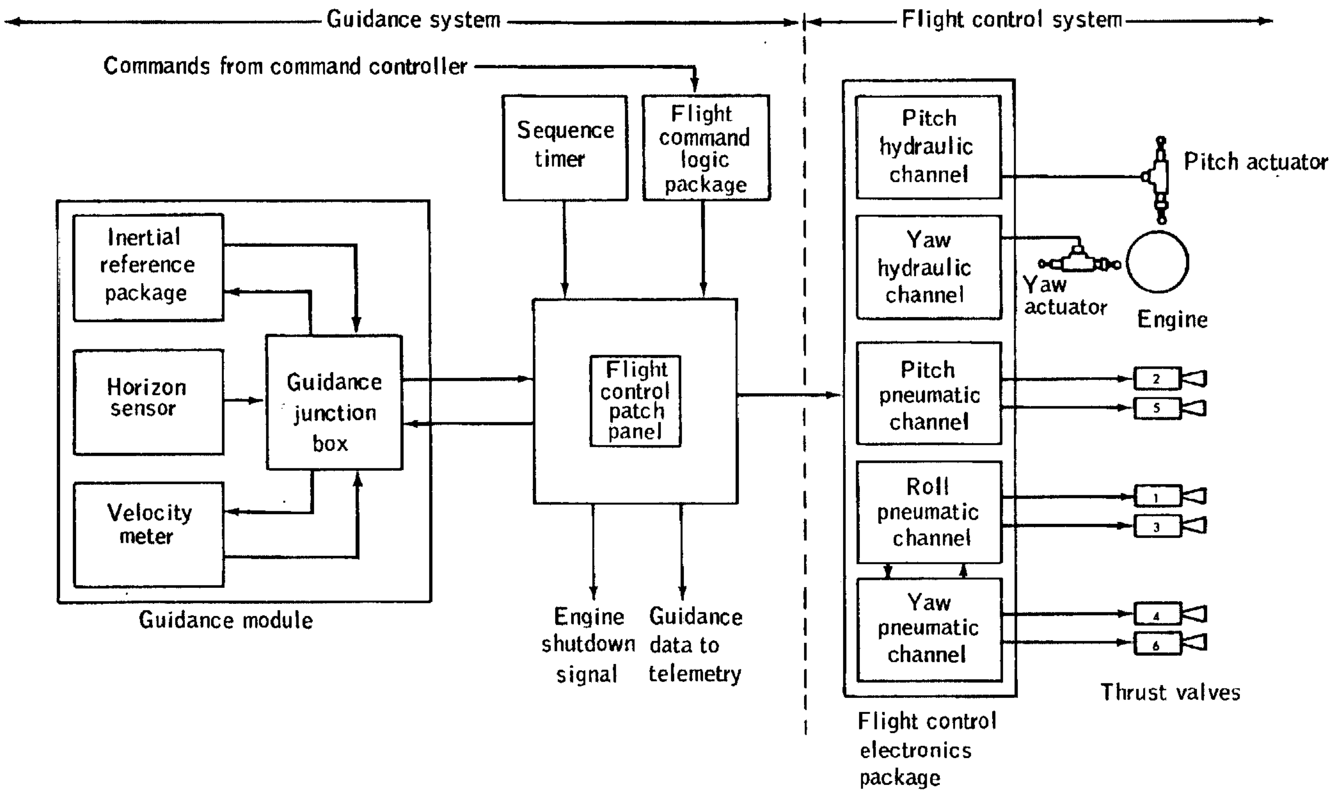


Figure 3.4-13. - Guidance system block diagram.

NASA-S-65-11,233A

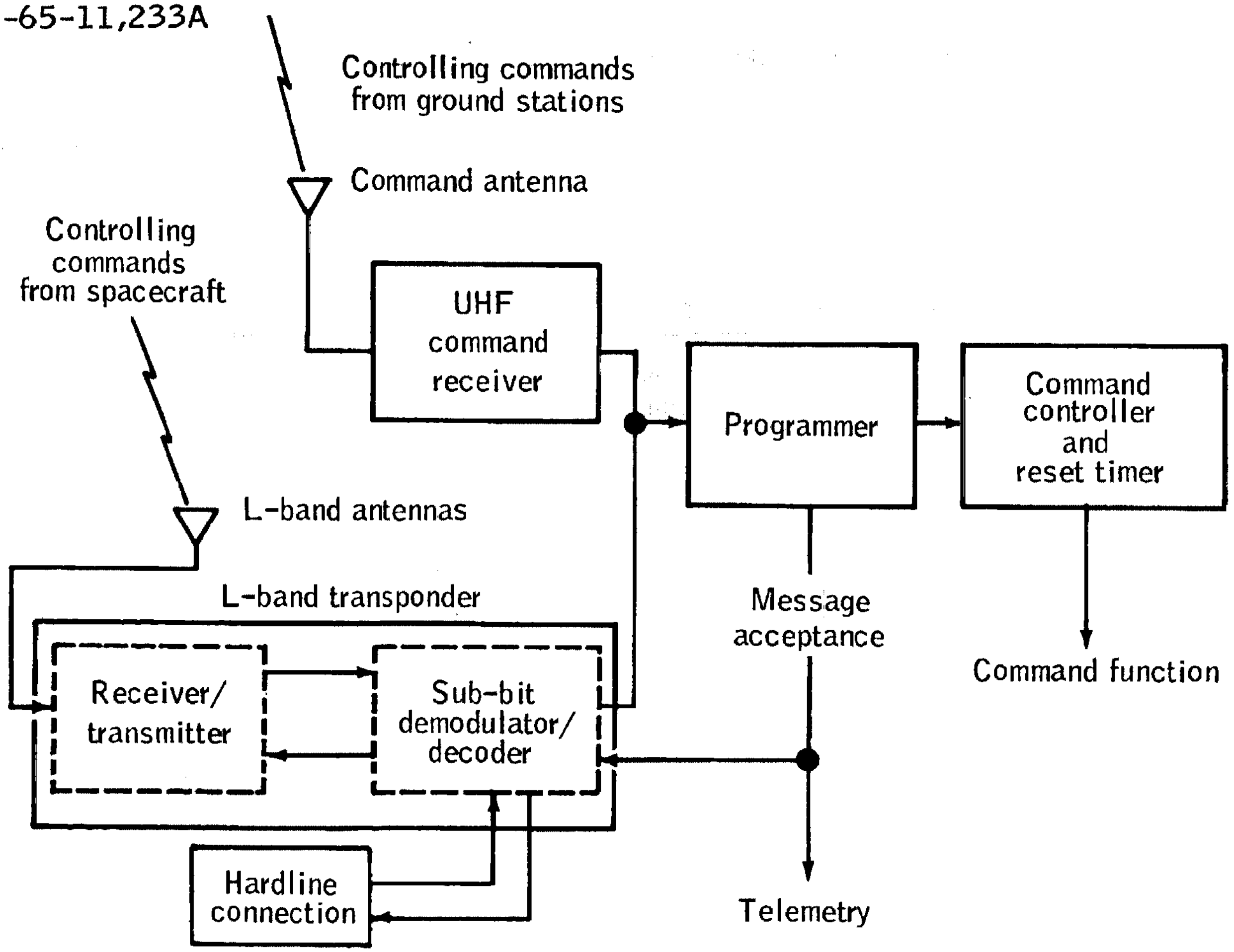
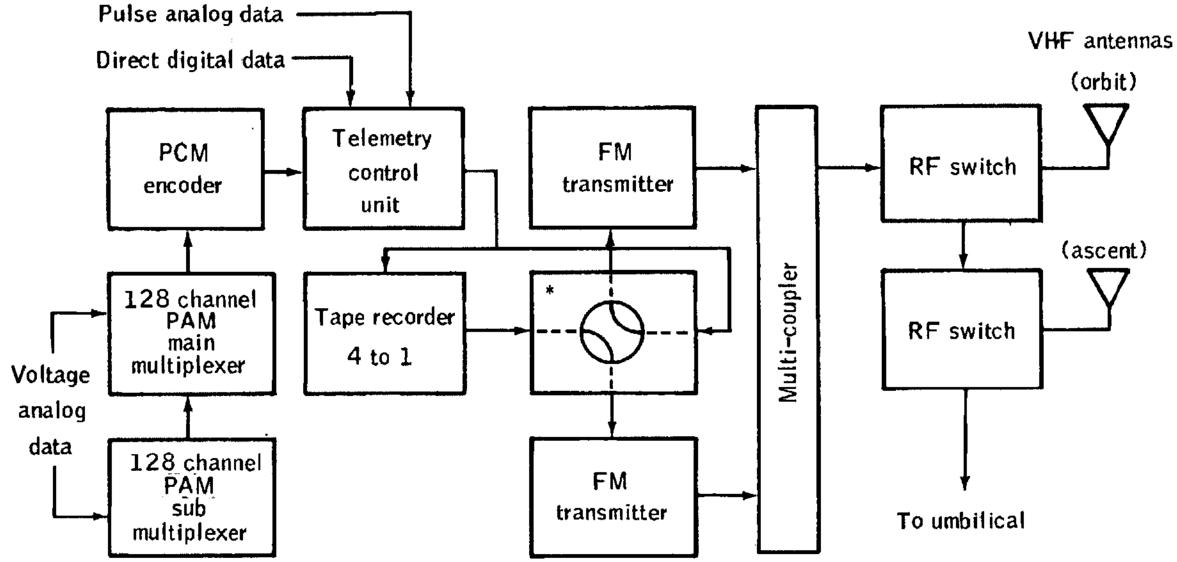


Figure 3.4-14. - Simplified block diagram of the command system.

NASA-S-65-11,231A



* Electromechanical switch located in command controller

Figure 3.4-15. - Telemetry system simplified block diagram.

## 3.5 TARGET LAUNCH VEHICLE

The target launch vehicle (TLV) for the Gemini VI-A mission was an Atlas space launch vehicle, SLV-3. This description of the TLV is intended to serve as the basic description of all target launch vehicles to be used for future Gemini rendezvous missions and will not be repeated in subsequent mission reports. Modifications to the TLV for future missions will be described in the applicable mission report with references to the description contained in this report. The TLV is shown in figure 3.5-1.

### 3.5.1 Structure

The TLV airframe was a cylindrical structure approximately 10 feet in diameter and 70 feet in length. This structure consisted primarily of two propellant tanks, a booster thrust section, a booster-section jettison system, and two electronic pods. The propellant tanks were pressurized for pad operations and flight to maintain the skin tension required for structural integrity.

3.5.1.1 Booster section.- The booster section consisted of a booster engine (two thrust chambers), nacelles, heat shield, and a fairing installation which formed a single compartment that housed the propulsion system and associated equipment. This section was attached to the thrust ring at the aft end of the tank section.

The booster-section jettison system was the mechanical linkage which secured the booster section to the tank section and released it at staging. The system consisted of 10 attachment and release fittings spaced around the periphery of the vehicle. The attachment and release devices were gas-operated from the booster-section separation bottle through an explosive valve assembly.

The booster section separated on command from the flight control subsystem. At the end of the predetermined booster powered flight period, a staging command from the ground guidance system initiated a programmer subroutine, which generated booster engine cut-off, booster-section jettison, and various engine nulling functions. The booster engine then shut down after 0.1 second and a pyrotechnic-activated device was ignited 3 seconds later and allowed pressurized helium gas to activate 10 separation fittings. Fluid and pneumatic lines uncoupled; and the booster thrust chambers, turbopumps, and associated equipment, together with the skirt structure, separated from the vehicle along the jettison guide rails.

3.5.1.2 Sustainer section. - The sustainer section consisted of a thin-walled all-welded monocoque, stainless-steel, conical-cylindrical structure which was divided into a fuel tank and a liquid oxygen tank by an intermediate bulkhead. The section was 10 feet in diameter with an ellipsoidal bulkhead closing the conical forward end and the thrust cone (joined to the aft tank by a thrust ring) closing the aft end. A propellant antislosh system of annular baffles was installed in the liquid oxygen tank. Equipment pods and fairings were mounted externally on the tank section to provide protection against aerodynamic effects.

3.5.1.3 Target launch vehicle-Gemini Agena target vehicle separation: The GATV was attached to the TLV by a cylindrical adapter section installed at the forward end of the TLV tank section. At vernier engine cut-off (VECO), the guidance-initiated cut-off signal was also transmitted to the adapter section where three pyrotechnic devices were detonated releasing the GATV. The retrorockets mounted on the TLV adapter section were ignited at the same time, slowing the TLV which provided a relative velocity between the TLV and the GATV. Complete disengagement took approximately 2 seconds. The TLV adapter remained attached to the forward end of the TLV, and rollers installed on the GATV equipment rack guided the vehicle out of the sustainer along channels incorporated in the adapter.

### 3.5.2 Major Systems

3.5.2.1 Propulsion. - The TLV received its thrust from an integrated propulsion system which consisted of a booster engine incorporating two 165 000-pound thrust chambers, one 57 000-pound thrust sustainer engine, and two vernier engines adding a total of 1340 pounds of thrust. Total nominal thrust at sea level is 388 340 pounds. Hypergolic ignition systems were installed on all engines, and a baffled injection system was included in the booster engine.

3.5.2.1.1 Booster engine: The two regeneratively cooled booster engine thrust chambers were independently gimbal-mounted to provide directional control and stability during booster-stage powered flight. The booster engine system incorporated two turbopump assemblies (one supplying each chamber and powered by a single-gas generator) a turbine exhaust system with an integral heat exchanger and an electro-pneumatic control system. The no. 1 turbopump, in addition to supplying propellants to the no. 1 booster thrust chamber, refilled the vernier fuel start tank (located inside the main fuel tank) to supply fuel during the vernier solo phase.

3.5.2.1.2 Sustainer engine: The sustainer engine started prior to lift-off, adding approximately 57 000 pounds of thrust to that supplied by the booster engine. The sustainer engine was activated for vehicle pitch and yaw control after the booster phase of the flight was terminated.

Components of the sustainer engine included a turbopump, a gas generator, a turbine exhaust system, a liquid oxygen regulator, a cylindrical lubricant tank, a pneumatic manifold, a hydraulic manifold, and associated valves and actuators. The combustion chamber of the sustainer engine had an expansion ratio of 25 to 1, and was regeneratively cooled by fuel flow. The total effective duration of sustainer engine thrust was approximately 300 seconds. Nominal specific impulse is approximately 213 seconds at sea level with an oxidizer-to-fuel ratio of 2.27 to 1.

During the sustainer stage of operation, the sustainer engine provided pitch and yaw directional control of the vehicle by gimbaling in any direction about the pitch and yaw axes. Gimbaling was controlled by hydraulic actuators.

The sustainer turbopump, in addition to supplying propellants to the sustainer engine, furnished propellants for operation of the vernier engines and refilled the vernier liquid oxygen start tank.

3.5.2.1.3 Vernier engines: The vernier engines were started before the booster and sustainer engines, prior to launch, and continued to provide thrust after SECO. The independently gimbaled vernier engines were locked in pitch and yaw, but free in roll during booster powered flight. They were free for pitch, yaw, and roll control for the first 7 seconds of sustainer phase and then locked to provide roll control only for the remainder of the sustainer phase. During the vernier phase (after SECO), the verniers provided pitch, yaw, and roll control in addition to thrust. Hydraulic actuators mounted on the engines permitted deflection of the thrust chambers either differentially or in unison for attitude control.

The main vernier system components were the thrust chambers, mounting brackets, propellant valves, electrical harnesses, hydraulic actuators, propellant start tanks, and necessary plumbing. Propellants for the vernier engines were supplied by the vernier start tanks during engine start and vernier solo phase, but were supplied by the sustainer dual turbopump during booster-sustainer operation.

3.5.2.1.4 Propellants: The propellants used by the target launch vehicle were liquid oxygen and RP-1 hydrocarbon fuel. The propellants were supplied to the combustion chambers under pressure from centrifugal pumps (turbopumps). Liquid oxygen and fuel were burned in two gas generators (booster and sustainer) and the resulting hot gases drove the turbines of the propellant pumps. The flow rate of the hot gases was controlled indirectly by regulation of the flow rate of liquid oxygen which, in turn, was controlled by a pneumatic regulator.

Helium provided the necessary power for operation of valves and other engine components. Helium was also used for pressurization of the propellant tanks and was routed to the liquid oxygen and fuel tanks through a heat exchanger installed in the booster hot-gas system and through pressure regulators to the tanks.

3.5.2.1.5 Propellant utilization system: The propellant utilization system operated to maintain a desired ratio balance of residuals in the main tanks by regulating the fuel to the sustainer engine. This was required to minimize propellant residual imbalance at SECO.

The propellant utilization system measured the rate of consumption by means of ultrasonic sensors. Operating in conjunction with a computer, the ultrasonic sensors presented reflected impedance when subjected to a liquid medium (loaded condition) and an impedance change when subjected to a gaseous medium (unloaded condition). A liquid depletion rate was obtained from the ultrasonic sensors which were mounted on lengths of aluminum tubing (stillwells) and installed inside the fuel and liquid oxygen tanks. As the liquid level receded and uncovered a pair of sensors (both tanks), the change in reflected impedance presented by each sensor to the computer was converted into electrical signals, which were compared in time to determine sense of the propellant error and magnitude of error so as to control the sustainer engine propellant utilization valve and correct the error. The computer assembly was mounted in the pod compartment of the sustainer section of the vehicle.

Figure 3.5-2 is a block diagram of the system and shows the system components in relation to the vehicle.

3.5.2.1.6 Hydraulic system: The launch vehicle contained two independent hydraulic systems which supplied the operating pressure required to position the engine thrust chambers for pitch, yaw, and roll control during flight. One system supplied the booster engine, and the other supplied the sustainer and vernier engines. Electrical signals from the autopilot were transmitted to hydraulic actuator assemblies, each consisting of a servo-valve, an actuating cylinder, and a linear transducer.

The booster hydraulic system provided hydraulic power to actuate the booster thrust chambers. The thrust chambers were actuated together for pitch and yaw control and differentially for roll control. The major components of the system were two servo-controlled valve-actuating cylinder assemblies on each thrust chamber, a hydraulic pump mounted on the B-2 booster turbopump, a hydraulic tank, two accumulators, and associated hardware.

The sustainer-vernier hydraulic system provided hydraulic power to gimbal the sustainer and vernier thrust chambers for pitch, yaw, and roll control from booster engine cut-off (BECO) until SECO.

The sustainer-vernier system obtained hydraulic power as follows:

1. Until SECO, power was obtained from a hydraulic pump driven by a power takeoff on the sustainer engine turbopump assembly.

2. After SECO, power for the vernier engine actuators was supplied by two vernier solo hydraulic accumulators.

The major components of the total system included two servo-controlled valve-actuating cylinder assemblies on each thrust chamber, a hydraulic pump mounted on the sustainer turbopump, a hydraulic tank, an accumulator, and associated hardware.

Figure 3.5-3 shows the hydraulic system in block diagram form.

3.5.2.2 Guidance.- The launch vehicle guidance system consisted of two subsystems. One subsystem (pulse beacon and decoder) measured the position of the vehicle and provided a command link, and the second (rate beacon) measured three components of velocity by continuous wave (cw) radar.

The guidance system was contained primarily in three canisters. One canister contained a mono-pulse radar beacon, one contained a cw radar beacon, and the third contained the decoder which operated in conjunction with the pulse beacon. A slotted wave guide antenna was mounted in the B-2 equipment pod.

Operation of the airborne guidance system was as follows:

The pulse beacons received a pulse-coded signal from a ground station which contained discrete (relay-closure) command information and steering commands. The pulse beacon sent a return signal to the ground station for measurement of position of the vehicle. The decoder decoded the pulse message from the ground station and distributed the information to the various vehicle systems. The cw beacon received a double side-band suppressed carrier signal from the ground station and generated a return signal which was between the frequencies of the two side bands.

The guidance system was powered by 28 V dc, each of the three canisters having its own power supply and dc-to-ac converter.

The ground-based components of the guidance system included a monopulse radar system capable of measuring the position of the vehicle and of transmitting a pulse-coded message to the vehicle-borne guidance system, a rate-measuring device (cw radar) which employed doppler-shift techniques to measure the vehicle's velocity, and a computer which accepted position and velocity coordinates of the vehicle and computed real-time steering and control commands.

3.5.2.3 Flight control system.- The flight control system performed three main functions:

1. Maintain vehicle stability throughout flight.

2. Accept guidance commands, perform steering functions, and generate associated required subroutines.

3. Generate the preset pitch and roll programs during the booster phase of flight.

The principal components of the flight control system were located in four separate packages in addition to the engine actuators. Three packages were located in the B-1 equipment pod, and one inside the adapter. The actuators were mounted on the respective engines.

The three packages mounted in the B-1 equipment pod were the programmer assembly, the servoamplifier assembly, and the displacement gyro assembly (one rate gyro for roll control was also included with the displacement gyros). The TLV adapter-mounted autopilot package contained the pitch and yaw rate gyros. The actuators, mounted near the respective engines, consisted of 10 actuator assemblies, two for each engine.

The displacement gyros sensed the attitude and changes in attitude from an initial reference. The changes and variations in attitude were then transmitted to the engines' servomechanisms which gimbaled the applicable engine or engines to correct the vehicle attitude and to realign it with the initial reference. Damping was provided, as necessary, by the rate gyros, and an integrator included in the system compensated for steady-state errors. The programmer, through the autopilot, rolled the vehicle to a predetermined attitude, pitched it into a predetermined trajectory, and sequenced timed commands during flight.

3.5.2.4 Electrical system.- The electrical system generated and distributed ac and dc power to the various airborne systems. The airborne equipment consisted of four 28-volt batteries, a 400-cycle inverter, a distribution box, two junction boxes, and a power changeover switch. The umbilical connectors were also a part of the system. (See fig. 3.5-4.)

3.5.2.4.1 Main battery: The main battery furnished 28 V dc power to the power changeover switch during flight. From this switch, power was distributed throughout the vehicle. A portion of the power was used to drive the 400-cycle inverter.

The battery consisted of 19 silver-zinc cells sealed in a canister. It was designed to deliver a maximum of 145 amperes for 10 minutes. Normal operation requires approximately 82 amperes for the inverter and about 23 amperes for the dc loads. This battery was manually activated during the countdown procedure.

3.5.2.4.2 Telemetry battery: The telemetry battery provided an independent power source for the telemetry system. This battery was similar in design to the main battery except that it produced 28 volts at 4.5 amperes for a minimum of 30 minutes with four 0.5-second loads of approximately 8 amperes during a 30-minute discharge.

3.5.2.4.3 Range safety command batteries: The range safety command batteries provided independent power supplies for each of the range safety command systems. These batteries were identical to the telemetry battery.

3.5.2.5 Pneumatic system.- During the powered flight phase, the pneumatic system supplied helium gas, at regulated pressures, for pressurization of the propellant tanks, and to actuate various controls. Maintaining the required absolute pressures and differential pressure for the liquid oxygen and fuel tanks assured tank structural integrity and rigidity under inertial and aerodynamic loads, and also insured that the pressure head at the propellant pumps was adequate.

Several service functions were also performed by the system. Pressurized gas was bled from the fuel tank pressurization line and used to pressurize the hydraulic reservoirs and the lubrication tanks. Helium pressure was used to activate the booster-section separation mechanism, pressurize vernier engine start tanks, and supply pressure for various engine control functions.

Helium gas was loaded at high pressure and low temperature for subsequent use at high temperature and decreasing pressure during flight. Heat for expansion of the gas on the vehicle was taken from the engine gas generator exhaust, and gas pressure reduction was accomplished in the hot portion of the system by remotely located regulators. The low pressure system was protected by relief valves. (See fig. 3.5-5.)

3.5.2.5.1 Booster stage pressurization system: The airborne pressurization system comprised two subsystems, one for main propellant tank pressurization and one for control of pressurization and purges in the propulsion system. Gas for tank pressurization during booster stage operation was supplied from six spherical containers located in the engine compartment. The containers were surrounded by metal shrouds into which liquid nitrogen was forced by ground pressure for cooling prior to launch. The cooling liquid was drained through the fill coupling during lift-off. A small fiberglas bottle mounted in the thrust barrel supplied gas pressure for activation of the booster staging cylinders when the booster-section jettison signal was received.

3.5.2.5.2 Sustainer stage pressurization system: Pressurization gas for the vernier engines during vernier operation after SECO was supplied by a spherical container located on the aft end of the fuel tank. Fuel-tank pressure was allowed to decay during sustainer stage operation, and no gas supply was required. Vapor pressure adequately maintained tank pressure in the liquid oxygen tank after booster-section separation. Connections between the booster and sustainer subsystems were made through mechanical disconnect valves which sealed the system at BECO.

3.5.2.5.3 Secondary systems: Gas for pressurization of the hydraulic and pump lubrication oil reservoirs was tapped from the fuel pressurization ducts in the booster and sustainer sections. Supplementary airborne equipment included a vent and shutoff (boiloff) valve for the liquid oxygen tank, a pressure transducer and switch for safety of the intermediate bulkhead, and appropriate manual shutoff and check valves throughout the system.

3.5.2.6 Instrumentation. - The instrumentation system consisted of the equipment required to transform such physical variables as temperature, acceleration, et cetera, into electrical signals for the purpose of obtaining technical data during flight. In addition, landline transmission was employed during launch operations prior to lift-off.

The TLV FM/FM telemetry system consisted of a telemetry package, battery and accessory packages, transducers, two antennas, and an antenna T-coupler. All telemetry equipment except the transducers and one antenna was located in the B-1 equipment pod. The antennas were mounted on opposite sides of the tank structure. The telemetry package was used to monitor 117 measurements which were distributed on nine continuous and five commutated channels. Table 3.5-I is a listing of the instrumentation parameters discussed in this report.

3.5.2.7 Range safety. - The vehicle-borne range safety command subsystem received coded signals which were transmitted by the ground-based range safety command system at the discretion of the Range Safety Officer.

The signals provided for command destruct only; the engine shut-down circuitry had been disabled and would have been used to arm the destruct circuit, if required. The subsystem consisted of the following components: two antenna pairs, an antenna ring coupler, two receiver-decoder units, an arming device, a power and signal control unit, two separate batteries, and a single destructor unit. The destructor unit was mounted in the B-1 equipment pod at the intersection of the intermediate bulkhead and the outer propellant tank walls. When detonated, the unit will completely destroy the TLV through intermixing and ignition of the propellants.

TABLE 3.5-I.- TLV INSTRUMENTATION MEASUREMENTS

| Measurement | Description | Instrumentation range | Type of data |
|---|---|---|---|
| A745T | Ambient at sustainer fuel pump | -50° F to 550° F | Real-time |
| E28V | Missile systems input | 20 to 35 V dc | Real-time |
| E51V | Phase A, 400-cycle | 105 to 125 V ac | Real-time |
| E52V | Phase B, 400-cycle | 105 to 125 V ac | Real-time |
| E53V | Phase C, 400-cycle | 105 to 125 V ac | Real-time |
| E95V | Guidance power input | 20 to 35 V dc | Real-time |
| E96V | Phase A gyro | 105 to 125 V ac | Real-time |
| E151 | Inverter frequency, 400-cycle | 0 to 150 V ac | Real-time |
| P330P | Sustainer fuel pump discharge | 0 to 1500 psia | Real-time |
| P671T | Thrust section temperature, quadrant IV | -50° F to 550° F | Real-time |
| P830U | Propellant utilization valve position | 0 to 5 V dc | Real-time |
| U113V | Propellant utilization valve feedback | 0 to 5 V dc | Real-time |

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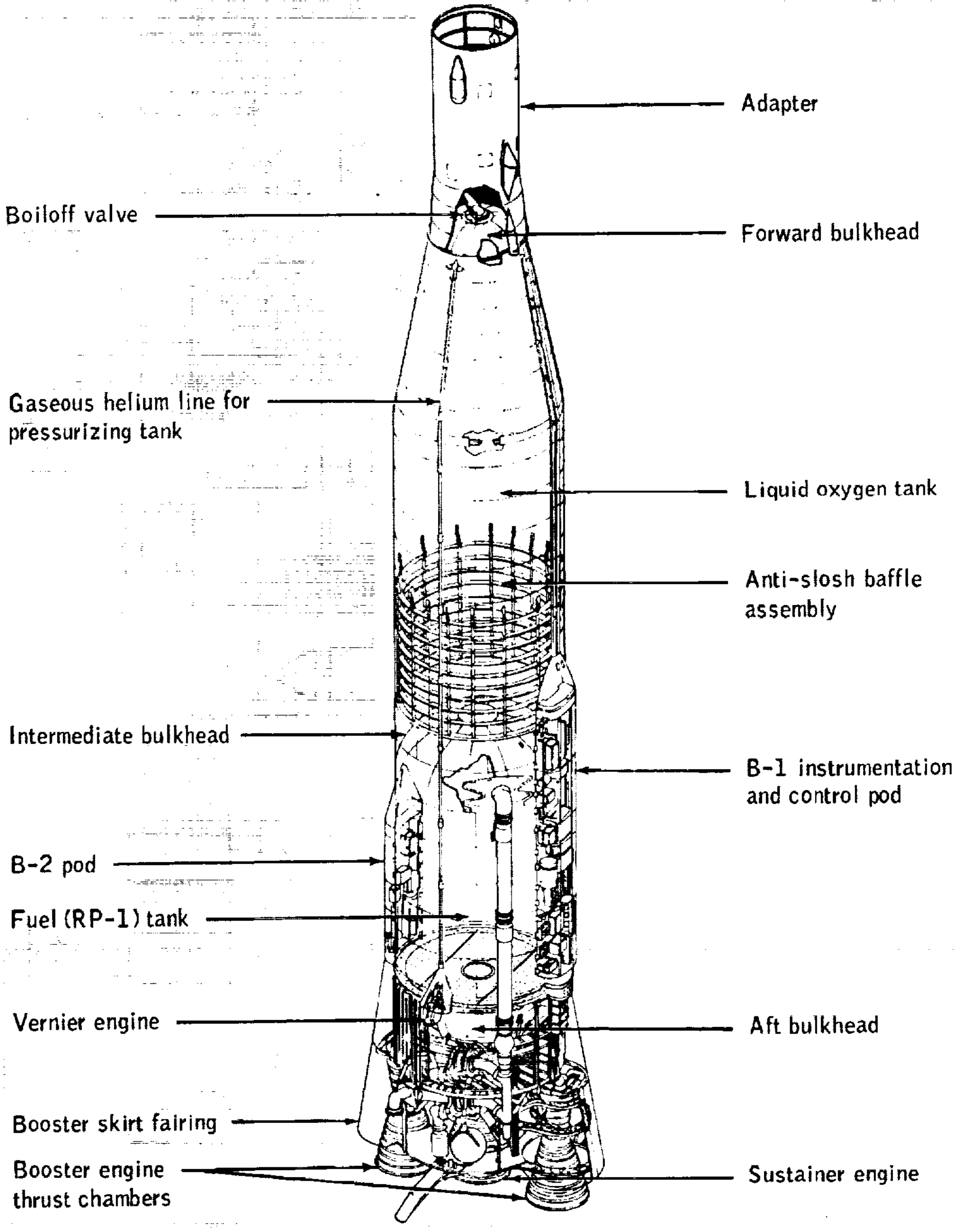

Figure 3.5-1. - Cutaway drawing of target launch vehicle.

