NASA SUPPORT DOCUMENT

# SATURN S-II
# GENERAL MANUAL

SM-S-II-01

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NORTH AMERICAN AVIATION, INC.
SPACE AND INFORMATION SYSTEMS DIVISION

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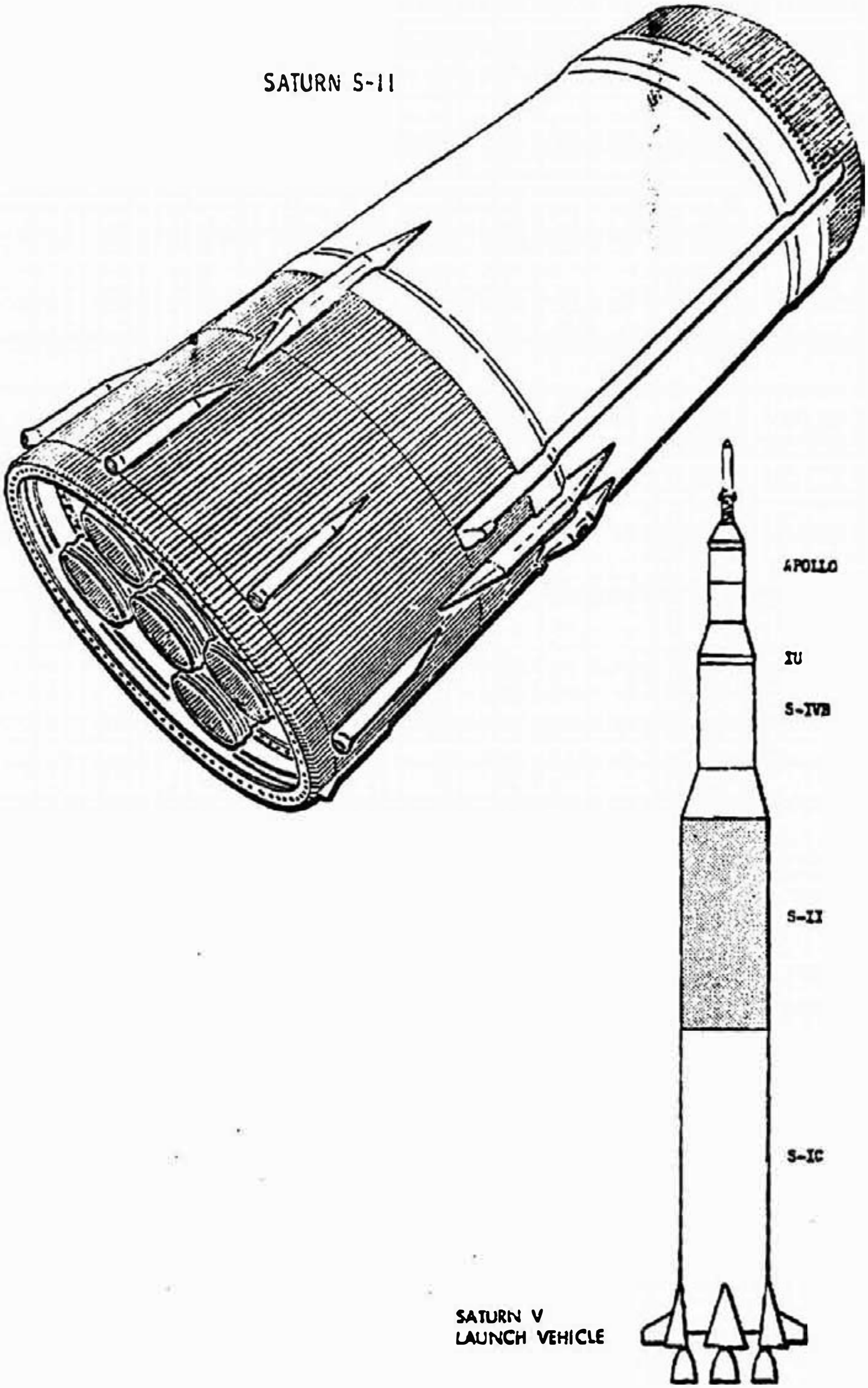


S-II-01-1B

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## LIST OF DOCUMENTS

Saturn S-II support documents are provided as part of contract NAS7-200 with the National Aeronautics and Space Administration. These documents provide operational and maintenance data in support of the S-II stage and related ground support equipment. The following is a list of the Saturn S-II support documents prepared by Space and Information Systems Division of North American Aviation, Inc., Downey, California.

| Support Document No. | Title |
|---|---|
| SM-S-II-01 | General Manual |
| SM-S-II-02 | Transportation Manual |
| SM-S-II-03 | Engine Installation and Removal Manual |
| SM-S-II-04 | Stage Handling and Maintenance Manual |
| SM-S-II-05 | Electrical and Ordnance System Checkout Manual |
| SM-S-II-06 | Propulsion System Checkout Manual |
| SM-S-II-07 | Flight Control System Checkout Manual |
| SM-S-II-08 | Instrumentation Systems Checkout Manual |
| *SM-S-II-09 | Integrated Systems Checkout Manual |
| *SM-S-II-10 | Static Firing/Countdown Manual |
| SM-S-II-11 | Mechanical Checkout Station Maintenance Manual |
| SM-S-II-12 | Radio Frequency Checkout Station Maintenance Manual |
| SM-S-II-13 | Ground Equipment Test Site Maintenance Manual |
| SM-S-II-14 | Electrical Checkout Station Maintenance Manual |
| SM-S-II-15 | Telemeter Checkout Station Maintenance Manual |
| SM-S-II-16 | Digital Data Acquisition Station Maintenance Manual |
| SM-S-II-17 | Servicing Equipment Maintenance Manual |
| SM-S-II-18 | Handling, Auxiliary, and Miscellaneous Checkout Equipment Maintenance Manual |
| SM-S-II-19 | Computer Complex Maintenance Manual |
| SM-S-II-20 | Systems Inspection Manual |
| SM-S-II-21 | GSE Inspection Manual |

*Indicates documents not published.

# INTRODUCTION

This publication contains general information covering the SATURN II (S-II) stage of the SATURN V launch vehicle. The S-II stage is designed and manufactured by the Space and Information Systems Division of North American Aviation, Inc., Downey, California, for the National Aeronautics and Space Administration.

Primarily prepared for dissemination of S-II information, this manual also contains general and introductory material pertaining to other stages and portions of Saturn and Apollo programs. Inclusion of such information provides an avenue for faster recognition and better understanding of the S-II role in the quest to effect a manned lunar landing during this decade. The manual may be used for familiarization or as a reference for general concepts, leading particulars relative to the stage, and for general descriptions of purpose, function, and hardware. Included are descriptions of operations and activities which the S-II undergoes from the time it leaves the factory until launched on its intended mission. The manual does not contain checkout, troubleshooting, and other maintenance instructions. Maintenance and checkout instructions will be found in the applicable support manuals.

Only approved designs and configurations are reflected in the support manuals. Revisions will be made as required to support the equipment at operational sites. Fast reaction changes, or those requiring immediate action, will be handled on an expedited basis. Such changes will generate interim revision pages for distribution to all holders of the affected manuals. Revision pages for fast reaction changes will normally be issued within 24 hours after determination of the change requirement.

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# SECTION I

# DESCRIPTION

## 1-1. GENERAL DESCRIPTION.

1-2. Saturn S-II is the second stage of the Saturn V launch vehicle. Measuring 33 feet in diameter and 81.5 feet in length, the S-II stage is a large, cylindrical booster, powered by five liquid-propellant rocket engines. (See figures 1-1 and 1-2.) Each engine develops approximately 200,000 pounds of thrust. The outer four engines are suspended by gimbal bearings to provide for thrust vector control about the vehicle pitch, roll, and yaw axes. The engines are positioned by hydraulic actuators which respond to stimuli from the guidance system. The engine propellant is liquid hydrogen and liquid oxygen, which accounts for 932,000 pounds of the stage gross weight of 1,036,000 pounds.

1-3. The S-II airframe consists of an aft interstage structure, an aft skirt and thrust structure, an ellipsoidal liquid oxygen tank, a cylindrical liquid hydrogen tank, a forward skirt, necessary fasteners, integral plumbing, fairings, bracketry, and major attach fittings. Installations include plumbing, wiring, valves, instrumentation, electrical and electronic equipment, ordnance, and eight solid-propellant ullage rocket motors.

1-4. Liquid oxygen and liquid hydrogen feed lines are each eight inches in diameter and routed to each engine from the respective tanks. Liquid oxygen lines extend from the lower end of the liquid oxygen tank sump directly to the rocket engines. Liquid hydrogen lines are routed along the exterior of the airframe structure. In addition to a fairing enclosure for each hydrogen line, each line is vacuum-jacketed for retention of the cryogenic state of the liquid hydrogen. Insulation of the common bulkhead, dividing tankage of the two fluids, minimizes heat transfer and retains the cryogenic storage requirements of each propellant fluid. Additionally, the hydrogen tank is insulated to its full length.

1-5. The forward skirt enclosure houses instrumentation equipment, radio and telemetry installations, upper umbilical pressure connections, hydrogen vent lines, radio command antennas, MISTRAM antennas, telemetry antennas, and GSE electrical umbilical connections. Within the aft skirt and interstage are fill and drain connections for each propellant tank, service connections, electrical equipment, engines and associated accessories, and an access door to the engine area. Eight ullage rocket motors are located approximately equidistant around the lower periphery of the interstage. The interstage is essentially a continuation of the aft skirt and is automatically jettisoned approximately 30 seconds after first stage separation.

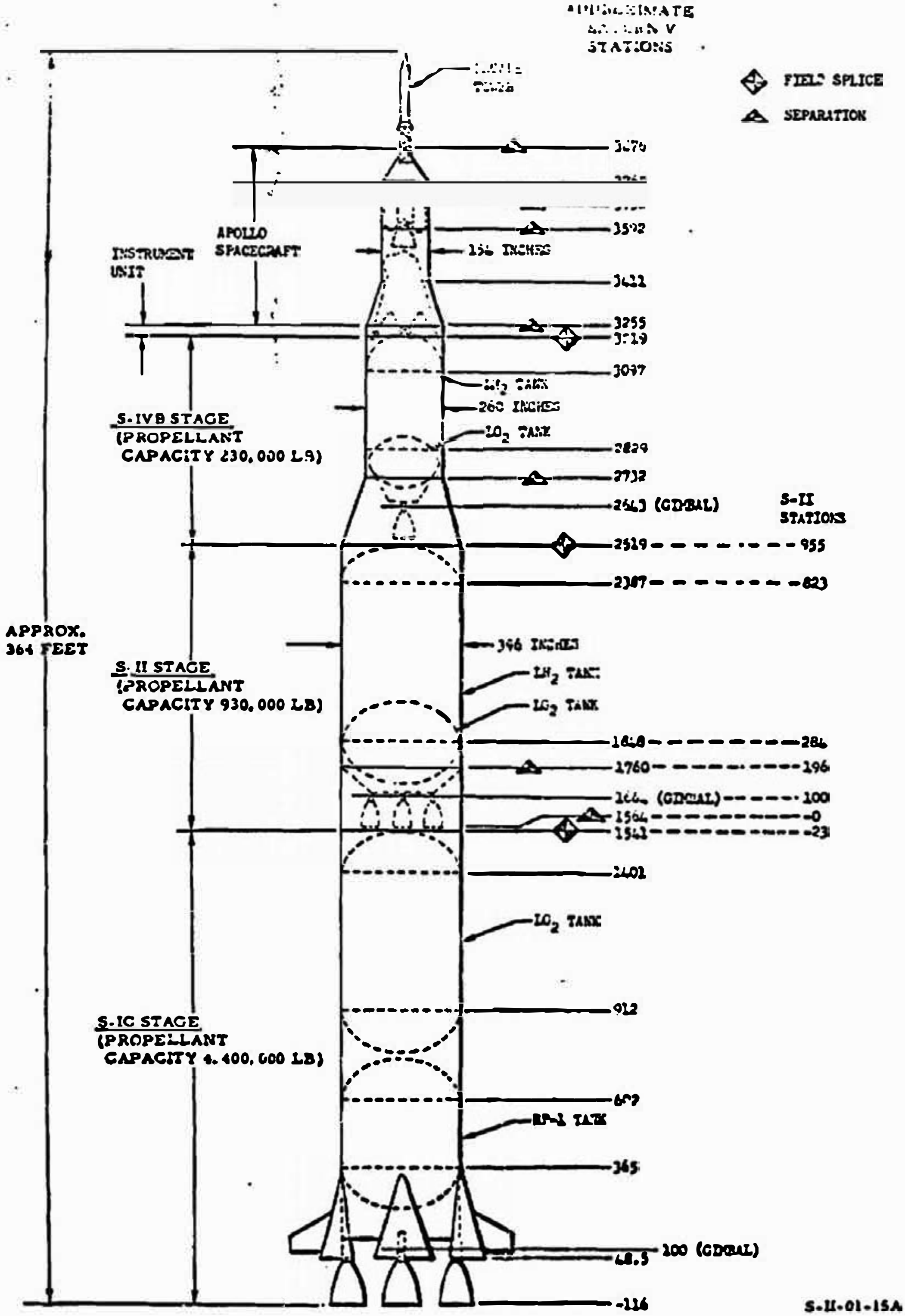


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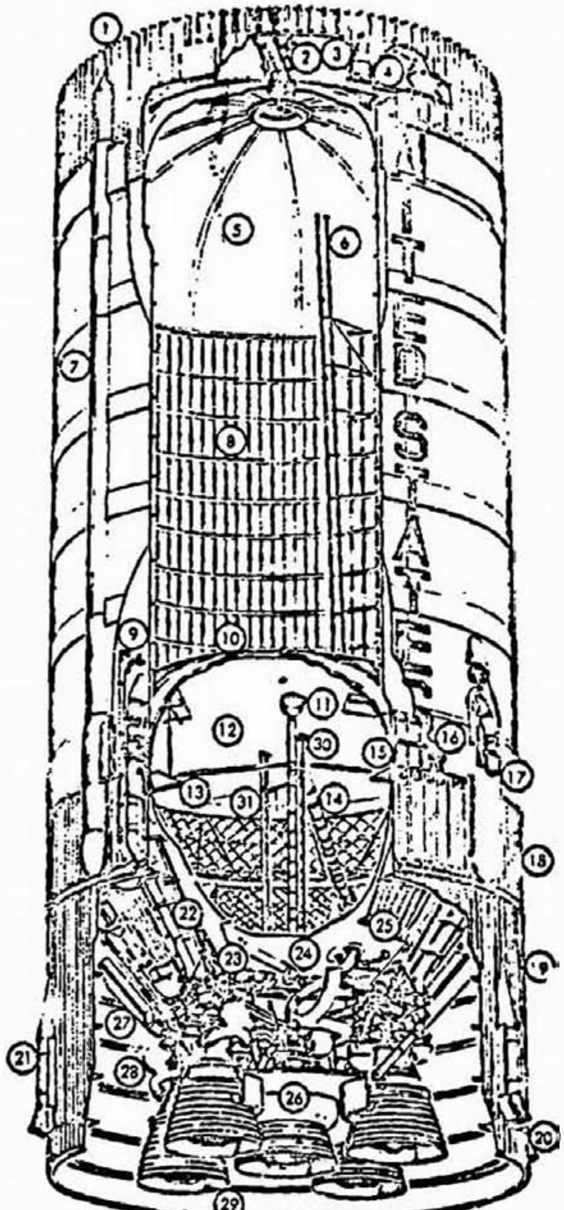
**Figure 1-1. Saturn V Launch Vehicle**



1. FORWARD SKIRT
2. $LH_2$ VENT LINES
3. TELEMETRY ANTENNA
4. HELIUM BOTTLES
5. $LH_2$ FORWARD BULKHEAD
6. PROPELLANT QUANTITY INDICATING SYSTEM
7. SYSTEMS TUNNEL
8. $LH_2$ TANK
9. $LH_2$ RECIRCULATION LINES
10. COMMON BULKHEAD
11. GAS DISTRIBUTOR
12. LOX TANK
13. SLOSH BAFFLE
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15. BOLTING RING
16. INSULATION
17. FEED LINE FAIRING
18. AFT SKIRT
19. INTERSTAGE
20. FLIGHT SEPARATION
21. ULLAGE ROCKET
22. $LH_2$ FEED LINE
23. LOX FEED LINE
24. LOX AFT BULKHEAD
25. THRUST STRUCTURE
26. HEAT SHIELD
27. INSTRUMENTATION CONTAINER
28. INTEGRAL SPIN START TANK
29. J-2 ENGINE
30. CAPACITANCE PROBE
31. RECIRCULATION LINE

S-II-01-31

**Figure 1-2. Saturn S-II Stage**

1-6. The J-2 engines of the S-II stage are manufactured by the Rocketdyne Division of North American Aviation, Inc. Collectively, the S-II engines generate a total thrust of 1,000,000 pounds, burn for 395 seconds, boost the remaining stages to near orbital altitude (after S-IC separation), and attain a vehicle velocity of 20,840 feet per second prior to propellant depletion and S-II separation. Except for the propellant, each engine is self-contained and has an integral turbopump for each propellant, a heat exchanger, required manifolding and by-pass plumbing, a start tank, gas generator, control package, helium regulator, and the necessary valves. All major engine accessories, including propellant pumps, are attached to and move with the respective engine.

1-7. LEADING PARTICULARS.

| | |
|---|---|
| Overall length | 978 inches |
| Diameter | 396 inches |
| Approximate weights: | |
| Loaded | 1,036,000 pounds |
| Dry | 72,000 pounds |
| Approximate propellant capacity | 932,000 pounds |
| Liquid hydrogen (266,000 gal.) | 157,000 pounds |
| Liquid oxygen (81,500 gal.) | 775,000 pounds |
| Propellant loading time | 30 minutes |
| Propellant unloading time | 45 minutes |
| Approximate propellant fill rates: | |
| Liquid hydrogen | 10,000 gpm |
| Liquid oxygen | 5,000 gpm |
| Approximate propellant drain rates: | |
| Liquid hydrogen | 6,600 gpm |
| Liquid oxygen | 3,300 gpm |
| Engines: | |
| Thrust (each) | 200,000 pounds |
| Length | 116 inches |
| Diameter | 80 inches |
| Weight | 3,000 pounds |
| Nozzle expansion ratio | 27:1 |

Ullage rockets

| | |
|---|---|
| Length | 90 inches |
| Diameter | 13 inches |
| Thrust | 22,900 pounds |
| Burn duration | 3.75 seconds |

1-8. PURPOSE AND FUNCTION. S-II is the second stage of the three-stage Saturn V launch vehicle. Stages one, two, and three, assembled with Apollo payloads, including escape systems and guidance equipment, stand approximately 364 feet high and have a gross lift-off weight of 6,315,000 pounds. The purpose of the S-II (after S-IC separation) is to thrust the S-IVB (third stage) and Apollo payload to orbital altitude and near orbital velocity, then detach and separate from the S-IVB. The S-IVB then thrusts itself and the payload to orbital velocity, where the S-IVB engine is shut down. After a planned earth orbit duration and upon command, the S-IVB engine is re-ignited to attain a velocity of 34,150 feet per second and an initial lunar course for the manned Apollo spacecraft. After separation, the first stage will generally follow a ballistic curve and impact within a preselected area of the Atlantic Ocean. After separation, the second stage, having attained near orbital velocity, will be subjected to the familiar re-entry and heat disintegration pattern. The third stage, after separation, will be lost in deep space. Third stage separation occurs at the conclusion of the lunar injection boost phase.

1-9. Stages one and three of Saturn V are manufactured, respectively, by the Boeing Company of Seattle and the Douglas Aircraft Company of Santa Monica.

1-10. CONFIGURATIONS. Ten S-II flight stages are scheduled to be built. Structural and system descriptions in this manual, for the most part, pertain to these ten flight stages. Prior to the construction of the flight stages, however, five nonflight test stages, of varying configurations, are to be produced. These test stages are used to verify systems performance and compatibility, to certify the structural integrity of the S-II flight stage, to verify GSE of the flight certification and launch facilities, and to develop and verify follow-on product improvements. The five test stages vary in construction with each stage serving as a test bed for a specific purpose. (Refer to the applicable appendix.) Detailed descriptions of the five test stages are not contained in the manual. Appendixes A through F describe the mission, test objective, structural and system differences, and list the MCRs that affect the various stages. Table 1-1 lists all the stage configurations.

Table 1-1. S-II Stage Configurations

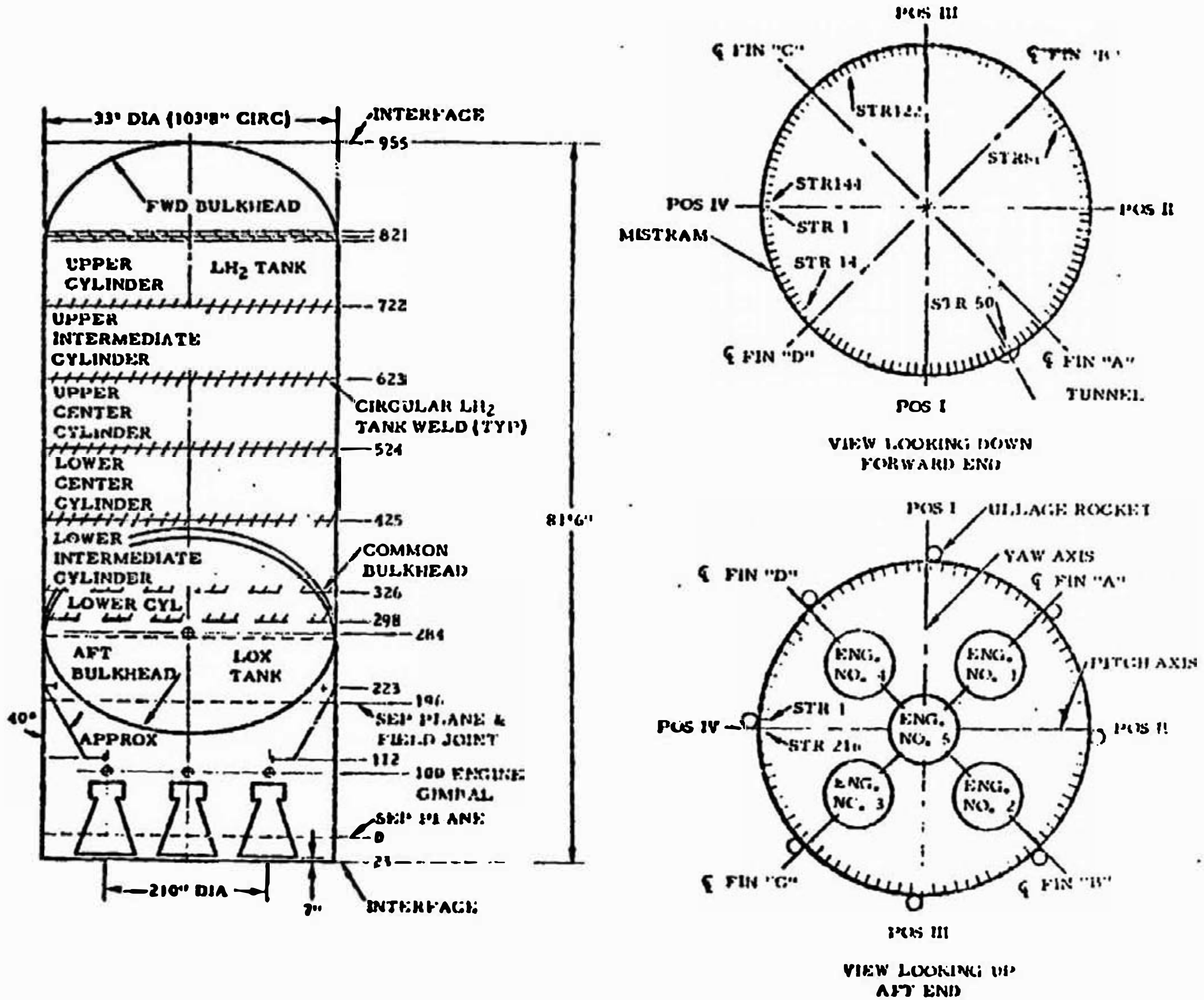
| S&ID | | NASA | | |
|---|---|---|---|---|
| Model No. | Unit No. | Serial No. | Function | Appendix |
| V7-1 | 1 | S-II-S | Static Test | A |
| V7-2 | 1 | None | Battleship | B |
| V7-1 | 2 | S-II-T | All-Systems Test | C |
| V7-1 | 3 | S-II-D | Dynamic Test | D |
| V7-1 | 4 | S-II-F | Facility Checkout | E |
| V7-1 | 5 thru 14 | S-II-1 thru S-II-10 | Flight | |

1-11. STRUCTURAL DESCRIPTION.

1-12. The S-II airframe is comprised of forward and aft skirt structures, liquid oxygen and liquid hydrogen tanks, an aft interstage structure and a systems tunnel. For principal dimensions and stations, see figure 1-3.

1-13. AFT INTERSTAGE STRUCTURE. The aft interstage is a semi-monocoque structure housing the five liquid propellant rocket engines. Made primarily from 7075 aluminum alloy sheet, the structure has internal circumferential supporting frames and external hat sections positioned vertically to provide structural rigidity. Fore and aft circumferential frames each have provisions for mating and alignment with adjacent structure. At the forward separation plane (station 196) tension loads are borne by tension plates designed to yield under impact of an accompanying dual explosive charge. Tension plates and the explosive charges are positioned around the periphery of the structure. The tension plates are attached to vertical stringers for load distribution, and each plate is exposed to the dual explosive charge, either of which will sever the respective tension tie. When the explosive charge of a separation plane is initiated, eight ullage rocket thrusters aft of the separation plane remain with that portion of structure jettisoned during staging. An access door, measuring approximately 32 inches by 77 inches, aligns with the tower umbilical arm and is used for interstage installations servicing.

1-14. AFT SKIRT AND THRUST STRUCTURE. The aft skirt and thrust structure, like the aft interstage structure, is semimonocoque construction fabricated from 7075 aluminum alloy. Although assembled separately, when mated, the two assemblies become a single S-II structural entity and remain so until separation occurs during staging. The aft skirt and thrust structure support the S-II engine complement. They also withstand and distribute compression loads from engine thrust, tension loads from idle engine weight when the S-II is vertical, and cantilever loads from engine weight during S-II transit. Structural members of the assembly include four circumferential support rings and an




S-II-01-3A

Figure 1-3. Principal Dimensions and Stations outer skin stiffened with hat sections similar to that of the aft interstage structure. Four structural beams extend upward from the lower circumferential ring to the upper ring and are joined at the lower end by the center engine support beam assembly. When assembled, the structure forms an inverted cone increasing in size from approximately 18 feet at the lower circumferential ring to the 33-foot diameter of the S-II airframe. The lower circumferential ring rests directly over the line of thrust of each outboard engine while the center engine support beam assembly is directly over the thrust line of the center engine. Four pairs of thrust longerons extend upward along the conical surface to distribute loads from the engine attach fittings through the remaining structure to the S-II airframe. Boost loads from the first stage (prior to separation) are transmitted through the aft skirt structure to the S-II airframe. Heat shields of pleated material around the center engine proper and outer engines collectively protect the stage base area from excessive temperatures caused by recirculation of engine exhaust gases.

1-15. LIQUID OXYGEN TANK. The liquid oxygen tank is an ellipsoidal container, 33 feet in diameter and 22 feet in height, and fabricated from ellipsoidal shaped fore and aft halves. The forward half section is a common bulkhead exposed to liquid oxygen on one side and liquid hydrogen on the other. The bulkhead is a sandwich structure with an insulation core to prevent heat transfer and retain the cryogenic properties of the two fluids to which it is exposed. The common bulkhead has fore and aft skin assemblies on either side of core segments of phenolic impregnated fiberglas. Fore and aft skins are each assembled from 12 thin aluminum gores, 12 machine-ribbed waffle panels, and an apex center panel. The forward skin has a "J" section return at the outer edge to permit peripheral attachment to the adjacent structure. Fiberglas core insulation thickness varies from approximately 5 inches at the apex to 0.080 inch at the outer extremity. Additionally, around the outer portion of the bulkhead, waffle recessions of the skin are filled with metal honeycomb-core insulation retained by a coverplate welded to the waffle protrusions. The aft half section of the liquid oxygen tank is also assembled from milled gore segments and is not insulated. A sump assembly with a fill/drain opening, and openings for the five engine feed lines, is in the lowest part of the section and bolted to the tank assembly. All sections and subassemblies of the tank are joined by welding. Also, a 20-inch access door in the aft section requires fasteners which penetrate a surface of the completed pressure vessel. The common bulkhead uses vented core segments arranged to create a flow pattern which sweeps the meridian and equatorial weld closures. Introduction of a gas of known purity (normally helium as a purging agent) into the passage network, and subsequent sniffing and analyses by leak detectors, permit constant monitoring for oxygen leakage.

1-16. LIQUID HYDROGEN TANK. The liquid hydrogen tank structure comprises the main bulk of the Saturn II vehicle; its measurements are 56 feet in height and 33 feet in diameter. Extending upward from station 284 to station 823, the tank sidewall is cylindrical and internally stressed to withstand compression loads imposed during boosting of Apollo payloads to near orbital altitude and velocity. The hydrogen tank is made from six cylindrical sections tiered and welded to form the entire vertical tank structure. An ellipsoidal (forward) bulkhead, together with the common bulkhead, completes the tank enclosure. Each of the six cylindrical sections is comprised of four curved, machined skins. Machined into the curved skins are waffle-like protrusions on the inside surface with the waffle extremities approximately 1/10 inch thick and protruding approximately 1-1/2 inches from the inner surface of the skin. Riveted to the circumferential waffle protrusions are flanged aluminum frames. The frames extend inward for approximately 7 inches and have lightening holes for propellant and cleaning liquids draining. All main sections and subassemblies of the tank are joined by welding. The tank sidewall is externally insulated with a layer of foam filled honeycomb. Protecting the exposed surface of the honeycomb are laminated nylon panels impregnated with phenolic resins. Sidewall insulation thickness including protective covering is approximately 1.6 inches. Forward bulkhead insulation is similar to the sidewall but is only 0.5 inch in thickness. Finally, a thin plastic covering envelops and seals the entire insulated surface. Like insulation of the common bulkhead, insulation of the liquid hydrogen tank has a network of passages through which an inert gas is drawn and sampled for hydrogen (leakage).

1-17. SYSTEMS TUNNEL. The systems tunnel has a semicircular shape, 22 inches wide and almost 60 feet long and is attached vertically to the outside wall of the stage. It protects and supports instrumentation, wiring, and tubing which connects system components located at both ends of the stage. Emerging from the aft skirt at Station 199, the tunnel extends upward and enters the forward skirt at Station 914 above the hydrogen tank. The tunnel structure consists of aluminum floors (which support the instrumentation, wiring, and tubing) and fiberglas doors (cover ). The tunnel doors are in sections which are hinged at the base of the tunnel floor and open to completely expose the tunnel floor area. When closed, the doors form the tunnel proper and are held in place by quick-locking fasteners.

1-18. FORWARD SKIRT STRUCTURE. The forward skirt structure, like the aft skirt structure, is semimonocoque and fabricated from 7075 aluminum alloy. Assembled from four curved sections, each spanning 90 degrees, the structure has four internal circumferential support rings. Hat sections attached vertically to the outer skin stiffen the completed assembly and provide the capability for support of the upper stage and the Apollo payload. Additionally, the free space provided by the enclosure affords space for location of S-II installations. The forward circumferential ring has provisions for alignment and attachment to the mating ring of the S-IVB stage while skin and vertical members of the skirt attach to a bolting ring at the forward end of the $LH_2$ tank structure. The bolting ring is an integral part of the S-II $LH_2$ tank structure. Attaching bolts screw into mating bosses of the bolting ring and do not protrude into the $LH_2$ pressure area.

1-19. EQUIPMENT LOCATIONS.

1-20. AFT INTERSTAGE AREA. (See figure 1-4.) In addition to engines and engine accessories, the aft interstage enclosure houses the following electrical and mechanical equipment:

- Signal conditioners and controllers
- Telemetering electronics
- Flight control electronics
- Service and interface umbilicals
- Electrical power control units
- Power distribution panels and batteries
- Inverters
- Propellant management electronics
- Propellant feed, vent, purge and hydraulic plumbing
- Ordnance installations
- Hydraulic pumps and accumulators

1-21. Equipment not required after first stage separation is located aft of the second separation plane and remains with an ejected aft interstage. Interface and service umbilicals, together with test and monitoring check points, are located in the skirt section of the aft interstage area. Electronics and electrical equipment are located in containers attached to and positioned around the lower conical surface of the thrust structure. Each container is made of aluminum-backed fiberglas and has internal insulation and an access door. In addition to electrical connections, each container is connected to a purge line through which $GN_2$ is introduced for equipment heating. Rate of $GN_2$ flow is GSE controlled in proportion to required heating.

1-22. LIQUID OXYGEN TANK AREA. (Internal and External). Internal LOX tank equipment includes percent-of-full sensors, temperature sensors, and a fluid level (capacitance) sensing probe. Percentage-of-full sensors are in clusters of three at six intermediate positions and at the approximate 100 percent position. Except for extreme fore and aft locations, the sensors are within a vertical stillwell to minimize the influence of oscillating and sloshing fluid. Vent, pressurization and recirculation lines, and a purge gas distributor complete the tank internal installations. External tank equipment and appurtenances include surface continuations of internal plumbing, electrical wiring and connections leading from the tank, an access door, and a tank sump. The tank sump is a common outlet for feed lines to the five engines and has a fill/drain opening. Tank vent valves are located externally and positioned near the vent line entry. A thermal convection recirculation system cycles LOX through each LOX pump and associated plumbing for engine conditioning.

1-23. LIQUID HYDROGEN TANK AREA. (Internal and External). As previously noted, the liquid hydrogen tank is integral to, and comprises the bulk of, the S-II vehicle. Information pertaining to tank equipment not related to tankage, fluid

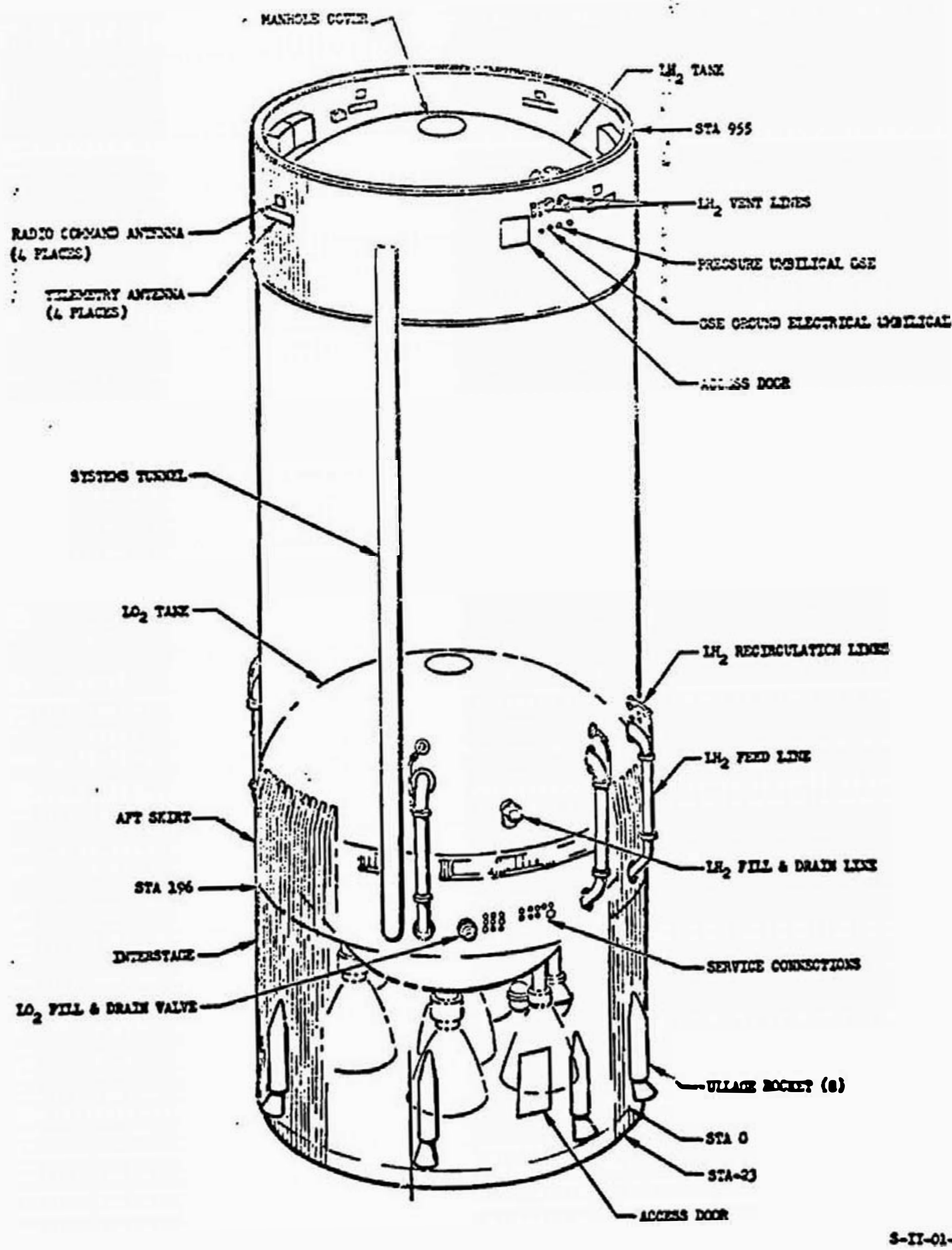



Figure 1-4. Saturn S-II Equipment Location (Sheet 1 of 3)

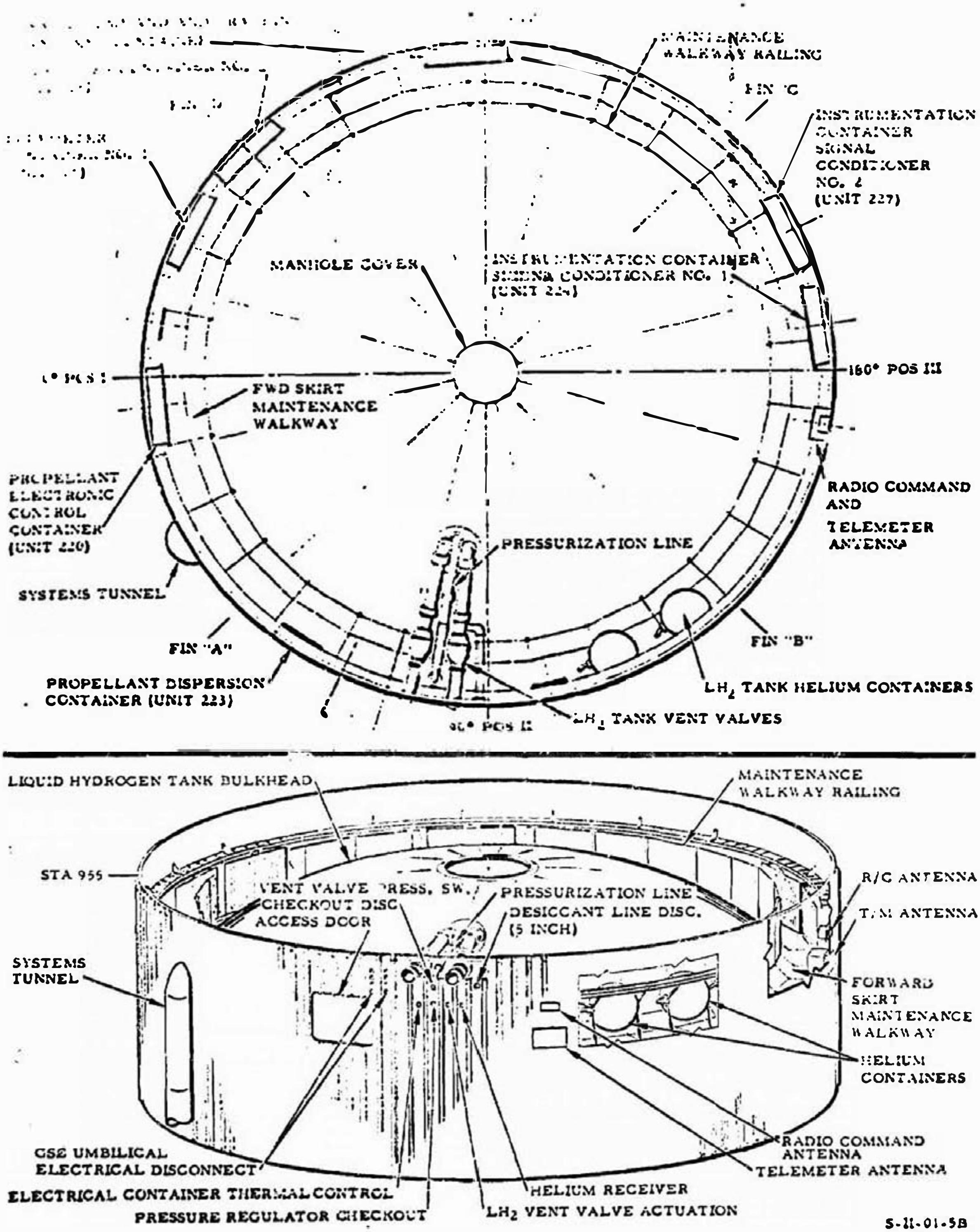



**Figure 1-4. Saturn S-II Equipment Location (Sheet 2 of 3)**

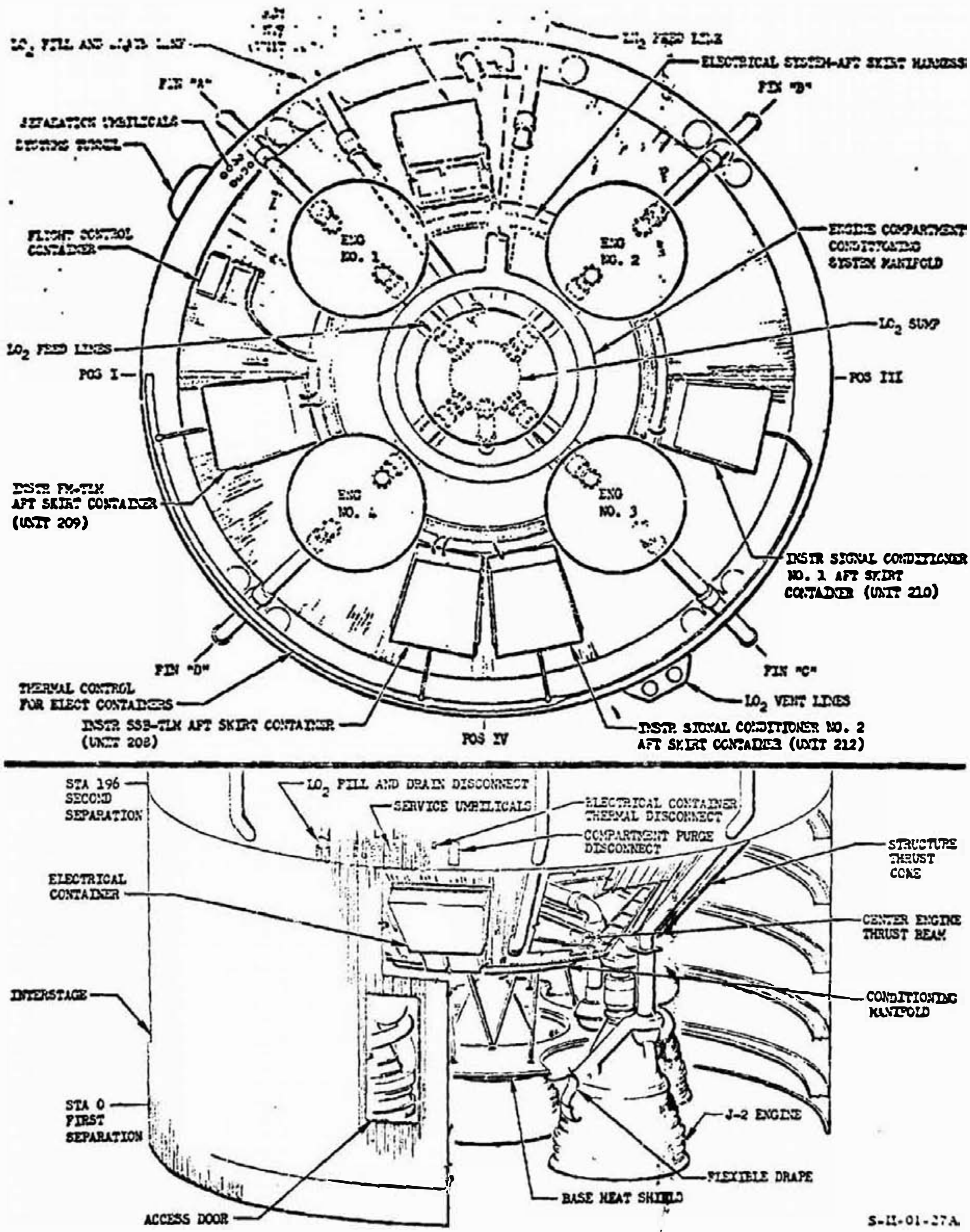



Figure 1-4. Saturn S-II Equipment Location (Sheet 3 of 3)

control and measurement, will be found in other sections of this manual. Internal electrical installations of the $LH_2$ tank include temperature sensors, fluid utilization and tanking probes, overfill sensors, and percent-of-full sensors at intermediate and near-extreme end positions of the tank. Internal mechanical installations include five recirculation pumps and associated plumbing, a pressurization line and manifold, two vent outlets common to one internal vent line, five propellant outlets, and a fill line opening. Vent valves and associated plumbing are external, atop the tank. Five insulated engine feed lines exit from the lower periphery of the tank and enter the engine area through the stage aft skirt. Each feed line is enclosed by a removable fiberglas shroud or fairing. Shutoff valves are in each engine feed line up-stream of the engine $LH_2$ pump. Each engine $LH_2$ pump has an insulated recirculation line from the tank and a return recirculation line to a common manifold. Recirculating fuel conditions the engine $LH_2$ pump, plumbing, and engine thrust cone and minimizes stratification within the tank. All $LH_2$ external recirculation, vent, and pressurization plumbing in insulated.

1-24. FORWARD SKIRT AREA. Within the forward skirt area are telemetry tracking and command antennas, ordnance connectors, a systems umbilical, an instrumentation and electrical patch panel, and associated junction boxes and the necessary wiring. Mechanical equipment includes liquid hydrogen vent valves, pressure sensing plumbing, pressure switches, and a vent umbilical. Like similar installations in the aft interstage area, electronic and electrical equipment are in fiberglas aluminum-backed containers. Similarly, each container is connected with a purge line through which $GN_2$ is introduced for thermal conditioning when liquid hydrogen is aboard. $GN_2$ purging from installations in the forward skirt area is discontinued concurrently with interruption of $GN_2$ purging from similar installations in the aft interstage area.

1-25. CLEANLINESS.

1-26. Saturn S-II manufacturing has made the necessary provisions for clean components, assemblies, and systems. Among these provisions are environmentally controlled areas for component cleaning and system assembly; training programs for all personnel assigned to the areas; quality control check points for cleanliness verification at the component, subassembly, assembly, subsystem, and system levels. Manufacturing and fabricating techniques are being upgraded to meet the stringent demands imposed on space vehicles. Special packaging and handling techniques have been, and are being, developed to maintain these stringent cleanliness requirements.

# SECTION II

## OPERATIONAL SYSTEMS

2-1. This section describes the operating systems in the S-II stage. This information covers the following major systems:

- Electrical
- Ordnance
- Propulsion
- Measurement
- Thermal control
- Flight control

2-2. The electrical system comprises the electrical control and electrical power subsystems. The ordnance system comprises the separation, ullage rocket moto., emergency detection, and propellant dispersion systems. The propulsion system comprises the pressurization, propellant feed, leak detection and insulation purge, engine compartment conditioning, and propellant management systems. The measurement system comprises the telemetry, instrumentation and antenna subsystems. The flight control system is comprised of the flight control electronics and the engine actuation subsystems.

2-3. ELECTRICAL SYSTEM.

2-4. ELECTRICAL POWER SYSTEM. The electrical power system consists of six d-c bus systems. (See figure 2-1.) In addition, a ground a-c bus system supplies 400 cps power to the auxiliary hydraulic pump motors. For flight, the electrical power system buses are powered from four 28-vdc batteries. Each battery employs silver-zinc cells using a potassium hydroxide electrolyte. An integral heater and temperature probe are included in each battery. Power to the heaters is supplied from GSE, and the heaters are operational only during ground operations. Stage-mounted, motor-driven power transfer switches are employed to remotely disconnect all batteries from the buses until just before launch. During checkout and prelaunch, all electrical power is supplied from regulated d-c ground power supplies.

2-5. The motorized power transfer switches are 2PDT, having a make-before-break-action (MBB). The MBB design prevents power interruption during transfer from ground power to battery power. The electrical power system is comprised of the following bus systems:

- Main d-c bus
- Instrumentation d-c bus

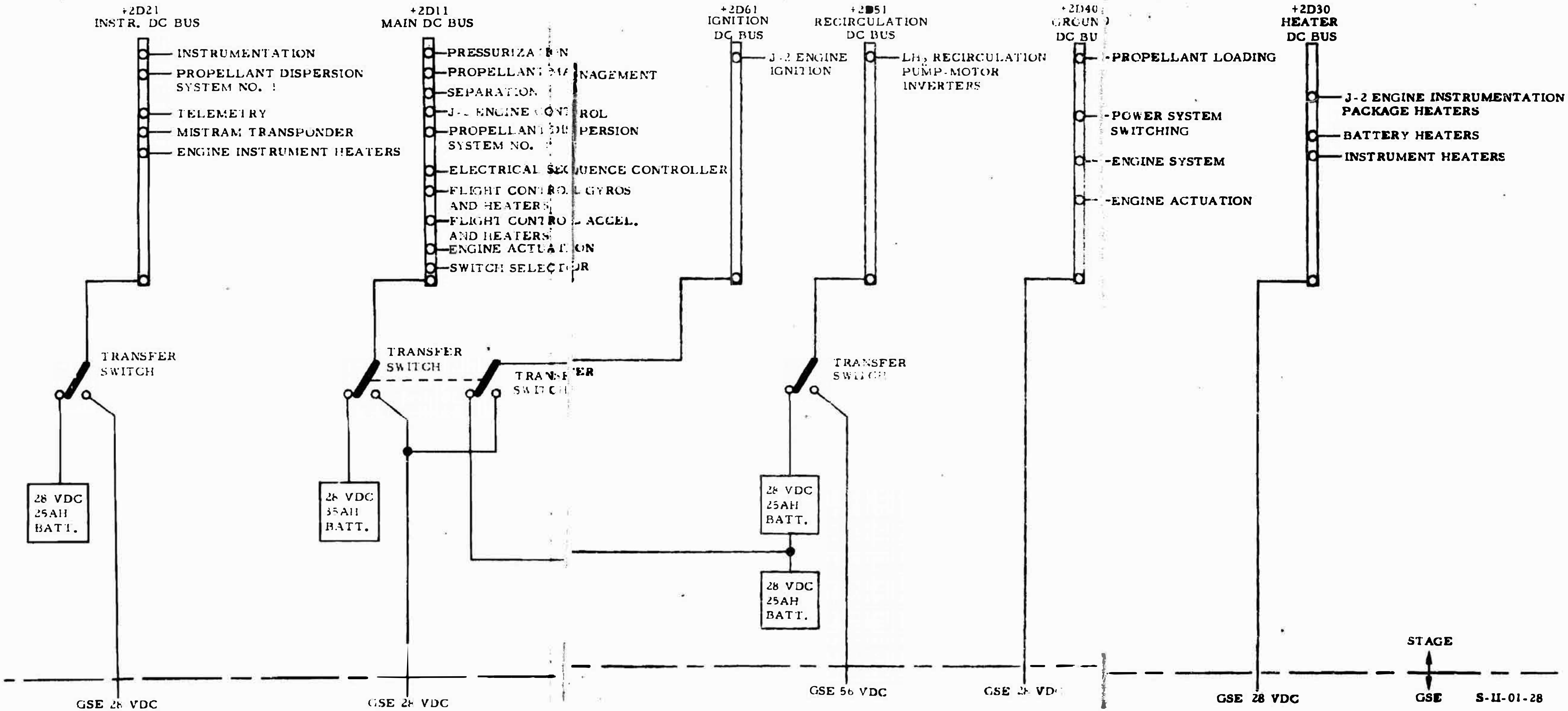



Figure 2-1. Electrical Power Distribution

- Recirculation d-c bus
- Ignition d-c bus
- Heater d-c bus
- Ground d-c bus

2-6. Main D-C Bus. The main battery provides 28 volts dc to the main d-c bus. The main d-c bus distributes d-c power to the system loads as shown in figure 2-1. Power during ground operation is supplied from a regulated d-c ground power supply using remote sensing for regulation control. Transfer from ground power to battery power is accomplished with a motorized power transfer switch. Auxiliary contacts on the power transfer switch are used to indicate switch position. An additional motorized power transfer switch is employed to apply power to the propellant management system.

2-7. Instrumentation D-C Bus. The instrumentation battery provides 28 volts dc to the instrumentation d-c bus. The instrumentation d-c bus provides d-c power to the system loads as shown in figure 2-1. Power during ground operation is supplied from a regulated d-c ground power supply using remote sensing for regulation control. Transfer from ground power to battery power is accomplished with an MBB, motorized power transfer switch.

2-8. Recirculation D-C Bus. Two 28-volt d-c batteries connected in series supply 56 volts dc to the recirculation d-c bus. The recirculation d-c bus supplies d-c power to five recirculation pump-motor inverters. Power for ground operation is supplied by a regulated d-c ground power supply using remote sensing for regulation control. Transfer from ground power to battery power is accomplished with an MBB, motorized power transfer switch. The five $LH_2$ recirculation pump motors receive power from the inverters which convert the 56 volts dc to three-phase, 400 cps, 42 volts (rms). The five inverters are turned on individually by five magnetic latching relays for checkout and operational purposes and are turned off prior to the first plane separation by resetting the five magnetic latching relays by switch selector command.

2-9. Ignition D-C Bus. A center tap from the recirculation d-c battery system supplies 28 volts dc to the ignition d-c bus. The ignition d-c bus supplies power to the five J-2 engine ignition buses. Power during ground operation is supplied from the main d-c bus regulated ground power supply. Transfer from the main bus ground power supply to battery power is accomplished with the second set of contacts on the main bus power transfer switch.

2-10. Heater D-C Bus. The heater d-c bus receives 28 volts dc from a regulated ground power supply and supplies this power to the bus loads as shown in figure 2-1.

2-11. Ground D-C Bus. The ground d-c bus receives 28 volts dc from a regulated ground power supply. The ground d-c bus supplies power to the bus loads as shown in figure 2-1.

2-12. ELECTRICAL CONTROL SYSTEM. The electrical control system controls various stage-mounted mechanical systems to implement their normal flight or ground operation. All of the electrical solenoids, switches, connectors, and the cables that are integral with the related mechanical system are components of the electrical control system. Electrical control is provided to the following systems:

- Propellant feed system
- Propellant utilization system
- Recirculation system
- Pressurization system
- Flight control system
- Engine systems
- Propellant depletion engine cutoff

2-13. Propellant Feed System Control. The propellant feed system consists of the propellant fill valves and the individual engine prevalves. Electrical control of the propellant fill valves is a GSE function and is routed through the lower launch umbilical. The two propellant fill valves (one for the LOX tank and one for the $LH_2$ tank) are pneumatically actuated and electrically controlled from GSE. The fill valves are operated only during propellant filling or draining operations. The sequence control package (located in the aft skirt area) contains the necessary circuits to operate the prevalves in the proper sequence. This is accomplished by triggering the solenoid associated with a particular prevalve. Whenever a cutoff signal is sent to an engine, it is followed, after a time delay, by a signal that operates the prevalve for that engine.

2-14. Propellant Utilization System Control. Electrical control of the propellant utilization system is performed in the following three areas of the system:

a. Control of the propellant utilization (PU) valve so as to minimize propellant residuals.

b. Control of propellant loading by providing primary signals for controlling vehicle loading.

c. Mass indication by providing accurate propellant mass information for telemetry signals.

2-15. The system is of the continuous capacitance type and works on an analog signal. In addition to the continuous system, there are 16 discrete liquid level sensors in each tank. Two of these provide backup signals for fast fill, shutoff, and overfill. The remaining 14 sensors per tank provide propellant volume information.

2-16. Recirculation System Control. Electrical controls are provided for flight operation, ground operation, system checkout, leak checks, and purging operations. The five $LH_2$ pumps are started on the ground by individual motor-start commands from GSE and are started in sequence to minimize starting current drain. The $LH_2$ pumps may be stopped on the ground by resetting the motor start lock-in with a recirculation control reset command. Inflight shutdown of the $LH_2$ pumps and the recirculation valves is accomplished by resetting the motor start lock-in with a command from the switch selector. The switch selector (located in the aft skirt area) originates the recirculation stop command and transmits the command to the electrical control system logic. The $LH_2$ pumps stop, and the recirculation valves return to the de-energized position. The recirculation valves are energized on the ground by the recirculation valves command from GSE. Engine feed system leak check and purge operations require the control by GSE of the $LH_2$ prevalves, the $LH_2$ recirculation valves, the J-2 engine bleed valves, the LOX return valve, and the LOX overboard valves. The control capability is provided to GSE through the launch umbilical.

2-17. Pressurization System Control. The flow of pressurizing gas to the tanks is controlled by a pressure regulator system. Built into each regulator is a solenoid actuated step pressurization function which drives the regulator to the full open position and pressurizes the tanks to the cracking pressure of the vent valves. The control system associated with each tank contains three pressure switches, a pressure regulator, control relays, and two solenoid valves. The switches all sense the same pressure; however, one operates at a lower pressure (23 psia) and provides information through the umbilical for GSE use in checkout and propellant tanking. Each of the other pressure switches operates a relay. When both relays for a tank system operate, a solenoid is actuated which shuts off the flow of pressurizing gas from the helium receiver. The pressure regulator utilizes a pneumatic feedback system to continuously regulate the flow of pressurizing gases from the engines in flight. Near the end of S-II boost, the regulator is held open by the de-energization of a solenoid. This control function is initiated by the switch selector and provides a step increase in tank pressure.

2-18. Flight Control System Control. Electrical control of this system is performed in two areas: hydraulic engine actuation and flight control electronics. The first system provides hydraulic power to gimbal the four outboard engines in response to outputs from the hydraulic servo valves. The hydraulic system is locked up and unlocked by logic in the electrical control systems directed by inputs from the switch selector. The second system consists of electrical wires, actuator position transducers, the flight control switch replacement assembly, and the servo valves. This system responds to signals from, and provides inputs to, the IU computer.

2-19. Engine Systems Control. This system consists of five J-2 rocket engines. The engines are started and cut off simultaneously, but capability is provided of individual GSE control to implement checkout requirements. Each engine provides a number of outputs to indicate operational condition. Three of these output signals; engine ready, mainstage ok, and engine cutoff on, are used for vehicle control. The first signal, engine ready, is sent out to GSE for use as a condition for C-5 launch. The second signal, mainstage ok, indicates that the engine has reached the 90 percent thrust point. This information is used by the start phase limiting circuit and separation systems. The third signal, engine cutoff on, indicates that the engine has been cut off, and it is used by the IU, and prevalve control circuits. The engine-contained engine failure sensing and shutdown (EFSS) system is designed to shut down if LOX injection pressure decays below a predetermined value or if the gas generator combustor temperature exceeds the red line value. The stage contains a start phase limiter, a function of which is to assure engine cutoff if a sequence stoppage occurs during the initial portion of the start sequence. To accomplish this, a switch selector output is utilized (signal from IU) to cut off the engines if the time from engine start to main stage OK exceeds a predetermined value.

2-20. Propellant Depletion Engine Cutoff Control. Electrical control of the system is maintained through the use of five point sensors in each tank plus associated electronics in electrical container 214. The liquid level point sensor controller provides constant current to the hot wire sensors and the variation in voltage across each sensor, due to a change in sensor resistance, provides the initiating signal for the system. The output from each controller has a time delay to provide an adjustment to allow the cutoff signal to occur when the propellant level is below the sensor units. The sensor outputs are voted by a two-out-of-five voting logic so that a single dry signal cannot initiate engine cutoff. A further protection against inadvertent engine cutoff is provided by the arming functions from the switch selector.

2-21. ORDNANCE SYSTEMS.

2-22. SEPARATION SYSTEM. A dual-plane method is used for S-IC/S-II separation, and a single-plane separation is used between the S-II/S-IVB stages. The separation methods may be divided into five functional areas for the S-IC/S-II and two functional areas for the S-II/S-IVB. Since separation is a major operation of the stage function, an extensive detail of the complete separation phase is carried in subsequent paragraphs. The separation functions are as follows:

a. Acceleration of the vehicle during separation. In order to start the engines in the S-II stage after first separation, propellant settling is required. This is accomplished by the firing of eight S-II ullage rockets positioned around the S-IC/S-II interstage skirt, thus maintaining a positive vehicle acceleration.

b. Severing S-IC/S-II stages. A linear-shaped charge is used to physically sever the stages at the first separation plane which is at station 0 on the S-II interstage. This function is electrically controlled by the S-IC stage.

c. Retarding the S-IC stage. Retro rockets, controlled and located on the S-IC stage, will be ignited to decelerate the stage.

d. Severing of the S-II interstage at the second separation plane. A linear-shaped charge is also used for separation at this plane, which is at station 196. This operation is controlled by S-II stage electrical signals.

e. Retarding the interstage. After J-2 engine stabilization, the combined effect of the S-II stage thrust and the reaction of the J-2 engine exhaust plume impingement forces will move the interstage away from the S-II stage.

f. Severing of the S-II/S-IVB stages. A mild detonating fuse is used to physically sever the S-IVB interstage at the S-IVB interstage mating plane located at station 2790 of the Saturn V launch vehicle. This action is controlled by the S-II stage.

g. Retarding the S-II stage. Four retro rockets embedded around the S-IVB interstage ignite to decelerate the S-II stage for complete separation. Ignition is controlled by the S-II stage.

2-23. S-II Separation System Description. The separation system receives its electrical power from the main 28-volt d-c bus. The system consists of parallel independent systems downstream from the controller, except for the linear-shaped charge assemblies which are initiated at both ends. (See figures 2-2 and 2-3.) Separation is achieved by severing each separation plane structure with a linear-shaped charge assembly. Initiation of the linear-shaped charge assembly is accomplished by utilizing exploded bridge-wire systems (EBW). Power is applied to each of the EBW firing units, and verification of capacitor full charge voltage is accomplished in flight. Safety is assured by rendering the system inoperative by application of the lift-off signal prior to launch and by application of return bus EBW trigger input until the proper command is received from the controller.

2-24. Provisions are included to lock out the second separation plane event if an outboard engine is out with capability of growth to an engine-out condition. The ordnance arm commands accomplish readying of the applicable EBW systems for subsequent ignition of the ordnance components. Signals from the controller trigger the applicable EBW gap switches causing discharge of the stored energy of the capacitor into the EBW detonators. The EBW detonators initiate detonation of the CDF manifold distribution system to the pyrogen initiator, and the linear-shaped charge assemblies. The interstage mounted ullage rockets are ignited by the CDF pyrogen initiators resulting in a positive G-force on the S-II stage during S-IC/S-II separation. The separation planes are severed by double-end initiated, linear-shaped charge assemblies causing loss of structural integrity between, and resulting in physical separation of, the S-IC/S-II stages.

2-25. Complete Separation System Flight Sequence of Operation. The switch selector employed in the separation system becomes operational when the main d-c bus is energized. At lift-off, the separation system is activated by a lift-off relay, and the separation power bus is energized. This gives the system the capability of responding to the sequenced stimuli of the switch selector. Prior to shutdown of the S-IC stage, the system is commanded by the instrumentation computer to arm the S-IC/S-II separation ordnance. The switch selector sequences the controller, thereby latching onto the ordnance arm.