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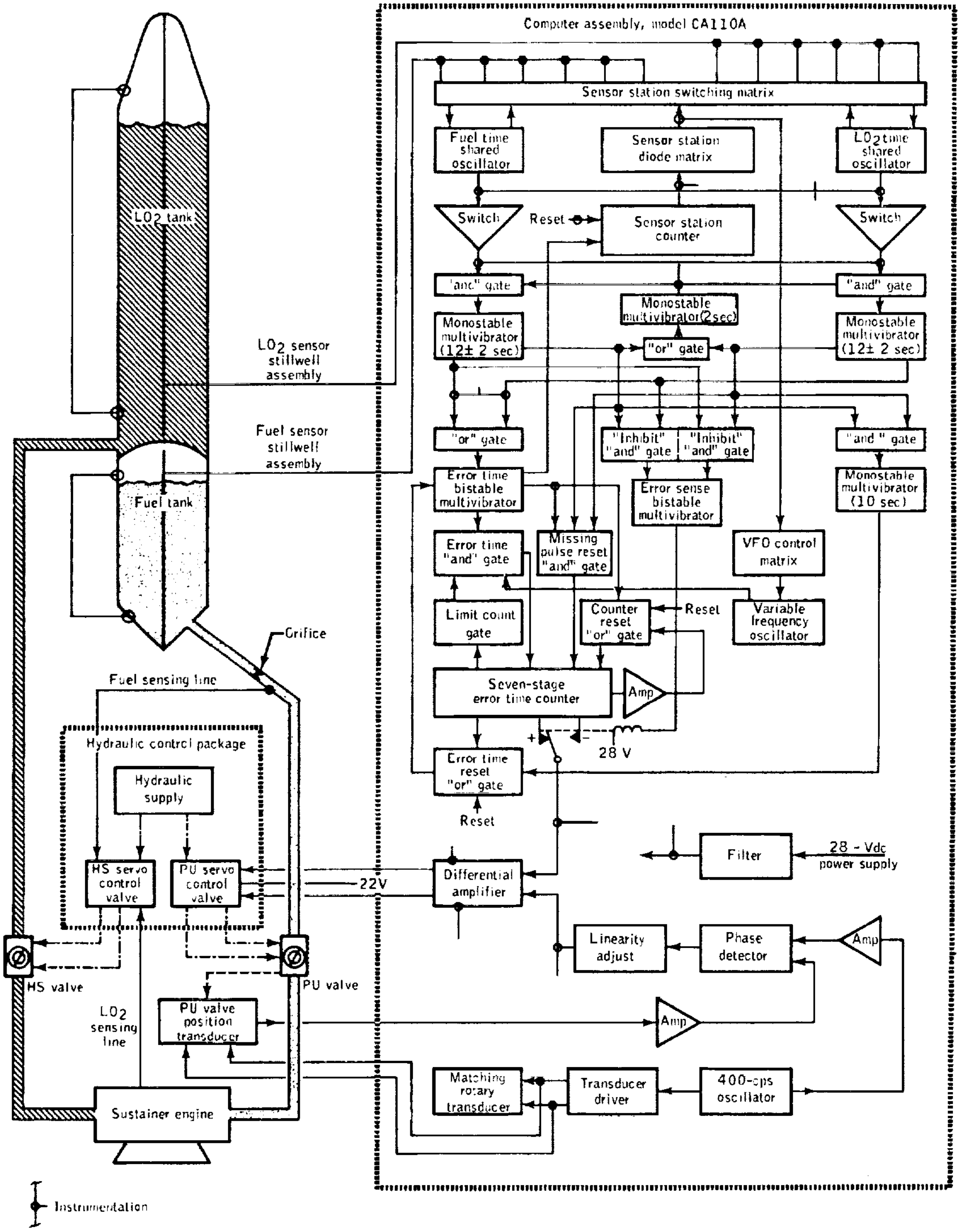

Figure 3.5-2. - Propellant utilization system.

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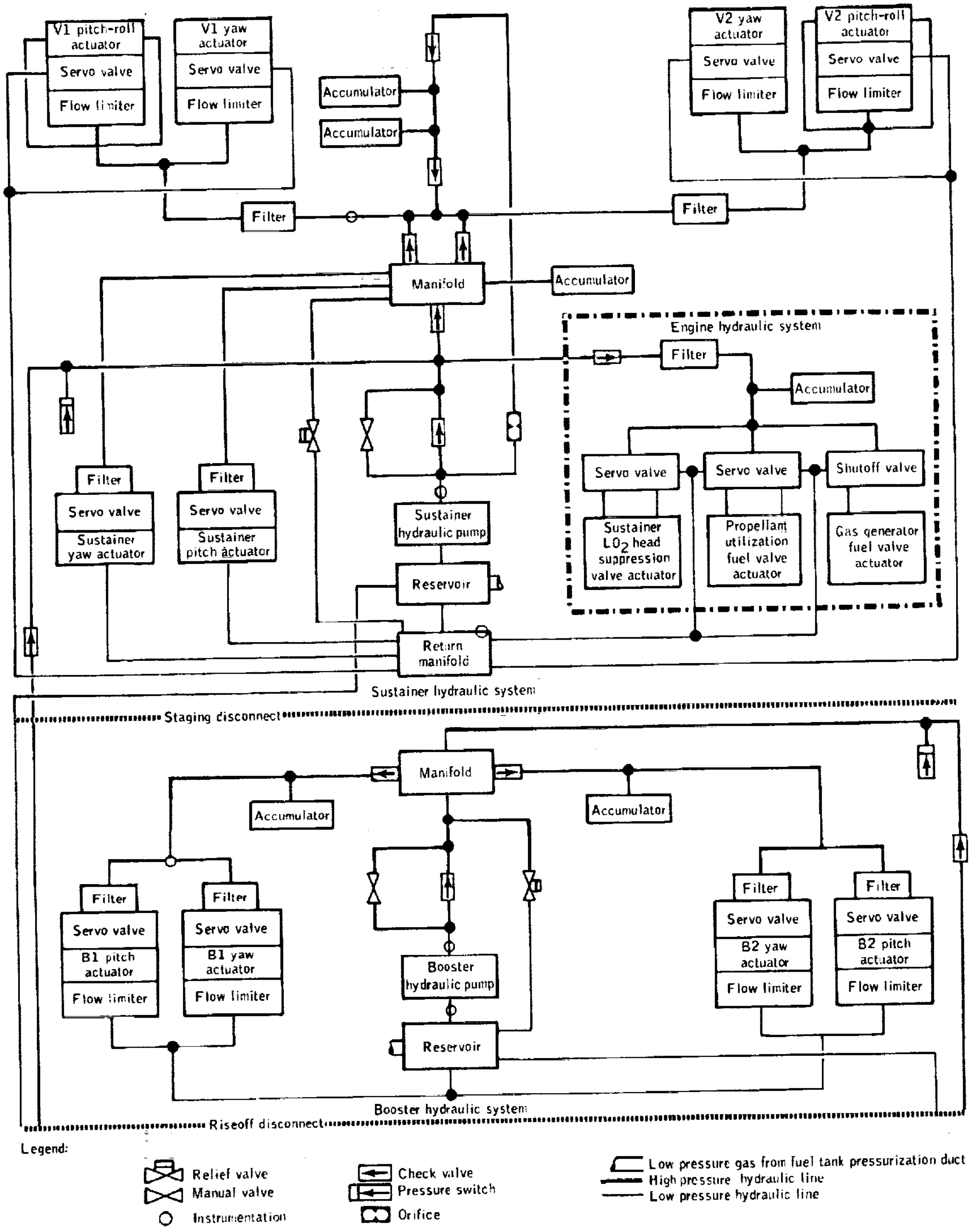

Figure 3.5-3. - Hydraulic system.

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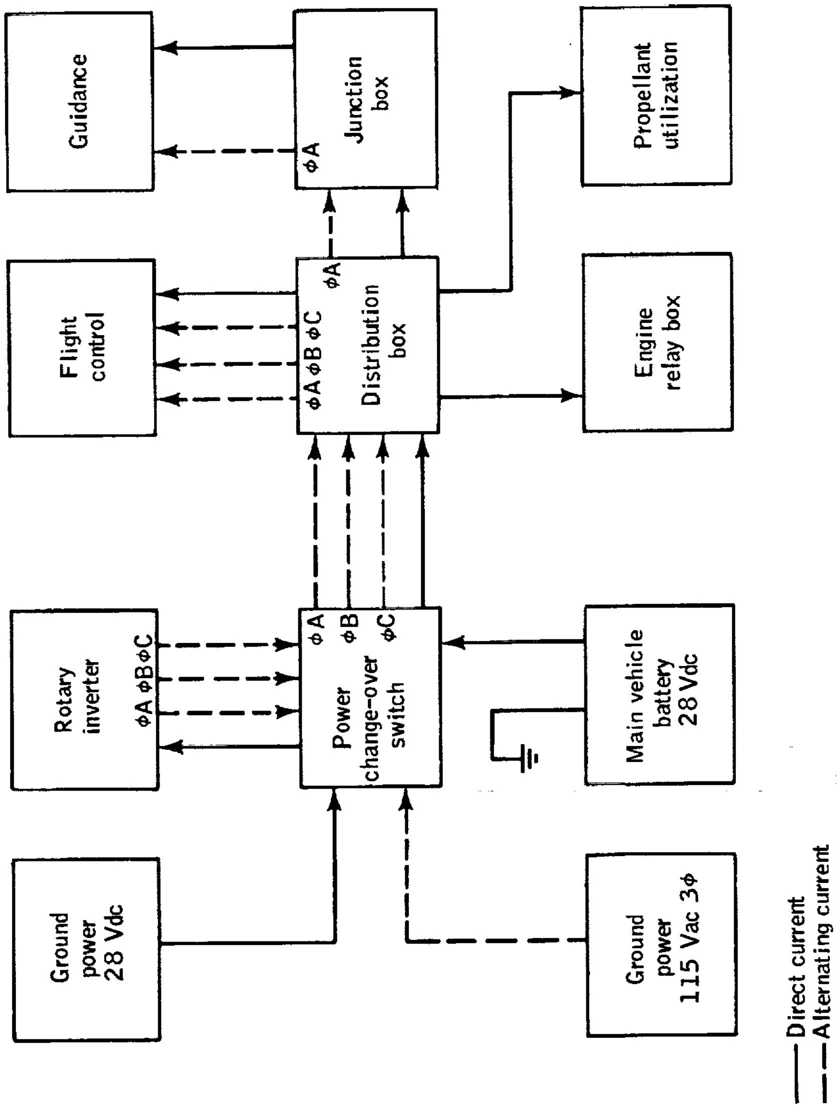

Figure 3.5-4. - TLV electrical system.

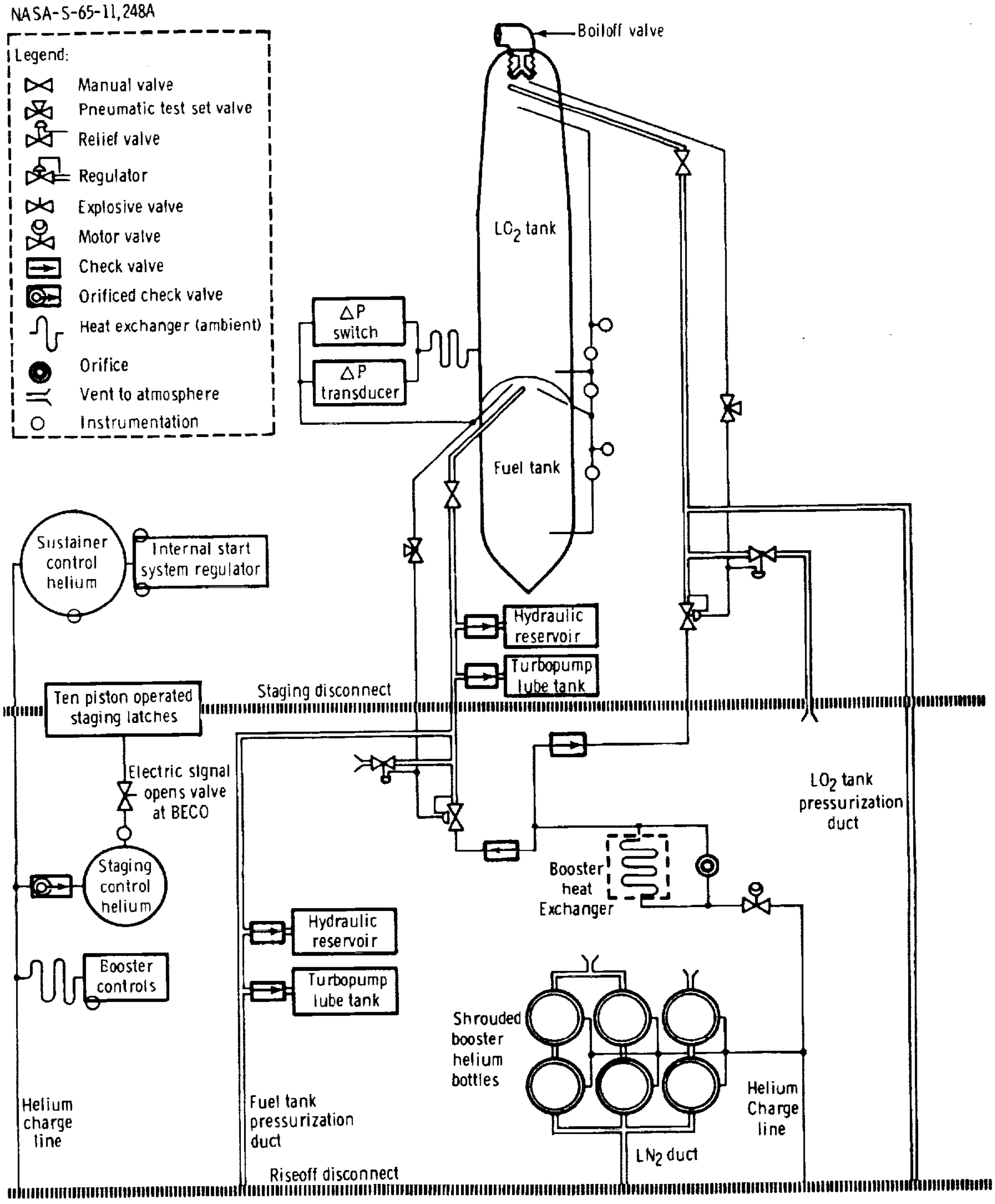

Figure 3.5-5. - Pneumatic pressurization system.

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# 4.0 MISSION DESCRIPTION

## 4.1 ACTUAL MISSION

Lift-off (LO) of the Gemini Atlas Agena target vehicle (GAATV) occurred on October 25, 1965, at 15:00:04.490 G.m.t.

During vertical flight, the vehicle was rolled from a pad azimuth of 105° to a flight azimuth of 85.7°. The flight profile was well within the $3\sigma$ trajectory boundary; however, booster steering in pitch was initiated for a short time at approximately LO + 111 seconds. (See section 5.5.5.) The flight dynamic plotboards and range safety plotboards at the Mission Control Center-Houston all indicated a nominal target launch vehicle (TLV) flight.

The Gemini Agena target vehicle (GATV) was separated from the TLV at LO + 305.97 seconds and started a -90 deg/min pitchdown rate at LO + 334.54 seconds. The pitchdown rate was continued until LO + 347.54 seconds at which time a -3.99 deg/min orbital geocentric rate was initiated. The secondary propulsion system (SPS) was ignited at LO + 349.55 seconds and continued until LO + 369.55 seconds. The ignition of the primary propulsion system (PPS) was initiated by the sequence timer at LO + 367.53 seconds. At approximately 1.5 seconds after the PPS initiation signal, the sequence-timer fired squibs that released helium gas to the propellant tanks. Shortly thereafter, a GATV structural failure apparently occurred. (See section 5.4.)

## 4.2 SEQUENCE OF EVENTS

The times at which major events were planned and executed are presented in table 4.2-I. All events were completed within permissible tolerances until the GATV failure.

TABLE 4.2-I.- SEQUENCE OF EVENTS

| Event | Planned time from lift-off, sec | Actual time from lift-off, sec | Difference, sec |
|---|---|---|---|
| Lift-off (15:00:04.490 G.m.t.) | 0.00 | 0.00 | 0.00 |
| Initiate TLV roll program | 2.00 | 2.01 | 0.01 |
| Terminate TLV roll program | 15.00 | 15.11 | 0.11 |
| Initiate TLV pitch program | 15.00 | 15.21 | 0.21 |
| Booster engine cut-off (BECO) | 131.00 | 130.45 | -0.55 |
| Booster engine separation (BECO + 3.0) | 134.00 | 133.41 | -0.59 |
| Primary sequencer (D-timer) start | 274.21 | 273.51 | -0.70 |
| Sustainer engine cut-off (SECO) | 281.99 | 281.39 | -0.60 |
| Vernier engine cut-off (VECO) | 302.34 | 303.70 | 1.36 |
| TLV-GATV separation (retrorocket fire) | 304.84 | 305.97 | 1.13 |
| Initiate horizon sensor roll control | 304.84 | 305.97 | 1.13 |
| Start 90 deg/min pitchdown | 335.21 | 334.54 | -0.67 |
| Stop 90 deg/min pitchdown | 348.21 | 347.54 | -0.67 |
| Start 3.99 deg/min orbital pitch rate | 348.21 | 347.54 | -0.67 |
| Initiate high-speed pitch control | 348.21 | 347.54 | -0.67 |
| SPS ignition | 350.21 | 349.55 | -0.66 |
| Open PPS gas generator valve | 368.21 | 367.53 | -0.68 |
| PPS ignition (90-percent chamber pressure) | 369.51 | NA | -- |
| SPS thrust cut-off | 370.21 | 369.55 | -0.66 |
| Fire jettison nose shroud squibs | 378.21 | NA | -- |
| Arm PPS thrust cut-off | 533.21 | NA | -- |
| Velocity meter cut-off | 550.39 | NA | -- |
| PPS thrust cut-off backup | 553.21 | NA | -- |

## 4.3 FLIGHT TRAJECTORY

The planned launch trajectory used in this report is the preflight calculated nominal trajectory from reference 4. The actual launch trajectory is based on radar data from the Manned Space Flight Tracking Network. In the planned trajectory, the Patrick Air Force Base and the 1959 ARDC model atmospheres were used below and above 25 nautical miles, respectively. In the actual trajectory, the atmosphere at the time of launch was used up to 25 nautical miles. A time history of the launch trajectory is shown in figure 4.3-1.

### 4.3.1 Spacecraft

This section is not applicable to this report

### 4.3.2 Gemini Agena Target Vehicle

The launch trajectory data shown in figure 4.3-1 are based on the real-time output of the range-safety impact prediction computer (IP-3600). The IP-3600 used data from the following sources:

| Station | Radar | Time from lift-off, sec |
|---|---|---|
| Patrick Air Force Base | FPQ-6 | 0 to 162 |
| Kennedy Space Center | TPQ-18 | |
| Grand Bahama Island | TPQ-18 | 162 to 282 |
| Grand Turk Island, Grand Bahama Island | TPQ-18 | 282 to 376 |
| Grand Turk Island, Bermuda[a] | FPS-16 | |
| Patrick Air Force Base | FPQ-6 | 389 to 548 |
| Kennedy Space Center[b] | TPQ-18 | |

[a] Beacon track

[b] Skin track

The actual launch trajectory, as compared with the planned trajectory in figure 4.3-1, was essentially nominal through the target launch vehicle booster-stage and sustainer-stage burns and the coast ellipse. Table 4.3-I contains a comparison of the trajectory parameters during this phase. Table 4.3-II contains a comparison of the planned and actual osculating elements at VECO. These parameters are based on the C-band tracking radars previously described. Shortly after primary propulsion system start at the termination of the coast ellipse, there was an inadvertent PPS termination. Subsequently, all tracking data (with the exception of some skin track) and all telemetry data were lost.

TABLE 4.3-I.- COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS

| Condition | Planned | Actual | Difference |
|---|---|---|---|
| BECO | | | |
| Time from lift-off, sec | 131.00 | 130.45 | -0.55 |
| Geodetic latitude, deg N | 28.54 | 28.54 | 0.00 |
| Longitude, deg W | 79.74 | 79.75 | 0.01 |
| Altitude, ft | 196 829 | 195 033 | -1796 |
| Altitude, n. mi. | 32.4 | 32.1 | -0.3 |
| Range, n. mi. | 42.9 | 42.3 | -0.6 |
| Space-fixed velocity, ft/sec | 9 797 | 9 754 | -43 |
| Space-fixed flight-path angle, deg | 21.28 | 21.52 | 0.24 |
| Space-fixed heading angle, deg E of N | 86.69 | 86.84 | 0.15 |
| SECO | | | |
| Time from lift-off, sec | 282.0 | 281.4 | -0.6 |
| Geodetic latitude, deg N | 28.85 | 28.84 | -0.01 |
| Longitude, deg W | 74.58 | 74.59 | 0.01 |
| Altitude, ft | 658 755 | 659 513 | 758 |
| Altitude, n. mi. | 108.4 | 108.5 | 0.1 |
| Range, n. mi. | 315.7 | 314.7 | -1.0 |
| Space-fixed velocity, ft/sec | 17 632 | 17 636 | 4 |
| Space-fixed flight-path angle, deg | 10.17 | 10.08 | -0.09 |
| Space-fixed heading angle, deg E of N | 86.48 | 86.20 | -0.28 |
| VECO | | | |
| Time from lift-off, sec | 302.3 | 303.7 | 1.4 |
| Geodetic latitude, deg N | 28.91 | 28.90 | -0.01 |
| Longitude, deg W | 73.60 | 73.52 | -0.08 |
| Altitude, ft | 718 863 | 724 795 | 5932 |
| Altitude, n. mi. | 118.3 | 119.2 | 0.9 |
| Range, n. mi. | 367.5 | 371.4 | 3.9 |
| Space-fixed velocity, ft/sec | 17 555 | 17 542 | -13 |
| Space-fixed flight-path angle, deg | 9.14 | 9.05 | -0.09 |
| Space-fixed heading angle, deg E of N | 86.99 | 86.86 | -0.13 |

TABLE 4.3-I.- COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS - Concluded

| Condition | Planned | Actual | Difference |
|---|---|---|---|
| Targeting Parameters | | | |
| Semi-major axis, n. mi. . . . . . . . . . | 2 330.7 | 2 330.5 | -0.2 |
| Eccentricity . . . . . . . . . . . . . . | 0.5435 | 0.5438 | 0.0003 |
| Inclination, deg . . . . . . . . . . . . | 28.90 | 28.90 | 0.00 |
| Inertial longitude of ascending node, deg . . . . . . . . . . . . . . . . . . | 69.55 | 69.80 | -0.25 |
| PPS Start | | | |
| Time from lift-off, sec . . . . . . . . . | 369.5 | 367.8 | -1.7 |
| Geodetic latitude, deg N . . . . . . . . | 29.02 | 29.01 | -0.01 |
| Longitude, deg W . . . . . . . . . . . . | 70.39 | 70.46 | 0.07 |
| Altitude, ft . . . . . . . . . . . . . . | 869 756 | 867 755 | -2001 |
| Altitude, n. mi. . . . . . . . . . . . . | 143.1 | 142.8 | -0.3 |
| Range, n. mi. . . . . . . . . . . . . . | 536.4 | 532.5 | -3.9 |
| Space-fixed velocity, ft/sec . . . . . . | 17 297 | 17 290 | -7 |
| Space-fixed flight-path angle, deg . . | 5.66 | 5.94 | 0.28 |
| Space-fixed heading angle, deg E of N . | 86.67 | 89.07 | 2.40 |

TABLE 4.3-II. - OSCULATING ELEMENTS AT VECO

| Element | Planned | Actual | Difference |
|---|---|---|---|
| Apogee altitude, n. mi. . . . | 158.1 | 158.2 | 0.1 |
| Perigee altitude, n. mi. . . | -2376.9 | -2377.4 | -0.5 |
| Period, min . . . . . . . . . . | 47.07 | 47.07 | 0.00 |
| Inclination, deg . . . . . . | 28.90 | 28.90 | 0.00 |
| True anomaly, deg . . . . . . | 172.15 | 172.23 | 0.08 |
| Argument of perigee, deg . . | -87.62 | -87.86 | -0.24 |
| Latitude of perigee, deg S . | 29.40 | 29.40 | 0.00 |
| Longitude of perigee, deg E . | 108.74 | 108.73 | -0.01 |
| Latitude of apogee, deg N . . | 29.02 | 29.03 | 0.01 |
| Longitude of apogee, deg W . | 77.16 | 77.17 | 0.01 |

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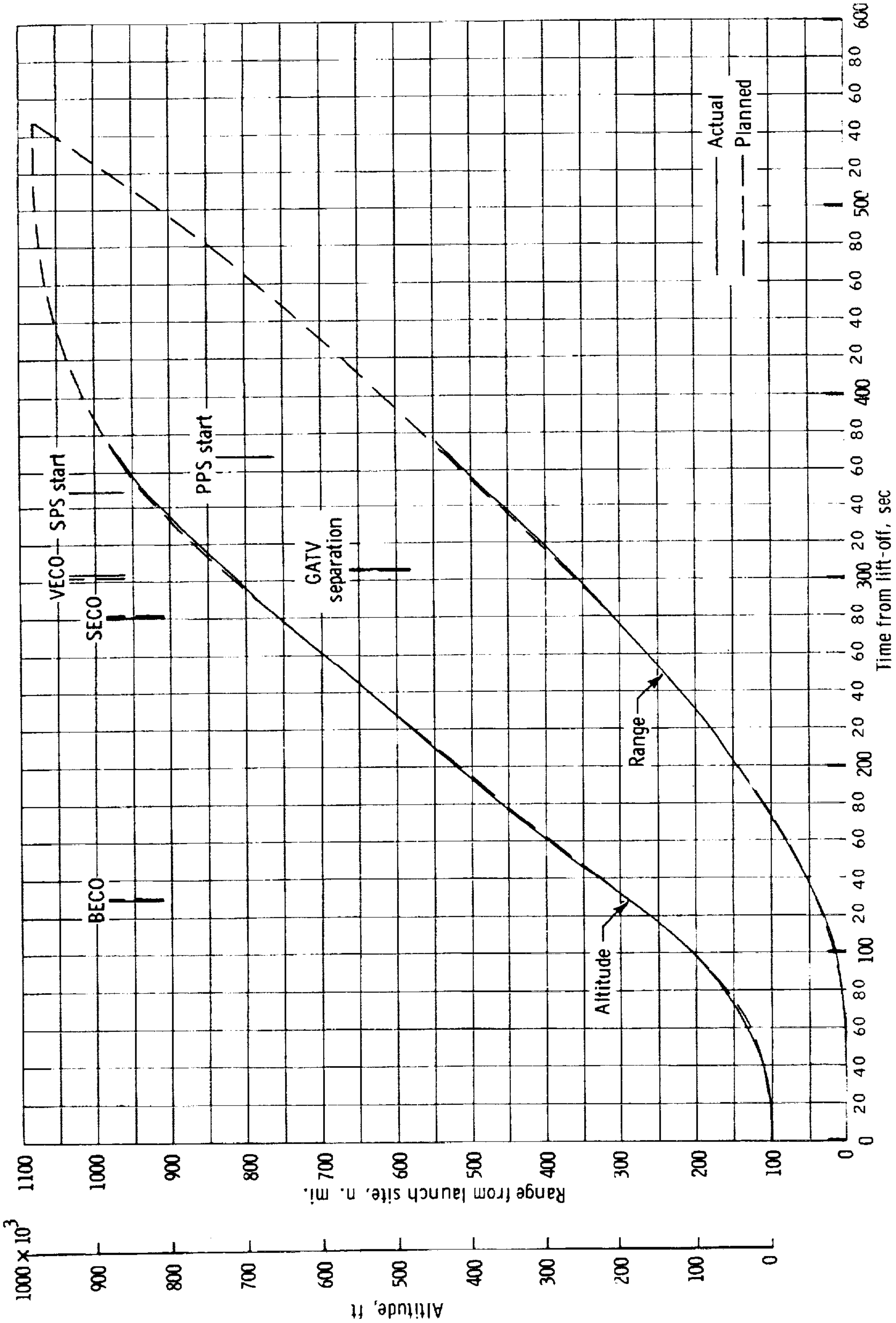

(a) Altitude and range.

Figure 4.3-1. - Trajectory parameters for the GAATV launch phase.

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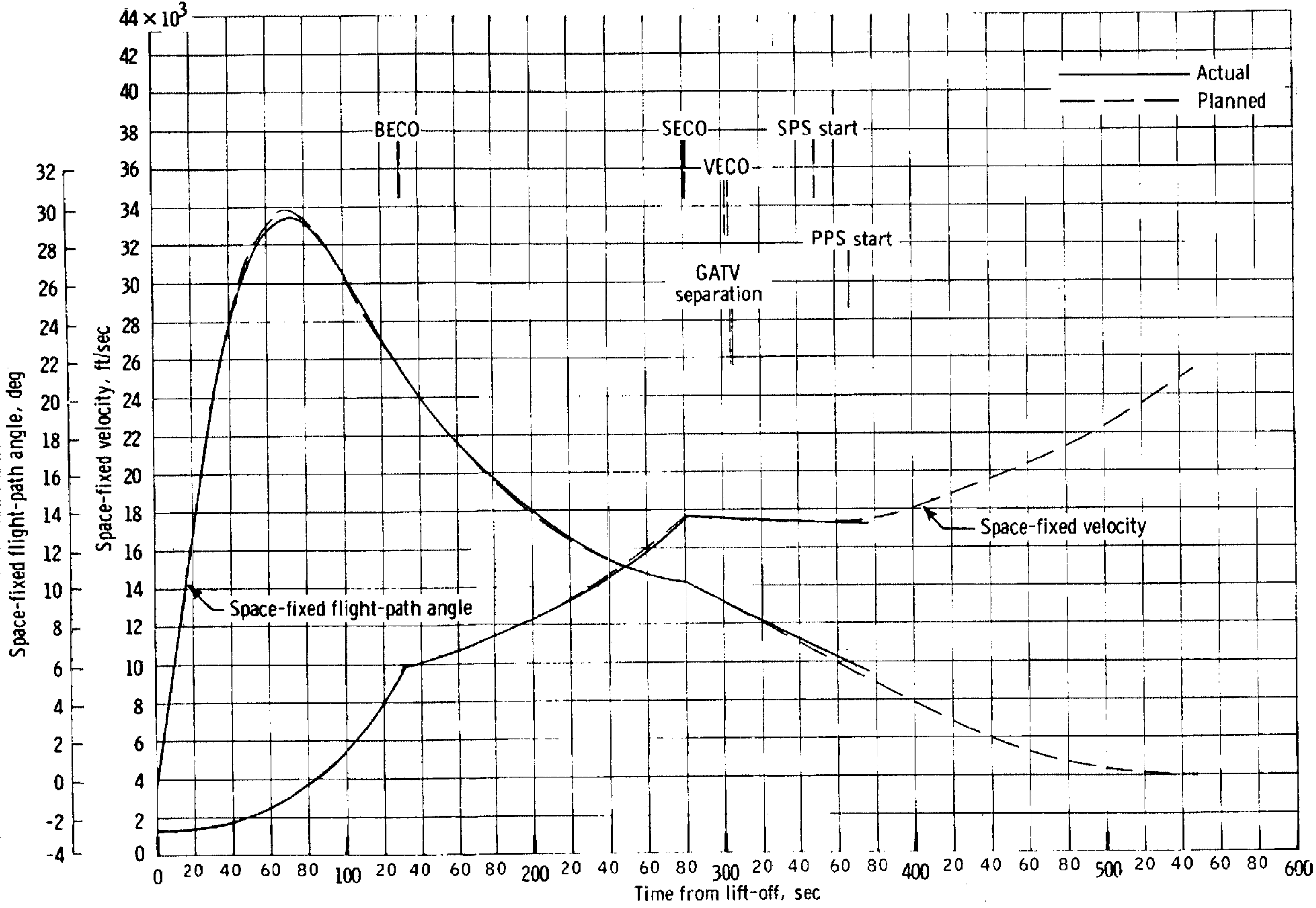
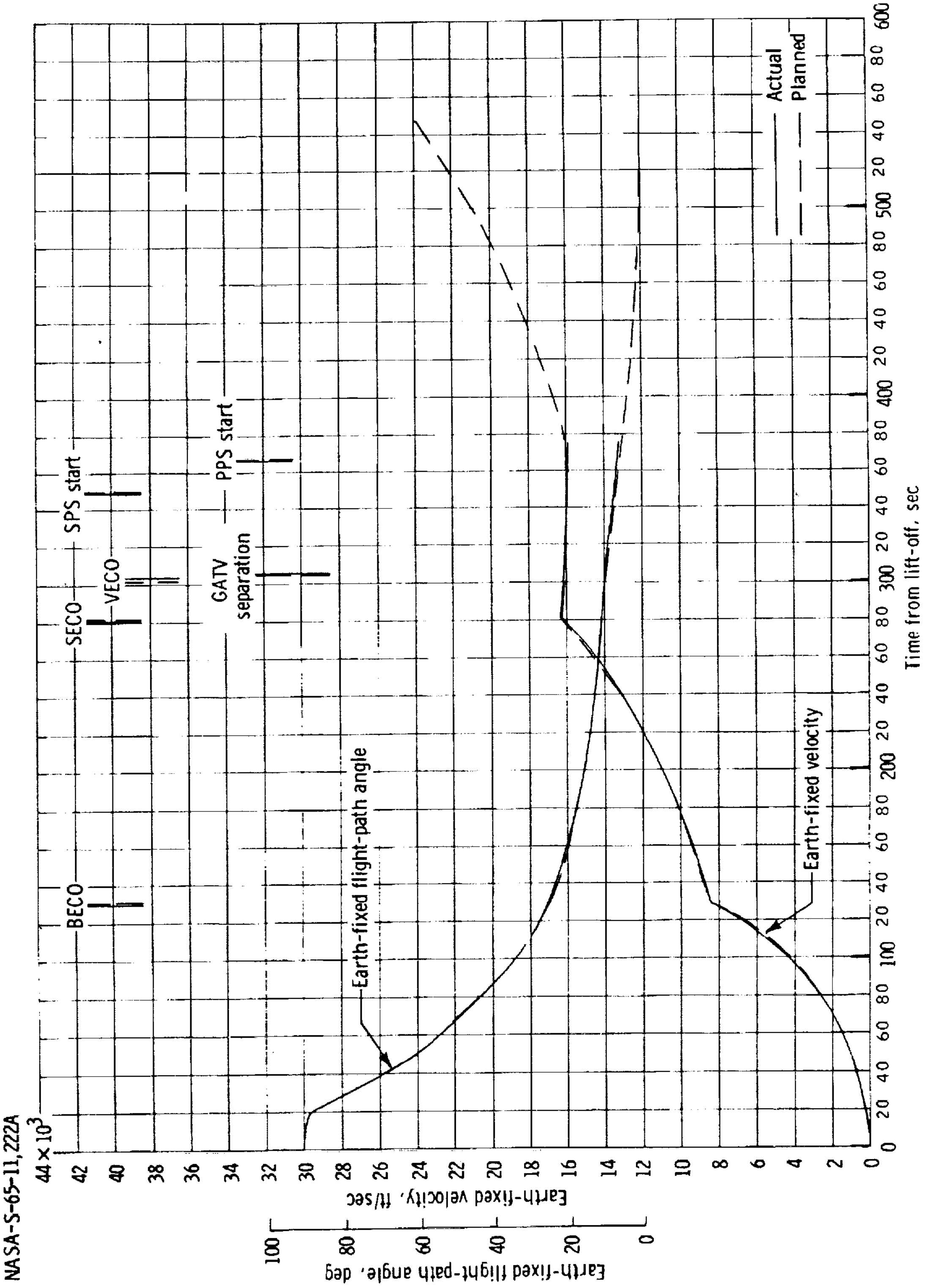


(b) Space-fixed velocity and flight-path angle.

Figure 4.3-1. - Continued.



(c) Earth-fixed velocity and flight-path angle.

Figure 4.3-1. - Continued.

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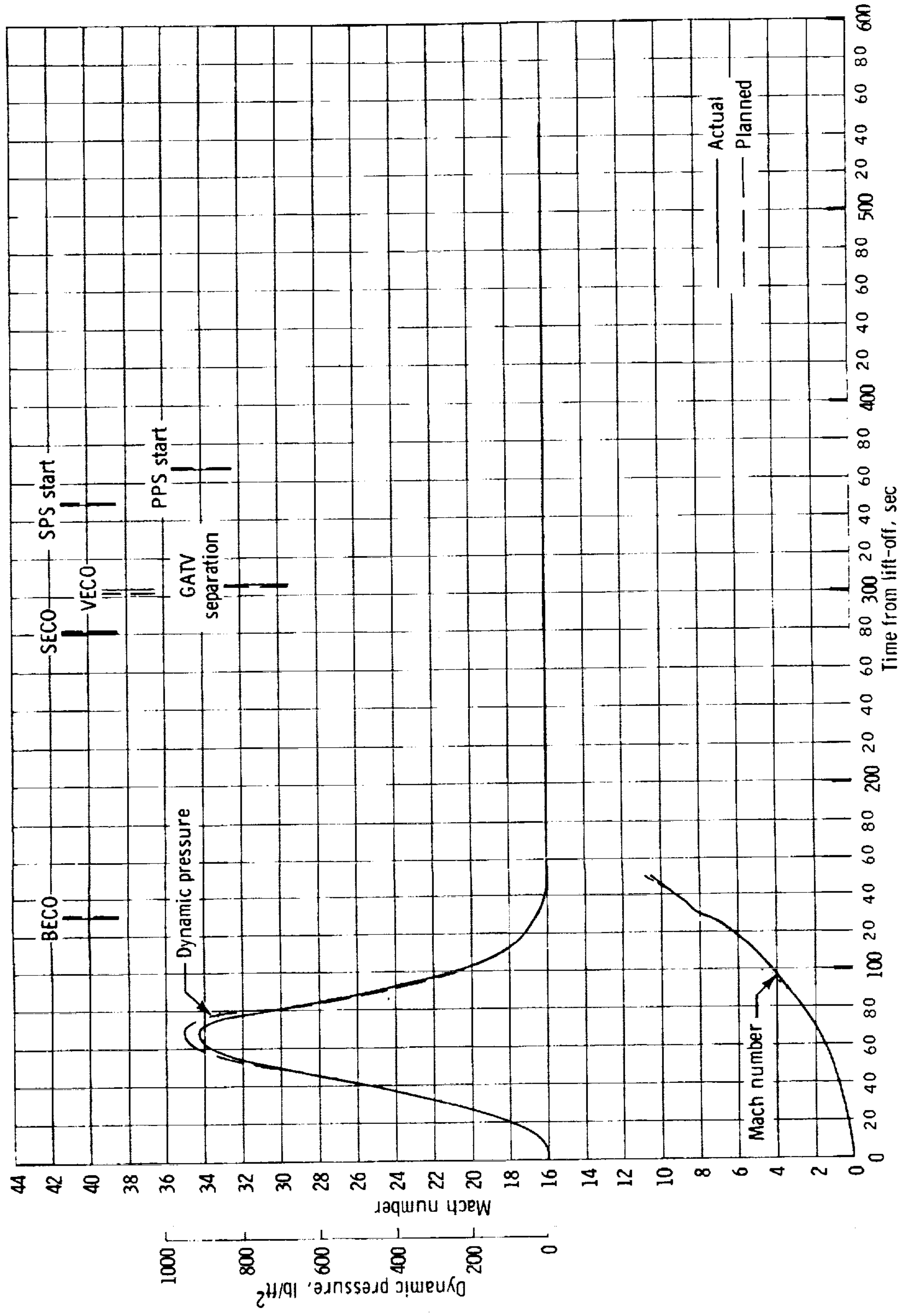

(d) Dynamic pressure and Mach number.

Figure 4.3-1. - Continued.

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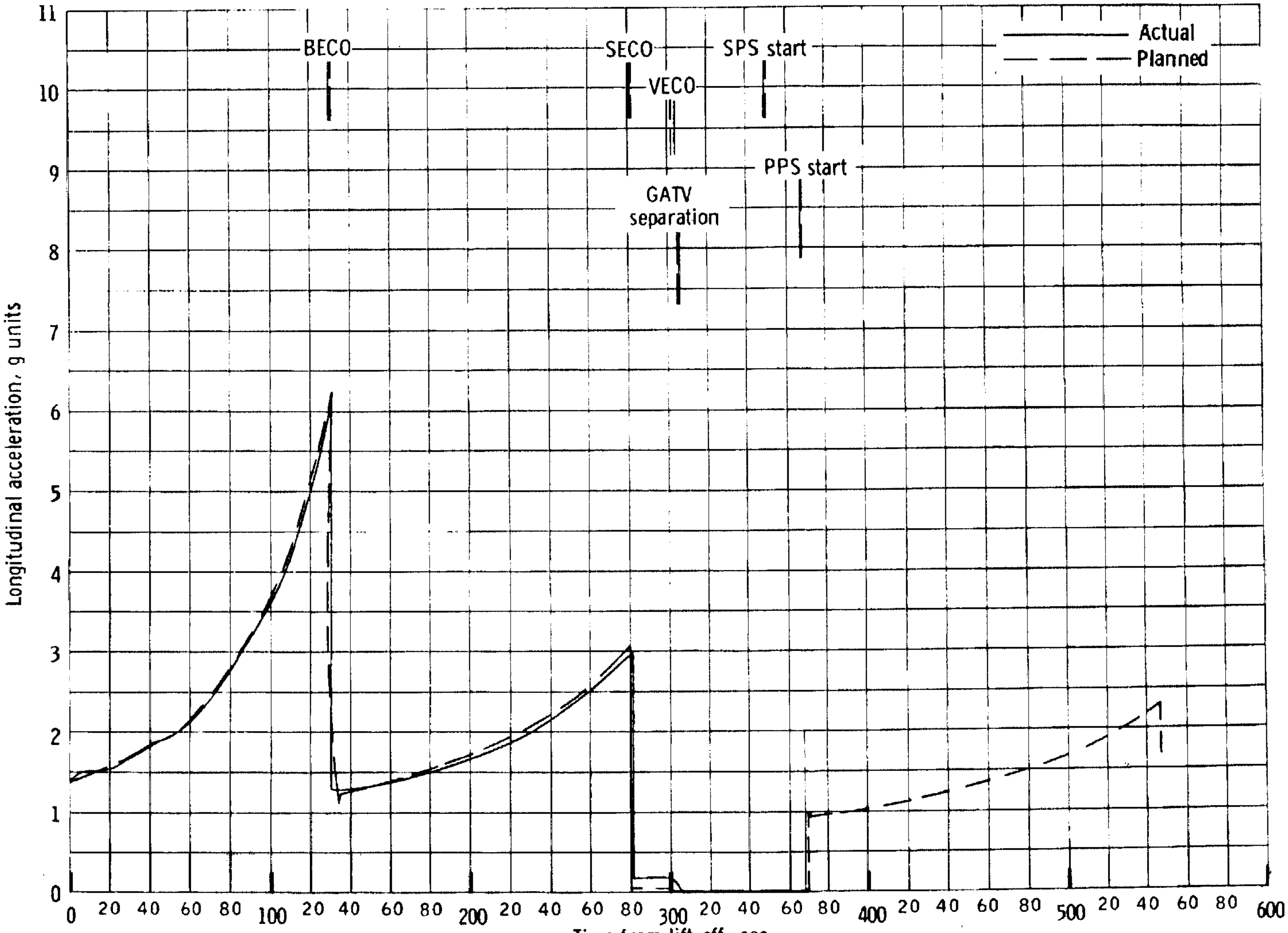

(e) Longitudinal acceleration.

Figure 4.3-1. - Concluded.

# 5.0 VEHICLE PERFORMANCE

## 5.1 GEMINI SPACECRAFT

This section is not applicable to this report

## 5.2 GEMINI LAUNCH VEHICLE

This section is not applicable to this report

## 5.3 GEMINI SPACECRAFT AND LAUNCH VEHICLE INTERFACE

This section is not applicable to this report

## 5.4 GEMINI AGENA TARGET VEHICLE PERFORMANCE

The Gemini Agena target vehicle (GATV) failed to attain orbit when the primary propulsion system (PPS) shut down approximately 1 second after initiation. Approximately 7 seconds later, all communications with the vehicle were lost.

The data indicate that all systems were nominal during the launch and boost phase. GATV separation from the target launch vehicle (TLV) appeared to be normal based on TLV and GATV telemetry data. The guidance and control system operated properly after separation. The secondary propulsion system (SPS) used for ullage orientation indicated nominal operation.

The initiation of the primary propulsion system, the premature shutdown, and the subsequent termination of the flight are covered in detail in the following sections.

### 5.4.1 Airframe

5.4.1.1 Loads.- Estimated GATV structural loads are given in the following table. These data indicate that maximum loading occurred at station 322 in the max $q\alpha$ region of flight.

| GATV station, in. | Max $q\alpha$ | | Pre-BECO | |
|---|---|---|---|---|
| | Load, lb | Design ultimate, percent | Load, lb | Design ultimate, percent |
| 248 | 29 000 | 39 | 7 200 | 10 |
| 322 | 55 300 | 43 | 36 100 | 28 |

5.4.1.2 Temperatures.- Shroud temperature sensors indicated that a steady increase from lift-off (LO) + 75 seconds until a peak of 150° F to 250° F, depending on location, was reached at approximately LO + 178 seconds. The temperature sensor of the horizon-sensor fairing indicated a peak temperature of 505° F at approximately LO + 140 seconds and went off-scale at LO + 302.75 seconds indicating a normal fairing separation.

The four shear-panel temperature sensors (measurements A-150 through A-153) indicated a maximum rise of 3° F until approximately LO + 369.0 seconds at which time the panel temperatures began a steady decrease (see fig. 5.4.1-1). It is difficult to obtain any conclusive data from these temperature measurements because of the slow sampling rate; however, it is reasonably clear that these temperatures did not start down until after the first indication of the anomaly at LO + 368.44 seconds.

During the normal ascent, the aft-bulkhead temperature sensors (measurements A-154 and A-155), the SPS-module bulkhead temperature sensors (measurements A-156 and A-157), and the radiation-shield temperature sensors (measurements A-158 and A-159) indicated small increases in temperature of approximately 18° F. The aft-bulkhead temperature sensors, however, also showed steady temperature decreases after the anomaly beginning at approximately LO + 369.0 seconds (see fig. 5.4.1-1).

5.4.1.3 Pressures.- Forward-compartment and aft-compartment pressure sensors (measurements A-20 and A-21) indicated normal pressure decays with altitude.

5.4.1.4 Accelerations.- The TDA longitudinal accelerometer (measurement A-9) indicated normal booster-engine start transients at lift-off and axial oscillations during transonic flight. A normal increase in acceleration was indicated to the measurement limit of 3.15g at approximately LO + 80 seconds. Measurement A-9 indicated that booster-engine cut-off (BECO), staging, sustainer-engine cut-off (SECO), and vernier-engine cut-off (VECO) were properly executed. At separation, both aft-mounted accelerometers ceased to function. The TDA-mounted accelerometer (A-4) showed VECO and TLV-GATV separation as transients.

TDA-mounted accelerometers A-4 and A-523 showed transients between LO + 367.80 and LO + 369.15 seconds. Accelerometer A-523 showed periods of intermittent operation during ascent; however, this particular trace is significant because it indicated separation time. Acceleration data are presented in figure 5.4.1-2.

5.4.1.5 Separation.- TLV-GATV separation-monitor A-14 normally shows three steps, each of approximately 1.25 volts, which are separated by time intervals of approximately 1 second. On this flight, the data indicated only two steps because the second step exceeded the telemetry channel 5-volt capability, and the remaining step could not be indicated. An approximate 0.75-second time interval between the first and second steps indicated an average separation velocity of 40 in./sec. By using a TLV calculated weight of 8480 pounds at separation, and assuming a nominal retrorocket thrust of 500 pounds for each retrorocket through a nominal 0.9-second burn time, a negative $\Delta V$ of 40.8 in./sec was computed. This shows good correlation with the separation monitor data.

The shroud separation monitor (A-52) showed no change through telemetry signal loss, indicating a mated condition. Separation was not scheduled to occur until after a steady-state condition for PPS engine thrust had been achieved.

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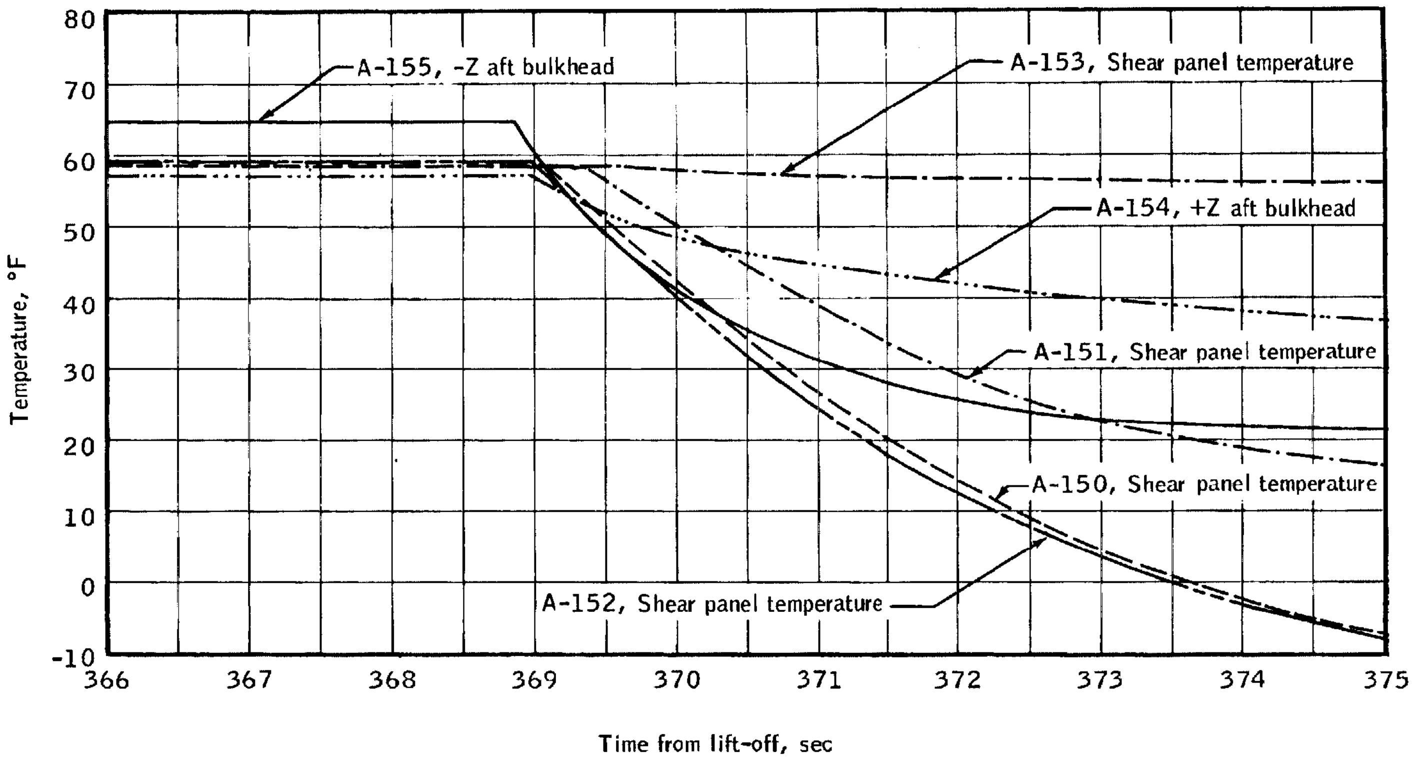

Figure 5.4.1-1. - Aft rack shear panel and aft bulkhead temperatures.

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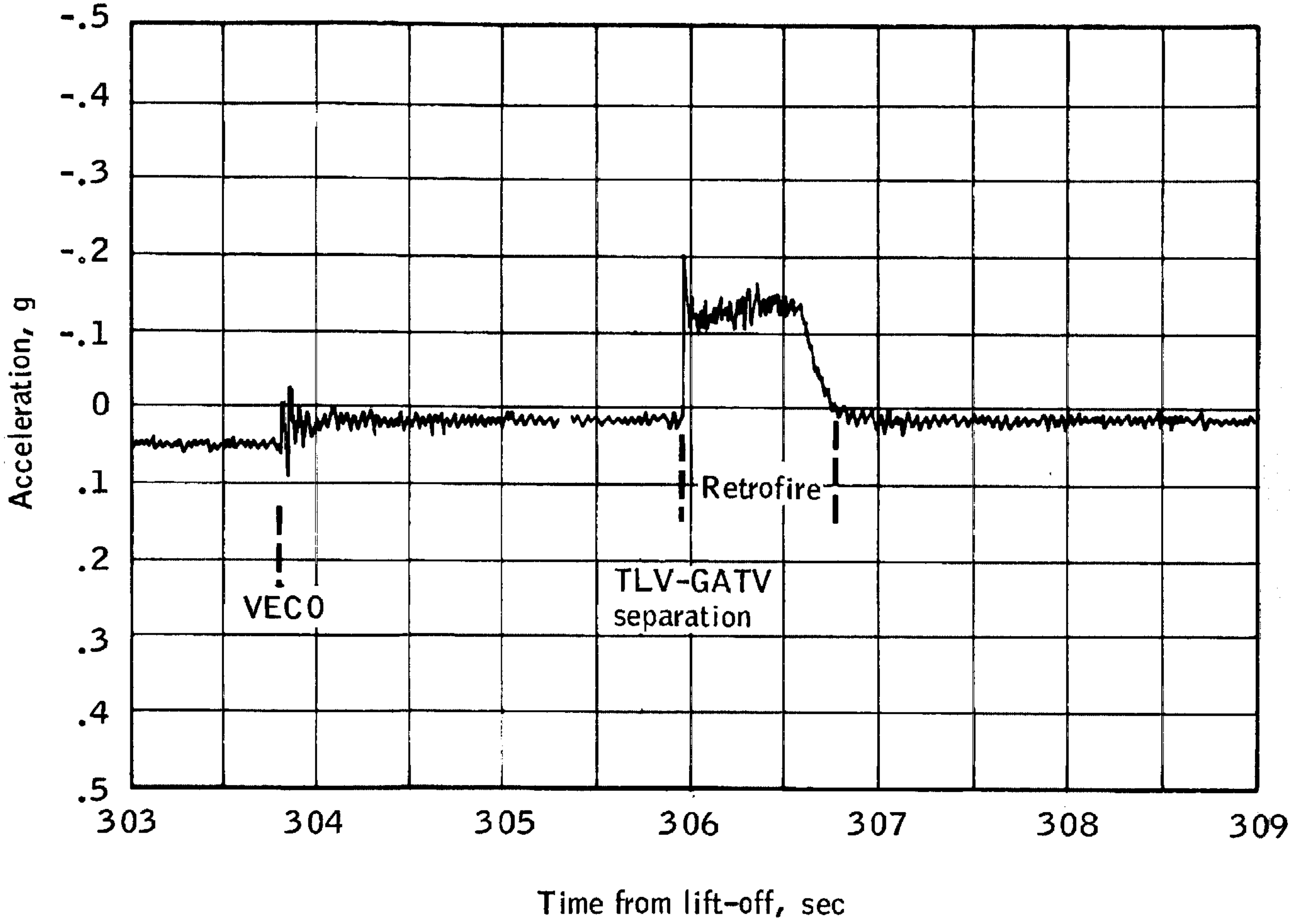

Figure 5.4.1-2. - TLV fine accelerometer data.

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## 5.4.2 Propulsion System

5.4.2.1 Summary. - All preflight and boost phase conditions for the propulsion system were normal until the starting period of the primary propulsion system (PPS). Start tank and main tank pressures were nominal at lift-off as shown in table 5.4.2-I which is a summary of PPS conditions. The components and instrumentation points are shown in figure 5.4.2-1. At 367.53 seconds after lift-off, power was simultaneously applied to the main engine gas generator valves and the pilot-operated solenoid valve (POSV) which controls main fuel flow. During the engine start transient, an anomaly occurred which resulted in a loss of power to the engine valves at or near LO + 368.44 seconds. This, in turn, caused a complete loss of engine power and led to the destruction of the vehicle as a result of main propellant tank overpressurization. During the same time period, several engine parameters exhibited abnormal changes indicating improper main engine operation. These parameters are shown in figures 5.4.2-2 and 5.4.2-3 and are discussed in the following paragraphs.

5.4.2.2 Propellant and pressurization systems. - The main propellant tanks were loaded and pressurized on the ground as shown in table 5.4.2-I. They exhibited no unusual characteristics until about LO + 368.94 seconds which was after the main engine anomalies occurred. Main tank pressures (B-8 and B-9) were normal at LO + 367.53 seconds and showed the expected pressure drop resulting from flow initiation at LO + 368.0 seconds. At LO + 368.9 seconds, the helium pressurization system squib valve was fired by the sequencer (D-timer) and pressurant flow was started. The sudden surge in tank pressures seen at this time is not unexpected because the transducers recording tank pressure are on the pressurization lines near the helium valve. However, the fact that the indicated pressures did not return to the normal values (slowly decreasing tank pressures) is indicative of no flow out of the propellant tanks. Because the helium flow is controlled only by orifices, tank pressure continued to increase as shown by measurements B-8 and B-9, and later as reflected on measurement B-1, until loss of telemetry at which time the fuel tank pressure was over 100 psig. Fuel tank rupture is indicated as the cause of vehicle breakup and loss of telemetry. The rated burst pressure for the propellant tanks is 75 psig.

5.4.2.3 Primary propulsion system. -

5.4.2.3.1 Normal GATV (8247 engine) start sequence: When power is applied to the engine electronic gate, either by D-timer operation or by the engine sequencer signals, it is simultaneously connected through the engine overspeed control relay contacts directly to the engine gas generator valves and the pilot-operated solenoid valve (main fuel valve). At this time, the engine is technically started and the following functions occur. The oxidizer gas generator valves open in about 40 milliseconds and the fuel gas generator valve in about 60 milliseconds. Because of the greater volume and smaller flow rate of the oxidizer system, fuel enters the gas generator first. Gas generator ignition occurs about 200 to 250 milliseconds after the valve signal and the turbine starts to turn. Since the main fuel valve solenoid has already been activated, both the main valves respond essentially as pressure actuated units. As pump outlet pressure increases, the oxidizer valve starts to open at about 275 psig. Oxidizer flow then starts to fill the engine cooling passages. The fuel valve starts to open at approximately 600 psig in the fuel valve activation line. Response of the valves combined with line volumes and flow rates results in a fuel preflow of about 2.5 pounds. (Preflow is the amount of fuel which flows past the injector face prior to oxidizer flow past the injector face.) Under nominal conditions ignition should occur at about 0.9 second after the valve signal. During this same time period, the start tank pressures have decayed while feeding the gas generator. As the pump speeds up, the system starts to bootstrap and recharge the start tanks while continuing to feed the gas generator. On a normal start, the tanks will be at the minimum pressure at about the time of engine ignition. Fuel side recharge will precede that of the oxidizer because of pump flow rates during the transient.

The GATV primary propulsion system is a modification of the standard Agena 8096 engine. Changes were made to provide a multiple restart system and to increase engine reliability, provide more repeatable start and shutdown transients, and conserve propellants. These alterations, other than the start system and turbine overspeed automatic shutdown, included removal of an oxidizer manifold pressure switch system, modification of the spring force in the main fuel and oxidizer valves, and a relocation of the point at which fuel valve actuation pressure was obtained. As a result of these changes, the normal 6.5-pound oxidizer lead of the Agena D (8096 engine) was changed to a GATV (8247 engine) fuel lead of about 2.5 pounds. All engine analysis and sea-level testing verified that the use of a fuel lead was satisfactory and apparently eliminated the thrust overshoot of the 8096 engine and provided a generally softer start. Altitude testing at Arnold Engineering Development Center (AEDC) with indicated fuel preflows of up to 2.4 pounds also verified this mode of engine operation. However, a detailed review of AEDC data by the contractor after the Gemini VI-A mission has revealed that fuel preflow did not occur on most of those tests and that the maximum value of fuel preflow attained during the altitude testing was only 1.1 pounds. The significance of these differences is being evaluated.

5.4.2.3.2 Start system: Both start tanks had nominal pressures at lift-off and at PPS ignition. Both pressures, as indicated at the venturi inlets (B-11 and B-12), started to drop as expected within 50 milliseconds after the gas generator valve signal. Until LO + 368.33 seconds these values were within the expected limits and the fuel side of the system had started to increase. This is indicative of full fuel bootstrap operation. (Fuel-side recharge precedes the oxidizer side due to the much greater pump flow rate on the oxidizer side during this period.) At the next recorded point, both measurements showed a marked increase to above normal values. The oxidizer start system, in particular, recorded a severe pressure oscillation. Following this transient, at LO + 368.83 seconds, both systems returned to a stable value indicating a lockup or no flow condition. This would be expected following the loss of gas generator valve electrical power.

5.4.2.3.3 Engine systems: The turbine manifold-pressure transducer (B-3) was inoperative after LO + 150 seconds and did not record gas generator ignition. Measurement B-132, a low range (0 to 120 psia) manifold pressure gage, did show the start of gas generator operation at LO + 367.76 seconds. Actual manifold operating pressure cannot be verified. Turbine gas-generator flow ceased with the dropout of the B-139 voltage, and a resultant loss of manifold pressure was indicated. Turbine speed is difficult to interpret because of the slow sampling rate; however, table 5.4.2-II is included to show the average rpm computed over 0.5-second periods (sampling rate). There is nothing in the data that indicates an abnormal turbine start, and also coast after shutdown appears normal. Fuel-valve actuation pressure (B-82) follows a nominal rise and dropoff curve and indicates normal pump and fuel valve operation. The valve cracking pressure was about 630 psia, and the valve was almost completely open at the time of engine shutdown. Oxidizer-injector pressure and engine-chamber pressure (B-148 and B-6) both began to rise in what appears to be a normal manner at about LO + 368.41 seconds. However, chamber pressure returned to 0 psi at LO + 368.44 seconds following a measured peak value of 436 psi. The rate of chamber pressure drop-off is not normal and is not in consonance with the continued oxidizer injector pressure (B-148) until LO + 369.00 seconds. It is possible that this transducer failed during the pressure rise period (see fig. 5.4.2-2). Fuel- and oxidizer-pump inlet pressures (B-1 and B-2) showed a normal drop starting at LO + 367.8 seconds (see fig. 5.4.2-3). Although the rate of oxidizer-pump inlet-pressure decay is less than on previous tests, it cannot be verified at this time as an abnormal condition. At approximately the time of some other engine anomalies, the oxidizer-pump inlet pressure went off scale at the high end and was lost. Fuel-pump inlet pressure indicated static inlet pressures (same as tank pressure) until the loss of telemetry. All data are under a continuing review, and the subsequent analysis will be presented as a supplement to this report.

### 5.4.2.4 Secondary propulsion system.-

5.4.2.4.1 General: The performance of the secondary propulsion system (SPS) during the ascent burn was normal. There were no anomalies within the system during the entire period between launch and the normal SPS cut-off at LO + 369.5 seconds.

5.4.2.4.2 Lift-off and ascent: Prior to launch, all SPS parameters were normal. The SPS nitrogen-sphere pressure transducer had been inoperative during the week prior to launch, but nitrogen sphere pressure was verified by aerospace ground equipment prior to launch, and it was decided to launch with the vehicle in this condition. All SPS temperatures were influenced prior to launch by the flow of air conditioning from the forward rack and were within the range of 50° to 60° F at lift-off. There was no increase or decrease in any SPS temperature during the ascent phase of flight prior to the SPS burn. The SPS propellant tanks were pressurized to operating levels prior to launch and these pressures remained constant during ascent.

5.4.2.4.3 SPS ascent burn: SPS burn for propellant orientation was initiated at LO + 349.5 seconds and was terminated at LO + 369.5 seconds. A pressurization start-valve lead time of 15 seconds had no noticeable effect on the previously pressurized propellant tanks. Thrust buildup to 90 percent was normal, and the 20-second burn and shutdown were effected satisfactorily. There was no detectable decrease in the nitrogen sphere pressure throughout the recorded flight period.