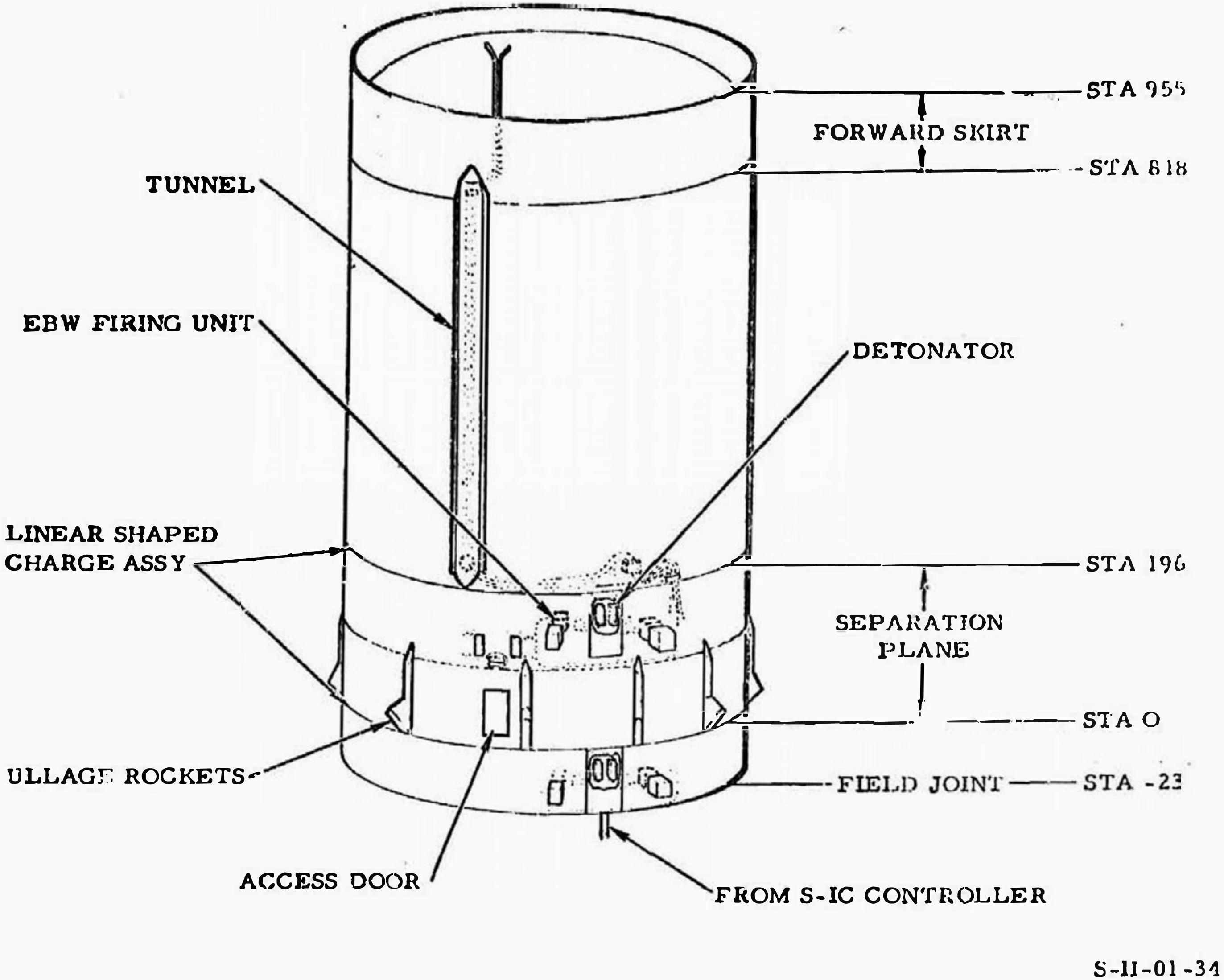



Figure 2-2. Stage Separation System

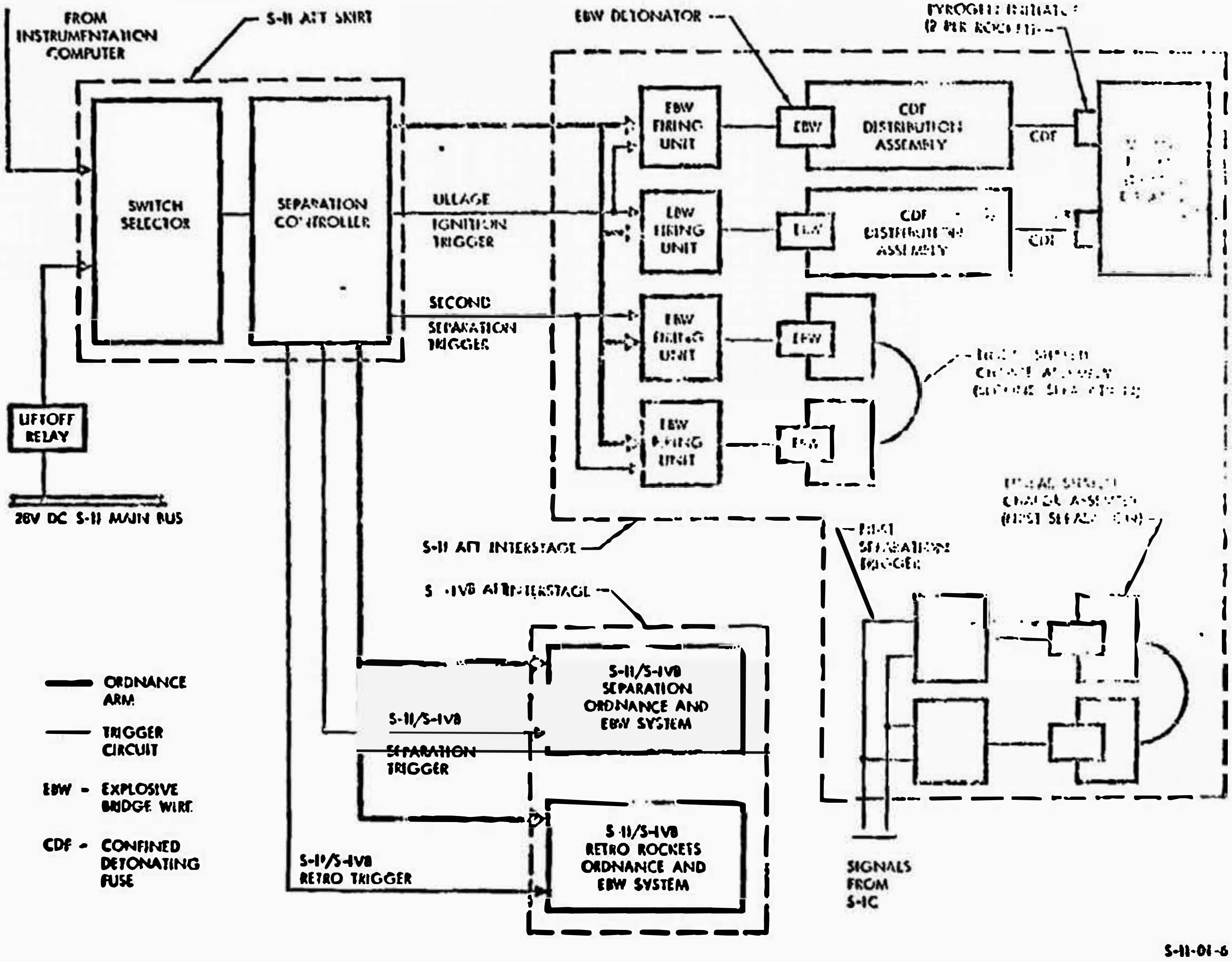



Figure 2-3. Separation System Block Diagram

2-26. Following receipt of S-IC propellant depletion (engine cutoff) signal, the system is commanded to trigger ullage rocket ignition by the instrumentation computer. The ullage trigger switching device is sequenced by the switch selector through the controller and latched on. This releases the electrical impulse for S-II ullage rocket ignition. When the vehicle acceleration level has decelerated to approximate 0.5G or less, the computer commands first separation and S-IC/S-II retro rocket ignition.

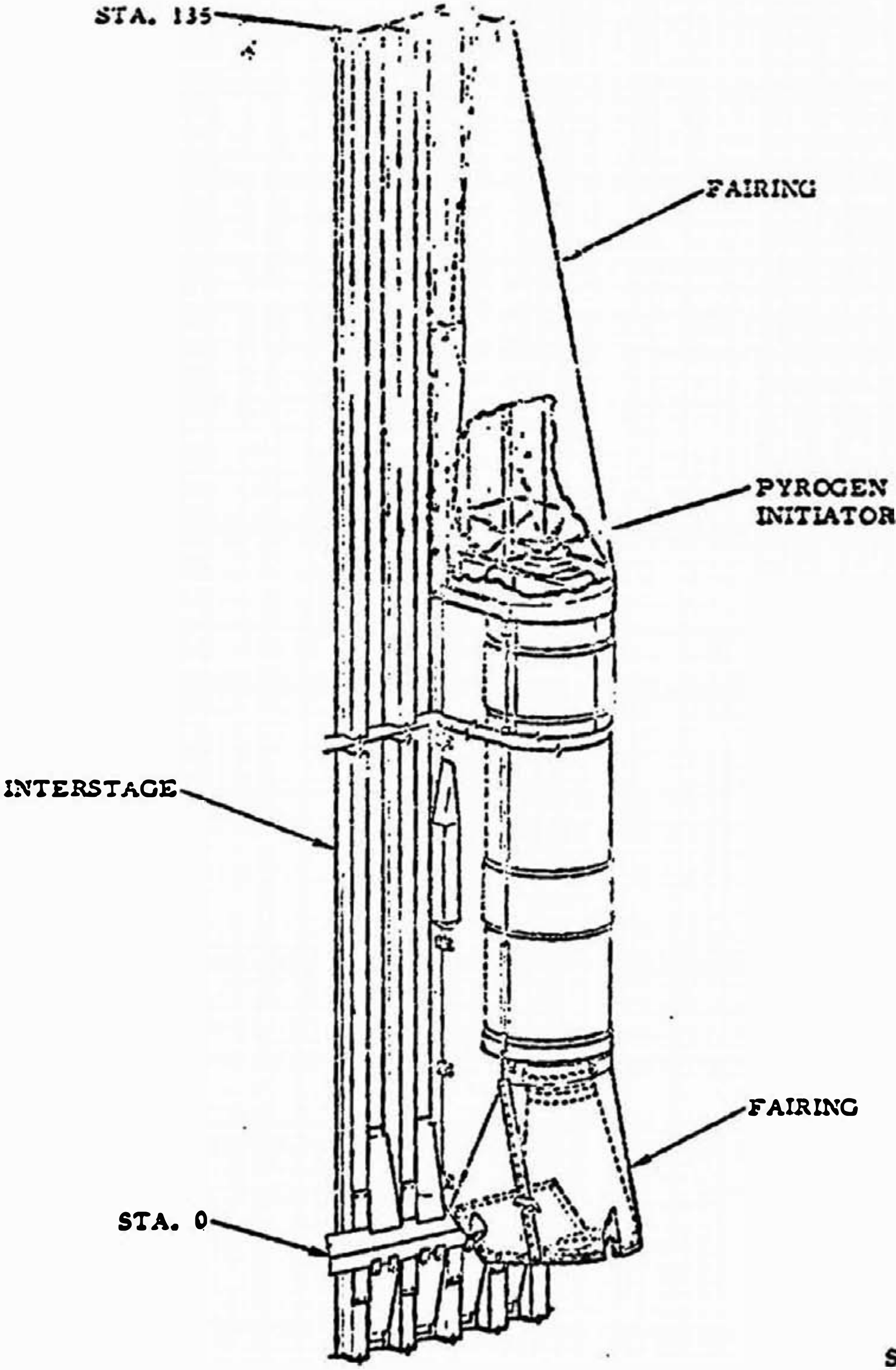
2-27. First-plane separation unlocks the separation system (by means of an umbilical disconnect) ensuring further system performance as required and prevents premature system operation. When the outboard J-2 engines reach 90-percent thrust, a 90-percent thrust signal is committed to the controller. Approximately 30 seconds after first separation, when the separation transients are damped out and the dynamic pressure is approximately zero, the instrumentation computer commands second-plane separation. Upon receipt of this signal, the switch selector sequences the controller, fulfilling this necessary condition for second separation. This concludes the necessary and sufficient conditions for second separation, thus triggering second separation.

2-28. Approximately 10 seconds prior to the S-II propellant depletion signal (J-2 engines cutoff), the computer commands S-II/S-IVB separation ordnance arm. This signal is committed to the controller by the switch selector latching on the S-II/S-IVB separation switching device, enabling the ordnance to arm. The controller receives a propellant depletion signal from the S-II propellant management system. This signal conditions the separation system for triggering S-II/S-IVB separation and retro rocket ignition when commanded by the computer. S-II/S-IVB physical separation occurs near the forward end of the S-IV interstage. The S-II/S-IVB retro rockets, which are mounted on the S-IV interstage, fire to decelerate the S-II stage. The S-IV interstage and retro rockets remain with the S-II.

2-29. ULLAGE ROCKET MOTORS. Eight ullage rockets of solid propellant configuration are used to impart a 0.1G relative acceleration to the S-II stage to insure a head pressure on the propellants during the separation phase. (See figure 2-4.) The motors are mounted externally 45 degrees apart on the aft interstage between stage stations 77 and 0.

2-30. The eight ullage rocket motors will burn for approximately 4 seconds and produce a thrust of 22,800 pounds per motor. Each motor nozzle is canted 10 degrees from the S-II stage centerline to eliminate ullage motor exhaust plume impingement on the J-2 engine nozzles and also to reduce the motor-out moment in case of an ullage motor malfunction.

2-31. In operation, when the EBW firing unit is triggered during the separation phase, a voltage of approximately 2200 volts is sent to a manifold assembly detonator. The manifold with an EBW installed provides a means of simultaneously




S-II-01-42

Figure 2-4. Ullage Rocket Motors

fire all the ullage rocket motors. A confined detonating fuse is routed from the manifold to each individual rocket motor and propagates the firing charge at a rate of approximately 22,000 feet per second. Failure of any one ullage motor to fire will not materially affect flight stabilization or separation.

2-32. EMERGENCY DETECTION SYSTEM. The Saturn V launch vehicle utilizes an integrated emergency detection system which will sense malfunctions in any booster stage. Power supply and logic circuits for this system are installed in the instrumentation unit located forward of the S-IVB stage. This system is not fully defined at present. However, the system will be provided on and about every system of the S-II to sense a failure and transmit a signal to the Saturn V vehicle instrument unit compartment for distribution and execution. The failure will be classified as catastrophic or critical. Catastrophic failures will immediately initiate an abort signal. Critical-type failures will require an amplifying information signal prior to initiating an abort. Examples of a few S-II stage detection emergencies to be sensed are as follows:

- Ullage overpressure or underpressure in the propellant tanks
- Voltage drop on the main d-c bus
- Separation system malfunctions
- Loss of engine thrust or flight vector control

2-33. Operationally, the emergency detection system will sense vehicle system failure or malfunctions and relay the signals directly to the instrument unit for immediate action. The system is closely monitored during ground (GSE) operations. System base location is presently slated for the instrument power distribution J-box in the forward skirt area.

2-34. PROPELLANT DISPERSION SYSTEM. The propellant dispersion system for the S-II stage is an integral part of the Saturn V launch vehicle flight termination system. (See figure 2-5.) The function of the vehicle flight termination system is to provide range safety in the event of a vehicle gross malfunction and consists (in the case of the S-II stage) of rupturing the propellant tanks by explosive means and of shutting the engines down. Flight termination is manually initiated from the launch site by the range safety officer by use of a UHF radio command system which transmits a coded output within the frequency range of 405 to 450 megacycles. Flight termination with a manned payload consists of the following three operations:

a. Thrust termination by shutting off propellants to the engines.

b. Ejection of the manned payload from the Saturn V launch vehicle (accomplished through the Saturn V instrument unit).

c. Propellant dispersion of all stages by rupturing the tanks.

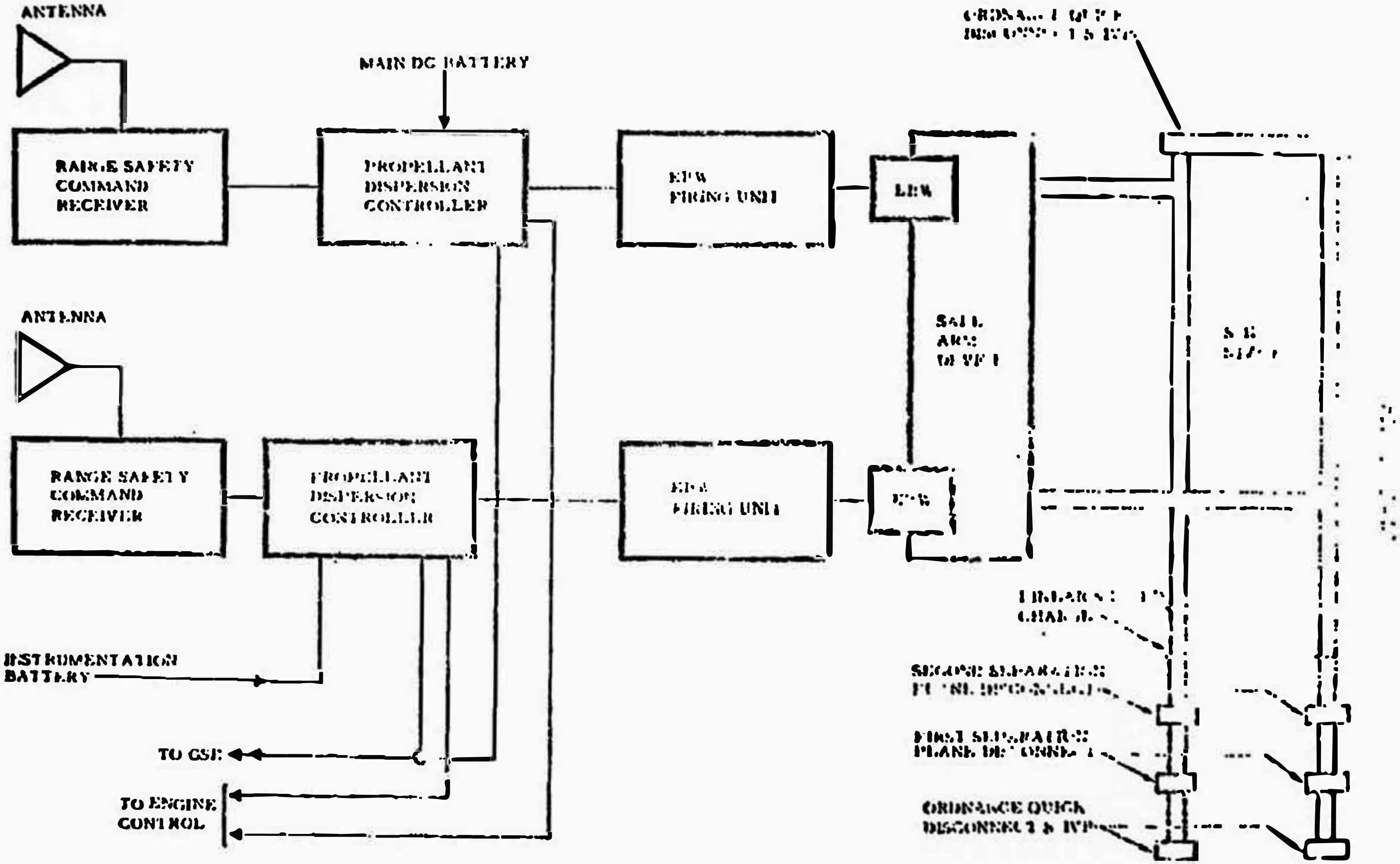



Figure 2-5. Propellant Dispersion System Block Diagram

2-35. Two independent propellant dispersion systems are employed in the S-II stage and include two receivers capable of receiving and decoding the propellant dispersion command. Each range safety command receiver is capable of initiating a command signal to the associated propellant dispersion system. The propellant dispersion systems are capable of dispersing the propellants through use of an explosive charge of sufficient size to cause tank rupture. The propellant dispersion controllers are the control centers for each propellant dispersion system. When the range safety command receivers initiate a command signal, the propellant dispersion controllers trigger the exploding bridge-wire firing units, starting the sequence to detonate a linear-shaped charge. Provisions for a time delay are included for a manned payload to allow for payload ejection and engine shutdown before destruction. When triggered, the exploding bridge-wire firing units produce 2200 volts for detonation. A safe and arm device is located between the EBW detonators and the explosive train. When this device is armed, it will allow the detonator to transfer its signal to the explosive charges through the confined detonating fuse, which will be jacketed to permit containment of detonation. The detonating fuse will transfer the charge at a rate of approximately 22,000 feet per second.

2-36. PROPULSION SYSTEMS.

2-37. The propulsion systems are made up of the pressurization system, propellant feed system, engine system, leak detection and insulation purge system, engine compartment conditioning system, and propellant management system. These systems and their respective subsystems comprise the S-II stage propulsion systems.

2-38. PRESSURIZATION SYSTEM. The pressurization system is utilized for the following functions (See figures 2-6 and 2-7.):

- Propellant tank pressurization
- Vent valve actuation
- Purging of liquid hydrogen tank pressurizing line
- Engine recirculation system valve actuation

2-39. <u>Propellant Tank Pressurization.</u> Pressurization of the propellant tanks is accomplished by two methods. Prior to launch, propellant tank pressurization is accomplished with gaseous helium from a ground source. During S-IC boost and S-II engine start transient, pressurization of each propellant tank is obtained from three separate high-pressure helium (gaseous) receivers (one for LOX tank and two for $LH_2$ tank). The pressure level of each tank is maintained by a combination of pressure switches and solenoid valves. After S-II engine start, tank pressurization is maintained with gaseous oxygen and gaseous hydrogen bled from the engines. The ullage pressure sensing pressure regulator controls the flow of gaseous oxygen and hydrogen to maintain desired tank pressures. To protect against overpressurization, each propellant tank is provided with two vent valves.

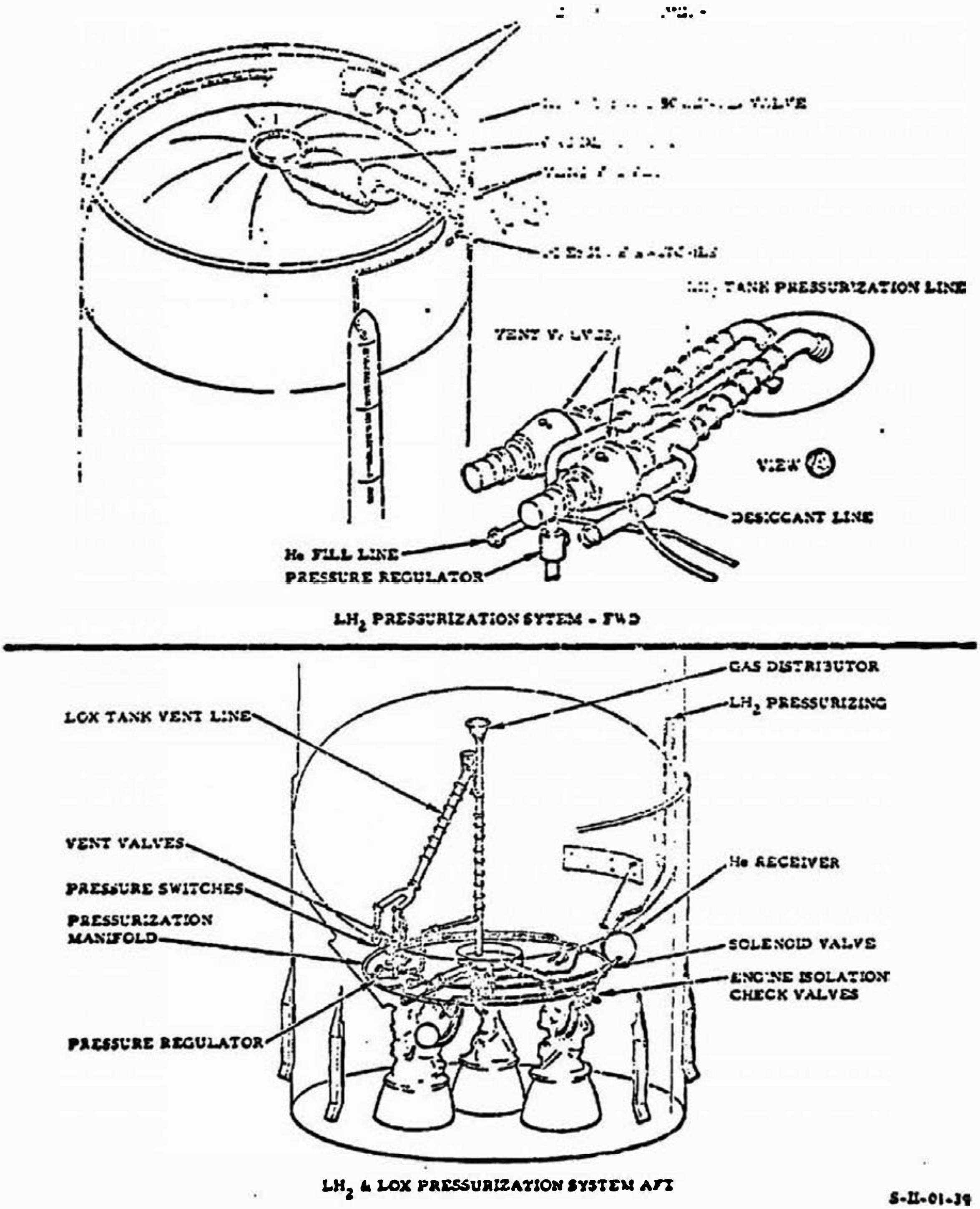



Figure 2-6. Propellant Pressurization System

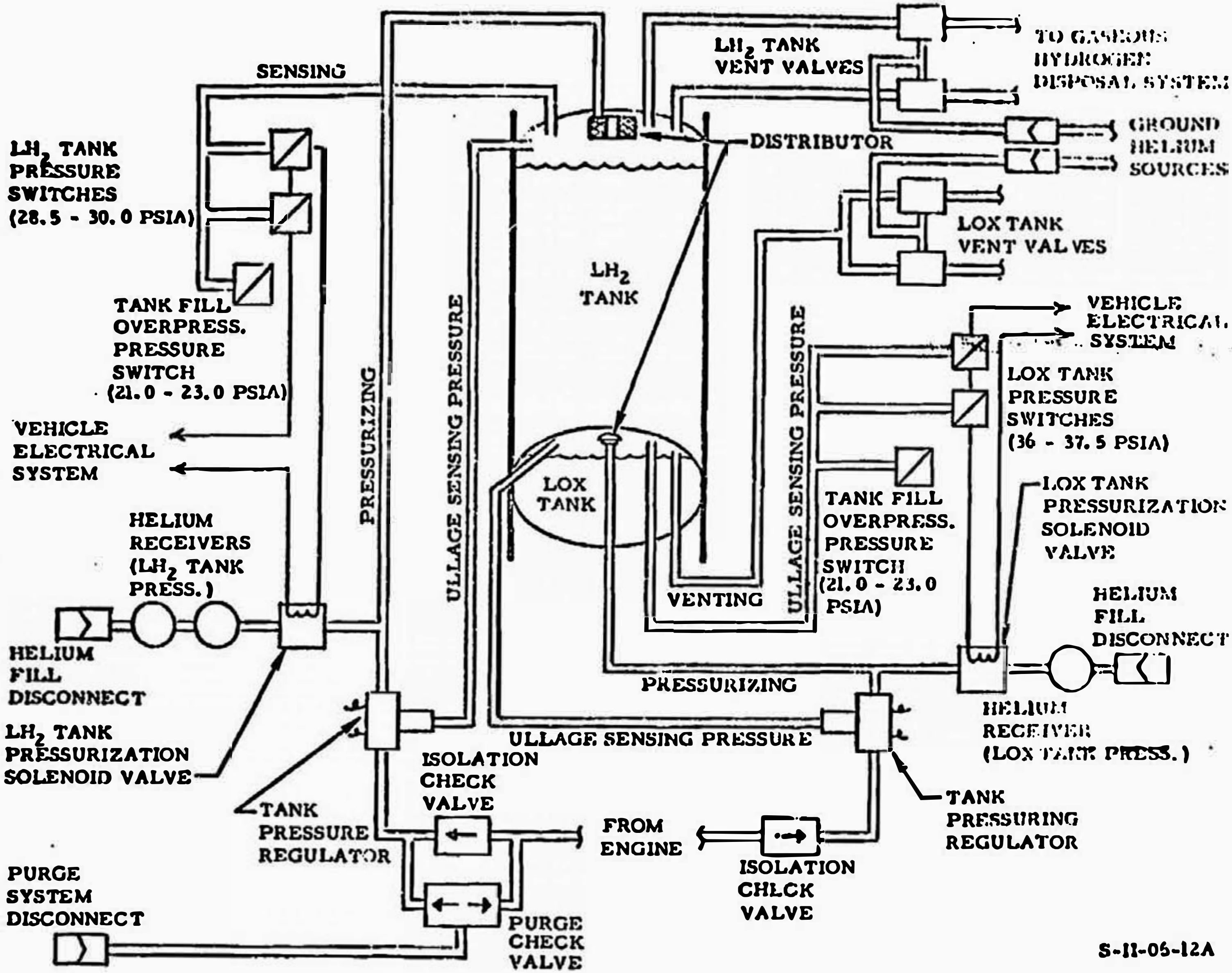



Figure 2-7. Pressurization System Diagram

The vent valves act as absolute pressure relief valves during flight, and are pneumatically opened to vent the tanks during propellant loading.

2-40. Initial pressurization of the liquid oxygen tank is accomplished from a ground-regulated supply of gaseous helium. As the helium flows from the fill disconnect fitting to the liquid oxygen tank, it passes through a high-pressure receiver and a normally open solenoid valve. The solenoid valve is controlled by two pressure switches pneumatically in parallel and electrically in series. The pressure switches sense ullage pressure within the liquid oxygen tank and maintain a pressure level of 36.0 to 37.5 psia. When the pressure within the liquid oxygen tank reaches its prescribed level and the solenoid valve is closed, the high-pressure receiver is pressurized to its normal operating range of 3000 (+250, -0) psig. During S-IC boost phase and S-II engine start transient, pressurization of the liquid oxygen tank is maintained with helium stored in the high-pressure receiver.

2-41. After S-II engine start, pressurization is maintained with gaseous oxygen obtained from heat exchangers located in the turbine exhaust system of each J-2 rocket engine. During the oxidizer turbopump discharge pressure buildup period, discharge pressure reaches approximately 100 psig; the heat exchanger antiflood check valve opens and liquid oxygen flows into the heat exchanger. The heat exchanger forms a part of the oxidizer pump turbine exhaust duct and is heated by the turbine exhaust. As liquid oxygen flows through the heat exchanger, a heat transfer occurs, and liquid oxygen is converted to gaseous oxygen. From the heat exchanger of each engine, the gaseous oxygen flows through an isolation check valve and is collected in a common manifold. The check valve prevents the loss of pressurized gas in case of a line failure between one of the engines and a check valve. The gaseous oxygen then flows to the liquid oxygen tank pressurizing line through a pressure regulator. The pressure regulator is never fully closed, and ullage pressure within the liquid oxygen tank is sensed to control further opening. A pressure level of 36.0 to 37.5 psia is maintained by the regulator. The gaseous oxygen enters the liquid oxyg tank pressurizing line at a junction point downstream of the pressure regulat and the solenoid vaive. Both gaseous helium and gaseous oxygen are distributed within the liquid oxygen tank by a gas distributor which is designed to reduce the velocity and impingement angle of the incoming gases.

2-42. Liquid hydrogen tank pressurization is accomplished initially and prior to S-II engine start in the same manner as initial pressurization of the liquid oxygen tank. The pressure switches and solenoid valve combination maintain a pressure level of 28.5 to 30.0 psia. Because of the larger volume of the liquid hydrogen tank, two high pressure receivers are used to store the gaseous helium.

2-43. Pressurization after S-II engine start is maintained with gaseous hydrogen bled from each engine. The J-2 rocket engine thrust chamber is of tubular construction and regeneratively cooled when liquid hydrogen passes through it before it enters the combustion chamber. A heat transfer occurs and the liquid hydrogen is converted to gaseous hydrogen. From a bleed fitting located on the upper fuel manifold of each engine, gaseous hydrogen flows through an isolation check valve and is collected in a common manifold. The check valve prevents the loss of pressurized gas in case of a line failure between one of the engines and a check valve. The gaseous hydrogen then flows to the liquid hydrogen tank pressurizing line through a pressure regulator. The pressure regulator is never fully closed and ullage pressure within the liquid hydrogen tank is sensed to control further opening. A pressure level of 28.5 to 30.0 psia is maintained by the regulator. The gaseous hydrogen enters the liquid hydrogen tank pressurizing line at a junction point downstream of the pressure regulator and the solenoid valve. Both gaseous helium and gaseous hydrogen are distributed within the liquid hydrogen tank by a gas distributor which is designed to reduce the velocity and impingement angle of the incoming gases.

2-44. After a prescribed period of S-II flight time, step pressurization is initiated to assure the net positive suction head requirements of the rocket engine turbopumps. A command is initiated in the instrument unit and sent to the S-II stage switch selector. A signal from the switch selector is sent to the sequence controller which locks both propellant tank pressure regulators fully open. Pressure levels within the propellant tanks are not controlled by the vent valves. The vent valves sense ullage pressure to maintain a pressure level of 40 to 42 psia in the liquid oxygen tank and 37 to 39 psia in the liquid hydrogen tank.

2-45. Each propellant tank has a third pressure switch which is used during propellant filling operations. These switches sense propellant tank pressure which would be unsafe for personnel. The switches are actuated at a pressure level of 21 to 23 psia. Actuation of either switch completes a GSE circuit and can be used to sound an alarm or reduce the flow of propellants.

2-46. Vent Valve Actuation System. Actuation pressure for the propellant tank vent valves is provided by two separate 750-psig ground-supplied helium systems. Each system consists of a disconnect fitting and connecting lines to the vent valves. One system actuates the liquid oxygen tank vent valves, and the other system actuates the liquid hydrogen tank vent valves. The vent valves are actuated open during propellant loading operations and actuated closed for tank pressurization.

2-47. Purging of Liquid Hydrogen Tank Pressurizing Line. The liquid hydrogen tank pressurizing line is purged prior to, and during, propellant loading operations. The purpose of the purge is to remove condensible gases, lower the water content of the gases present, and prevent the back flow of gaseous hydrogen during liquid hydrogen tank filling. The purge gas is supplied from a ground regulated supply of helium at 750 psig. The helium flows from the disconnect to a common manifold where it branches into five distribution lines. One line is used for each engine. From the distribution line, the helium flows through two check valves and two orifices and enters the pressurizing lines upstream and downstream from each engine isolation check valve. The check valves prevent the loss of pressurized gas through the engine thrust chamber in case of an engine-out condition. The orifices insure an equal rate of purge gas flow through each purging line.

2-48. [illegible] System Valve Actuation System. Actuation pressure for the engine recirculation system valves and propellant feed prevalves is provided by 750 psig of helium. The pressurization portion of the system consists of a disconnect fitting, high-pressure helium receiver, pressure regulator, two check valves, and two helium surge chambers. (See figure 2-8.) The system is initially charged with helium from a ground supply. From the disconnect fitting, the helium flows through the high-pressure receiver to the pressure regulator. The pressure regulator maintains a pressure level of 750 psig. From the pressure regulator, the helium branches into two pressurizing lines. One line pressurizes the liquid oxygen prevalve surge chamber and recirculation system valves. The other line pressurizes the liquid hydrogen prevalve surge chamber and recirculation system valves. The surge chambers store helium for prevalve actuation and are isolated by check valves to prevent the back flow of pressurized gas. After the surge chambers and lines are pressurized to 750 psig, the high pressure receiver is further pressurized to 3000 (+250, -0) psig. Helium stored in the receiver is used for valve actuation and surge chamber replenishment after launch.

2-49. PROPELLANT FEED SYSTEM. The propellant feed system consists of the propellant servicing subsystem, the engine feed subsystem, and the fuel and oxidizer forward flow recirculation subsystems. (See figures 2-9 and 2-10.)

2-50. Propellant Servicing Subsystem. Servicing operations include the filling and draining of both propellant tanks and the purging of the tank fill lines. The purging of the tanks is accomplished with ullage pressure supplied by the propellant pressurization system. A separate disconnect coupling, service line, and fill valve are provided for each propellant tank.

2-51. The disconnect coupling consists of a vehicle mounted part which is an open line and mates with a service arm mounted ground part. The mounted ground part of the disconnect incorporates a pneumatically actuated shutoff valve which is controlled from GSE. When the airborne and ground parts of the disconnect couplings are mated, they are enclosed within a purge shroud. During propellant loading operations, ambient helium at a maximum pressure of 2 psig and flow rate of 1.0 to 1.6 scfm is circulated within the shroud. This provides an inert atmosphere about the disconnect coupling.

2-52. The disconnect coupling is manually engaged. Disengagement is accomplished by applying pneumatic pressure to the disconnect coupling lock and actuating the push-off mechanism. A secondary, or backup, method to disengage the disconnect coupling is accomplished by a remotely attached lanyard. The vertical rise of the vehicle will unlock the locking mechanism and disengage the ground part of the disconnect from the airborne part. Electrical switches in the ground part of the disconnect provide the signals for disconnect coupling engagement and lockup and the disconnect valve open and closed conditions.

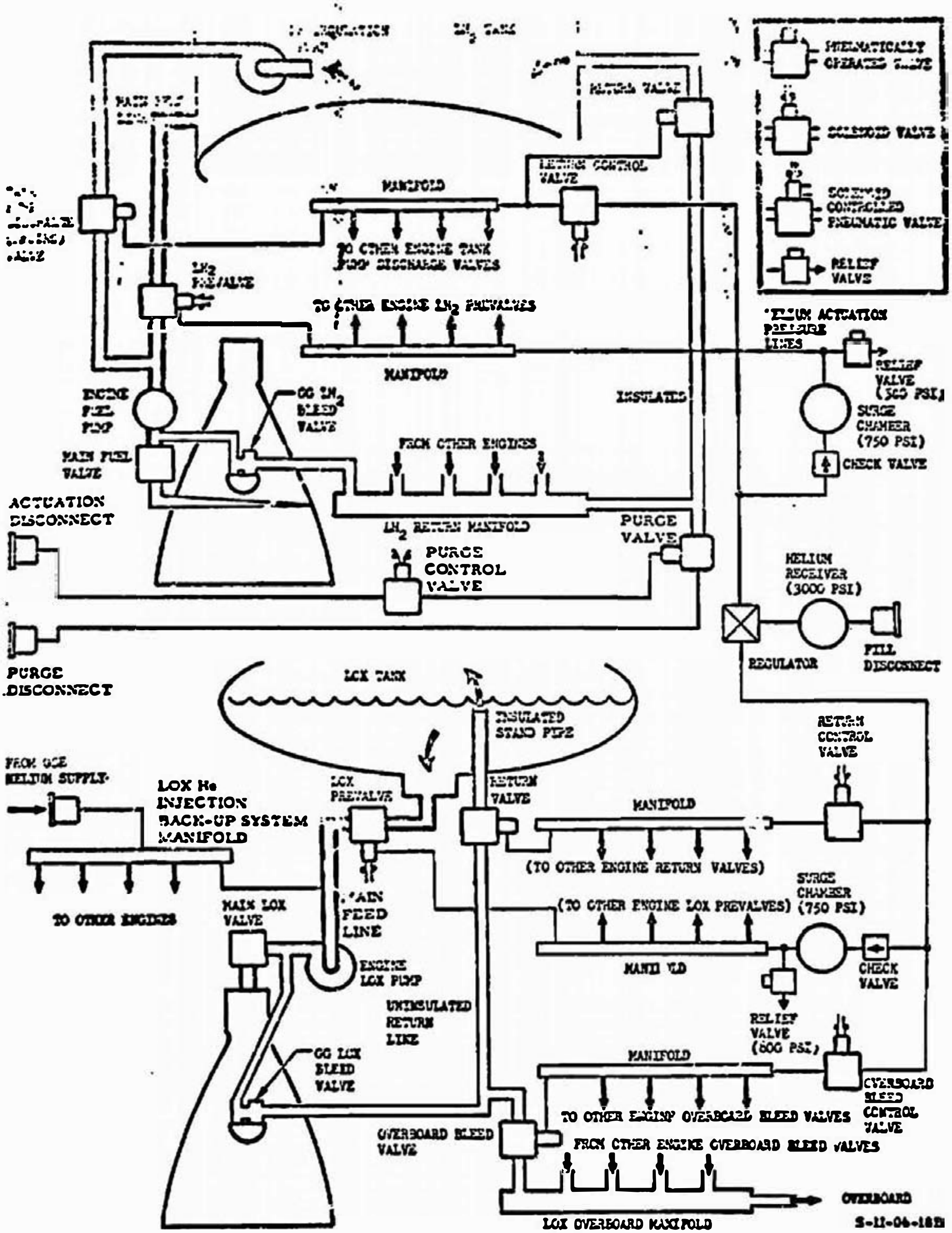



Figure 2-8. Recirculation System Diagram

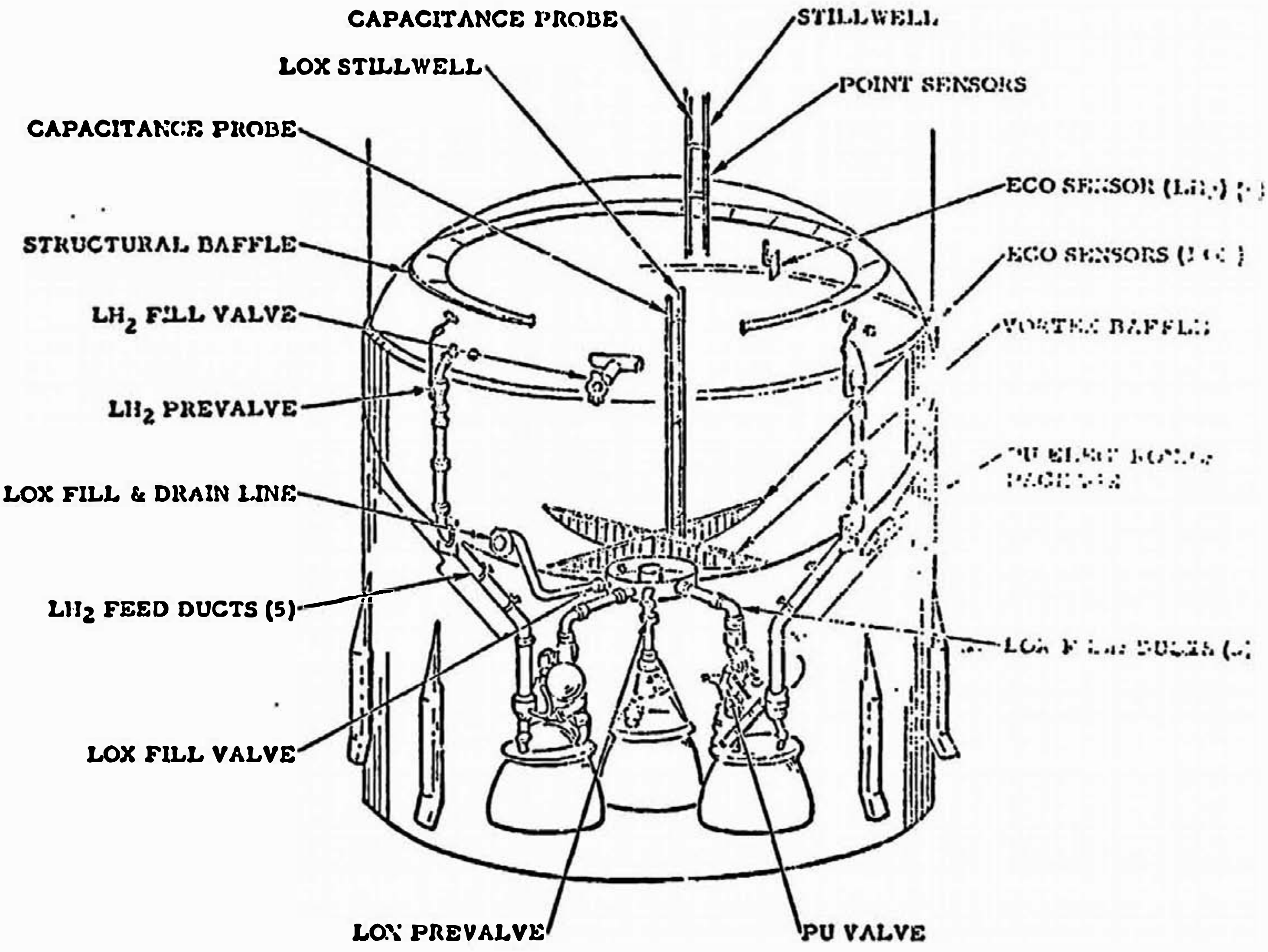



Figure 2-9. Propellant Feed System

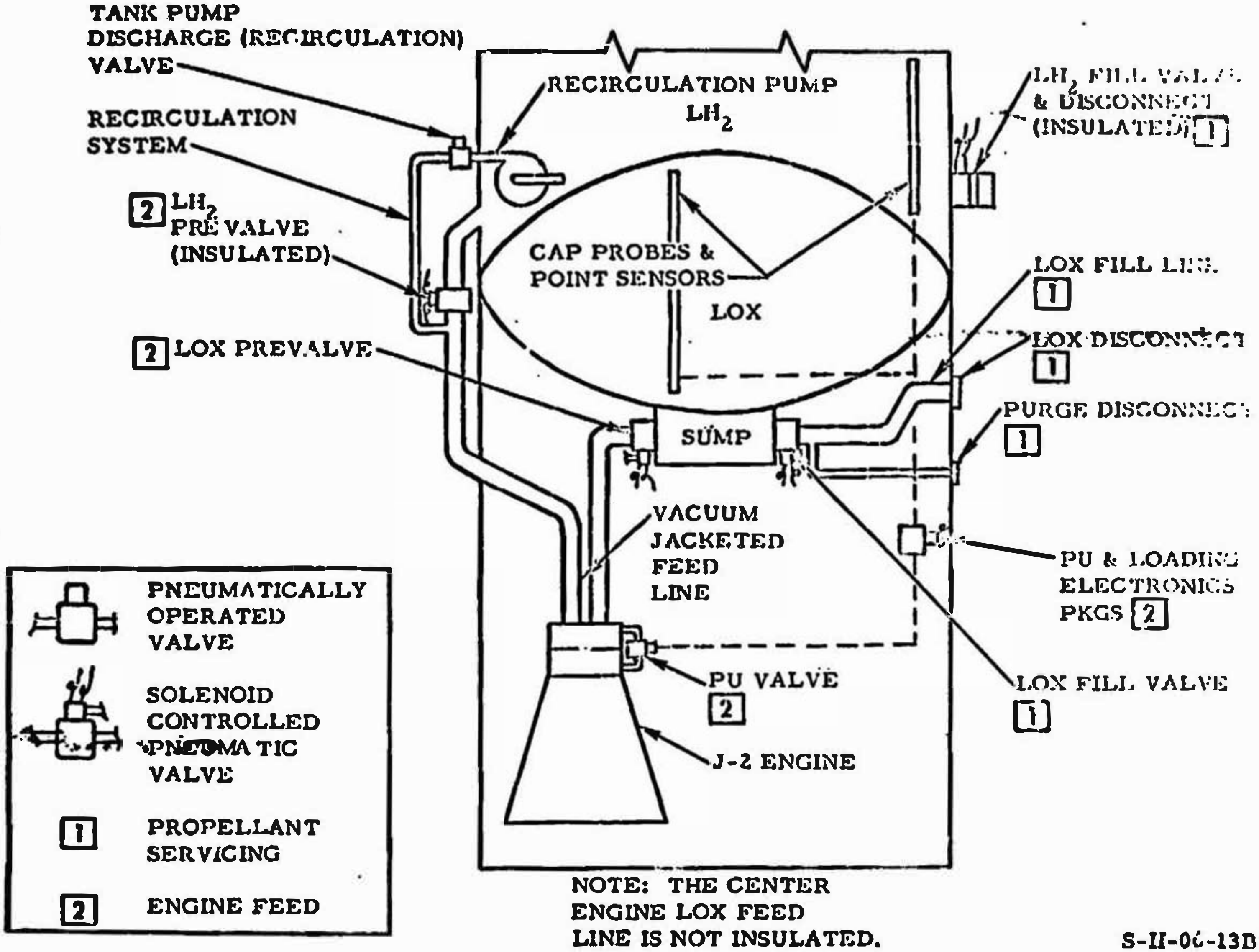



Figure 2-10. Propellant System Diagram

2-53. The propellant fill valve is a [illegible] actuated, solenoid controlled, normally closed butterfly valve. Actuation pressure is provided by a ground regulated supply of helium at 750±50 psig. A mechanical lock is incorporated in the valve design which locks the butterfly in the closed position and prevents inadvertent opening during flight. Loss of helium pressure or electrical power during filling or draining operations will result in the butterfly returning and locking in the closed position.

2-54. When servicing operations are initiated, a signal from GSE opens the fill valves and the shutoff valves in the ground [illegible] of the disconnect coupling. At the conclusion of propellant loading operations, the fill valves and the LOX disconnect coupling shutoff valve are closed, but the $LH_2$ disconnect coupling shutoff valve remains open. The LOX fill line is then drained and purged through a 1-inch purge line that goes through the umbilical panel. The $LH_2$ fill line is drained and purged back to the disconnect coupling. When the S-IC thrust-commit signal is received, the shutoff valve in the $LH_2$ ground disconnect coupling is closed; then, the couplings separate from the vehicle. If the launch is aborted, draining of the propellant tanks can be accomplished by pressurizing the tanks, opening the fill valves and disconnect coupling shutoff valves, then reversing the filling operation.

2-55. Engine Feed Subsystem. The function of the engine feed subsystem is to transfer the liquid propellants from the appropriate tanks to the J-2 rocket engines. Each propellant tank is provided with five prevalves which control the stoppage or flow of propellants through separate feed lines to each J-2 engine.

2-56. The recirculation system and propellant utilization (PU) valve, parts of the propellant management system, are illustrated in figure 2-8. These items have been included in the propellant schematic because all three systems are functionally interrelated.

2-57. The prevalve is a normally open, pneumatically actuated, electrically controlled, butterfly-gate type valve. A built-in four-way pneumatic control solenoid permits 750±50 psig helium pressure to actuate the valve to the open and closed positions. This pressure will be supplied from an airborne source for the duration of the S-II boost. Should a loss of pneumatic or electrical power occur, the valve will be spring-actuated to the open position. Limit switches incorporated in the prevalve provide full open and full closed signals to GSE and launch programmer. The prevalve will remain open during S-II boost unless a signal is received from the engine shutdown system. Static firing capabilities of the valve provide a latching mechanism that locks the valve closed. Pneumatic pressure supplied from GSE unlocks the latch allowing the valve to be spring actuated to the open position. The LH2 prevalves are insulated to protect the unit mechanism from extreme thermal conditions.

2-58. The propellant feed lines, with the exception of the center engine LOX line, are [illegible]-inch-diameter, vacuum-jacketed, thermal insulated ducts. The center engine LOX feed line is an 8-inch, non-insulated line. The vacuum jackets incorporate a service valve and thermocouple so that periodic vacuum checks may be performed. Rupture discs are also in the jacket structure as a means of relieving excessive pressure rise in the jacket annulus. To compensate for thermal expansion and allow freedom of movement, the feed lines incorporate bellows.

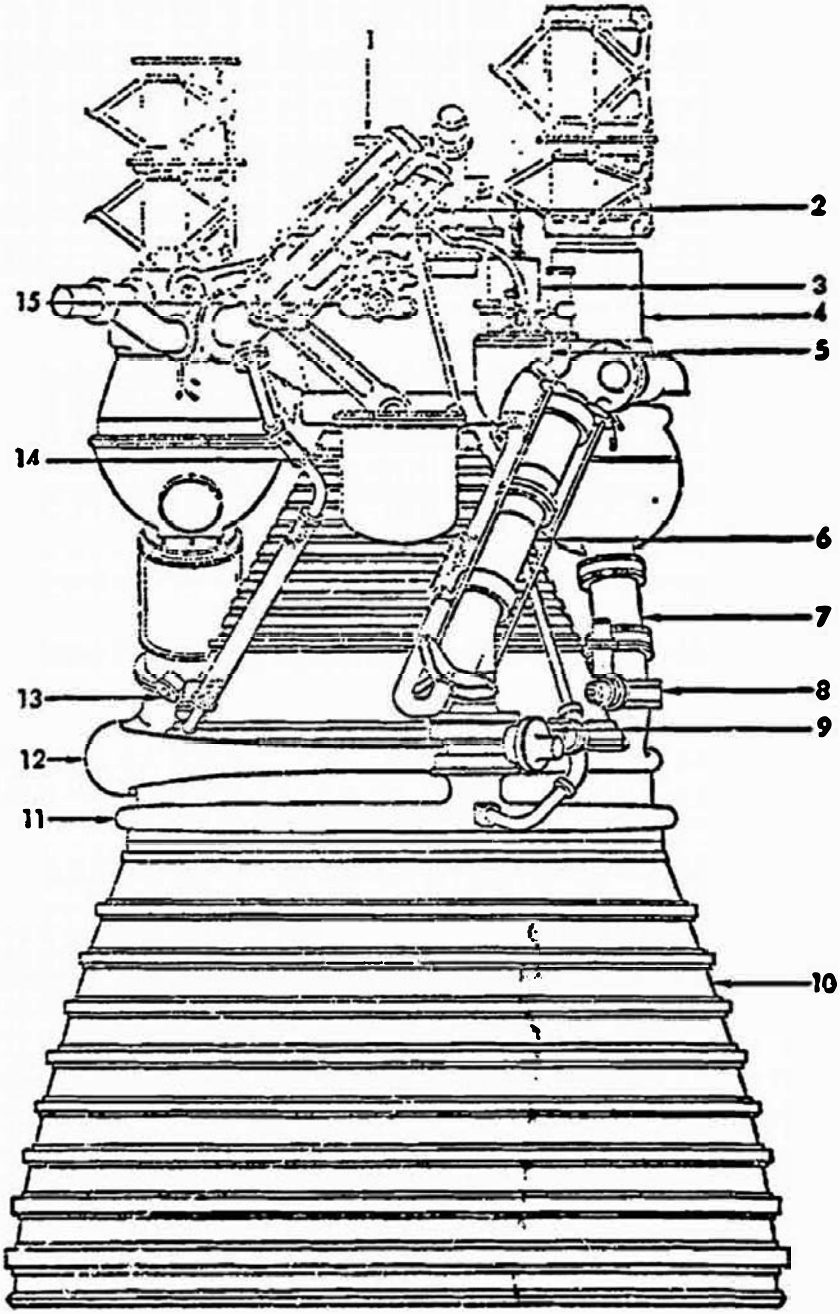
2-59. Actuation pressure for the prevalves is obtained from a stage mounted common manifold pressurized with helium from an airborne supply source of 750±50 psig. The prevalves are actuated closed by a signal from the engine failure sensing and shutdown system. The $LH_2$ prevalves are also actuated closed during $LH_2$ recirculation.

2-60. ENGINE SYSTEM. The engine system consists of five J-2 rocket engines utilizing liquid oxygen and liquid hydrogen for propellants. Each J-2 engine is rated at 200,000 pounds vacuum thrust. The four outer engines are suspended by gimbal bearings to allow control of the thrust vector while the center engine is fixed. (See figure 2-11.) The J-2 engine features a bell-shaped thrust chamber with approximately 27:1 expansion ratio. The basic envelope for each engine is approximately 80 inches in diameter and 116 inches long. Each engine contains the following integrally mounted systems: two turbopumps, an electrical sequence controller, separate high-pressure helium system, a gaseous hydrogen storage bottle, gas generator, a common electrical power supply, separate (closed) hydraulic system, and a propellant utilization valve.

2-61. Fuel ($LH_2$) Recirculation Subsystem. The liquid hydrogen recirculation subsystem consists of five submerged-type cryogenic pumps, five pneumatically actuated prevalves, five pneumatically actuated pump discharge valves, five 2-inch bypass lines, two pneumatic manifolds, a common propellant return manifold, a single return shutoff valve, and a single 3-inch return line. All propellant lines are vacuum-jacketed. The pumps are mounted just above each feed line and operate by means of individual inverters powered by a 56-volt battery. In flight, the battery is ejected with the interstage. The pump discharge valves and return valve operate simultaneously from the same pneumatic manifold. A pneumatically operated purge valve, connected to the common propellant return manifold, permits system purge prior to tanking operations.

2-62. During the tanking operation, prior to launch, when recirculation is first initiated, the $LH_2$ prevalves are closed, discharged pump action GSE is initiated, and pump discharge valves and the return valve are uniformly opened by the solenoid-controlled pneumatic pressure manifold causing the feed line propellants to bypass the prevalves. Propellant then enters the feed line, J-2 engine fuel pump and gas generator, and common manifold where it is directed by the common return line, through the return valve, back to the $LH_2$ tank. Just prior to lift-off, electrical control is shifted to airborne power and the above recirculation action

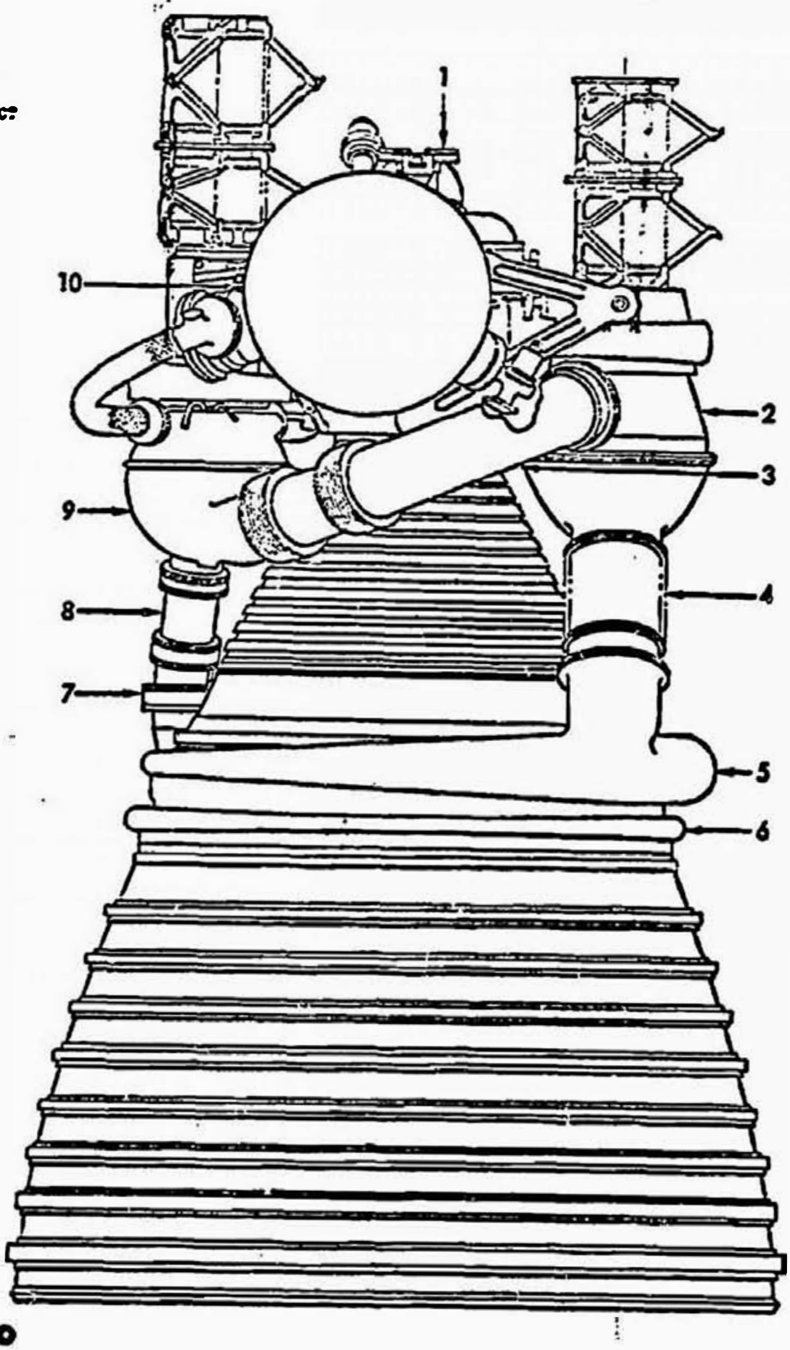
1. GIMBAL
2. MAIN OXIDIZER VALVE
3. GAS GENERATOR CONTROL VALVE
4. FUEL TURBOPUMP
5. GAS GENERATOR
6. MAIN FUEL DUCT
7. TURBINE BYPASS DUCT
8. OXIDIZER TURBINE BYPASS VALVE
9. MAIN FUEL VALVE
10. THRUST CHAMBER
11. FUEL MANIFOLD
12. EXHAUST MANIFOLD
13. VEHICLE TANK PRESSURIZATION SUPPLY (OXIDIZER)
14. ELECTRICAL CONTROL PACKAGE
15. HELIUM REGULATOR




S-II-03-9

Figure 2-11. J-2 Engine and Components Identification (Sheet 1 of 2)

1. GIMBAL
2. OXIDIZER TURBOPUMP
3. TURBINE EXHAUST DUCT
4. HEAT EXCHANGER
5. EXHAUST MANIFOLD
6. FUEL MANIFOLD
7. OXIDIZER TURBINE BYPASS VALVE
8. TURBINE BYPASS DUCT
9. FUEL TURBOPUMP
10. START TANK




S-II-03-10

**Figure 2-11. J-2 Engine and Components Identification (Sheet 2 of 2)**

continues during S-IC boost. Upon a signal from the selector switch just prior to S-IC/S-II separation, the $LH_2$ prevalves are pneumatically opened, recirculation pumps are shut down, gas generator bleed valves closed, and pump discharge and return valves simultaneously closed. Normal engine start and propellant flow sequence follow.

2-63. Oxidizer (LOX) Recirculation System. This system consists of stage vacuum-jacketed main feed lines, each containing a normally open prevalve, five overboard pneumatically actuated valves, a common propellant overboard manifold, five pneumatically actuated return valves, five 3-inch return uninsulated lines, and three common pneumatic manifolds. A backup system consisting of GSE initiated helium supply backup manifold and lines can be utilized during ground operations to subcool the liquid oxygen in the main feed line. The common overboard manifold permits overboard porting of the propellant during subcooling operations. All overboard and return line valves operate simultaneously from their individual pneumatic manifolds. Each of the return lines is insulated within the LOX tank. Each normally open prevalve remains open throughout all phases of the recirculation cycle.

2-64. During ground subcooling operations utilizing the backup system (prior to launch), the overboard valves are pneumatically opened and the LOX return valves are closed. This permits propellant flow through the engine oxidizer pump, the gas generator, and out through the overboard valve and common overboard manifold. GSE initiated helium is supplied momentarily into each feed line during this phase through the backup manifold as required to subcool the fluid. This action may be repeated several times.

2-65. Natural recirculation during the launch and S-IC boost phase consists of keeping the LOX feed line prevalve open, closing all the overboard valves, and opening all the return valves. This is accomplished through the associated pneumatic-helium manifolds. Recirculating propellant flow is directed through the engine, gas generator, and through each engine individual return line and return valve back to the LOX tank. This propellant flow through each engine uninsulated return line picks up heat which in turn creates thermal augmentation, thus implementing natural flow. A selector switch signal closing the return valves and gas generator bleed valves is received just prior to S-IC/S-II separation.