Propellant tank manifold pressures correlated closely with data obtained during the preflight checkout of the gas pressure regulators. Actual performance from both modules (serial nos. 4 and 5) agreed closely with the predicted values. Thrust level on the serial no. 5, Unit I, was somewhat low, resulting in lower than predicted performance. However, all performances, when evaluated through approximately 15 seconds of run time, were within the specification limits. The following table shows the performance specification limits and describes the actual values obtained.

| Parameter | Specification limits | | Actual values | |
|---|---|---|---|---|
| | Min | Max | serial no. 4 | serial no. 5 |
| Thrust, lb . . . . . | 14.2 | 17.6 | 15.61 | 15.03 |
| $I_{sp}$, sec . . . . . . | 241 | -- | 255 | 242 |
| Mixture ratio . . . . | 1.048 | 1.152 | 1.085 | 1.090 |

### TABLE 5.4.2-I.- TANK PRESSURES AND TEMPERATURES

| | At lift-off | At LO + 367.0 sec |
|---|---|---|
| Helium sphere pressure, psig . . . | 2475 | 2475 |
| Fuel tank pressure, psig . . . . . . | 41 | 55 |
| Oxidizer tank pressure, psig . . . | 30 | 44 |
| Fuel temperature, °F . . . . . . . . | 51 | 50 |
| Oxidizer temperature, °F . . . . . . | 48 | 46 |
| Start tank pressure (oxidizer), psig . . . . . . . . . . . . . . . | 1000 | 1000 |
| Start tank pressure (fuel), psig . . . . . . . . . . . . . . . | 980 | 990 |
| Start tank temperature (oxidizer), °F . . . . . . . . . . . . . . . . | 60 | 60 |
| Start tank temperature (fuel), °F . . . . . . . . . . . . . . . . | 52 | 56 |

## TABLE 5.4.2-II.- TURBINE SPEED DURING PRIMARY PROPULSION SYSTEM START SEQUENCE

| Time from lift-off, sec | Pulses, total | Pulses over $\frac{1}{2}$ second | Turbine, rpm (a) |
|---|---|---|---|
| 367.20 | 0 | | |
| 367.45 | | 0 | 0 |
| 367.70 | 0 | | |
| 367.95 | | 192 | 9 912.6 |
| 368.20 | 192 | | |
| 368.45 | | 416 | 21 477.2 |
| 368.70 | 608 | | |
| 368.95 | | 304 | 15 694.9 |
| 369.20 | 912 | | |
| 369.45 | | 192 | 9 912.6 |
| 369.70 | 1104 | | |
| 369.95 | | 160 | 8 260.5 |
| 370.20 | 1264 | | |
| 370.45 | | 128 | 6 608.4 |
| 370.70 | 1392 | | |
| 370.95 | | 128 | 6 608.4 |
| 371.20 | 1520 | | |
| 371.45 | | 96 | 4 956.3 |
| 371.70 | 1616 | | |
| 371.95 | | 96 | 4 956.3 |
| 372.20 | 1712 | | |
| 372.45 | | 80 | 4 130.2 |
| 372.70 | 1792 | | |
| 372.95 | | 80 | 4 130.2 |
| 373.20 | 1872 | | |
| 373.45 | | 96 | 4 956.3 |
| 373 70 | 1968 | | |
| 373.95 | | 32 | 1 652.1 |
| 374.20 | 2000 | | |
| 374.45 | | 0 | 0 |
| 374.70 | 2000 | | |

[a] The turbine rpm was computed as follows:

$$\text{rpm} = K \times 2N \times 60$$

where: K = constant = 0.43023 revolutions/pulse

N = pulses over $\frac{1}{2}$-second period

rpm = average rpm between sample points

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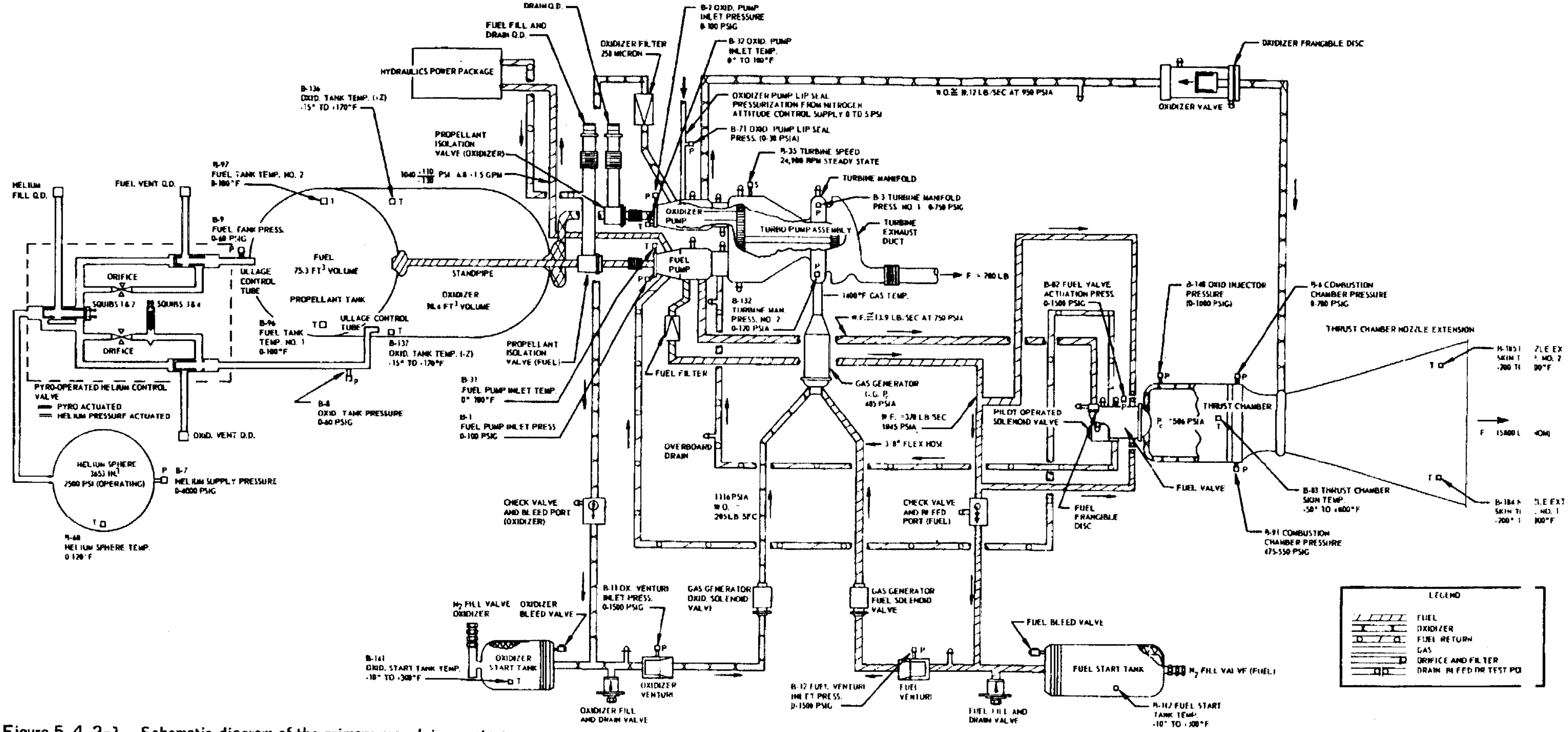

Figure 5.4.2-1.- Schematic diagram of the primary propulsion system.

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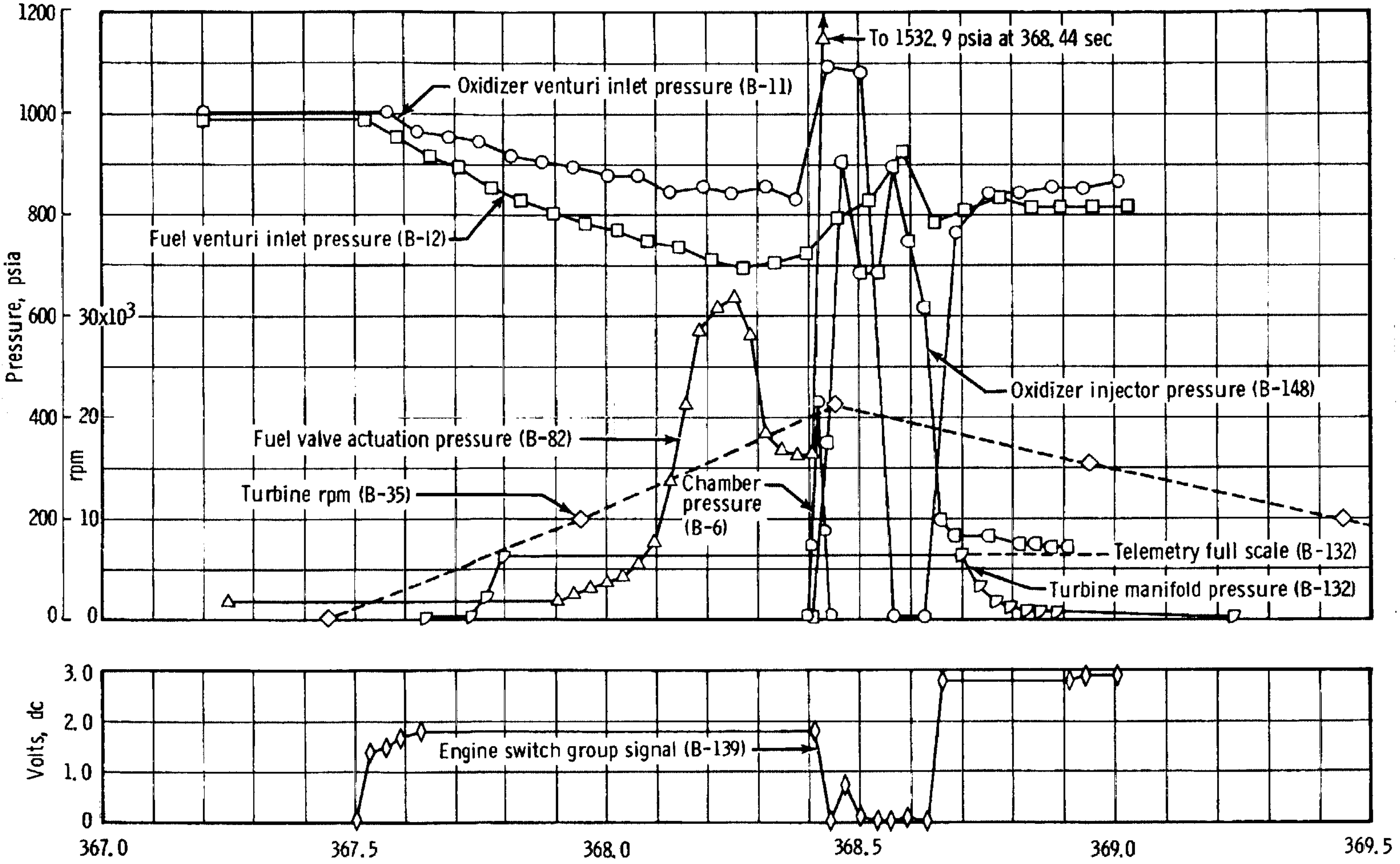

Figure 5.4.2-2. - Primary propulsion system start sequence.

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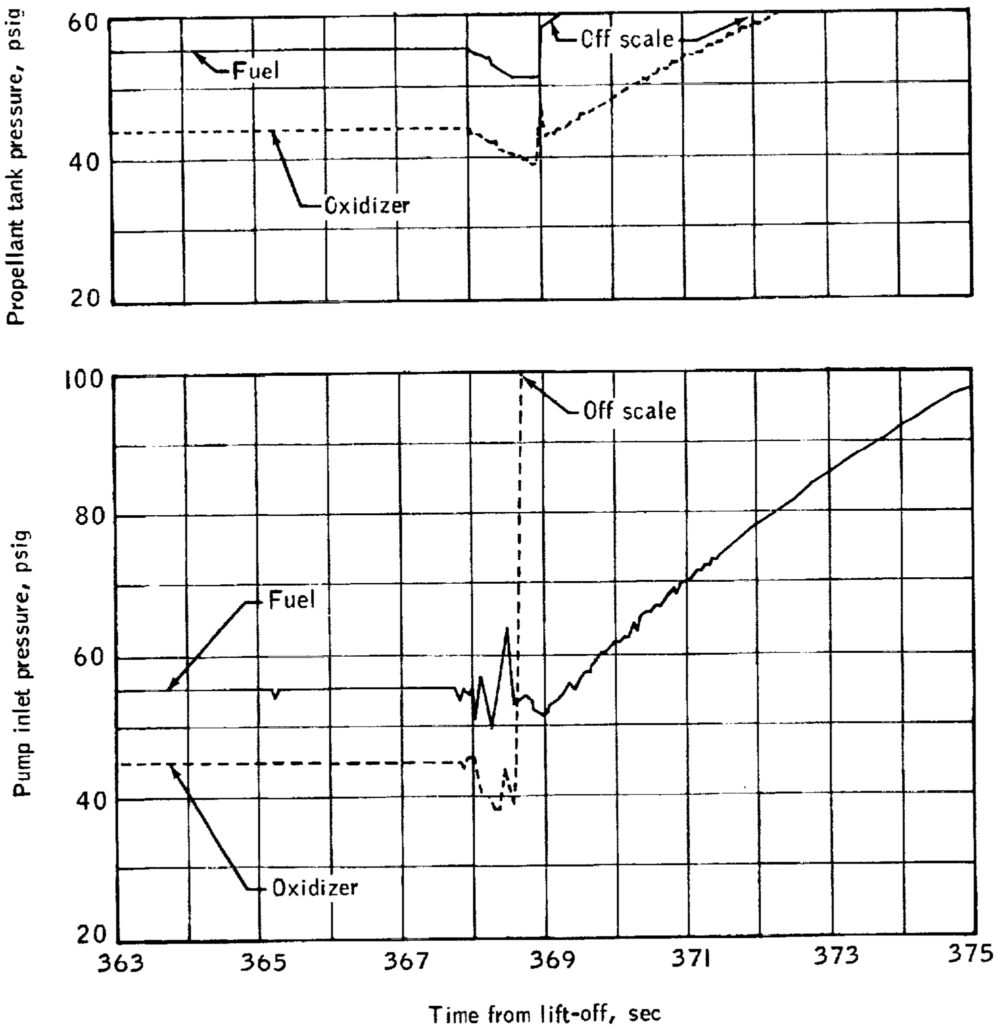

Figure 5.4.2-3. - PPS propellant tank and pump inlet pressure increase.

## 5.4.3 Communications and Control System

The performance of the communications and control system was satisfactory throughout the flight except for the instances noted in the following paragraphs.

5.4.3.1 Command system. - An evaluation of the command system determined that its operation was satisfactory for this mission. Commands 12 and 14 were the only commands loaded into the programmer memory. Command 12 is the emergency reset timer reset and command 14 is the L-band beacon off.

A message acceptance pulse (MAP) was generated at approximately LO + 368.62 seconds or about 0.18 second after the engine switch group telemetry voltage dropped to zero. This time was verified by correlation with the PCM wave train. In addition, no change could be seen in the vehicle command status bits, indicating an erroneous MAP. It appears that this MAP was self-generated by the GATV, and therefore was an effect of the engine anomaly and not a cause.

5.4.3.2 Tracking system. - The C-band and S-band tracking systems operation was satisfactory.

5.4.3.3 Telemetry system. - The PCM telemetry system performed in a satisfactory manner, and design coverage was obtained for all portions of the flight. There were two synchronization losses noted and they are described as follows with respect to time of occurrence and cause.

(a) A loss at LO + 4 seconds was due to a phase lock of the telemeter to the programmer clock. This is a normal occurrence after starting the programmer clock.

(b) A loss at LO + 134 seconds was due to target launch vehicle staging and is also a normal occurrence.

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### 5.4.4 Hydraulic System and Pneumatics

5.4.4.1 Hydraulic system.- Hydraulic system operation began at engine ignition. Prior to hydraulic system pump operation, the pump discharge pressure remained constant at about 72 psig as shown in figure 5.4.4-1. At LO + 367.94 seconds, the hydraulic-pump discharge pressure started increasing. It reached a value of 2490 psig at LO + 368.25 seconds and peaked at 2720 psig at LO + 368.70 seconds. (The design steady-state pressure is 2810 ± 60 psig.) This pressure gradually decreased to 72 psig at LO + 370.20 seconds, and finally dropped to 6.6 psig at LO + 371.06 seconds. Hydraulic-return line and low-pressure line values remained constant at about 70 and 54 psig, respectively, during the entire flight.

The engine-nozzle pitch actuator remained in the extended (from null) position at a 0.96° nozzle position until LO + 368.00 seconds when the actuator started retracting. The actuator reached null position at LO + 368.69 seconds, and by LO + 369.88 seconds had retracted to about the 0.60° nozzle position where it remained until LO + 375.19 seconds.

The engine-nozzle yaw actuator varied in the extended position from 0.27° to 1.06° in nozzle position; then, during engine ignition, started retracting and reached a null position at LO + 368.01 seconds. By LO + 370.17 seconds, the actuator had retracted completely to the 1.89° nozzle position. By LO + 375.19 seconds, the actuator had gradually changed to the 0.84° nozzle position with the actuator still retracted with respect to null.

The data indicate that the yaw actuator was first in assuming null position as hydraulic pressure built up. It was followed quickly by the pitch actuator which assumed a null position in an additional 0.7 second. After the null positions had been attained momentarily, the actuators responded to gyro-control signals for a brief period before becoming unpowered and uncontrolled.

5.4.4.2 Pneumatics.-

5.4.4.2.1 Propellant tank pressurization system: The pressure in the propellant-tank helium-pressurization sphere remained constant at 2475 psia from lift-off until LO + 369.33 seconds. At that time, corresponding to the scheduled opening time of the pyrotechnic-operated helium-control valve to the propellant tanks, the pressure started dropping and had reached 2280 psia at LO + 375.02 seconds and remained there until loss of telemetry at LO + 375.77 seconds. After engine shutdown, although propellant flow from the tanks had stopped, the helium flow continued and steadily increased the pressure in the oxidizer and fuel tanks. This result is to be expected because pressure regulation provisions are not incorporated in the valve except for flow control orifices in the two valve outlets to the tanks. The shutoff squib in the oxidizer outlet does not operate until some time after insertion of the vehicle into orbit. The propellant tank pressure buildup apparently continued until the tank ruptured. Fuel tank pressure attained the full instrument scale value of 60 psig by LO + 369.25 seconds, and the oxidizer tank pressure reached the same full scale value by LO + 372.32 seconds (see fig. 5.4.2-3). Fuel tank pressure, as indicated from the fuel pump inlet pressure, reached 103.3 psig before loss of signal. The nominal burst pressure for this tank is 75 psig.

5.4.4.2.2 Attitude control system: The attitude control system (ACS) was activated by the command monitor sequence timer at LO + 308.41 seconds, which was shortly after separation of the GATV from the TLV. The pressure in the three nitrogen supply bottles remained nearly constant at 3350 psia from lift-off until separation. At SPS ignition (LO + 349.5 sec), the pressure had dropped to 3250 psia. At PPS ignition (approximately LO + 367.53 sec), the pressure had dropped to 3221 psia. This was when the switchover to the hydraulic control system was made. The ACS supply-bottle pressure was 3190 psia at LO + 375.20 seconds. The ACS apparently functioned satisfactorily throughout the flight.

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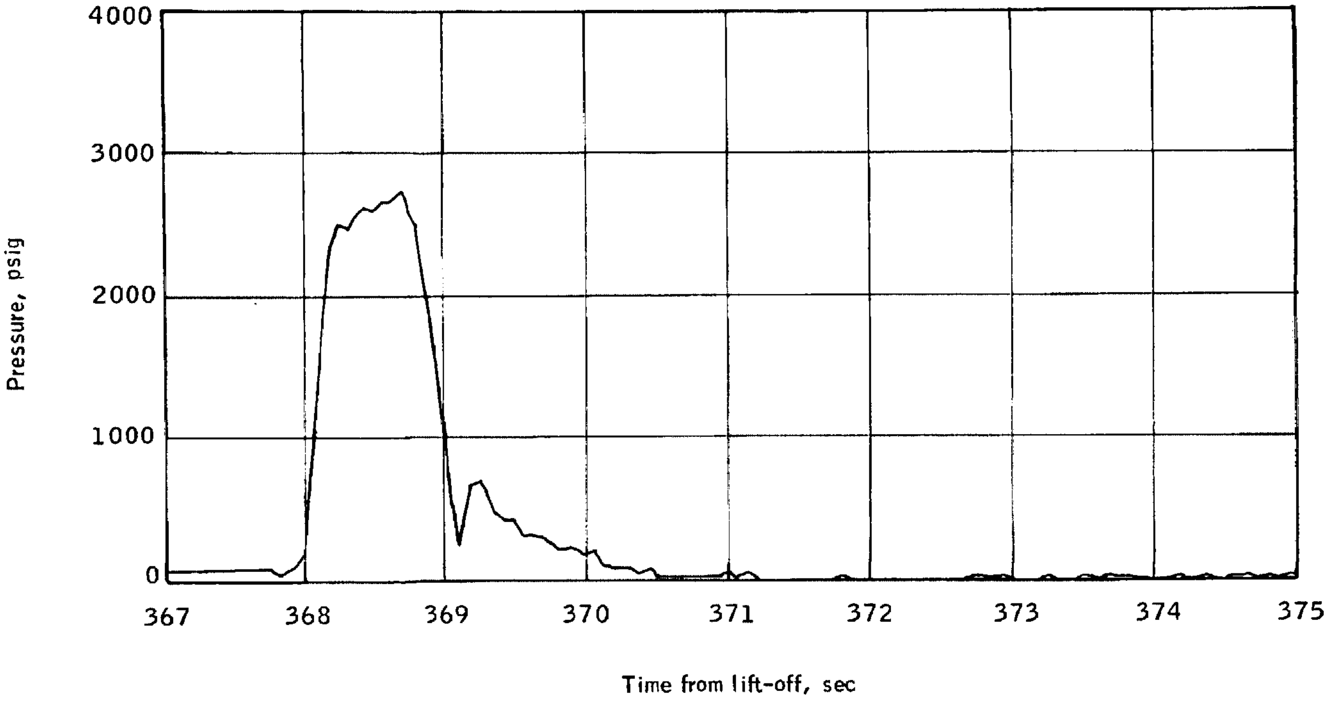

Figure 5.4.4-1. - Hydraulic pump discharge pressure.

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### 5.4.5 Guidance and Control System

5.4.5.1 General.- Based on overall gyro performance from T-10 seconds to LO + 375.4 seconds, adequate vehicle control was maintained, and operation of all performing guidance and control system components occurred without any known anomalies.

5.4.5.2 Sequence of events.- The sequence of events as reflected by the booster command monitor indicated the following timed events:

(a) Start sequence timer at LO + 273.66 seconds.

(b) VECO, uncage gyros at LO + 303.73 seconds.

(c) Separation at LO + 306.29 seconds.

(d) Enable attitude control system (ACS) at LO + 308.41 seconds.

(e) Uncage gyros backup signal at LO + 325.54 seconds.

(f) Pitch rate on (-1.5 deg/sec) at LO + 334.54 seconds.

(g) Disable pitch and yaw ACS at LO + 367.54 seconds.

5.4.5.3 Control of flight.- Control of the GATV flight was initiated by the sequence timer and started at LO + 273.66 seconds. The roll gyro position output between LO + 303.68 seconds (VECO) and LO + 368 seconds remained between 1.0° and -1.0°. Initiation of the -1.5 deg/sec pitchover rate occurred at LO + 334.50 seconds. The roll horizon sensor error of -3.2° at separation was diminished to between 1.2° and -1.0° by LO + 367 seconds. At LO + 345 seconds, correction of vehicle movement was visible on the roll sensor trace. At LO + 347.55 seconds, the pitch rate was turned off and the -3.99 deg/min geocentric rate was initiated. A final position offset of 0.295° was achieved and maintained until LO + 368.50 seconds. During the anomaly period, the roll gyro experienced a clockwise torque starting at LO + 367.80 seconds. This is normal and results from the PPS turbine spinup. At LO + 368.1 seconds, a yaw movement to the left was detected and, at LO + 368.45 seconds, a pitch-down movement was initiated. Gyro and horizon-sensor operation was correct until telemetry was lost.

5.4.5.4 Gas jet operation.- The gas jets operated correctly during torquing corrections throughout the flight and the last indications showed that a counterclockwise roll had been activated. Pneumatic and hydraulic operational components also were observed to be operating properly during flight.

5.4.5.5 Velocity meter.- The velocity meter stored word did not change with the last telemetry monitoring which occurred at LO + 374.25 seconds. This verified that no change from the original stored word had occurred. No velocity cut-off signal was recorded.

### 5.4.6 Electrical System

5.4.6.1 General.- An analysis of the available flight data indicates that the Gemini Agena target vehicle power sources performed within specification limits. The electrical system appeared to function properly until the point where systems anomalies were first indicated on telemetry. At this point, the telemetry sampling rate of the electrical parameters was insufficient to establish the adequacy of system operation with respect to the indicated anomalies. However, the available data from the switch group voltage plot indicated power was lost and restored to the electronic gate as shown in figure 5.4.2-2. The fluctuations of the switch group voltage indicate that some type of mechanical break occurred to interrupt the 28 V supply to the propellant valves. An 0.8 voltage spike indicated a momentary restoration of power to the electronic gate but without power to the propellant solenoids. At approximately 200 milliseconds after the first anomaly point, the switch group voltage changed to 2.9 volts, the level which indicates one turbine overspeed relay open, and remained there until loss of telemetry. There was no telemetry indication of activation of attitude control system pneumatics which would normally follow either one or both turbine-overspeed relays opening nor was there an indication of turbine overspeed. This again indicates some type of mechanical break interrupted the signal. The electrical schematic of the propulsion system, including the electronic gate, is shown in figure 5.4.6-1.

5.4.6.2 Power system.- The power supply and battery case temperatures were nominal with the exception of battery temperature sensor no. 2 which was faulty prior to launch. This battery was verified to be at about the same temperature as the other batteries prior to liftoff. The total power used for the flight was integrated and found to be 1.6 ampere-hours which was not of sufficient magnitude to register on the amp-hour meter.

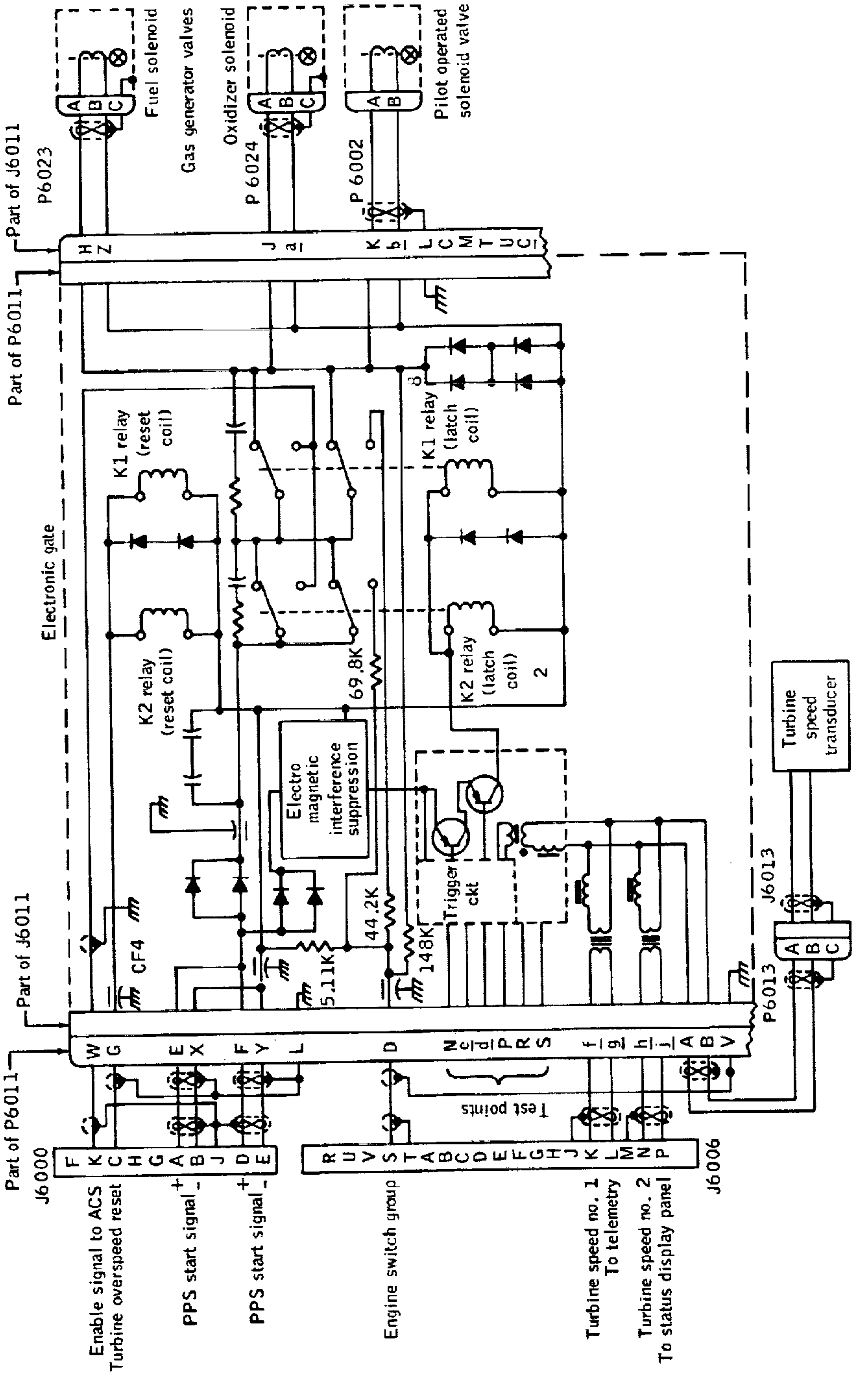

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Figure 5.4.6-1. - Schematic diagram of the GATV 8247 engine electrical system.

### 5.4.7 Instrumentation System

The instrumentation system provided for monitoring 234 parameters. Two instrument parameters (B-201 and C-13) became inoperative prior to lift-off and four instrumentation anomalies (parameters B-3, A-5, A-523, and A-522) occurred during ascent. An examination of the real-time telemetry data revealed that the instrumentation system, with the exceptions noted, performed satisfactorily.

The four instrumentation anomalies consisted of one intermittent parameter, one suspect parameter, and two instrumentation failures.

The target docking adapter (TDA) accelerometer A-523, no. 1, mounted in the GATV Z-axis (yaw), experienced four periods of intermittent or over-scale readings. These occurred during the periods of LO + 83.24 to LO + 99.43 seconds, LO + 134.68 to LO + 136.01 seconds, LO + 229.68 to LO + 229.74 seconds, and LO + 260.93 to LO + 306.3 seconds. The data obtained from all other periods appeared normal.

The turbine manifold pressure no. 1, parameter B-3, presented suspect data starting at 150 seconds after lift-off. The data indicated a gradual departure from a correct value of zero pressure to a value of 40 psia. It remained there from LO + 160 seconds until termination of the flight. The turbine manifold pressure should have remained at zero pressure until primary propulsion system (PPS) start, and then it should have built up to a peak of 500 psia, returned to 450 psia and remained there until engine shutdown. The turbine manifold pressure is also monitored by parameter B132, which is turbine manifold pressure no. 2. This parameter has a lower instrumentation range to monitor the turbine start transients accurately. This measurement indicated satisfactory performance and was, as anticipated, over scale during the period of attempted PPS start.

The two aft accelerometers located near the TLV-GATV separation plane indicated a failure at LO + 305.96 seconds. These were accelerometers A-5, mounted parallel to the vehicle Z-axis, and A-522, mounted parallel to the vehicle Y-axis. At LO + 306.22 seconds, both accelerometer signal outputs went to the full scale value of +1.5g. This was coincident with the firing of the separation (TLV-GATV) primacord squibs.

Two instrumentation parameters which failed prior to launch were known to be inoperative but were not important enough to warrant replacement or repair. These measurements were:

(a) Gas sphere pressure, parameter B-201. This measurement became inoperative 8 days prior to launch. The failure of this parameter was first realized during the TDA instrumentation verification test.

The reason for failure was not determined because it would have required demating of the TLV and GATV vehicles.

(b) Battery case temperature no. 2, parameter C-13. This measurement delivered erroneous temperature data after the battery was installed in the GATV at T minus 7 hours. Testing with an external temperature probe indicated that the battery case temperature was normal and that the instrumentation was in error.

### 5.4.8 GATV Range Safety System and Ordnance

5.4.8.1 Range safety system.- The Gemini Agena target vehicle range safety system operated satisfactorily from lift-off to loss of telemetry.

5.4.8.1.1 Inadvertent separation system: Operation of the inadvertent separation system was normal during the mission. The SECO signal from the TLV rendered the system safe prior to GATV separation.

5.4.8.1.2 Engine cut-off system: The engine cut-off system operated normally. Command receiver signal strength telemetry indicated that the radio frequency (RF) link was capable of executing a cut-off command at any time. No cut-off commands were sent and no spurious cut-off commands were generated by the range safety system.