2-66. Servicing of Engine System. All servicing of the engine is performed on the ground prior to launch. Servicing of the engine must be performed before it can be operated. The majority of the service disconnections are made on umbilical panel arm No. 3A, except for the LOX pump seal drain which is located 180 degrees from panel arm No. 3A at station 237. Each engine service system disconnection leads to a common manifold which services all engines. Manifold configurations are circular and are rigidly attached to the thrust structure.

2-67. Turbopump and Gas Generator Purge Requirements. Before tanking propellants, the oxidizer turbine seal cavity, fuel turbine seal cavity, fuel pump seal cavity, and gas generator fuel manifold must be purged with gaseous helium. The turbopump purge must be applied for 10 minutes before tanking propellants, and for 10 minutes after cutoff for static test firing. The turbopump purge requires a helium flow rate of 6.0 scfm at a temperature of 70±30°F and a regulated supply source not to exceed 100 psia. The purge removes air and moisture from the cavities, preventing formation of ice when cryogenic propellants are introduced.

2-68. Fuel System Purge Requirements. The engine fuel system should be conditioned prior to tanking propellants. The only substance other than hydrogen that can be left in the system is helium. The purging procedure must insure that the concentration of oxygen in the system is well below the combustible limit which is 4 percent oxygen by volume.

2-69. Thrust Chamber Purge. The engine thrust chamber is purged and chilled to obtain a prestart condition during static tests and prelaunch operations. The purge is required in order to remove the moisture from, and chill, the five J-2 thrust chambers to -150±50°F prior to static firing or launch.

2-70. Start Tank Service Disconnects. The start tank service disconnections on umbilical panel 3A are start tank fill, start tank vent control, and start tank vent.

2-71. The start tank fill disconnection provides a distribution source for gaseous hydrogen to each engine start tank through a fill manifold. The gaseous hydrogen is supplied at a pressure and temperature of approximately 1250 psig and -250°F. To assure adequate cleanliness of the system, the gaseous hydrogen is supplied through a 10-micron filter.

2-72. The engine hydrogen start tank vent control disconnection distributes gaseous helium through the fill manifold to each engine vent control valve at a nominal pressure and temperature of the gas, when delivered, of 400 psig and 70±30°F. The gaseous helium is used to actuate the engine hydrogen start tank vent valve.

2-73. The engine start tank vent and relief disconnection provides a common overboard vent for the engine hydrogen start tank vent and relief valves. A manifold collects and vents to the facility disposal area the gaseous hydrogen vented from each engine hydrogen start tank and prevents accumulation of hydrogen in the engine compartment.

2-74. The engine helium tank filling system distributes pressurized gaseous helium to each engine helium tank. The pressurized helium is delivered through the disconnection at approximately 3000 psia at a temperature of about -250°F.

2-75. The $LH_2$ pump seal drain disconnection is located on umbilical panel arm No. 3A and serves as an overboard outlet for the common manifold. The disconnection provides for venting each engine hydrogen pump seal cavity. It also acts as a common vent for helium discharging during the turbopump purge operation.

2-76. The LOX pump seal drain disconnection is located 180 degrees from umbilical panel arm No. 3A at station 237 and serves as an overboard outlet for the common manifold provided for venting each engine oxygen pump seal cavity. It also acts as a common vent for helium discharging during the turbopump purge operation.

2-77. The liquid hydrogen feed system purge disconnection provides a means for distributing a gaseous helium purge not to exceed 8 psig. Purging of the fuel feed system is performed prior to tanking fuel and after detanking of fuel.

2-78. The liquid oxygen overboard bleed valve disconnection provides a common overboard bleed for the LOX tank feed lines and the gas generator oxygen chilldown bleed valves. Prior to a launch or during a hold, a chilldown bleed is performed to assure that the oxygen is in a liquid state at the pump inlets and gas generator bleed valves.

2-79. The helium injector disconnection provides a source for injecting chilled, gaseous helium into the liquid oxygen system main feed lines during subcooling operations. This backup system is used during ground subcooling operations in conjunction with the oxidizer recirculation system to expedite chilldown of the engine oxygen.

2-80. The $LH_2$ system recirculating manifold collects and returns to the $LH_2$ tank gaseous and liquid hydrogen bled from each gas generator hydrogen bleed valve during the chilldown procedure.

2-81. Engine Operation. During the S-II engine firing period of approximately 390 seconds, the propellants are supplied to the thrust chamber by the turbopumps at a nominal oxidizer/fuel ratio of 5:1 (5 pounds of oxygen to 1 pound of liquid hydrogen). Engine starting, stopping, turbopump starting, and gas turbine operation are all initiated by the electrically controlled sequence controller. Helium is used to purge the system and operate the various sequence valves, and gaseous hydrogen is used to initially start the turbopumps. Bleed lines from each engine supply gaseous hydrogen and gaseous oxygen pressure to the respective propellant tanks ensuring a constant pressure head on each propellant tank as fuel is consumed. The oxidizer turbopump also drives the main hydraulic pump which supplies hydraulic pressure to the engine actuation system servoactuators which position the engine.

2-82. Engine Cutoff. A signal of either low liquid oxygen level or low liquid hydrogen level or a signal from the instrument unit computer will initiate the

...gine cutoff sequence. All five engines shut down simultaneously by the ... of the main-stage solenoid and closing of the ignition-phase control ...valves. Propellant flow ceases, and engine thrust pressure decays. When thrust chamber pressure is lowered sufficiently, gaseous helium enters the liquid oxygen dome through a time-operated solenoid to purge the engines of residual oxygen.

2-83. Engine Failure Detection and Shutdown. Shutdown of one engine during the S-II boost shall be considered to preclude fulfillment of the S-II mission since the stage is not designed for single engine-out capability. However, in this respect, each engine is provided with a failure detection subsystem to detect engine malfunctions and effect safe engine shutdown. The engine failure detection and shutdown subsystem does not depend upon any engine component for its proper operation. A signal for engine shutdown will be transmitted to the applicable pair of propellant tank prevalves located in the liquid oxygen and liquid hydrogen lines upstream of the flexible ducts. Continued operation of the remaining four engines until propellant depletion will depend on manned payload decision.

2-84. LEAK DETECTION AND INSULATION PURGE SYSTEM. The primary function of the leak detection and insulation purge system is to prevent air liquefaction during cryogenic operations. It also provides a means of detecting any hydrogen, oxygen, or air leaks, and diluting and removing leaking gases. (See figure 2-12.)

2-85. Any operation involving $LH_2$ may be extremely hazardous to the vehicle, GSE and personnel; therefore, safe operating techniques and personnel training are of utmost importance. Hydrogen in the presence of oxygen can create a fire or have detonating results. The low temperature atmosphere created by hydrogen will cause air to liquefy and solidify against the $LH_2$ tank if any leak exists in the tank insulation. The organic portion of the insulation can become impact-sensitive when drenched in liquid air or oxygen, resulting in catastrophic failure. Insulation saturated with cryopumped air will add weight to the vehicle and possibly cause damage during defueling because of a pressure buildup created when the liquefied air returns to a gaseous form. Therefore, detection, control, and elimination of any hydrogen system leakages from the vehicle or associated facility is a paramount function, performed by leak detection and insulation purge systems.

2-86. The leak detection and insulation purge system checkout consists of leak testing the $LH_2$ tank, $LH_2$ tank insulation, and the common bulkhead. Also included in the testing is the verification of the leak detection and insulation purge system integrity.

2-87. The areas to be leak-checked are divided into several circuits, each having inlet and outlet disconnection couplings (taps). The tank wall, forward bulkhead, and common bulkhead, must be checked.

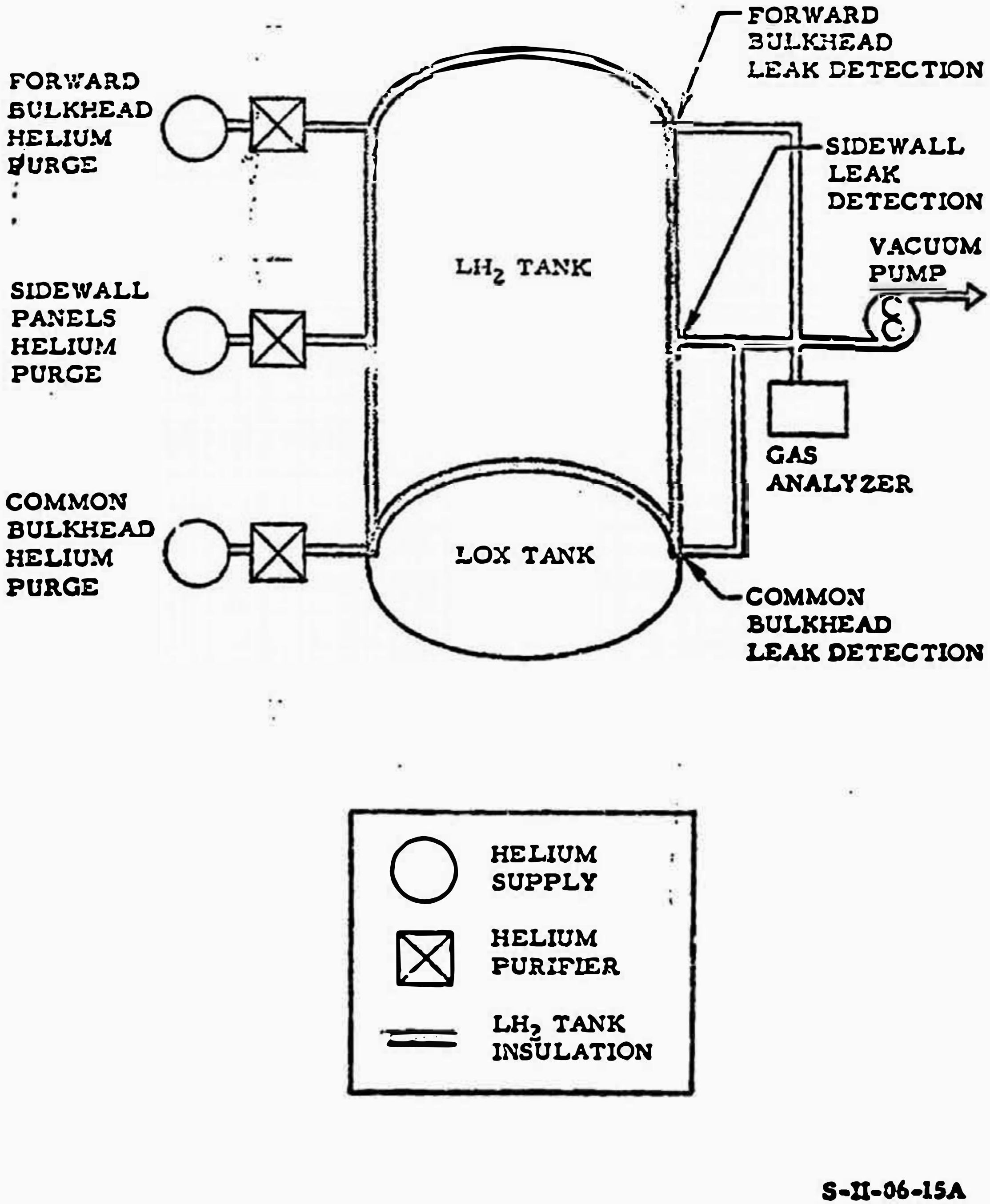



**Figure 2-12. Leak Detection and Insulation Purge System Diagram**

2-88. The hydrogen leak test is performed to verify integrity of the $LH_2$ tank insulation during cryogenic operation. The purge system is used in conjunction with the leak detection system when performing this check. From the initiation of hydrogen loading until launch, the insulation and core of the common bulkhead are continuously purged of hazardous gases. During defueling, the $LH_2$ tank insulation, forward bulkhead insulation, and the common bulkhead are continuously evacuated. A gas analyzer determines the concentration of hydrogen in the purging gases and, consequently, any existing leakage. The evacuation phase is a mandatory function to prevent pressure buildup in the insulation and bulkheads due to the gasification of entrapped condensible gases. The vacuum equipment of the leak detection subsystem will be used for this evacuation. The insulation purge prevents air from entering the insulation and prevents hydrogen, oxygen, and air from entering the common bulkheads. The insulation purge dilutes, removes, and/or reduces the concentration of hazardous gases. This purge and evacuation must be maintained during defueling and until the tank insulation has returned to ambient temperature.

2-89. ENGINE COMPARTMENT CONDITIONING SYSTEM. The engine compartment conditioning system (figure 2-13) provides a means of purging the engine and interstage areas of explosive mixtures and maintains a proper temperature control in critical regions of the S-II aft compartment. Purging of the compartment is accomplished prior to tanking and whenever propellants are on board.

2-90. The purge system consists of a manifold disconnection, a 13-inch diameter purge feed line, an orificed, circular, 10-inch diameter manifold, four thrust cone ducts, four distribution ducts, a thrust structure close-out, and a series of overboard vent holes surrounding the engine compartment and skirt area.

2-91. The purge system disconnection is located near the umbilical connection panel No. 3A. It provides a distribution source for the purge system manifold and ceases to deliver purging gases at lift-off. It will perform under pressures and temperatures of 2.0 psig maximum and 20° to 250°F.

2-92. The purge manifold is made up of a 13-inch feed line and a 10-inch diameter, orificed, circular manifold. The manifold is located below the thrust structure and encircles the center engine but inside of the four outboard engines. The circular manifold contains a sufficient number of circular orifices to properly distribute purging gas. The orifices are located so as to direct the purge in the following boundary areas requiring warming: the area between the thrust structure and the S-II LOX tank, the bottom of the thrust structure including the lower surface of the thrust cone, the aft skirt and interstage between stations 223 and 46, and the top surface of the heat shield. This area will be maintained above -50°F. The area above the close-out should be maintained below -50°F in order to keep structural temperatures low.

2-93. The vent holes are located on the S-II stage under the supporting hat sections on the exterior surface of the aft skirt. This configuration prevents wind, rain, and dust from entering the engine compartment. The vents are so

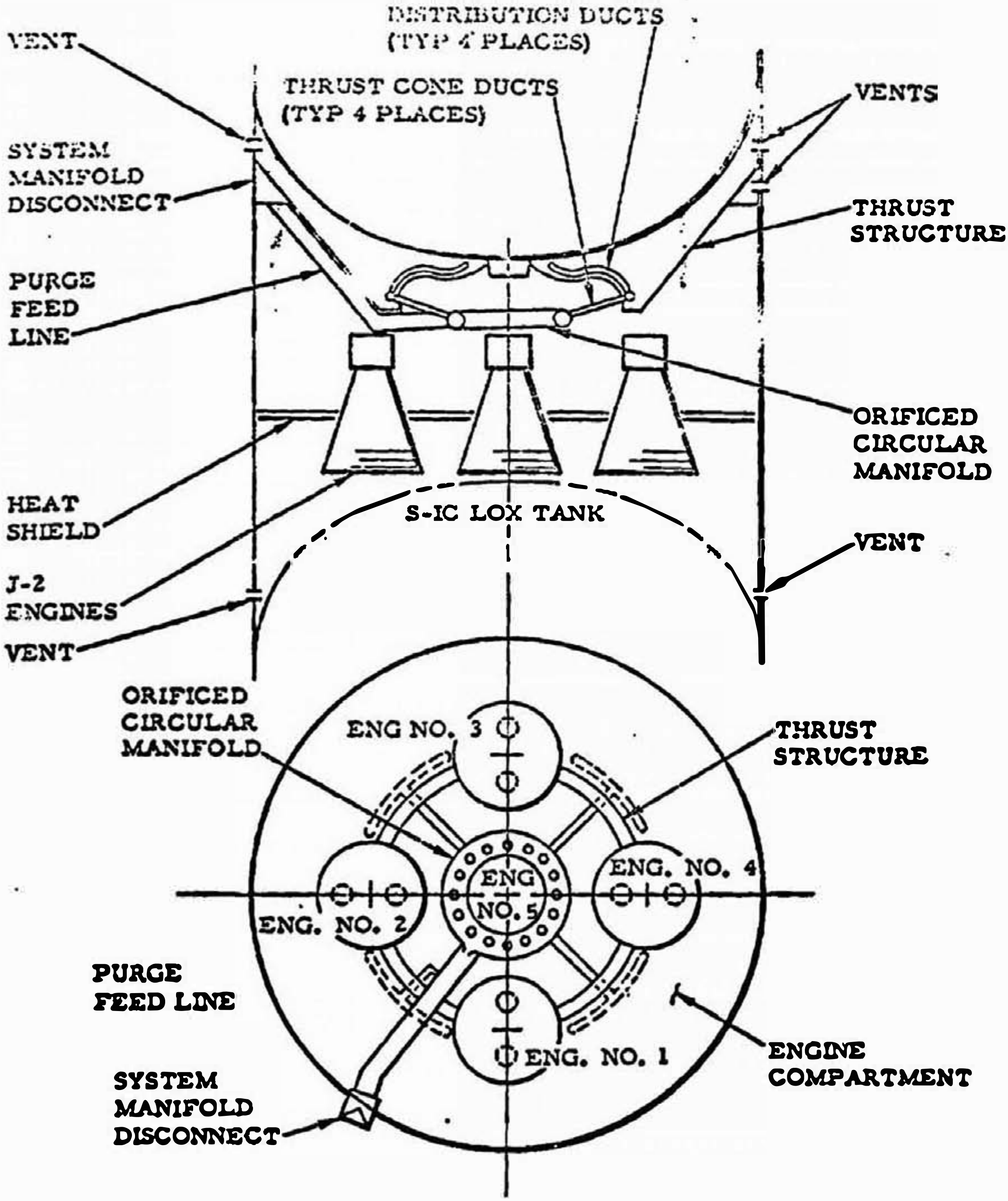



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**Figure 2-13. Engine Compartment Conditioning System Diagram**

sized and located that the gas flow pattern produced is conducive to good thermal control and the expelling of hazardous gases. Although the vent area is minimized so as to exclude air from the engine compartment prior to launch, it is, however, sufficient to prevent an access interstage pressure differential during S-IC boost.

2-94. Purging of the aft skirt and interstage areas is accomplished by introducing warm gaseous nitrogen at a flow rate of 300 to 500 lb/min at a temperature of 80° to 250°F and under a pressure not in excess of 1.5 psig through the 13-inch diameter feed line. The nitrogen is then evenly distributed through the 10-inch diameter, orificed, circular manifold and thrust cone ducts to the temperature sensitive areas. The purging gas then falls into a flow pattern and escapes through the series of vent holes surrounding the compartment. By maintaining a 98 percent nitrogen atmosphere within the compartment, desired temperatures are maintained, and the danger of fire or explosion resulting from propellant leakage is minimized.

2-95. PROPELLANT MANAGEMENT SYSTEM. The propellant management system (figure 2-14) provides control, monitoring and checkout for propellant utilization functions, propellant loading, propellant mass indication, and a propellant depletion engine cutoff signal. The propellant management system is comprised of the following subsystems:

- Propellant utilization
- Propellant loading
- Propellant mass indication
- Engine cutoff
- Propellant level monitoring

2-96. Propellant Utilization System. The main function of the propellant utilization subsystem is to coordinate propellant flow rates in such a manner that both propellants will tend to be depleted simultaneously. This system provides closed-loop control of the engine mixture ratio for minimizing propellant residuals. The propellant utilization bypass valve located at the liquid oxygen turbopump outlets provides control of liquid oxygen usage as referenced to remaining liquid hydrogen. Control of the engine mixture will increase stage payload capability. The propellant utilization subsystem is integrated with the propellant loading subsystem, sharing the full length tank probes and certain of the ground checkout and monitoring equipment.

2-97. Propellant Loading System. The main function of the propellant loading system is to control loading and maintain propellants at any predetermined quantity. During tanking, the full length capacitance probes sense liquid mass in the tanks. Discrete liquid-level point sensors are used to monitor propellant liquid levels. A ground-based computer will be used to control propellant loading. The full length probes provide low level signals to an airborne propellant management computer. This airborne computer provides 0 to 28 volt d-c signals to a

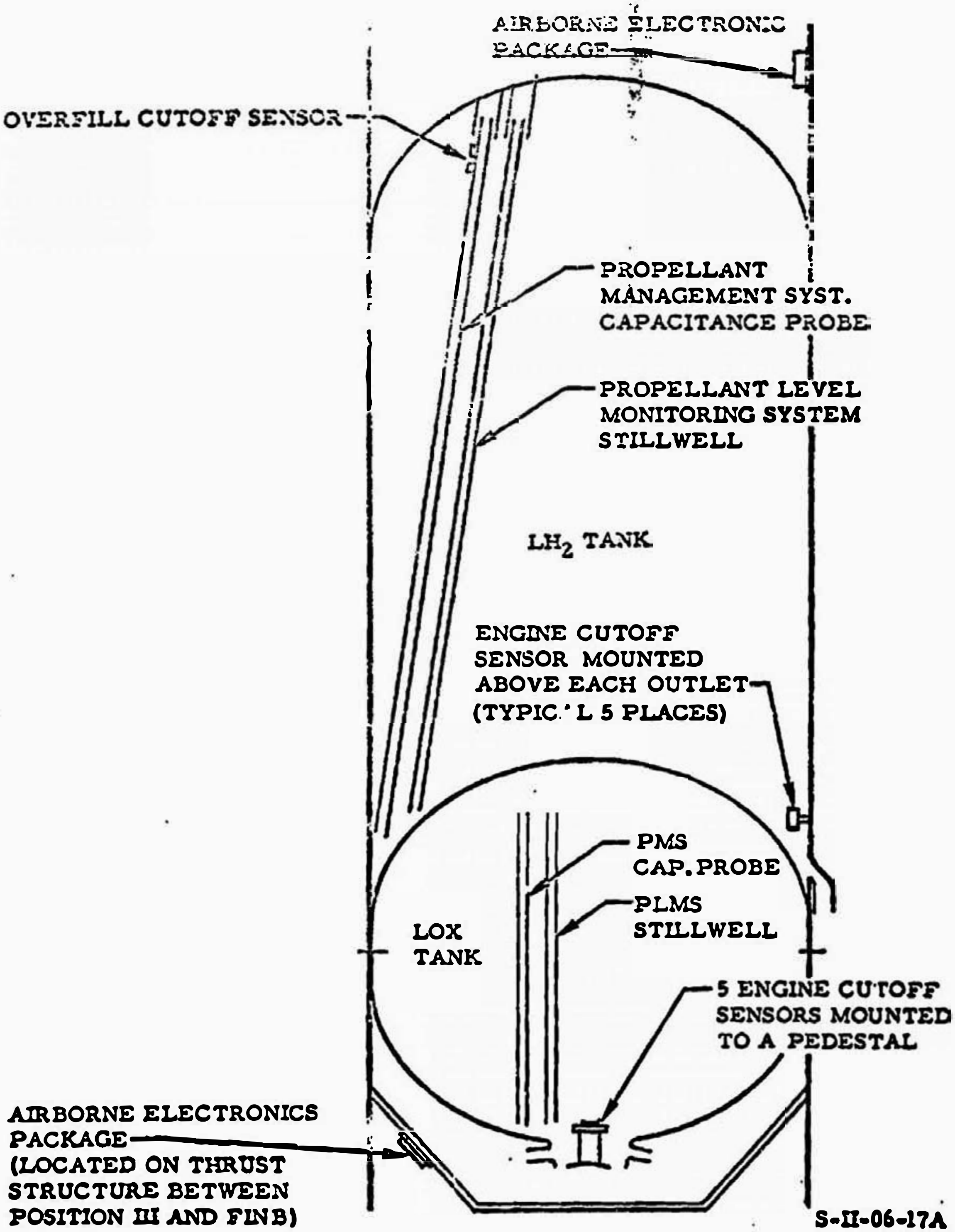



Figure 2-14. Propellant Management and Propellant Level Monitoring System Diagram

ground-based signal conditioner (filter) and the loading control. The order of propellant loading is LOX first and then $LH_2$. LOX is pumped from ground storage tanks to the stage. $LH_2$ is transferred to the stage by pressurizing the $LH_2$ storage tanks with $GH_2$. Initial tanking is accomplished at a slow rate to allow for tank chilldown. The $LH_2$ tank is chilled before LOX loading to minimize structural stresses. Operations for propellant loading are accomplished through the umbilical tower. Each tank will have been purged prior to the introduction of cryogenic fluids. The sensors will be of the hot wire (gold-plated platinum) resistance type. Sensing transducers are located in the tanks, and associated solid-stage electronic controllers are located in electrical containers outside the tanks. The controllers provide a power source for the transducers and detect the change in resistance of the sensing element as the transducer passes from liquid to gas, or from gas to liquid. The principle of operation is based on the following:

a. The sensing element wire resistance is a function of the wire temperature for a given length and diameter.

b. Liquids provide a greater rate of heat transfer than vapor or gas.

2-98. When the heated sensing element is wetted by a liquid, the increased heat transfer results in a decrease of wire temperature, which is indicated by a drop in measured resistance. Separate controllers are used to monitor liquid oxygen, liquid hydrogen, and water, since no adjustment is provided to compensate for the different heat transfer rates of each fluid. Changes of resistance are converted to on-off 28 volt d-c signals by the controllers located in the electronics package and sent to propellant system GSE which controls the loading through the loading valve complex and associated facilities. Controls in the system have the capability for loading to the 5, 10, 20, 40 and 80 percent levels. The fast-fill cutoff backup signal, which is at the 98 percent level, and the overfill signal for each tank are provided by discrete liquid-level sensors which are mounted on the outside of the propellant management system capacitance probes.

2-99. Propellant Mass Indication System. The propellant mass indication signal system is integrated with the propellant loading system and will be utilized for the flight telemetry system. Discrete sensors will be used to determine propellant levels, and temperature sensors, provided by the pressurization system, will be used to determine propellant density and ullage temperature profiles.

2-100. Engine Cutoff System. The main function of the engine cutoff system is to provide a signal to signify the depletion point of either propellant. This system is an independent system and consists of five hot-wire sensors in each propellant tank plus associated electronics. The $LH_2$ cutoff sensors are located above each tank outlet while the LOX cutoff sensors are located directly over the sump. The cutoff sensors will initiate a signal to shut down the engines when two out of five engine cutoff signals from the same tank are received. The system will, however, ignore any cutoff sensors that have failed prior to the end of the S-II boost.

2-101. Propellant Level Monitoring System. The propellant level monitoring system is not considered a control-type system, but it has the following capabilities:

- Provides calibration checkpoints for the continuous capacitance probe used in the propellant management system.
- Monitors propellant levels during S-II firing.

2-102. These functions will be performed by hot-wire sensors mounted on a continuous stillwell. These stillwells are adjacent to, and parallel to, the continuous capacitance probe in each tank. The monitoring point sensors for the propellant level monitoring system total 14 and will indicate 0.5, 1, 2, 3, 5, 10, 20, 40, 60, and 80 percent levels, the 100 percent unpressurized level and upper limit no-go, and the 100 percent pressurized level and lower limit no-go.

2-103. Propellant Tank Purging. After the propellant tanks are cleaned and the tank personnel entry/exit closures are installed, both tanks must be purged of ambient air to expel latent moisture and/or gases incompatible with cryogenic propellants. Additionally, purging of certain propellant valves and plumbing is accomplished either concurrently with purging of the respective tanks, or immediately prior to introduction of the cryogenic fluids.

2-104. Purging of the liquid hydrogen tank requires the use of special GSE to control and monitor flow of the purge gas (gaseous helium). GSE purge gas control valves and tank inlet and outlet valves are positioned to establish (through the tank) a purge gas flow rate of approximately 6500 cubic fpm. The flow rate is maintained until periodic samplings of the tank atmosphere indicate that all moisture and contaminants have been expelled from the tank, associated valves, and plumbing. At the conclusion of the purge gas flow, the tank outlet valves will be closed and purge-gas tank pressure permitted to rise to between 2 and 8 psig. After the tank is pressurized, the purge-gas inlet valves are closed and the tank pressure is permitted to stabilize. This condition will be maintained until the initiation of cryogenic tanking.

2-105. Purging of the liquid oxygen tank requires the same general procedure as that required for the liquid hydrogen tank. Purge gas flow (gaseous nitrogen) through the liquid oxygen tank is required to reduce the moisture content to a level corresponding to a dew point of -60°F prior to closing the outlet valves and starting the purge gas pressure buildup. The pressurizing and differential pressure-hold are the same for the liquid oxygen tank and the liquid hydrogen tank. Propellant loading will be accomplished through chilldown, main fill, slow fill, and topping sequences.

2-106. Chilldown. The propellant loading sequence begins with the LOX chilldown phase on signal from the propellant-fill ready light. Chilldown flow rates for the tanks during initial fill (0 to 5 percent tanked propellant mass) are 500 gpm for

OX and 1000 gpm for $LH_2$. When the 5 percent level is indicated by the appropriate sensor in the tanks, the main fill phase begins.

2-107. Main Fill. Stage propellant line pressures during main fill (5 to 93 percent tanked propellant mass) are 53 psig for LOX and 28 psig for $LH_2$. Propellant flow rates during main fill are 5000 gpm for LOX and 10,000 gpm for $LH_2$. When the 93 percent level is indicated by the appropriate sensor, the slow fill phase begins.

2-108. Slow Fill. Slow fill rates (93 to 100 percent tanked propellant mass) are 1000 gpm for LOX and 1000 gpm for LH2.

2-109. Topping. The replenish valve maintains the propellants at the 100 percent level by establishing fill rates equal to boil-off rates. To hold the propellants at the 100 percent level, flow rates are 0 to 200 gpm for LOX and 0 to 500 gpm for $LH_2$. At no time will the tanked propellant mass be permitted to go beyond the 101 percent level. When the 101 percent level is reached an independent sensor will cause the replenish valve to close until the 100 percent level is reached. If the propellant level should drop below the 98 percent level during the replenish phase, the slow-fill valves will be opened and the 100 percent level re-established.

2-110. Emergency Drain. Flow rates for draining propellants from the tanks are 3300 to 3360 gpm for LOX and 6600 to 6674 gpm for $LH_2$.

2-111. MEASUREMENT SYSTEM.

2-112. The S-II stage measurement system consists of instrumentation, telemetry, and radio frequency subsystems. The instrumentation subsystem conditions the performance signals from the vehicle and presents these and the preflight and flight calibration electrical signals to the telemetry subsystem. In flight, the telemetry subsystem multiplexes the signals from the instrumentation subsystem and transmits them to the ground receiving stations for real time and postflight vehicle performance evaluation. The instrumentation subsystem consists of transducers, signal conditioners, patch panels, interconnecting wiring, systems calibrator, and the required auxiliary equipment such as converter chassis, transducer environmental control assemblies, etc. Signal conditioners and transducers are located throughout the stage. Patch panels are located in the aft skirt area.

2-113. The telemetry subsystem comprises three types of telemetry which are suited to the various types of data obtained from the vehicle systems. The three major telemetry subsystems are as follows:

- PAM-FM/FM for low-to-medium frequency content data

- SS/FM for high-frequency data transmission of acoustics and vibration data
- PCM for the automatic checkout of the S-II stage

2-114. These telemetry subsystems are complemented by auxiliary equipment such as telemetry calibration equipment, FM-FM telemetry chassis, RF power amplifier equipment, and specialized power supplies. The FM-FM telemetry time division multiplexers and calibrators chassis are all located in the forward skirt area.

2-115. In addition to telemetry and instrumentation, it is necessary to maintain radio frequency links between the S-II and the ground at all times during flight. All instrumentation required for this purpose is included in the S-II radio frequency (RF) subsystem and consists of the necessary airborne antennas, dual radio command receivers, and a tracking aid transponder. The systems are known as the telemetry antenna system, UHF radio command system, and the MISTRAM tracking aid system.

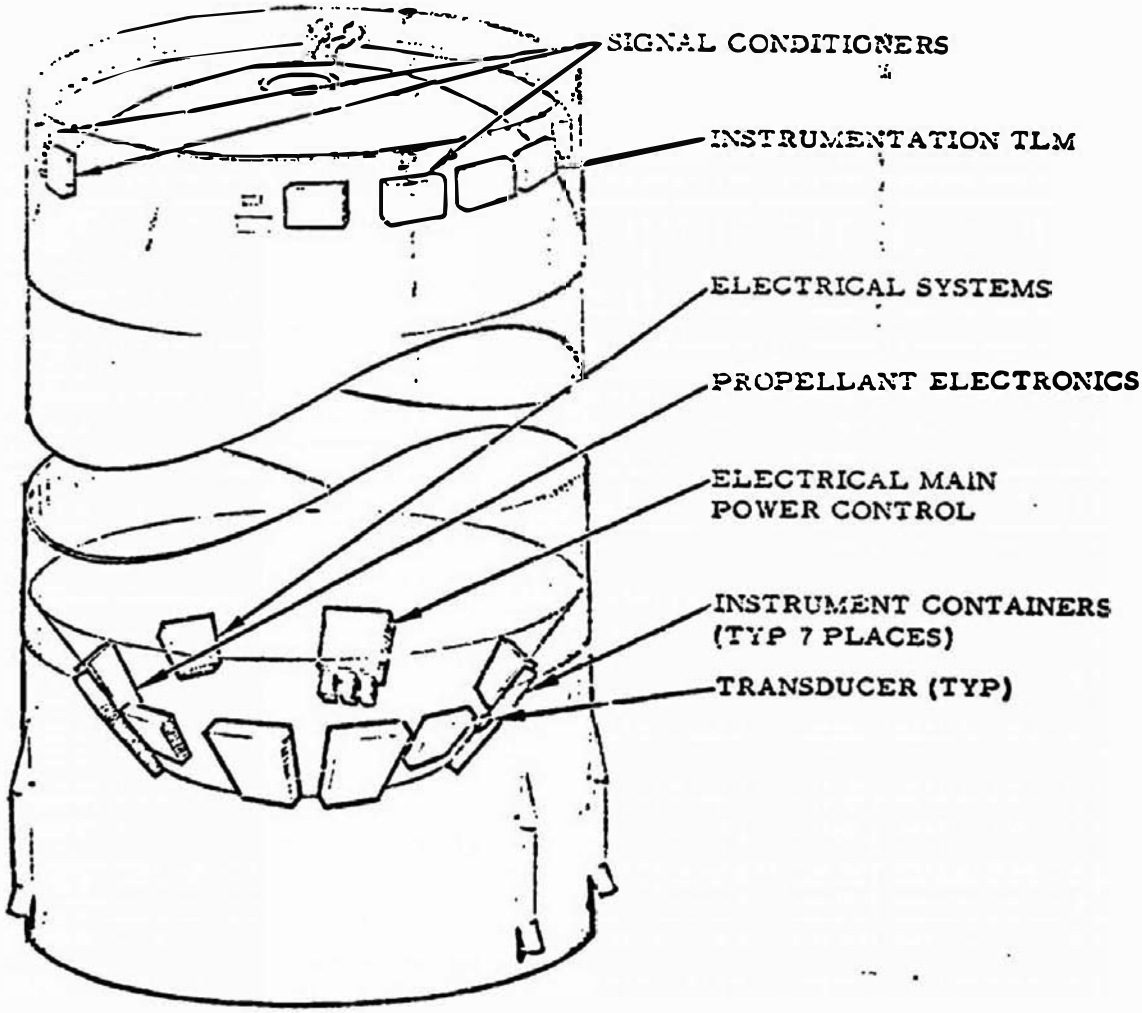
2-116. TELEMETRY SYSTEMS. Three basic types of telemetry subsystems (figures 2-15 and 2-16) are provided for three basically different types of data requirements: PAM-FM/FM for airborne telemetering measurements of vehicle system parameters of relatively low-frequency content, SS/FM for airborne telemetering of relatively high-frequency measurements, and PCM for ground telemetering by direct wire of measurements required for automatic checkout of the S-II vehicle.

2-117. Measurements carried by a PAM-FM/FM subsystem are treated in the following ways:

a. The majority of measurements are sampled by commutators to form time-division multiplexed signals. Each such signal modulates a voltage-controlled subcarrier oscillator.

b. The remaining measurements continuously modulate voltage-controlled subcarrier oscillators. The outputs of all subcarrier oscillators in one PAM-FM/FM system are combined to form the modulator input signal of an RF transmitter.

2-118. Each PAM-FM/FM telemetry subsystem includes a maximum of three packages. One package is the time division multiplexer. The second package contains the FM multiplexing equipment, which accepts 0 to 5 volts dc and signals, including the time division multiplexer output, and produces a mixed audio signal for the transmitter modulation input. The multiplexers contain power supplies and voltage regulators necessary for operation on 28-volt d-c power. The third package includes the RF power amplifier and power supplies required for operation of the transmitter and power amplifier.

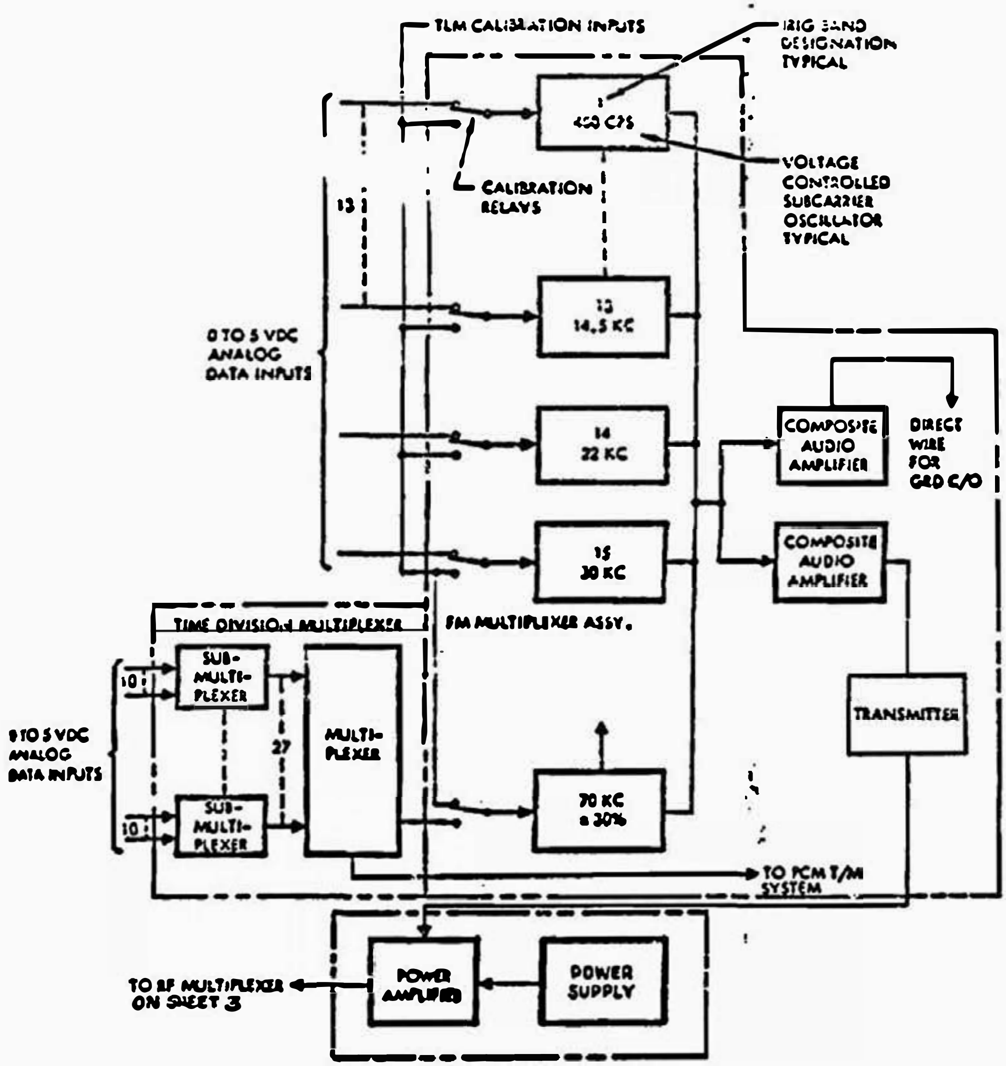



| TELEMETRY SYSTEMS | MAX DATA FREQUENCY |
|---|---|
| (3) PAM FM - FM | 0-25 CPS |
| (2) SINGLE SIDEBAND | 25-3000 CPS |
| (1) PULSE CODE MODULATION | ———— |

S-II-01-36

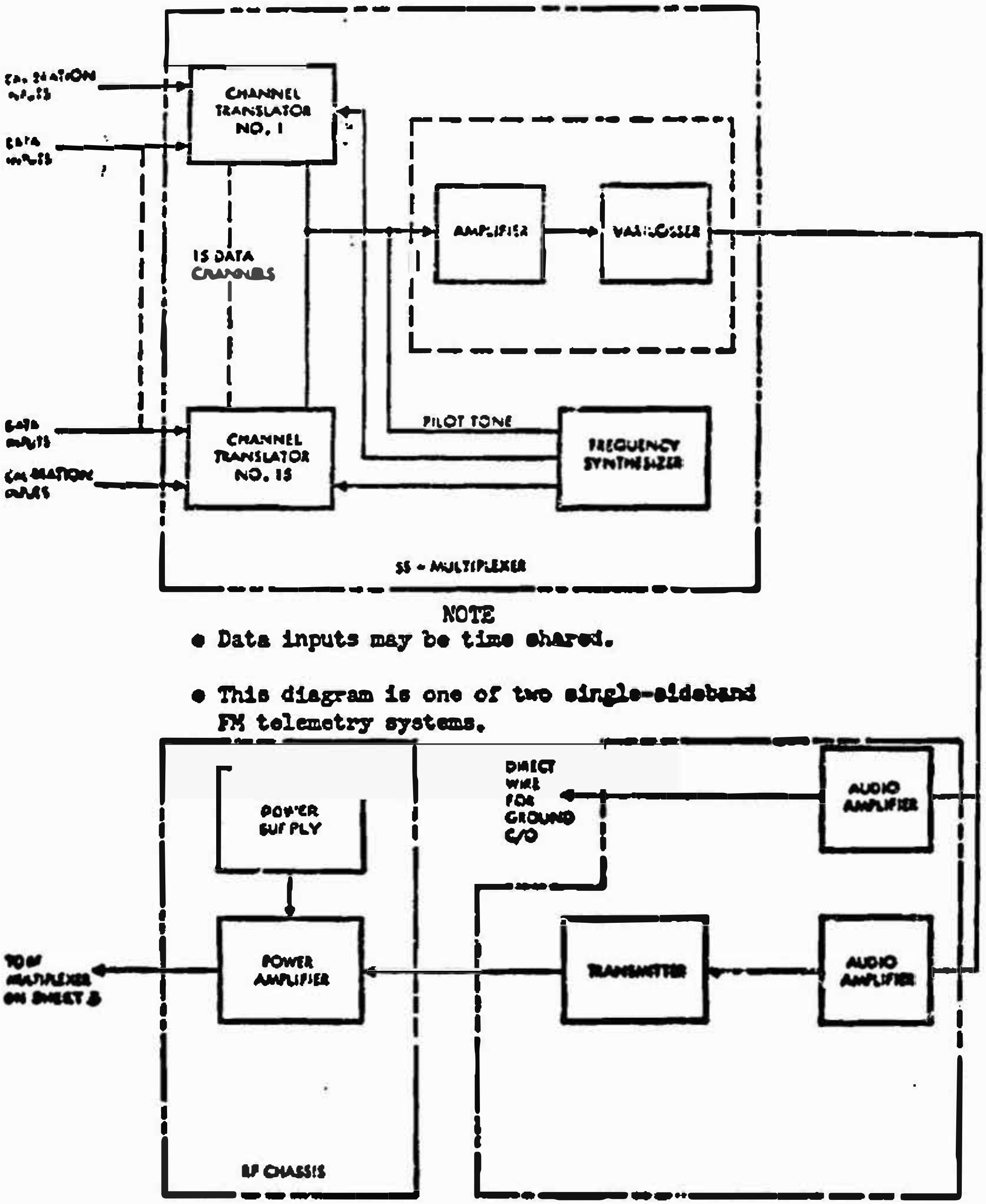
Figure 2-15. Telemetry Systems

NOTE
This diagram is one of four typical
PAM-FM/FM Telemetering Systems




S-II-01-6

Figure 2-16. Telemetry System Block Diagram (Sheet 1 of 3)




S-II-01-9

Figure 2-16. Telemetry System Block Diagram (Sheet 2 of 3)

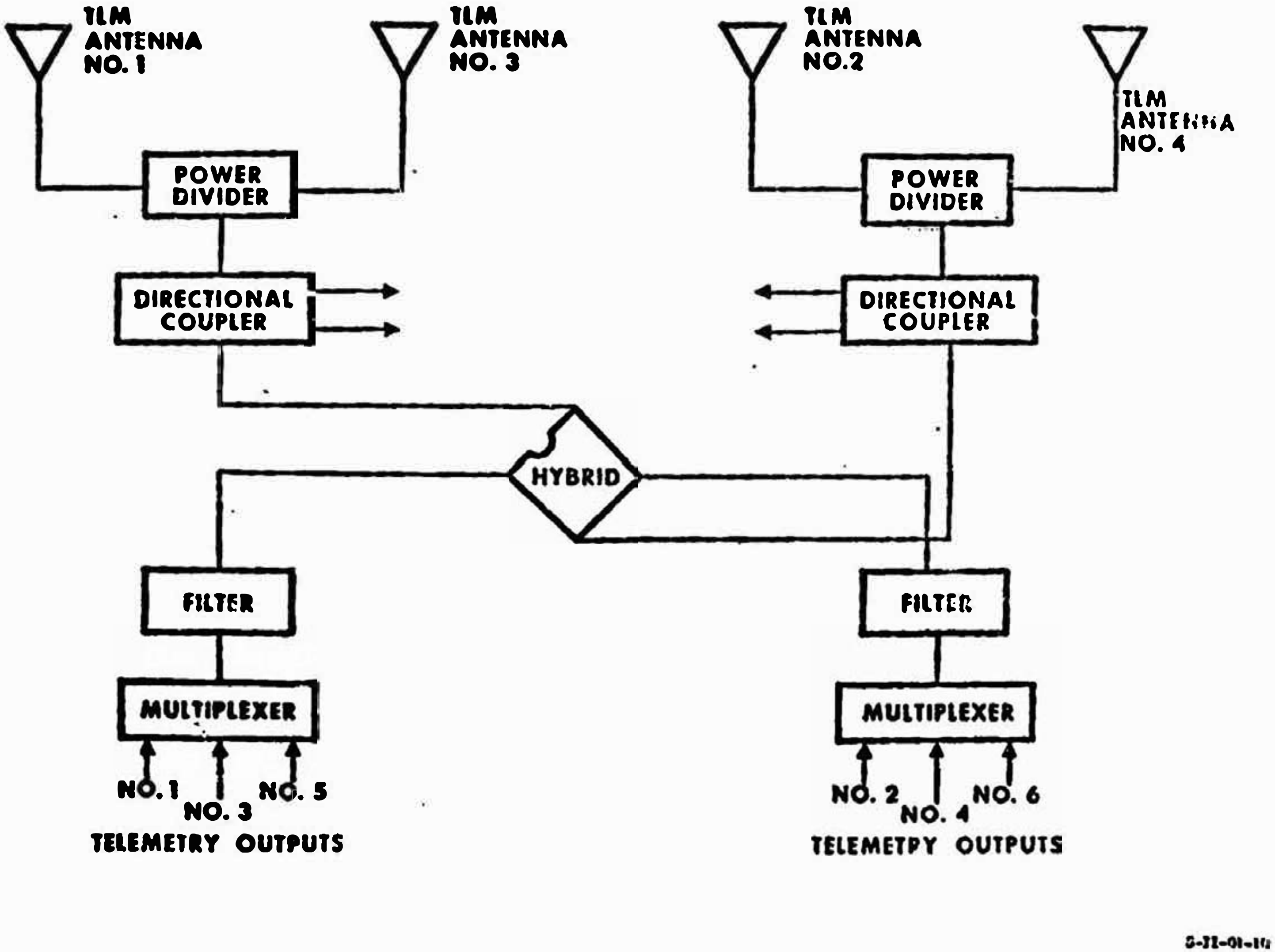



Figure 2-16. Telemetry System Block Diagram (Sheet 3 of 3)

2-119. INSTRUMENTATION SYSTEM. The instrumentation system includes transducers and signal conditioners. It senses vehicle performance parameters and feeds signals to the telemetering system. The output of the vehicle transducers and/or signal conditioners is fed to a high-level (0 to 5-volt d-c) telemetering system for transmission to the ground. Each measurement pickoff is listed in table 2-1.

Table 2-1. S-II Stage Measurements

| Sensor | Description |
|---|---|
| Pressure | Potentiometer and/or d-c to d-c type transducers consisting of a strain gage or reluctance pickup and using solid-stage integral electronics will be used for all pressure measurements. These devices, excited by 28 volts dc, produce a high-level signal (0 to 5 volts dc) output. Where an environmental condition consisting of extreme temperatures exists, potentiometer pressure pickups are used; d-c to d-c type transducers are utilized on all hydraulic pressure measurements. |
| Temperature | Platinum resistance probes are used for most temperature measurements. |
| Flow | The liquid hydrogen and liquid oxygen flow rates for each engine are measured by volumetric flowmeters producing electrical output pulses which are a function of the angular velocity of a rotating vane installed in the fuel lines. Both rate and quantitative data can be obtained. |
| Vibration | Piezoelectric vibration pickups with associated transistorized amplifiers are used for flight application. |
| Noise | The systems for measuring noise are similar to those used for measuring vibration. Piezoelectric transducers are used for flight application where frequencies from 50 cps to 3 kc are to be observed. |

Table 2-1. S-II Stage Measurements (Cont)

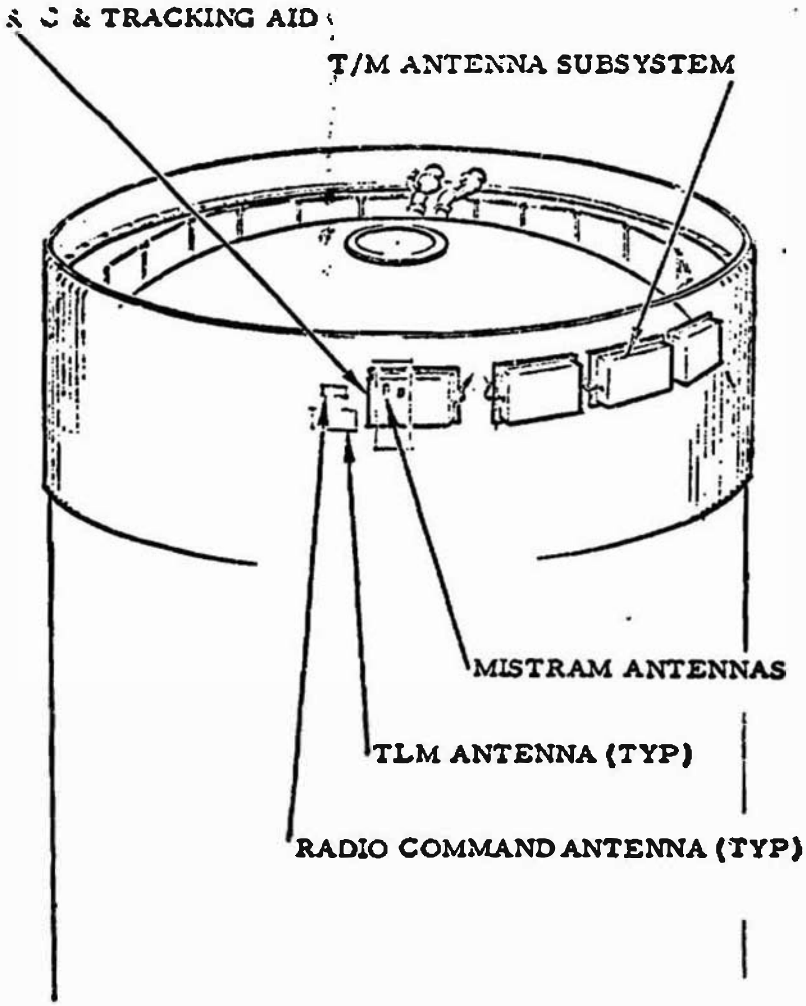
| Sensor | Description |
|---|---|
| Position | Flight control system position measurements are obtained from the control loop pickoffs. Other position measurements use reluctance devices. These devices are provided with solid-state electronics to develop a high-level 0 to 5-volt d-c signal. |
| Acceleration | Vehicle acceleration measurements are made using both reluctance and strain gage low-frequency response accelerometers. These instruments are self-contained, single-packaged units, using solid-state electronics to develop a high level 0 to 5-volt d-c output. |
| Residual liquid level | Eight liquid-level point sensors are located in the lower 5 feet of each propellant tank to determine the residual fuel and liquid oxygen at engine cutoff. |

2-120. ANTENNA SYSTEMS. Antennas provided on the S-II stage are flush-mounted one above the other on the forward skirt. (See figures 1-4, 2-16, and 2-17.) Antenna systems are provided for the following:

- Telemetry subsystem
- Command destruct subsystem
- MISTRAM tracking aid subsystem

2-121. The telemetry antenna system as well as the radio command antenna system must provide omnidirectional coverage. To meet this requirement, the antennas for each system will be installed at 90-degree intervals around the forward skirt. Both systems employ linear cavity-backed slot antennas which mount flush to the skirt skin. Each telemetry antenna measures approximately 30 x 5 x 9 inches and weighs approximately 18 pounds. A radio command antenna measures only 9 x 3 x 6 inches and weighs approximately 7 pounds. The radio command antennas will operate between 405 and 450 megacycles during flight to provide sufficient coverage for ground control of flight termination.

2-122. The telemetry antenna system must be capable of accommodating up to six telemetry carriers which will be within the 225 to 260-megacycle band. Four RF links will be by PAM-FM/FM telemetry. These four pulse amplitude modulation systems will be identical except for the RF output frequencies which will be in the 225 to 260-megacycle band. Each system will have an input




| RADIO FREQUENCY SYSTEMS |
| --- |
| DUAL COMMAND-CONTROL-UHF<br>TRACKING-MISTRAM<br>ANTENNAS - (3) TELEMETRY;<br>(2) TRACKING;<br>(4) COMMAND |

S-II-01-35

Figure 2-17. Antenna System Installation capability of 15 continuous channels and 270 commutated channels. These inputs will be in the form of 0 to 5-volt d-c analog signals. High-frequency data, such as vibration and acoustics, will be sent by SS/FM RF link via a single-sideband telemetry system. Each of two systems has an input capability for 15 continuous channels and will transmit this data within the 225 to 260-megacycle band.

2-123. The MISTRAM transponder is located in the forward skirt area opposite the tunnel and operates with four separate frequencies simultaneously: two receiving and two transmitting. Two separate antennas (side by side) will perform this function to provide adequate tracking coverage.

2-124. THERMAL CONTROL SYSTEM.

2-125. The thermal control system is a ground operated system for providing proper temperature control for the equipment containers in the forward and aft skirt areas. (See figure 2-18.) Two completely separate systems are provided for delivering a constant tempered air or nitrogen flow to the equipment containers. One system is for the forward skirt area and the other is for the engine compartment area. Tempered air is used to cool and heat the containers prior to propellant loading. Preparation for loading includes changing from air to nitrogen for container inerting. The nitrogen flow is terminated at liftoff, and the container insulation maintains equipment temperatures throughout the S-II flight trajectory.

2-126. Each separate system (forward skirt and engine compartment) contains a single manifold interconnected to each container, individual fixed-flow orifices to each container, and individual relief holes from each container. Within each container is a temperature transducer interconnected to a ground telemeter to provide temperature monitoring until lift-off. All plumbing contain thermal insulation. Container insulation and thermal inertial preclude excessive temperature changes on containers exposed to base heating.

2-127. In operation prior to propellant loading, filtered air flows through each separate disconnect and manifold where fixed orifices control flow to each container. Air enters the container, is heated by the operating equipment, and exits through the container relief holes. All air exits from the container and dissipates in the forward skirt and interstage areas. Minutes before propellant loading, the air is changed to nitrogen, with flow the same as air. Nitrogen is used to insure that all oxygen is expelied from the container in the interstage area. If necessary, nitrogen or air can be heated by ground heaters to maintain temper re in an allowable range until lift-off.

2-128. FLIGHT CONTROL SYSTEM.

2-129. S-II flight control is accomplished by manipulating the four gimbaled rocket thrust engines as required for thrust vector control. Manipulating is accomplished by hydraulic-powered actuators whose action is controlled by

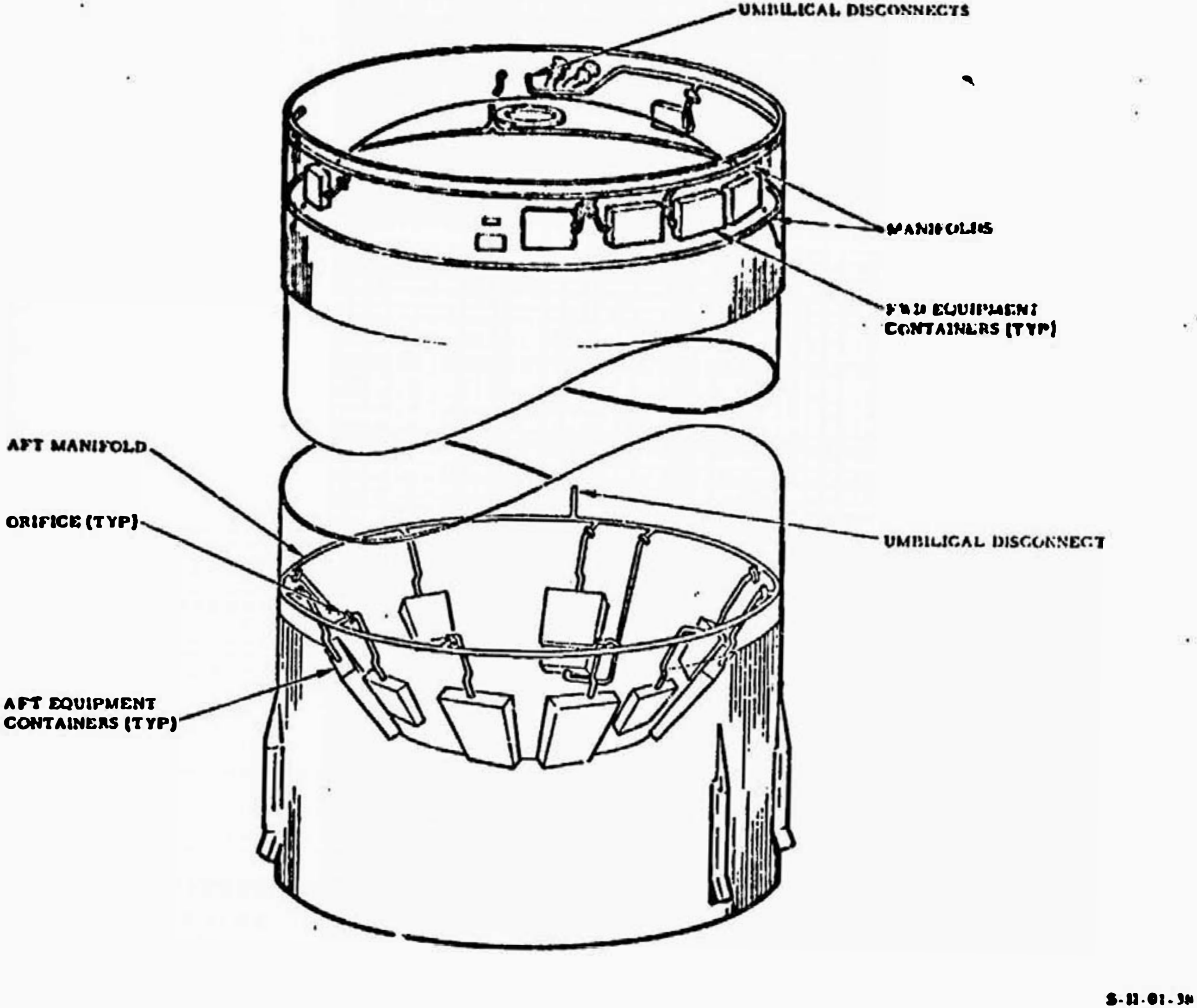



Figure 2-18. Thermal Control System

electrical signals generated by the flight control computer located in the instrumentation unit (IU) above the S-IVB stage. (See figure 2-29.) Hydraulic power for operating each of the actuators is supplied by individual turbine-driven hydraulic pumps (one for each engine).

2-130. FLIGHT CONTROL ELECTRONICS. During flight, the Saturn V guidance system continuously determines an optimum vehicle steering command based on vehicle position, velocity, and acceleration. The guidance signal processor, located in the instrument unit (IU), delivers guidance position error signals to the flight control computer, also within the IU. The signals are shaped, scaled, and summed with shaped and scaled rate information from the rate gyros in the IU or in the S-II stage. These summed error signals are then directed to the appropriate servoactuator amplifiers which, in turn, drive their respective servo valves in the S-II stage. The actuator servo valves convert the electrical error signals into hydraulic forces causing actuator positioning. The rate gyros, located in the IU, supply the rate at which the vehicle attitude changes, in incremental form, to prevent oversteering or understeering by the engine actuation system.

2-131. ENGINE ACTUATION SYSTEM. The S-II stage is provided with a separate hydrualic power supply system for each of the four gimbaled J-2 rocket engines. Together, these hydraulic systems comprise the engine actuation system. Each hydraulic system is a self-contained, closed-loop, stage-mounted system operating under a pressure of 3650 psi and contains the following major components:

- One engine-mounted main hydraulic pump
- One electrically driven structure-mounted auxiliary hydraulic pump
- One accumulator reservoir manifold assembly (ARMA)
- Two servoactuators

2-132. The components of each system are primarily stage-mounted in a single container. These containers are mounted to the thrust structure above each gimbaled engine. Each main hydraulic pump is mounted to, and driven by, the liquid oxygen turbopump on the corresponding engine. The auxiliary hydraulic pump is used only during checkout and to maintain a warm fluid just prior to launch. The auxiliary pump cannot operate in flight. Two servoactuators for each engine provide the necessary forces and support to accurately position the engines in response to the flight control systen signals. One actuator is positioned on the pitch plane and one on the yaw plane. Each actuator is a servo-controlled unit of the double-acting, balanced-piston type, with mechanical feedback to the servo valve. The actuator will actuate each engine ±7 degrees from the vehicle centerline at the rate of 8 degrees per second. The ARMA is a hydropneumatic unit composed of an accumulator, a reservoir, a manifold, filters, and relief valves. Both hydraulic pumps are of the variable-displacement, pressure-compensated, multiple-piston type. The main pump operates at 3650 psi; the auxiliary pump, between 3000 and 3650 psi.

2-1[illegible]5. Hydraulic oil is supplied from the reservoir to the two pumps under a positive pressure. During J-2 engine operation, hydraulic oil, under pressure, is routed from the main pump to the pressure manifold of the reservoir-accumulator. This manifold distributes hydraulic pressure within the reservoir system to the accumulator, high-pressure filter, and relief valve. Pressure is also directed to the two actuators which are mounted between the thrust structure and the engine. Actuator return fluid is returned to the reservoir through the return filter. Provided in the return manifold is a low-pressure relief valve which is disabled by capping its vent prior to launch.

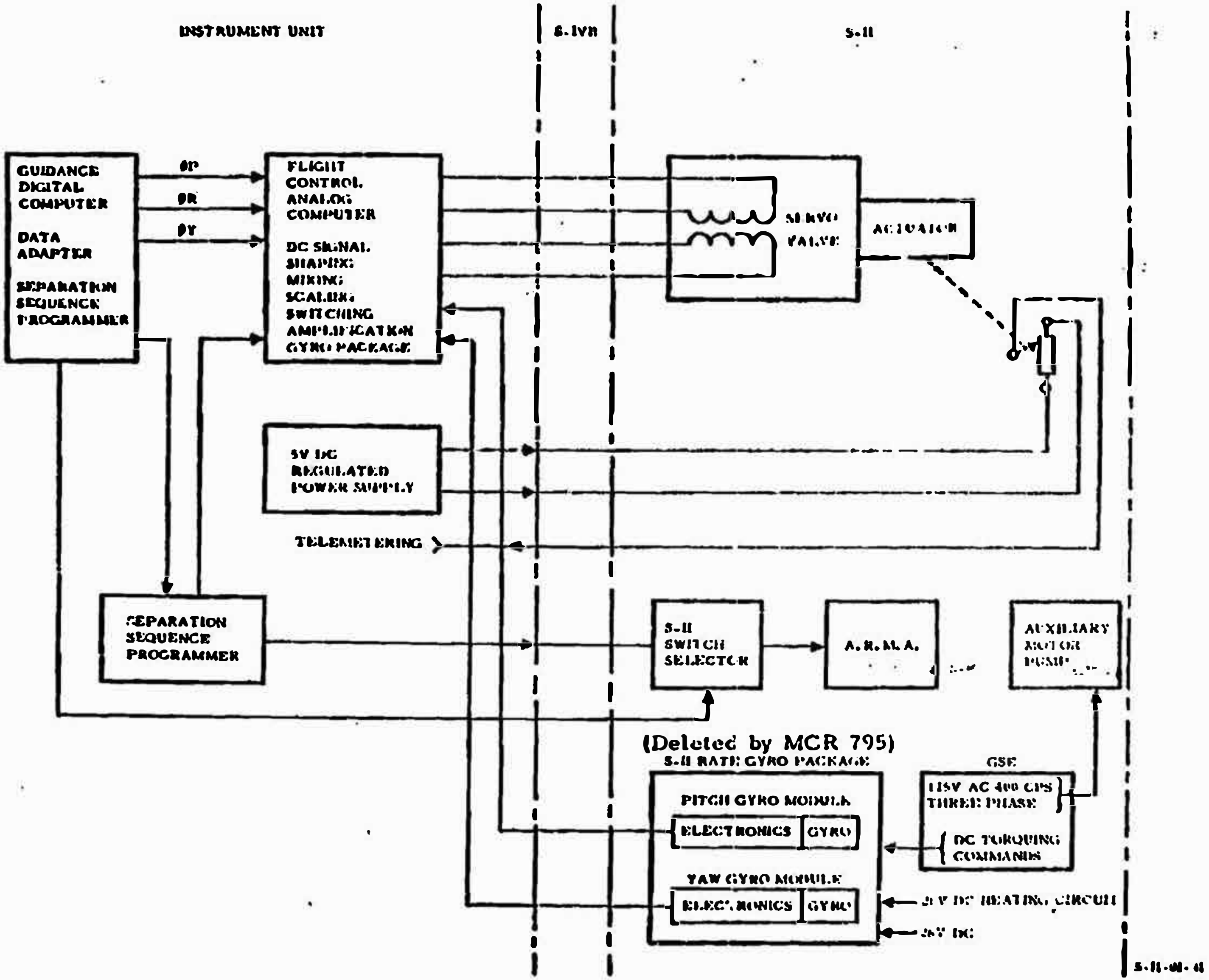



Figure 2-19. Flight Control System

SM-S-II-61

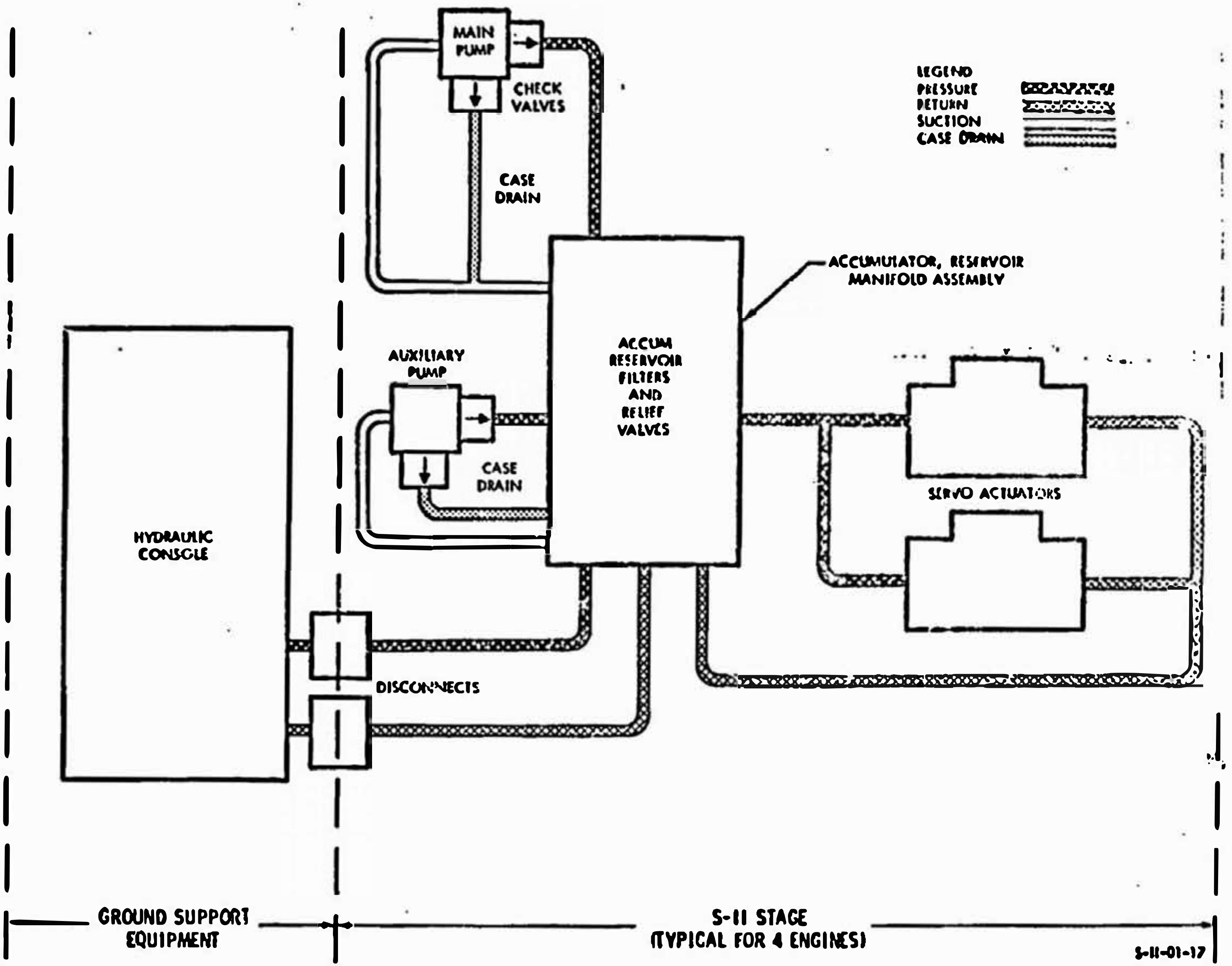



Figure 2-20. - Engine Actuation System Block Diagram

# SECTION III

## S-II GROUND SUPPORT EQUIPMENT

3-1. During all phases of S-II handling and servicing, specific types of ground handling equipment are required. Ground support equipment used with the S-II stage are of four types:

a. Checkout equipment, manual and automatic, which is used to control and monitor stage test and checkout operations

b. Servicing equipment which is used to service the stage during the same operations

c. Handling equipment which is used to transport the stage and stage components during transportation, test, and maintenance operations

d. Auxiliary equipment which is used to support automatic checkout and servicing equipment

3-2. Each unit of equipment is explained in further detail as to function and placed in chart form under the specific equipment name and model designation.

3-3. AUTOMATIC CHECKOUT EQUIPMENT. This equipment is the most complex of all ground support equipment. The automatic checkout is divided into test stations and a controlling computer complex. In the automatic mode of operation, the computer complex sends control signals to the stations to apply stimuli to the stage.

3-4. Five checkout stations operate manually, or automatically, to monitor and control the various stage systems during checkout. While in the automatic mode of operation, a computer complex is employed to control station operation. The checkout equipment (stations) are grouped into the following functional areas:

a. Telemeter checkout station. The telemeter checkout station, which consists of 10 racks, permits checkout of the FM/FM and SS/FM telemetry systems.

b. Electrical checkout station. The electrical checkout station, which consists of seven racks, permits checkout of stage electrical power and control systems.

c. Mechanical checkout station. The mechanical checkout station consists three racks and provides hydraulic and pneumatic control for various stage systems.

d. RF systems checkout station. This station, which consists of one rack, checks out the UHF radio command system.

e. Digital data acquisition station. This station, which consists of four racks, converts stage measurements from binary coded form received from PCM systems into binary-coded decimal form for display by other checkout stations.

3-5. A table has been provided to cover all facility checkout equipment and station equipment to indicate the performance function of each unit and rack where applicable. (See table 3-1.)

3-6. Checkout Equipment. Automatic checkout ground support equipment is used for the checkout of the S-II stage at the MTF under the jurisdiction of Space and Information Systems Division. The purpose of the equipment is twofold in nature. The primary use is for malfunction isolation, checkout, and certification of the S-II stage. The secondary purpose is to obtain greater confidence in checkout through a more thorough checkout, elimination of human errors, and maintaining complete records. A third purpose is to maintain the same configuration for the equipment at all checkout stations. All or portions of the ground support equipment is used to control the S-II stage, apply a stimulus, record and evaluate test data during static firing tests, individual systems checkout (i.e., all systems test). Table 3-1 lists the checkout equipment utilized at all the facilities.

Table 3-1. Checkout Equipment

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Automatic checkout program set | C7-2 | Provides all digital computer instructions (program tapes) as required for particular stage systems. A separate program set will be provided for each functionally different stage checkout. |
| Staging area cable installation | C7-26 | Connects GSE to computer complex, also to connect GSE to S-II stage. |
| Electrical cable tester | C7-28 | Used to test cables which interconnect stage component checkout GSE. |

Table 3-1. Checkout Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Acceptance test stand No. 1 cable installation | C7-35 | Used on acceptance test stand to connect S-II stage to controlling GSE through facility wiring. |
| MTF firing control center cable installation | C7-38 | Connects GSE in firing control center to stage through facility wiring. |
| Acceptance test stand No. 2 cable installation | C7-40 | Used on acceptance test stand to connect S-II stage to controlling GSE through facility wiring. |
| Remote power distribution panel | C7-41 | Provides remote control electrical power from facility power to S-II stage. |
| Stage static test electrical harness set | C7-43 | Provides interface with LOX prevalve actuation system, fail-safe engine actuation system for flame bucket protection, and vibration safety cutoff system. |
| Ground equipment test set | C7-44 | Confirms initial functional readiness of stage checkout GSE and aids in developing automatic checkout programs. |
| Stage checkout electrical harness set | C7-46 | Provides mating connector for each accelerometer and rate gyro wheel package to which both jumpers and resistors can be installed. |
| Time code rack | C7-48 | Provides accurate time reference for correlating data while checkout takes place. |
| Manual pressure checkout transducer set | C7-50 | Aids in providing pneumatic system pressure to be displayed and/or recorded for leak detection and measurement. |

...continued

Table 3-1. Checkout Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Engine system flow monitoring unit | C7-51 | Measures and monitors engine system bleed flow. |
| Pneumatic checkout blanking plate set | C7-53 | For calibration of GSE pneumatic systems. |
| Engine checkout electrical power cable set | C7-59 | Interconnects facility power and electrical checkout console, and flight instrumentation checkout and recorder consoles. |
| Stage battery simulation electrical wiring harness set | C7-65 | Jumpers stage main dc, instrumentation dc, recirculation motor dc, and ignition dc battery supply circuits to ground power supply circuits. |
| 56 VDC-200A power supply rack | C7-67 | Provides 56-volt power to S-II stage recirculation bus. |
| Mobile mechanical equipment checkout unit | C7-70 | Performs pre-servicing checkout of S7-41 console set and A7-71 $LH_2$ heat exchanger. |
| SLAM electrical harness set | C7-72 | Used during engine firing operations and is routed between C7-73 junction box and various SLAM components. |
| SLAM support structure | C7-73 | Tie point for single facility input cabling and nine individual cables to SLAM components. |
| FCC stand #1 power distribution system | C7-78 | Located at MTF and used in fire control center for distribution of facility power to GSE. |
| FCC stand #2 power distribution system | C7-79 | Located at MTF and used in fire control center for distribution of facility power to GSE. |
| Stand #1 power distribution system | C7-80 | Located at MTF and used in stand #1 for distribution of facility power to GSE. |

Table 3-1. Checkout Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Stand #2 power distribution system | C7-81 | Located at MTF and used in stand #2 for distribution of facility power to GSE. |
| Automatic checkout computer | C7-101 | Used as part of GSE for automatic program control of S-II systems tests, preliminary data storage, and arithmetic operations. |
| Test conductor console | C7-102 | Provides control and display of all necessary portions of S-II GSE required for automatic checkout of S-II stage systems. |
| Program input set | C7-103 | Provides means for inserting new programed material into computer, enabling computer complex to perform desired automatic checkout procedures. |
| Data printout rack | C7-104 | Provides permanent printed record essential for tests performed by S-II checkout GSE. |
| Auxiliary memory rack | C7-105 | Used for data and program storage. Data received by auxiliary memory from computer is stored until computer requests it for data printout and use at data processing center. Program which computer receives is stored in auxiliary memory. Test conductor commands computer to search for desired test program. Test program is then shifted into computer memory and performed. |
| Buffer equipment rack | C7-106 | Provides logic level change, command distribution, and temporary storage data capability and trigger signal restoration. |
| Local digital drive link rack | C7-107 | Provides digital communication link between computer complex and remote digital drive link rack (C7-108). |

...continued

Table 3-1. Checkout Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Remote digital drive link rack | C7-108 | Provides digital communication link between local digital drive link rack (C7-107) and remote located checkout stations. |
| Computer isolation rack | C7-109 | Provides logic level conversion for all GSE buffer equipment input lines to computer (C7-101), and isolates computer frame ground from other GSE grounding. |

3-7. Telemeter Checkout Station. The telemeter checkout station is used for both the single sideband (SS/FM) telemeter system and the pulse amplitude modulated (PAM/FM) telemeter system. The checkout philosophy used for both telemeter systems will be selection and measurement of one channel at a time. Both systems will be under automatic control of the computer for rapid checkout. Table 3-2 lists the racks utilized.

Table 3-2. Telemeter Checkout Station

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Automatic control and display rack | C7-510 | Provides computer station interfaces for all automatic mode functions with exception of PCM format. |
| Digitizing system rack | C7-511 | Converts analog data from output of discriminator rack to a parallel PCM format for comparison with output from computer complex. |
| Oscillograph rack | C7-512 | Provides analog display of telemetered responses from stage. |
| Decommutation rack | C7-513 | Operates time-shared channels of PAM pulse train, and provides visual display for outputs of decommutation system. |

Table 3-2. Telemeter Checkout Station (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Discriminator rack | C7-514 | Discriminates all incoming composite video telemetry signals, calibrates discriminators, and measures frequency of RF carrier. |
| Receiver rack | C7-515 | Receives RF signals, converts these signals and distributes them to tape recorder, discriminator, and PCM format rack. |
| Tape recorder rack | C7-516 | Records and reproduces signals routed through record/playback patch panel from receiver rack. |
| Single sideband rack | C7-518 | Receives composite signal consisting of vibration data from S-II stage, demultiplexes, and routes analog information to oscillographs. |
| PCM rack | C7-519 | Receives 72-kc serial pulse train from DDAS station, and supplies analog signals which can be recorded at oscillograph rack. |

3-8. Electrical Checkout Station and Static Firing Station. The electrical checkout station provides test stimuli and accepts test results between the following S-II stage systems and GSE: flight control, separation control, thermal control, pressurization control, electrical power control, engine control systems, mechanical checkout station, and remote power distribution rack. The station is controlled locally by a station operator, or remotely, by an automatic program from the computer complex. The static firing station provides test stimuli and accepts test results between flight control, thermal control, pressurization control, electrical power control, and engine control systems during static firing operations. The station is controlled manually by a station operator. Table 3-3 lists the equipment for both stations.

Table 3-1. Electrical Checkout Equipment

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Automatic control rack | C7-201 | Provides buffering and decoding functions for automatic control of station and routing of station response signals to computer or to displays in rack C7-202. |
| Manual control and display rack | C7-202 | Provides local control capability of electrical checkout station, and displays stage response signals during checkout of S-II stage. |
| Signal distribution rack | C7-204 | Provides electrical checkout station with capability of selecting and distributing proper signals to S-II stage or display panels as required. |
| Special data rack | C7-205 | Monitors critical stage functions and commercial items to facilitate calibration and troubleshooting. |
| Station control and display rack | C7-208 | From an auxiliary position, enables control of station power supplies, measuring instruments, limit detectors, echo check, and displays for station status, test data, and stage response. |
| Local control and display rack | C7-209 | From an auxiliary position, enables local control of engine stimuli and propellant fill, and associated displays. |
| Stage substitutes rack | C7-210 | Provides necessary stimuli to verify proper functioning of stage flight control, engine actuation, and separation systems. |
| Scanning rack | C7-211 | Used to receive control instructions and sub-addresses from computer to perform a scanning operation of stage hardware discrete signals. |

Table 3-3. Electrical Checkout Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Discrete display rack | C7-212 | Used to display hardware discretes from stage, mechanical checkout station, and relay interlock rack. |
| Relay interlock rack | C7-213 | Provides logic circuitry to interlock and sequence stage functions during static firing and checkout operations. Tests various types of relays in electrical checkout station. |
| Local static firing A rack | C7-801 | Provides an interface for separation of electrical checkout station and stage at static firing sites. |
| Remote static firing A rack | C7-802 | Provides an interface for separation of electrical checkout station and stage at static firing site. |
| Engine cutoff rack | C7-803 | Provides all engine cutoff signals. |
| Static firing monitor rack | C7-807 | Displays source of engine cutoff signals. |

3-9. Mechanical Checkout Station. The mechanical station receives commands through the electrical station to check out the propellant systems and the engine actuation systems. Table 3-4 lists the mechanical equipment involved.

Table 3-4. Mechanical Checkout Station

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Pneumatic checkout console set | C7-603 | Used to check out S-II stage pressurization systems and performs or assists in performing leak and functional checks on engine and propellant systems. |

3-10. Radio Frequency Checkout Station. The radio command receiver is checked with the radio frequency checkout station. Characteristics of the receiver are determined by applying stimuli from the electrical and radio frequency checkout stations and evaluating response data through the telemetry systems. Table 3-5 lists the radio equipment involved.

Table 3-5. RF Systems Checkout Station

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Command destruct receiver (CDR) checkout rack | C7-307 | Used to manually check out command destruct receiver and associated antenna systems. |

3-11. Digital Data Acquisition Station. Checkout of the pulse code modulated (PCM) telemetry system will be performed at the digital data station. At this station, coded pulse trains from the PCM system are regenerated to remove transmission noise and converted from serial to parallel format to produce an output signal suitable for processing in the computer. Table 3-6 lists the necessary equipment for performing these operations.

Table 3-6. Digital Data Acquisition Station

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Automatic control and display rack | C7-401 | Used to display responses of digital data acquisition station; accepts digitally encoded logic control signals from general purpose computer and decodes program commands and displays stage responses. |
| Local control and display rack | C7-402 | Provides local operation of digital data acquisition station and display distribution. |
| PCM rack | C7-403 | Demodulates and degenerates signals transmitted from stage. |
| Computer adapter rack | C7-406 | Provides binary to BCD conversion and routes BCD to displays located at other stations and computer complex. |

3-12. SERVICING EQUIPMENT. Servicing equipment is required to provide electrical power for ground operations and furnishing operating liquids, gases and solids to the Saturn S-II assembly. This equipment consists of desiccator systems hydraulic service units, pneumatic-operated service units, and service cables and lines. Items of servicing equipment with their specific application are listed in table 3-7.

Table 3-7. Servicing Equipment

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Stage area fluid distribution system | S7-13 | Used with pneumatic checkout console and hydraulic power console to supply, distribute, and control fluids required for checkout of S-II stage. |
| Accept stand No. 1 fluid distribution system* | S7-27 | Used with swing arm pneumatic console, pneumatic checkout console, and hydraulic power console, to supply, distribute and control fluids required and control fluids required for S-II stage checkout and static firing. |
| Accept stand No. 2 fluid distribution system* | S7-33 | Used with swing arm pneumatic console, pneumatic checkout console, hydraulic power console, and instrument air servicing unit to supply, distribute, and control fluids required for checkout of S-II stage. |
| Electrical container air servicing unit | S7-34 | Manual control blower and filter unit for continuous filtered air to stage disconnect. |
| Portable vacuum pump unit | S7-37 | Re-evacuates vacuum-jacketed lines of fluid distribution systems and stage propellant feed lines. |
| Hydraulic accumulator precharge servicing unit | S7-38 | Used to precharge pneumatic side of accumulator reservoir for each engine actuating system. |
| Purge and thermal control nitrogen servicing unit | S7-40 | Used to condition and purge containers and engine compartment. |
| Pneumatic servicing and checkout console set | S7-41 | Provides gaseous helium, nitrogen, and $LH_2$ for servicing and checkout of S-II stage pneumatic and propellant systems. |
| Electrical pneumatic servicing console | S7-42 | Provides remote electrical control for S7-41 console set. |

*Equipment not used at MSFC or MILA facilities.

3-13. HANDLING EQUIPMENT. Handling equipment is used for handling the booster and components during all phases of manufacture, transportation, servicing, and repair. This equipment includes slings, covers, dollies, transporters, ramps, and component installers and handlers which are used on various stages of S-II stage manufacturing and handling. Each phase of handling is ordinarily under a specific category such as equipment, transportation, hoisting equipment, etc. Equipment for handling S-II stage is listed in table 3-8.

Table 3-8. Handling Equipment

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| S-II stage pallet | H7-1 | Supports S-II stage in horizontal position and provides means of rotating stage while on transporter. |
| Forward stage support ring | H7-2 | Supports stage on transporter and provides attach points for forward hoisting frame (H7-24). |
| Aft stage support ring | H7-3 | Supports stage on transporter and provides attach points for aft hoisting frame (H7-25). |
| Transporter forward truck | H7-4 | Converts S-II stage pallet into roadable S-II stage transporter. |
| Transporter aft truck | H7-5 | Converts S-II stage pallet into roadable S-II stage transporter. |
| Aft interstage dolly | H7-8 | For support and delivery of interstage from Seal Beach Facility to MILA, via ocean vessels. |
| Stage front cover<br>Stage mid-body cover<br>Stage aft cover | H7-9<br>H7-11<br>H7-14 | Model No. H7-9, -11, and -14 provide environmental protection for stage against sand, dust, water, snow, etc., during handling, transportation, and storage. |
| Interstage aft cover | H7-13 | Provides environmental protection of interstage during delivery and storage cycle. |

Table 3-8. Handling Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Stage fit-up fixture | H7-17 | Used to proof-load both transporters, verify road transportation to Santa Susanna, verify sea transportation to MTF. |
| Transport illumination set | H7-18 | Provides illumination for S-II stage and surrounding areas during night highway transport. |
| Engine actuator simulator | H7-20 | Strut used to replace engine actuator when the actuator is removed for maintenance. |
| Static firing skirt | H7-21 | Used, in conjunction with H7-3, to provide support for aft end of stage during transportation and handling operations. In addition, skirt provides support for stage during static firing. |
| Stage erecting sling | H7-23 | Attaches to forward hoisting frame to provide means of hoisting S-II stage. |
| Forward hoisting frame | H7-24 | Distributes loads encountered during stage hoisting procedures to forward stage support ring (H7-2). |
| Aft hoisting frame | H7-25 | Used for horizontal hoisting and when erecting from horizontal to vertical or lowering. |
| Interstage and static firing skirt segment sling | H7-27 | Used to handle segments of interstage and static-firing skirt (H7-21). |
| Support ring segment sling | H7-28 | Used to hoist and maneuver support ring segments during assembly or disassembly of H7-2 and H7-3. |
| Tag lines adapter | H7-29 | Provides attachment for tag lines which are used to guide stage during erection. |

...continued

Table 3-8. Handling Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Static firing skirt sling | H7-30 | Used to hoist and maneuver static-firing skirt (H7-21) and interstage. |
| Engine protective frame | H7-72 | Used to protect stage engines during transport. |
| Engine protective frame attitude control sling | H7-76 | Controls attitude of engine protective frame during installation. |
| Aft hoisting frame access ladder sling | H7-78 | Hoists access ladder used to service aft hoisting frame. |
| Bracket set stage guide | H7-79 | Provides positive control and guidance of stage while lowering it onto static firing stand (two req.). |
| Forward hoisting frame holding fixture | H7-81 | Used as a rest support for H7-24 hoisting frame when hoisting frame is not in use. |
| Transporter components sling | H7-83 | Used for hoisting transporter components such as cradle, pallet, and truck assemblies. |
| Interstage forward support ring | H7-92 | Protects interstage forward mating interface, and provides hoisting attachment. |
| Interstage aft support ring | H7-93 | Protects interstage aft mating interface, and provides means of attaching interstage to S-II checkout dolly. |
| Center engine vertical installation adapter | H7-94 | Used for raising and lowering center engines during engine installation and removal. |
| Outboard engine vertical installation adapter | H7-95 | Used for raising and lowering outboard engines during engine installation and removal. |
| Separation linear shaped charge installer | H7-97 | Used to unwind linear shaped charge from storage reels during separation system installation. |

Table 3-8. Handling Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| $LH_2$ access cover handle | H7-99 | Used to lift off $LH_2$ tank access cover. |
| LOX drain valve assembly installer | H7-100 | Used at MTF to install and remove the 15 minute drain valve assembly. |
| S-II stage interstate pallet | H7-101 | Pallet, forward truck, and aft truck make up type II transporter used to deliver flight stages to MTF and MILA. Type II transporter is not permitted on California highways. |
| Interstage transporter forward truck | H7-104 | |
| Interstage transporter aft truck | H7-105 | |
| Stage weighing forward support stand | H7-107 | Attaches to stage erecting sling H7-23 for weighing S-II stage (one required). |
| Stage weighing aft support stand | H7-108 | Attaches to aft stage support ring H7-3 for weighing S-II stage (two required). |
| Aft hoisting frame adapter | H7-111 | Provides interconnection between crane hoisting hook and stage handling equipment. |
| Stage erecting sling adapter | H7-112 | Provides interconnection between crane hoisting hook and stage handling equipment. |
| Aft hoisting frame adapter | H7-113 | Provides interconnection between crane hoisting hook and stage handling equipment. |
| Stage erecting sling adapter | H7-114 | Provides interconnection between crane hoisting hook and stage handling equipment. |

**3-14. AUXILIARY EQUIPMENT.** Auxiliary equipment used with the booster assembly is required to provide safety provisions and protective apparatus for personnel and various S-II units (modules) as well as furnish special tools, alignment fixtures, test sets, walkways, and instrumentation units to facilitate combined systems checkout. Umbilical arm extensions are provided to be used in conjunction with tower umbilical swing arms. These mechanically operated swing arms support the propellant feed vent, power cables, checkout and leak detection lines for checkout purge and servicing of booster systems, operating umbilicals, and supply tanks. Items of auxiliary equipment and their specific application are listed in table 3-9.

Table 3-9. Auxiliary Equipment

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| Transport instrumentation unit | A7-3 | Monitors and records environmental conditions and acceleration loads on S-II stage during different types of transportation. |
| Electrical connector cover set | A7-6 | Seals umbilicals and interface open electrical sockets from dust and dirt. |
| Fluid connector cover set | A7-7 | Seals all open fluid lines and propellant lines from dust and dirt. |
| Warning streamer set | A7-8 | Warning streamers marked REMOVE BEFORE FLIGHT used during transportation and handling of stage. |
| Vertical engine compartment platform | A7-12 | Provides access to engine compartment and serves as a drop screen to prevent damage to engines with stage in vertical position. |
| Engine compartment light set | A7-14 | Provides floodlighting in engine compartment to facilitate maintenance. |
| Thrust alignment set | A7-15 | Accurately confirms alignment of individual engine assemblies during engine installation. |
| $LH_2$ tank servicing mechanism | A7-35 | For "in tank" instrumentation installation and inspection. |
| Forward skirt maintenance walkway | A7-38 | A rigid removable platform surrounding inner periphery of forward skirt for maintenance operations on S-II and S-IVB stages. |

Table 3-9. Auxiliary Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| $LH_2$ tank servicing air conditioner | A7-40 | Provides clean atmosphere and continuous air purge during interior servicing of $LH_2$ tank. |
| Umbilical disconnect arm No. 3A carrier plate assembly | A7-41 | Provides mounting of all GSE disconnects to stage. |
| Umbilical disconnect arm No. 4 carrier plate assembly | A7-42 | Provides mounting of all GSE disconnects to stage. |
| Forward stage access platform | A7-44 | Provides access to H7-23 stage erecting sling for crane hook attachment during stage hoisting operations. |
| Static firing heat shield | A7-47 | Protects equipment in the S-II stage engine compartment from radiant heat energy of engine exhaust plumes. |
| Engine compartment auxiliary purge manifold | A7-57 | Provides a $GN_2$ purge between static firing skirt and thrust structure during static firing. |
| Fixed umbilical-disconnect arm No. 3A carrier plate assembly | A7-61 | Used for connecting fluid and electrical lines from facility power to S-II stage during static firing. |
| Fixed umbilical disconnect arm No. 4 carrier plate assembly | A7-62 | Used for connecting fluid and electrical line from facility power to S-II stage during static firing. |
| $LH_2$ fill disconnect | A7-64 | Provides connection for main $LH_2$ fill and drain lines for C5 launch configuration. |
| LOX fill disconnect | A7-65 | Provides connection for main LOX fill and drain lines for C5 launch configuration. |

...continued

Table 3-9. Auxiliary Equipment (Cont)

| Nomenclature | Model Designation | Use and Application |
|---|---|---|
| $LH_2$ fill disconnect adapter | A7-66 | Provides connection for main $LH_2$ fill and drain lines for S-II stage static firing. |
| LOX fill disconnect adapter | A7-67 | Provides connection for main LOX fill and drain lines for S-II stage static firing. |
| Arm No. 3A carrier plate support mechanism | A7-69 | Hoists and positions A7-61 carrier plate assembly to S-II stage. |
| Arm No. 4 carrier plate support mechanism | A7-70 | Hoists and positions A7-62 carrier plate assembly to S-II stage. |
| $LH_2$ heat exchanger | A7-71 | Chills down cryogenic system prior to launch. |
| Static firing purge manifold | A7-72 | Flows $GN_2$ throughout engine compartment during static firing to prevent an explosive atmosphere. |

# SECTION IV

## FACTORY THROUGH LAUNCH OPERATIONS

4-1. This section provides a brief description of the S-II stage manufacturing activities along with the facility support and service techniques. Included is an abbreviated table of system flight operations to inform those unfamiliar with the S-II flight sequence of operation.

4-2. The Saturn vehicle is planned to support manned space missions. This goal must be performed without benefit of extensive flight tests. Stage reliability will be developed and confirmed through R&D testing of stage components and systems. An advanced test vehicle is programed for these tests. The test vehicle will be system-mated and checked out with each of the sister test stages for assured compatibility. Production stages (totalling 10 in all) will immediately follow the basic test vehicle path.

4-3. SEAL BEACH MANUFACTURING AND TEST FACILITY.

4-4. Manufacturing of the S-II stage will be accomplished at Seal Beach, California. (See figure 4-1.) Located approximately 1 mile from the Naval harbor, this facility consists of a service building, vertical assembly building, a bulkhead fabrication building, hydrostatic test tower, and a pneumatic paint and packaging building. All structural welding, assembly, hydrostatic testing, component installation, tank cleaning, sealing, final assembly, and system checkout will be accomplished at this facility. Various structural components procured from outlying facilities, along with system components, will also be finally assembled at Seal Beach.

4-5. STAGE MANUFACTURING AND FLOW. Ten major structural assemblies built up from several minor structural components structurally make up the stage. Stage manufacture consists of riveting, bolting, and skate welding structural components and then assembling each unit into a vertical jig for final buildup and circumferential assembly welding. (See figure 4-2.) X-rays are taken of each weld and insulation bonded to the structure exterior.

4-6. Final fabrication of all riveted units, such as the forward skirt, aft skirt, thrust cone, and interstage, is accomplished in the vertical assembly building. Each unit is in four separate sections (except eight interstage sections) and is assembled in master jigs. The $LH_2$ tank-ring panels (four for each ring) have insulation applied prior to the machine welding of skins. After hydrostatic tests and weld inspections, final insulation stripping is installed. Each bulkhead; forward, common, and aft, is made up of 12 preformed, pie-shaped, gore

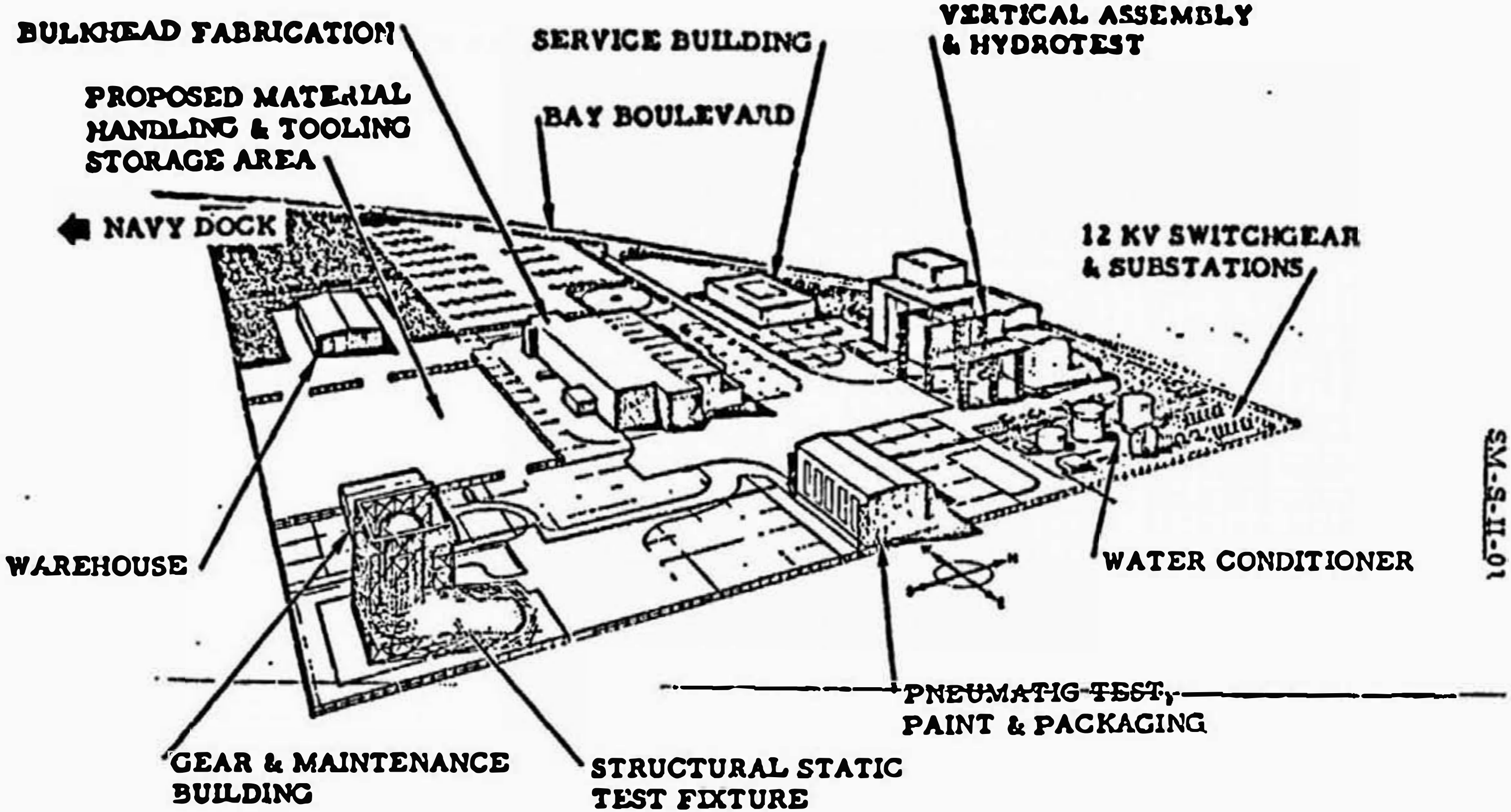



Figure 4-1. Seal Beach Facility

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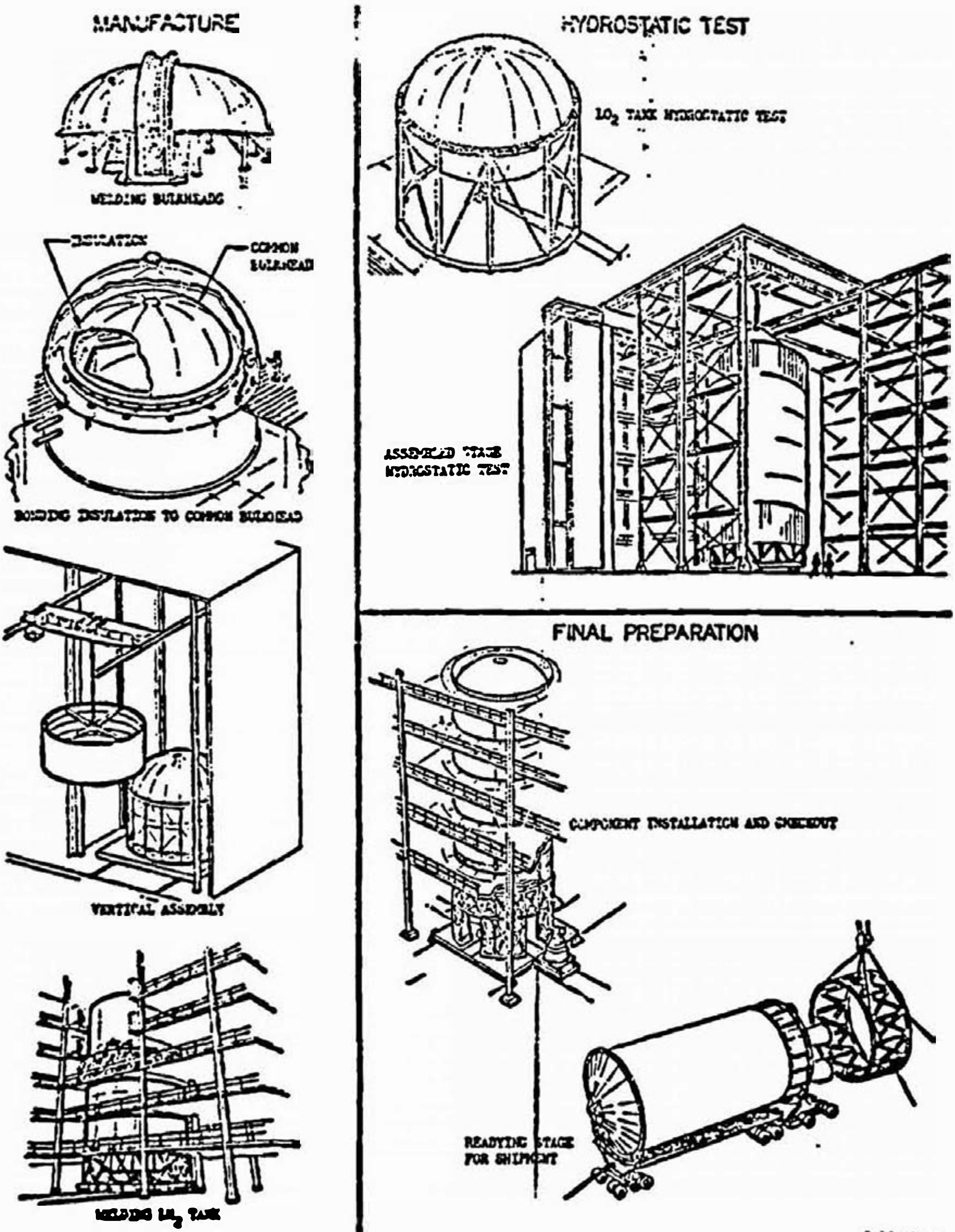


Figure 4-2. Seal Beach Facility Operations

segments butt welded into large diaphragms by machine welders in the bulkhead fabrication building. Insulation is applied to each forward bulkhead pie-shaped gore prior to welding, while the common bulkhead insulation is preassembled into a diaphragm configuration and bonded to the common bulkhead after hydrostatic tests are completed. (See figure 4-2.)

4-7. Hydrostatic tests are individually performed on each diaphragm after fabrication and prior to assembly in the bulkhead fabrication building. Upon assembly of the liquid oxygen tank and bolting ring, the forward bulkhead and liquid oxygen tank are moved to, and assembled with, the $LH_2$ tank in the vertical assembly building. Hydrostatic tests of the assembled stage are then performed in the vertical hydrostatic test tower. Tanks are filled with treated, purified water and cycle-pressurized for specified times. Tests include inverting the tank, and all welds are immediately helium-checked for leakage. Upon completion of tests, all structural components are thoroughly cleaned and dried.

4-8. Upon test completion, the stage structural assembly is positioned in the vertical assembly station where various systems are installed. Each system is verified for proper installation and thoroughly tested by independent checks after assembly. Thorough cleaning, inspection, and checkout of each component follows every movement of the stage.

4-9. Following systems installation, the stage is checked out through separate and integrated systems checkout procedures. Upon manufacturing's completion of all phases of test and final inspection approval, the stage is moved to the paint hangar where it is painted and prepared for shipment in accordance with packaging and preservation specifications.

4-10. SANTA SUSANA TEST AREA.

4-11. Located in the Santa Susana mountains near Santa Susana, California, this facility contains two S-II test stand complexes, cryogenic storage, transfer, and disposal systems, pretest building, a control center, and various types of supporting equipment. (See figure 4-3.) This overall facility is utilized as an R&D facility for North American Aviation, Inc., to perform engineering evaluation on actual flight hardware, of overall system performance and limitations, as well as to determine corrective measures to be applied to problem areas occurring during product improvement tests. Two separate types of test stages are utilized for this purpose, the battleship stage and the all-systems test stage (S-II-T). The battleship stage is assembled on its test stand, while the all-systems test stage is assembled at Seal Beach, transported to Santa Susana, and installed. Each stage is tested prior to delivery of the first flight stage.

4-12. TRANSPORTATION.

4-13. Transportation requirements for the Saturn S-II require special considerations because of its extreme size and physical limitations of existing cargo aircraft, rail, and highway transport methods. Therefore, water transportation

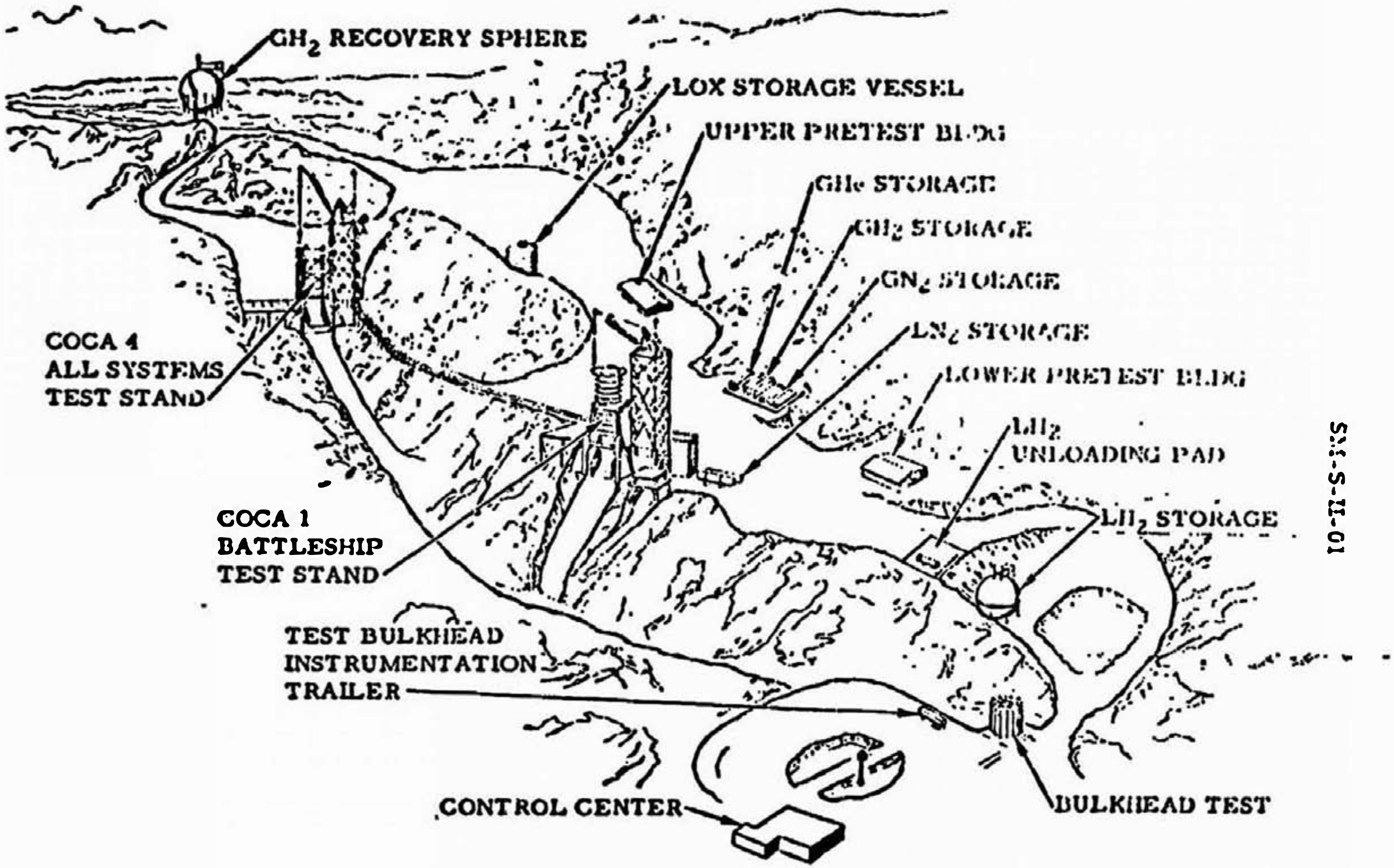


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Figure 4-3. Santa Susana Test Facilities is utilized as the major means of transportation to the launch facility, with limited highway transport being utilized between the various inland facilities and seaports involved. The Saturn S-II is transported from Seal Beach to Michoud, Louisiana, from Michoud to MTF, from MTF to Michoud, and on to MILA. Space and Information Systems Division of North American Aviation is responsible for delivery of the stage to each facility. The customer-furnished AKD-1, or equivalent, shipping vessel and YFNB barges are provided for this purpose. Each vessel contains a large, protective, metal cover which completely covers the stage. To facilitate transportation operations, a specially designed, sectionalized, roadable, man-operated, transport trailer is provided which permits the Saturn S-II to remain on the transport trailer during all phases of transportation. Protection against exposure to various environmental conditions is provided in the form of an engine-protective frame, protective nylon-reinforced plastic covers.

4-14. Land Transportation Requirements. (See figures 4-4 and 4-5.) The S-II stage is conveyed on a transporter for all phases of transportation. For short-distance overland movements, the stage/transporter is towed by an M-26 (or equivalent) prime mover. To avoid serious jar and impact loads, transporter-tow speeds over all roads will be limited to 5 mph. Because of California highway restrictions, two types of transporters are necessary. One, designated Type I, (figure 4-4) is equipped with 24 wheels and used to transport the stage within California. The other, designated Type II, (figure 4-5) is equipped with 12 wheels, and used to transport the stage outside of California. Refer to "Saturn S-II Transportation Manual," SM-S-II-02, for further details on the two types of transporters.

4-15. Sea Transportation Requirements. For waterborne requirements, three types of conveyances are utilized. For long-distance transoceanic (Seal Beach to Michoud) transfer, the AKD-1 shipping vessel is used. For short-distance transoceanic (Michoud to MILA) transfer, the YLNB-33 ocean barge is used. For inland waterway (Michoud to MTF or MSFC) transfer, the YLNB-1 shuttle barge is used. The YFNB-1 shuttle barge is also used for transferring the stage from Seal Beach to Port Hueneme for overland transportation to Santa Susana. Rolling is the method used for transferring the stage between dock and shipping vessel, or barge, and between shipping vessel and barge. An M-26 prime mover (or equivalent) will be used for all loading and unloading operations.

4-16. To insure that the stage and all components arrive at the using site in clean, undamaged condition, protective equipment is provided. Included are protective covers, handling equipment, and monitoring instrumentation. The stage is protected from the elements by nylon reinforced vinyl covers. Water transporting vessels are fitted with hard-cover structures to protect the stage. Stage systems, as well as exposed components, are preserved and sealed against adverse climatic conditions. Refer to "Saturn S-II Transportation Manual," SM-S-II-02, for further details regarding transportation of the stages to the various test sites.

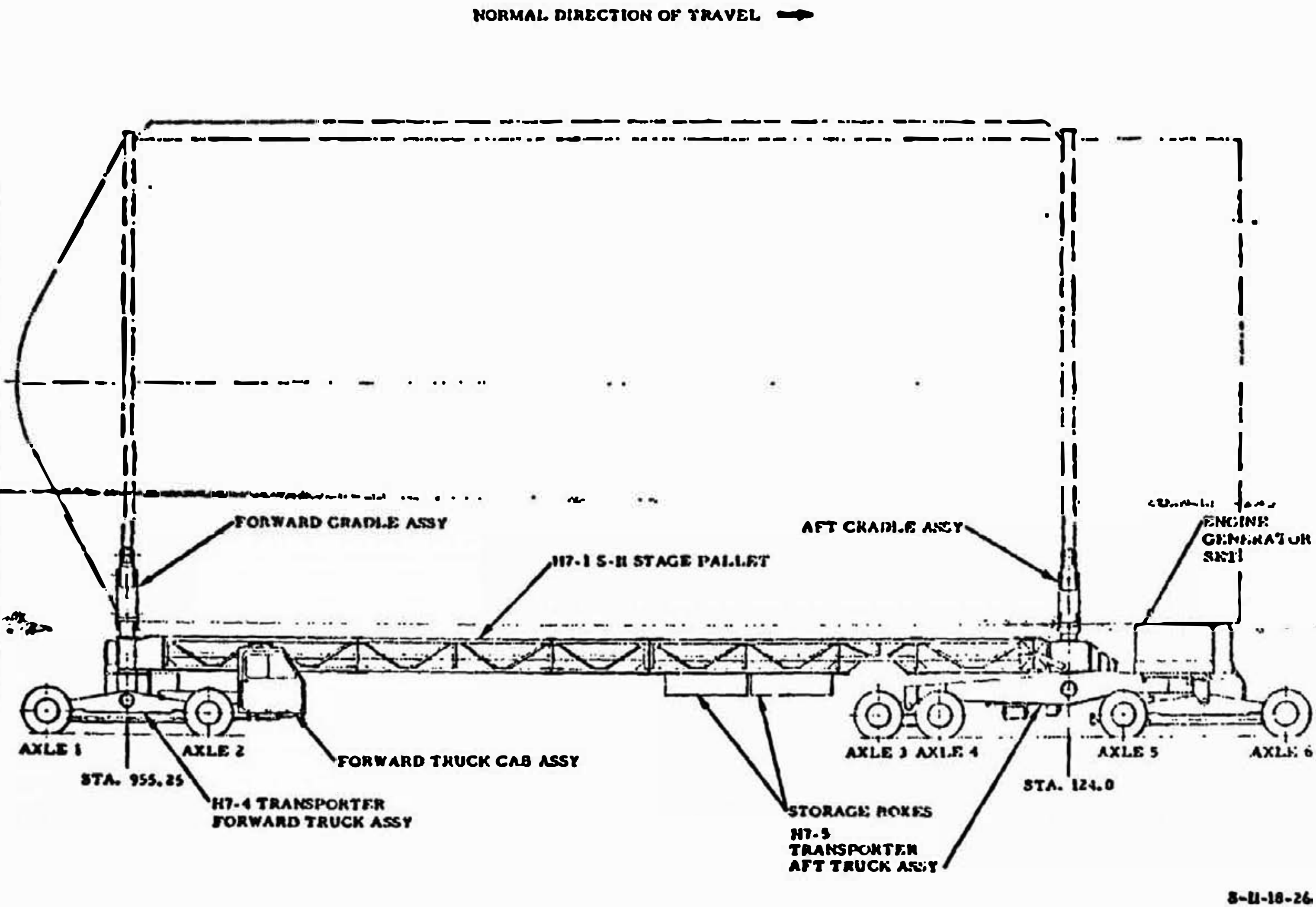


Figure 4-4. S-II Stage Transporter, Type I

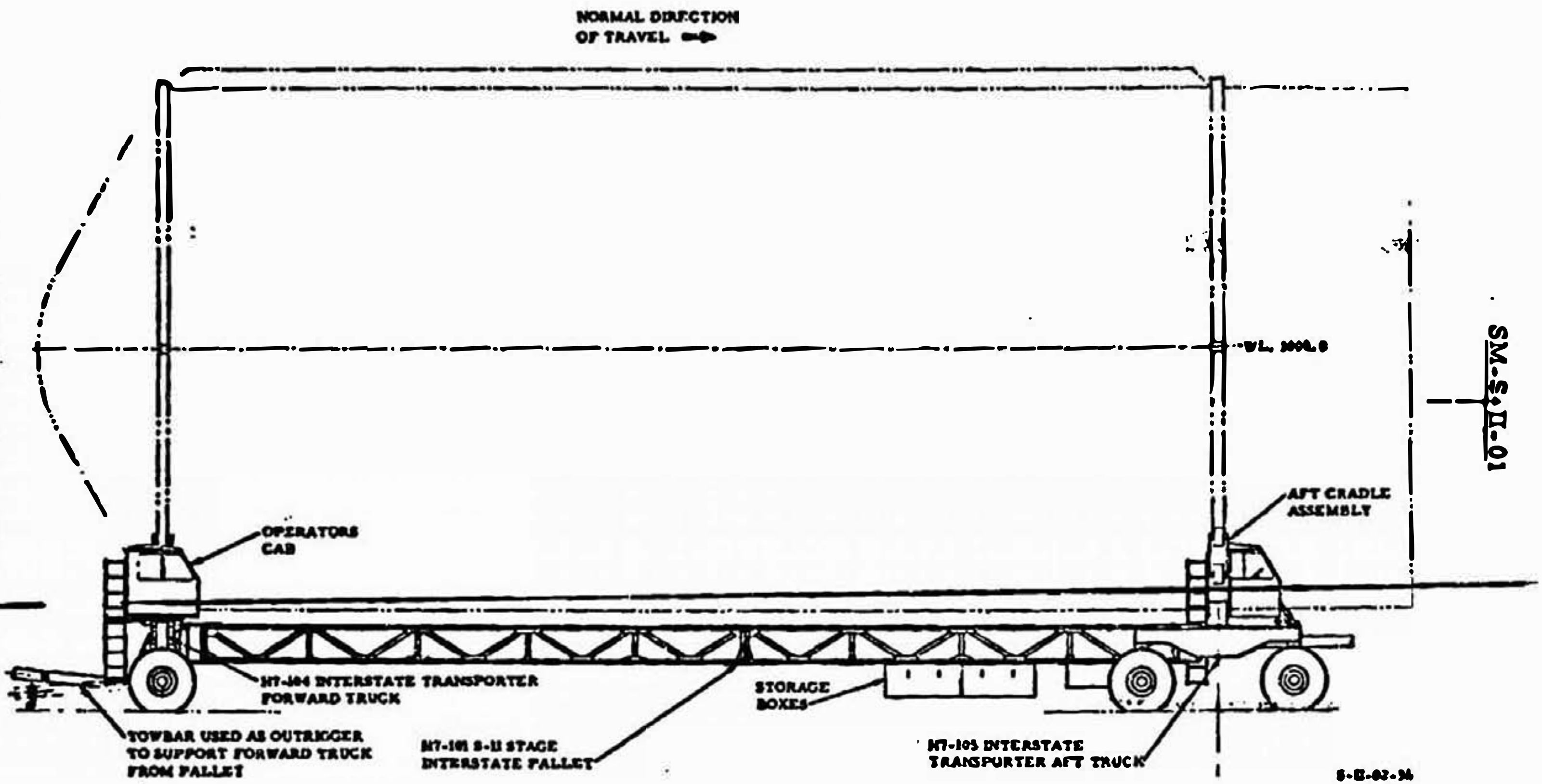


Figure 4.5 S-II Stage Transporter, Type II

4-17. FLIGHT ACCEPTANCE AND LAUNCH FACILITIES.

4-18. Two separate facilities (test and launch) are presently programmed to support the Saturn S-II program after leaving North American's S&ID Seal Beach Facility manufacturing area. The two facilities are the Mississippi Test Facility (MTF), located at Picayune, Mississippi, and the Merritt Island Launch Area (MILA), located at Cape Kennedy, Florida. The primary purpose of the test facility is to qualify each stage and its related systems as flight certified prior to delivery to the launch facility. At the launch facility, all prelaunch, launch, and down-range tracking activities are performed on each stage of the Saturn V vehicle.

4-19. MISSISSIPPI TEST FACILITY (MTF). The MTF, centered in Hancock County, Mississippi, on a site approximately 40 miles northeast of New Orleans, Louisiana, consists of a "fee area" of approximately 13,500 acres in which testing operations will be performed. (See figures 4-6 and 4-7.) An easement area of approximately 125,000 acres surrounding the fee area establishes a buffer zone in which people may work but not reside. The fee area is divided into two basic areas: the test area, which includes facilities for static firing vehicle stages, and the support area, which contains administrative, engineering, warehousing, vehicle storage, and other non-hazardous support facilities.

4-20. S-II Test Complex. The S-II test complex is an integrated facility for vertical static testing of the S-II stage. Initially, the complex will include two single position test stands and a test control center operating in conjunction with control, service, instrumentation, and utility systems necessary to perform static firing tests. The test stand structure is the primary supporting and servicing system for the stage during captive test firing. It houses mechanical equipment, piping, instrumentation, electrical service, stage support equipment, work area, storage facilities, and offices necessary to the operation of the stage before, during, and after static firing. The test control center (TCC) is designed to provide an environment for equipment and personnel required to control, observe, supervise, and monitor operation of the test complex. Two complete sets of GSE and recording and monitoring equipment utilizing several hundred channels will be housed in the TCC to control and monitor the test firings.

4-21. Other facilities operated in support include the following:

a. Observation bunker. The bunkers are reinforced concrete, and one bunker is located approximately 400 feet from each test stand. The bunkers are blast proof structures from which test personnel can observe test firings at close range.

b. Instrumentation towers. Two towers at each test stand support banks of floodlights for illumination of the stage. Remotely controlled television and motion picture cameras and other auxiliary test and recording equipment can be mounted on the towers.

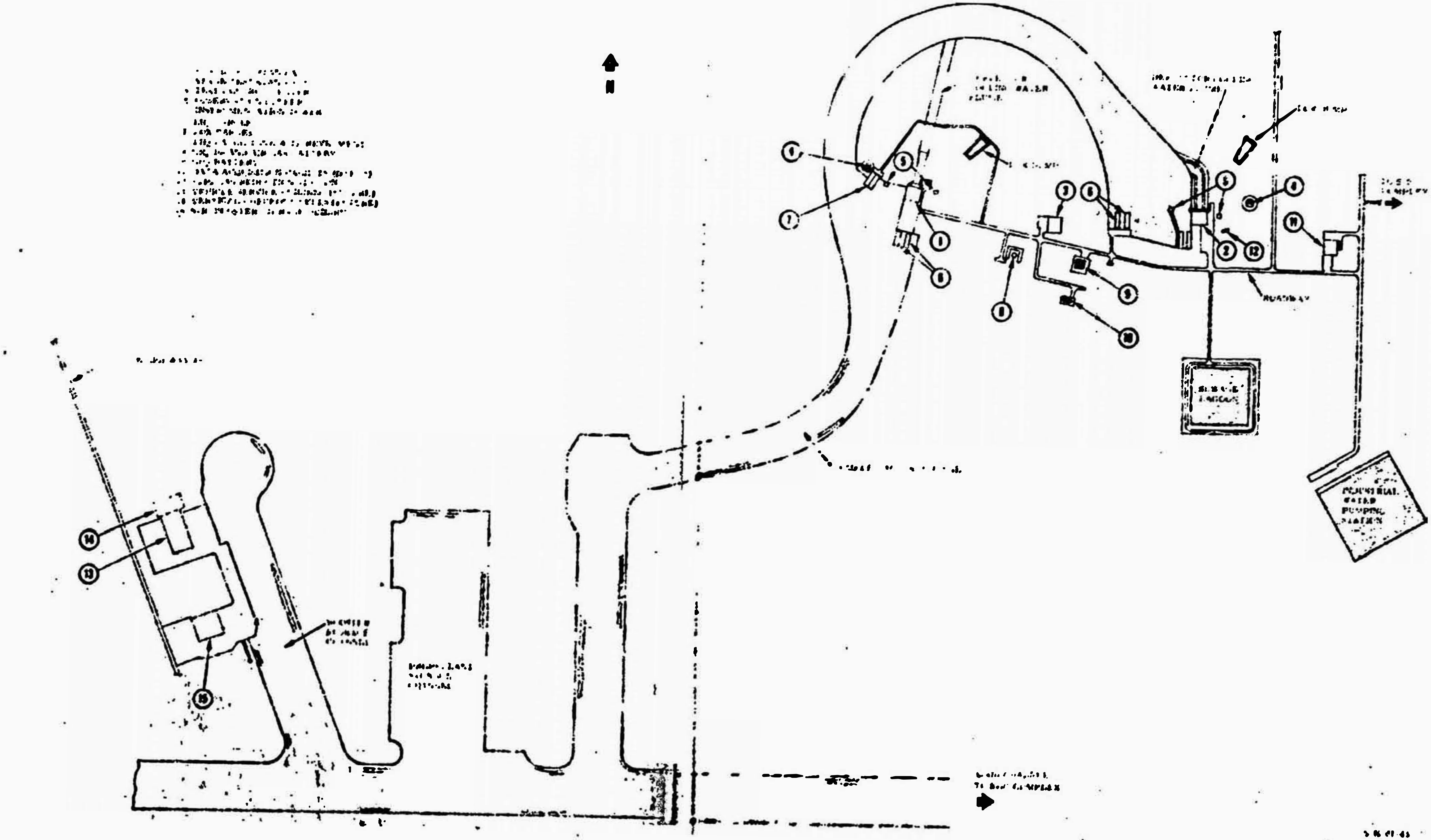


Figure 4-6. Mississippi Test Facility

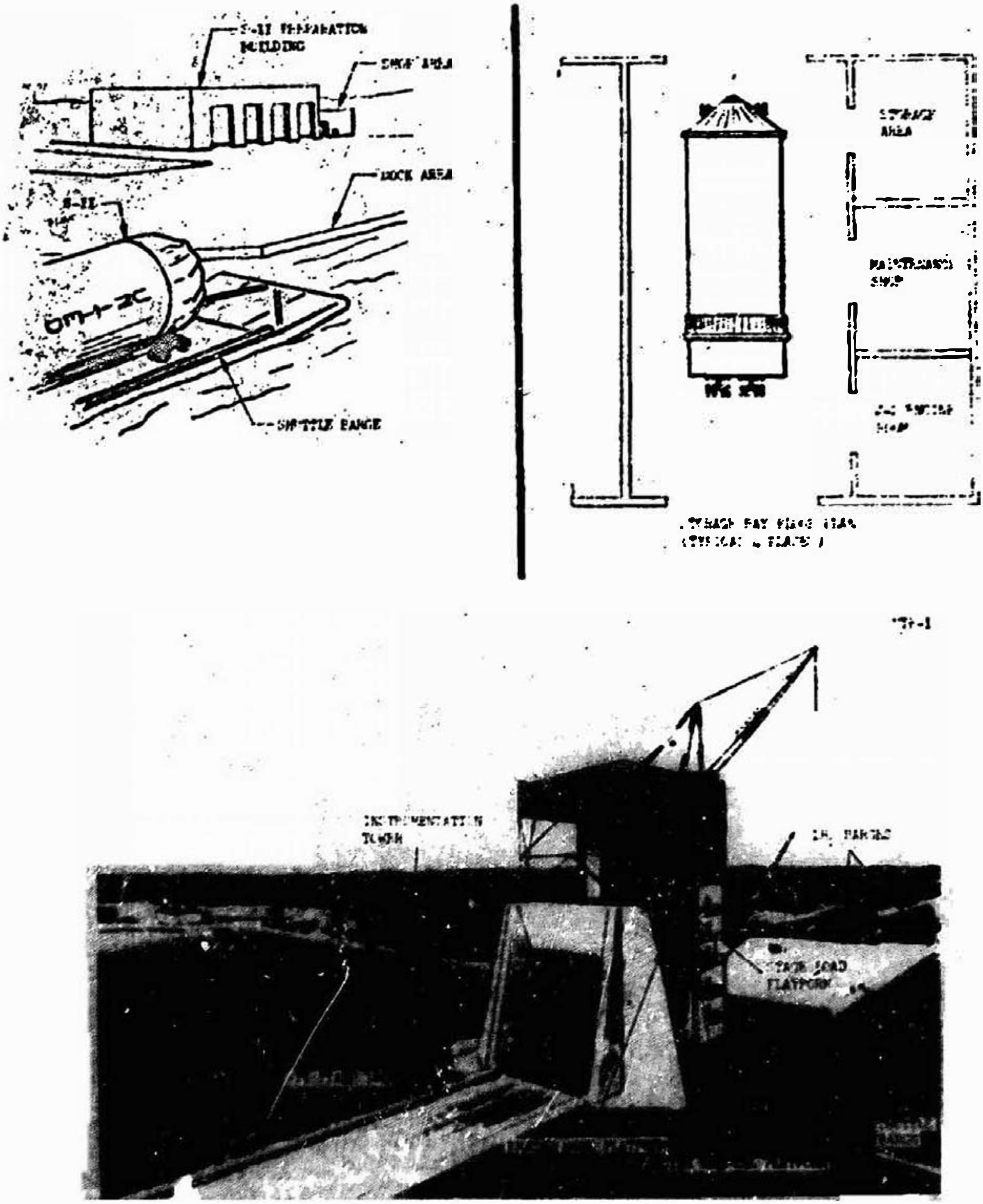


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Figure 4-7. S-II Stage MTF Operations

c. S-II stage service building. The service building provides facilities for receipt, inspection, storage, and shipment of stages.

d. Laboratory and engineering building. The building provides office space for NASA, corps of engineers, support contractors, and stage contractors.

e. Data acquisition facility (DAF). The DAF is a centralized data collection unit for hardware instrumentation measurements obtained during stage tests.

f. Data handling center (DHC). The DHC receives test data in recorded form from test facilities and processes the data as required to aid in test analysis and in the preparation of engineering reports.