5.4.8.1.3 Tracking aids: The S-band and C-band transponders operated normally throughout flight. Their signal termination was coincident with the loss of telemetry.

5.4.8.2 Ordnance.-

5.4.8.2.1 Horizon-sensor cover squibs: The horizon-sensor cover squibs operated normally as was evidenced by the opening of the cover temperature monitor at LO + 303.07 seconds and by normal operation of the horizon sensors during the coast phase of the flight prior to SPS engine ignition.

5.4.8.2.2 TLV-GATV separation: The TLV-GATV separation components appear to have functioned properly and in the proper time sequence (see section 5.5.1).

5.4.8.2.3 Helium valve pyrotechnic squibs: The helium valve pyrotechnic squibs apparently fired properly since there was an increase of pressure in the propellant tanks. Loss of telemetry occurred prior to the normal closure time of the valve to the oxidizer tank.

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### 5.4.9 Target Docking Adapter

5.4.9.1 General.- Target docking adapter (TDA) performance was normal throughout the flight. Structural integrity and electrical continuity was maintained at the TDA interfaces with the rest of the GATV and with the shroud. The mooring drive system position monitors indicated that the docking cone remained in the normal rigidized position. The L-band transponder monitors indicated a normal "off" condition and also indicated that the dipole antenna remained in the retracted position.

5.4.9.2 Temperatures.- The TDA skin temperatures began to increase at LO + 50 to 60 seconds and, thereafter, they decreased steadily until the loss of telemetry. A plot of the temperatures indicated by the four sensors mounted in a longitudinal row along the TDA (see fig. 5.4.9-1) shows that the maximum temperature was reached at approximately TDA station 9.50 (GATV station 220.50). This established the point of shroud shock wave reattachment. Three additional temperature sensors spaced radially 90° apart at the same station yielded peak temperatures of 115° to 134° F indicating symmetrical flow.

5.4.9.3 Accelerations.- The TDA accelerometer data are discussed in section 5.4.1.4.

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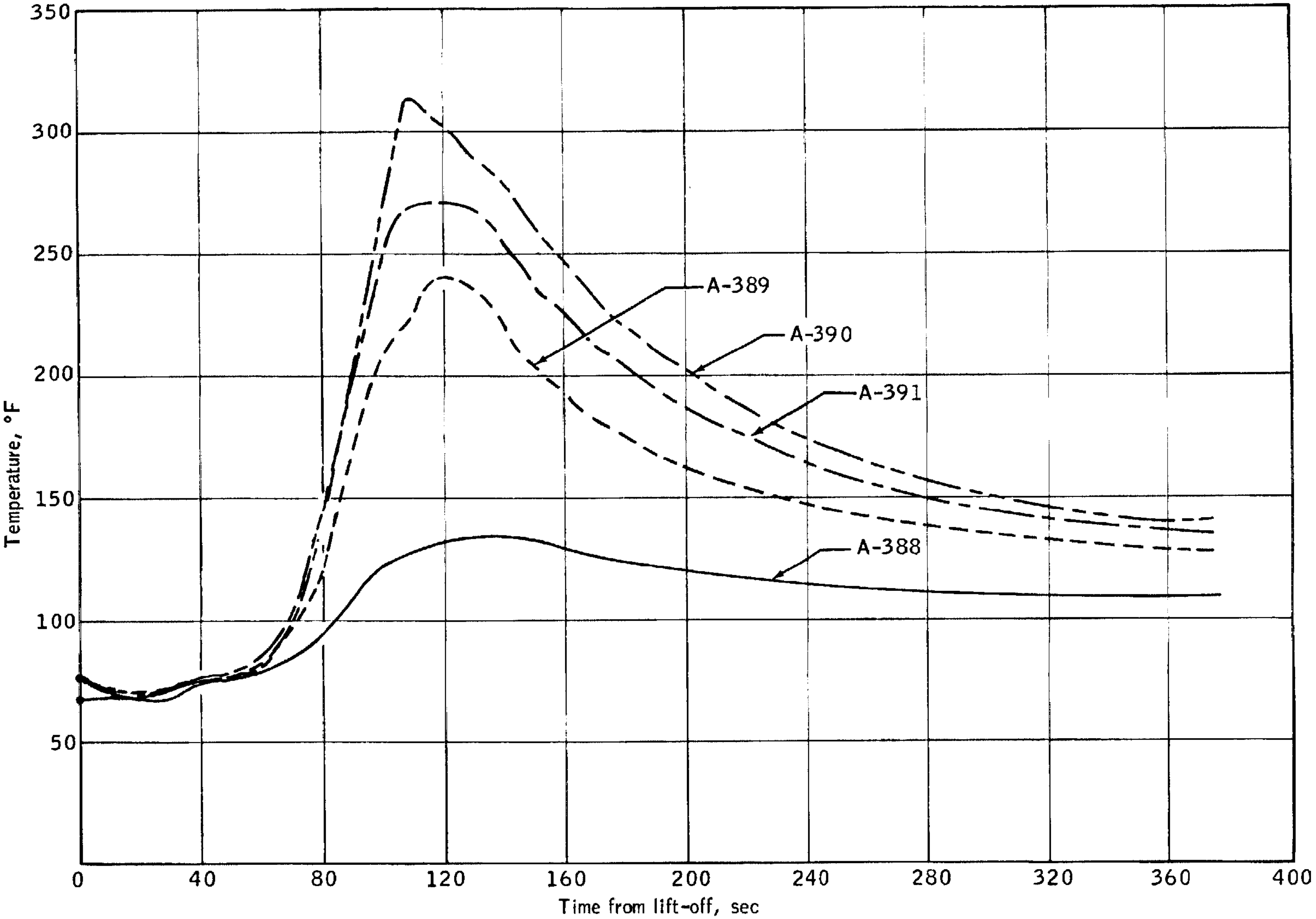

Figure 5.4.9-1. - TDA temperatures.

## 5.5 TARGET LAUNCH VEHICLE PERFORMANCE

The performance of the target launch vehicle (TLV), an Atlas SLV-3, was satisfactory in all respects. The TLV boosted the Gemini Agena target vehicle (GATV) to the required velocity and spatial position for subsequent insertion into the planned orbit. The TLV also provided the required discrete signals to the GATV for staging-system operation and for separation from the TLV.

### 5.5.1 Airframe

Structural integrity of the TLV airframe was satisfactorily maintained throughout the flight. Lift-off transients produced a longitudinal oscillation with a frequency of 5 cps that reached a peak amplitude of ±0.21g at LO + 5 seconds. The response was damped out by LO + 25 seconds. The TLV contractor reported that this vibration is typical for an SLV-3 launch from a launcher equipped with Benbow release valves (average of 12 launches is ±0.25g peak). This launch represented the first use of Benbow release valves at the Air Force Eastern Test Range (ETR).

The engine compartment thermal environment was satisfactory during the flight. The temperatures were normal with the exception of temperature measurement P671T which indicated a low localized temperature during a portion of the flight (see section 5.5.2). The maximum ambient temperature recorded was 112° F near the sustainer fuel-pump inlet (measurement A745T) at booster engine cut-off (BECO).

Axial vehicle acceleration data indicate that TLV staging and GATV separation were normal. Peak axial acceleration at BECO was 6.2g and at sustainer engine cut-off (SECO) was 3.0g. TLV and GATV accelerations at separation are shown in figure 5.5.1-1 for comparison with the time required for separation. This separation time is extrapolated from separation monitor records. No significant accelerations are shown by the data after retrorocket fire, indicating that separation was normal.

Estimated structural loads for the powered phase of flight are given in the following table. These data indicate that maximum TLV loading occurred at station 563 in the pre-BECO region of flight.

| TLV station, in. | Load | | | |
|---|---|---|---|---|
| | Max qα | | Pre-BECO | |
| | Load, lb | Design ultimate, percent | Load, lb | Design ultimate, percent |
| 563 | 106 500 | 41 | 112 700 | 43 |
| 850 | 145 300 | 40 | 119 700 | 33 |

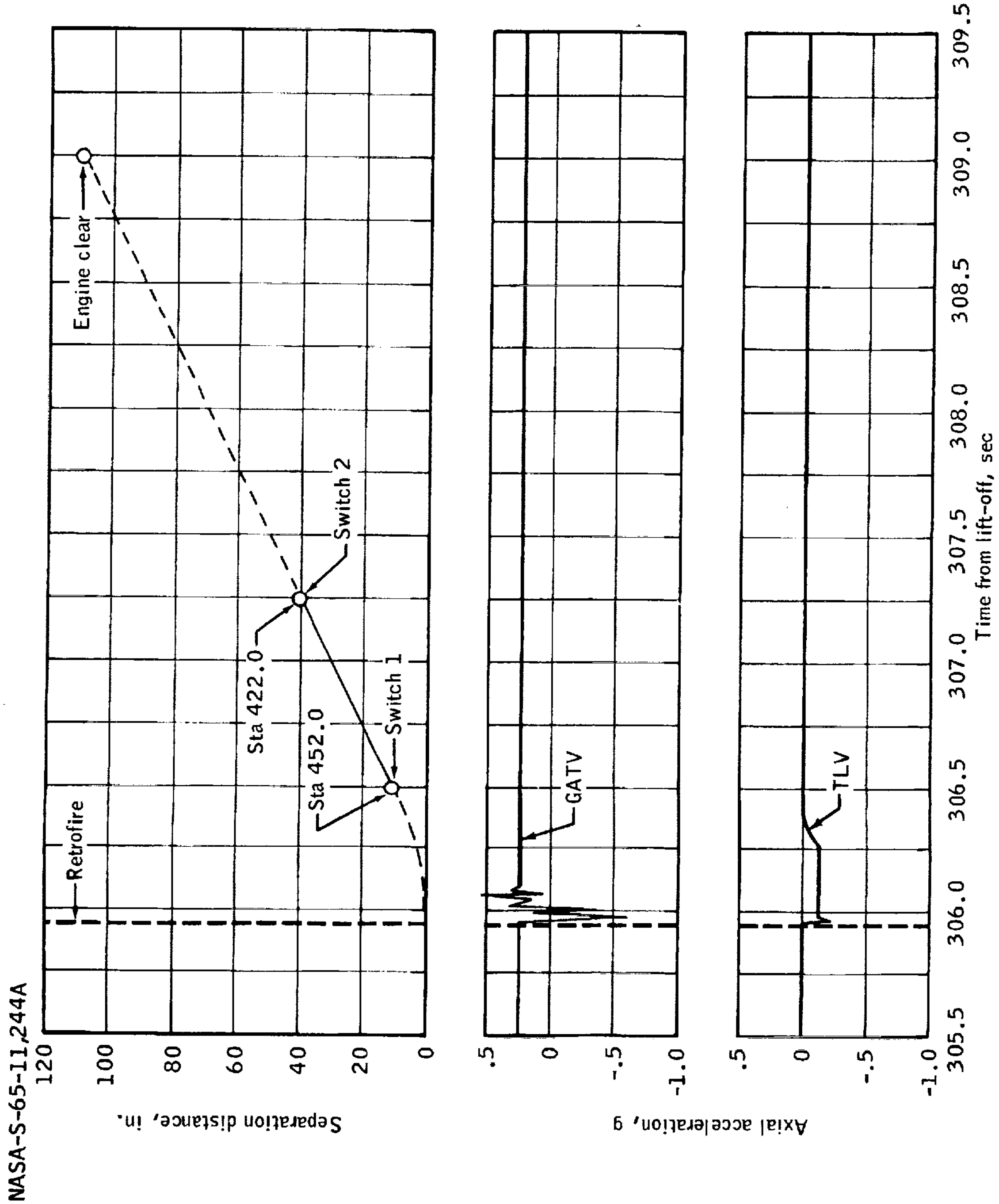

Figure 5.5.1-1. - TLV - GATV separation.

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### 5.5.2 Propulsion System

5.5.2.1 TLV engine systems.- Operation of the TLV engine systems was normal in practically all respects. A comparison of actual engine thrust obtained during the flight with thrust values predicted before the flight is shown in the following table.

TLV ENGINE PERFORMANCE

| Event | Thrust, lb | | | | | |
|---|---|---|---|---|---|---|
| | Booster engine | | Sustainer engine | | Vernier engine | |
| | Predicted | Actual | Predicted | Actual | Predicted | Actual |
| Lift-off | 330 400 | 323 300 | 56 800 | 56 800 | 1149 | 1188 |
| BECO | 379 500 | 375 800 | 80 400 | 81 100 | 1404 | 1468 |
| SECO | — | — | 79 600 | 78 900 | 1042 | 1115 |
| VECO | — | — | — | — | 1050 | 925 |

Note: Predicted values were obtained from a preflight trajectory simulation. Actual values were calculated from combustion chamber pressure data.

There were two observed anomalous conditions, neither of which had an effect on propulsion system performance. Temperature measurement P671T, located in the thrust section just inboard of the B1 booster combustion chamber on the aft side of the jettison rail support, indicated a temperature decrease from a normal 58° F at LO + 75 seconds to the lower instrumentation band limit (-50° F) within 20 seconds. The temperature returned to the calibrated band at LO + 187 seconds and rose to 10° F by SECO. A qualitative out-of-band analysis of these data indicated that the temperature decreased until booster-section jettison, responded normally to the jettison event (sustainer flame flashback), and started rising toward the lower calibrated limit. The data are believed to be indicative of a localized condition in the engine compartment because other temperature measurements did not reflect this low temperature condition. A minor liquid oxygen leak in the thrust section, together with the undefined circulation patterns, is the most likely cause for this temperature decrease.

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Measurement P330P, sustainer fuel-pump discharge pressure instrumentation, indicated a gradual pressure decay starting at LO + 36 seconds. The pressure decayed from 900 psia to 690 psia at LO + 78 seconds when it recovered to the normal 900 psia level in 2 seconds. Fuel-pump discharge pressure was normal for the remainder of the flight. Other engine parameters indicated that the abnormal fuel-pump discharge pressure decay was not a true indication of actual discharge pressure. Engine operation was not affected. The most probable cause of this pressure decrease is a temporary blockage in the instrumentation sensing line as a result of freezing of the static fuel in the sensing line and cooling of the vapor in the line between the plug and the sensor element. The heat influx at base pressure reversal could then have resulted in thawing the line. Similar indications (frozen fuel sensing line indications) have occurred during the flight of nine previous vehicles (80D, 118D, 211D, 232D, 243D, 248D, 285D, 289D, and 297D). The sensing line for the sustainer fuel-pump discharge pressure is routed within 2 inches of the liquid oxygen dome and within 1 inch of a plugged liquid oxygen dome boss. This area is partially shielded from the ambient engine-compartment temperature transducers.

Prior to launch, a special leak check of the engine liquid oxygen tank fittings with liquid nitrogen was performed as well as the liquid oxygen start system leak check after propellant loading demonstration. This latter leak check was initiated as a result of previous fuel sensing line freezing experience.

5.5.2.2 Propellant utilization.- Operation of the propellant utilization (PU) system was satisfactory. A summary of actual and predicted propellant residuals available after SECO is shown in the following tabulation.

USABLE RESIDUALS AT SECO
[a]

| Propellant | Predicted, lb | Actual, lb | Time to $LO_2$ depletion, sec | Outage, lb |
|---|---|---|---|---|
| Fuel | 532 | 497 | — | 122[b] |
| Liquid oxygen | 942 | 816 | 4.26 | — |

[a] The liquid oxygen depletion level is 200 pounds above the sustainer pump inlet. The fuel depletion level is the station 1198 anti-vortex web, 64 pounds above the pump inlet.

[b] There is a 115-pound PU design fuel bias. Therefore, from a PU system standpoint, there was a 7-pound fuel imbalance at theoretical liquid oxygen depletion.

PU valve angular position data, measurements U113V (PU valve position feedback) and P830U (PU valve position), displayed sinusoidal oscillations of the PU valve from the station 3 to the station 6 sensor uncovering times, when the valve was between the nominal position and the closed limit. The oscillations of valve angular motion had a frequency of approximately 0.4 cps and had maximum peak-to-peak amplitudes of 0.3° (U113V) and 0.4° (P830D) between stations 3 and 4, 0.2° (U113V) and 0.3° (P830D) between stations 4 and 5, and 0.4° (U113V) and 0.5° (P830D) between stations 5 and 6. Although this is the first SLV-3 flight during which PU valve oscillations of this type have been observed, similar valve oscillations have occasionally occurred in the past during PU system checkouts in the factory and at the launch site. PU valve oscillations were noted at the launch site when the PU system of this vehicle was checked out using two different PU computers (flight and backup) and two different sustainer engine hydraulic control packages. The PU valve oscillations had no significant effect on PU system performance. The exact reason for these oscillations is not presently known and investigation is continuing by the contractor as to their cause.

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## 5.5.3 Flight Control System

5.5.3.1 Flight control system.- Operation of the flight control system was satisfactory. Telemetered engine position shifts at booster section staging were normal. Vehicle transients at lift-off were moderate and were quickly damped following autopilot activation at 42-inch motion. The lift-off roll transient reached 0.52° in the clockwise direction at a peak rate of 1.86 deg/sec.

Gyro data provided a qualitative indication that the roll and pitch program maneuvers were successfully executed. The nominal pitch profile, in terms of voltage and time, was the same on this vehicle as it has been on all SLV-3 vehicles launched to date. The nominal pitch program slaving sensitivity was 0.388 deg/volt/sec.

The usual evidence of propellant slosh and rigid body oscillations was observed as the vehicle passed through the region of maximum dynamic pressure. Gyro and engine data reflected the effects of a wind shear, primarily in the pitch plane, at approximately LO + 60 seconds with a resulting engine position movement of 1.1° peak-to-peak. Maximum booster engine positive pitch deflections to counteract the effects of aerodynamic loading occurred at approximately LO + 63 seconds with an average deflection of 0.9° from post-lift-off levels.

The programmer enabled guidance at approximately LO + 80.0 seconds. Pitch steering command transmission began at LO + 111.2 seconds.

Low amplitude oscillations at a frequency of 2.0 cps were observed on rate gyro data late in the booster phase of flight.

The guidance staging discrete was measured at the programmer input at LO + 130.299 seconds and the resulting programmer switching sequence was successfully executed. Vehicle transients associated with BECO and booster-section jettison were normal and were quickly damped by the autopilot. The vehicle first bending mode occurred predominantly in the pitch plane between BECO and booster-section jettison. The maximum zero-to-peak amplitude as indicated on the rate gyro was 0.6 deg/sec at a frequency of 4.3 cps and exhibited a decaying trend. Similar bending modes were present on previous SLV-3 flights.

Proper system response was demonstrated to all guidance steering commands. The initial steering commands in the sustainer phase resulted in rigid body oscillations primarily in the yaw plane. The oscillations were damped to negligible values by LO + 238 seconds.

The guidance SECO discrete was measured at the programmer input at LO + 281.387 seconds. The vernier attitude correction steering commands were small and resulted in no control oscillations.

The guidance VECO and TLV-GATV separation discrete commands occurred at LO + 303.697 seconds and LO + 305.943 seconds, respectively. Gyro and axial accelerometer data exhibited normal characteristics for these events. Displacement gyro errors at VECO (the signal to uncage GATV gyros) were less than 0.03° in all three channels.

Rate gyro and axial accelerometer data, including booster-section jettison and TLV-GATV separation data, were carefully reviewed and no abnormal disturbances or unusual indications were observed prior to or during separation.

During the coast phase, the following events were noted:

(a) The roll rate gyro indicated a slight oscillation at approximately LO + 344.2 seconds which is a result of the vernier engine nulling in pitch and yaw. This event is normal and occurs at SECO plus 62.7 seconds when the programmer low-power switch 3 resets.

(b) Gyro and axial accelerometer indications, similar to those noted on normal flights at the time of Agena engine ignition, were observed on this flight at approximately LO + 377 seconds.

5.5.3.2 Separation of TLV-GATV.- The GATV separation signal was transmitted from the TLV at LO + 305.945 seconds. This signal initiated the events for primacord separation and retrorocket firing at LO + 305.955 seconds. Data indicate normal primacord detonation and firing of the retrorockets.

Based on TLV gyro data and TLV axial accelerometer data, separation was normal in this flight. (See fig. 5.5.1-1.) Comparison of these data with other Atlas-Agena separations indicates no anomalies with respect to TLV motions and events.

### 5.5.4 Pneumatic and Hydraulic Systems

5.5.4.1 Pneumatic system.- Operation of the pneumatic system was satisfactory, and all pressurization and pneumatic control functions were normal during the flight. The helium gas ullage pressure in the liquid oxygen tank remained practically constant during the flight varying from 30 psig at 10 seconds before lift-off to 28.7 psig at vernier engine cut-off (VECO). The helium gas ullage pressure in the fuel tank varied from 66 psig just prior to launch to 49 psig at VECO.

The pressure across the bulkhead between the fuel tank and the oxidizer tank was maintained higher on the fuel side than on the oxidizer side throughout the flight as is necessary to prevent collapse of the bulkhead. During the flight the minimum transient differential pressure was 10.9 psi across the intermediate bulkhead. For the first 25 seconds after lift-off, a 5-cps oscillation at a maximum peak-to-peak value of 5 psi occurred in this differential pressure. This oscillation always exists and results from the 5-cps vehicle longitudinal oscillation which normally occurs immediately after lift-off.

There were 151 pounds of chilled helium aboard the vehicle at engine ignition and 66 pounds at BECO indicating a usage of 85 pounds during the booster engine phase of flight. The helium temperature varied from -320° F at lift-off to -384° F at BECO when the helium bottles were jettisoned.

5.5.4.2 Hydraulic system.- The hydraulic system functioned satisfactorily prior to launch and during the flight. Pressures in the hydraulic systems of the booster engine and sustainer engine are shown in table 5.5.4-I.

TABLE 5.5.4-I.- HYDRAULIC PRESSURES

| | Pressure, psi | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Before evacuation (a) | After evacuation (a) | T-10 seconds | Peak at lift-off | Steady state | BECO | SECO | VECO |
| Booster accumulator | 2000 | 2000 | 2000 | 3465 | 3120 | 3080 | — | — |
| Booster pump discharge | — | — | — | — | 3150 | 3100 | — | — |
| Booster system return | 120 | 90 | 90 | 80 | 95 | 90 | — | — |
| Vernier system supply line | 2000 | 1970 | 1910 | 3385 | 3120 | 3100 | 3100 | 1280[b] |
| Sustainer pump discharge | — | — | — | 3465 | 3140 | 3120 | 3120 | — |
| Sustainer/vernier system return | 120 | 95 | 95 | 80 | 90 | 90 | 85 | 90 |

[a] 29.5 seconds prior to launch the reservoirs were first filled with fluid, after which a fixed amount of fluid was evacuated for ullage control.

[b] 22 seconds after VECO the pressure had dropped to 830 psia which is the bottoming-out pressure of the vernier solo accumulators; the pressure then dropped immediately to zero.

### 5.5.5 Guidance System

The target launch vehicle was guided by the MOD III radio guidance system (RGS) which performed satisfactorily throughout the countdown and powered flight. This was accomplished by both the ground and airborne systems properly sending and decoding the required steering and planned discrete commands.

5.5.5.1 Programmed guidance.- Stage I programmed guidance, as indicated by rate gyro output from the autopilot, executed the planned roll and pitch rate maneuvers successfully (refer to section 5.5.3).

5.5.5.2 Radio guidance.-

5.5.5.2.1 Booster steering: The ground radio guidance tracker trajectory cube acquired the pulse beacon of the target launch vehicle at LO + 61.7 seconds. Rate lock was acquired at LO + 55.6 seconds. Both rate and track lock were continuous, except for the normal momentary interruption at staging, until loss of vehicle tracking at LO + 380 seconds.

Booster steering, implemented to steer out stage I dispersions as a function of look angle constraints, was enabled by the TLV flight control system at LO + 80 seconds as planned. As a result, one pitch-down steering command was sent by the ground computer to the airborne pulse beacon at LO + 111.2 seconds, indicating a slightly dispersed first-stage flight. BECO occurred at LO + 130.45 seconds at an elevation angle of 37°. The errors at BECO were 43 ft/sec low in velocity, 1796 feet low in altitude, and 0.24° high in flight-path angle. (See table 4.3-I.)

5.5.5.2.2 Sustainer steering: Sustainer steering was initiated at LO + 145.4 seconds. At this time, an initial 6 percent pitch-down steering command (0.12 deg/sec) was given for 0.5 second followed by relatively smaller and varying commands between ±0.06 deg/sec until SECO (LO + 281.39 sec). Yaw steering, which started at the same time as the pitch steering, was characterized by a 78-percent yaw-left command (1.56 deg/sec) for 1.4 seconds. The large yaw commands were issued, as expected, to provide the pre-planned dog-legged maneuver used for the purpose of increasing the Gemini launch vehicle (GLV) window. The yaw commands for the rest of the sustainer flight were of very small magnitude varying between positive and negative commands of 0.05 deg/sec.

VECO occurred at LO + 303.70 seconds (end of closed-loop steering) at an elevation angle of 14°. The VECO conditions (see table 5.5.5-I) were well within the $3\sigma$ limits. The inertial velocity was 0.4 ft/sec low, the vertical velocity was 4.0 ft/sec low, and the yaw velocity was 1.0 ft/sec to the right. Table 5.5.5-I compares the actual conditions of the achieved coast ellipse with those of the real-time filtered inflight desired conditions (i.e. real-time error analysis). The vernier corrections were transmitted at LO + 281.9 seconds and consisted of a 0.3° pitch-up attitude change and a 0.14° yaw-right attitude change.

TABLE 5.5.5-I. - COMPARISON OF THE INFLIGHT DESIRED AND ACTUAL CONDITIONS

| VECO | | |
|---|---|---|
| Condition | Filtered inflight desired | Actual |
| Time from lift-off, sec . . . . . | 302.3 | 303.7 |
| Space-fixed velocity, ft/sec . . . | 17 543.4 | 17 543.0 |
| Vertical velocity, ft/sec . . . . | 2 752 | 2 748 |
| Yaw velocity, ft/sec . . . . . . . | 0.0 | -1.0 |

### 5.5.6 Electrical System

Operation of the electrical system was satisfactory during countdown operations and throughout powered flight. All electrical parameters measured were within tolerance and remained stable. There was no evidence of unusual transients or anomalies. Electrical system dc and ac parameter measurement values, at selected flight times, are presented in table 5.5.6-I.

TABLE 5.5.6-I.- ELECTRICAL SYSTEM PERFORMANCE

| Measurement | T-10 sec | Lift-off | BECO | SECO | VECO | LO+350 sec | Specification tolerance |
|---|---|---|---|---|---|---|---|
| E28V MSL systems input, V dc . . . | 28.2 | 28.2 | 27.6 | 28.1 | 28.1 | 28.2 | 26.0 to 30.4 |
| E51V Phase A, 400-cycle, V ac . . | 115.2 | 115.0 | 115.2 | 114.8 | 114.7 | 114.6 | 112.3 to 118.3 |
| E52V Phase B, 400-cycle, V ac . . | 116.0 | 115.8 | 116.1 | 115.6 | 115.4 | 115.3 | Phase A ±2.5 percent |
| E53V Phase C, 400-cycle, V ac . . | 116.5 | 116.0 | 116.2 | 115.8 | 115.7 | 115.6 | Phase A ±2.5 percent |
| E151V Inverter frequency, cps . . . | 400.0 | 399.1 | 400.0 | 400.0 | 400.0 | 400.0 | 390 to 410 |
| E95V Guidance power, V dc[a] . . . . | 28.1 | 28.1 | 27.9 | 28.0 | 28.1 | 28.1 | 25.0 to 30.0 |
| E96V Phase A gyro, V ac[b] . . . . . | 115.4 | 115.4 | 115.4 | 115.4 | 115.4 | 115.2 | |

[a] The value measured by E95V should be less than that indicated by E28V. The indicated discrepancy is within the accuracy of the telemetry system.

[b] The value measured by E96V cannot be greater than that measured by E51V. The indicated discrepancy is within the accuracy of the telemetry system.

## 5.5.7 Instrumentation System

5.5.7.1 Telemetry.- The vehicle telemetry system operated satisfactorily during the flight. One lightweight telemetry package was used to monitor 117 measurements which were distributed on 9 continuous and 5 commutated channels. All except two of the measurements were of good quality, and these two were readable. The sustainer fuel-pump discharge pressure (P330) had an anomalous decrease in pressure early in the flight that was believed to be because of a temporarily frozen sensing line. Sustainer liquid oxygen pump-inlet pressure sensor P55P was noisy from LO to LO + 282 seconds, but was readable.

Telemetry dropped out once during the flight at the normally encountered dropout time associated with booster-section jettison. This began at LO + 133.875 seconds and ended at LO + 134.185 seconds.

The landline instrumentation system carried a total of 44 analog and 58 discrete vehicle-borne measurements. All 102 measurements provided satisfactory information until planned disconnection at lift-off.

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### 5.5.8 Range Safety System

Operation of the range safety system was satisfactory during powered flight. No range safety functions were required or transmitted and no spurious range safety commands were generated. Range safety plotboards and telemetry readouts in Central Control were normal during the flight.

RF signal strength received at command receiver 1 indicated that adequate signal margins were available for proper operation of the RF link at all times during the flight. Manual fuel cut-off and destruct were not indicated. No auxiliary sustainer cut-off (ASCO) signal was sent on this mission.

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## 5.6 GEMINI AGENA TARGET VEHICLE AND TARGET LAUNCH VEHICLE INTERFACE PERFORMANCE

Performance of the TLV-GATV interface was satisfactory through the TLV powered flight phase. The TLV transmitted the separation signal to the GATV at LO + 305.945 seconds, initiating the separation events of primacord fire and retrorocket fire at LO + 305.97 seconds. A comparison of recorded data with data from previous Atlas-Agena separations indicates that the separation was normal (see section 5.5.1).

Ambient pressure and temperature within the TLV adapter were normal. The ambient pressure exhibited the usual exponential decay that is characteristic of this measurement. The ambient temperature increased from -20° F at lift-off to 54° F at GATV separation.

Structural integrity of the TLV-GATV interface was satisfactorily maintained throughout launch vehicle operation. Estimated flight loads are given in the following table. The relieving effect of compartment pressure has not been included in these estimates. These data indicate that maximum loading occurred in the pre-BECO region of flight.

| Condition | Load, lb | Ultimate design load, percent |
|---|---|---|
| Max $q\alpha$ | 107 800 | 41 |
| Pre-BECO | 111 900 | 43 |

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# 6.0 MISSION SUPPORT PERFORMANCE

## 6.1 FLIGHT CONTROL

The Gemini VI mission was to have been controlled by the Mission Control Center-Houston (MCC-H) flight control team; however, mission control was not the responsibility of this team until after the Gemini Agena target vehicle (GATV) had been placed in orbit. Consequently, flight control support for the Gemini VI-A mission consisted of mission preparations, simulations, and pad support.

This section of the report is based on real-time observations and may not agree with the detailed postflight analysis and evaluations in other sections of the report.

### 6.1.1 Premission Operations

6.1.1.1 Premission activities.- The flight control team participated in extensive simulations and supported the various vehicle pad tests. These exercises extended over a period of 30 days before launch, and provided operational and equipment familiarity and confidence for all three flight control teams. The significant tests are summarized as follows:

| Tests | Number of tests |
|---|---|
| Simulated network simulations | 11 |
| Network simulations | 2 |
| Joint flight acceptance and configuration | 1 |
| Simultaneous launch demonstration | 2 |
| Launch abort simulations | 8 |
| Reentry simulations | 4 |
| Simulated flight | 2 |
| Digital command system (DCS) loading | 1 |
| Data flow | 3 |
| Target launch vehicle (TLV)-GATV launch simulations | 1 |
| Network systems tests | As required |

6.1.1.2 Documentation.- The documentation effectiveness for this mission cannot be evaluated since the complete mission was not conducted.

However, all the flight control support documentation was published on schedule.

6.1.1.3 Mission Control Center-Houston network flight control operations.- The network went on mission status October 12, 1965. The Carnarvon flight control team deployed on October 10, 1965, and the other teams were on site by October 16, 1965. The DCS loading test was satisfactory, but there were minor problems with the telemetry program which necessitated three telemetry data-flow tests. The entire network was well prepared for launch.