4-22. Preparation. Upon arrival at the MTF, the S-II stage is shuttle-barge transported to docking facilities at the preparation hangar; then, the stage is towed to the test preparation hangar where it is positioned horizontally so packaging and shipping safeguards can be removed and the stage inspected for transportation damage. The stage remains on the transporter throughout its preparation activity except where unusual servicing is necessary. The engine-protective frame is removed and stored, and the firing skirt and aft support ring remain on the stage at all times.

4-23. Preparation activities to ready the stage for test stand operation consist of removal of preservatives, servicing systems, installing necessary instrumentation and signal conditioners, and adding additional touchup requirements necessary at this time. Modifications (if required) are accomplished during this period. Overhead cranes capable of handling the S-II stage on and off the transporter are utilized as required. All stage refurbishing and preparation for shipment to MILA after static-firing tests are completed are also accomplished in the preparation hangar.

4-24. Test Stand. Upon readying the stage in the preparation building, the stage is rolled onto the shuttle barge and transported to the firing area where test stand overhead cranes lift the stage directly from the barge and mount it vertically onto the static-firing test stand. The static-firing skirt is used as the tie-down interface. Integrated system tests, tanking tests, engine manipulation, and full duration static firing are performed on the test stand to certify complete stage integrity. Systems test operations take approximately six months.

4-25. Satisfactory completion of acceptance tests permits return of the stage to the preparation building, utilizing the shuttle barge, where all necessary stage refurbishing is accomplished. Upon satisfactory inspection, shipment to MILA follows.

4-26. STATIC FIRING COUNTDOWN SEQUENCE (MTF).

4-27. Table 4-1 provides a typical example of a static firing countdown sequence with approximate times of an approximate series of events given.

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Table 4-1. Static Firing Countdown Sequence

| Event No. | Functional Description |
|---|---|
| 1. | a. Temperature-regulated air supply for thermal control system initiated.<br>b. GSE ground power bus energized.<br>c. GSE main power bus energized.<br>d. GSE instrumentation bus energized.<br>e. GSE heater bus energized.<br>f. GSE pneumatic pressure supplied for LOX tank vent control valves.<br>g. GSE pneumatic pressure supplied for $LH_2$ tank vent control valves.<br>h. MISTRAM de-energized. |
| 2.<br>T-168 min | a. Countdown initiated.<br>b. T/M energized.<br>c. Engine actuation system temperature control energized.<br>d. Propellant management system energized.<br>e. GSE pneumatic pressure supplied for recirculation bottle control pressure.<br>f. LOX tank vent valves closed.<br>g. $LH_2$ tank vent valves closed.<br>h. Leak detection system evacuation initiated.<br>i. GSE pneumatic pressure supplied for engine start tank vent valves control.<br>j. Engine helium bottle purge initiated.<br>k. Fill and drain valves disconnect purge initiated. |

...continued

Table 4-1. Static Firing Countdown Sequence (Cont)

| Event No. | Functional Description |
|---|---|
| 2. (Cont) | l. GSE pneumatic pressure supplied for recirculation purge valves and propellant tank fill and drain valves control. |
| | m. GSE pneumatic pressure supplied for engine helium bottles control pressure (1000 psig). |
| | n. Engine helium bottles purge initiated. |
| | o. GSE pneumatic pressure to $LH_2$ helium receivers, LOX helium receivers, and recirculation disconnect actuator initiated. |
| | p. Thrust chamber purge and $LH_2$ tank pressurizing line high flow purge initiated. |
| | q. Engine-compartment purge initiated. |
| 3. T-167 min | a. Temperature regulated air supply for thermal control system terminated. |
| | b. $GN_2$ supply for thermal control system initiated. |
| | c. Stage control reset command initiated. |
| | d. Stage control reset achieved. |
| | e. Selector switch reset command initiated. |
| | f. Selector switch reset achieved. |
| | g. Lift-off relays energized. |
| | h. All engines safe command initiated. |
| | i. Battery heaters energized. |
| 4. T-158 min | a. $LH_2$ tank GHe pressurizing system purge initiated (low flow). |
| | b. Leak detection system evacuation achieved and terminated. |
| | c. Leak detection system purges initiated. |

Table 4-1. Static Firing Countdown Sequence (Cont)

| Event No. | Functional Description |
| --- | --- |
| 4. (Cont) | d. Engine start tanks vent valves opened.<br>e. Engine helium bottles purge achieved and terminated. Helium bottles control pressure continued (1000 psig).<br>f. Engine start bottles purge initiated.<br>g. Turbo pumps purge initiated. |
| 5. T-148 min | a. $LH_2$ recirculation valves and gas generator bleed valves opened.<br>b. $LH_2$ tank 8 psig maximum pressure switch control initiated.<br>c. $LH_2$ tank pressurizing system high flow purge terminated. Low flow purge continued.<br>d. $LH_2$ tank fill and drain valve opened.<br>e. $LH_2$ tank pre-valves opened.<br>f. $LH_2$ tank preconditioning initiated. |
| 6. T-128 min | a. LOX recirculation valves opened.<br>b. LOX tank 8 psig maximum pressure switch control initiated.<br>c. Common bulkhead temperature of -160°F achieved on $LH_2$ tank side.<br>d. LOX tank fill & drain valve opened.<br>e. LOX tank chilldown initiated. |
| 7. T-98 min | a. LOX tank 5% level achieved.<br>b. LOX tank chilldown terminated.<br>c. LOX tank fast fill initiated. |

...continued

Table 4-1. Static Firing Countdown Sequence (Cont)

| [illegible] No. | Functional Description |
|---|---|
| [illegible] T-[illegible]7 min | a. LOX tank pressure exceeds 8 psig.<br>b. LOX tank vent valves opened.<br>c. LOX tank 8 psig maximum pressure switch control terminated. |
| 9. T-83 min | a. LOX tank 98% level achieved.<br>b. LOX tank fast fill terminated.<br>c. LOX tank fast topping initiated. |
| 10. T-75 min | a. LOX tank 100% unpressurized level achieved.<br>b. LOX tank fast topping terminated.<br>c. LOX tank topping initiated. |
| 11. T-70 min | a. $LH_2$ tank chilldown initiated. |
| 12. T-50 min | a. $LH_2$ tank 5% level achieved.<br>b. $LH_2$ tank chilldown terminated.<br>c. $LH_2$ tank fast fill initiated. |
| 13. T-48 min | a. $LH_2$ tank pressure exceeds 8 psig.<br>b. $LH_2$ tank vent valves opened.<br>c. $LH_2$ tank 8 psig maximum pressure switch control de-energized. |
| 14. T-44 min | a. $LH_2$ tank 30% level achieved.<br>b. Recirculation pumps started.<br>c. $LH_2$ tank pre-valves closed. |

Table 4-1. Static Firing Countdown Sequence (Cont)

| Event No. | Functional Description |
|---|---|
| 15. T-25 min | a. $LH_2$ tank 98% level achieved.<br>b. $LH_2$ tank fast fill terminated.<br>c. $LH_2$ tank fast topping initiated. |
| 16. T-14 min | a. $LH_2$ tank 100% unpressurized level achieved.<br>b. $LH_2$ tank fast topping terminated.<br>c. $LH_2$ tank topping initiated. |
| 17. T-630 sec | a. LOX lines GHe bubbling initiated (15 sec. bursts).<br>b. Engine helium bottles 1000 psig control pressure terminated.<br>c. Engine helium bottles 3000 psig control pressure initiated.<br>d. Engine start bottles purge terminated.<br>e. Engine start bottles charge initiated.<br>f. Engine thrust chamber chill initiated.<br>g. MISTRAM energized. |
| 18. T-450 sec | a. LOX tank GHe receiver chilldown initiated. |
| 19. T-330 sec | a. LOX tank GHe receiver chilldown terminated.<br>b. LOX tank GHe receiver pressurization initiated.<br>c. Engine start tank vent valves closed. |
| 20. T-285 sec | a. LOX tank topping terminated.<br>b. LOX tank fill & drain valve closed. |

...continued

Table 4-1. Static Firing Countdown Sequence (Cont)

| No. | Functional Description |
|---|---|
| 21.<br>T-270 sec | a. LOX fill line purge initiated. |
| 22.<br>T-230 sec | a. LOX tank GHe receiver pressurization completed.<br>b. $LH_2$ tank GHe pressurization system low flow purge terminated.<br>c. $LH_2$ tank GHe receivers chilldown initiated.<br>d. $LH_2$ tank pressurization system low flow purge terminated. |
| 23.<br>T-140 sec | a. Engine actuation system temperature control de-energized. |
| 24.<br>T-120 sec | a. $LH_2$ tank GHe receivers chilldown terminated.<br>b. $LH_2$ tank GHe receivers pressurization initiated. |
| 25.<br>T-90 sec | a. $LH_2$ tank topping terminated.<br>b. $LH_2$ tank fill & drain valve closed. |
| 26.<br>T-70 sec | a. $LH_2$ tank fill line purge initiated.<br>b. Command destruct relay power initiated. |
| 27.<br>T-60 sec | a. Hydraulic accumulators locked up. |
| 28.<br>T-50 sec | a. Propellant dispersion EBW power initiated.<br>b. Command destruct relay power transfer initiated. |
| 29.<br>T-30 sec | a. Propellant dispersion EBW power transfer initiated.<br>b. Recirculation pumps power transfer initiated.<br>c. Recirculation control bottle pressurization terminated. |

Table 4-1. Static Firing Countdown Sequence (Cont)

| Event No. | | Functional Description |
|---|---|---|
| 29. (Cont) | d. | GSE pneumatic pressure supply for recirculation purge valves and fill & drain valves terminated. |
| | e. | Engine control bottles 3000 psig pressurization charge terminated. |
| | f. | GSE pneumatic pressure supply for $LH_2$ tank pressurization & LOX tank pressurization terminated. |
| | g. | Thrust chambers chill terminated. |
| | h. | Engine start tanks charge terminated. |
| | i. | Turbopumps purge terminated. |
| | j. | $LH_2$ fill line purge terminated. |
| | k. | LOX fill line purge terminated. |
| | l. | Battery heaters off. |
| | m. | Main bus power transfer initiated. |
| | n. | Instrumentation bus power transfer initiated. |
| 30. T-20 sec | a. | Arm safe/arm initiated. |
| 31. T-0 | a. | Liftoff. |
| | b. | Liftoff relays de-energized. |

4-28. MERRITT ISLAND LAUNCH AREA (MILA). Final confidence operations, mating of stages, prelaunch checkout, testing, and servicing operations are performed at the MILA facility. (See figure 4-8.) After unloading the stage from the barge at the Merritt Island Launch Area (MILA), the Saturn S-II is towed to, and positioned in, the center aisle (transfer aisle) of the low bay area in the vertical assembly building where the stage is depackaged, cleaned, and acceptance inspected. Upon completion of these operations, the stage is raised from the transporter and positioned vertically in a low bay checkout cell. The interstage is positioned next to the stage. In the cell, the stage is fully instrumentated, and stage system checkout, along with compatibility checkouts with the interstage and other stage simulators, is begun.

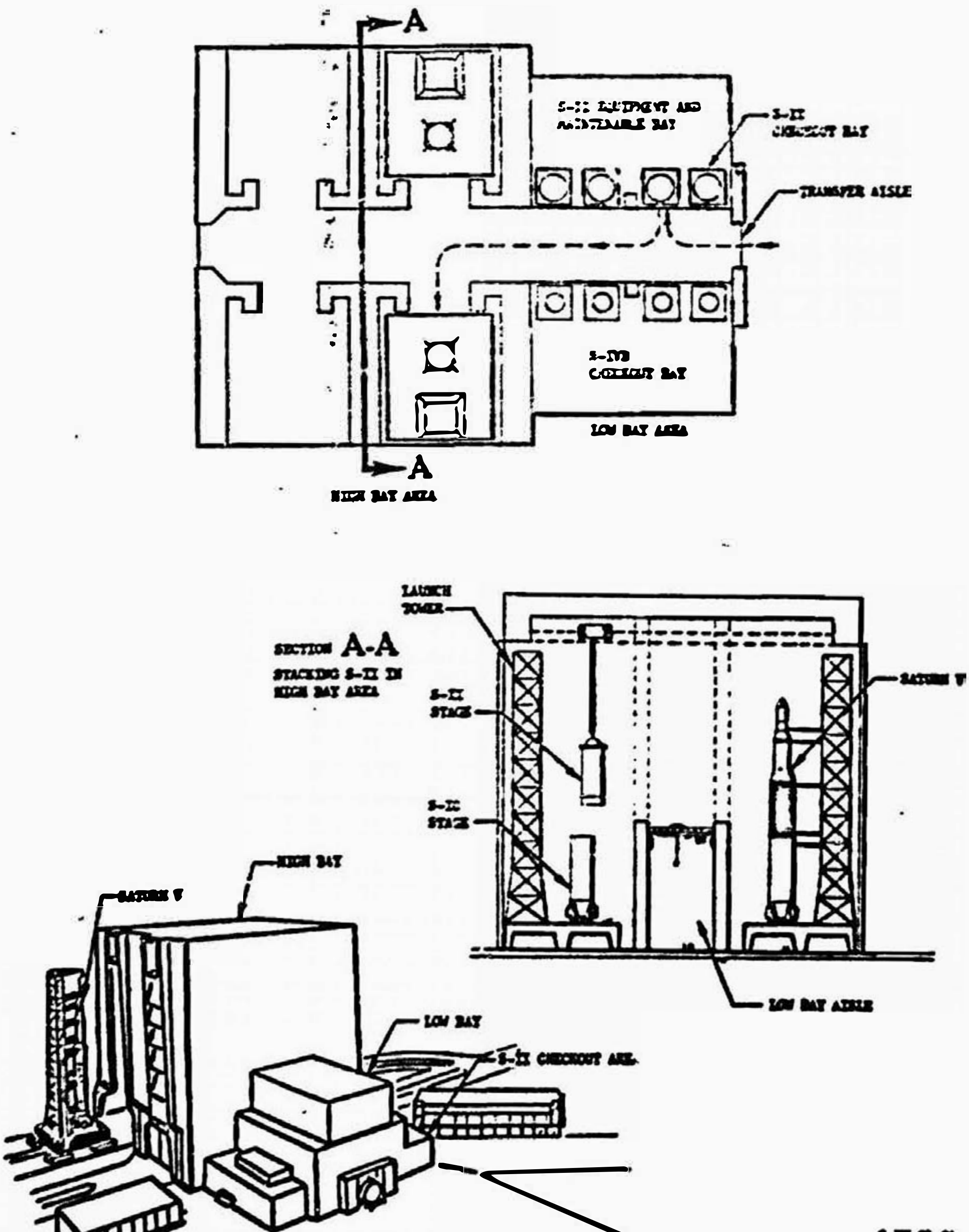


**Figure 4-8. S-II Stage MILA Operations**

4-29. Preparation (High Bay). Physical mating of the Saturn S-II vertically with the S-IC is accomplished in the high bay area upon a movable launch umbilical tower within the vertical assembly building. Umbilical service arms attach to each stage and handle all stage service connections. All tower service umbilicals will be manually or mechanically attached to the S-II vehicle. An electrical control and compatibility check is made between the launch control center and launch umbilical tower prior to integrated stage checkouts with mating stages.

4-30. High Bay Checkout. After tower compatibility checks are completed, the S-II stage is electrically mated with the other Saturn stages and undergoes integrated compatibility checkout and tests and simulated flight compatibility tests.

4-31. Ordnance. Upon completion of all systems tests in the high bay, Saturn V and the launch umbilical tower are transported to the launch pad by a large surface crawler. The arming tower is transported to the launch pad and positioned against the launch vehicle to check out, assemble, and align the ullage rockets and to install the detonator and separation and destruct charges. Ordnance is installed individually onto each stage.

4-32. Launch Pad. Three launch pads are available for launch purposes and contain propellant facilities, burn pond, holding pond, gas storage, and fire-fighting equipment. A terminal connection building beneath the launch pad handles propellant loading, monitoring, and utility equipment. A special parts van is parked close by for necessary servicing and part replacement requirements. Central launch control centers, located within or near the vertical assembly building, will monitor all launch preparations and countdown operations.

4-33. Countdown Requirements. It is planned to have the S-II stage in the launch-ready configuration approximately 25 seconds prior to S-IC engine ignition. The S-II countdown requirements include a list of events necessary to bring the S-II stage to launch-ready configuration, their sequence of occurrence, and their times of occurrence as referenced to the master countdown. In addition, the requirements include a list of the functions that must be monitored until lift-off to verify that the S-II stage is in launch-ready configuration.

## 4-34. MAINTENANCE CONCEPT.

4-35. The maintenance operations performed on the Saturn S-II stage and related GSE equipment are primarily removal, replacement, or reinstallation of components and/or subassemblies. The design of the stage and related equipment is such that failed items or malfunctions can be isolated through testing the assembly to the lowest subassembly or component level. The repair of items which can, by the nature of the malfunction, be reworked in place will not require removal. Proper functioning of components, subassemblies, or items must be verified prior to installation into the stage or GSE systems. Any system undergoing maintenance will be maintained to the level of cleanliness specified for that system. Components, subassemblies, or items requiring disassembly for repair or overhaul will be rejected and returned to the depot level maintenance activity for repair. Maintenance will not be attempted beyond the technological state-of-the-art of the site or facility at which the stage is located.

4-36. STAGE MAINTENANCE GROUND RULES. The S-II stage is not to be used as a component test bed. When a malfunction occurs, the nature and identity of the malfunction and the proper functioning of the replacement spare part is to be established before checkout or countdown proceeds. The following rules supply a detailed activity of maintenance operations:

a. All rupture weld cracks or other damages to propellant tanks do not have maintenance techniques spelled out as yet.

b. Minor repairs or adjustments will be performed on site. These will consist of removal and replacement of small components, replacing gaskets, etc. All repairs will be duly supervised and recorded.

c. Removed-assembly repairs will be accomplished at a centralized maintenance activity. Each article will be certified stage-ready prior to placing the article on stand-by.

d. Engine subassemblies or components which do not affect engine calibration with engine installed on the stage may be replaced.

e. Engine items affecting calibration shall require a return of the Saturn V launch vehicle to the vertical assembly building and the replacement of the complete engine. (See figure 4-9.)

4-37. Handling and Testing of Replacement Equipment. Operational system equipment replaced on the Saturn S-II during a countdown will necessitate a countdown backup check of several hours to assure replacement equipment reliability. Where a malfunction occurs in close proximity to the countdown start, the countdown will start over after replacement of the malfunctioning equipment. No adjustment or realignment of airborne equipment will be permitted on the booster vehicle during the launch phase. Equipment found to be malfunctioning during the horizontal checkout will be replaced, bench-checked, aligned, and returned to stock. Nonfunctioning equipment will be replaced or repaired as necessary as long as system function is uninterrupted.

4-38. CHECKOUT CONCEPT.

4-39. The S-II stage, as assembled in the Saturn V vehicle configuration on the launch pad, is checked out automatically. All measurements to determine if the stage is launch-ready are made through the skin umbilical connectors via launch

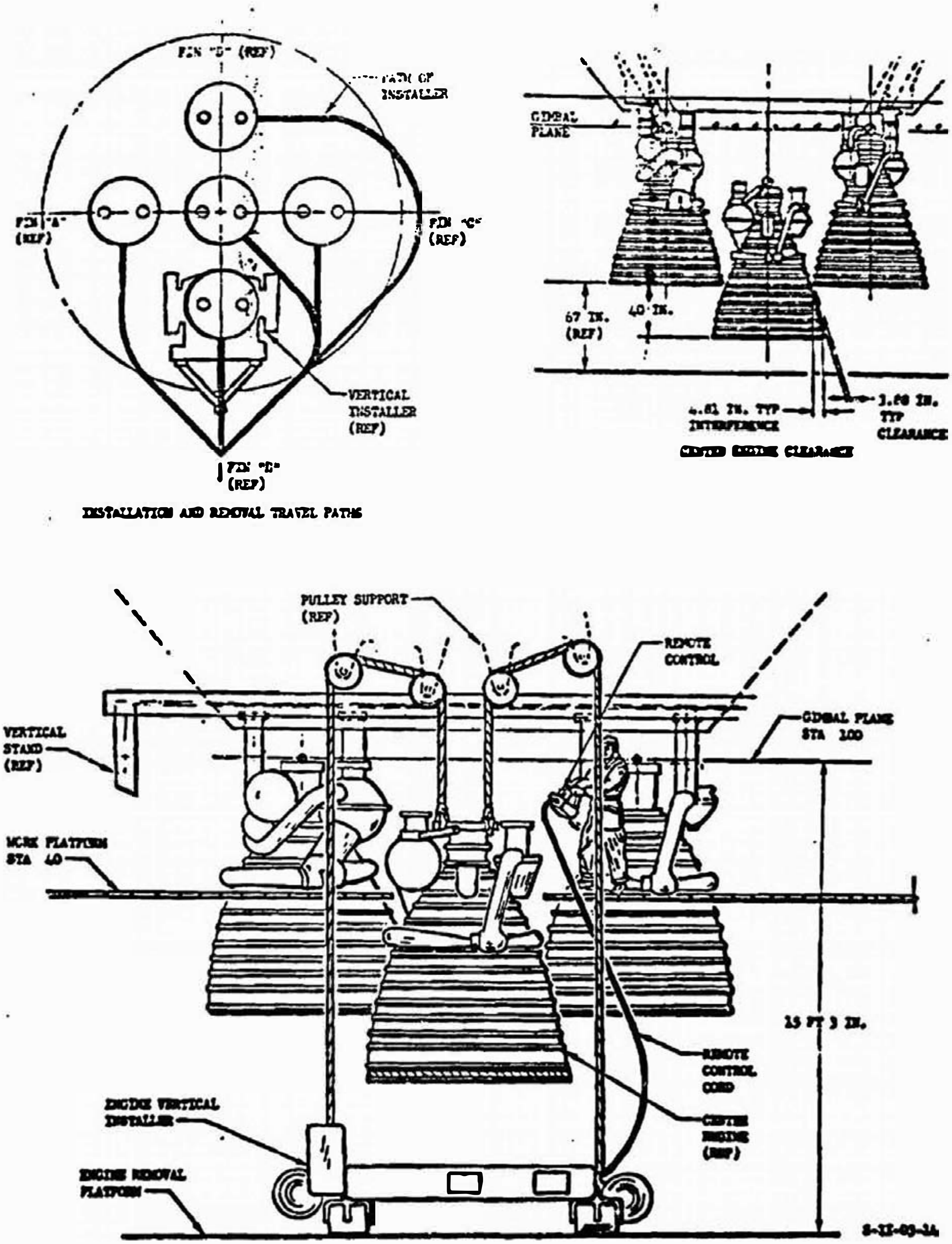


**Figure 4-9. Installing Engines**

tower swing arms. All measurements through the umbilicals are of the launch-readiness nature with no detail checkout lower than the subsystem (or subassembly) level. However, in the case of a no-go, a more detailed checkout to lower hardware levels is conducted through the use of special checkout harnesses.

4-40. COMPONENT CHECKOUT. All malfunctioning components removed from the stage are thoroughly tested and evaluated immediately upon removal to determine the reason for the malfunction and to detect potential stage system deterioration. Component failures, if any, are recorded on applicable documents and forwarded to the reliability data center for analysis. New replacement components, such as control valves, pressure regulators, instrumentation unit relays, and related equipment are thoroughly tested by the supplier prior to initial acceptance. All tests are conducted with equipment designed and certified for the specific subsystem testing. Appropriate disposition will be made of components which fail to meet specific test requirements.

4-41. Automatic Checkout Equipment (ACE). The primary purpose of the ACE is to check out and certify the stage and to isolate any malfunctions. A secondary purpose is to assure a higher confidence level for the stage through thoroughness of checkout, elimination of human error, and completeness of checkout records. Ground support equipment (GSE) which includes ACE is used to control the S-II stage, apply stimuli, and record and evaluate test data during static firing tests, individual systems checkout, and combined systems checkout. Checkout equipment has been made as automatic as possible. Manual operations have been retained wherever automation of certain functions does not prove feasible. To provide the greatest versatility in test procedures, the automatic checkout system has been designed for control by a computer. Therefore, programed test procedures are not restricted to a fixed go/no-go type of test. Instead, procedures are flexible and will expand as necessary to include all alternative and exploratory techniques required for thorough testing. The ACE tests the following systems in the S-II stage:

- Engine systems
- Propellant feed system
- Propellant management system
- Engine compartment conditioning system
- Pressurization system
- Electrical power system
- Electrical control system
- Separation system
- Propellant dispersion system
- Emergency detection system
- Flight control electronic system
- Thermal control system
- RF systems
- Measurement system

# APPENDIX A

## STATIC TEST STAGE (S-II-S)

### A-1. GENERAL.

A-2. This appendix describes the mission, test objectives, test program, and structure and system deviations from the S-II flight stage of the S-II-S static test stage.

A-3. The static test stage is a structurally complete S-II stage, being the first production article from the final assembly building at Seal Beach. The stage is designated model V7-1, unit 1, by S&ID and serial number S-II-S by NASA.

### A-4. STAGE MISSION.

A-5. The mission of the S-II-S stage is to duplicate as closely as possible the primary load-carrying structure of the S-II flight stages in support of the static load test program.

### A-6. TEST OBJECTIVES.

A-7. The structural static test program is conducted primarily to certify the structural integrity of the complete S-II stage when subjected to critical design loads and simulated temperature environments and to determine the stiffness of the thrust structure. Results of the static tests are used to verify the accuracy of the analytical methods used by Engineering to predict stress levels and to confirm the existing analysis of the engine actuation system dynamic response for the Flight Dynamics group.

### A-8. TEST PROGRAM DESCRIPTION.

A-9. The structural static test is conducted on the structural static test fixture at Seal Beach (figure A-1) and consists of nine test conditions which are grouped into two major categories: body loading conditions and engine thrust conditions. Table A-1 identifies and describes each of the test conditions under each of these categories. The test program subjects each major structural component of the stage to its critical loading conditions. During all applications of pressure loading the propellant tanks are filled with water to minimize pneumatic explosive hazards as well as to acquire ullage when necessary.

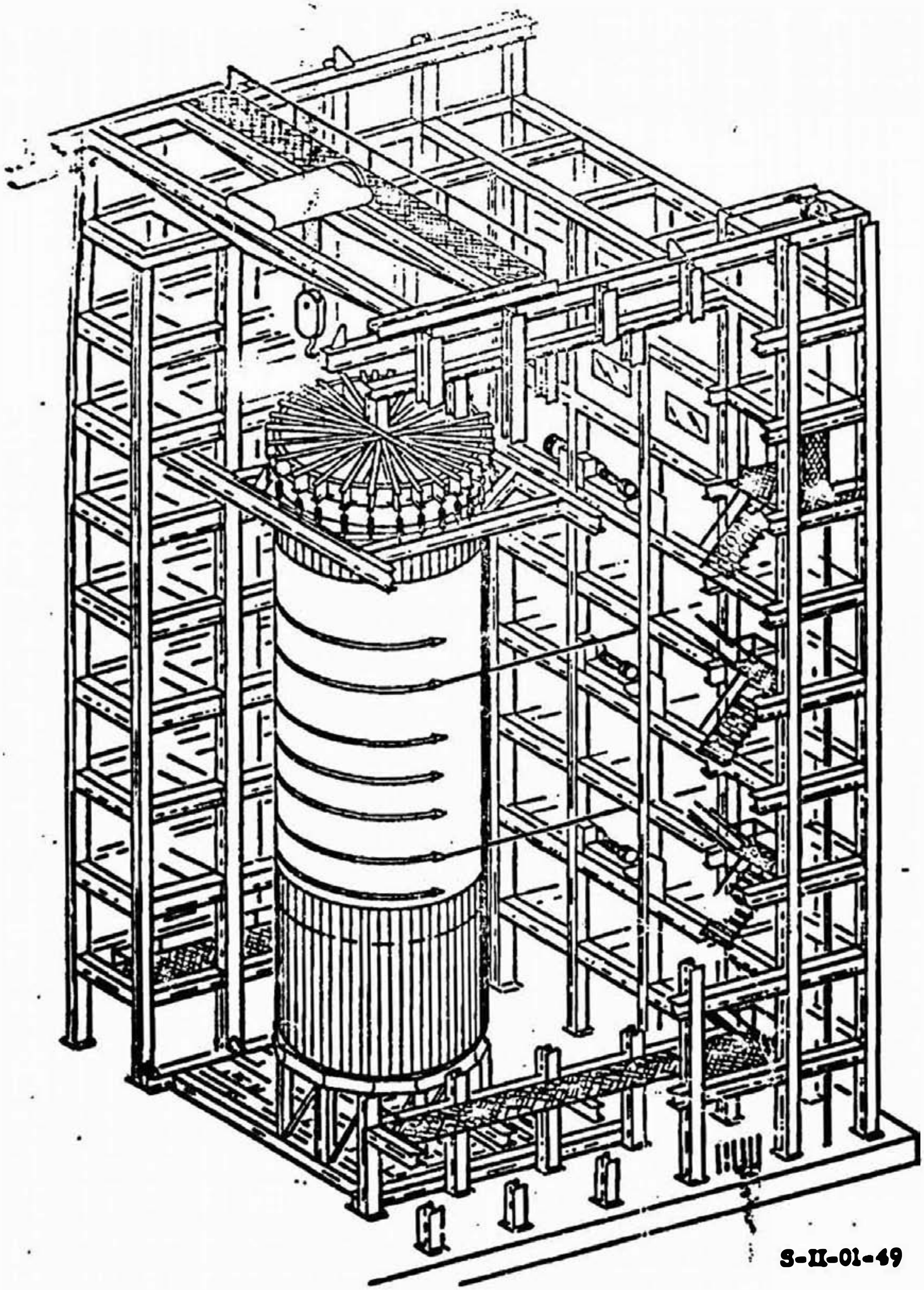

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Figure A-1. Static Test Stage (S-II-S) Installed in Structural Static Test Fixture

Table A-1. Structural Static Test Conditions

| General Category | Test Condition | Simulates | Test Description |
|---|---|---|---|
| Body loading conditions | I (deleted) | Static firing | Deleted from test requirements. |
| | IIA | Prelaunch (99.9% probability wind profile) | No internal pressure; test critical for $LH_2$ tank in compression. |
| | IIB | Prelaunch | Pressure loads; test critical for common bulkhead collapsing. |
| | III | Maximum q | t = 71 seconds, λ = 1.96g; combined with internal pressure; test critical for forward skirt in compression. |
| | IVA | End of S-IC boost | t = 146.05 seconds, λ = 4.68g; combined with maximum collapse flight pressure on common bulkhead; test critical for aft skirt and aft interstage in compression. |
| | IVB | End of S-IC boost | t = 146.05 seconds, λ = 4.68g; combined with maximum bursting pressure on aft LOX bulkhead; test critical for aft LOX tank bulkhead in tension. |
| Engine thrust load conditions | V | Thrust vector changed by engine actuation system (EAS) | 800,000 lbs of water in LOX tank; 400,000 lbs in $LH_2$ tank; outboard engine thrust simulators positioned at 10° in same direction; actuator load loop is applied with tension at actuator attach points. |
| | VI | Thrust vector changed by EAS and single-engine-out | Same as condition V but with engine thrust simulator #3 at zero thrust. |

Table A-1. Structural Static Test Conditions (Cont)

| General Category | Test Condition | Simulates | Test Description |
|---|---|---|---|
| Engine thrust load conditions (cont) | VII | Thrust vector changed by EAS and multi-engine condition | Same as test condition V but with engine thrust simulator #4 at 40% thrust and engines #1 and #2 at 90% thrust. |
| | VIII | Engine thrust during boost phase in general | Measure deflection of gimbal attach fitting and both actuator attach fittings of one engine mount, while six load conditions are applied to these fittings. |

A-10. STRUCTURAL STATIC TEST FIXTURE. The structural static test fixture at Seal Beach provides the means by which flight stage load environments can be simulated. Test support and loading fixtures, using conventional hydraulic struts, simulate the adjacent structure of the S-IC and S-IVB stages. Four large hydraulic loading cylinders attached to the engine support structure apply simulated S-II engine thrust loads. Other hydraulic struts simulate loads imposed by S-IC engine thrust, lateral inertia, and aerodynamic resistance. Although propellant tank fill, drain, and pressurization capabilities are provided by the structural static test fixture; cryogenic liquids are not used. Demineralized (hexavalent chromium-treated) water is used to acquire tank ullage and dynamic head pressure conditions. To compensate for the necessary omission of cryogenic liquids from the test, internal and external structural test loads are adjusted to simulate the effects of cryogenic temperatures on the stage structure under operating conditions. (The necessary structural tests using cryogenic liquids are conducted on the common bulkhead test fixture at Santa Susana, concurrent with the structural static test at Seal Beach.) Special instrumentation, readout, and recording systems are used to record test data from over 3000 sensing devices attached to the S-II-S stage. Approximately 2000 axial strain gages, 500 bi-axial strain gages, 500 shear rosettes, 10 pressure transducers, and 100 deflection indicators are installed. Up to 600 channels of instrumentation are recorded for a given test condition.

A-11. STAGE DESCRIPTION.

A-12. STRUCTURE DESCRIPTION. In general, structural components not required to carry loads or to stabilize the primary load-carrying structure are not installed. These include the systems tunnel, heat shield, heat shield support structure propellant tank insulation, and a number of system component support brackets. Otherwise, the structure is the same as the S-II-1 flight stage, except the $LH_2$ tank wall and the forward skirt skin are of lighter-gauge aluminum. The lighter materials are used because the design change that increases tank and forward compartment pressures in the S-II-1 stage is not effective for the S-II-S stage.

A-13. SYSTEM DESCRIPTION. No flight system components are installed or simulated by mass. Stage systems consist of special tank venting systems (shown in figure A-2) and special instrumentation installed to sense the response of the stage structure to various test loads. The propellant tanks are pressurized to desired pressures by adjusting the amount of conditioned water in the tanks.

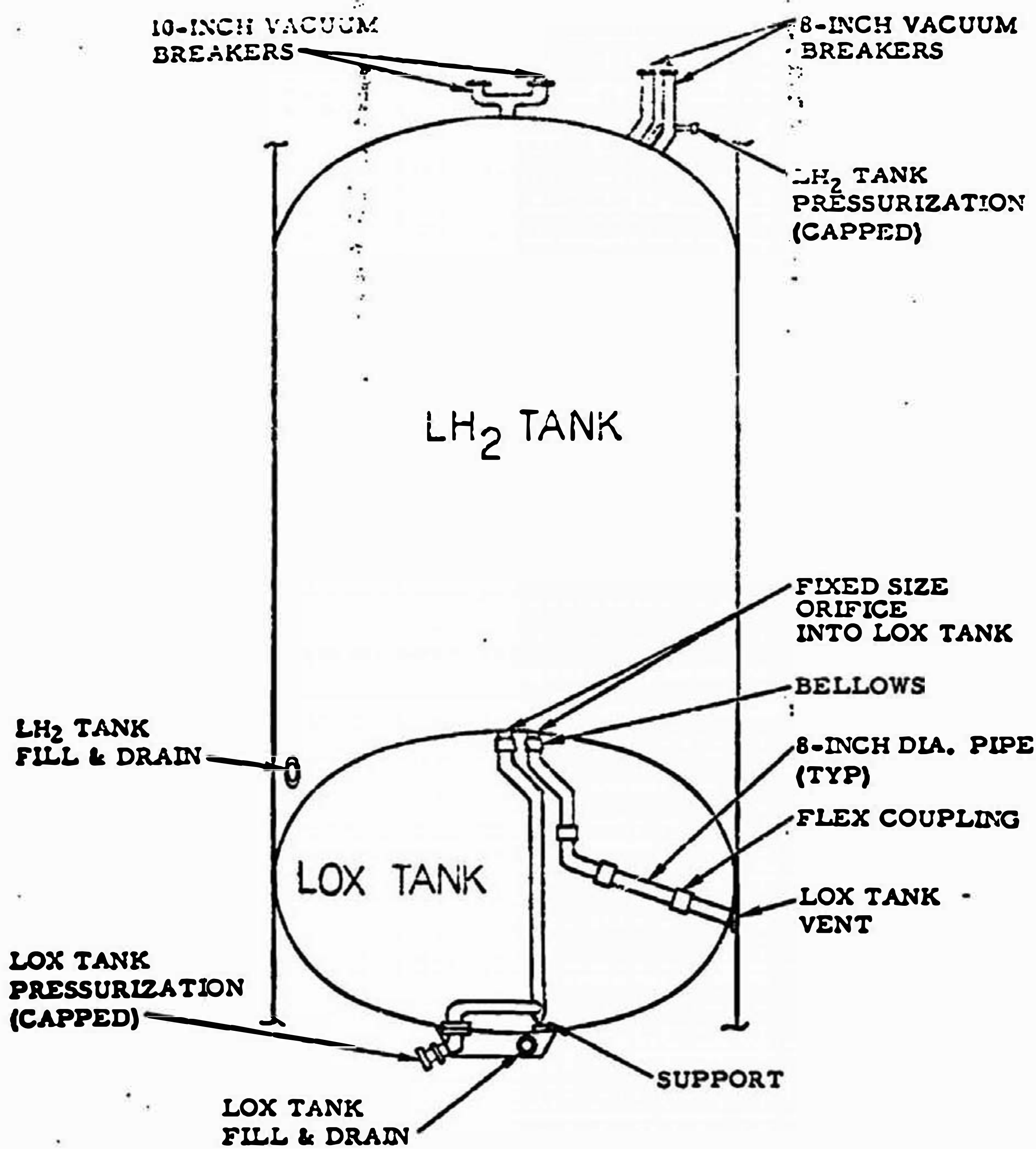
A-14. DESIGN CHANGES.

A-15. CONFIGURATION CHANGE POINTS. Configuration change points (CCPs) have been established for all S-II stages. CCPs are defined to be points along stage assembly, checkout, and testing operations which are conducive to the incorporation of design changes. Each of these points has been assigned an identification number to facilitate ease of documentation. As each S&ID master change record (MCR) is processed, determination is made as to the need for deferment of the change on one or more of the stages. Appropriate CCP numbers are then assigned which describe the desired immediate installation or deferment. Table A-2 lists the established CCPs for the S-II-S static test stage. The calendar dates given are subject to change with changes in engineering test and production schedules.

Table A-2. Configuration Change Points for the Static Test Stage

| CCP Number | Definition | Approx. Date |
|---|---|---|
| SA100 | During preparation of stage for delivery to structural test fixture | December 1964 |
| SA200 | At initiation of stage test operations in structural text fixture | February 1965 |

A-16. LIST OF CHANGES. Refer to Appendix F.




NOTE: INTERFACES NOT SHOWN IN SCALED POSITIONS.
$LH_2$ AND LOX TANKS ARE PRESSURIZED BY ADDING CONDITIONED WATER THROUGH THEIR RESPECTIVE FILL & DRAIN PORTS UNTIL THE DESIRED TANK ULLAGE PRESSURE IS REACHED.

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Figure A-2. Systems Installation for Static Test Stage

# APPENDIX B

## BATTLESHIP TEST STAGE

### B-1. GENERAL.

B-2. This appendix describes the mission, test objectives, test program, and general configuration of the battleship test stage. Associate GSE and facility equipment descriptions are not included.

B-3. The battleship test stage, designed jointly by S&ID and Rocketdyne, is a heavy-duty, nonflyable, propulsion test stage, permanently assembled on the Coca I static test stand of the Propulsion Field Laboratory (PFL), located in the Santa Susana mountains. (See figure B-1.) Although functionally and structurally similar to the flight stage, the battleship test stage, designated Model V7-9, Unit 1 by S&ID (no NASA designation), has been beefed up to withstand extraordinary loads which might be encountered during the initial hot firing tests of the S-II propulsion system. Only the systems and GSE necessary to carry out the propulsive mission of the stage are installed.

### B-4. STAGE MISSION.

B-5. The battleship test stage serves as a workhorse for the systematic development and improvement of the J-2 engine cluster, engine-related systems, propellant handling procedures, and static firing procedures.

### B-6. TEST OBJECTIVES.

B-7. The prime test objective of the battleship program is to provide early testing and evaluation of the S-II propulsion system in preparation for subsequent static firings of flight-weight stages, beginning with the all-systems stage. (Refer to Appendix C.) Specific objectives include evaluation of full-scale propellant handling procedures; determination of the degree and effects of stratification in the full-scale $LH_2$ tank; development and evaluation of the J-2 engine cluster, and engine operating and safety procedures; establishment of necessary operational placards and limitations; evaluation of the effects of vortex characteristics within the propellant tanks; evaluation of the acoustical, thermal expansive and contractive, vibrative, and heating effects on stage-mounted components; and training of personnel for assignments at the all-systems, MTF, and MILA sites.

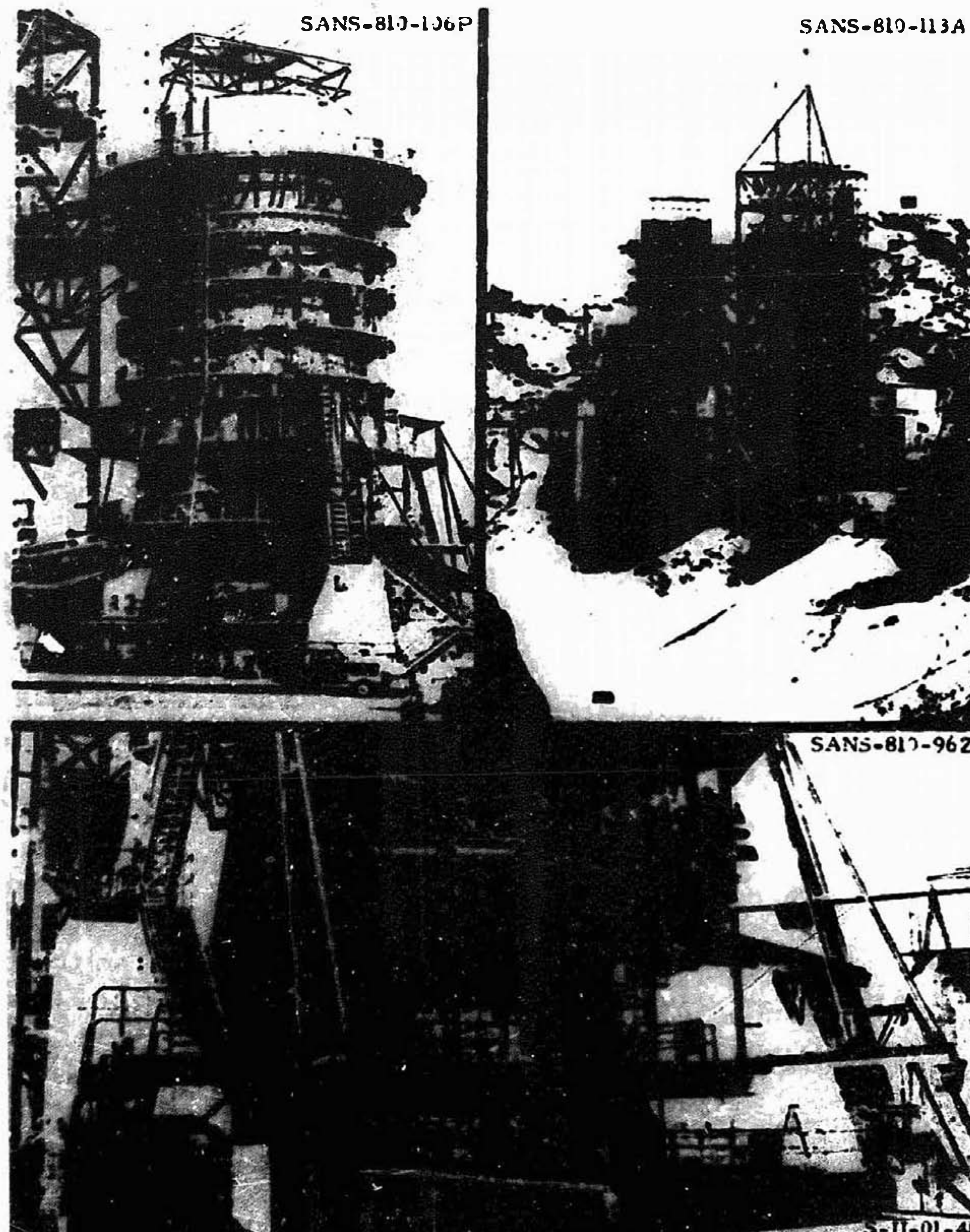


**Figure B-1. Battleship Test Stage on Coca I Test Stand**

B-8. TEST PROGRAM DESCRIPTION.

B-9. The battleship test program is an integral part of the confidence development plan for the S-II stage. The program is divided into four phases to cover the tasks presently assigned. (Refer to table B-1.) Phase I, the initial testing effort, is concerned primarily with the checkout of the facility and the development of facility operating procedures. The propellant tank installations are made, followed by the checkout of the GSE and the testing of the compatibility of the facility, stage, and GSE systems. Personnel training is of prime importance during this period of preparation for the static-firing test phase. Upon installation of the development set of J-2 engines, a comprehensive engineering evaluation program is initiated under phases II, III, and IV of the program.

Table B-1. Battleship Test Stage Program Phases

| Phase | Name | Description |
|---|---|---|
| I | Activation | Phase I initiated upon joint S&ID/Rocketdyne test stand occupancy; phase includes installation and checkout of facilities, GSE, individual battleship test stage systems, and verification of ability of systems to handle cryogenic materials. |
| II | Engine system test | Single engine firings, multiple engine firings, and a 1-second cluster firing of all five engines. |
| III | Cluster development | A series of cluster firings of increased duration, including full-duration firings. |
| IV | Products improvement | Flight support, special tests, and off-limit testing. |

B-10. STAGE DESCRIPTION.

B-11. STRUCTURE DESCRIPTION. The battleship test stage is not structurally identical to the flight stage. This is mainly due to the requirements of increased safety and test flexibility. Structural deviation from the flight stage configuration occurs primarily in the areas of tank construction and thrust structure design load. The deviations are discussed in the following paragraphs.

B-12. Propellant Tanks. The propellant tanks are made of stainless steel instead of aluminum to reduce the effects of expansion and contraction under the environmental changes caused by the introduction of cryogenic liquids and to provide for additional structural strength to support special gas and static head pressures for test and calibration purposes. Both tanks are equipped with anti-slosh and antivortex baffles, standpipes, and feed line nozzles. The LOX tank in the battleship is similar in shape to the flight-weight tank. The battleship LOX tank is a true 1.5:1.0 ellipsoid, while the flight-stage tank is a modified 1.5:1.0 ellipsoid. The common bulkhead is of special construction. It consists of two sheets of steel, separated by an evacuated chamber. (See figure B-2.) Similarly, the $LH_2$ tank is of double-wall construction with an evacuated chamber between. The primary purpose for the double-wall, chambered construction is to permit simulation of various degrees of flight-weight tank insulation by regulating the gas pressure within the chambers. The outer shell also acts as a secondary $LH_2$ vessel which can contain any liquid or gas which might escape from the inner vessel through a hole or rupture in its shell. Several thicknesses of laminated Fiberglas and aluminum foil insulation are secured over the outside surface of the inner shell to reduce radiant heat transfer. This insulation is supported away from the shell surface by standoff studs to permit free circulation of chamber gas. The space between the inner and outer shell of the $LH_2$ tank is of sufficient width (30 inches) to permit personnel entry for the purpose of installing sensing devices or performing inspections and repairs as necessary. A spiral ramp within this chamber provides a walkway for personnel. (See figure B-8.) Special ports are provided through the walls of both tanks at strategic locations so that, if determined necessary at a later date, television, motion picture, or still cameras and lights may be installed to afford observation of gas bubble formation within the cryogenic liquids. Both propellant tanks and their pressure relief vents conform to ASME safety codes.

B-13. $LH_2$ Tank Heat Loss. The $LH_2$ tank heat loss can be reduced to a small value. The tank is rated to have less than 2 percent boiloff in 24 hours with the $LH_2$ tank 90 percent full of $LH_2$ and the LOX tank 90 percent full of LOX. Vacuum leaks through the outer shell of the tank are detected by means of a mass spectrometer helium detector. The probe of this detector is located in the vacuum line to the vacuum pumps. The chambers are evacuated to 10 microns and helium is sprayed on the weld seams. Not more than $10^{-9}$ atm-cc/sec of helium is permitted to leak into the chambers.

B-14. Aft Skirt and Thrust Structure. The aft skirt is similar to the flight-weight article. Its lower trim line is the same as the flight stage, but the skirt is removable in sections at a point approximately 52 inches below the centerline of the LOX tank. The aft skirt supports a heavy-duty thrust structure, designed to withstand greater loads and fire temperatures than the flight-weight structure.

B-15. Aft Interstage. The battleship test stage does not use an aft interstage or a static firing skirt for support on the test stand. The stage is supported by the special frame shown in figure B-1.

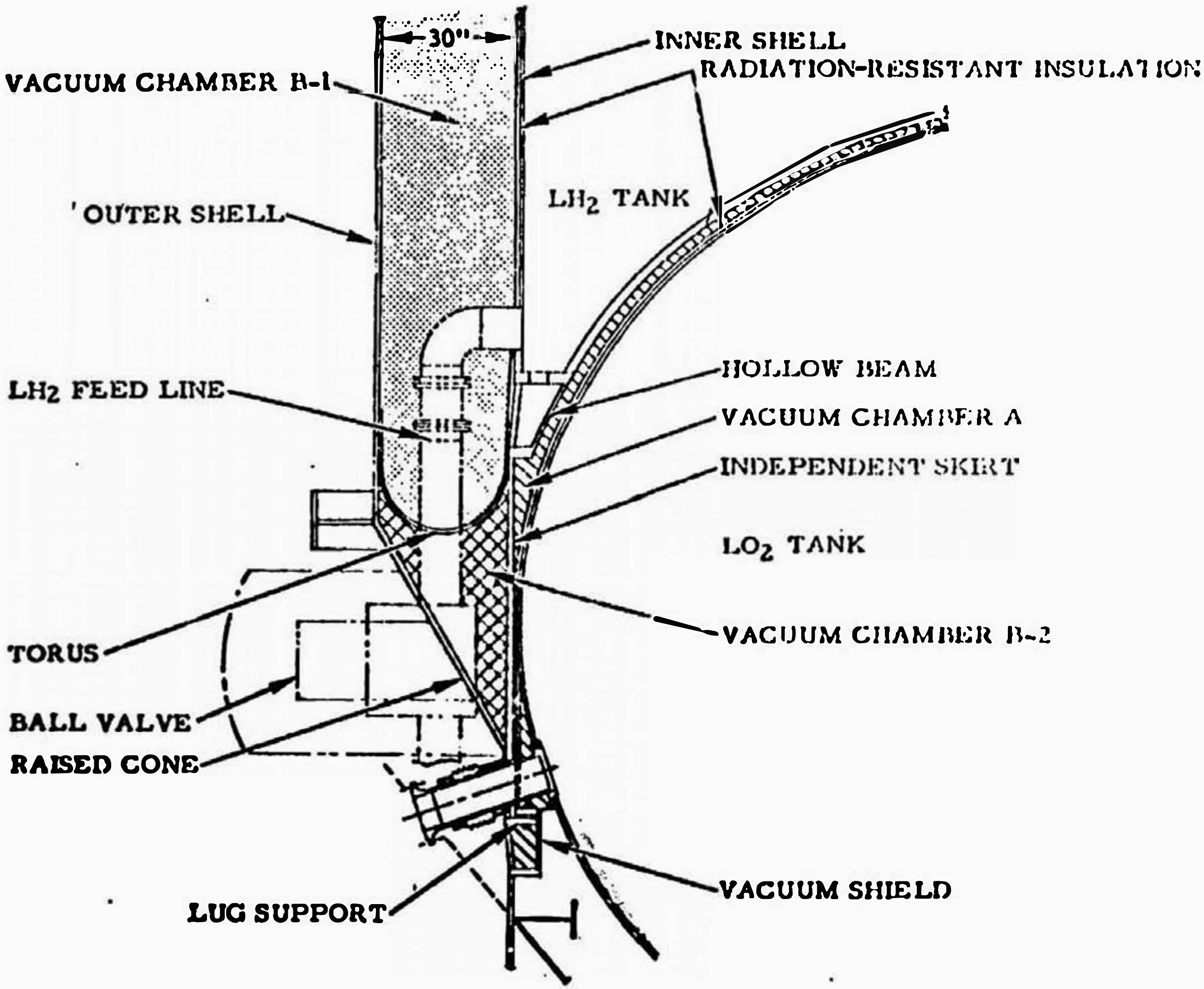


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Figure B-2. Double-Wall Construction of Battleship Test Stage

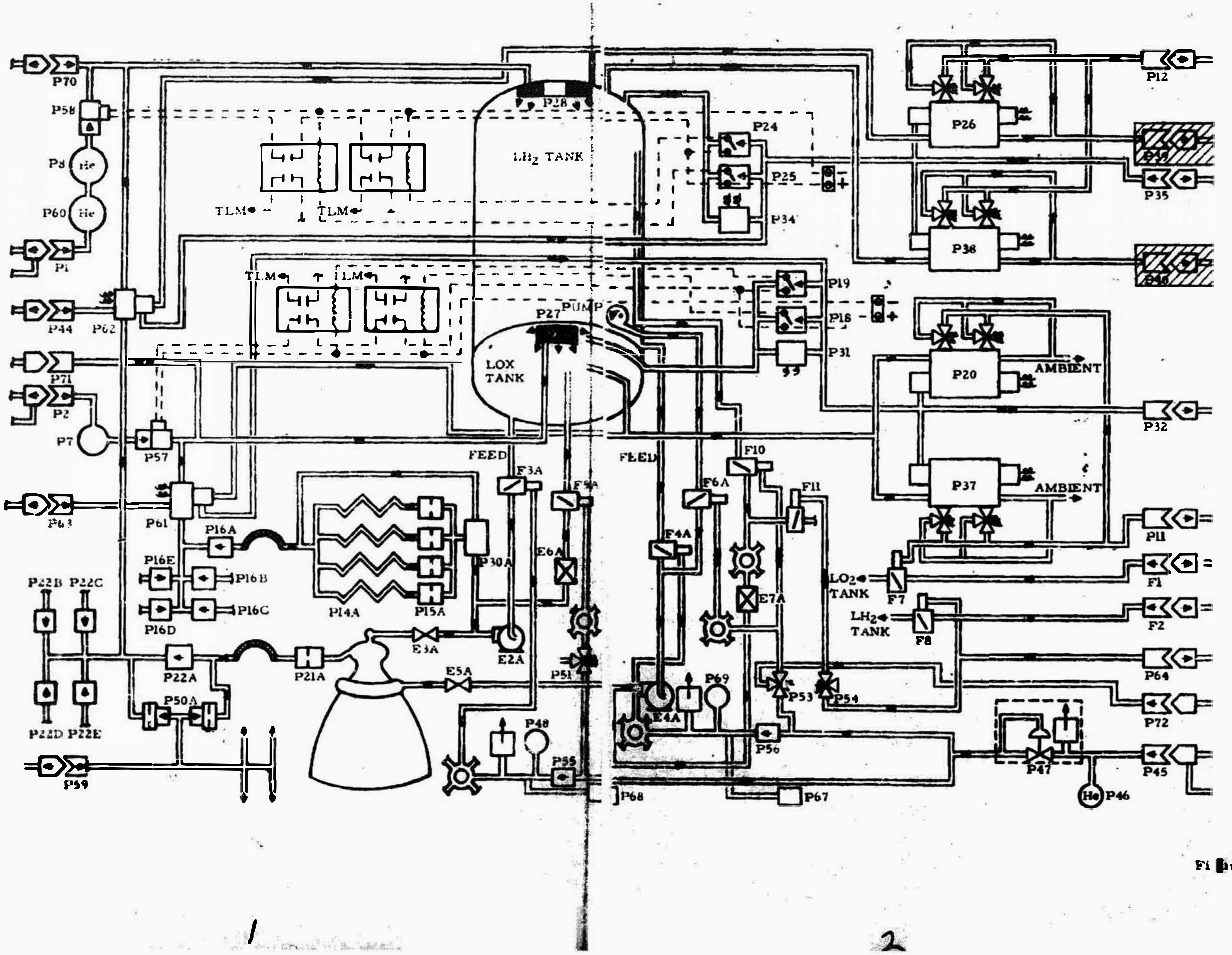
B-16. Forward Skirt. A flight-weight forward skirt is installed atop the $LH_2$ tank. Because of the difference in the $LH_2$ tank external size and shape, an adapter ring is used to attach the forward skirt to the top of the tank. The interface of the skirt and adapter is 655 inches above the LOX tank centerline.

B-17. SYSTEM DESCRIPTION. Only systems required to support J-2 engine cluster development and analysis are installed in the battleship test stage. This means that, in general, all flight systems are installed except the emergency detection, separation, propellant dispersion, ullage motor, radio frequency systems, and portions of several other systems as described later. The systems that are installed, however, do not necessarily duplicate flight systems because of the R&D nature of the battleship test stage. Some components are substitutes or prototypes which are scheduled to be replaced by production components if these components become available. An attempt is made, however, to duplicate flight systems as closely as feasible or necessary in order to carry out the stated test objectives of the battleship program. The following paragraphs describe the major or general deviations of the installed battleship systems from the flight stage systems. These descriptions do not necessarily include all possible temporary component omissions or interchanges of substitute, prototype, and production components because component delivery schedules are naturally subject to rapid changes.

B-18. Pressurization. Although the pressurization system is functionally similar to the flight system, most system components are prototypes of flight hardware. This system cannot be used until the required confidence level is achieved by breadboard testing. The facility pressurization and venting system, installed in the central area of the forward skirt, can be substituted for the stage system. However, five-engine cluster firings cannot be accomplished without the operation of the stage system. This is due to the limited flow capacity of the facility system. Figure B-3 shows the pressurization system configuration. It is a flight-type system except for the fact that the $LH_2$ vent disconnects P39 and P40 are bypassed by hard lines.

B-19. Propellant Fill and Drain. The battleship configuration for propellant fill and drain is shown in figure B-4. This system is flight-configured, except that the flight-type, airborne halves of the LOX and $LH_2$ fill and drain disconnects are not compatible with the hard-line design of the battleship test stand and, therefore, are not used. Instead, hard lines are connected directly to the $LH_2$ fill valve and to the LOX fill and drain line.

B-20. Engine. The development set of engines for the battleship test stage are flight-configured, except for a few small areas. First, the oxidizer and fuel bleed valves are smaller; stage-controlled, normally closed instead of engine-controlled, normally open; and connected differently into the engine system. (See figure B-5.) Second, the fuel pump used is a prototype which does not meet the nominal pressure static head (NPSH) requirement of 192 feet for the flight




**LEGEND**

**PRESSURIZATION SYSTEM COMPONENTS Furnished by S&ID**

- P20, P26, P37, P38 LOX & $LH_2$ Tank Vent Valves
- P34, P31 Fill Pressure Switch
- P18, P19, P24, P25 Pressure Switch
- P1, P2, P45 Helium Fill Disconnect
- P39, P40 $LH_2$ Tank Vent Disconect
- P16, P22 Engine Isolation Check Valve
- P7, P8, P60 Helium Receiver
- P50, P55, P56 Helium Purge and Actuation Check Valve
- P11 Actuation & Receiver
- P12, P64, P32, P35 Checkout Disconnect
- P46 Recirc Helium Receiver
- P48 LOX Recirc Helium Receiver
- P47 Recirc Regulator
- P57, P58 Helium Pressurization Solenoid Valve
- P51, P53, P54 Recirc Solenoid Valve
- P61, P62 Tank Pressure Regulator
- P44, P63 Checkout Disconnect
- P59 Purge Disconnect
- P67 $LH_2$ Recirc Relief Test Connector
- P68 LOX Recirc Relief Test Connector
- P69 $LH_2$ Recirc Helium Receiver
- P72 $LH_2$ Pre-Valve Static Firing Actuation Disconnect
- P70 Positive Pressure Disconnect - $LH_2$
- P71 Positive Pressure Disconnect - LOX
- P27 Gas Distributor
- P28 Gas Distributor

**PRESSURIZATION SYSTEM COMPONENTS Furnished by Rocketdyne as part of the Engine**

- P14 LOX Vaporizer
- P15 LOX Vaporizer Inlet Orifice
- P21 $GH_2$ Equilizer Orifice
- P30 LOX Vaporizer Anti-Flood Check Valve

**ENGINE SYSTEM COMPONENTS**

- E2 LOX Turbo Pump
- E3 LOX Main Valve
- E4 $LH_2$ Turbo Pump
- E5 $LH_2$ Main Valve
- E6 LOX Gas Generator Bleed Valve
- E7 $LH_2$ Gas Generator Bleed Valve

**PROPELLANT SYSTEM COMPONENTS**

- F1 LOX Filling Disconnect
- F2 $LH_2$ Filling Disconnect
- F3 LOX Tank Pre-Valve
- F4 $LH_2$ Tank Pre-Valve
- F5 LOX Return Valve
- F6 $LH_2$ Tank Pump Discharge Valve
- F7 LOX Fill Valve
- F8 $LH_2$ Fill Valve
- F9 LOX Overboard Bleed Valve
- F10 $LH_2$ Return Valve
- F11 $LH_2$ Purge Valve

DISCONNECTS BYPASSED BY HARD LINES

Manifold

Relief Valve

NOTE:
Although the Engine and Propellant System components listed above are not part of the Pressurization System; they are identified by name merely to obtain continuity in utilizing the Pressurization Schematic Drawing.

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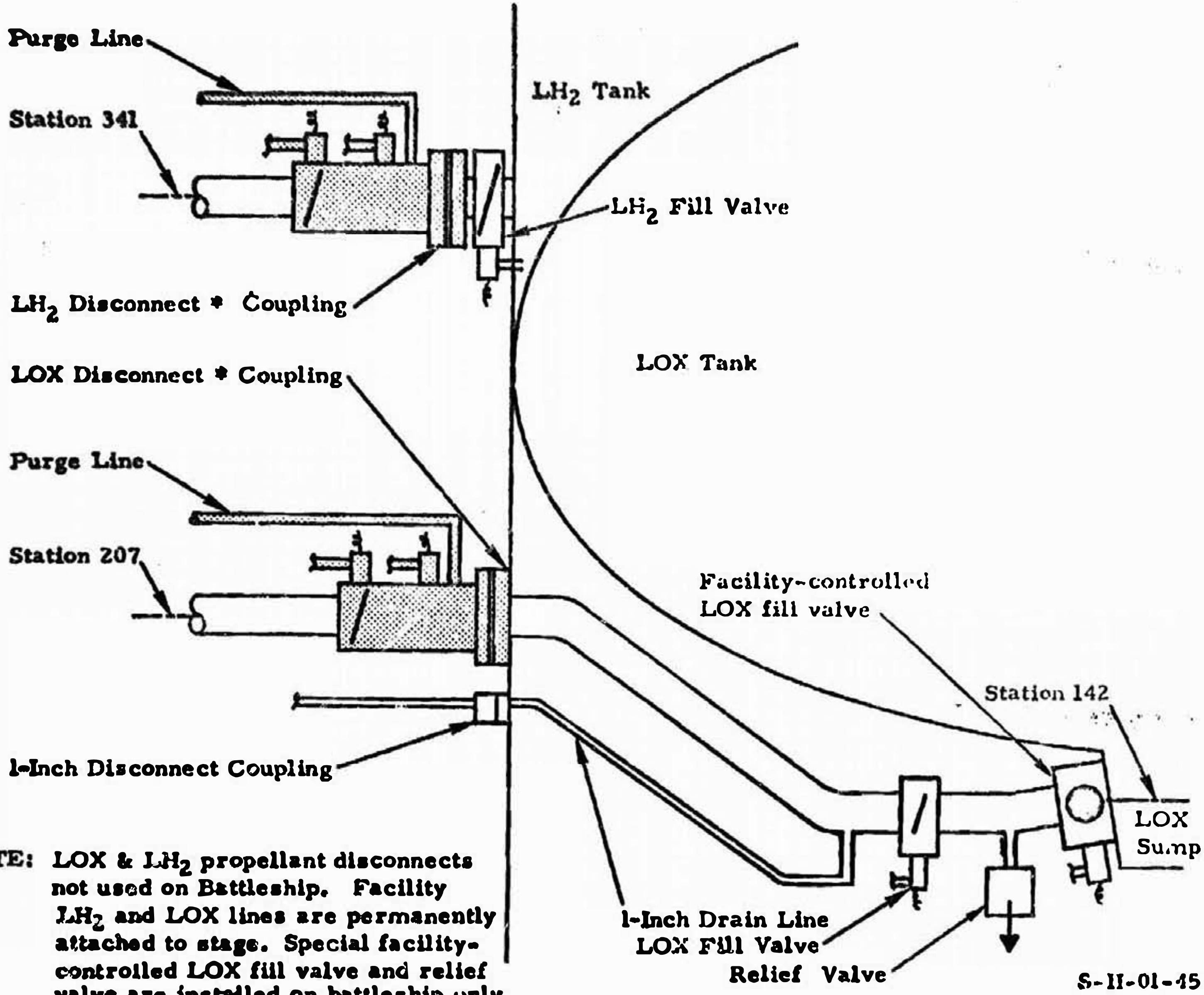
Figure B-3. Pressurization System Configuration for Battleship Test Stage




* NOTE: LOX & $LH_2$ propellant disconnects not used on Battleship. Facility $LH_2$ and LOX lines are permanently attached to stage. Special facility-controlled LOX fill valve and relief valve are installed on battleship only.

Figure B-4. Propellant Fill and Drain System Configuration for Battleship Test Stage

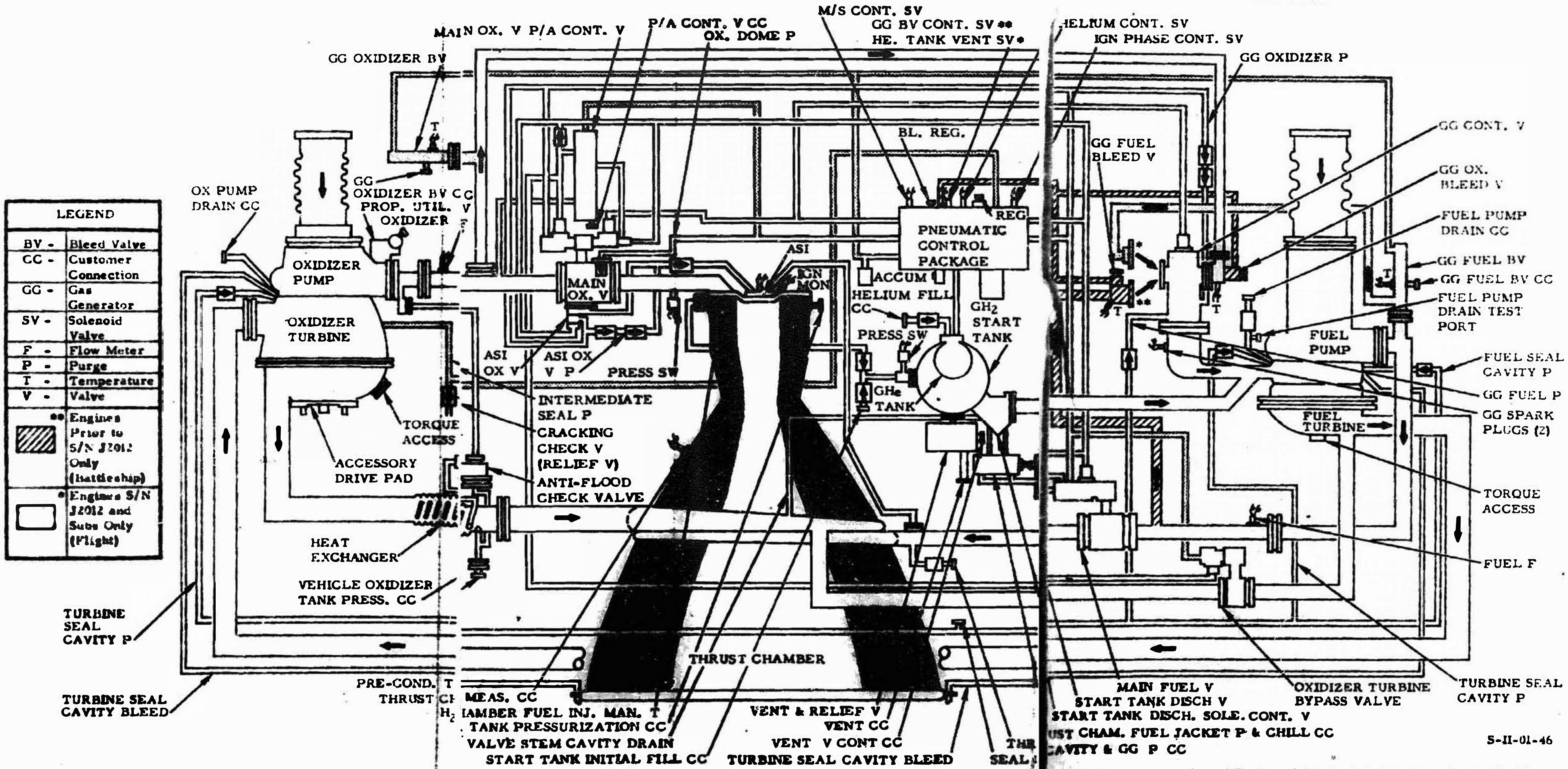



Figure B-5. Configuration of Engines Initially Scheduled for the Battleship Test Stage

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stage. As a result, the start-tank pressure is 450 psia higher than the flight stage, and the engine fuel inlet pressure requirement is 8.5 psia higher than that of the flight stage. Third, the back pressure on the oxidizer pump seal drain must be held to less than 10 psig, instead of 30 psig. This decrease is due to an intermediate seal purge line not being present on these engines to supplement the seal. The aforementioned differences from the flight configuration hold true for engines prior to serial number J2012, all of which are scheduled to be installed on the battleship stage. Along with these, other differences exist: the electric cabling on the battleship engines is not armored or pressurized; the propellant utilization valve is of the gate/actuator type; and the gas generator overtemperature cutout is ground-controlled. The fuel and oxidizer pumps are fitted with substitute Naflex-configured seals made from 718 inconel steel, with a teflon coating. The type of seal to be used on the flight stage is still being determined. The manifold configurations for engine servicing are similar but not identical to their flight counterparts because of interface differences and the higher start-tank pressure requirement.

B-21. Engine Compartment Conditioning. Since the engine compartment on the battleship test stage is open, there is no requirement for maintaining a minimum temperature for equipment conditioning purposes. However, the compartment must be maintained in an inert condition as does the flight stage. This task is normally accomplished by a single flight purge manifold in flight, or a combination of a static firing purge manifold (A7-73) and an auxiliary purge manifold (A7-57) when the flight stage is undergoing static firing tests at MTF. On the battleship test stage, however, the flight purge manifold is replaced by the battleship purge manifold only. (See figure B-6.) Purge gas is projected upward only at an angle of 30 degrees above the horizontal. Downward purge is not required because the static firing skirt is not used on the battleship test stage. The auxiliary purge manifold is not required because the vent holes through the upper perimeter of the static firing skirt are larger than those on the flight stage.

B-22. Electrical Power. The four batteries, current sensors, ignition bus power distributor, and power transfer switches for the main and instrument d-c buses are not installed because ground power is used exclusively. Power modules for the rate gyros, accelerometers, battery heaters, and mistram transponders are not installed. The inverters for the fuel recirculation pump motors are mounted on the forward skirt, since the pump wiring access is through the forward bulkhead of the $LH_2$ tank on the battleship test stage.

B-23. Thermal Control. Functionally, the thermal control system is similar to the flight system. Physically, the ducting is changed to conform to peculiar interfaces and the smaller number of containers requiring conditioning. The battleship containers are aluminum; whereas, the flight containers are Fiberglas. (See figure B-7.)

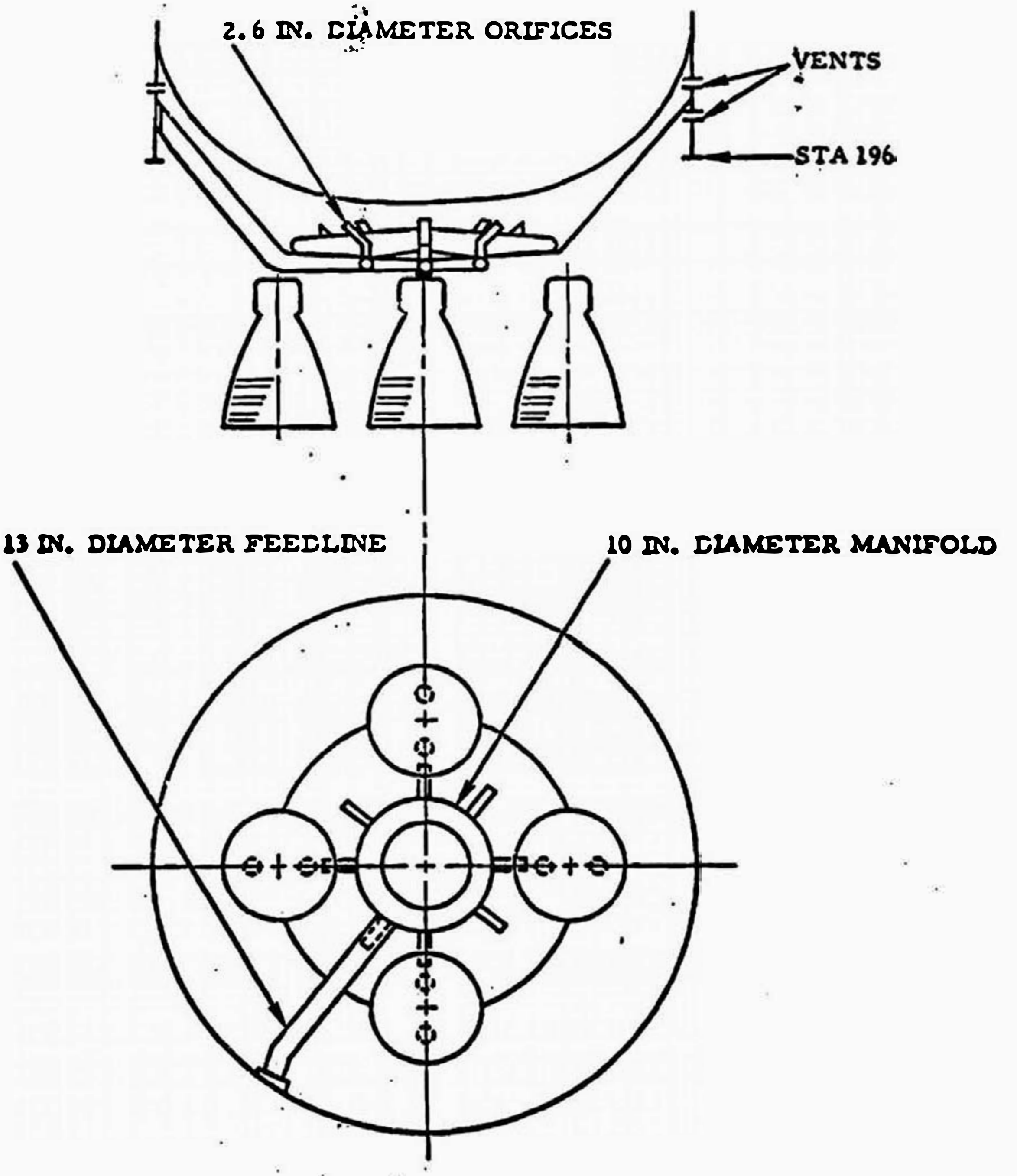


Figure B-6. Engine Compartment Purge System for Battleship Test Stage

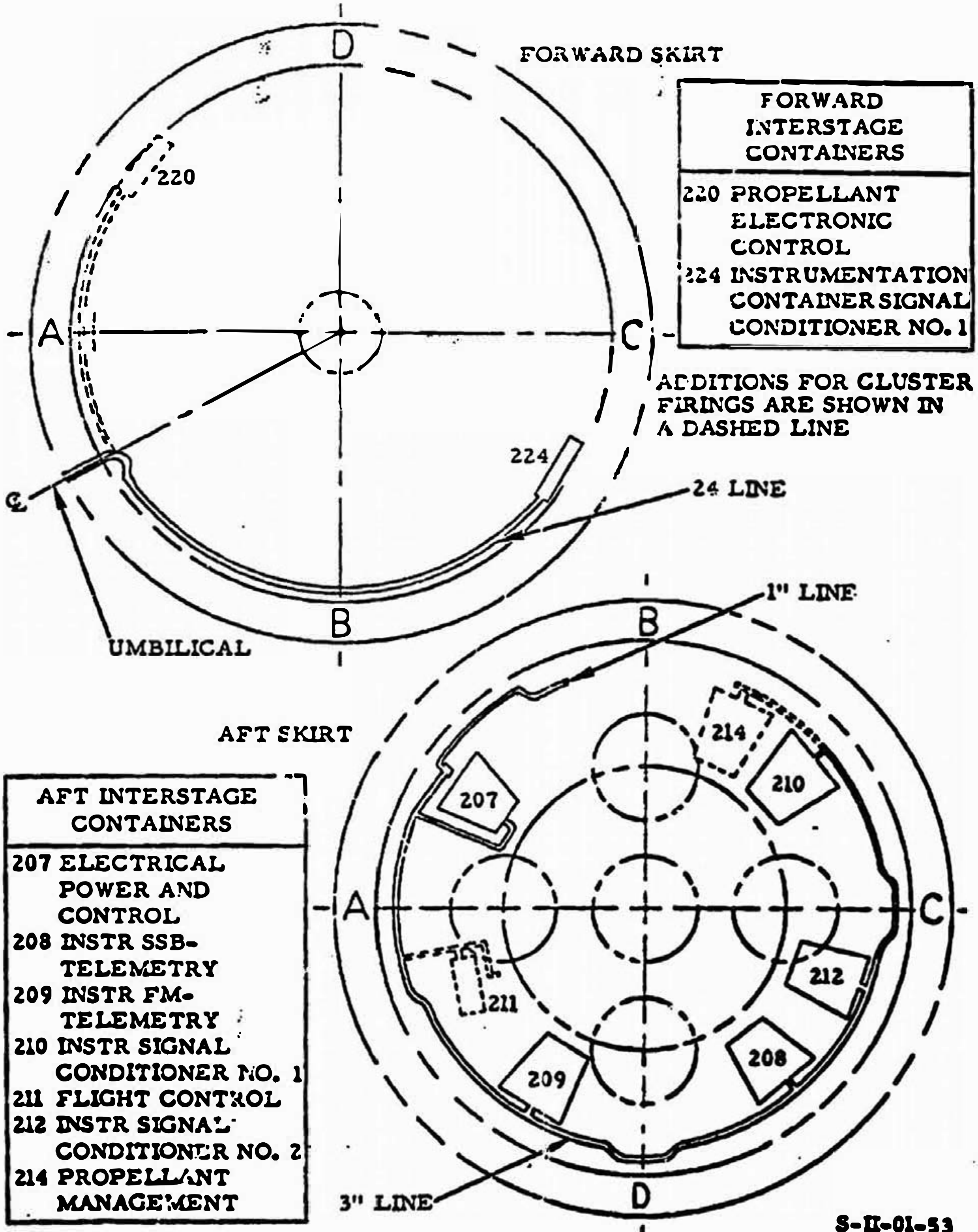


Figure B-7. Thermal Control System for Battleship Test Stage

B-24. Insulation Simulation System. The $LH_2$ tank is of double-wall construction, primarily to permit duplication of the heat-transfer characteristics of various types of flight-weight insulation. The heat-transfer characteristics are obtained by regulation of the gas pressure within vacuum chambers A, B-1, and B-2. (Refer to figure B-2.) First, each of the chambers is evacuated to a hard vacuum and checked for vacuum decay. Then, helium, or another gas, is injected until the desired vacuum level is attained, thereby reproducing the desired heat-transfer characteristics of the flight-weight insulation being simulated. Finally, the chambers are isolated and $LH_2$ tank chill-down operations are initiated.

B-25. $LH_2$ Tank Chill-Down System. The battleship stage has a special chill-down system for the $LH_2$ tank. (See figure B-8.) This system uses $LN_2$ to bring the temperature of the inner shell of the tank down to approximately minus 300°F prior to filling the tank with $LH_2$ at a temperature of minus 423°F. About eight hours are required to bring the inner-shell temperature down to minus 300°F with $LN_2$.

B-26. MEASUREMENT SYSTEMS. As stated previously, no radio frequency components are installed on the battleship test stage. The necessary measurements are transmitted from the stage to recording and monitoring equipment through hard-wire systems. A number of special measurements are made on the battleship test stage which are not made on the flight stage. On the other hand, many flight stage measurements are not required of the battleship test stage because of its incomplete system complement. NAA report SID 63-1299 lists the measurements that are programed for the battleship test stage.

B-27. DESIGN CHANGES.

B-28. CONFIGURATION CHANGE POINTS. Configuration change points (CCP's) have been established for all S-II stages. CCP's are defined to be points along stage assembly, checkout, and testing operations which are conducive to the incorporation of design changes. Each of these points has been assigned an identification number to facilitate ease of documentation. As each S&ID master change record (MCR) is processed, determination is made as to the need for deferment of the change on one or more of the stages. Appropriate CCP numbers are then assigned which describe the desired immediate installation or deferment. Table B-2 lists the established CCP's for the battleship test stage. The calendar dates given are subject to change with changes in engineering test and production schedules.

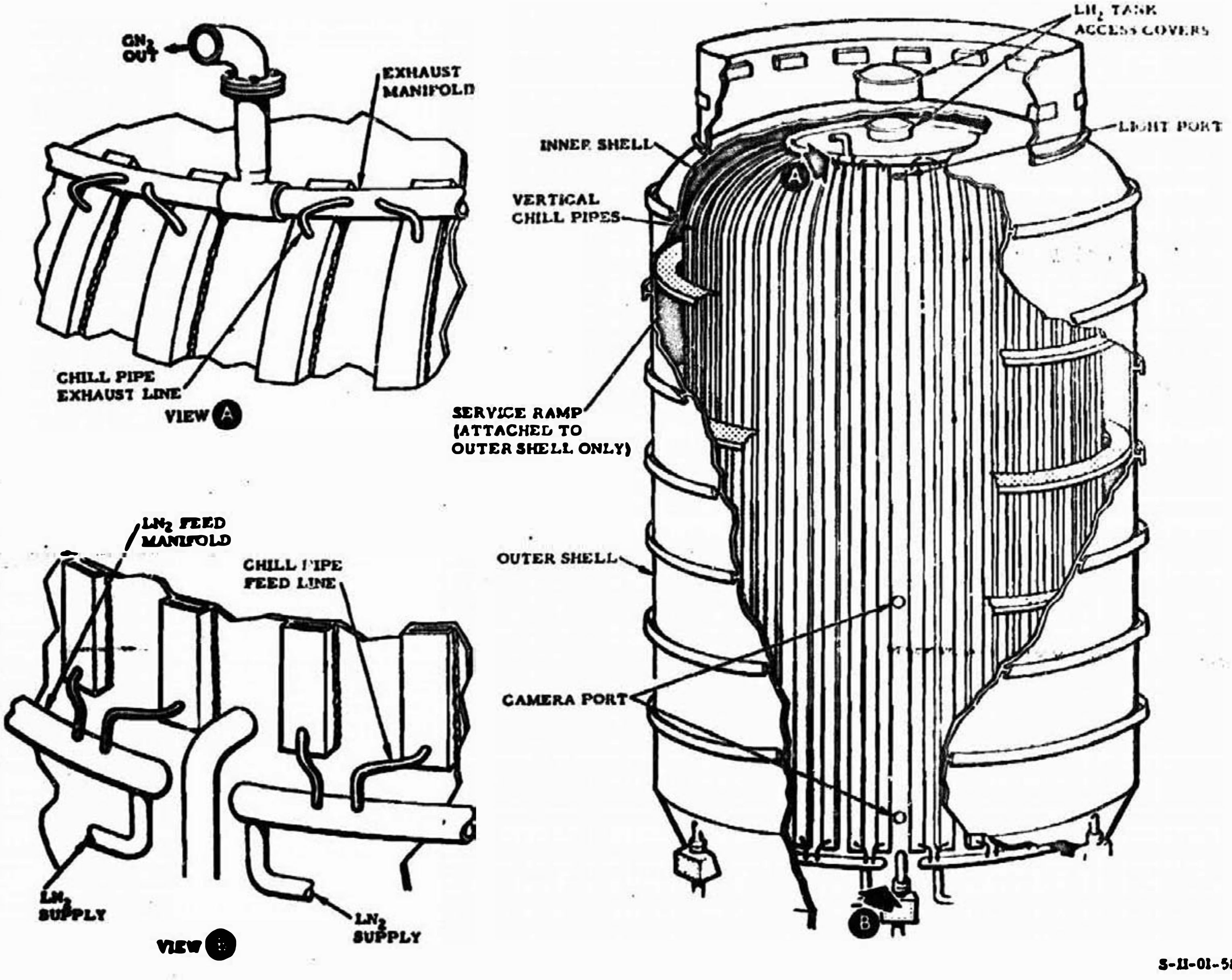


Figure B-8. $LH_2$ Tank Chill-Down System for Battleship Test Stage

Table B-2. Configuration Change Points for the Battleship Program

| Major CCP Number | Detailed CCP Number | Description of Point | Approx. date* |
|---|---|---|---|
| | BA020 | Start, install and checkout of electro-mechanical and propulsion systems | |
| | BA030 | Begin installation and C/O of instrumentation systems. | |
| | BA040 | Begin tests preparatory to closing $LH_2$ and LOX tanks. | |
| | BA050 | Close $LH_2$ and LOX tanks and begin tank leak checks. | |
| | BA060 | Begin cryogenic tests preparatory to installation of engine #5. | |
| | BA064 | $LH_2$ tanking tests - $LH_2$ tank | |
| | BA070 | Begin installation of engine #5. | |
| | BA080 | Begin propulsion system pre-fire C/O. | |
| | BA090 | Integrated systems C/O. | |
| BA100 | | Initiation of countdown for cryogenic tanking tests | October 1964 |
| | BA130 | Dual propellant tanking tests | |
| | BA150 | Begin integrated systems C/O. | |
| | BA170 | Begin simulated firing countdown. | |
| BA200 | | Initiation of the countdown for the first static firing. | November 1964 |
| | BA210 | No. 5 engine ignition | |
| | BA220 | No. 5 engine transition | |
| | BA230 | No. 5 engine mainstage | |
| | BA240 | Begin installation of engine number 1 and 3. with diffusers. | |
| | BA250 | Begin integrated systems C/O. | |
| | BA260 | Begin simulated firing countdown. | |
| | BA270 | Initiate countdown for first three engine firing. | |
| | BA290 | Begin simulated firing countdown. | |
| BA300 | | Initiation of countdown for five engine cluster firing | January 1964 |
| | BA310 | Cluster transition | |
| | BA320 | Cluster mainstage | |

Table B-2. Configuration Change Points for the Battleship Program (Cont)

| Major CCP Number | Detailed CCP Number | Description of Point | Approx. date* |
|---|---|---|---|
| | BA350 | 5 second cluster firing | |
| | BA370 | 10 second cluster firing | |
| BA400 | | Initiation of countdown for first five engine cluster test of greater than ten second duration | February 1965 |
| | BA410 | 50 second cluster firing | |
| | BA420 | 150 second cluster firing | |
| | BA440 | Full duration (395 sec.) cluster firing | |
| | BA450 | Begin 2 month refurbish period | |
| BA500 | | Initiation of countdown for the first five engine cluster firing with complete flight systems installed. | September 1965 |

*Calendar dates given are subject to change with test schedule changes.

B-29. LIST OF CHANGES. Refer to Appendix F.

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# APPENDIX C

## ALL-SYSTEMS TEST STAGE (S-II-T)

C-1. GENERAL.

C-2. This appendix describes the mission, test objectives, test program, and structure and system deviations of the S-II flight stage from the S-II-T all-systems test stage. Associate GSE and facility descriptions are not included.

C-3. The S-II-T stage is a factory-assembled, flight-weight stage that is permanently installed on the Coca IV static test stand of the Propulsion Field Laboratory (PFL), located in the Santa Susana mountains. (See figure C-1.) Although this stage is the second unit from the production line at Seal Beach, it is the first fully-equipped stage to be produced. The stage is designated Model V7-1, Unit 2 by S&ID and Serial Number S-II-T by NASA.

C-4. STAGE MISSION.

C-5. The S-II-T stage serves as an intermediate step in the confidence development plan for the S-II flight stage, permitting the results of tests in the engineering development lab and on the battleship test stage to be verified in a more nearly operational configuration and environment prior to the commencement of S-II-1 flight stage flight-certification operations at MTF.

C-6. TEST OBJECTIVES.

C-7. The primary objectives of the all-systems test program are to evaluate the operation and adequancy of each installed flight-weight system and certain structural components, using both manual and automatic GSE controls; and to finalize the initial flight stage servicing, checkout, and static-firing procedures as to limits, time elements, and additional safety precautions. These finalized procedures are used to verify rough draft MTF flight-acceptance procedures. In striving toward these primary objectives, secondary objectives are also fulfilled. These include validation of repair procedures, evaluation of the spares supply system, and evaluation of the component modification and repair support system.

C-8. Specific test objectives cited in connection with the all-systems test program include the determination of the chill-down periods and top-off rates for the LOX and $LH_2$ tanks; the base cooling and heating characteristics; the leakage rates and characteristics before and after static firing; the effectiveness and adequacy of safety and back-up systems; the effectiveness and adequacy of remaining stage

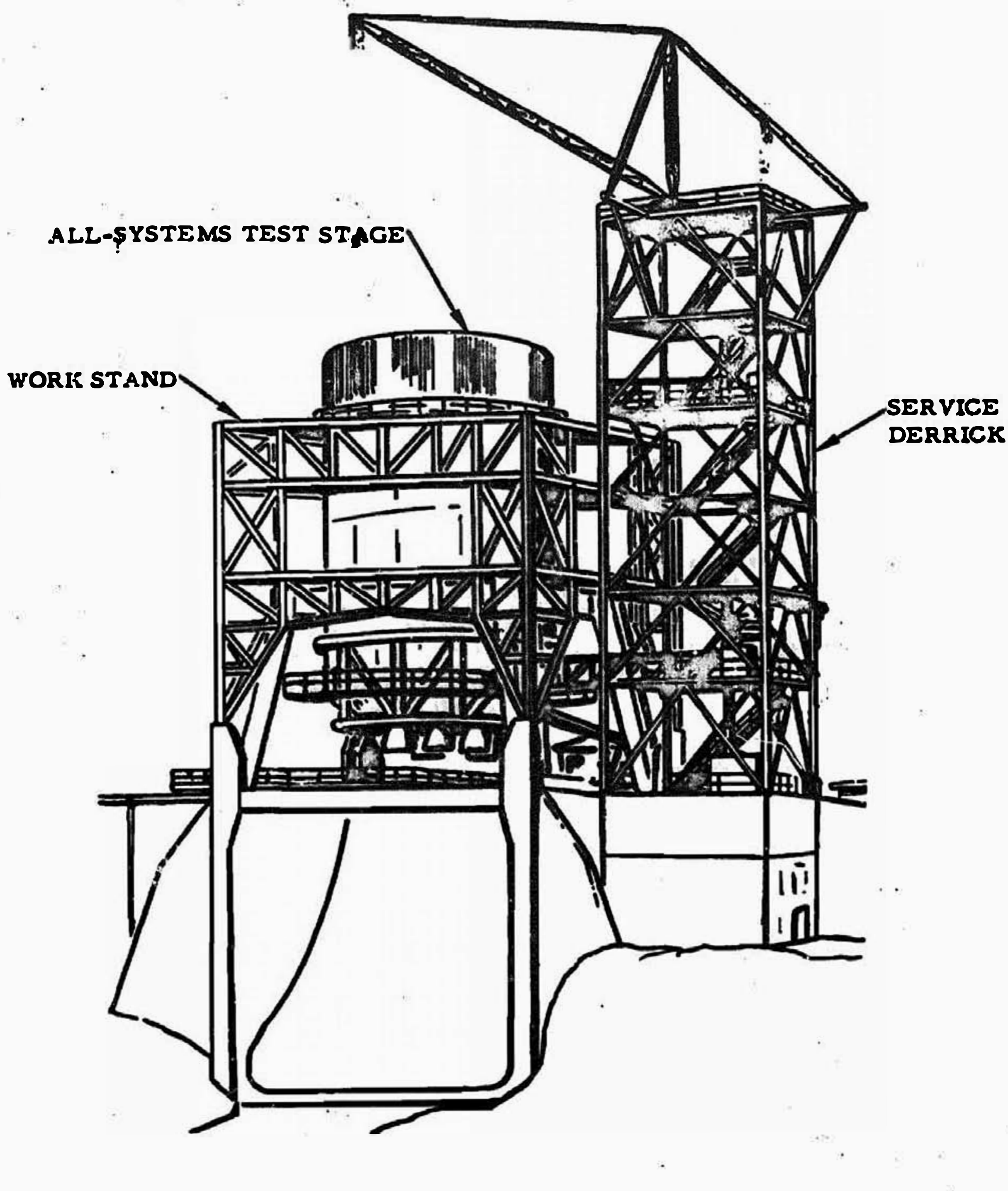


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Figure C-1. All-Systems Test Stage (S-II-T) on Coca 4 Test Stand systems; the adequacy of manual and automatic GSE systems; the adequacy of stage handling, servicing, and checkout procedures; and the compliance of this first complete stage with flight acceptance criteria.

C-9. TEST PROGRAM DESCRIPTION.

C-10. The all-systems test program provides for the initial field-type stage checkout and verification activities which link engineering design and manufacturing results with customer usage criteria. It provides for the transition of information from the R&D state to the operational state through satisfaction of the aforementioned test objectvies. To facilitate documentation and planning, the activities of the all-systems test program are divided into five general phases.

C-11. PHASE I - ACTIVATION. The effort during phase I is devoted to preparation of the Coca IV test stand; installation and functional integration of test stand, facility, and control center GSE; functional checkout of the S-II-T stage in the manufacturing area at Seal Beach; and transportation and installation of the S-II-T stage on the test stand. Automatic checkout equipment and its tape programs are debugged using the C7-44 ground equipment test set (GETS) to simulate the stage.

C-12. PHASE II - INTEGRATED SYSTEMS DEVELOPMENT. Phase II of the all-systems test program encompasses those tasks necessary to develop confidence in the integration between the stage systems and the servicing and control GSE in preparation for engine static firing tests. The major tasks are manual operations, automatic operations, and tanking operations.

C-13. Manual Operations. Manual operations include tests to verify the controllability of the stage systems and the feedback capability of the instrumentation system.

C-14. Automatic Operations. Automatic checkout operations include running the instrumentation calibration, engine system, and integrated systems automatic checkout tape programs. Simulated countdowns are performed for both tanking and static firing tests.

C-15. Tanking Operations. Cryogenic tanking operations are performed using cryogenic materials to develop procedures and confidence in the flight-weight tanks of the S-II-T stage. In the interest of safety, the first tanking test is conducted using $LN_2$ (liquid nitrogen), a less hazardous material. Although $LN_2$ at -320°F does not duplicate the temperatures and specific gravities of the S-II flight stage fuel and oxidizer, it provides a satisfactory cryogenic environment for the initial verification of tank structure, insulation bonding, chill-down rates, ullage control, thermal control, leakage and boil-off rates, etc. The second and third tanking tests are conducted using LOX with $LN_2$ and $LH_2$ with $LN_2$, respectively. Safety regulations at PFL do not permit full tanking of LOX and $LH_2$ simultaneously in flight-weight tanks. Therefore, $LN_2$ is used to simulate $LH_2$

during tanking tests with LOX and then used to simulate LOX during tanking tests with $LH_2$. In this way, a near operational environment is obtained. (The battleship stage is designed to permit full tanking with both LOX and $LH_2$ without exceeding established PFL safety regulations.) Lasting effects of the cryogenic environment on stage systems is determined by performing automatic tape checkout of the stage before and after each tanking.

C16. PHASE III - STAGE SYSTEMS DEVELOPMENT. Phase III simulates, as accurately as possible, the entire operational mission of the S-II flight stage to gain test data which can be used to evaluate the performance of the existing stage and to establish the need for an extended confidence development effort. Hot firings are conducted with durations of up to 25 seconds. Longer firings are not permitted due to PFL safety restrictions which presently limit the combined propellant load in both tanks to a maximum of 66, 670 pounds. This allows tanking to approximately 7 percent capacity.

C-17. Pretest checkout and countdown activities are conducted prior to each static firing. Integrated systems tests, manual functional and leak checks, and visual inspections are conducted after each firing to determine lasting effects of the firing on the stage and its systems.

C-18. The initial four static firings of the S-II-T stage consist of limited, simultaneous firings of all five J-2 engines (cluster configuration). The first firing is limited to ignition only, while the second firing includes a partial start transition test. These are followed by a 5-second firing and a 10-second firing.

C-19. Mainstage (full-rated thrust output) firings follow the initial four confidence build-up firings. The engines are fired simultaneously for periods lasting up to the 25 seconds.

C-20. PHASE IV - CONFIDENCE DEVELOPMENT. An extended confidence development program called Phase IV is being proposed to handle matters such as product improvement testing, safety-limit design testing, flight acceptance problem resolution, and prelaunch and flight problem resolution.

C-21. PHASE V - BOATTAIL ENVIRONMENTAL TEST. A fifth phase has been added to the all-systems test program due to the cancellation of the operations simulator and the inability of the battleship stage to provide the required conditions. It is called the boattail environmental test. This test duplicates the launch-pad configuration of the stage in regard to the closure of the aft interstage area so that the prelaunch and S-IC boost conditions of the engine compartment can be evaluated. A brief description of the boattail test follows: The engine actuation system (EAS) is permitted to warm up through operation of the auxiliary hydraulic pumps. Then, the engine system chilldown is initiated by purging the start tank helium spheres. The engine compartment conditioning GSE is then activated and allowed to operate. After approximately 20 minutes, S-II-T LOX tank filling and S-IC simulated LOX tank filling are initiated. This is followed by the chilling and filling of the $LH_2$

start tank. Full pressurization of the start tank helium spheres is then accomplished. Upon completion of S-II-T stage LOX tank filling, the LOX recirculation/engine preconditioning system is activated. Upon completion of the chilldown activity and monitoring, the engine compartment purge and conditioning system is shut down, simulating the S-IC boost phase of flight, and warm-up of the engines is monitored.

C-22. STAGE DESCRIPTION.

C-23. The S-II-T stage is basically identical to the S-II flight stage as it rests on the static firing stand at MTF, except for additional instrumentation and several configuration changes which, if incorporated, would cause an excessive program delay. These include the continued use of the original lighter-gage wall for the $LH_2$ tank and 0.8-inch thick $LH_2$ tank wall insulation, rather than 1.6-inch thick insulation as on the S-II flight stage. Also, the forward skirt skin is lighter gage aluminum.

C-24. Naturally, at the onset of the programed tests, the S-II-T stage may have other differences due to component shortages or substitutions, but these are only temporary differences and, therefore, are not included in this description. The ultimate desire is to mold the S-II-T stage into a configuration wherein the functions of the stage duplicate those of the flight stage as closely as possible.

C-25. DESIGN CHANGES.

C-26. CONFIGURATION CHANGE POINTS. Configuration change points (CCPs) have been established for all S-II stages. CCPs are defined to be points along stage assembly, checkout, and testing operations which are conducive to the incorporation of design changes. Each of these points has been assigned an identification number to facilitate ease of documentation. As each S&ID master change record (MCR) is processed, determination is made as to the need for deferment of the change on one or more of the stages. Appropriate CCP numbers are then assigned which describe the desired immediate installation or deferment. Table C-1 lists the established CCPs for the all-systems test stage. The calendar dates given are subject to change with changes in engineering test and production schedules.

Table C-1. Configuration Change Points for the All-Systems Program

| Major CCP Number | Detailed CCP Number | Description of Point | Approx Date* |
|---|---|---|---|
| | AA000 | Facility construction complete | |
| | AA020 | Start C/O of ACE (automatic equipment) | |
| | AA050 | Start C/O of ACE (static firing control equipment) | |
| | AA070 | Installation of stage in stand | |
| AA100 | | Initiation of stage checkout operations at Santa Susana | June 1965 |
| | AA150 | Start of simulated countdown operations | |
| AA200 | | Initiation of countdown for first cryogenic tanking test | Sept 1965 |
| | AA220 | Initiation of tanking test No. 2 | |
| | AA240 | Initiation of tanking test No. 3 | |
| AA300 | | Initiation of countdown for first static firing test | October 1965 |
| | AA320 | Initiation of static firing (transition) | |
| | AA340 | Initiation of static firing (mainstage) - 5 second | |
| | AA360 | Initiation of static firing (mainstage) - 10 second | |
| AA400 | | Initiation of countdown for first 25 second duration test | December 1965 |
| | AA420 | Initiation of static firing (mainstage) - 25 second No. 2 | |
| | AA440 | Initiation of static firing (mainstage) - 25 second No. 3 | |
| AA500 | | Initiation of countdown for fourth 25 second duration test | January 1966 |
| | AA520 | Initiation of static firing (mainstage) - 25 second No. 5 | |
| | AA540 | Initiation of static firing (mainstage) - 25 second No. 6 | |
| | AA560 | Initiation of static firing (mainstage) - 25 second No. 7 | |
| AA600 | | Initiation of boattail environmental tests | March 1966 |
| AA700 | | Initiation of follow-on testing (not contractually approved) | May 1966 |

*Calendar dates given are subject to change with test schedule changes.

**C-27. LIST OF CHANGES.** Refer to appendix F.

# APPENDIX D

## DYNAMIC TEST STAGE (S-II-D)

D-1. GENERAL.

D-2. This appendix describes the mission, test objectives, test program, and structure and system deviations from the S-II flight stage of the S-II-D dynamic test stage. Associate GSE and facility descriptions are not included.

D-3. The S-II-D dynamic test stage is a production S-II stage, with an external envelope duplicating that of the S-II flight stage. Stage systems are, for the most part, simulated by dummy masses to achieve the dynamic characteristics of the S-II flight stage at minimum cost and in minimum time. The stage is the fourth S-II stage from the production line at Seal Beach, and is designated Model V7-1, Unit 3 by S&ID and Serial Number S-II-D by NASA.

D-4. STAGE MISSION.

D-5. The mission of the S-II-D stage is to serve as the second-stage booster in the Saturn SA-500-D dynamic test vehicle and to possess the structural-dynamic and stage-to-stage mechanical-interface characteristics of the S-II flight stage, in support of the launch-vehicle structural dynamic tests conducted at MSFC.

D-6. TEST OBJECTIVES.

D-7. The test objectives for the S-II-D stage in the dynamic test program can be summarized with the following:

a. Obtain elastic body data through dynamic testing to verify structural dynamic response predictions.

b. Explore thrust structure compliance under dynamic conditions and obtain experimental thrust transfer functions for the Saturn V control system.

c. Assess the compatibility of the S-IC/S-II-S-IVB mechanical interfaces.

D-8. TEST PROGRAM DESCRIPTION.

D-9. The S-II-D stage is delivered to MSFC where the stage is instrumented and wired for test by MSFC personnel. Although no stage wiring is provided by S&ID, some instrumentation is provided in the engine actuation system. (Refer to Stage Description.) With the aid of an S&ID special-assistance technical team, the S-II-D stage is installed on top of the S-IC-D stage in the dynamic test facility (DTF) at MSFC, carefully checking S-IC-D and S-II-D mechanical interfaces. Next, the S-IVB-D stage is stacked on top of the S-II-D. Mechanical interfaces are again checked. This is followed by the installation of the S-IU200D/500D instrument unit and the simulated payload. (See figure D-1.) This stacked assemblage is identified as the SA-500-D dynamic test vehicle. The booster propellant tanks are serviced with appropriate amounts of conditioned water (for LOX and RP-1) and plastic foam spheres (for $LH_2$), and pressurized.

D-10. The entire vehicle is vibrated with bending, torsional, and longitudinal forces provided by a facility generator/transducer system capable of applying up to 10,000 pounds of force for the S-IC boost configuration and up to 2000 pounds of force for the S-II boost configuration of the test. The S-II boost configuration is shown in figure D-1. In this configuration, the S-II stage, with payload, is physically separated from the S-IC stage. During these dynamic tests, the shapes and frequencies of the natural vibratory modes and the transmissibility characteristics of the two vehicle configurations are recorded, analyzed, and used as support data for vehicle flight control and dynamic response investigations. Experimental thrust structure transfer functions are also obtained through engine gimbal tests during this period.

D-11. STAGE DESCRIPTION.

D-12. The S-II-D stage is delivered as an assembled stage, with a dry mass distribution, total weight, and dry center-of-gravity nearly equivalent to that of the contractural requirements of the S-II-1 flight stage. Although some errors exist in these values, they are not considered to be enough to affect the results of the dynamic test appreciably. Since the mission of the S-II-D stage does not include functional operation of most stage systems, manufacturing time has been reduced by substituting equivalent simulated masses for many of the non-operative components, by continuing to use lighter-gage aluminum skin on the forward skirt, and by retaining the R&D 0.8-inch tank wall insulation thickness. (See figure D-2.) These and other dissimilarities between the S-II-D stage and the S-II flight stage are discussed in the following paragraphs.

D-13. STRUCTURE DESCRIPTION. Structurally, the S-II-D stage differs little from the S-II flight stage. Besides stage weight and balance, the forward skirt and $LH_2$ tank construction is different, along with component mounting techniques. The differences are described below.

D-14. Weight and Balance. System components not required to be functional are either installed or mass simulated. The S-II-D stage total weight and dry mass, however, are within 3 percent of the predicted values for the S-II-1 stage; the dry c.g. is within 6 inches. Some error has been introduced knowingly

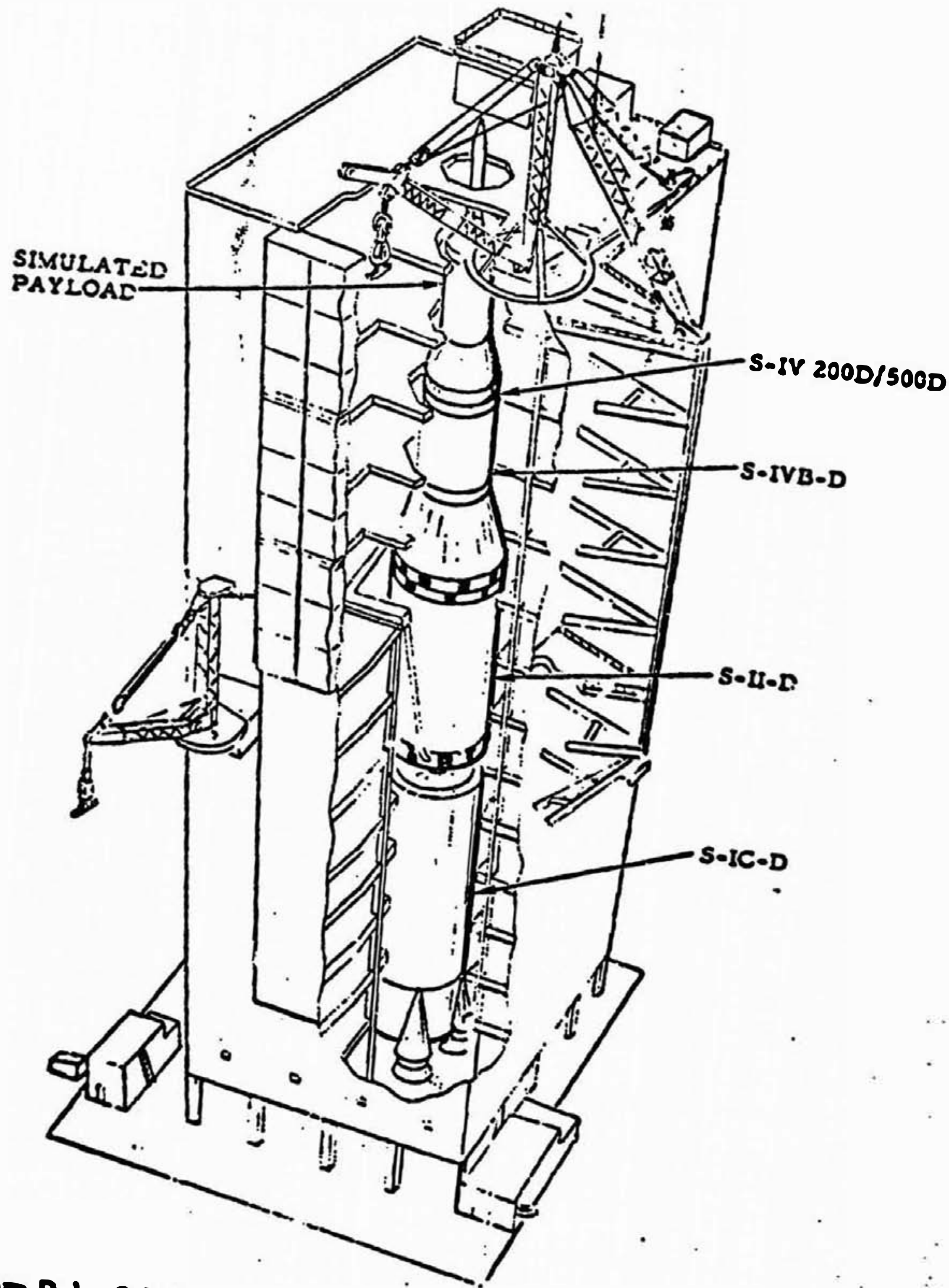


Figure D-1. S-II Boost Configuration of S.I-500D Dynamic Test Vehicle

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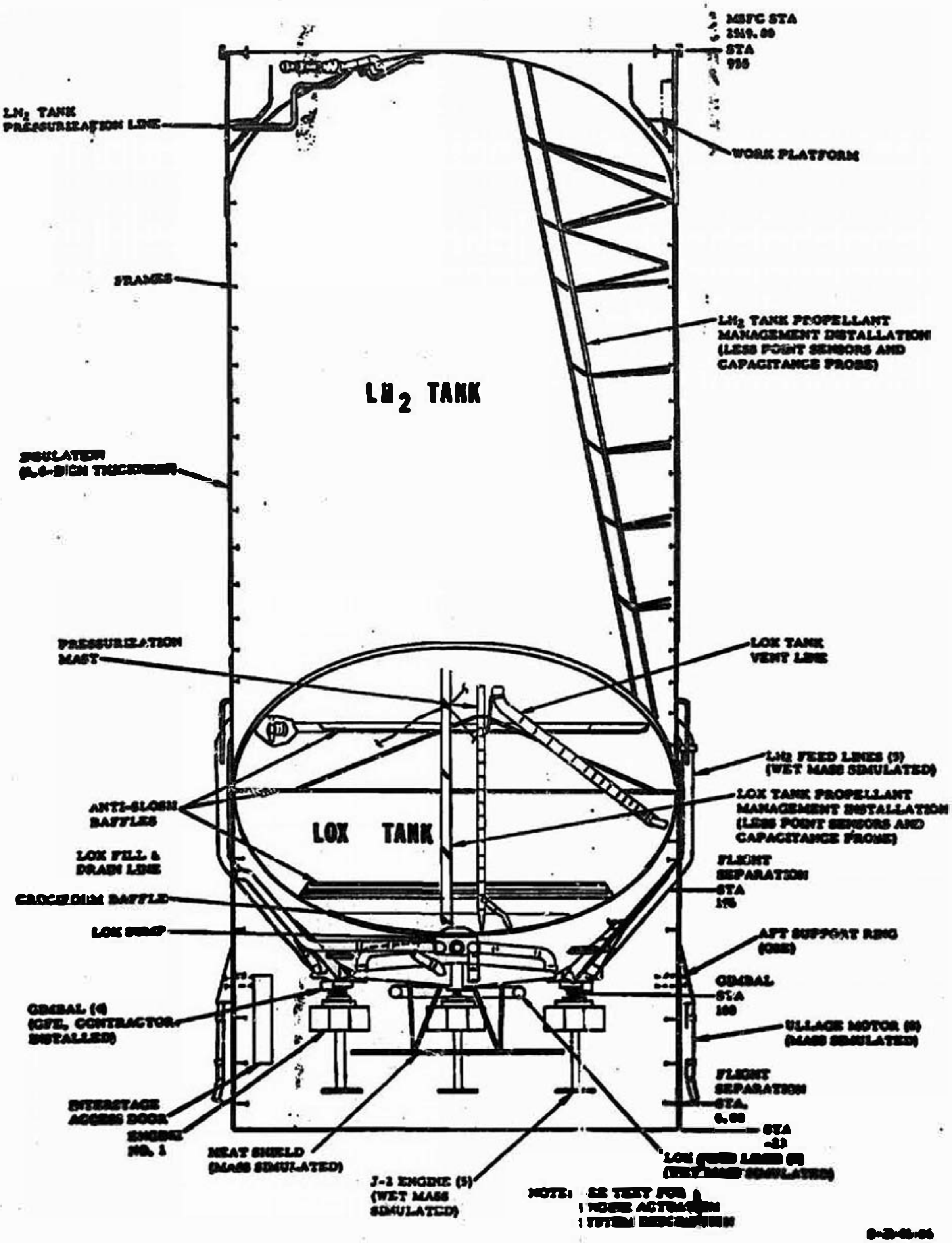


Figure D-2. Inboard Profile of S-II-D Stage because the propellant feed lines and engines are simulated as being wet, rather than dry, to simulate S-II boost conditions.

D-15. $LH_2$ Tank. Lighter-gage aluminum is used for the $LH_2$ tank wall. A NASA change order increased the S-II-1 wall thickness, but did not include the S-II-D stage in its effectivity because production would have been delayed. Also, the insulation used in the $LH_2$ tank wall of the S-II-D stage is 0.8 inch thick, instead of 1.6 inches thick as presently specified for the S-II flight stages. Engineering investigation has confirmed that neither of these differences can cause more than a one-percent difference between the modal frequencies of the S-II-D stage and the S-II flight stage.

D-16. Forward Skirt. As an expedient, lighter-gage skins are used on the forward skirt. This move has negligible effect on the mission of the S-II-D stage.

D-17. Component Mounting Brackets. Simulated components are mounted so as to simulate the components they replace; however, the method of attachment may differ from the S-II flight stage.

D-18. SYSTEM DESCRIPTION. Most system components on the S-II-D stage are either mass and c.g. simulated or are non-functional. No wiring is installed on the S-II-D stage by S&ID. The following describes the extent to which the S-II-D stage is system-equipped. (See figure D-2.)

D-19. Engine. Five dummy engines are provided. The outboard engines are mounted on GFE flight-specification gimbal bearings. The center dummy engine is installed rigidly, but not to flight specification. The dummy engine weight, c.g. location, and mass moment-of-inertia are within 5 percent of the actual wet engine. The values for the stiffness EI (modules of elasticity times moment of inertia) of the dummy engine cross-sections between the actuator attach points and the gimbal bearing are at least as great as those of the actual engine. The EI's of the cross-sections near the bottom of the dummy engine, however, are less than those of the actual engine.

D-20. Engine Actuation. The number 1 engine is provided with a complete hydraulic system (except stage wiring) for actuation of the engine. This includes all flight instrumentation integral to this system as well. Dummy engines 2, 3, and 4 are equipped with flight-type actuators only. These actuators are equipped with pressure and temperature transducers, and bleed valves.

D-21. Propellant. The propellant fill and drain system is installed, but the propellant feed lines and prevalves are simulated as being filled with propellant liquid. The propellant management system is not functional.

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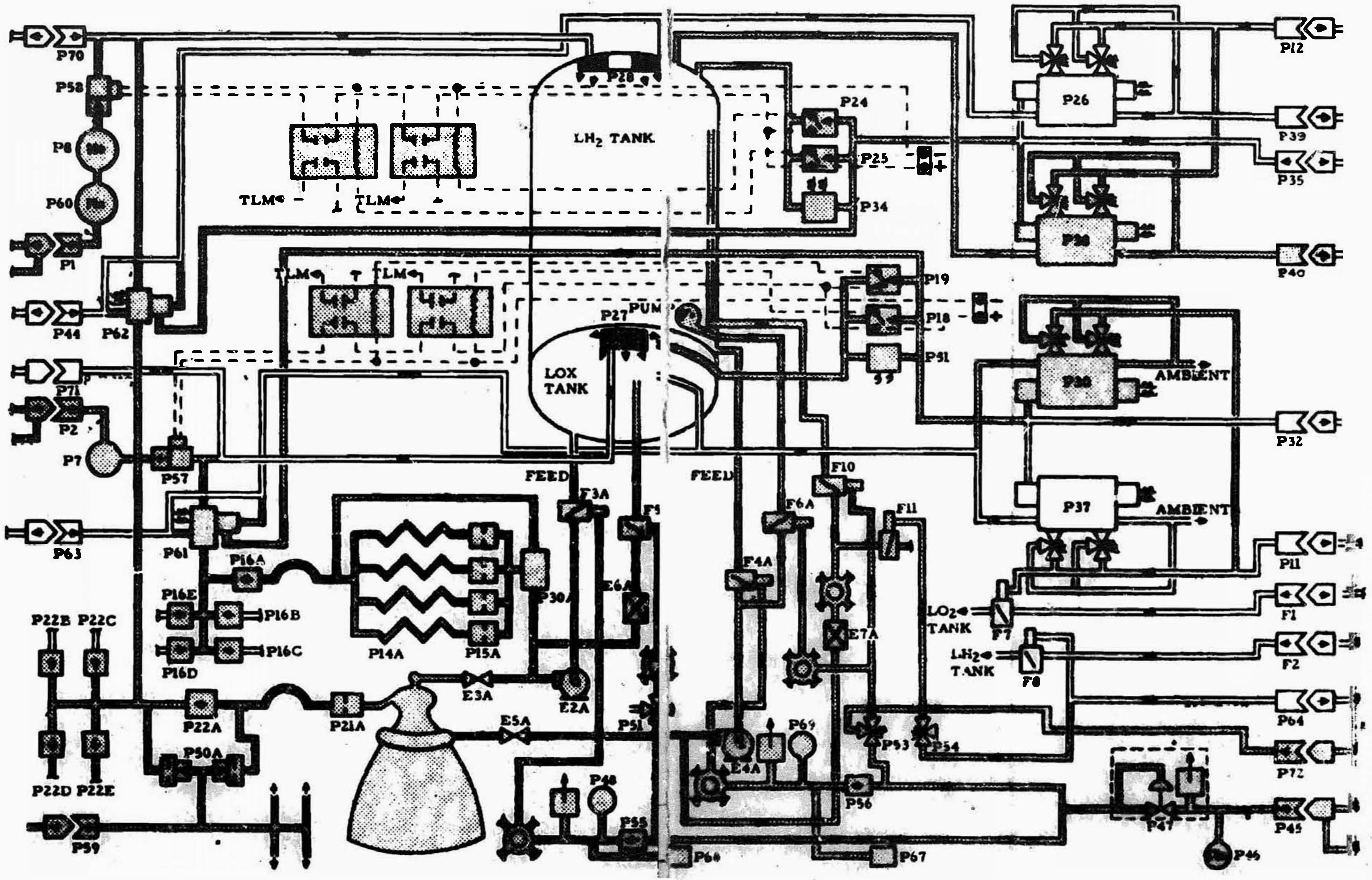
D-22. Pressurization. Tank pressurization and venting is accomplished by means of the system shown in figure D-3. Flight-type disconnects and vent valves are provided. Pressurization of the tanks is accomplished through the




| LEGEND | |
|---|---|
| **PRESSURIZATION SYSTEM COMPONENTS Furnished by S&ID** | |
| P20 P26 P37 P38 | LOX & $LH_2$ Tank Vent Valves |
| P34 P31 | Fill Pressure Switch |
| P18 P19 P24 P25 | Pressure Switch |
| P1 P2 P45 | Helium Fill Disconnect |
| P39 P40 | $LH_2$ Tank Vent Disconect |
| P16 P22 | Engine Isolation Check Valve |
| P7 P8 P60 | Helium Receiver |
| P50 P55 P56 | Helium Purge and Actuation Check Valve |
| P11 | Actuation & Receiver |
| P12 P64 P32 P35 | Checkout Disconnect |
| P46 | Recirc Helium Receiver |
| P48 | LOX Recirc Helium Receiver |
| P47 | Recirc Regulator |
| P57 P58 | Helium Pressurization Solenoid Valve |
| P51 P53 P54 | Recirc Solenoid Valve |
| P61 P62 | Tank Pressure Regulator |
| P44 P63 | Checkout Disconnect |
| P59 | Purge Disconnect |
| P67 | $LH_2$ Recirc Relief Test Connector |
| P68 | LOX Recirc Relief Test Connector |
| P69 | $LH_2$ Recirc Helium Receiver |
| P72 | $LH_2$ Pre-Valve Static Firing Actuation Disconnect |

| | |
|---|---|
| P70 | Positive Pressure Disconnect - $LH_2$ |
| P71 | Positive Pressure Disconnect - LOX |
| P27 | Gas Distributor |
| P28 | Gas Distributor |
| **PRESSURIZATION SYSTEM COMPONENTS Furnished by Rocketdyne as part of the Engine** | |
| P14 | LOX Vaporizer |
| P15 | LOX Vaporizer Inlet Orifice |
| P21 | $GH_2$ Equilizer Orifice |
| P30 | LOX Vaporizer Anti-Flood Check Valve |
| **ENGINE SYSTEM COMPONENTS** | |
| E2 | LOX Turbo Pump |
| E3 | LOX Main Valve |
| E4 | $LH_2$ Turbo Pump |
| E5 | $LH_2$ Main Valve |
| E6 | LOX Gas Generator Bleed Valve |
| E7 | $LH_2$ Gas Generator Bleed Valve |
| **PROPELLANT SYSTEM COMPONENTS** | |
| F1 | LOX Filling Disconnect |
| F2 | $LH_2$ Filling Disconnect |
| F3 | LOX Tank Pre-Valve |
| F4 | $LH_2$ Tank Pre-Valve |
| F5 | LOX Return Valve |
| F6 | $LH_2$ Tank Pump Discharge Valve |
| F7 | LOX Fill Valve |
| F8 | $LH_2$ Fill Valve |
| F9 | LOX Overboard Bleed Valve |
| F10 | $LH_2$ Return Valve |
| F11 | $LH_2$ Purge Valve |
| (shaded) | COMPONENTS AND LINES NOT FUNCTIONAL |
| Manifold | Relief Valve |

NOTE: Although the Engine and Propellant System components listed above are not part of the Pressurization System; they are identified by name merely to obtain continuity in utilizing the Pressurization Schematic Drawing.

S-II-01-51

Figure D-3. Pressurization System Configuration for S-II-D Stage positive pressurization disconnects. Tank pressure is sensed through the line from the tank to the regulator sensing port which, in turn, is connected to the line from the regulator to the regulator checkout disconnect.

D-23. DESIGN CHANGES.

D-24. CONFIGURATION CHANGE POINTS. Configuration change points (CCP's) have been established for all S-II stages. CCP's are defined to be points along stage assembly, checkout, and testing operations which are conducive to the incorporation of design changes. Each of these points has been assigned an identification number to facilitate ease of documentation. As each S&ID master change record (MCR) is processed, determination is made as to the need for deferment of the change on one or more of the stages. Appropriate CCP numbers are then assigned which describe the desired immediate installation or deferment. Table D-1 lists the established CCP's for the S-II-D dynamic test stage. The calendar dates given are subject to change with changes in engineering test and production schedules.

Table D-1. Configuration Change Points For Dynamic Test Stage

| Major CCP Numbers | Detailed CCP Numbers | Description of Point | Approx. Date* |
|---|---|---|---|
| DA100 | | Initiation of stage checkout operations at Seal Beach. | September 1965 |
| DA200 | | Preparation for shipment to MSFC. | November 1965 |

*Calendar dates given are subject to change with test schedule changes.

D-25. LIST OF CHANGES. Refer to Appendix F.

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# APPENDIX E

## FACILITY CHECKOUT STAGE (S-II-F)

E-1. GENERAL.

E-2. This appendix describes the mission, test objectives, test program, and general configuration of the S-II facility checkout stage. Associated GSE and facility descriptions are not included.

E-3. The S-II-F facility checkout stage is a production S-II stage with an external envelope duplicating that of the S-II flight stage. The stage is fitted with a limited system complement designed toward fulfilling the test objectives for the stage at MTF and at MILA, where the S-II-F stage is made an integral part of the SA-500F facilities checkout vehicle. This stage is the third S-II stage from the production line at Seal Beach and is designated model V7-1, unit 4, by S&ID and serial No. S-II-F by NASA.

E-4. STAGE MISSION.

E-5. The mission of the S-II-F stage is to duplicate the outward appearance and certain functions of the S-II flight stage so that critical areas of compatibility between the Saturn V vehicle stages and between the S-II stage and the flight-certification, vertical-assembly, and launch facilities can be verified prior to delivery of the S-II-1 flight stage.

E-6. TEST OBJECTIVES.