6.1.1.4 Countdown.- Very few problems were encountered in the countdown, a fact that reflects the considerable effort that went into the development of the integrated rendezvous countdown. The count proceeded normally until 1:21 a.m. c.s.t. when the projection plotters were reported to be unsatisfactory by Maintenance and Operations (M and O) personnel. Checks were made on this equipment and by the T-260-minute trajectory run (approximately 7:21 a.m. c.s.t.) the plotters were working normally.

The GATV command loading was conducted without incident.

At 2:44 a.m. c.s.t. the GATV parameter C-013 (battery temperature) failed. It was decided to launch without this readout.

Voice transmission between all sites was excellent. All remote site flight control support which interfaced into the countdown was satisfactory.

### 6.1.2 Mission Operations Summary

6.1.2.1 Powered flight.- Lift-off of the Gemini Atlas Agena target vehicle (GAATV) occurred at 15:00:04 G.m.t., and all events through vernier engine cut-off (VECO) were nominal.

Separation of the GATV appeared to be very abnormal, and after separation, rather large dispersions in GATV attitudes were noted. The attitude control system was very active in attempting to stabilize the vehicle, but did not appear to damp out the oscillations completely at the time of GATV primary propulsion system (PPS) engine ignition.

The engine start signal was observed exactly on time; however, no thrust chamber pressure was displayed, and an abrupt pitch-down and yaw-left were observed just as the start signal occurred.

A message acceptance pulse (MAP) was observed on the GATV telemetry approximately 1 second after the engine start signal, although no commands had been sent from MCC-H.

At 374 seconds after lift-off, or 7.5 seconds after the engine start signal (LO + 366.5 sec), the telemetry signal was lost. A check with Houston and Cape Kennedy telemetry revealed that all Kennedy Space Center (KSC) and Grand Turk Island (GTI) telemetry receivers had lost signal at the same time. About this time the Flight Dynamics Officer (FIDO) reported loss of the C-band track and, later, the S-band track. About 30 seconds later the network reported to the Flight Director that Patrick Air Force Base radar was tracking five targets.

The Canary Island (CYI) station was instructed to attempt to command C-band beacon on, S-band beacon on, mod-bus reverse, and telemetry on, via real-time commands based on nominal acquisition time and look angles. In the meantime, the MCC-H telemetry ground station magnetic tape was replayed several times, and all flight controllers observed the data through the real-time computer complex (RTCC) display system and on analog recorders and event lights. A pressure rise in the fuel and oxidizer tanks was noted and attributed to the opening of the pyrotechnic-operated helium control valve which applied high pressure helium to the fuel and oxidizer tanks. An engine shutdown signal was observed 0.9 second after the engine start signal (LO + 367.4 sec). At LO + 367.6 seconds, an indication was noted that one turbine overspeed relay had closed. It was believed at this time that the unexplained engine shutdown signal had lead to a catastrophic failure due to overpressurization and ultimate bursting of the fuel tank. At approximately 15:16:00 G.m.t., the Range Safety Officer reported that the GATV PPS did not appear to have ignited.

Data Select personnel reported low-speed S-band data from Bermuda (BDA) at approximately 15:15:00 G.m.t. These data points, however, were found to be prior to the time for PPS ignition. A Keplerian orbit determination was made and showed an apogee of 157 nautical miles and a perigee of -381 nautical miles.

An impact point was calculated in the auxiliary computer room as latitude 27° 30' N. and longitude 48° 50' W., which was passed to recovery personnel. The IP-3600 facility calculated the following vacuum impact points:

| | | |
|---|---|---|
| a. | Based on data at LO + 311 seconds | 27° 27.14' N.<br>48° 50.97' W. |
| b. | Based on KSC data at LO + 492 seconds | 27° 30.57' N.<br>48° 59.33' W. |

6.1.2.2 Orbital.- In spite of the apparent catastrophic failure, continued attempts were made to establish contact with the GATV from Canary Island, Carnarvon, Hawaii, Guaymas, Texas, and the Air Force Eastern Test Range on the first orbit, based on RTCC nominal insertion data. The Gemini space vehicle countdown was discontinued at T-42 minutes (approximately 16:00 G.m.t.). Commands were sent to turn on both beacons and telemetry and to apply the telemetry modulation to the second transmitter. A stored program command load to accomplish the same functions was also attempted from the MCC-H. One more attempt was made from Carnarvon and Hawaii on the second orbit before the search was abandoned. The emergency reset timer was set to clock-out over Hawaii on the second orbit, which should have turned on the radar beacons and telemetry transmitters. Negative acquisition was reported from all sites, including the North American Air Defense Command (NARAD) skin track radars.

## 6.2 NETWORK PERFORMANCE

The network was placed on mission status for Gemini VI mission on October 12, 1965. On launch day, October 25, 1965, the network was ready to support the mission at lift-off.

### 6.2.1 Mission Control Center-Houston and Remote Facilities

The network configuration and the general support provided at each station are indicated in table 6.2-I. Figure 6.2-1 shows the network station locations and figure 6.2-2 illustrates the network complex at Cape Kennedy and at the Kennedy Space Center. Approximately 15 aircraft and one ship were available for supplementary photographic, weather, telemetry, and voice-relay support. There were no significant network problems at lift-off.

### 6.2.2 Network Facilities

Performance of the network is reported on a negative basis by system and site. All performance not detailed in this report was satisfactory.

6.2.2.1 Remote sites.-

6.2.2.1.1 Telemetry: Premission test problems occurred at some sites because of errors on the simulation tapes, but there were no significant problems at any site on launch day. Gemini Agena target vehicle (GATV) signals were lost abruptly at Cape Kennedy, Florida (CNV), Grand Bahama Island (GBI), Grand Turk Island (GTI), Antigua Island (ANT), and Bermuda (BDA) at 15:06:20 G.m.t. The BDA elevation angle at GATV loss of signal (LOS) was 20°. The target launch vehicle (TLV) acquisition of signal (AOS) and LOS telemetry-reception profile on 249.9 megacycles is shown in G.m.t. in the following chart:

| | AOS, G.m.t. | LOS, G.m.t. |
|---|---|---|
| GBI | 15:00:42 | 15:12:16 |
| GTI[a] | 15:06:46 | 15:12:16 |
| BDA | 15:03:06 | 15:12:40 |

[a] Manually tracked after GATV LOS.

6.2.2.1.2 Radar: The network simulations generally produced satisfactory results for the tracking and radar handover exercises. Radar operation was normal from GAATV lift-off until 15:06:20 G.m.t., at which time both the C-band and S-band beacons failed. Both Patrick Air Force Base (PAT) and KSC acquired a skin track rapidly, and it was retained by PAT until 15:09:25 G.m.t. Bermuda C-band and S-band radars transmitted only six points of low-speed radar data via teletype to MCC-H before the GATV transponder failure. Although a catastrophic failure was believed to have occurred, the C-band radars at Point Arguello (CAL), White Sands (WHS), Eglin Air Force Base (EGL), and the Air Force Eastern Test Range (ETR) were requested to configure for skin track. This was done but no targets were observed. The network was released at approximately 18:24:00 G.m.t. Radar performance during the launch phase is shown in the following chart:

| Station | Type radar | Mode (a) | AOS, G.m.t. | LOS, G.m.t. | Remarks |
|---|---|---|---|---|---|
| KSC | TPQ-18 | 3&1[b] | 15:00:14 | 15:09:05 | Mode 3<br>15:00:14 to 15:06:15<br>Mode 1<br>15:07:35 to 15:09:05 |
| PAT | FPQ-6 | 3&1[b] | 15:00:18 | 15:09:25 | Similar to KSC |
| CNV | [c]584-MOD 2 | 2 | 15:00:17 | 15:04:59 | |
| GBI | TPQ-18 | 3 | 15:01:20 | 15:06:20 | |
| GBI | FPS-16 | 3 | 15:01:15 | 15:06:20 | |
| BDA | FPS-16 | 3 | 15:03:45 | 15:06:23 | |
| BDA | Verlort | 2 | 15:04:14 | 15:06:20 | |
| GTI | TPQ-18 | 3 | 15:04:17 | 15:06:20 | |
| ANT | FPQ-16 | 3 | 15:05:45 | 15:06:20 | Some skin hits<br>No track |

[a] Mode 1 - Skin track
Mode 2 - S-band beacon
Mode 3 - C-band beacon

[b] Skin track target appeared to be several pieces

[c] Used only during launch as redundant support

6.2.2.1.3 Acquisition aids and timing: There were no major problems with acquisition; however, the timing system at Woomera had a radar time-tag omission problem which was corrected before launch.

6.2.2.1.4 Command: A command handover procedure had been developed to provide carrier and antenna switching for rendezvous missions for the remoted facilities at Corpus Christi, Bermuda, Cape Kennedy, Grand Bahama Island, Grand Turk Island, and Antigua. Network simulation testing revealed serious defects in these procedures which were subsequently modified. One important change incorporated was that the Flight Director was to arbitrate conflicting requirements for GATV and Gemini systems command carrier priority. The new procedures were evaluated in later simulations and found to be satisfactory.

The auxiliary sustainer engine cut-off (ASCO) command from MCC-H was disabled and responsibility for its execution was placed with the Range Safety Officer. No commands from the network were sent to the GATV from T-405 minutes in the countdown until several minutes following separation and after the loss of all signals. The network command sites later radiated at the nominal AOS-LOS times until approximately 18:00:00 G.m.t. There was no verification of any of the commands transmitted. Commands radiated at Carnarvon (CRO) during the first revolution period are furnished below as an example of the efforts to establish vehicle contact:

| Signal | Signal sent, number of times |
|---|---|
| S-band on | 19 |
| MOD bus reverse | 18 |
| MOD bus normal | 3 |
| Telemetry on | 21 |
| Telemetry dump on | 18 |
| VHF antenna, orbit | 5 |
| VHF antenna, ascent | 2 |
| C-band on | 7 |

6.2.2.1.5 Missile trajectory measurement system (MISTRAM): Performance of MISTRAM was satisfactory.

6.2.2.2 Computing.-

6.2.2.2.1 MSC computers: During the Gemini VI simulation period, a number of program failures occurred. These failures, in general, were due to a lack of complete system testing prior to support of the simulations. However, during the final network simulations, and precount support, the real-time computer complex (RTCC) support participation was completed without any significant failures. It was found that the simultaneous countdown presented no problems, and the RTCC was able to meet all tests on schedule.

Only one problem occurred during precount operations. A switch on the 7286 data channel was found to be in the test position. The computer maintenance and operations (M and O) personnel decided that moving the switch to the operate position would cause no problem, but when the switch was moved to this position, the computer failed and a type A restart had to be performed. The restart was accomplished, and the computer was returned to an operational status in less than 10 minutes. This procedural error has been corrected.

With the exception of the problem noted, the RTCC successfully supported the test operation until termination of the mission.

6.2.2.2.2 Remote site data processors (RSDP): During the simulation period, several procedural and hardware interface problems were isolated and corrected. The RSDP's performed satisfactorily during the countdown and flight.

6.2.2.2.3 Goddard Space Flight Center (GSFC) computing: The GSFC computing center supported the mission by providing pointing data without serious difficulty.

6.2.2.2.4 ETR IP-3600 computer: The ETR IP-3600 computer furnished impact point (IP) data during powered flight based on KSC radar tracking. An IP of 27° 30.57' N. and 48° 59.33' W. was generated near the time of the GATV failure. The RTCC computed a negative apogee at about this same time (15:07 G.m.t.) based on Bermuda C-band and S-band data.

6.2.2.3 Communications.-

6.2.2.3.1 Ground communications: Some microwave fading, distortion, and cross-talk were experienced on teletype and voice circuits across the southern states; these difficulties were corrected by using alternate paths. At 15:30 G.m.t. on launch day, a 3-minute voice circuit failure to CRO occurred, but it was corrected by changing to another circuit. There were no data circuit failures resulting in a loss of support. A radar handover circuit to Corpus Christi (TEX) was defective at lift-off, but was restored at 15:29 G.m.t., in sufficient time to have provided support on the first revolution. Ground communications for this mission were very good.

6.2.2.3.2 Air-to-ground: There were no known problems with network air-to-ground equipment.

6.2.2.3.3 Frequency interference: No reports of interference were received by the network controller.

TABLE 6.2-I.- NETWORK SUPPORT

| Systems / Stations | C-band radar | S-band radar | SPANDAR | R and R telemetry | Real-time display telemetry | Delayed-time telemetry | High-speed telemetry | GIDS | Remote site data processor summary | GLV telemetry | Digital command system | Downrange uplink | Data routing and error detection | RF command | Voice | Teletype | Horizon scanner radar data | FC manned | Acquisition aid | Telemetry RCV antenna | FC, air-to-ground | air-to-ground remoting |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MCC-H | | | | | X | X | | | X | | Ⓧ | | | | X | X | X | X | | | X | X |
| MCC-C | | | | X | | X | X | X | | X | X | | X | | X | X | X | | X | X | | |
| KSC | X | | | | | | | | | | | | | | | | | | | | | |
| CNV | X | X | | X | | | | | | X | | X | | X | | | | | | | | |
| PAT | X | | | | | | | | | | | | | | | | | | | | | |
| GBI | X | X | | X | | X | X | | | X | | X | | X | | | | | X | X | | X |
| GTI | X | X | | X | | X | X | | | | | X | | X | | | | | X | | | X |
| BDA | X | X | | X | | X | X | | | | | X | | X | X | X | X | | X | X | | X |
| CYI | X | X | | X | X | X | | | X | | X | | | X | X | X | | X | X | | X | |
| KNO | | | | X | | | | | | | | | | | X | X | | | X | | | X |
| TAN | | | | X | | | | | | | | | | | X | X | | | X | | | X |
| PRE | X | | | | | | | | | | | | | | | | | | | | | |
| CRO | X | X | | X | X | X | | | X | | X | | | X | X | X | | X | X | | X | |
| CTN | | | | | | | | | | | | | | | X | X | | | X | | | X |
| HAW | X | X | | X | X | X | | | X | | X | | | X | X | X | | X | X | | X | |
| GYM | | X | | X | X | X | | | X | | | | | | X | X | | X | X | | X | |
| CAL | X | X | | X | | | | | | | | | | | X | X | | | X | | | X |
| TEX | | X | | X | | X | X | | | | X | X | | X | X | X | X | | X | | | |
| WHS | X | | | | | | | | | | | | | | X | X | | | X | | | |
| EGL | X | | | | | | | | | | | | | | X | X | | | X | | | |
| ANT | X | | | X | | X | X | | | | | X | | X | | | | | X | X | | X |
| ASC | X | | | X | | | | | | | | | | | | | | | X | X | | X |
| CSQ | | | | X | X | X | | | X | | X | | | X | X | X | | X | X | | X | |
| RKV | | | | X | X | X | | | X | | X | | | X | X | X | | X | X | | X | |
| RTK | X | | | X | | | | | | | | | | | | | | | X | | | X |
| A/C | | | | X | | | | | | | | | | | | | | | | | | X |
| WLP | | | $\boxed{\text{X}}$ | | | | | | | | | | | | | | | | X | | | |

Ⓧ – Master DCS

$\boxed{\text{X}}$ – If available

Ship positions:

| | | |
|---|---|---|
| CSQ | 125°E | 20°N |
| RKV | 39°W | 19°S |
| WHE | 175°W | 25°N |
| RTK | 175°W | 25°N |

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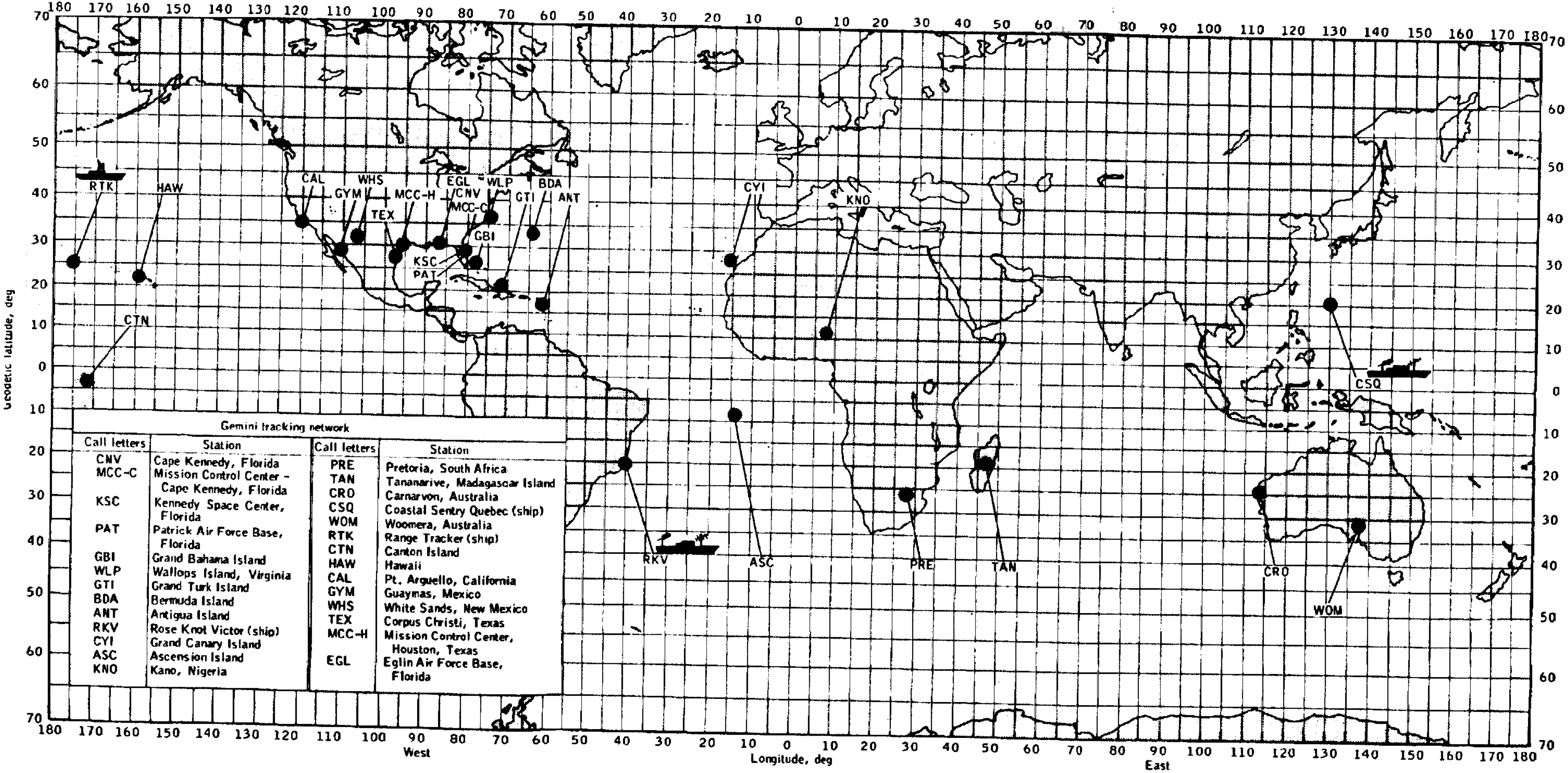

Gemini tracking network

| Call letters | Station | Call letters | Station |
|---|---|---|---|
| CNV | Cape Kennedy, Florida | PRE | Pretoria, South Africa |
| MCC-C | Mission Control Center - Cape Kennedy, Florida | TAN | Tananarive, Madagascar Island |
| KSC | Kennedy Space Center, Florida | CRO | Carnarvon, Australia |
| PAT | Patrick Air Force Base, Florida | CSQ | Coastal Sentry Quebec (ship) |
| GBI | Grand Bahama Island | WOM | Woomera, Australia |
| WLP | Wallops Island, Virginia | RTK | Range Tracker (ship) |
| GTI | Grand Turk Island | CTN | Canton Island |
| BDA | Bermuda Island | HAW | Hawaii |
| ANT | Antigua Island | CAL | Pt. Arguello, California |
| RKV | Rose Knot Victor (ship) | GYM | Guaymas, Mexico |
| CYI | Grand Canary Island | WHS | White Sands, New Mexico |
| ASC | Ascension Island | TEX | Corpus Christi, Texas |
| KNO | Kano, Nigeria | MCC-H | Mission Control Center, Houston, Texas |
| | | EGL | Eglin Air Force Base, Florida |

Figure 6.2-1. - Network stations, world map.

6-11

6-11-a

6-11-a

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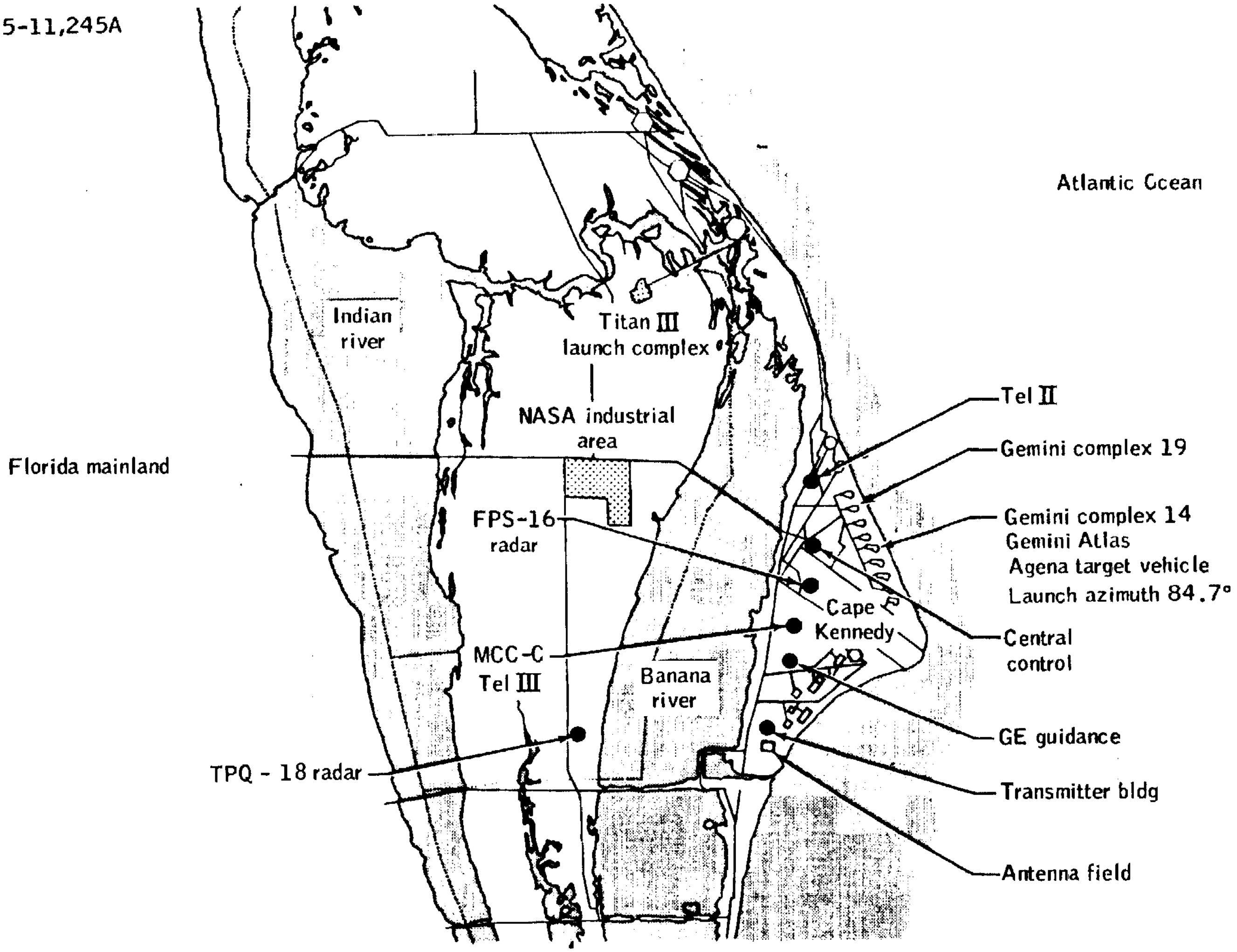

Figure 6.2-2. - Cape Kennedy - Kennedy Space Center network facilities.

## 7.0 FLIGHT CREW

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## 8.0 EXPERIMENTS

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## 9.0 CONCLUSIONS

1. The combined countdown for the Gemini Atlas Agena target vehicle and Gemini space vehicle was satisfactory with no holds and lift-off of the first vehicle occurred on schedule. The Gemini space vehicle countdown continued with no holds until the mission was canceled 54 minutes after the first launch when it was confirmed that the Gemini Agena target vehicle had not achieved orbit.

2. The target launch vehicle powered flight phase was normal in all aspects with booster, sustainer, and vernier engine cut-offs and Gemini Agena target vehicle separation occurring at nominal times and altitudes.

3. The Gemini Agena target vehicle performance was nominal until 368.44 seconds after lift-off when an anomaly occurred during the primary propulsion system start sequence. Approximately 7 seconds later, this anomaly led to the loss of the vehicle. Telemetry data have ruled out several failure modes, but have not identified the type, cause, or magnitude of the initial failure. The possibility exists that there was a primary propulsion system hard start. There is also a possibility that there was a power interruption to the gas generator propellant valves or the pilot-operated solenoid valve. There is no evidence of a major engine explosion, but the data indicate that some propellant lines may have been ruptured, or electrical wiring broken, or both.

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## 10.0 RECOMMENDATIONS

The following recommendation is made as a result of the Gemini VI-A mission.

1. Establish and implement any necessary modifications and retesting of the Gemini Agena target vehicle model 8247 engine system to eliminate the failure conditions encountered during the Gemini VI-A mission.

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## 11.0 REFERENCES

1. Lockheed Missiles and Space Co.: Gemini Agena Target Vehicle Familiarization Handbook. Report LMSC-A602521, revised February 22, 1965.
2. McDonnell Aircraft Corp.: NASA Project Gemini Familiarization Handbook. SEDR-300, revised May 31, 1965.
3. Gemini Program Office: Gemini Agena Interface Specification and Control Document. MSC document ISCD-2, Apr. 20, 1965, as revised.
4. Anon: 5301/5302 Reference Pre-injection Trajectory and Data for Gemini VI. Lockheed Missiles and Space Co. report LMSC/A765589, Sept. 24, 1965.

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# 12.0 APPENDIX A

## 12.1 VEHICLE HISTORIES

### 12.1.1 Spacecraft Histories

Spacecraft histories at the contractor's facilities at St. Louis, Missouri, are shown in figures 12.1-1 and 12.1-2, and at Cape Kennedy, Florida, in figures 12.1-3 and 12.1-4. Figures 12.1-1 and 12.1-3 are summaries of activities with emphasis on spacecraft systems testing and prelaunch preparation. Figures 12.1-2 and 12-1-4 are summaries of significant, concurrent problem areas. Spacecraft 6 history from October 25, 1965, to the date of launch will be included in the applicable mission report.

### 12.1.2 Gemini Launch Vehicle Histories

Gemini launch vehicle (GLV) histories at the contractor's facilities at Denver, Colorado, and Baltimore, Maryland, are shown in figure 12.1-5, and at Cape Kennedy, Florida, in figure 12.1-6. Figure 12.1-5 is a summary of significant manufacturing activities and concurrent problem areas. Figure 12.1-6 summarizes the GLV test and prelaunch preparation activities and also presents a summary of the significant, concurrent problem areas. GLV-6 history from October 25, 1965, to the date of launch will be included in the applicable mission report.

### 12.1.3 Gemini Agena Target Vehicle and Target Docking Adapter

Histories at the contractor's facilities for the Gemini Agena target vehicle (GATV) at Sunnyvale, California, and for the target docking adapter (TDA) at St. Louis, Missouri, are shown in figures 12.1-7 and 12.1-8, and at Cape Kennedy in figures 12.1-9 and 12.1-10. Figures 12.1-7 and 12.1-8 show significant manufacturing activities and concurrent problem areas. Figure 12.1-9 is a summary of activities with emphasis on GATV and TDA testing and prelaunch preparation. Figure 12.1-10 is a summary of GATV and TDA concurrent problem areas.

### 12.1.4 Target Launch Vehicle

Target launch vehicle (TLV) histories at the contractor's facilities at San Diego, California, are shown in figure 12.1-11, and at Cape

Kennedy, Florida, in figure 12.1-12. Both figures include systems testing and concurrent problem areas. Figure 12.1-12(a) covers the period from TLV receipt at Cape Kennedy through the storage period and figure 12.1-12(b) shows the remaining activities through launch.

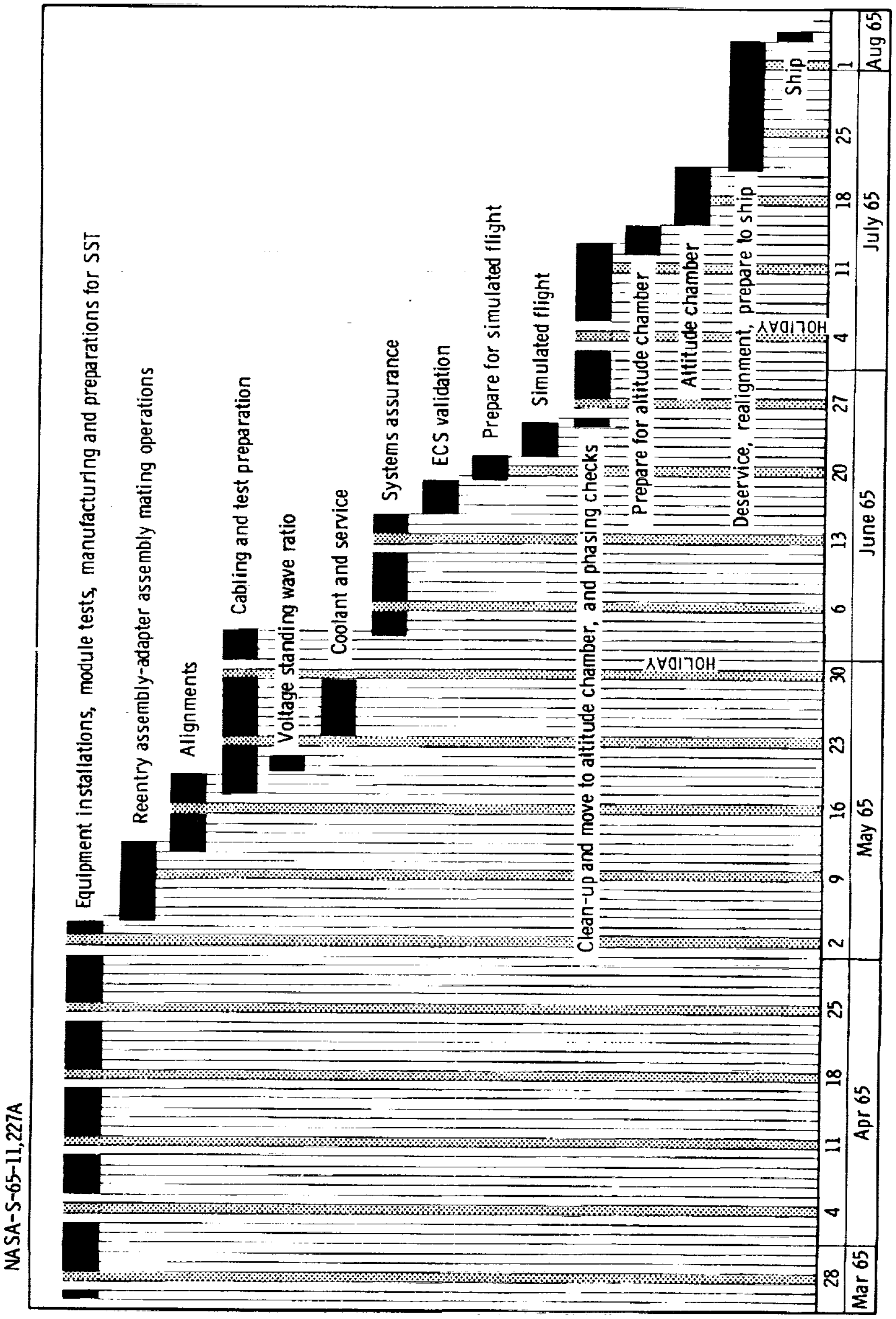

Figure 12.1-1. - Spacecraft 6 test history at contractor facility.