E-7. The test objectives for the S-II-F stage are divided between the two major facilities, MTF and launch complex 39 (MILA).

E-8. MTF TEST OBJECTIVES. The test objectives for the S-II-F stage while at MTF include:

- Mechanical compatibility checks between the stage and the GSE in the horizontal preparation area
- Mechanical compatibility checks between the stage and static firing test stand A-2
- Verification of propellant loading, draining, and pressurization facilities and procedures by performing these operations with LOX and $LH_2$ on test stand A-2.

E-9. MILA TEST OBJECTIVES. The S-II-F stage is used by the customer with assistance from an S&ID technical team to verify the following in launch complex 39 facilities at MILA:

- The compatibility between the stage and the GSE in the low bay of vertical assembly building
- Stage mating and checkout operations with the S-IC-F and S-IVB-F stages in the high bay of vertical assembly building
- Mechanical compatibility and propellant loading and pressurization operations on launch pads A, B, and C
- Installation techniques for ordnance, using inert ordnance.

E-10. TEST PROGRAM DESCRIPTION. Following completion of manufacturing and production checkout at Seal Beach, the S-II-F stage is transported by means of the land transporters, ocean vessel, and barge to MTF. The stage is processed through the horizontal preparation area, verifying stage and GSE compatibilities. Next, the stage is installed on test stand A-2 where mechanical compatibilities are checked and propellant loading and pressurizing operations are performed, using $LH_2$ and LOX. During this time, performance of the propellant management system is evaluated. The point-sensor and capacitance systems are evaluated for operation, and their performances are compared.

E-11. The S-II-F stage is then transported by barge to launch complex 39 at MILA. In the low bay of the vertical assembly building at this complex, the S-II-F is processed through a limited receiving inspection to verify its acceptability to the customer after transport and to verify GSE compatibility in that area. From the low bay the S-II-F stage is moved into the adjacent high bay of the same building where the stage is installed atop the S-IC-F stage. The S-IVB-F third stage, the S-IU-500F instrument unit, and a dummy payload are then bolted on top to form the SA-500F facilities checkout vehicle. Compatibilities are checked and ordnance installations are demonstrated, using the set of inert ordnance provided with each vehicle stage. Upon completion of vertical assembly and processing of the SA-500F vehicle, the vehicle is moved by railed transporter to each of the three launch pads. The launch/umbilical tower at each pad is checked for compatibility, and propellant fill, replenishment, drain, and pressurization operations are performed, using $LH_2$ and LOX, to verify launch pad servicing facilities.

E-12. Following completion of launch pad verification activities, the SA-500F vehicle is returned to the vertical assembly building where it is dismantled and placed into storage until needed for additional facility and vehicle compatibility assignments which may arise.

E-4. STAGE DESCRIPTION.

E-14. STRUCTURE DESCRIPTION. The S-II-F stage has all the mechanical features of the S-II flight stage, such as external protuberances, interstage interfaces, and facility interfaces. The center of gravity of the dry S-II-F stage is within 24 inches of the flight stage dry center of gravity, and its weight is within 10 percent of the flight stage weight. Only minor structural differences exist between the S-II-F and the S-II flight stage, none of which hinders the S-II-F stage mission. The LH2 tank is made of lighter gage aluminum and has 0.8-inch insulation, instead of 1.6-inch. These differences exist because the change to higher tank pressure and 1.6-inch insulation was not made effective on the S-II-F stage for economy and time reasons. Another difference is the deletion of the heat shield and thrust cone insulation, since functional engines are not provided.

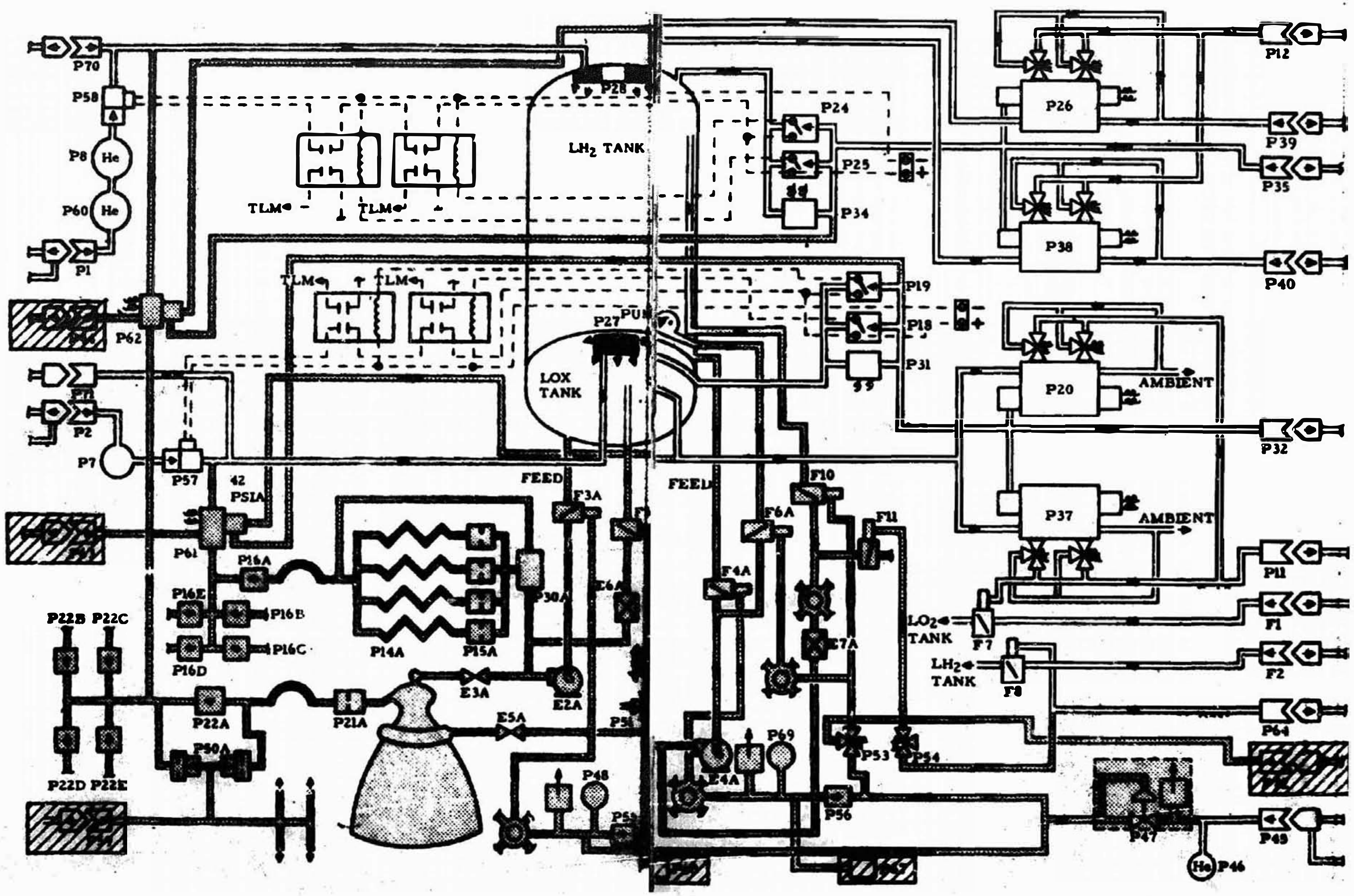
E-15. SYSTEM DESCRIPTION. Systems and system components not required for fulfillment of the stage mission are either deleted from the S-II-F stage, or are replaced by simulating masses to maintain a near standard stage weight and center of gravity. All interface connections are installed and are to flight stage specification, even though some are not functional. The leak detection and insulation purge system, the thermal control system, and the engine compartment conditioning system are complete and flight-type. The other systems installed in the S-II-F stage are described in the following paragraphs.

E-16. PRESSURIZATION. The S-II-F pressurization system is flight-type, except that portions of the system that provide pressure for actuation of valves in the propellant feed and recirculation systems are not installed; although, the high-pressure helium receivers are provided, along with the fill disconnects and interconnecting lines. (See figure E-1.) All other disconnects are installed only to complete the GSE mechanical interface.

E-17. PROPELLANT. The propellant system consists of a flight-type fill and drain system and a flight-type propellant management system. However, the engine cutoff portion of the propellant management system is not functional due to the omission of the five ECO point sensors from each tank.

E-18. ENGINES. The J-2 engines are simulated by dummy masses, rigidly mounted to the thrust structure by fixed actuator-simulator links and gimbal-plane attachments. However, the five helium/hydrogen start tanks are provided, together with their associated fill lines and disconnects. Not all engine interface connections are provided, but the GSE interface at the umbilical panel is complete.

E-19. ORDNANCE. Some inert flight-type ordnance items are provided, but no electrical wiring or electrical assemblies. Included are two pyrogen initiators, one ullage motor (all eight fairings are installed), one LH2 tank destruct charge, one LOX tank destruct charge, one CDF tee, one CDF assembly, on CDF disconnect, one separation charge (LSC assembly), one CDF manifold, and one CDF assembly (separation). These are provided for the purpose of performing ordnance installation verification tests at MILA.




LEGEND

| PRESSURIZATION SYSTEM COMPONENTS Furnished by S&ID | |
|---|---|
| P20, P26, P37, P38 | LOX & $LH_2$ Tank Vent Valves |
| P34, P31 | Fill Pressure Switch |
| P18, P19, P24, P25 | Pressure Switch |
| P1, P2, P45 | Helium Fill Disconnect |
| P39, P40 | $LH_2$ Tank Vent Disconect |
| P16, P22 | Engine Isolation Check Valve |
| P7, P8, P60 | Helium Receiver |
| P50, P55, P56 | Helium Purge and Actuation Check Valve |
| P11 | Actuation & Receiver |
| P12, P64, P32, P35 | Checkout Disconnect |
| P46 | Recirc Helium Receiver |
| P48 | LOX Recirc Helium Receiver |
| P47 | Recirc Regulator |
| P57, P58 | Helium Pressurization Solenoid Valve |
| P51, P53, P54 | Recirc Solenoid Valve |
| P61, P62 | Tank Pressure Regulator |
| P44, P63 | Checkout Disconnect |
| P59 | Purge Disconnect |
| P67 | $LH_2$ Recirc Relief Test Connector |
| P68 | LOX Recirc Relief Test Connector |
| P69 | $LH_2$ Recirc Helium Receiver |
| P72 | $LH_2$ Pre-Valve Static Firing Actuation Disconnect |
| P70 | Positive Pressure Disconnect - $LH_2$ |
| P71 | Positive Pressure Disconnect - LOX |
| P27 | Gas Distributor |
| P28 | Gas Distributor |

| PRESSURIZATION SYSTEM COMPONENTS Furnished by Rocketdyne as part of the Engine | |
|---|---|
| P14 | LOX Vaporizer |
| P15 | LOX Vaporizer Inlet Orifice |
| P21 | $GH_2$ Equilizer Orifice |
| P30 | LOX Vaporizer Anti-Flood Check Valve |

| ENGINE SYSTEM COMPONENTS | |
|---|---|
| E2 | LOX Turbo Pump |
| E3 | LOX Main Valve |
| E4 | $LH_2$ Turbo Pump |
| E5 | $LH_2$ Main Valve |
| E6 | LOX Gas Generator Bleed Valve |
| E7 | $LH_2$ Gas Generator Bleed Valve |

| PROPELLANT SYSTEM COMPONENTS | |
|---|---|
| F1 | LOX Filling Disconnect |
| F2 | $LH_2$ Filling Disconnect |
| F3 | LOX Tank Pre-Valve |
| F4 | $LH_2$ Tank Pre-Valve |
| F5 | LOX Return Valve |
| F6 | $LH_2$ Tank Pump Discharge Valve |
| F7 | LOX Fill Valve |
| F8 | $LH_2$ Fill Valve |
| F9 | LOX Overboard Bleed Valve |
| F10 | $LH_2$ Return Valve |
| F11 | $LH_2$ Purge Valve |

| | |
|---|---|
| (hatched) | DISCONNECTS INSTALLED BUT NOT FUNCTIONAL |
| (stippled) | NOT INSTALLED ON S-II-F |

NOTE:
Although the Engine and Propellant System components listed above are not part of the Pressurization System; they are identified by name merely to obtain continuity in utilizing the Pressurization Schematic Drawing.

S-II-01-57

Figure E-1. Pressurization System Configuration for S-II-F Stage

## LEGEND

### PRESSURIZATION SYSTEM COMPONENTS Furnished by S&ID

| | |
|---|---|
| P20, P26, P37, P38 | LOX & $LH_2$ Tank Vent Valves |
| P34, P31 | Fill Pressure Switch |
| P18, P19, P24, P25 | Pressure Switch |
| P1, P2, P45 | Helium Fill Disconnect |
| P39, P40 | $LH_2$ Tank Vent Disconect |
| P16, P22 | Engine Isolation Check Valve |
| P7, P8, P60 | Helium Receiver |
| P50, P55, P56 | Helium Purge and Actuation Check Valve |
| P11 | Actuation & Receiver |
| P12, P64, P32, P35 | Checkout Disconnect |
| P46 | Recirc Helium Receiver |
| P48 | LOX Recirc Helium Receiver |
| P47 | Recirc Regulator |
| P57, P58 | Helium Pressurization Solenoid Valve |
| P51, P53, P54 | Recirc Solenoid Valve |
| P61, P62 | Tank Pressure Regulator |
| P44, P63 | Checkout Disconnect |
| P59 | Purge Disconnect |
| P67 | $LH_2$ Recirc Relief Test Connector |
| P68 | LOX Recirc Relief Test Connector |
| P69 | $LH_2$ Recirc Helium Receiver |
| P72 | $LH_2$ Pre-Valve Static Firing Actuation Disconnect |
| P70 | Positive Pressure Disconnect - $LH_2$ |
| P71 | Positive Pressure Disconnect - LOX |
| P27 | Gas Distributor |
| P28 | Gas Distributor |

### PRESSURIZATION SYSTEM COMPONENTS Furnished by Rocketdyne as part of the Engine

| | |
|---|---|
| P14 | LOX Vaporizer |
| P15 | LOX Vaporizer Inlet Orifice |
| P21 | $GH_2$ Equilizer Orifice |
| P30 | LOX Vaporizer Anti-Flood Check Valve |

### ENGINE SYSTEM COMPONENTS

| | |
|---|---|
| E2 | LOX Turbo Pump |
| E3 | LOX Main Valve |
| E4 | $LH_2$ Turbo Pump |
| E5 | $LH_2$ Main Valve |
| E6 | LOX Gas Generator Bleed Valve |
| E7 | $LH_2$ Gas Generator Bleed Valve |

### PROPELLANT SYSTEM COMPONENTS

| | |
|---|---|
| F1 | LOX Filling Disconnect |
| F2 | $LH_2$ Filling Disconnect |
| F3 | LOX Tank Pre-Valve |
| F4 | $LH_2$ Tank Pre-Valve |
| F5 | LOX Return Valve |
| F6 | $LH_2$ Tank Pump Discharge Valve |
| F7 | LOX Fill Valve |
| F8 | $LH_2$ Fill Valve |
| F9 | LOX Overboard Bleed Valve |
| F10 | $LH_2$ Return Valve |
| F11 | $LH_2$ Purge Valve |

(Hatched) DISCONNECTS INSTALLED BUT NOT FUNCTIONAL

(Stippled) NOT INSTALLED ON S-II-F

NOTE:
Although the Engine and Propellant System components listed above are not part of the Pressurization System; they are identified by name merely to obtain continuity in utilizing the Pressurization Schematic Drawing.

S-II-01-57

Figure E-1. Pressurization System Configuration for S-II-F Stage

E-20. [illegible] complete flight-type stage wire harnesses are used in the S-II-F stage, although the majority of the wires and connectors are not functional. Most of the electrical power system components including batteries are not installed. The partial system consists of main, instrumentation, and ground buses, the propellant management power transfer switch and two isolation resistors. The electrical control system is flight-type but limited in its control capability, since only two relay modules are installed in the electrical sequence controller package.

E-21. MEASUREMENT. Portions of the flight-type DDAS telemetry system are provided to transmit propellant management signals through the hardwire system to the control room. (No radio frequency or tracking systems are installed.) Inasmuch as the minimum DDAS system required for this primary function has a large capacity for data transmittal, other select flight measurements, along with a number of special customer-requested measurements, are transmitted by the system also.

E-22. DESIGN CHANGES.

E-23. CONFIGURATION CHANGE POINTS. Configuration change points (CCPs) have been established for all S-II stages. CCPs are defined to be points along stage assembly, checkout, and testing operations which are conducive to the incorporation of design changes. Each of these points has been assigned an identification number to facilitate ease of documentation. As each S&ID master change record (MCR) is processed, determination is made as to the need for deferment of the change on one or more of the stages. Appropriate CCP numbers are then assigned which describe the desired immediate installation or deferment. Table E-1 lists the established CCPs for the S-II-F facility checkout stage. The calendar dates given are subject to change with changes in engineering test and production schedules.

Table E-1. Facility Checkout Stage CCP Numbers

| Major CCP No. | Detailed CCP No. | Description of Point | Approx Date* |
|---|---|---|---|
| FA100 | | Initiation of stage checkout operations at Seal Beach | May 1965 |
| FA200 | | Preparation for shipment to MTF | June 1965 |
| FA300 | | Initiation of countdown at MTF | October 1965 |
| FA400 | | Preparation for shipment to MILA | January 1966 |

*Calendar dates given are subject to change with test schedule changes.

E-24. LIST OF CHANGES. Refer to appendix F.

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# APPENDIX F

## S-II STAGE DESIGN CHANGE INFORMATION

### F-1. GENERAL.

F-2. The purpose of this appendix is to provide abbreviated information concerning S-II stage design changes. All properly initiated S&ID and customer directives and design changes generated and available as of October 8, 1964 are listed. No attempt is made to give the status of the changes other than to declare known cancellations, supersedures, or revisions. This appendix does not authorize or initiate changes or effectivities. Queries regarding the status of design changes should be directed to S-II Program Management or the Configuration Control group of S-II Engineering.

### F-3. DESIGN CHANGE INFORMATION.

F-4. The design change information is tabulated into two tables, F-1 and F-2. A glossary is contained in Table F-3 which defines design change-related abbreviations used by both the customer and S&ID.

F-5. CUSTOMER TECHNICAL DIRECTIVES. Table F-1 lists and describes by title each customer technical directive, request, and related contract letter received by the S&ID Contracts and Proposals group. With each listing is given related S&ID change control documents which present a plan of action for implementing the change requested by the customer. Of these documents, the MCR's and/or EDC's usually provide good descriptions of the proposed changes and, therefore, are listed herein under Table F-2.

F-6. DESIGN CHANGE DESCRIPTIONS. Table F-2 lists and describes all changes assigned a "uniform control number" by the Change Control group. This includes MCR's, EDC's, and TVA's. (EDC's and MCR's initiated for the same design change are assigned the same uniform control number.) The table gives an abbreviated description of the change, along with effectivities of the change. Effectivities are listed only for those design changes which directly alter the configuration of one or more of the S-II test or flight stages. Effectivities for GSE changes are not given; however, the GSE changes are described to complete the picture of existing design changes. The reader is cautioned that the effectivities shown in Table F-2 are not necessarily approved; they serve merely to flag possible effectivities for familiarization purposes. Table F-2 is current to October 8, 1964.

F-7. GLOSSARY. Refer to Table F-3 for definitions of design change-related abbreviations.

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 1 | Rigid Body Control Data for the Saturn C-5 LOR Vehicle | 19 Feb 63 | | | | | | |
| 2 | S-II/S-IC Field Splice | 14 Feb 63 | | 105 | | | | |
| 3 | Switch Selectors to Furnish Stage Sequence Signals in Conjunction with the Instrument Unit Guidance Computer | 19 Feb 63 | 56 | 65 | 11 | | | |
| 4 | Minutes of First Static Firing Working Group between NASA, S&ID, and MSFC | 25 Feb 63 | | | | | | |
| 5 | S-II Stage Rear Skirt Section | 21 Feb 63 | | 119 | | | 11 | |
| 6 | Stage Design Criteria | 27 Feb 63 | | | | | | |
| 7 | Proposal Work Platform S-II Forward Heating Frame (H7-26) | 22 Feb 63 | 166 Et Al | 110 | | | | |
| 8 | | | | | | | | |
| 9 | Vehicle and Stage Numbering System for Saturn Vehicles | 4 March 63 | | | | | | |
| 10 | Minutes of S-II Stage Vehicle Dynamics & Control Working Group | 13 March 63 | | | | | | |
| 11 | | | | | | | | |
| 12 | Action Items - J-2 Engine/Stage Interface Meeting, Feb. 6, 1963 | 16 March 63 | | | | | | |
| 13 | S-II Stage Propellant Utilization System | 20 March 63 | 130 | 99 | | | | |
| 14 | Data Submittal Documentation | 10 March 63 | | 20 | | | 55 | |
| 15 | Propellant Conditioning and Emergency Shut-Off Valves | 18 March 63 | 1[illegible], 222 | 107 | | 22 | | |
| 15-1 | Propellant Conditioning and Emergency Shut-Off Valves | 1 Oct 63 | | | | | | |
| 16 | | | | | | | | |
| 17 | S-II Facilities Checkout Vehicle | 15 March 63 | 131 | 97 | | | | |

**Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)**

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 18 | J-2 Engine Delivery for S-II Stage | 11 March 63 | | | | | | |
| 19 | S-IVB Baffle Requirements during S-II Burning | 11 March 63 | | | | | | |
| 20 | | | | | | | | |
| 21 | S-II Action Items, Dynamics and Control Working Group Meeting, 12 Feb. 1963 | 10 March 63 | 102 | 95 | | | | |
| 22 | Action Items of the S-II Vehicle Instrumental Working Group Meeting, 13 February 1963 at S&ID | 11 March 63 | | | | | | |
| 22.1 | Revision to T. D. No. 22 | 16 Dec 63 | | | | | | |
| 22-2 | J-2 Engine Leak Detection Measurements | 22 May 64 | 647 | | | | | |
| 23 | MSFC Policy for Automation of Telemetry and Rapid Frequency Ground Systems during Stage Checkout | 14 March 63 | | | | | | |
| 24 | Guidelines for Design of Ground Support Equipment Test Set | 11 March 63 | See Note | 181 | | [illegible] | | [illegible] |
| 25 | Pressure Transducers for Hydraulic Systems Pressure Arrangements | 20 March 63 | 174 | 150 | | | | |
| 26 | Automatic Checkout of Radio Frequency Systems | 26 March 63 | See Note | 184 | | 52 | | [illegible] |
| 27 | Screening of Electrical Parts for S-II Stage and GSE | 26 March 63 | | | | | | |
| 28 | Action Items of Actuator Splinter Meeting of the Dynamic and Control Working Group | 18 March 63 | 159, 178 | 91 | 22 | | | |
| 29 | Minutes of 5th Meeting/Saturn V Electrical Systems Design Integration Working Group, 18 February 1963 | 19 March 63 | 158 | 141 | | 29 | | |
| 30 | Isolation Between Networks and Telemetry | 26 March 63 | | | | | | |
| 31 | | | | | | | | |
| 32 | Transmittal of Propellant Fill Disconnect Coupling Specification Information | 28 March 63 | | | | | | |

...continued

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 33 | Action Items from the S-II/S-IVB (S-V) Interface Meetings, Splinter Group of the Vehicle Mechanical Integration Working Group | 5 April 63 | 230 | 111 | | | | |
| 34 | Action Items from the First Meeting of J-2 Eng/Stage Sea Level Testing Comm. | 2 April 63 | 218, 323 | 156, 189, 250 | 25 | 44 | | |
| 35 | | | | | | | | |
| 36 | MSFC Material Review Requirements for Major Stage Contractors, 10-9-62 | 26 March 63 | | | | | | |
| 37 | Action Items of the First Systems C/O Working Group Meeting with Stage Contractors on the S-I & S-V Programs | 2 April 63 | | | | | | |
| 38 | Flame Impingement Protection for the Center Engine of the S-II Stage | 2 April 63 | | | | | | |
| 39 | | | | | | | | |
| 40 | S-II Stage Erection Criteria | 28 March 63 | | | | | | |
| 41 | Telemetry Checkout Station | 8 April 63 | 185 | 136 | | | | |
| 41-1 | Telemeter Ground Station and DDAS Ground Station | 17 July 63 | 120, 277 | 184, 229 | | 52 | | 3647MA |
| [illegible] | [illegible] Saturn S II | 6 Aug 63 | | 254 | | | | |
| 42 | Response to Action Items for S-II Vehicle Instrumentation Working Group Meeting of February 13, 1963 | 10 April 63 | | | | | | |
| 43 | S-II Checkout Dolly Requirements Meeting of March 7, 1963 at NAA/S&ID | 10 April 63 | | 109 | | | | |
| 44 | Umbilical Arm Clearance for Equipment Removal from Saturn V [illegible] | 15 April 63 | | | | | | |
| 45 | Preliminary Test Plan for Dual Plane Separation Tests | 15 April 63 | | | | | | |
| 46 | Saturn V, S-II Stage Emergency Drain | 15 April 63 | | | | | | |

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## Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 47 | Action Items from S-II Base Heat Shield Review Meeting | 15 April 63 | | | | | | |
| 48 | Review of 12-1-62 Issue of S-II Environmental Data Documents for Stage, SID 473-1 and GSE, SID 473-2 | 23 April 63 | | | | | | |
| 49 | Explosive Hazard Class. Procedure | 15 April 63 | | | | | | |
| 50 | Delete Weight System for Horizontal Checkout Building at MTF | 13 June 63 | | 201 | | | | |
| 50-1 | Weight System for Horizontal Building at MTF | 11 Feb 64 | 534 | 366 | | | | |
| 51 | Revision to the Electro-Mechanical Systems Integration Data Submittal Requirements for the S-II Stage | 15 April 63 | | | | | | |
| 52 | Policy Concerning Use of Bridge Circuits | 17 April 63 | | | | | | |
| 53 | Action & Decision Items Resulting from the S-II Vehicle Mech. Designation Integration Working Group | 10 April 63 | 189, 190, 191 354 | 144, 2[illegible] | | 19, 41 | | |
| 54 | Trans. of LH2 Tank Wall Design Analyses | 15 April 63 | 240 | 190 | | | | |
| 55 | Implementation of Control Rate Gyros & Control Accelerometers into Stage Electrical Systems for S-V | 15 April 63 | 231 | 185 | | 34 | | |
| 56 | Procedure for Conformal Coating of Printed Circuit Assemblies | 15 April 63 | | | | | | |
| 56-1 | Conformal Coating of Printed Circuitry Boards | 5 Aug 63 | 321 | 25[illegible] | | | | |
| 57 | Action Item #1 from First Systems C/O Working Group Meeting on Saturn V, 21 February 1963 | 22 April 63 | 182 | 72 | | | | |
| 58 | Action Items resulting from the 13 March 1963 Ordnance Item Review at MSFC | 15 April 63 | 197 | 166 | | 28 | | |
| 59 | Saturn V Time Code Format | 17 April 63 | | | | | | |
| 60 | S-II Production Servoactuator | 22 April 63 | 196, 208, 213, 217 | 157 | | 26 | | |

...continued

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 61 | Saturn V Electrical Systems Schematics and Cable Interconnect Diagrams Originated by Contractors | 17 April 63 | 232, 238 | 155 | | 15 | | |
| 62 | S-II Stage Hydraulic System Buildup and Installation Fixtures & Accumulator Reservoir Manifold Assembly | 24 April 63 | See Note 143 | 184, 32 | | 52 | | |
| 63 | Solid Propellant Motor Ignition for Auxiliary Propulsion on Saturn V | 19 April 63 | | | | | | |
| 64 | Saturn V & IB Separation Criteria | 23 April 63 | | | | | | |
| 65 | Standardization of Calibration Data Formats by All Contractors | 23 April 63 | 241 | 199 | | | | |
| 65-1 | Standardization of Calibration Data Format | 5 Feb 64 | | | | | | |
| 66 | | | | | | | | |
| 67 | Proposed Implementation of Flight Stage Static Firing Measurement Program | 3 May 63 | 60 | 64 | 5 | | | |
| 68 | Action Items from the Second Meeting of the J-2/Stage Sea Level Testing Comm. | 2 May 63 | 229, 235 | 109 | | 25 | | |
| 69 | J-2 Engine Pump Inlet Conditions | 10 May 63 | | | | | | |
| 70 | S-II Base Heat Shield Review | 1 May 63 | 242 | 205 | | 35 | | |
| 71 | | | | | | | | |
| 72 | | | | | | | | |
| 73 | Substitute Control Computer | 14 May 63 | | | | | | |
| 74 | Direction in the Areas of Quality Requirements (MPC-200-3) | 23 May 63 | | | | | | |
| 75 | S-II Hydraulic Actuation System | 8 May 63 | 196, 208, 213, 217 | 157 | | 26 | | |
| 76 | Inter-Communication System for AMR & MTD | 8 May 63 | See Note | 184 | | 52 | | |
| 77 | | | | | | | | |

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 78 | Standardization of Nomenclature for Saturn V Vehicle | 8 May 63 | | | | | | |
| 79 | Electrical Systems Design Integration Group Action Items | 8 May 63 | | | | | | |
| 80 | 2nd LOC Working Group Action Items | 22 May 63 | | 230 | | | | |
| 81 | Propellant Fill & Drain Coupling | 22 May 63 | 250 | 195 | | 30 | | |
| 82 | Incorporation of QWLD Non-Clocked Connectors | 31 May 63 | | 336 | | | | |
| 83 | Special Power Supply Equipment for S-II at MTO | 31 May 63 | 280, 317, 363 | 259, 288 | | | | |
| 84-1 | S-II Engine Actuation System Installation | 9 July 63 | 13, 143 | 138, 32 | | | | |
| 85 | S-II Flight Control Switch | 13 June 63 | 268 | 202 | | 47 | | |
| 86 | Action Items from Propulsion Splinter Meeting, May 14-15, 1963 | 10 June 63 | | | | | | |
| 87 | S-II Automatic Checkout Equipment | 13 June 63 | 255, 6, 7, 8, 259, 285, 293, 343, 296, 610 | 212, 13, 14, 215, 16, 239, 467, 245 | | 84, 89 | | |
| 87-1 | Review of Electro-Mechanical Automatic Checkout Equipment | 21 Nov 63 | 363, 280, 317, 368, 476, 537 | 259, 260, 288, 301, 367, 348, 401 | | 118, 119 | | |
| 87-2 | Use of MSFC Gimbal Control Programmer at Static Firing Sites | 12 Dec 63 | 382 | 333 | | | | |
| 87-3 | Discrete Event Recording Requirements for Saturn [illegible] Checkout | 3 Jan 64 | 482 | 360 | | 126 | | |
| 88 | MSFC Transportation Plan | 13 June 63 | | 206, 253 | | | | |
| 89 | Trans. of Prem. Loads for Design of Umbilical Carrier and Push-Off Actuators | 26 June 63 | | 210 | | | | |
| 90 | Telemeter Ground Stations DDAS Ground Station | 26 June 63 | 277 | 229 | | | | |
| 91 | Minutes EBW Splinter Meeting | 17 June 63 | | 218 | | 54 | | |
| 92 | Closed Circuit Checkout of RF Systems on All Saturn V Stages at VAB | 24 June 63 | 272 | 209 | | 47 | | |

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## Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 93 | Fitting for Use on S-II Stage Engine Gimbal System | 24 June 63 | 451 | 343 | | | | |
| 94 | Criteria for Remote Checkout of Pressure Switches and Heater Blankets | 26 June 63 | | | | | | |
| 95 | Checkout of Range Safety Command Receiver (AN/DRW-13) System | 26 June 63 | 297 | 233 | | | | |
| 95-1 | Checkout of Command Destruct Receiver and Mistram Transponder for the S-II Stage | 17 July 63 | 184 | 130 | | | | |
| 95-2 | Command Destruct System Checkout Rack | 4 Dec 63 | | | | | | |
| 96 | Electrical Systems for S-II Propellant Conditioning | 5 July 63 | | 107 | | 22 | | |
| 97 | Grounding of Telemetry and Command Systems FS-V Vehicles | 1 July 63 | | | | | | |
| 98 | Saturn V Specification Weights and Compatible Trajectories | 25 June 63 | | | | | | |
| 99 | Dual Output of Transducers | 26 June 63 | | 217 | | | | |
| 100 | Saturn V Umbilical Carrier Release Switch | 3 July 63 | 135 | 115 | | | | |
| 100-1 | Saturn V Umbilical Carrier Release Switch | 17 July 63 | 135 | 115 | | | | |
| 101 | Amendments to Saturn SA-500-F Facility Checkout Vehicle Plan | 3 July 63 | 390 | 226 | | 42 | | |
| 101-1 | S-II Facilities C/O Stage (S-II-F) | 2 Oct 63 | 390 | 226 | | 42 | | |
| 101-2 | Request for Design Information Concerning Facility Checkout Stage | 20 April 64 | | | | | | |
| 102 | Stage Function Actuator (Verification Console) | 3 July 63 | 188 | 149 | | | | |
| 103 | S-V Propellant Fill Drain, and Hydrogen Vent Couplings | 3 July 63 | 250 | 195 | | 30 | | |
| 104 | Rev. of Loads Memo, M-P&VE-SL-9-62 | 1 July 63 | | | | | | |
| 105 | Trans. of Press., Vibration and Design Criteria Comments - S-V, S-II Stage | 3 July 63 | | | | | | |
| 106 | Saturn V Propellant Couplings | 3 July 63 | | | | | | |

SM-S-II-01

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 106-3 | Saturn V Propellant Couplings | 31 July 63 | | | | | | |
| 107 | Amendments to SID 348 "S-II Stage GSE Requirements and Utilizations" | 3 July 63 | 276, 298 | 223, 231, 184 | | 52 | | |
| 107-1 | Amendments to SID 348 "Saturn S-II Stage GSE Requirements and Utilizations" | 1 Aug 63 | | | | | | |
| 107-2 | Vibration Safety Cutoff System | 19 Nov 63 | | 430 | | | | |
| 108 | Centralized Timing System for MTF at Michoud | 3 July 63 | | 225 | | | | |
| 109 | | | | | | | | |
| 110 | Contract MPC-200 AMR Pneumatic Requirements | 1 Aug 63 | 358 | 272 | | 88 | | |
| 110-1 | AMR Pneumatic Requirements | 23 Oct 63 | 358 | 272 | | 88 | | |
| 110-2 | AMR Pneumatic Requirements | 6 Jan 64 | 358 | 272 | | 88 | | |
| 111 | Data Processing Equipment Requirements for Saturn S-II Stage | 3 July 63 | 288 | 227 | | | | |
| 112 | S-II-2 Instrumentation Program | 15 July 63 | 286, 577 | 235, 430 | | 51, 117 | | |
| 113 | Standard Method for Numbering of Assembled Stage Test Procedures | 15 July 63 | | | | | | |
| 113-1 | Standard Method for Numbering of Assembled Stage Test Procedures | 9 Aug 63 | | | | | | |
| 113-2 | Standard Method for Numbering of Assembled Stage Test Procedures | 7 July 64 | | | | | | |
| 114 | S-II Common Bulkhead Backup Design | 15 July 63 | | 240 | | 46 | | |
| 114-1 | S-II Common Bulkhead Backup Design | 8 Aug 63 | 344 | 240 | | 46 | | |
| 115 | S-II Stage Umbilical Disconnects | 17 July 63 | 135 | 115 | | | | |
| 116 | GSE for Battleship Test Stand at Santa Susana | 15 July 63 | | | | | | |
| 117 | S-II Umbilical Carrier Support Foot and Swing Arm Extension Bumper | 31 July 63 | | | | | | |

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## Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| [illegible] No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | [illegible] |
|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] for Checkout of all Stages on Launch Pad at AMR | 29 July 63 | 310 | 246 | | | | |
| [illegible]-1 | [illegible] for Checkout of all Stages on Launch Pad at AMR | 16 March 64 | | | | | | |
| [illegible] | [illegible] Instrumentation on S-II [illegible] Test Vehicle | 26 July 63 | | | | | | |
| [illegible] | [illegible] S-II Test Stands, FY[illegible] | 29 July 63 | 600 | 321 | | | | |
| [illegible] | [illegible] of Minutes of Flying Accessories and [illegible] Panel Meeting | 2 Aug 63 | | | | | | |
| [illegible] | Requirement for Short Instrumentation on Contractor Test Stands | 31 July 63 | 316 | 230 | | | | |
| [illegible] | S-II [illegible] Electrical Connectors | 25 July 63 | | | | | | |
| [illegible] | S-II Hydrogen Vent Coupling Locking Mechanism | 25 July 63 | 379 | 307 | | 84 | | |
| [illegible] | Action Items - 5th VMC Working Group | 25 July 63 | 462 | 322 | | 91 | | |
| 126 | Common Booster Electrical Separation Connector | 25 July 63 | 308 | 243 | | | | |
| 126-1 | Electrical Separation Connectors Required for Emergency Detection System | 21 Oct 63 | 308 | 243 | | | | |
| 127 | | | | | | | | |
| 128 | Test Requirements for the EDW Destruct System Controller | 25 July 63 | | | | | | |
| 128-1 | Test Requirements for the EDW Destruct System Controller | 6 Dec 63 | | | | | | |
| 128-2 | Test Requirements for the EDW Destruct System Controller | 9 March 64 | | | | | | |
| 129 | S-II Mechanical Test Requirements | 23 July 63 | 343 | 239 | | 69 | | |
| 130 | Common Guidance Items | 6 Sept 63 | | | | | | |
| 130-1 | Common Guidance Items | 14 Jan 64 | | | | | | |
| 130-2 | Common Guidance Items | 9 March 64 | | | | | | |

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 131 | Comments on Ullage Motor Specifications | 24 July 63 | | | | | | |
| 131-1 | Comments on the S-II Stage Ullage Motor Specification | 20 Nov 63 | | | | | | |
| 131-2 | Comments on the S-II Stage Ullage Motor Specification | 20 March 64 | | | | | | |
| 132 | $LH_2$ Vent System Installation Design Change | 24 July 63 | | | | | | |
| 133 | Saturn V Design and Testing for Vibration and Acoustic Environments | 25 July 63 | 330 | 242 | | | | |
| 133-1 | Revision to T.D. No. 133 | 28 Nov 63 | 606 | 495 | | | | |
| 134 | Electrical System Design Integration Working Group | 8 Aug 63 | 316 | 263 | | | | |
| 134-1 | Action Items of 7th Meeting of Electrical System Design Integration Working Group | 13 Aug 63 | 316 | 263 | | | | |
| 135 | Reliability Program Revisions | 1 Aug 63 | | | | | | |
| 136 | Range Safety Requirements on S-II-1FD | 6 Aug 63 | 322 | 255 | | | | |
| 137 | S-II Mechanical Test Requirements | 7 Aug 63 | | | | | | |
| 138 | Flight Type Batteries for Overall Tests at AMR | 24 Sept 63 | | 292 | | | | |
| 139 | Design Circumferential Pressure Distributions for S-V LOR Vehicle | 7 Aug 63 | | | | | | |
| 139-1 | Design Circumferential Pressure Distributions for the S-V LOR Vehicle | 14 Jan 63 | | | | | | |
| 140 | Electrical Power for J-2 Engine Component Testing | 7 Aug 63 | | | | | | |
| 141 | Saturn V Design Criteria | 7 Aug 63 | | | | | | |
| 142 | Saturn V Launch Vehicle System Specification | 22 Aug 63 | 372, 421 | 286 | | | | |
| 143 | Screen Room for the 924A Computer | 7 Aug 63 | | | | | | |
| 143-2 | Screen Room for 924A Computer for EMM | 21 Nov 63 | | | | | | |

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Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 144 | Stage Transportation Instrumentation Requirements | 6 Aug 63 | 491 | 204, 253, 349 | | | | |
| 145 | Static Firing Measurement Program | 14 Aug 63 | 291, 377 | 262, 276 | | 85 | | |
| 146 | Standard for Electrical and Electronic Reference Designations | 20 Aug 63 | | | | | | |
| 146-1 | Standard for Electrical and Electronic Reference Designations | 17 March 64 | | | | | | |
| 146-2 | Application of MSFC-STD-349 in Numbering Relays, Resistors, Diodes, and Similar Parts | 16 April 64 | | | | | | |
| 0718MA (146-3) | Electrical and Electronic Reference Designations | 17 July 64 | | | | | | |
| 147 | Removable Walkway Platform on the S-II Interstage | 21 Aug 63 | | | | | | |
| 148 | Accessibility of Safe Arm Device | 20 Aug 63 | | | | | | |
| 149 | Actuator Holding and Damping Studies | 19 Aug 63 | 159, 178 | 91, 265 | 25 | | | |
| 150 | EBW Firing Unit Specification | 20 Aug 63 | | 270 | | 50 | | |
| 151 | | | | | | | | |
| [illegible] | | | | | | | | |
| 153 | Requirements for Separable Field Connection in Launch Vehicle | 20 Aug 63 | | | | | | |
| 153-1 | Policies for Design of Mechanical Separable Seal Connectors | 18 Oct 63 | | | | | | |
| 153-2 | Policies for Design of Mechanical Separable Seal Connectors | 6 March 64 | 576, 646 | 511 | | | | |
| 154 | S-II Stage Basic Static Firing Measurement Program | 1 Oct 63 | | | | | | |
| 154-1 | Basic Static Firing Measurement Program | 21 Nov 63 | | | | | | |
| 155 | Saturn V Interface Control Drawing Transmittal | 26 Aug 63 | 346 | 268 | | | | 3718MA |

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 156 | J-2 Engine LOX and Fuel Turbopump Seal Drain Criteria | 28 Aug 63 | | | | | | |
| 157 | Vehicle Coordinate Axes and Notation System | 26 Aug 63 | | | | | | |
| 157-1 | Vehicle Coordinate Axes and Notation System | 16 Oct 63 | | | | | | |
| 158 | | | | | | | | |
| 159 | S-II Stage Hydrogen Tank Purge Requirements at AMR | 28 Aug 63 | | | | | | |
| 159-1 | EBW Firing Unit Specification | 28 Feb 64 | | | | | | |
| 160 | Cathode Ray Tube Display "Data Format" S-II/S-IVB | 8 Sept 63 | | | | | | |
| 161 | S-II Switch Selector Design Requirements | 5 Sept 63 | 364 | 287 | 11 | | | |
| 161-1 | S-II Switch Selector Description | 11 Feb 64 | 364, 660 | 287, 493 | 11 | | | |
| 7252MA (161-1) | S-II Switch Selector (Mod. 1) | 19 June 64 | | 493 | | | | |
| 162 | Design Guide Lines for the Vehicle Telemetry Channel Wiring | 29 Aug 63 | 400 | 296 | | | | 3716MA |
| 162-1 | Checkout of Continuous Telemetry Channels | 30 Sept 63 | | | | | | |
| 163 | S-II Intermediate Umbilical Carrier Withdrawal System | 5 Sept 63 | | | | | | |
| 164 | Action Items of Special Meeting Checkout Working Group | 5 Sept 63 | | | | | | |
| 164-1 | S-II Checkout Requirements | 12 Dec 63 | | | | | | |
| 164-2 | Master Schematics for S-II Stage Checkout | 23 Jan 64 | | | | | | |
| 164-3 | Continuous Monitor of Vehicle Status While in Local Control Mode | 5 Feb 64 | | 397 | | | | |
| 165 | Propulsion System Computer Program | 20 Sept 63 | 387 | 284 | | 85 | | |
| 166 | Stage Common EBW Systems Components Requirement - Drawing No. 40M02959 | 5 Sept 63 | 413, 449 | 318, 345 | | 39, 113 | | |

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Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 167 | Recoverable Cameras for S-II | 19 Sept 63 | 372 | 280 | | 172 | | |
| 167-1 | Recoverable Cameras for S-II | 6 Dec 63 | 557 | 486 | | 146 | | |
| 168 | S-II Electrical Support Equipment "ESE" | 19 Sept 63 | 406 | 323 | | | | |
| 168-1 | S-II Electrical Support Equipment "ESE" | 16 Oct 63 | 406 | 323 | | | | |
| 168-2 | S-II Electrical Support Equipment (ESE) | 5 Feb 64 | | | | | | |
| 169 | Design Ground Rules, S-V Propellant Dispersion System | 1 Oct 63 | 386 | 297 | | | | |
| 170 | Relocation of Exploding Bridgewire (EBW) Firing Units and Detonators for S-V | 24 Sept 63 | 380, 645 | 290 | | | | |
| 171 | J-2 Engine S-II/S-IVB Hydraulic Pump Interface and Start Tank Pressure Increase | 24 Sept 63 | 405 | 291 | | 40 | | |
| 172 | S-II Stage Pressure for J-2 Engine "CALIPS" Mainstage or Pressure Switches | 30 Sept 63 | 401 | [illegible] | | 103 | | |
| 172-1 | S-II Stage Provisions for the J-2 Engine CALIPS Mainstage OK Pressure Switches | 19 March 64 | 001 | 293 | | 90 | | |
| 173 | SATURN-APOLLO Manned Flight Stamp | 26 Sept 63 | | 289 | | | | |
| 174 | Vehicle Mechanical Design Integration Working Group | 1 Oct 63 | 419 | 326 | | 40 | | |
| 174-1 | Action Items/Vehicle Dynamics and Control Working Group | 20 Nov 63 | 419 | 326 | | 40 | | |
| 175 | Normally Open versus Normally Closed 2" Valves in S-II Recirculation Systems | 1 Oct 63 | 384, 568 | 298, 432 | | | | |
| 176 | Platform Requirements for Saturn V, S-II Stage | 16 Oct 63 | 399 | 310 | | | | |
| 176-1 | Work Platform Requirements for S-V | 28 Nov 63 | | | | | | |
| 176-2 | Work Platform Requirements for S-V | 4 Dec 63 | 492 | 454 | | 139 | | |
| 177 | Remote Automatic Calibration System | 11 Oct 63 | 402 | 309 | | | | |
| 178 | MSFC Comments on the S-II Stage Ullage Motor | 16 Oct 63 | | | | | | |

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 179 | S-II Stage/J-2 Engine Gimbal Actuator Lug Configuration | 16 Oct 63 | 412 | 312 | | | | 2085MA |
| 180 | Saturn V, S-II Stage Valve Position Sensors | 16 Oct 63 | | | | | | |
| 181 | S-II Vehicle Instrumentation Working Group Meeting, 24 September 1963 | 30 Oct 63 | | | | | | |
| 182 | Vehicle Dynamics and Control Working Group - 9 October 1963 | 31 Oct 63 | | | | | | |
| 183 | S-II Stage/J-2 Engine Calibration | 6 Nov 63 | | | | | | |
| 184 | Electrical Systems Design Integration Working Group | 6 Nov 63 | | | | | | |
| 185 | Installation of EBW Destruct System Controller Plug | 21 Nov 63 | 437 | 329 | | | | |
| 186 | S-II Propellant Loading Meeting, November 5-6, 1963 | 19 Nov 63 | | | | | | |
| 186-1 | S-II Propellant Loading Meeting, November 5-6, 1963 | 14 Jan 64 | | 354 | | | | |
| 187 | Welding of S-II Stage Quick-Disconnect Coupling End Fittings to Internal Piping | 21 Nov 63 | | | | | | |
| 188 | S-II Stage Base Heat Shield Meeting, [illegible] | 26 Nov 63 | | | | | | |
| 189 | Systems Checkout Working Group, 7 November 1963 | 4 Dec 63 | | | | | | |
| 189-1 | MSFC Electro-Mechanical Mock-Up Testing Documentation Requirements | 20 Feb 64 | | | | | | |
| 0712MA (189) | Standard Method of Processing Automatic Test Procedures for Saturn IB and Saturn V | 22 July 64 | | | | | | |
| 190 | Addition of Plug Supervision Circuits to S-V Stage to GSE Interfaces | 1 Jan 64 | 541 | | | | | |
| 191 | Determination of Equipment and Manpower Required to Support New Low Bay Checkout Philosophy | 21 Jan 64 | | 370 | | | | |

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Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 192 | Magnetic Pickups on J-2 Engine Turbopumps for Coil Checkout | 17 Jan 64 | 381, 560 | 304 | | 102 | | |
| 193 | MSFC's Launch and Checkout Computer Program Configuration and Control Plan | 27 Jan 64 | 537 | 401 | | 119 | | |
| 194 | Action Items/Propulsion Management Splinter Meeting | 17 Jan 64 | | | | | | |
| 195 | Saturn V Vehicle Ordnance Installation in the Vertical Assembly Building | 24 Jan 64 | | | | | | |
| 196 | S-II Engine Gimbal System Test Plan | 5 Feb 64 | | | | | | |
| 197 | S-II Stage Forward Bulkhead Protection Requirements | 30 Jan 64 | 590 | 451 | | | | |
| 0900MA (197) | S-II Forward Bulkhead Protection Requirements | 26 July 64 | | | | | | |
| 198 | Action Items - 6th Vehicle Design Ing. Group, January 8-9, 1964 | 30 Jan 64 | | | | | | |
| 198-1 | Action Items from 6th Vehicle Mechanical Design Integration Working Group | 11 March 64 | | | | | | |
| 199 | Action Items - S-V Common Ordnance Meeting - [illegible] | 30 Jan 64 | | | | | | |
| 199-1 | Action Items from the S-V Common Ordnance Splinter Meeting, December 10-11, 1963 | 24 March 64 | 604 | | | | | |
| 200 | Utilization of C7-601 Hydraulic Power Console S7-10 Hydraulic Service Jumper Unit and S7-6 Hydraulic Fluid Service Unit | 12 Feb 64 | 464, 545 | 363, 450 | | | | 3005MA 5747MA |
| 201 | MSFC-SPEC-339, Hermetically Sealed D.C. Relays for Space Vehicles and GSE | 25 Feb 64 | | | | | | |
| 202 | Relocation of First Plane Separation Detonators | 25 Feb 64 | 514 | 390 | | 114 | | |
| 203 | Routing of J-2 Engine LOX Pump Seal Cavity Bleed Lines | 28 Feb 64 | 538 | 396 | | 109 | | |
| 204 | Fill and Drain Valves Recirculation Valve and the Engine Isolation Check Valve | 6 March 64 | | | | | | |

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 205 | Work Platform Requirements for Saturn V, S-II Stage | 13 March 64 | | | | | | |
| 206 | Action and Decision Items, J-2 Engine Interface Meeting | 10 March 64 | | | | | | |
| 6683MA (206) | Additional Instrumentation, J-2 Engine Program | 10 June 64 | | | | | | |
| 207 | Electrical Wiring for Potentiometric Tape Measurements | 13 March 64 | | | | | | |
| 207-1 | Request for a Revision of T.D. 207-64 | 12 May 64 | | | | | | |
| 208 | S-II Stage/J-2 Engine Design Requirements | 24 March 64 | | | | | | |
| 209 | S-II Stage, Six J-2 Engine Configuration Study | 24 March 64 | | 421 | | | | W7342MA |
| 209-1 | Study of S-II Stage with Six J-2 Engine and/or Modified J-2 Engine | 8 April 64 | | 421 | | | | W7342MA |
| 210 | S-II Stage, Cryogenic Burst Tests of Welded 2014-T6 and 2219-T87 Cylinders | 24 March 64 | | | | | | |
| 210-1 | S-II Stage, Cryogenic Burst Tests of Welded 2014-T6 and 2219-T87 Cylinders | 30 April 64 | | | | | | |
| 211 | Action Items from Splinter Meeting of the Static Firing Working Group | 24 March 64 | | | | | | |
| 212 | Standard for Preparation of Elec. Control Drawings, -MSFC Document 40M39508A, 25 February 1964 | 2 April 64 | | | | | | |
| 213 | Saturn S-II Stage Pressurization System for Handling, Shipping, and Storage | 2 April 64 | 520 | 425 | | 135 | | |
| 214 | Action Items from the Flight Evaluation Working Group Meeting, 10 March 1964 | 2 April 64 | | | | | | |
| 215 | Coaxial Umbilical Connectors for Saturn V Vehicles | 2 April 64 | | | | | | |
| 216 | Action Items from the Vehicle Dynamics and Control Working Group, 25 February 1964 | 2 April 64 | 645 | 491 | | | | |

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Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 217 | Modifications to S-II Telemetry System | 3 April 64 | 599 | 427 | | | | |
| 218 | Instrumentation, Tracking, and Data Acquisition Subgroup of S-V Launch Operations Held, 25 February 1964 | 2 April 64 | | | | | | |
| 219 | S-II Handling Sling Adapters | 2 April 64 | 579 | 428 | | 131 | | |
| 220 | GSE Electrical Terminals | 9 April 64 | 632 | 476 | | | | |
| 693TMA (220) | GSE Electrical Terminals | 11 June 64 | 632 | 476 | | | | |
| 221 | Study of Alternate S-II Stage Abort Missions | 15 April 64 | 575 | 371 | | 86 | | |
| 222 | Lanyard Cam-Off Umbilical Release for Saturn S-II Stage | 24 April 64 | | 115 | | | | |
| 223 | Potentiometric Pressure Transducers, Zero Offset | 30 April 64 | | | | | | |
| 224 | S-II Stage Umbilical Grounding Requirements | 8 May 64 | | 115 | | | | |
| 225 | Post Separation Measurements in the S-II/S-IVB Saturn V Interstage | 6 May 64 | | | | | | |
| [illegible] | Vehicle Instrumentation Working Group - April 21st and 22nd [illegible] | 11 May 64 | | | | | | |
| 709 3MA (226) | Leak Meter Specifications | 29 July 64 | | | | | | |
| 227 | Facility Instrumentation at MTF - S-II Complex | 22 May 64 | 640, 641 | 472, 473 | | | | |
| 228 | S-II Stage Control Rate Gyro Package and Control Accelerometer Locations | 22 May 64 | 639 | 474 | | | | |
| 229 | S-II Stage Propellant Loading Signal Transmission | 25 June 64 | | | | | | |
| 230 | Overall Test Requirements for S-II Stage | 1 July 64 | | 496 | | | | |
| 231 | Emergency Detection System for S-V Vehicles | 1 July 64 | | 497 | | | | |
| 231-1 | Emergency Detection System for S-V Vehicles | 7 July 64 | | 497 | | | | |

Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| 232 | Action Items I [illegible] Electrical System Design Integration Group | 1 July 64 | | | | | | |
| 232 | Action Items Vehicle Mechanical Design Integration Group | 29 June 64 | 479 | 419 | | | | |
| 8526MA (232) | Minutes of 10th Meeting of Saturn V Elec. Design Integration Working Group | 29 July 64 | | | | | | |
| 23. | EBW Firing Units for S-II Stage | 17 July 64 | | 513 | | 138 | | |
| 234 | Stage Mounted Engine Oriented Instrumentation | 17 July 64 | | | | | | |
| 235 | Not Received | | | | | | | |
| 236 | S-II LOX Tank Upper Slosh Baffle | 10 July 64 | 657 | 502 | | 137 | | |
| 237 | J-2 Engine Interface Meeting | 17 July 64 | | | | | | |
| 2[illegible] | Static Firing Working Group Meeting Action Items | 17 July 64 | | JPL | | | | |
| 239 | S-II Ullage Motor Handling and Checkout at MILA | 23 July 64 | | | | | | |
| *[illegible]MA 8 June 64 | Static Test Use of S-II Stage Flight Transducers | 11 June 64 | | | | | | |
| *06924MA 28 May 64 | S-II Stage Forward Bulkhead Protection Requirements | 11 June 64 | 590 | 451 | | | | |
| *07471MA 8 June 64 | Random Access for Telemetry Checkout Station | 23 June 64 | | 512 | | | | |
| *07897MA 23 June 64 | Additional S-II Hardware Measurements | 26 June 64 | | 490 | | | | |
| *08106MA [illegible] July 64 | Monitoring of Sideloads During Ground Testing of J-2 Engine | 8 July 64 | | 506 | | | | |
| *08101MA 23 June 64 | S-II Stage Static Firing Instrumentation | 9 July 64 | | | | | | |
| *08318MA 1 July 64 | Request for Checkout Computer Programming Information | 16 July 64 | | | | | | |

*Change correspondence from Customer bearing no TD/TR number.

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Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| *08720MA<br>8 July 64 | CDF Assembly Length for S-II Propellant Dispersion System | 11 July 64 | | | | | | |
| *08718MA<br>2 July 64 | Segmented Cover for S-II Electrical and Instrument Containers | 17 July 64 | | 516 | | | | |
| *08719MA<br>6 July 64 | Approval of C7-603 Mechanical Checkout Console | 20 July 64 | | 508 | | | | |
| *08809MA<br>16 July 64 | Use of International System of Units on Flight Measurements | 22 July 64 | | 69 | | | | |
| *08907MA<br>13 July 64 | Automatic Particle Counters for J-2 Engine Gimbal System | 23 July 64 | | | | | | |
| *09023MA<br>13 July 64 | Electrical and Electronic Reference Designations for S-II OSE | 24 July 64 | | | | | | |
| *08908MA<br>10 July 64 | S-II Forward Bulkhead Protection Requirements | 26 July 64 | | | | | | |
| [illegible]<br>22 July 64 | Fusing of S-II/OSE Interface | 24 July 64 | | | | | | |
| *08323MA<br>6 July 64 | Structural Testing of S-II/S-IVB Interstage by DAC | 22 July 64 | | | | | | |
| [illegible]<br>1 July 64 | Selection of Switch Selector Channels | 17 July 64 | | | | | | |
| *09060MA<br>10 July 64 | S-II Umbilical Vibration Requirements | 24 July 64 | | | | | | |
| *09534MA<br>3 Aug 64 | CEC-VR-300 Tape Recorders RFI Suppression | 6 Aug 64 | | 526 | | | | |
| *09923MA<br>[illegible] Aug 64 | Pressurization System for Propellant Tank Environmental Protection System | 14 Aug 64 | 720 | 533 | | | | |
| *09777MA<br>6 Aug 64 | Weight System for Use at Horizontal Checkout Building at MTF | 13 Aug 64 | 607 | 534 | | | | |
| *09781MA<br>7 Aug 64 | Potential Longitude Oscillation (POGO) Evaluation Study | 14 Aug 64 | | 537 | | | | |

*Change correspondence from Customer bearing no TD/TR number.

## Table F-1. Customer Technical Directive, Descriptions, and List of Related Documents (Cont)

| TD/TR No. | Title | Date Rec'd | MCR/EDC No. | CRN No. | CCN No. | C.O. No. | S/A No. | Other |
|---|---|---|---|---|---|---|---|---|
| *9865MA 21 July 64 | Mod. 08, GSE Phase I Submittal Comments | 18 Aug 64 | | 538 | | | | |
| *9926MA 11 Aug 64 | Control Cable for S-II Test Stands at MTF | 17 Aug 64 | | | | | | |
| *10145MA 7 Aug 64 | Nonconformance Reporting System | 24 Aug 64 | | 543 | | | | |
| *9782MA 10 Aug 64 | Incorp. Apollo Test Requirements Into NAS7-200 | 18 Aug 64 | | 531 | | | | |
| *10475MA 25 Aug 64 | Request for Impact of Incorp. Apollo Test Requirements | 2 Sept 64 | | 531 | | | | |

*Change correspondence from Customer bearing no TD/TR number.

NOTE

CRN 184 incorporates EDC's:

Approved by C.O. 52: 12, 24, 50, 67, 81, 115, 117, 120, 125, 147, 160, 180, 184, 185, 188, 192, 206, 216, 234, 251, 257, 258, 259, 277, 278, and 477.

Pending Approval: 13, 16, 19, 22, 53, 57, 64, 66, 79, 86, 85, 86, 87, 90, 96, 97, 99, 111, 113, 114, 119, 127, 128, 141, 152, 164, 167, 168, 169, 174, 201, 205, 212, 220, 225, 243, 245, 249, 255, 256, 267, 270, 276, 298, 309, 311, 315, 332, and 341.