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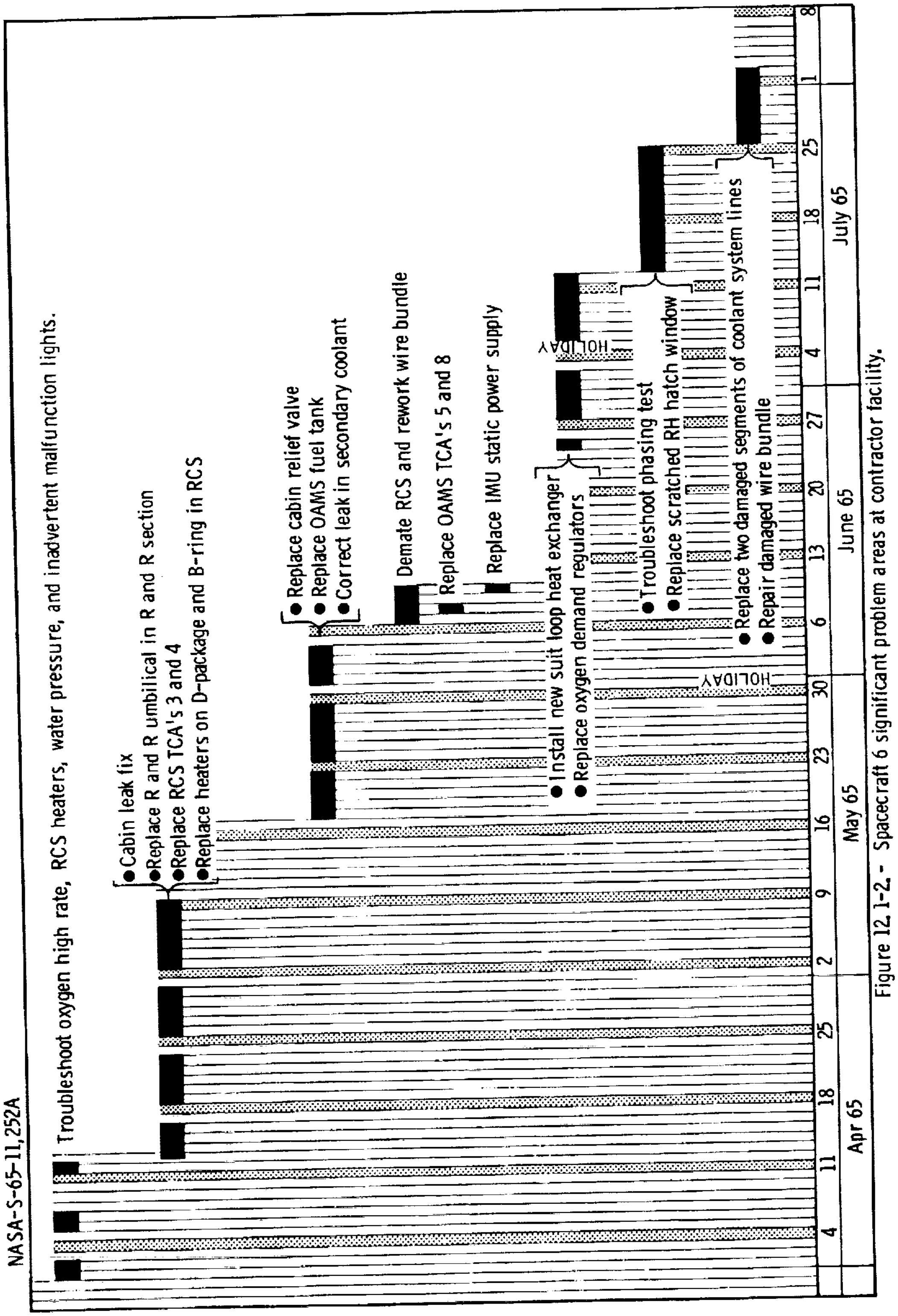

Figure 12.1-2.- Spacecraft 6 significant problem areas at contractor facility.

NASA-S-65-11,258A

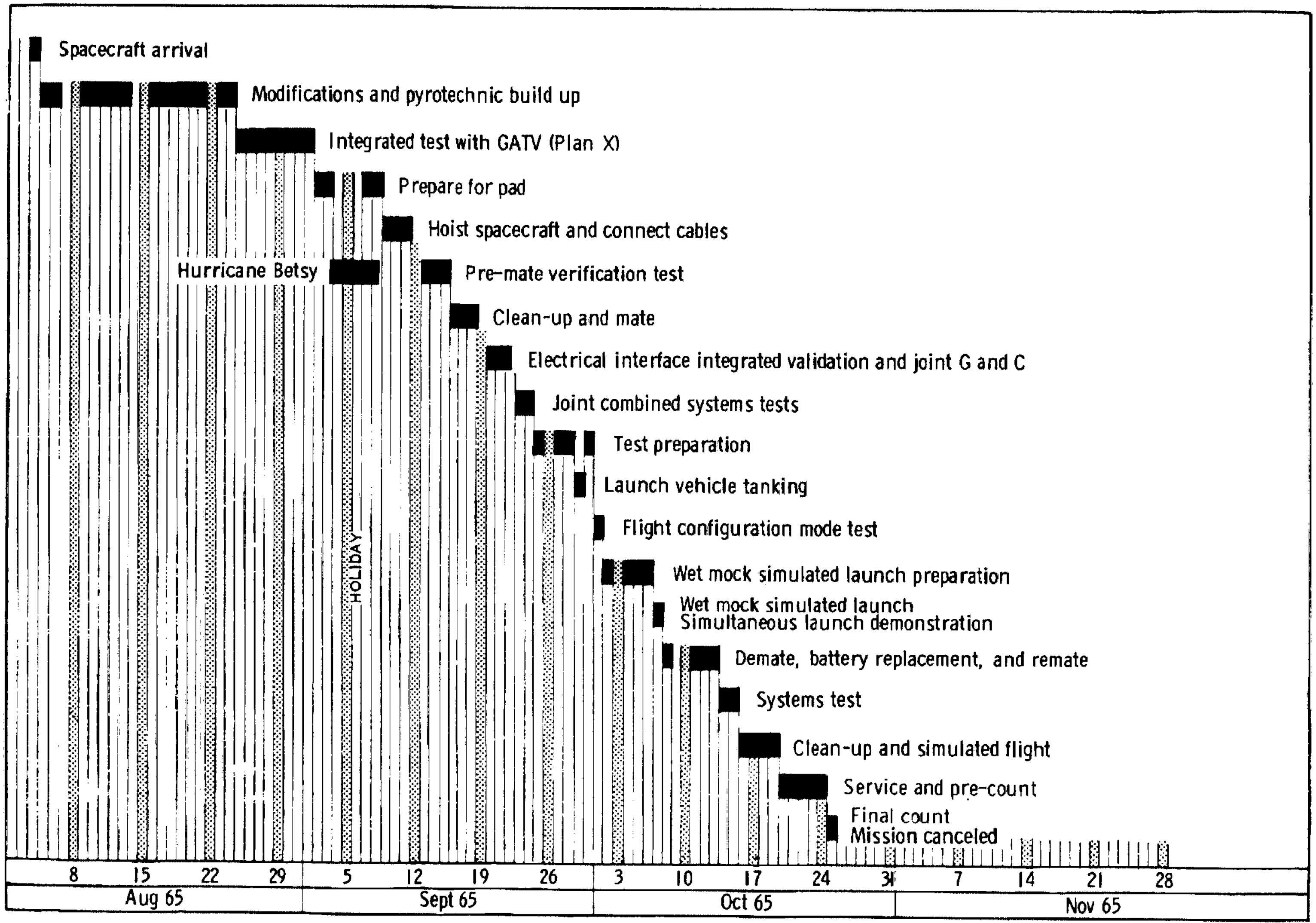

Figure 12.1-3. - Spacecraft 6 test history at Cape Kennedy.

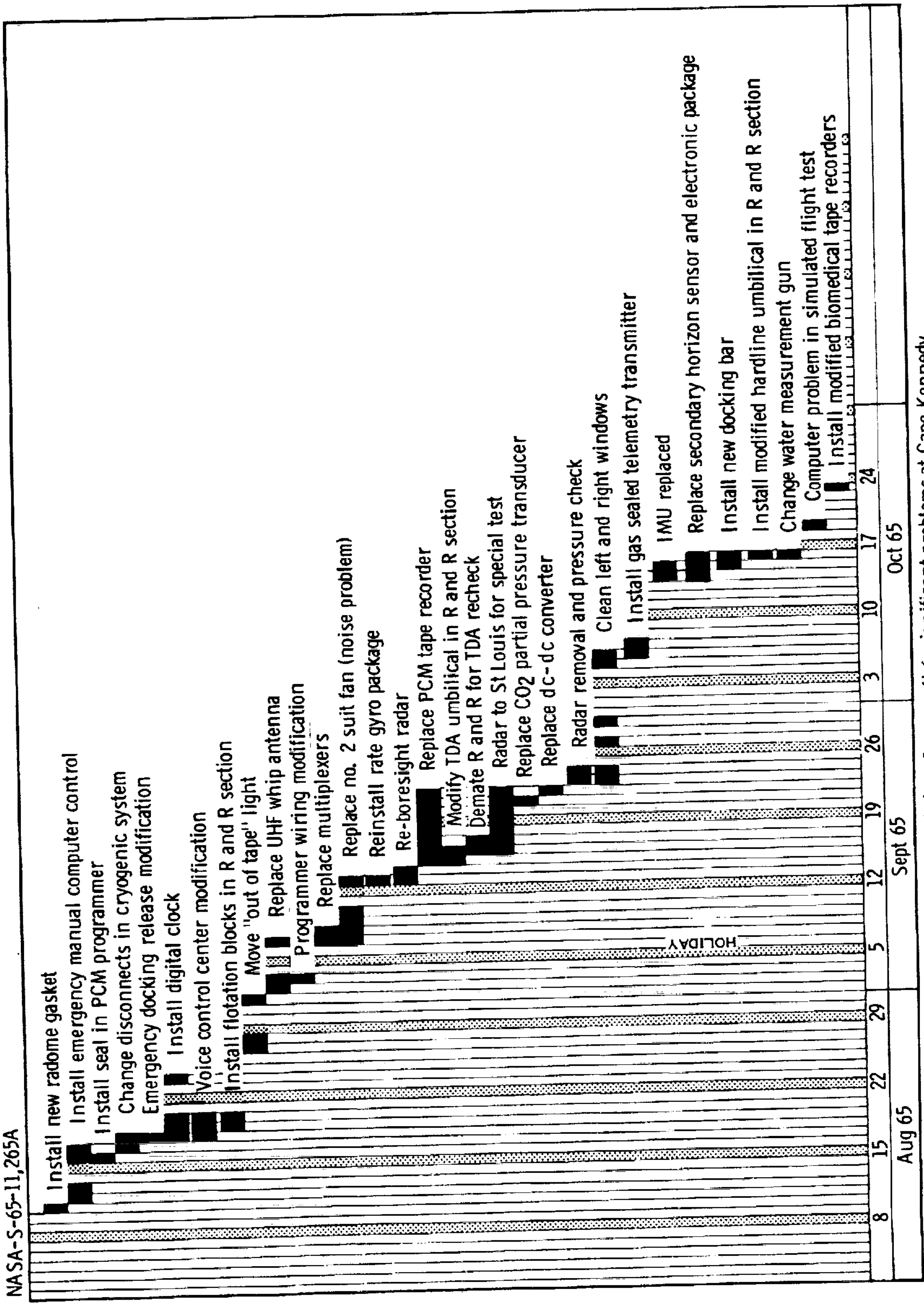

Figure 12.1-4. - Spacecraft 6 significant problems at Cape Kennedy.

NASA-S-65-11,261A

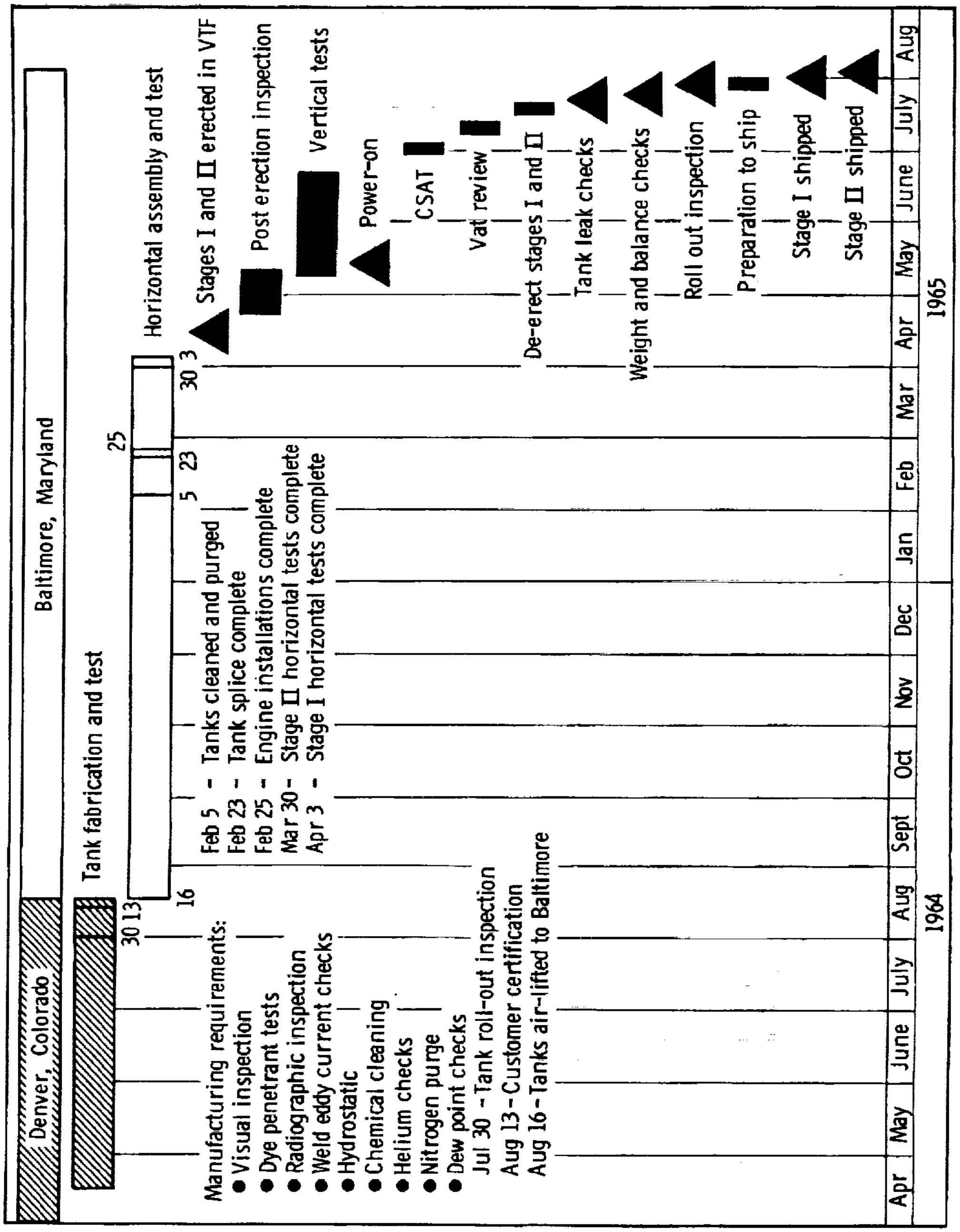

Figure 12.1-5.- GLV-6 history at Denver and Baltimore.

NASA-S-65-11,247A

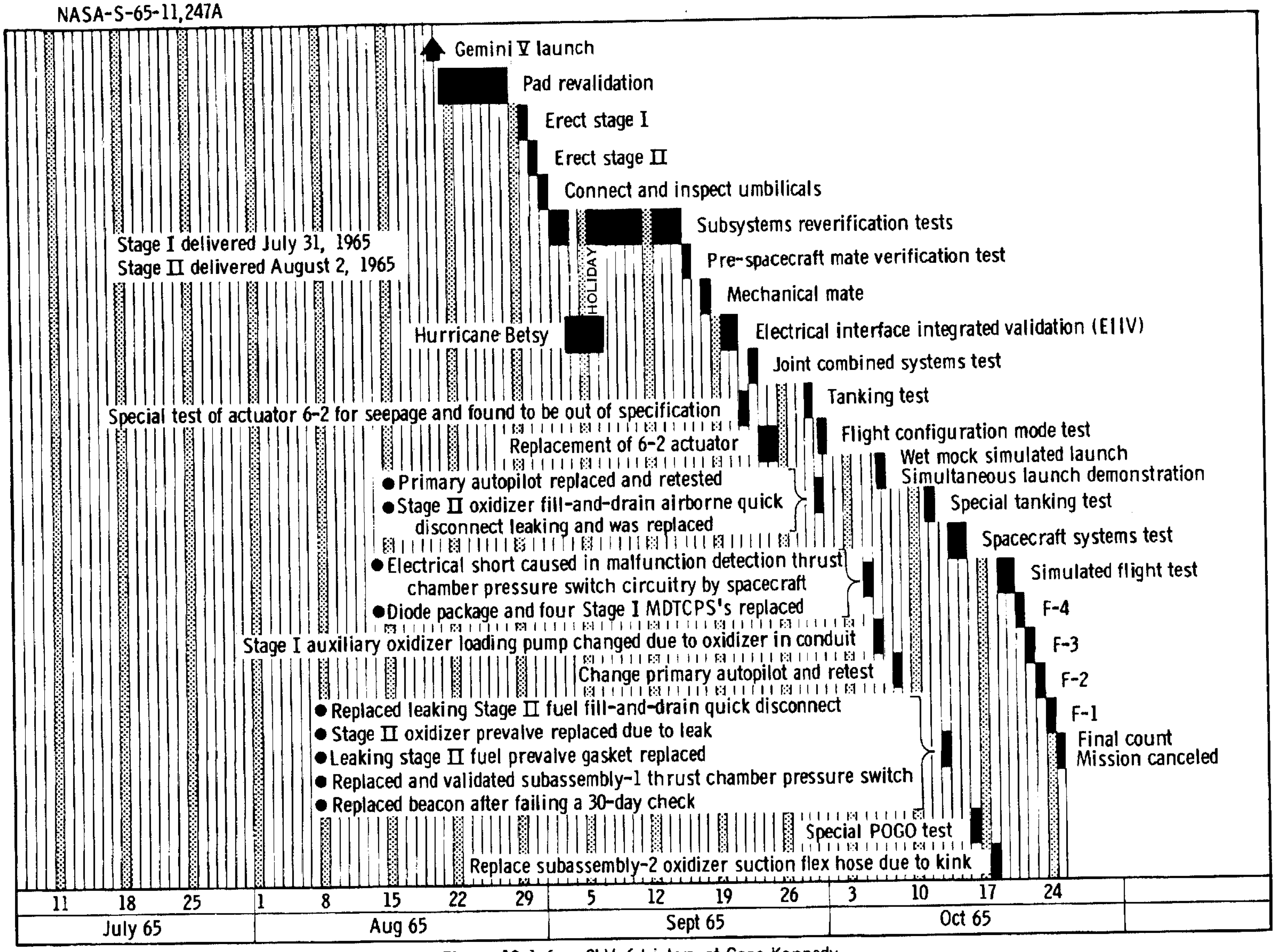

Figure 12.1-6. - GLV-6 history at Cape Kennedy.

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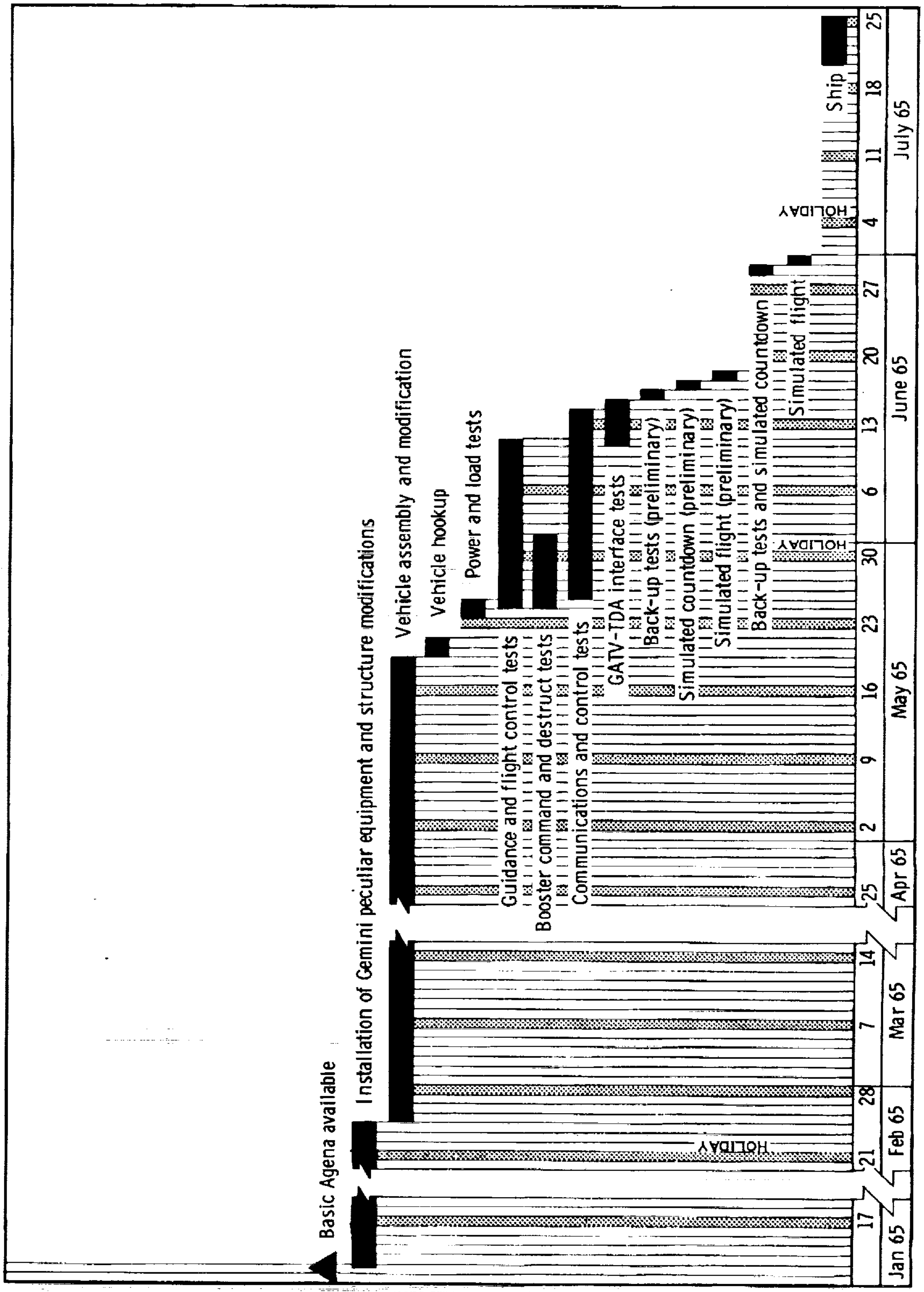

Figure 12.1-7. - GATV 5002 history at contractor facility.

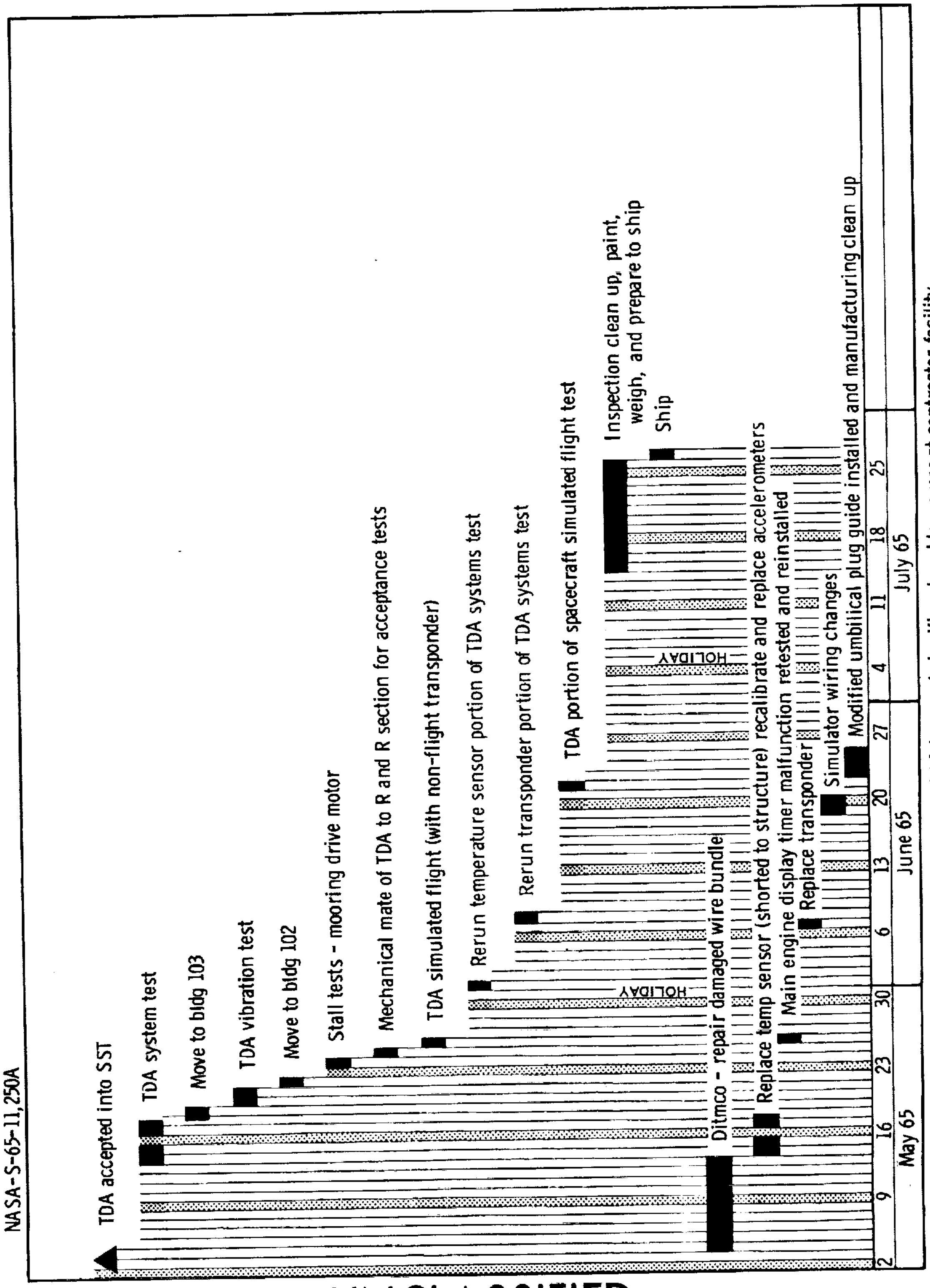

Figure 12.1-8. - TDA 2 test history and significant problem areas at contractor facility.

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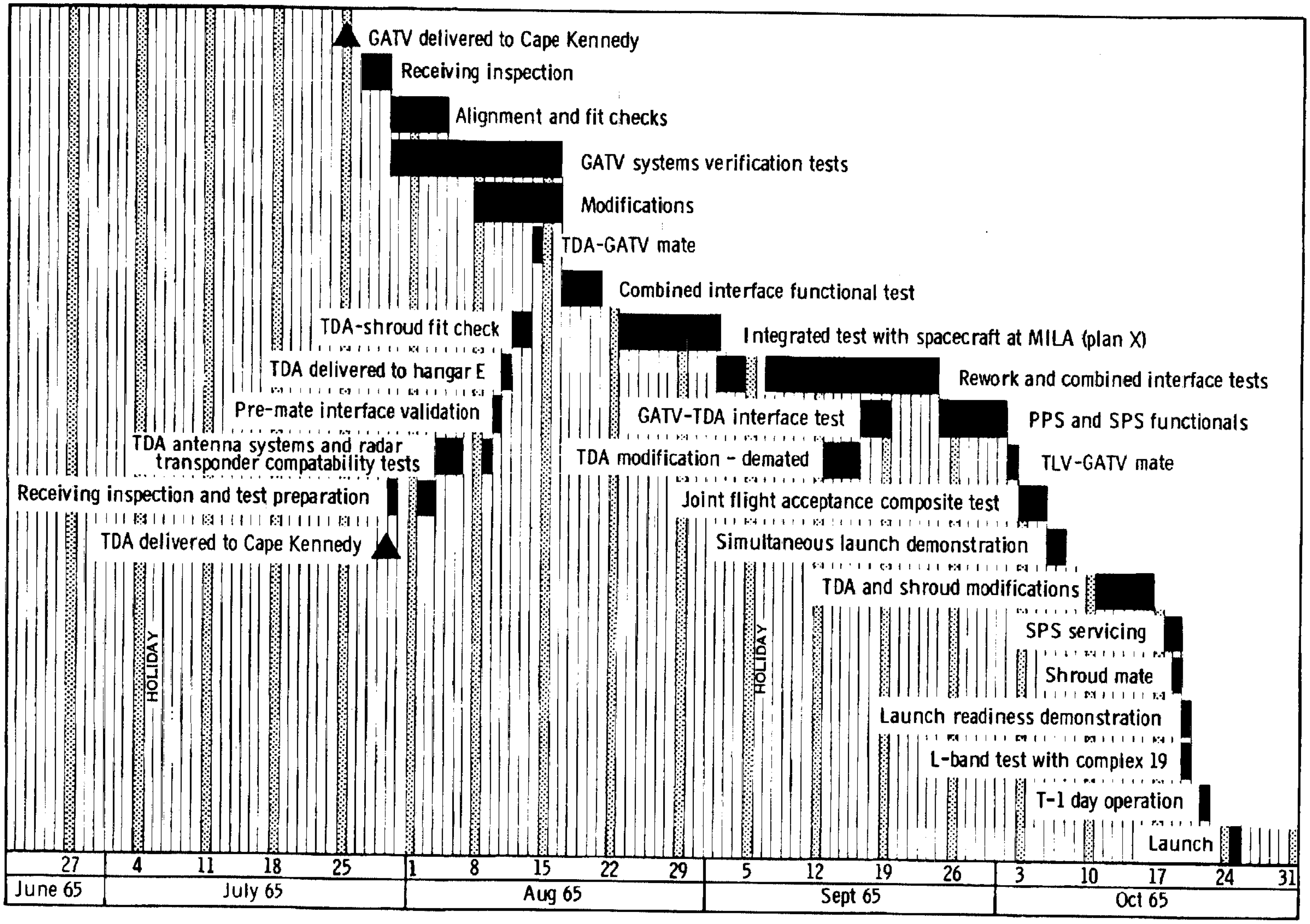

Figure 12.1-9. - GATV 5002 and TDA-2 history at Cape Kennedy.

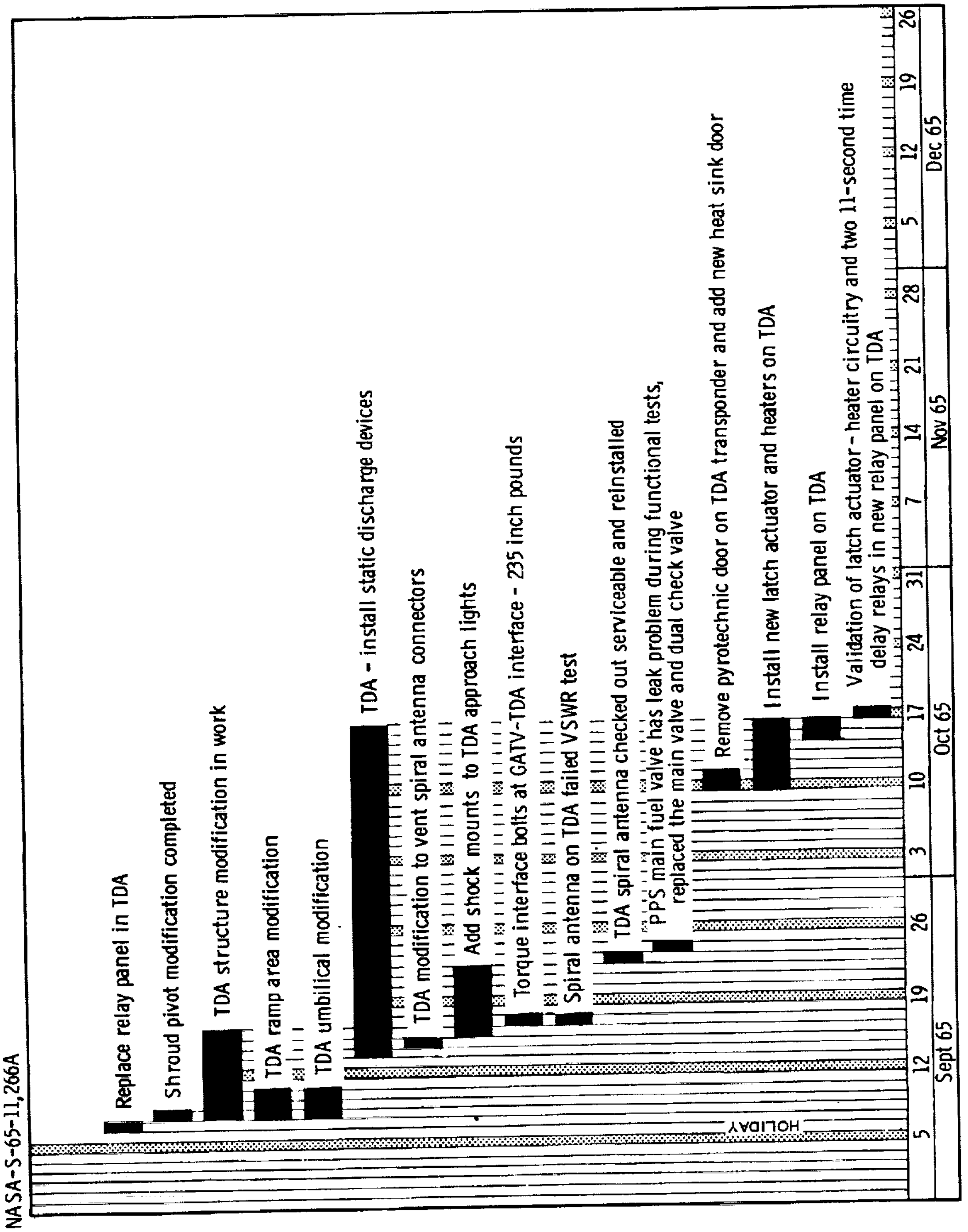

Figure 12.1-10. - GATV-TDA modifications and problems at Cape Kennedy.

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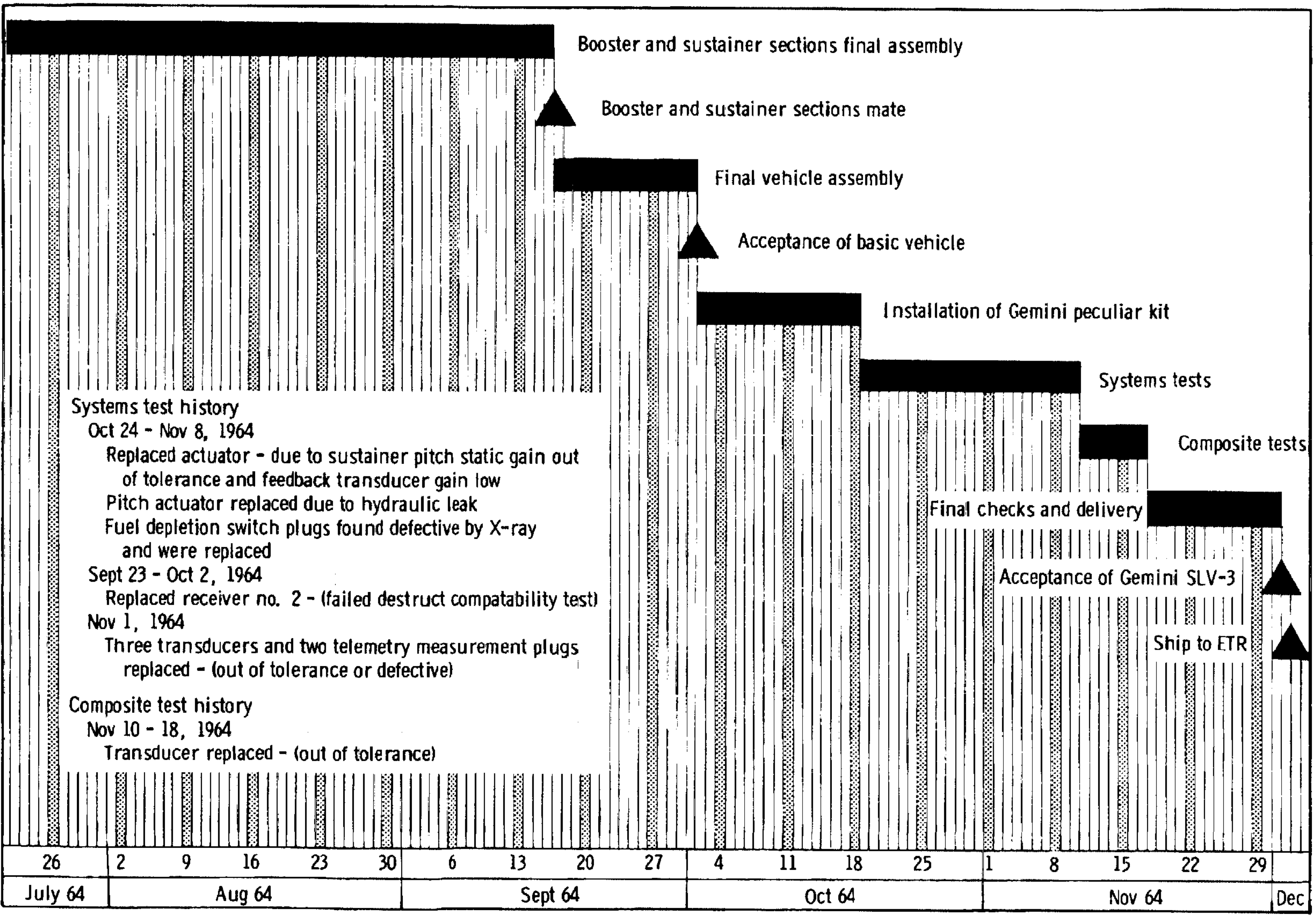

Systems test history

Oct 24 - Nov 8, 1964

Replaced actuator - due to sustainer pitch static gain out of tolerance and feedback transducer gain low

Pitch actuator replaced due to hydraulic leak

Fuel depletion switch plugs found defective by X-ray and were replaced

Sept 23 - Oct 2, 1964

Replaced receiver no. 2 - (failed destruct compatability test)

Nov 1, 1964

Three transducers and two telemetry measurement plugs replaced - (out of tolerance or defective)

Composite test history

Nov 10 - 18, 1964

Transducer replaced - (out of tolerance)

Figure 12.1-11.- SLV 5301 history at contractor facility.

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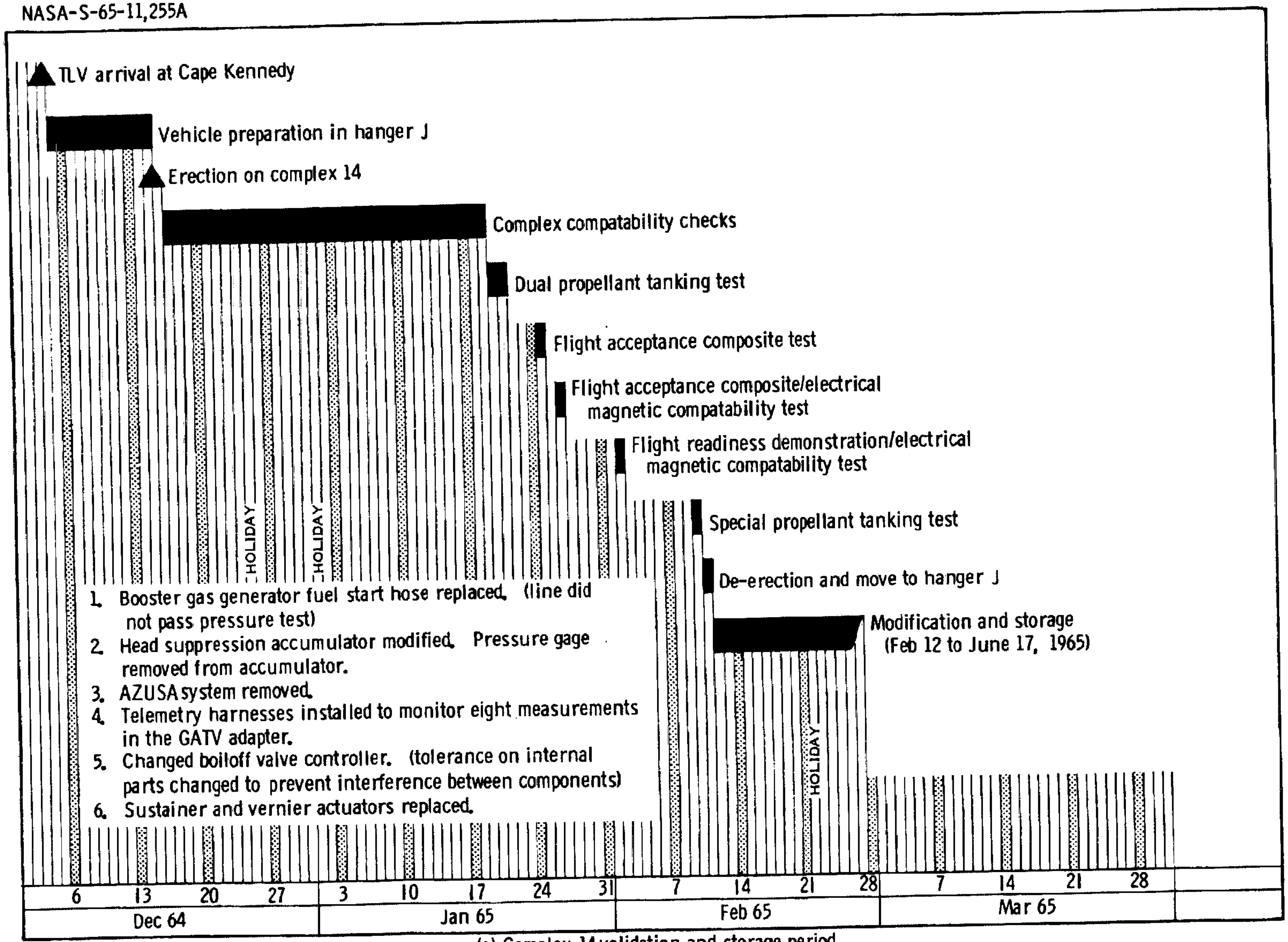
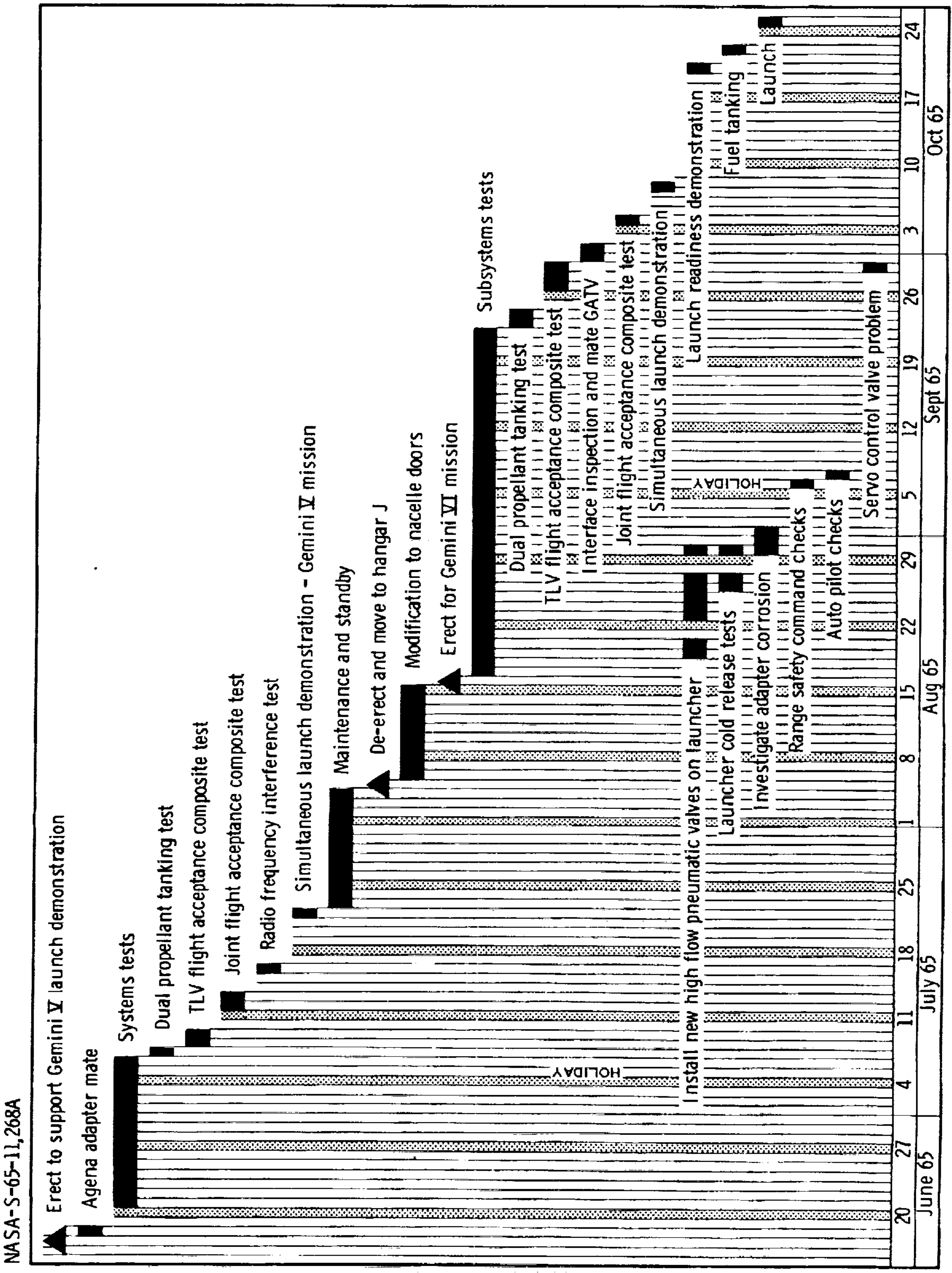


1. Booster gas generator fuel start hose replaced. (line did not pass pressure test)
2. Head suppression accumulator modified. Pressure gage removed from accumulator.
3. AZUSA system removed.
4. Telemetry harnesses installed to monitor eight measurements in the GATV adapter.
5. Changed boiloff valve controller. (tolerance on internal parts changed to prevent interference between components)
6. Sustainer and vernier actuators replaced.

(a) Complex 14 validation and storage period.

Figure 12.1-12.- TLV 5301 history at Cape Kennedy.



(b) Testing to support Gemini V and Gemini VI launch.

Figure 12.1-12.- Concluded.

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## 12.2 WEATHER CONDITIONS

The weather conditions in the launch area at Cape Kennedy were satisfactory for all operations on the day of the launch, October 25, 1965. Surface weather observations in the launch area at 10:00 a.m. e.s.t. (15:00 G.m.t.) were as follows:

| | |
|---|---|
| Cloud coverage | $\frac{2}{10}$ covered, scattered at 2300 feet |
| Wind direction, degrees from North | 0 to 10 |
| Wind velocity, knots | 10 |
| Visibility, miles | 10 |
| Pressure, in. Hg | 30.17 |
| Temperature, °F | 72 |
| Dew point, °F | 52 |
| Relative humidity, percent | 51 |

Table 12.2-I presents the launch area atmospheric conditions at 50 minutes after lift-off (15:50 G.m.t.). Figure 12.2-1 presents the launch area wind direction and velocity plotted against altitude.

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TABLE 12.2-I.- LAUNCH AREA ATMOSPHERIC CONDITIONS
AT 15:50 G.m.t., OCTOBER 25, 1965

| Altitude, ft | Temperature, °F (a) | Pressure, lb/sq ft (b) | Density, slugs/cu ft (c) |
|---|---|---|---|
| $0 \times 10^3$ | 74 | 2134 | $2319 \times 10^{-6}$ |
| 5 | 43 | 1782 | 2059 |
| 10 | 46 | 1480 | 1702 |
| 15 | 29 | 1227 | 1461 |
| 20 | 29 | 1010 | 1255 |
| 25 | -10 | 823.7 | 1067 |
| 30 | -33 | 665.4 | 910.0 |
| 35 | -46 | 532.8 | 752.8 |
| 40 | -64 | 422.9 | 622.8 |
| 45 | -81 | 332.5 | 512.2 |
| 50 | -93 | 258.8 | 411.3 |
| 55 | -94 | 200.7 | 320.1 |
| 60 | -89 | 155.8 | 244.4 |
| 65 | -76 | 122.0 | 184.3 |
| 70 | -71 | 95.9 | 143.5 |
| 75 | -66 | 75.6 | 112.5 |
| 80 | -59 | 59.7 | 87.3 |
| 85 | -58 | 47.4 | 67.9 |
| 90 | -58 | 37.6 | 54.3 |
| 95 | -58 | 29.9 | 42.6 |
| 100 | -46 | 23.8 | 32.9 |
| 105 | -45 | 19.0 | 27.1 |
| 110 | -48 | 15.2 | 21.3 |

[a] Accuracy, ±1° F

[b] Accuracy, ±1 percent, rms

[c] Accuracy, ±0.5 percent, rms (0 to $60 \times 10^3$ ft altitude)
±0.8 percent, rms (60 through $110 \times 10^3$ ft altitude)

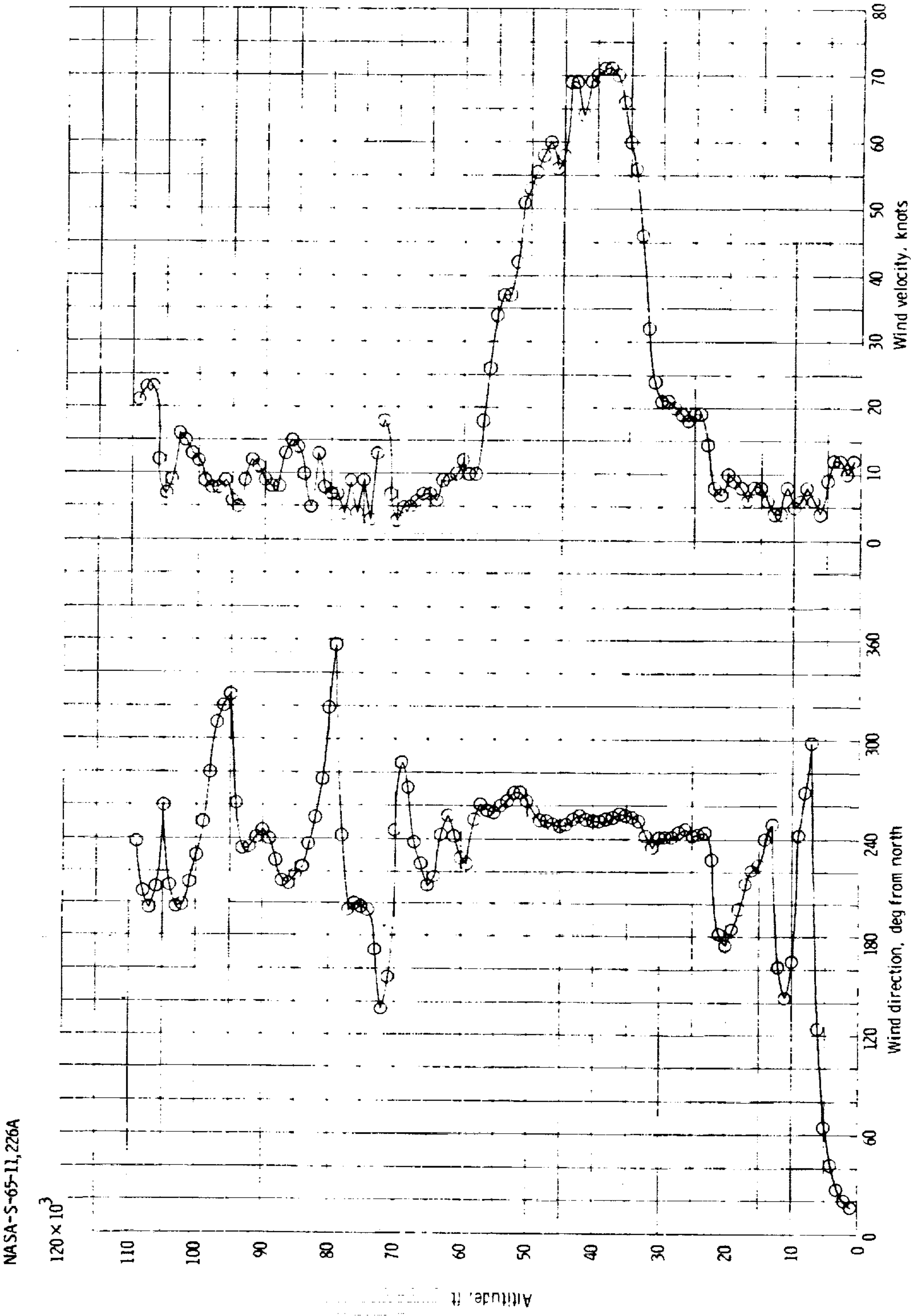

Figure 12.2-1. - Variations of wind direction and velocity with altitude for launch area at 15:50 G.m.t., October 25, 1965.

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## 12.3 FLIGHT SAFETY REVIEWS

The flight readiness of the Gemini spacecraft and launch vehicle for Gemini VI flight, as well as the flight readiness of the target launch vehicle (TLV) and Gemini Agena target vehicle (GATV) and readiness of all supporting elements, was determined at the review meetings noted in the following paragraphs.

### 12.3.1 Spacecraft

The Flight Readiness Review was held on October 11 and 12, 1965, at John F. Kennedy Space Center, Florida. Items to be accomplished prior to the Mission Briefing included:

a. A detailed inspection of spacecraft wiring to assure a satisfactory condition, because of an excessive number of discrepancy reports (DR's) written on broken or chaffed wires.

b. Expeditious handling of the open failure analyses, so as to minimize last minute impact.

c. Replacement of the locking bar assembly with one that has the proper steel breeches and fitting radii.

Upon completion of the above items and resolution of a few other minor problems, the spacecraft was found ready for flight.

### 12.3.2 Gemini Launch Vehicle

12.3.2.1 Technical Review.- A Technical Review of the Gemini launch vehicle (GLV) for Gemini VI was held at SSD Headquarters, Los Angeles, California, on September 23, 1965. The Air Force Space Systems Division (AFSSD) and Aerospace Corp., presented the status of the vehicle. The POGO oscillation experienced on Gemini V was attributed to not having a proper gas bubble in the standpipe to act as a damper. It was stated that a procedure change to the method of charging this standpipe would be incorporated on Gemini VI. At this point in time, the launch vehicle systems were found ready for flight.

12.3.2.2 Preflight Readiness Review.- On October 21, 1965, a Preflight Readiness Review was held at Cape Kennedy, Florida. AFSSD, Aerospace Corp., and the GLV contractor representatives presented a system status of the GLV and supporting equipment. All elements were found ready for flight.

### 12.3.3 Target Launch Vehicle

12.3.3.1 Technical Review.- A Technical Review of the TLV was held at SSD Headquarters, Los Angeles, on September 23, 1965. AFSSD, Aerospace Corp., and TLV contractor personnel reviewed the history and changes to the vehicle since the last Project Mercury mission. The current status of the Gemini VI TLV systems was presented and three open items remained:

a. A tap check was to be made on the nacelle rivets to determine the presence of any fatigue or corrosion effects.

b. Lock wedges were to be added to the fuel prevalves.

c. Several temperature sensors were to be changed.

12.3.3.2 Preflight Readiness Review.- On October 21, 1965, at Cape Kennedy, Florida, a Preflight Readiness Review was held. AFSSD and TLV contractor representatives presented the TLV systems status. All open items from previous reviews had been closed and all elements were found ready to support the launch.

### 12.3.4 Gemini Agena Target Vehicle

12.3.4.1 Technical Review.- A Technical Review of GATV no. 5002 was held at SSD Headquarters, Los Angeles, on September 22, 1965. AFSSD, Aerospace Corp., and GATV contractor representatives presented the history and present system status on the GATV. A detailed presentation of the system differences between the GATV and the standard Agena D was made. Qualification, reliability, and special testing required on any component were detailed. Problem areas needing resolution before launch were:

a. NASA input of micrometeorite data.

b. Elimination of destruct package nomenclature.

c. Target docking adapter shroud aerodynamic and qualification data review.

d. More battery background information.

e. Resolution of operational turnaround time.

f. Finalizing of some operational procedures.

12.3.4.2 Preflight Readiness Review.- On October 21, 1965, at Cape Kennedy, Florida, a Preflight Readiness Review was held. AFSSD and GATV contractor representatives presented the operations history on the GATV and status of the systems. All items from previous reviews were complete and all elements were found ready for flight.

### 12.3.5 Mission Briefing

The Gemini VI Mission Director convened the Mission Briefing on October 22, 1965, at John F. Kennedy Space Center, Florida. All elements reviewed their status and were found in readiness to support the launch and mission.

### 12.3.6 Flight Safety Review Board

The AFSSD Flight Safety Review Board met on October 23, 1965, at Cape Kennedy, Florida, and recommended to the Mission Director that the GLV, the TLV, and the GATV be committed to flight, as all ground and airborne systems were in readiness.

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## 12.4 SUPPLEMENTAL REPORTS

The supplemental report for the Gemini VI-A mission is listed in table 12.4-I. The report will be identified on the title page as being a Gemini VI-A supplemental report, and will be reviewed by the cognizant members of the Mission Evaluation Team and approved by the Gemini Program Manager.

TABLE 12.4-I.- SUPPLEMENTAL REPORT

| Number | Report title | Responsible organization | Completion date | Text reference section and remarks |
|---|---|---|---|---|
| 1 | Flight Evaluation and Performance Analysis Report - GATV 5002 | Lockheed Missiles and Space Company | Dec. 9, 1965 | Section 5.4 |

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## 12.5 DATA AVAILABILITY

Tables 12.5-I and 12.5-II list the mission data which are available for evaluation. The trajectory and telemetry data (table 12.5-I) will be on file at the MSC, CAAD, Central Metric Data File. The photographic data (table 12.5-II) will be on file at the MSC Photographic Technology Laboratory.

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TABLE 12.5-I.- INSTRUMENTATION DATA AVAILABILITY

| Paper recordings |
|---|
| GATV telemetry measurements |
| TLV telemetry measurements |
| TLV and GATV signal strength recordings |
| Telemetry and radar operators logs |
| Range safety and MCC-H plotboard charts |
| **Magnetic tapes** |
| Telemetry magnetic tapes |
| Voice tapes (Prime GOSS network) |
| **Radar data** |
| IP-3600 trajectory data |
| C-band data-final reduced position, velocity, and acceleration |
| Trajectory data processed at MSC |
| **Reduced GATV telemetry data<br>(Lift-off - 10 sec to loss of telemetry signal)** |
| Engineering units versus time |
| Plots of all analog parameters except the following: |
| A14, A20, C130, C131, C132, D37, D85, D86, D87, H101, H103, H331, H334, H337, H347, H379, H380, H381 |
| Tabulations of all parameters except those listed as special |
| Special tabulations |
| Direct digital tabulations of parameters D35, D88, and H165 |
| Tabulations of parameters H32 (Programmer Memory Readout) and H34 (Command Function Status Monitor) |
| Special computation |
| Ascent phase heating rates for the target docking adapter |

TABLE 12.5-II.- LAUNCH-ENGINEERING SEQUENTIAL CAMERA DATA AVAILABILITY

| Item no. | Camera | | | | Presentation |
|---|---|---|---|---|---|
| OD and PSR | Size | Type | Focal length | Speed, fps | |
| 1.2-1<br>K11 PLD | 16-mm | MITCHELL | 15-mm | 96 | Emergency high-speed surveillance of all functions during tanking and detanking and/or launch. |
| 1.2-2<br>K12 PLD | 16-mm | MITCHELL | 10-mm | 96 | Emergency high-speed surveillance of all functions during tanking and detanking and/or launch. |
| 1.2-3<br>K13 PLD | 16-mm | MITCHELL | 15-mm | 96 | Emergency high-speed surveillance of all functions during tanking and retanking and/or launch. |
| 1.2-4<br>K15 PLD | 16-mm | MITCHELL | 15-mm | 96 | High-speed presentation of launcher release action, engine ignition, $LO_2$, and fuel rise-off disconnect action and electrical umbilical disconnect. |
| 1.2-5<br>K34 PLD | 16-mm | MITCHELL | 15-mm | 96 | Overall coverage of entire GAATV. |
| 1.2-6<br>K33 PLD | 16-mm | MITCHELL | 15-mm | 96 | Overall coverage of entire GAATV. |
| 1.2-7<br>K14 PLD | 16-mm | MITCHELL | 25-mm | 96 | High-speed presentation of launcher release action, engine ignition, $LO_2$, and fuel rise-off disconnect action and electrical umbilical disconnect. |
| 1.2-8<br>K16 PLD | 16-mm | MILLIKEN | 100-mm | 400 | High-speed presentation of launcher release action, engine ignition, $LO_2$, and fuel rise-off disconnect action and electrical umbilical disconnect. |
| 1.2-9<br>K17 PLD | 16-mm | MILLIKEN | 100-mm | 400 | High-speed presentation of launcher release action, engine ignition, $LO_2$, and fuel rise-off disconnect action and electrical umbilical disconnect. |
| 1.2-10<br>K28 PLD | 16-mm | MILLIKEN | 15-mm | 400 | Heat shield coverage to verify integrity of the heat shield, engine boots, and rise-off disconnects. |
| 1.2-11<br>K29 PLD | 16-mm | MILLIKEN | 15-mm | 400 | Heat shield coverage to verify integrity of the heat shield, engine boots, and rise-off disconnects. |

TABLE 12.5-II.- LAUNCH-ENGINEERING SEQUENTIAL CAMERA DATA AVAILABILITY - Concluded

| Item no. | Camera | | | | Presentation |
|---|---|---|---|---|---|
| OD and PSR | Size | Type | Focal length | Speed, fps | |
| 1.2-12<br>K1 PLD | 16-mm | MILLIKEN | 10-mm | 200 | Observation of the release of the GATV upper umbilicals. |
| 1.2-13<br>K2 PLD | 16-mm | MILLIKEN | 10-mm | 200 | Observation of the release of GATV lower umbilicals. |
| 1.2-14<br>K3 PLD | 16-mm | MILLIKEN | 40-mm | 200 | Observation of the retraction of the boom with respect to the vehicle. |
| 1.2-15<br>K32 PLD | 70-mm | MITCHELL | 5" | 40 | Overall coverage of the TLV. |
| 1.2-16<br>K22 PLD | 16-mm | MITCHELL | 40" | 96 | Attitude during lift-off and early phase of flight. |
| 1.2-17<br>K36 PLD | 16-mm | MITCHELL | 40" | 96 | Overall coverage of entire GAATV. |
| 1.2-18<br>K30 PLD | 35-mm | MITCHELL | 40" | 32 | Mid-range tracking of engine section during first 40 sec (approx) and thereafter general surveillance of entire GAATV. |
| 1.2-19<br>K20 PLD | 35-mm | MITCHELL | 80" | 32 | Attitude during lift-off and early phase of flight. |
| 1.2-20<br>K21 PLD | 35-mm | MITCHELL | 120" | 32 | Attitude during lift-off and early phase of flight. |
| 1.2-21<br>K4 PLD | 35-mm | MITCHELL | 500" | 32 | Tracking from acquisition to limit of visibility. |
| 1.2-22<br>K5 PLD | 70-mm | FLIGHT RESEARCH | 360" | 30 | Tracking from acquisition to limit of visibility. |
| 1.2-23<br>K6 PLD | 70-mm | PHOTO-SONICS | 400" | 30 | Tracking from acquisition to limit of visibility. |
| 1.2-24<br>K7 and K8 PLD | 70-mm | PHOTO-SONICS | 500" | 30 | Tracking from acquisition to limit of visibility. |