SM-S-II-01

## Table F-2. Change Descriptions and Effectivities

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Increases piston area of hydraulic servo actuator. | | | X | | X | X | | X | X | X | X | X | X | X | X | X | X |
| 2 | Deletes MIL-W-[illegible] specification (wire installation). | | | | | | | | | | | | | | | | | |
| 3 | Relocates separation plane from station 152 to 196. | X | 38 | | | | | | | | | | | | | | | |
| 4 | J-2 engine [illegible] conditioning study. | | | | | | | | | | | | | | | | | |
| 5 | Amends model specification SID 61-361. | X | | | | | | | | | | | | | | | | |
| 6 | Steady electric power for engine control. | X | | | | | | | | | | | | | | | | |
| 7 | Reduction in number of ullage rockets from 8 to 4. | X | | | | | | | | | | | | | | | | |
| 8 | S-II baffle configuration. (Unit #6 covered by MCR 62.) | | 62 | | | X | X | X | X | | X | X | X | X | X | X | X | X |
| 9 | Requirements for installation of wiring. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 10 | Study for prelaunch retraction of C-5 umbilical arms. | X | 39 | | | | | | | | | | | | | | | |
| 11 | Deletes SDD-208, SDD-209, and SDD-210. | | | | | | | | | | | | | | | | | |
| 12 | Deletes C7-602 and S7-11. | | | | | | | | | | | | | | | | | |
| 13 | Adds new item: A7-31 (revision of MCR deletes requirement). (Reinstated by MCR 638.) | | 638 | | | | | | | | | | | | | | | |
| 14 | Relocates retrorockets to the S-IC stage. | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 15 | Provides elevators for COCA I and IV test stands. | | | | | | | | | | | | | | | | | |
| 16 | Changes name and quantity of A7-16. | | | | | | | | | | | | | | | | | |
| 17 | Provides steel cable for instrument mounting in fuel tanks. | | | X | | | X | | X | (flight stages as required) | | | | | | | | |
| 18 | Provides graphic display panel at PFL and MTF. | | | | | | | | | | | | | | | | | |
| 19 | Reduces quantity of C7-15 (deletes one for PFL and MTF stands). | | | | | | | | | | | | | | | | | |
| 20 | Cancels major EDWA's 6713 and 6714. | | | | | | | | | | | | | | | | | |
| 21 | Relocates J-2 engine connector panel from engine to stage structure. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | Deletes A7-19 engine blastoff cover. | | | | | | | | | | | | | | | | | |
| 23 | Deletes remote pressure changing capability on C7-601. | | | | | | | | | | | | | | | | | |
| 24 | Adds new OSE: C7-41. | | | | | | | | | | | | | | | | | |
| 25 | Deletes A7-10 and adds LH2 tank servicing mechanism. | X | 81 | | | | | | | | | | | | | | | |
| 26 | Adds new item: A7-38, deletes A7-11. | | | | | | | | | | | | | | | | | |
| 27 | Cancellation of operations simulator and establishment of EMM and others. (See MCR 324.) | | | | | | | | | | | | | | | | | |
| 28 | Cancels advanced (second) engine actuation system. | | | | | | | | | | | | | | | | | |
| 29 | Combines and relocates J-2 engine elect. connect panel and stage-mounted J-box. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 30 | Relocates instrumentation d-c bus system. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 31 | Revises flight control simulator effort. | | | | | | | | | | | | | | | | | |
| 32 | Revises major IDWA No. 6705 ((dilution of ullage rocket [illegible] | | | | | | | | | | | | | | | | | |
| 33 | Deletes RF portion of telemetry and tracking aids from battleship. | | | X | | | | | | | | | | | | | | |
| 34 | Deletes EC purge system from C7-605 and revises title of C7-605. | X | | | | | | | | | | | | | | | | |
| 35 | Establishes mechanical, electrical, and logic symbol standards. | | | | | | | | | | | | | | | | | |
| 36 | Revises mission statements and design criteria for advanced Saturn C-5. | | | | X | X | X | X | X | | X | X | X | X | X | X | X | X |
| 37 | Adds end item A7-3A, piston position indicator. | | | | | | | | | | | | | | | | | |
| 38 | Dual-plane separation mode for S-II stage; cancels MCR 3. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 39 | Study umbilical arms and disconnects. | | | | | | | | | | | | | | | | | |
| 40 | Adds component test station. | X | | | | | | | | | | | | | | | | |

...continued

# Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refers to EDC/MCR No. | Change Effectivity: Test Stages VT-I 1 | Test Stages VT-I 1 | 2 | 3 | 4 | Flight Stages VT-I 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | Deletes two S/S telemeters. | X | | | | | | | | | | | | | | | | |
| 42 | Deletes some S/S telemeters, leaving the quantities indicated. | | | 0 | | 2 | | | 2 | | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| 43 | Study J-2 engine propellant conditioning and engine start transient. | | | | | | | | | | | | | | | | | |
| 44 | Study of MTF horizontal checkout area and associated GSE. | X | | | | | | | | | | | | | | | | |
| 45 | Study effects of reducing S-II-T stage firing time to 25 seconds. | | | | | | | | | | | | | | | | | |
| 46 | Adds two new items to C7-200 series station. | X | | | | | | | | | | | | | | | | |
| 47 | Installs remotely calibrated pressure switches where calibration is required. | | | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 48 | Manual checkout and firing equipment for battleship program. | X | | | | | | | | | | | | | | | | |
| 49 | Redesigns LH2 and LOX tank seal. | X | | | | | | | | | | | | | | | | |
| 50 | [illegible] S-II stage pr[illegible]ions. | | | | | | | | | | | | | | | | | |
| 51 | Changes point of final acceptance of stage from high bay to low bay at MILA. | | | | | | | | | | | | | | | | | |
| 52 | Adds purge system. | X | 141 | | | | | | | | | | | | | | | |
| 53 | Deletes end items S7-14 and S7-15. | | | | | | | | | | | | | | | | | |
| 54 | Incorporates short chambered J-2 engine with detachable skirt. | X | | | | | | | | | | | | | | | | |
| 55 | Adds forward skirt cover to battleship and all-systems test stands. | X | | | | | | | | | | | | | | | | |
| 56 | Utilization of C-5 I.U. for S-II stage timing signals. | | | | | X | | | X | | X | X | X | X | X | X | X | X |
| 57 | Addition of J-2 engine thrust chamber purge and chill system. | | | X | | X | | X | X | | X | X | X | X | X | X | X | X |
| 58 | Initiate design analysis effort for an alternate common bulkhead using the membrane seal principle. | | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Test Stages V7-2 1 | Test Stages V7-1 1 | 2 | 3 | 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | Establishes utilization of horizontal preparation area and test stand at MTF. | | | | | | | | | | | | | | | | | |
| 60 | Establishes central data station at MTF. | | | | | | | | | | | | | | | | | |
| 61 | Cancels requirement to weigh S-II stage while in test stands at MTF and COCA. | | | | | | | | | | | | | | | | | |
| 62 | Changes nonpropulsive stage (501) from heavy-gage to light-weight aluminum. | | 8 | | | | | | | X | | | | | | | | |
| 63 | Implements in-flight first-plane separation of nonpropulsive stage. | | 446 | | | | | | | | | | | | | | | |
| 64 | Increases quantities of H7-2, H7-3, H7-23, and H7-24. | | | | | | | | | | | | | | | | | |
| 65 | Adds blow-down ducting for propellant feed lines on battleship. | X | 103 | | | | | | | | | | | | | | | |
| 66 | Adds vibration safety cutoff requirements for J-2 engine. | | | X | | | | | | | | | | | | | | |
| 67 | Declares stage interface substitutes CFE rather than GFE. | | | | | | | | | | | | | | | | | |
| 68 | Study of changes to thermal control system to reduce weight. | X | 140 | | | | | | | | | | | | | | | |
| 69 | Increases quantity of H7-19 engine actuator lock from 96 to 138. | | | | | | | | | | | | | | | | | |
| 70 | Desiccant systems disconnects to larger size. | | | X | | X | X | X | X | | X | X | X | X | X | X | X | X |
| 71 | Places airborne half of hydraulic servicing disconnects under same procurement-specification as ground half. | | | | | | | | | | | | | | | | | |
| 72 | Incorporates GFAE MISTRAM tracking aid system into S-II stage. | | | | | X | | | X | | X | X | X | X | X | X | X | X |
| 73 | Deletion of emergency detection control logic (placed in I.U.). | | | | | X | | | X | | X | X | X | X | X | X | X | X |
| 74 | Study to determine optimum transporter to move stage from SS to MTF/MILA. | | | | | | | | | | | | | | | | | |
| 75 | Deletes redundant main d-c bus battery. | X | 134 | | | | | | | | | | | | | | | |

...continued

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity – Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 76 | Adds equipment necessary to control battleship vacuum system. | | | X | | | | | | | | | | | | | | |
| 77 | Increases J-2 engine helium tank pressure from 2700 to 3000 psig. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |
| 78 | Provides for relocation of systems tunnel to 11°15' from position I toward position II. | X | | | | | | | | | | | | | | | | |
| 79 | Establishes weight and balance requirements of MSFC-PROC-[illegible] as applicable to S-II. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 80 | Reorientation of battleship test program. | | | | | | | | | | | | | | | | | |
| 81 | Deletes A7-10 and adds equipment required to enter and clean $LH_2$ tank. | | 592 | | | | | | | | | | | | | | | |
| 82 | Reduces quantity of S-II stage transporters. | X | 249 | | | | | | | | | | | | | | | |
| 83 | Deletes H7-62 $LH_2$ inlet duct handler; changes title of H7-63. | X | 245 | | | | | | | | | | | | | | | |
| 84 | Deletes A7-18 engine protractor. | | | | | | | | | | | | | | | | | |
| 85 | Deletes H7-26 aft hoist frame support [illegible] | | | | | | | | | | | | | | | | | |
| 86 | Adds A7-36 pump shaft seal visual leakage indicator. | | | | | | | | | | | | | | | | | |
| 87 | Study desirability of increasing propellant feed line diameter. | | | | | | | | | | | | | | | | | |
| 88 | Study effects of mechanical feedback actuator for S-II. | | | | | | | | | | | | | | | | | |
| 89 | Design changes to H7-33 stage erecting sling. | | | | | | | | | | | | | | | | | |
| [illegible] | Design changes [illegible] forward hoisting frame. | | | | | | | | | | | | | | | | | |
| 91 | Adds emergency manual equipment to GSE. | X | | | | | | | | | | | | | | | | |
| 92 | Revises propellant loading and engine cutoff system design. | X | 130 | | | | | | | | | | | | | | | |
| 93 | Study of propellant utilization. | X | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages VT-2: 1 | Test Stages VT-T: 1 | VT-T: 2 | VT-T: 3 | VT-T: 4 | Flight Stages VT-1: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94 | Redesign center-engine feed lines to eliminate suction ducts. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 95 | Revises bulkhead test program to provide stratification data. | | | | | | | | | | | | | | | | | |
| 96 | Design changes to H7-35 aft hoist frame. | | | | | | | | | | | | | | | | | |
| 97 | Design changes to H7-8 aft interstage dolly. | | | | | | | | | | | | | | | | | |
| 98 | Adds GSE transporter for common bulkhead. | X | 173 | | | | | | | | | | | | | | | |
| 99 | Adds GSE frame, engine protective frame, and engine protective frame sling. | | 574 | | | | | | | | | | | | | | | |
| 100 | Adds special walkway for forward skirt on battleship. | | | X | | | | | | | | | | | | | | |
| 101 | Adds camera time code signal distribution equipment. | | | | | | | | | | | | | | | | | |
| 102 | Adds power conversion equipment for rate gyros and accelerometers. | X | | | | | | | | | | | | | | | | |
| 103 | Adds cutoff annunciator panel. | | | | | | | | | | | | | | | | | |
| 104 | [illegible] to the main [illegible] bus battery. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |
| 105 | Study to develop auxiliary battery system. | | | | | | | | | | | | | | | | | |
| 106 | Fairings for $LH_2$ feed lines. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 107 | Increases quantity of A7-34. | | | | | | | | | | | | | | | | | |
| 108 | Study to evaluate wheel unit concept developed for S-IC transporter. | | | | | | | | | | | | | | | | | |
| 109 | Establishes DDAS/PCM equipment as CFE, rather than GFAE. | | | | | X | | Note 1 | X | X | X | X | X | X | X | X | X | X |
| 110 | Redesign of LOX tank to incorporate a central sump. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 111 | Changes name and quantity of C7-103 program input rack. | | | | | | | | | | | | | | | | | |
| 112 | Increases quantity of C7-106. | X | | | | | | | | | | | | | | | | |

Note 1: Provide installation provisions only.

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 113 | Changes name and quantity of C7-187 and adds new item C7-188. | | | | | | | | | | | | | | | | | |
| 114 | Relocates C7-202 at PFL and MTF. | X | 216 | | | | | | | | | | | | | | | |
| 115 | Deletes C7-203, incorporates function into C7-204. | | | | | | | | | | | | | | | | | |
| 116 | Increases quantity of C7-206 to six. | X | 216 | | | | | | | | | | | | | | | |
| 117 | Adds new item C7-208. | | | | | | | | | | | | | | | | | |
| 118 | Deletes C7-305, incorporates function into C7-306. | X | | | | | | | | | | | | | | | | |
| 119 | Deletes C7-404 and incorporates function into C7-409. | X | 185 | | | | | | | | | | | | | | | |
| 120 | Deletes C7-207 and adds calibration capability in C7-205 and C7-208. | | | | | | | | | | | | | | | | | |
| 121 | Redesigns C7-403 to MSFC criteria. | | | | | | | | | | | | | | | | | |
| 122 | Redesigns C7-504 to MSFC criteria. | X | 185 | | | | | | | | | | | | | | | |
| 123 | Changes nomenclature from "Manual" to "Local Control" on GSE. | X | | | | | | | | | | | | | | | | |
| 124 | Adds resettable timers for hydraulic system operating time. | X | | | | | | | | | | | | | | | | |
| 125 | Replaces honeycomb-type insulation with vacuum jacket on $LH_2$ feed lines. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 126 | Adds new item: static firing fragmentation shield. | X | | | | | | | | | | | | | | | | |
| 127 | Adds new item: PCM multiplexer handler. | X | | | | | | | | | | | | | | | | |
| 128 | Adds new item: H7-75 main bus battery handler. | X | | | | | | | | | | | | | | | | |
| 129 | Reorientation of battleship test program. | X | 427 | | | | | | | | | | | | | | | |
| 130 | Propellant loading and engine cutoff system design. | | | | | | | | | | | | | | | | | |
| 131 | Redefines the facility checkout stage. | X | 390 | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Test Stages V7-2 1 | Test Stages V7-1 1 | 2 | 3 | 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 132 | Stratification test program for 1/4-scale tank insulation. | X | 191 | | | | | | | | | | | | | | | |
| 133 | Defines pressurization test program for 1/4-scale $LH_2$ tank. | X | 191 | | | | | | | | | | | | | | | |
| 134 | Extends S-II test program to include near and far field acoustic test program. | X | | | | | | | | | | | | | | | | |
| 135 | Redesigns and relocates S-II stage C-5 umbilical disconnects. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 136 | Installs delta pressure sensing lines for propellant loading. | X | | | | | | | | | | | | | | | | |
| 137 | Incorporates recirculation systems and 56-volt power source. | | | X | Note 2 | X | Note 2 | Note 2 | X | Note 2 | X | X | X | X | X | X | X | X |
| 138 | Establishes MSFC-PROC-158A (soldering) as applicable to S-II stage and GSE. | | | | | | | | | | | | | | | | | |
| 139 | Redesigns airborne engine compartment purge system. | | | X | | X | | X | X | | X | X | X | X | X | X | X | X |
| 140 | Replaces present thermal control system with a continuous-flow $GN_2$ system. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 141 | Adds purge system for press. system $LH_2$ pressurizing lines. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 142 | TLM and RF station integration to form one instrumentation station. | X | | | | | | | | | | | | | | | | |
| 143 | Deletes A7-19 hydraulic system installation fixture. (Reinstalled by MCR 630.) | | 630 | | | | | | | | | | | | | | | |
| 144 | Control and procurement of pulse checker power supplies. | X | | | | | | | | | | | | | | | | |
| 145 | Revises SID 61-348 to include additional GSE items. | | | | | | | | | | | | | | | | | |
| 146 | Replaces glass fabric laminate insulation with low-modulus nylon phenolic laminate. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 147 | Deletes C7-405; relocates C7-403 and C7-401; and deletes printer and scope. | | | | | | | | | | | | | | | | | |
| 148 | Adds facility control panel. | X | | | | | | | | | | | | | | | | |

Note 2: Structures only.

...continued

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2: 1 | Test Stages V7-1: 1 | 2 | 3 | 4 | Flight Stages V7-1: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149 | Relocates pressure line and adds $LH_2$ fill valve actuation disconnect to lower disconnect panel (cancelled). | X | | | | | | | | | | | | | | | | |
| 150 | Adds engine actuation fail-safe system. | | | CCP 400 | | | | | | | | | | | | | | |
| 151 | Provides for an inert atmosphere around propellant fill disconnects. | | | | | | | | | | | | | | | | | |
| 152 | Redesigns C7-603 to provide engine system gross leak checks. | X | 278 | | | | | | | | | | | | | | | |
| 153 | Adds aerodynamic fairing around LOX vent valves. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 154 | Provides for use of nonflight-weight thrust structure. | | | X | | | | | | | | | | | | | | |
| 155 | Redesigns pressurization system. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 156 | Adds step pressurization capability to $LH_2$ tank pressurization system. | X | 135 | | | | | | | | | | | | | | | |
| 157 | Incorporates J-2 thrust chamber temperature sensing bypass or lock-in capability. | X | | | | | | | | | | | | | | | | |
| 158 | Implements EBW systems checkout. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 159 | Study of transient side loads at engine start and shutdown. | | | | | | | | | | | | | | | | | |
| 160 | Adds radiant heat shields around engines to protect equipment. | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 161 | Study of alternate structure to reduce stage weight. | | | | | | | | | | | | | | | | | |
| 162 | Incorporates checkout features into tank vent valves. | | | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 163 | S-II capacitance gage system. | X | 261 | | | | | | | | | | | | | | | |
| 164 | Redesigns thrust structure to 240,000 lbs; was 206,000 lbs. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 165 | Incorporates hydraulic fluid heating by recirculation, rather than by heaters. | | | X | | X | X | | X | | X | X | X | X | X | X | X | X |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | V7-1 2 | V7-1 3 | V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 166 | Adds new item A7-44 forward access platform. | | | | | | | | | | | | | | | | | |
| 167 | Configuration changes to H7-27, H7-28, and H7-30. | | | | | | | | | | | | | | | | | |
| 168 | Reduces quantity of A7-12 to two. | | | | | | | | | | | | | | | | | |
| 169 | Deletes H7-42 and H7-22. | | | | | | | | | | | | | | | | | |
| 170 | Provides LOX topping bypass in S7-2. | X | | | | | | | | | | | | | | | | |
| 171 | Adds flowmeters to S7-1 and S7-2. | X | | | | | | | | | | | | | | | | |
| 172 | Adds new item: Auxiliary thrust structure transport frame. | X | | | | | | | | | | | | | | | | |
| 173 | Adds new item: common bulkhead test specimen transporter. | | | | | | | | | | | | | | | | | |
| 174 | Adds new items: A7-43 and H7-78. | | | | | | | | | | | | | | | | | |
| 175 | Provides for manufacturing of S/S multiplexer to MSFC documentation instead of S&ID. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 176 | Provides for manufacturing of T/D multiplexer to MSFC documentation instead of S&ID. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 177 | Electrical umbilical ejection during checkout at AMR low bay. | X | | | | | | | | | | | | | | | | |
| 178 | [illegible] redesign. | X | 235 | | | | | | | | | | | | | | | |
| 179 | Provides for fail-safe type propellant prevalves. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |
| 180 | Adds new item: C7-109. | | | | | | | | | | | | | | | | | |
| 181 | Adds vent systems bypass lines for burst diaphragm incorporation. | | | | | X | | | | | | | | | | | | |
| 182 | Component test station proposal. | X | | | | | | | | | | | | | | | | |
| 183 | Adds blow-down ducting for propellant feed lines at battleship and S-II-T. | X | 237 | | | | | | | | | | | | | | | |
| 184 | Deletes cabs, RF station items and adds new item: C7-307. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-II | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 185 | Deletes TM checkout station items and adds new items: C7-510 thru C7-519. | | | | | | | | | | | | | | | | | |
| 186 | Incorporates relay to eliminate interstage disconnect. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |
| 187 | Study of dynamic springback of bulkheads. | | | | | | | | | | | | | | | | | |
| 188 | Deletes C7-10 and adds new item: C7-44. | | | | | | | | | | | | | | | | | |
| 189 | Revises LH2 tank insulation requirements. | | 354 | | | X | X | X | | | | | | | | | | |
| 190 | Increases LOX and LH2 tank pressures to 42 psia and 39 psia, respectively. | | | Note 3 | | Note 3 | | Note 3 | X | X | X | (8 and subs. determined later.) | | | | | | |
| 191 | Enlarges scope of 1/4-scale LH2 tank insulation test program. | | | | | | | | | | | | | | | | | |
| 192 | Reorients intercommunication system. | | | | | | | | | | | | | | | | | |
| 193 | Study to determine NPSH requirements for J-2 engines in S-II. | X | 331 | | | | | | | | | | | | | | | |
| 194 | Changes EAS pressure transducer from d-c/d-c type to potentiometer type. | | - | X | | X | X | | X | | X | X | X | X | X | X | X | |
| 195 | Study to accumulate nonlinear aerodynamic information. | | | | | | | | | | | | | | | | | |
| 196 | Changes servoactuator measurement from extend and retract pressures to differential pressure. | X | 317 | | | | | | | | | | | | | | | |
| 197 | Revises SAID ordnance procurement specifications. | | | | | | | | | | | | | | | | | |
| 198 | Redesigns 1/10-scale dynamic model. | X | | | | | | | | | | | | | | | | |
| 199 | [illegible] propellant utilization system. | X | | | | | | | | | | | | | | | | |
| 200 | Study to determine feasibility of providing baffles, etc., to prevent LOX from leaving contact with aft bulkhead upon S-IC engine shutdown. | | | | | | | | | | | | | | | | | |
| 201 | Changes name and quantity of items which make up C7-104. | | | | | | | | | | | | | | | | | |

Note 3: Affects systems only.

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | [illegible] |
| 202 | Use of C7-102 test conductors console for CPDF. | X | | | | | | | | | | | | | | | | |
| 203 | Adds new item: H7-79 stage guide bracket. | | | | | | | | | | | | | | | | | |
| 204 | Adds new item: LOX tank helium receiver handler. | X | | | | | | | | | | | | | | | | |
| 205 | Adds new item: H7-85 $LH_2$ tank helium receiver sling. | X | | | | | | | | | | | | | | | | |
| 206 | Adds new items of handling equipment. | | 675 | | | | | | | | | | | | | | | |
| 207 | Adds resistors in series with elect. control system TLM outputs for isolation. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 208 | Updates preproduction EAS to fit production engine. | X | 217 | | | | | | | | | | | | | | | |
| 209 | Updates preproduction EAS to fit preproduction engine. | X | | | | | | | | | | | | | | | | |
| 210 | Provides for manufacture of FM/FM TLM calibrator to MSFC documentation. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 211 | Provides for manufacture of remote time div. submult. to MSFC documentation. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 212 | Reidentifies and reduces quantity of S7-1 and S7-2. | | | | | | | | | | | | | | | | | |
| 213 | Changes A7-34 to a linear scale. | X | 217 | | | | | | | | | | | | | | | |
| 214 | Adds new item: stage checkout dolly spacer. | X | | | | | | | | | | | | | | | | |
| 215 | Provides for addition of aerodynamic fairings to external protrusions. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 216 | Adds new items: consoles of C7-800 checkout station; changes elect. checkout station. | | | | | | | | | | | | | | | | | |
| 217 | Incorporates mechanical feedback into servoactuator and resizes ARMA. | | | X | | X | X | | X | | X | X | X | X | X | X | X | X |
| 218 | Study of J-2 engine side load effects. | | 333 | | | | | | | | | | | | | | | |
| 219 | Changes design of S7-6. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| ECP/MCR No. | Change Description and Remarks | Cancelled | Refer to ECP/MCR No. | Change Effectivity: Test Stages V7-1 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 220 | Changes design of C7-601. | | | | | | | | | | | | | | | | | |
| 221 | Study power source for recirculation system and exciters and heaters for J-2 ignition. | X | | | | | | | | | | | | | | | | |
| 222 | Study concerning 56-vdc recirculation pump motor. | | | | | | | | | | | | | | | | | |
| 223 | Redesigns LOX and $LH_2$ feed lines to reduce pressure loss. | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 224 | Redesigns test point selector of C7-401. | | | | | | | | | | | | | | | | | |
| 225 | Adds circuit protection in stage/GSE interface wires with a potential 28 volts or greater. | | | | | | | | | | | | | | | | | |
| 226 | Adds S-II pressurization system checkout requirements. | X | 269 | | | | | | | | | | | | | | | |
| 227 | Provides power switching for flight control sensors. | X | 231 | | | | | | | | | | | | | | | |
| 228 | Adds facility gaseous hydrogen disposal system, pyrotechnic type | X | | | | | | | | | | | | | | | | |
| 229 | Redesigns battleship thrust structure for engine firing side loads. | X | 235 | | | | | | | | | | | | | | | |
| 230 | Redesigns forward skirt structure for 5 psi differential pressure and 30 $in^2$ leak area. | | | | Note 4 | Note 4 | Note 4 | X | X | X | X | X | X | X | X | X | X | X |
| 231 | Provides for mounting, wiring, and power for gyro and accelerometer packages. | | 795 | | | X | X | | X | X | X | X | X | X | X | X | X | X |
| 232 | Establishes MSFC drawing 10463376 (elect. symbols) as applicable to S-II. | | 35, 238 | | | | | | | | | | | | | | | |
| 233 | Design for graphic display panel. | X | | | | | | | | | | | | | | | | |
| 234 | Adds new item: ullage motor installer. | X | | | | | | | | | | | | | | | | |
| 235 | Describes SLAM program and authorizes issuance of stop orders. | | 323 | X | | X | | | | | | | | | | | | |

Note 4: Includes purge system modification requirement.

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 236 | Adds thrust structure insulation. | X | | | | | | | | | | | | | | | | |
| 237 | Adds new item: model 144 cryogenic piping installation fixture. | | | | | | | | | | | | | | | | | |
| 238 | Establishes standard format for electrical schematic and cabling diagram. | | 232 | | | | | | | | | | | | | | | |
| 239 | Study of 15-minute emergency drain system for propellant. | | | | | | | | | | | | | | | | | |
| 240 | Redesigns $LH_2$ tank longitudinal stiffeners. | | | | | | | | X | X | X | | | | | | | |
| 241 | Provides capability to plot transducer calibration data in standard format. | | | | | | | | | | | | | | | | | |
| 242 | Study heat shield design versus use of local insulation. | | | | | | | | | | | | | | | | | |
| 243 | Delete requirement for H7-28 in EMM area. | | | | | | | | | | | | | | | | | |
| 244 | Provides for ground pressurization capabilities to permit full-duration, 5-engine battleship static firings without J-2 engine heat exchanger. | X | | | | | | | | | | | | | | | | |
| 245 | Establishes equipment peculiar to engine component handling as OPE, rather than CFE. | | | | | | | | | | | | | | | | | |
| 246 | Redesigns $LH_2$ tank wall using a column fixity factor of 1, rather than 1.5. | | | | | | | | X | X | X | | | | | | | |
| 247 | Adds 56-vdc power system for $LH_2$ recirculation pump [illegible] | X | 137 | | | | | | | | | | | | | | | |
| 248 | Deletes requirement for an aft interstage structure for S-II-T. | | | | | X | | | | | | | | | | | | |
| 249 | Reduces quantity of type II stage transporter; defines transporters; and adds new items: H7-101, H7-104, and H7-199. | | | | | | | | | | | | | | | | | |
| 250 | Redesigns propellant fill disconnect coupling. | | | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 251 | Adds new items: H7-92 and H7-93. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages VT-2 1 | Test Stages VT-1 1 | VT-1 2 | VT-1 3 | VT-1 4 | Flight Stages VF 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 252 | Provides for verification of thrust structure stiffness using S-II-S stage. | | | | X | | | | | | | | | | | | | |
| 253 | Incorporates double-seal insulation design. | X | | | | | | | | | | | | | | | | |
| 254 | Double-seal insulation design. | X | | | | | | | | | | | | | | | | |
| 255 | Deletes all lamp test switches, press-to-test type lights, and lamp test circuitry from S-II C7E. | | | | | | | | | | | | | | | | | |
| 256 | Adds two-axis display meters to C7-202. | | | | | | | | | | | | | | | | | |
| 257 | Adds new item: C7-211 scanning rack. | | | | | | | | | | | | | | | | | |
| 258 | Adds new item: C7-212 discrete display. | | | | | | | | | | | | | | | | | |
| 259 | Adds new item: C7-213 relay interlock rack. | | | | | | | | | | | | | | | | | |
| 260 | Redesigns thrust structure to increase stiffness. | X | | | | | | | | | | | | | | | | |
| 261 | Adds capacitance-type system for propellant loading, mass determination, and utilization control during engine operation. | | | X | | X | | Note 5 | X | Note 5 | X | X | X | X | X | X | X | X |
| 262 | Deletes time division multiplexer assembly from No. 208 container. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 263 | Study to optimize propellant mixture ratio. | | | | | | | | | | | | | | | | | |
| 264 | Provides for manufacture of FM/FM TLM assembly to MSFC documentation. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 265 | Provides for manufacture of vibration multiplexer (TD) to MSFC documentation. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 266 | Study to evaluate Aerojet-General's Cryojet insulation conception. | X | | | | | | | | | | | | | | | | |
| 267 | Deletes requirement for and reidentifies A7-1 and A7-2. | | | | | | | | | | | | | | | | | |
| 268 | Cancels S-II P/C switch, provides mechanical and electrical capability for insertion of the DACO S-IVB switch, and provides interim jumper cable. | | | | | X | X | | X | | X | X | X | X | X | X | X | X |

Note 5: Loading and mass measurement functions only.

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 269 | Adds S-II pressurization system checkout requirements. | X | | | | | | | | | | | | | | | | |
| 270 | Deletes A7-9. | | | | | | | | | | | | | | | | | |
| 271 | Adds new item: SDD-154 terminal distributor. | | | | | | | | | | | | | | | | | |
| 272 | Design for closed circuit checkout of RF systems. | | | | | X | | | X | | X | X | X | X | X | X | X | X |
| 273 | Provides another PCM coax to GSE when lower umbilical is dropped for simulated flight. | X | 286 | | | | | | | | | | | | | | | |
| 274 | Provides position monitor and reset for latching relays. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |
| 275 | Nomenclature and usage changes to GSE electrical harness requirements. | X | | | | | | | | | | | | | | | | |
| 276 | Deletes H7-33, H7-49, and H7-50; adds new item: SDD-219. | | | | | | | | | | | | | | | | | |
| 277 | Deletes C7-517; adds new item: C7-48. | | | | | | | | | | | | | | | | | |
| 278 | Redesigns C7-603 to include manual operation and engine system gross leak checks. | | | | | | | | | | | | | | | | | |
| 279 | Provides for electrical interconnection of stage and aft interstage at AMR. | | | | | | | | | | | | | | | | | |
| 280 | Adds new items: C7-60, C7-61, and C7-62. | X | | | | | | | | | | | | | | | | |
| 281 | Revises stage checkout procedure and associated GSE. | X | 343 | | | | | | | | | | | | | | | |
| 282 | Provides for potting of GSE connectors. | | | | | | | | | | | | | | | | | |
| 283 | Establishes MSFC 40M38592 (relay numbering) as applicable to S-II. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 284 | Study to define in-flight LH2 venting problems and techniques. | | | | | | | | | | | | | | | | | |
| 285 | Adds new item: C7-64. | | | | | | | | | | | | | | | | | |
| 286 | Provides for RF transmission of PCM and deletion of one PAM/FM/FM TLM link. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 287 | Adds blow-down ducting for $LH_2$ feed lines at battleship. | X | | | | | | | | | | | | | | | | |
| 288 | Provides data processing system capable of reducing vibration and cyclic (pulse and sinusoidal) data into suitable form for analysis. | | | | | | | | | | | | | | | | | |
| 289 | Adds new items: H7-94, H7-95, model 911, and model 912. | | | | | | | | | | | | | | | | | |
| 290 | Redefines facility checkout stage (superseded by MCR 390). | X | 390 | | | | | | | | | | | | | | | |
| 291 | Implements battleship static firing program as defined by TD 145-63. | | | X | | | | | | | | | | | | | | |
| 292 | Provides for use of EBW firing unit and pulse sensor simulators, rather than flight-qualified items, in the C7-210 simulator. | | | | | | | | | | | | | | | | | |
| 293 | Adds new item: SDD-167 (interim substitute for C7-603 at battleship). | | | | | | | | | | | | | | | | | |
| 294 | Adds new item: C7-58 central time buffer rack. | X | | | | | | | | | | | | | | | | |
| 295 | Changes cryogenic connector mounting to use naflex seal. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 296 | Provides elect. connectors for computer complex consoles and cables. | X | | | | | | | | | | | | | | | | |
| 297 | Adds new item: C7-300 com. destruct system checkout rack. | X | | | | | | | | | | | | | | | | |
| 298 | Deletes requirement for A7-14 at AMR; still used at PFL and MTF. | | | | | | | | | | | | | | | | | |
| 299 | Reduces quantity of C7-15. | X | 427 | | | | | | | | | | | | | | | |
| 300 | Use of nonlocked connectors in GSE. | X | | | | | | | | | | | | | | | | |
| 301 | Provides cables for connecting GFP checkout consoles to J-2 engine. | | | | | | | | | | | | | | | | | |
| 302 | Deletes RFI-shielded computer rooms at PFL, MTF, and AMR. | | | | | | | | | | | | | | | | | |
| 303 | Adds new item: A7-57. | | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 304 | Removal of LOX tank internally mounted components through access opening. | X | | | | | | | | | | | | | | | | |
| 305 | Provides for ground control of He pressurization solenoid, using nonairborne relay. | X | 458 | | | | | | | | | | | | | | | |
| 306 | Provides for removal of LOX tank components through access opening. | X | | | | | | | | | | | | | | | | |
| 307 | Combines S7-35 and S7-36 to form new items: S7-40 and EDD-168. | | | | | | | | | | | | | | | | | |
| 308 | Deletes lanyard type stage interface connectors and incorporates DACs design in connector; also, adds connectors for emergency detection system wiring. | | | | | X | | Note 6 | X | Note 6 | X | X | X | X | X | X | X | X |
| 309 | Provides additional S7-36 for EDDs. | | | | | | | | | | | | | | | | | |
| 310 | Adds new item: C7-69 and provisions on stage for battery simulation. | X | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 311 | Increases quantity and revises utilization of H7-8. | | | | | | | | | | | | | | | | | |
| 312 | Adds new items: EDD-159 and EDD-161 thru EDD-165. | | | | | | | | | | | | | | | | | |
| 313 | Provides for structural test of forward skirt and interstage using S-II-S stage. | X | | | | | | | | | | | | | | | | |
| 314 | Provides blast instrumentation for static firing test stands at FTL. | | | | | | | | | | | | | | | | | |
| 315 | Deletes H7-71 and initiates study to develop method of handling ARMA. | | | | | | | | | | | | | | | | | |
| 316 | Deletes emergency detection system (cancelled, but limits effort to study). | | | | | | | | | | | | | | | | | |
| 317 | Adds new item: C7-63. | X | | | | | | | | | | | | | | | | |
| 318 | Provides thrust structure closeout and modifies engine compartment purge manifold. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |

Note 6: Emergency detection system connectors not included.

...continued

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Test Stages V7-2 1 | Test Stages V7-1 1 | V7-1 2 | V7-1 3 | 4 | Flight Stages VB-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 319 | Changes printed circuit board coating from epoxy to polyurethane. | X | | | | | | | | | | | | | | | | |
| 320 | Addendum to full-scale common bulkhead test plan. | X | | | | | | | | | | | | | | | | |
| 321 | Provides for substitution of polyurethane for epoxy conformal for printed circuit board coating. | | | | | | | | | | | | | | | | | |
| 322 | Adds electrical portion of command destruct system to meet range safety requirements. | | | | | | | | | X | | | | | | | | |
| 323 | Redefines SLAM (side-load arresting mechanism) development program. | | | | | | | | | | | | | | | | | |
| 324 | Implements accomplishment of boattail tests on S-II-T and scale model tests. | | | | | X | | | | | | | | | | | | |
| 325 | Redesigns valve actuation system. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 326 | Relocates equipment for control and monitor of pressure isolation valves. | | | | | | | | | | | | | | | | | |
| 327 | Directs selection of second supplier for CDF pyrogen initiator. | | | | | | | | | | | | | | | | | |
| 328 | Reduces quantity of production EASs for EMM from 4 to 2. | | | | | | | | | | | | | | | | | |
| 329 | Redesigns C7-41 to permit alternate method of cable entry. | X | 24 | | | | | | | | | | | | | | | |
| 330 | Defines MSFC dynamic environment test and analysis program. | | | | | | | | | | | | | | | | | |
| 331 | Provides for design, fabrication, and delivery of propellant feed lines to Rocketdyne for NPSH tests. | | | | | | | | | | | | | | | | | |
| 332 | Adds structure to H7-17 to permit transfer of torsional load. | | | | | | | | | | | | | | | | | |
| 333 | Adds three special instrumentation containers adjacent to the S-II-T. | X | 532 | | | | | | | | | | | | | | | |
| 334 | Adds standby 120/208-vac, 400-cycle, 30-kw engine generator set for FTL. | | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Controlled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 335 | Adds flowmeter to $LH_2$ topping system on battleship and all-systems. | X | | | | | | | | | | | | | | | | |
| 336 | Adds new item: H7-106 vertical engine installer sling. | X | 395 | | | | | | | | | | | | | | | |
| 337 | Adds new item: H7-97. | | | | | | | | | | | | | | | | | |
| 338 | Adds new item: H7-88 ullage motor installer. | X | 648 | | | | | | | | | | | | | | | |
| 339 | Adds new items: A7-56, A7-58, and A7-60. | | | | | | | | | | | | | | | | | |
| 340 | Adds new item: C7-66 portable vacuum tester. | X | | | | | | | | | | | | | | | | |
| 341 | Deletes H7-15 and H7-16. | | | | | | | | | | | | | | | | | |
| 342 | Incorporates real-time display on C7-102. | X | | | | | | | | | | | | | | | | |
| 343 | Revises stage systems checkout procedures and associated GSE. | | | | | | | | | | | | | | | | | |
| 344 | Defines tasks associated with effort to fabricate and sub-assembly detail parts of strip-seal forward facing sheets for [illegible] bulkhead alternate design. | | | | | | | | | | | | | | | | | |
| 345 | Provides method for manual readout in station IV at Seal Beach if DDAS is inoperable. | X | | | | | | | | | | | | | | | | |
| 346 | Incorporates stage-mating alignment fittings at stage interfaces. | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 347 | Revises center-engine fluid line interface panel design. | | | X | | X | | X | X | | X | X | X | X | X | X | X | X |
| 348 | Provides for permanent installation of engine system checkout lines on H7-21. | | | | | | | | | | | | | | | | | |
| 349 | Adds requirement for $LH_2$ biaxial burst tests in lieu of model cyl. stability test. | | | | | | | | | | | | | | | | | |
| 350 | Provides for mechanical attachment of insulation to forward skirt in lieu of adhesive bonding. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 351 | Adds new item: C7-43. | | | | | | | | | | | | | | | | | |
| 352 | Redesigns ullage motor attachment as a result of ullage motor weight increase. | X | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| | | | | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-2 | | | | | | | | | |
| ECP/MCR No. | Change Description and Remarks | Cancelled | Refer to ECP/MCR No. | T | F | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 353 | Adds heavy-duty prevalve and relief valve in LOX fill and drain line. | | | X | | | | | | | | | | | | | | |
| 354 | Redesigns LH2 tank wall insulation. | | | | | | | | X | X | X | | | | | | | |
| 355 | Deletes instrumentation measurements from S-II-D that are not integral to a system. | | | | | | X | | | | | | | | | | | |
| 356 | Study of AMRs engine compartment access platform requirements. | | | | | | | | | | | | | | | | | |
| 357 | Adds new item: logic module tester for GSE. | X | | | | | | | | | | | | | | | | |
| 358 | Creates pneumatic servicing and control GSE for LUT at MILA and utilization of this equipment at MTF and all-systems, replacing the C7-605. | | | | | | | | | | | | | | | | | |
| 359 | Study to achieve 99.9% accuracy on propellant mass loading. | | | | | | | | | | | | | | | | | |
| 360 | Revises J-2 engine/stage interface cable and J-box design. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 361 | Implements computer program changes at field sites. | X | | | | | | | | | | | | | | | | |
| 362 | Corrects interference between SOD-195 and COCA IV stage support frame. | | | | | | | | | | | | | | | | | |
| 363 | Adds new items: power supplies for GSE. | | | | | | | | | | | | | | | | | |
| 364 | Redirects ESID to use MOD I switch selector for stage sequencing. | | | | | X | | Note 7 | X | X | X | X | X | X | X | X | X | X |
| 365 | Adds 1.5-inch auxiliary bleed line system to LH2 feed lines and adds connection ports only in LOX feed lines. | | | X | | | | | | | | | | | | | | |
| 366 | Study of forward stage protection while in S/F configuration at MTF and all-systems. | | 470 | | | | | | | | | | | | | | | |
| 367 | Incorporates J-2 thrust chamber temperature-sensing bypass circuit. | X | 369 | | | | | | | | | | | | | | | |
| 368 | Adds meter displays in C7-200 series consoles. | X | | | | | | | | | | | | | | | | |

Note 7: Wiring and installation provisions only.

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | 2 | 3 | 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 369 | Incorporates J-2 engine thrust chamber temperature-sensing bypass circuit. | | | | | | | | | | | | | | | | | |
| 370 | Study requirements for installing instrumentation containers on battleship. | | 429 | | | | | | | | | | | | | | | |
| 371 | Incorporates gaseous hydrogen burning system for battleship. | | | | | | | | | | | | | | | | | |
| 372 | Provides for review of MSFC-CD-503. | X | 431 | | | | | | | | | | | | | | | |
| 373 | Provides for guidance steering and time-to-cutoff polynomial development. | X | | | | | | | | | | | | | | | | |
| 374 | Redefines effort to solve the side load arresting mechanism (SLAM) problem. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 375 | Provides spool piece to replace LOX feed line facility ball valve until valve is available. | | | X | | | | | | | | | | | | | | |
| 376 | Redesigns LOX fill and drain line to withstand surge pressure of 336 psig. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 377 | Defines the static firing measuring system (SFMS) requirements for flight stages at MTF and the S-II-T. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 378 | Provides recoverable camera systems for viewing first- and second-plane separation. | | | | | X | | | X | | X | | | | | | | |
| 379 | Replaces self-latching LH2 tank vent disconnects with nonlatching type. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 380 | Adds new item: interstage checkout dolly adapter set. | X | | | | | | | | | | | | | | | | |
| 381 | Incorporates static firing emergency shutdown capability. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |
| 382 | Provides plug-in capability for MSFC's Saturn engine programmer. | X | | | | | | | | | | | | | | | | |
| 383 | Adds positive indicators of auto/local display. | | | | | | | | | | | | | | | | | |
| 384 | Redesigns recirculation valves. | X | 560 | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 T | Test Stages V7-1 1 | 2 | 3 | 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 385 | Transfers Rocketdyne's valve program to S&ID. | | | | | | | | | | | | | | | | | |
| 386 | Study to provide preliminary redesign of propellant dispersion system to meet YD 169 requirements. | | | | | | | | | | | | | | | | | |
| 387 | Provides for computer prediction of propulsion system performance during static and flight firings. | | | | | | | | | | | | | | | | | |
| 388 | Relocates EBW firing units and detonators to vicinity of interstage access door. | X | | | | | | | | | | | | | | | | |
| 389 | Adds drain system lines on H7-21 for LOX pump seals. | | | | | | | | | | | | | | | | | |
| 390 | Redefines facility checkout stage (S-II-F). | | | | | | | X | | | | | | | | | | |
| 391 | Defines initial internal tank systems configuration for battleship. | | | X | | | | | | | | | | | | | | |
| 392 | Reroutes LOX recirculation lines outboard in a radial direction. | X | | | | | | | | | | | | | | | | |
| 393 | Deletes requirement for A7-37 and A7-47 at battleship and replaces them with new items SDD-225 and SDD-227. | | | | | | | | | | | | | | | | | |
| 394 | Redesigns OSE connector J2 on ME464-0032 power supply to meet voltage and current ratings. | | | | | | | | | | | | | | | | | |
| 395 | Adds new item: H7-106 vertical engine installer sling. | X | | | | | | | | | | | | | | | | |
| 396 | Deletes A7-17 auxiliary engine (ullage motor) alignment fixture. | | | | | | | | | | | | | | | | | |
| 397 | Study to develop handling device for $LH_2$ tank access cover. | | | | | | | | | | | | | | | | | |
| 398 | Adds measurement requirements to S-II stage. | | 966 | | | | | | X | X | X | | | | | | | |
| 399 | Study to develop engine access platform design. | | | | | | | | | | | | | | | | | |
| 400 | Provides relay switching networks to permit continuous telemeter channel checkout through the DDAS. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 401 | Changes operation code of RACS and eliminates voltage-drop problems. | | | X | | X | | | X | | X | X | X | X | X | X | X | X |

## Table F-2. Change Descriptions and Effectivities (Cont)

| ECO/MCR No. | Change Description and Remarks | [illegible] | [illegible] | Change Effectivity: Test Stages 1 | 1 | 3 | 2 | Flight Stages 4 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 402 | Provides removable 15-minute LOX drain assembly. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 403 | Provides pneumatic/electric checkout capabilities for J-2 engine CALIPS's and LOX sequence valve. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 404 | Provides thermal protection for J-2 engine hatbands. | X | | | | | | | | | | | | | | | | |
| 405 | Provides changes resulting from increasing engine start tank pressure from 800 psia to 1500 psia. | | | X | | X | | X | X | | X | X | X | X | X | X | X | X |
| 406 | Adds main d-c and instrumentation d-c fail-safe batteries. | X | | | | | | | | | | | | | | | | |
| 407 | Deletes conduit hubs from C7-41. | X | | | | | | | | | | | | | | | | |
| 408 | Revises $GN_2$ bottles in S7-38 from 6000 psig to 3600 psig. | | | | | | | | | | | | | | | | | |
| 409 | Provides 500 gpm drain system for facility LOX tank at PTL. | | | | | | | | | | | | | | | | | |
| 410 | Defines EMM and Seal Beach interstage checkout requirements. | X | 429 | | | | | | | | | | | | | | | |
| 411 | Changes quantity of C7-104. | X | | | | | | | | | | | | | | | | |
| 412 | Provides J-2 engine servoactuator piston and rod and leg compatibility with flight hardware on EMM. | | | | | | | | | | | | | | | | | |
| 413 | Establishes EBW pulse sensors (No. 224 and No. 224-1) as GFE, rather than CFE, and deletes C7-15 EBW pulse [illegible]. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 414 | Study to determine feasibility of using a metal systems [illegible] or equivalent lightning arresting agent. | | 540 | | | | | | | | | | | | | | | |
| 415 | Adds recording capability at Seal Beach. | X | | | | | | | | | | | | | | | | |
| 416 | Development of a shaker test program for battleship and all systems. | X | | | | | | | | | | | | | | | | |
| 417 | Provides cooling and remote control for S7-30. | | | | | | | | | | | | | | | | | |
| 418 | Changes accuracy of digital multimeter (ME432-0034) from ±1.0% to ±0.1%. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 | Test Stages V7-1 | | | | Flight Stages V7-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 419 | ~~Redesigns forward skirt due to change in pressure differential.~~ | | | | | | | | X | X | X | X | X | X | X | X | X | X |
| 420 | Adds new items: H7-99 | | | | | | | | | | | | | | | | | |
| 421 | Review of MSFC-CD-501, -502, -503, -504, and -505 to determine their impact on program. | | | | | | | | | | | | | | | | | |
| 422 | Deletes A7-4 helium leak detector and adds new items of GSE to provide propellant tank leak detection and insulation purging system. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 423 | Study to develop program for making tape program changes. | | | | | | | | | | | | | | | | | |
| 424 | Adds thermal protection for upper and lower umbilical panels. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 425 | Adds new item: C7-806; and modifies other equipment to provide a static firing fire detection system. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 426 | Replaces C7-605 with C7-(X) | X | 358 | | | | | | | | | | | | | | | |
| 427 | Reorientate battleship program to propulsion systems development only, using manual GSE. | | | | | | | | | | | | | | | | | |
| 428 | QRE on unit price for flanged fitting for EAS. | | | | | | | | | | | | | | | | | |
| 429 | Adds new item: Model No. 907 instrumentation container installer for battleship. | | | | | | | | | | | | | | | | | |
| 430 | Study and proposal for engine actuation measuring. | | | | | | | | | | | | | | | | | |
| 431 | Study for engine actuator and support. | | | | | | | | | | | | | | | | | |
| 432 | Incorporates thermal pressure relief capability into helium pressurization system solenoid valves and in the recirculation system act. system regulator. | | | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 433 | Provides checkout capability for wiring to and from the "inert" safe-arm device. | | | | | | | | | | | | | | | | | |
| 426 | Consolidates LOX tank mast and line support into one system. | X | | | | | | | | | | | | | | | | |

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# Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 435 | Adds new items: Models 908, 909, 910 and 913 adapters for battleship LOX ball valve installation. | | | | | | | | | | | | | | | | | |
| 436 | Provides capability for patching in sequence pen recorders. | X | | | | | | | | | | | | | | | | |
| 437 | Provides new EBW destruct system controller test and checkout plug which extends checkout capability to include PD system. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 438 | Clarifies configuration of disconnects and umbilical carrier plates, and their locations; also, identifies 17 new items. | | | | | | | | X | X | X | X | X | X | X | X | X | X |
| 439 | Provides accessory equipment for A7-35. | | | | | | | | | | | | | | | | | |
| 440 | Defines FAS configuration for the S-II-D stage. | | | | | | X | | | | | | | | | | | |
| 441 | Deletes thermal control system thermostats (ME036-0001-0001). | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 442 | Provides control configuration required for three modes of operation: automatic checkout, manual static firing, and leak checks (OSE changes). | | | | | | | | | | | | | | | | | |
| 443 | Adds new item: A7-73; and redesigns aft comp. vent area and purge manifold. | X | | | | | | | | | | | | | | | | |
| 444 | Replaces $LH_2$ recirculation system with ground-supplied prelaunch conditioning capability and in-flight overboard bleed system. | X | | | | | | | | | | | | | | | | |
| 445 | Modifies engine compartment conditioner system; adds new item: A7-73. | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 446 | Changes S-II-FD stage to S-II-2 and defines first flight stage as V7-1, No. 5. | | | | | | | | X | X | | | | | | | | |
| 447 | Modifies and enlarges EMM control room equipment layout. | | | | | | | | | | | | | | | | | |
| 448 | Study to provide data for calculation of heat transfer from J-2 engine exhaust. | X | 631 | | | | | | | | | | | | | | | |
| 449 | Provides EBW detonator test chamber for each EBW firing unit. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |

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### Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity — Test Stages — V7-2 | | | | | Flight Stages — V7-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V7-2: 1 | V7-1: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 430 | Revises He pressure disconnect actuation systems for $LH_2$, LOX, and recirculation systems. | X | | | | | | | | | | | | | | | | |
| 431 | Provides qualification test program for "MC" flared tube fittings. | X | | | | | | | | | | | | | | | | |
| 432 | Adds fittings to H7-17 for attachment of umbilical carrier plates and propellant fill disconnects. | | | | | | | | | | | | | | | | | |
| 433 | Provides for thermal pressure relief downstream from each He check valve. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 434 | Provides electrical control for all-engine shutdown during adjacent-outboard-engine-out condition. | X | | | | | | | | | | | | | | | | |
| 435 | Implements off-stage measurement requirements for battleship and all systems (suspended). | | | | | | | | | | | | | | | | | |
| 436 | Adds new item: Type I, 28-vdc battery handler. | X | | | | | | | | | | | | | | | | |
| 437 | Redesignates electrical buses on S-II stage to conform with Saturn V vehicle. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 438 | Deletes external LOX and $LH_2$ ullage pressure sensing [illegible] with a total pressure sensing line from the inlet of the vent valves. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 439 | Defines basic requirements for providing photographic equipment for battleship and all systems. | | | X | | X | | | | | | | | | | | | |
| 440 | Provides deflector at $LH_2$ fill port to minimize initial fill splashing of $LH_2$. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 441 | Incorporates direct purge of $LH_2$ point sensor stillwell. | X | | | | | | | | | | | | | | | | |
| 442 | Revises J-2 engine He/$H_2$ start tank purge requirement. | X | | | | | | | | | | | | | | | | |
| 443 | Procurement documentation of MSFC-STD-110A parts used in criticality categories I, II, and III. | X | | | | | | | | | | | | | | | | |
| 444 | Redesignates C7-601 as SDD-193 and reduces quantity. | | | | | | | | | | | | | | | | | |
| 445 | Relocates EBW firing units and CDE manifolds for ullage motor ignition system. | X | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-3: 1 | Test Stages V7-1: 1 | 2 | 3 | 4 | Flight Stages V7-1: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 466 | Adds redundant shutoff valves in high-pressure He fill systems. | | | | | CPP 400 | | | | | | X | X | X | X | X | X | X |
| 467 | Provides additional quantities of computer program development equipment. | | | | | | | | | | | | | | | | | |
| 468 | Revises design requirements for ACE-controlled static firing. | | | | | | | | | | | | | | | | | |
| 469 | Relocates electrical power connectors on aft skirt instrumentation containers to reduce RFI and weight. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 470 | Adds static firing weather shield GSE and associated equipment. | | | | | | | | | | | | | | | | | |
| 471 | Provides engine area Firex system for all static firing sites. | | | | | | | | | | | | | | | | | |
| 472 | Provides GSE to remotely unlatch S-II prevalves. | X | | | | | | | | | | | | | | | | |
| 473 | Preliminary study on possibility of propellant tank collapse. | | | | | | | | | | | | | | | | | |
| 474 | Changes He temperature from -250°F to -410°F for ullage prepressurization. | X | | | | | | | | | | | | | | | | |
| 475 | Provides for simulation of fill, pre, and recirculation system valves for EMM. | X | | | | | | | | | | | | | | | | |
| 476 | Incorporates lamp driver amplifiers as a result of incorporation of current limiters in stage electrical circuitry. | | | | | | | | | | | | | | | | | |
| 477 | Revises design requirements for G7-46. | | | | | | | | | | | | | | | | | |
| 478 | Increases quantity of C7-41 to eight. | | | | | | | | | | | | | | | | | |
| 479 | Statement of work for design and implementation of stage/facility/GSE $LH_2$ tank preconditioning systems. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 480 | Provides for emergency drain line from S-II-T stage LOX tank to spillway. | | | | | | | | | | | | | | | | | |
| 481 | Increases diameter of base heat shield from 310 inches to 356 inches. | | | | | Note 8 | | | X | X | X | X | X | X | X | X | X | X |

Note 8: Will be mockup construction on S-II-T.

...continued

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-3 | Test Stages V7-1 | | | | Flight Stages V7-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 482 | Provides continuous recording of discrete digital events; adds new items: C7-77 and SDD-331. | | | | | | | | | | | | | | | | | |
| 483 | Additional requirements for solid state scanner in ECO station. | | | | | | | | | | | | | | | | | |
| 484 | Modifies affected equipment to increase ACE scanning and lamp display capability from 240 to 720 hardwire discretes. | | | | | | | | | | | | | | | | | |
| 485 | Provides for SMM configuration "X". | | | | | | | | | | | | | | | | | |
| 486 | Study to provide complete, structure-mounted shroud around ullage motors. | | 559 | | | | | | | | | | | | | | | |
| 487 | Adds relays and switches in the C7-801 and C7-802. | X | 468 | | | | | | | | | | | | | | | |
| 488 | Adds new item: forward bulkhead leak detection access platform. | X | | | | | | | | | | | | | | | | |
| 489 | Study of requirements for propellant tank preconditioning. | | 479 | | | | | | | | | | | | | | | |
| 490 | Redesigns center-engine LOX feed line, eliminating its vacuum jacket, to accommodate ±3-degree engine deflection. | | 497 | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 491 | Deletes A7-3, in lieu of GFP units, and adds cables and sensors to support GFP units (C7-82 and C7-83). | | | | | | | | | | | | | | | | | |
| 492 | Deletes A7-12, and adds new item A7-84 (redesign of A7-12 to meet additional area and personnel requirements). | | | | | | | | | | | | | | | | | |
| 493 | Provides water spray system as backup for SDD-227 heat shield. | X | | | | | | | | | | | | | | | | |
| 494 | Adds new item: A7-83 engine actuator pin tool set. | | | | | | | | | | | | | | | | | |
| 495 | Analysis of stage wiring in an effort to reduce stage weight of V7-1, unit 8 and subs. | | | | | | | | | | | | | | | | | |
| 496 | Declares that S-II-F is not a backup inert or live launch stage. | | | | | | | | | | | | | | | | | |
| 497 | Redesigns EAS to accommodate ±3-degree rotational movement of J-2 engines. | | 490 | X | | X | | | X | X | X | X | X | X | X | X | X | X |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Test Stages V7-2 1 | Test Stages V7-1 1 | 2 | 3 | 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 498 | Changes systems tunnel wiring to reduce stage weight. | | | | | | | | | | | | | | | | | |
| 499 | Changes container wiring to reduce stage weight. | | | | | | | | | | | | | | | | | |
| 500 | Deletes 5 ECO-point sensors at station 157 in lieu of ECO sequence initiation by an engine-generated low-LOX-injection pressure signal. | | | | | | | | | | | | | X | X | X | X | X |
| 501 | Redesigns mixture ratio control system from closed-loop to open-loop type. | X | 655 | | | | | | | | | | | | | | | |
| 502 | Redesigns instrumentation into two systems: operational and variable; the variable system (provided by S&ID on units 8 and 9 only) is to be removed prior to launch to reduce weight. | | | | | | | | | | | X | X | X | X | X | X | X |
| 503 | Modifies LH2 tank wall to account for curvature effects on structural ability. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 504 | Redesigns S-II stage using one ultimate safety factor of 1.3 in lieu of 1.4. | X | 634 | | | | | | | | | | | | | | | |
| 505 | Reduces thickness of facing sheets on common bulkhead and provides a propellant tank differential pressure monitoring system to control vent valves. | | | | | | | | | | | X | X | X | X | X | X | X |
| 506 | Increases LH2 tank wall stringer spacing to reduce stage weight. | X | 634 | | | | | | | | | | | | | | | |
| 507 | [illegible] for He bottles now required to maintain ullage pressure during S-IC boost phase and S-II engine start. | | | | | | | | | | | X | X | X | X | X | X | X |
| 508 | Reduces LH2 tank pressure from 39 psia to 33 psia and adds He bubbling system. | X | 634, 673 | | | | | | | | | | | | | | | |
| 509 | Reduces LOX tank pressure from 42 psia to 40 psia and adds He bubbling system. | | 673 | | | | | | | | | X | X | X | X | X | X | X |
| 510 | Adds Hilsch tube to LOX tank pressurization system and modifies J-2 engine heat exchanger coil usage. | | | | | | | | | | | | | X | X | X | X | X |
| 511 | Replaces steel structural bolts with titanium bolts to reduce stage weight. | | | | | | | | | | | X | X | X | X | X | X | X |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 512 | Deletes lower LOX tank slosh baffle and modifies center baffle structure to reduce stage weight. | | | | | Note 9 | Note 9 | Note 9 | Note 9 | Note 9 | X | X | X | X | X | X | X | X |
| 513 | Eliminates EAS thermal insulation and adds thermal barrier between EAS main pump and its engine mounting. | X | 555, 556 | | | | | | | | | | | | | | | |
| 514 | Relocates first-plane separation detonators. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 515 | Changes structural materials to reduce stage weight. | X | 634 | | | | | | | | | | | | | | | |
| 516 | Changes structural materials to reduce stage weight. | X | 634 | | | | | | | | | | | | | | | |
| 517 | Provides continuous position measurement of battleship $LH_2$ and LOX No. 1 and No. 5 feed line prevalves. | | | X | | | | | | | | | | | | | | |
| 518 | Installs bubble deflectors at the ends of the propellant stillwells. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 519 | Adds new item: A7-85 thrust cone internal access ladder. | | | | | | | | | | | | | | | | | |
| 520 | Deletes propellant tank desiccation system and employs propellant tank pressurization system to do the job. | | | | | Note 10 | X | X | X | X | X | X | X | X | X | X | X | X |
| 521 | Provides for camera time-code signal distribution at PFL. | | | | | | | | | | | | | | | | | |
| 522 | Adds remote and automatic capabilities. | X | | | | | | | | | | | | | | | | |
| 523 | Adds 28-vdc return in lower umbilicals for arc-suppression diodes. | X | 629 | | | | | | | | | | | | | | | |
| 524 | Adds redundant power inputs to local static firing "B" rack (C7-803). | X | | | | | | | | | | | | | | | | |
| 525 | Issues stop orders and studies removal of thermal insulation from EAS and continuous operation of auxiliary pump. | | 714 | | | | | | | | | | | | | | | |
| 526 | Study deletion of ECO sensors from propellant tanks. | X | 610 | | | | | | | | | | | | | | | |
| 527 | Provides for inadvertent destruct alert lock-in for C7-307. | X | | | | | | | | | | | | | | | | |

Note 9: Center baffle modification not accomplished until unit 7.

Note 10: Special interim equipment to be used to support schedule.

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | V7-1 2 | V7-1 3 | V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 528 | Establishes MSFC-PROC-186A (molding and potting with elastomeric dielectric compounds) as applicable to S-II. | | | | | | | | | | | | | | | | | |
| 529 | Establishes MSFC-PROC-196 (potting with epoxy resins) as applicable to S-II. | | | | | | | | | | | | | | | | | |
| 530 | Removes relay tester from C7-213. | | | | | | | | | | | | | | | | | |
| 531 | Adds new item: SDD-149 LOX tank pressurization unit for PFL. | | | | | | | | | | | | | | | | | |
| 532 | Defines ground rules for implementing free ride-type instrumentation on all systems stage. | | 316 | | | X | | | | | | | | | | | | |
| 533 | Adds GN2 boattail Firex and inerting purge system in facilities at PFL and MTF. | | | | | | | | | | | | | | | | | |
| 534 | Provides stage weighing system for use at MTF. | X | 693 | | | | | | | | | | | | | | | |
| 535 | Provides simulators for EMM vehicle system components during tape development. | | | | | | | | | | | | | | | | | |
| 536 | Changes cutoff and hazardous monitor by deleting 35 parameters and replacing limit detectors with relays. | | | | | | | | | | | | | | | | | |
| 537 | Implements MSFC-85M05078 launch and checkout computer program configuration and control plan. | | | | | | | | | | | | | | | | | |
| 538 | Redesigns J-2 engine LOX pump seal drain system. | | | X | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 539 | Study of configuration differences between S-II-S, S-II-T, and S-II-F. | X | | | | | | | | | | | | | | | | |
| 540 | Study to resolve propellant feed-line installation problems on battleship. | | | | | | | | | | | | | | | | | |
| 541 | Implements necessary changes resulting from a change in J-2 engine bleed valves. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 542 | Study to prepare MTF vertical checkout facility definition. | | | | | | | | | | | | | | | | | |
| 543 | Revises plug supervision circuits to S-II stage/GSE interfaces. | | | X | | CCP 700 | | X | X | X | X | X | X | X | X | X | X | X |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 544 | Installs bumper guards on all systems test stand to protect stage during installation and removal. | | | | | | | | | | | | | | | | | |
| 545 | Reduces quantities of S7-6 and S7-10; remaining units re-identified as SDD-243 and SDD-244, respectively. | | | | | | | | | | | | | | | | | |
| 546 | Changes LO2 tank aft bulkhead grid panel spacing for weight reduction. | X | | | | | | | | | | | | | | | | |
| 547 | Provides for Chem-Mill of lower skins of aft skirt. | X | | | | | | | | | | | | | | | | |
| 548 | Provides for metallized systems tunnel. | X | 414 | | | | | | | | | | | | | | | |
| 549 | Reduces quantity of H7-18 and redesignates remaining units (2) as SDD-232. | | | | | | | | | | | | | | | | | |
| 550 | Replaces patch panels on C7-213 with NASA type. | X | | | | | | | | | | | | | | | | |
| 551 | Defines ground rules for anodizing stage structure. | X | | | | | | | | | | | | | | | | |
| 552 | Provides additional quantities of GSE to support station VIII and station IX checkout operations. | | | | | | | | | | | | | | | | | |
| 553 | Study to determine ability to remove LOX tank components using existing access manholes. | | | | | | | | | | | | | | | | | |
| 554 | Suspends work on A7-13 thrust alignment set until further notice. | | | | | | | | | | | | | | | | | |
| 555 | Adds thermal barrier between EAS main pump mounting flange and the J-2 engine accessory-drive pad. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 556 | Eliminates battleship and all systems EAS thermal insulation. | X | 714 | | | | | | | | | | | | | | | |
| 557 | Provides motion picture camera coverage of first- and second-plane separations. | | | | | | | | X | X | | | | | | | | |
| 558 | Provides checkout capabilities for LOX sequence valves. | X | 403 | | | | | | | | | | | | | | | |
| 559 | Provides for redesign of ullage motor fairing as a result of MCR 464. | | 464 | | | | | X | X | X | X | X | X | X | X | X | X | X |

Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 T | Test Stages V7-1 T | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 560 | Deletes turbopump over-speed cutoff device checkout by C7-200 in lieu of self-check at S/F sites. | | | | | | | | | | | | | | | | | |
| 561 | Provides interim patch panels for EMM. | | | | | | | | | | | | | | | | | |
| 562 | Provides for preparation and maintenance of noncontractual document "GSE and ACE Design Reference, SID 64-702". | | | | | | | | | | | | | | | | | |
| 563 | Provides protective devices for manhole openings in LOX and $LH_2$ tanks to prevent damage to sealing surfaces when open. | | | | | | | | | | | | | | | | | |
| 564 | Adds new items: models 916, 917, and 919 (GSE lifting frames). | | | | | | | | | | | | | | | | | |
| 565 | Redesigns SDD-130. | X | | | | | | | | | | | | | | | | |
| 566 | Thermal control system development test on EMM and S-II-T. | | | | | X | | | | | | | | | | | | |
| 567 | Reduces number of criticality components in C7-41. | X | | | | | | | | | | | | | | | | |
| 568 | Changes 2-inch recirculation valves to normally-open valves, except five LOX bleed valves and the $LH_2$ purge valve. Redundant closing feature provided for the five LOX bleed valves. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 569 | Provides for installation of GFE controller which charges EBW firing units in flight upon receipt of R-F engine cutoff command. | | | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| [illegible] | Provides for preparation and maintenance of noncontractual document "S-II Stage Design Reference, SID 64-652". | | | | | | | | | | | | | | | | | |
| 571 | Defines feed line requirements for S-II-D. | X | | | | | | | | | | | | | | | | |
| 572 | Deletes manual mechanical checkout equipment at EMM. | | | | | | | | | | | | | | | | | |
| 573 | Adds insulation on outer base of forward equipment containers, except container No. 223. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 574 | Deletes H7-73 and H7-77 and increases quantity of H7-27 from 6 to 7. | | 989 | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 | Test Stages V7-1 | | | | Flight Stages V7-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 575 | Study of mission aborts and alternative missions from primary parking orbit. | | | | | | | | | | | | | | | | | |
| 576 | Removes portion of propellant tank leak detection system. | X | 646 | | | | | | | | | | | | | | | |
| 577 | Provides two tape recorders and associated electronics and TLM equipment to record S-IC/S-II and S-II/S-IVB separation and to transmit this data after S-II/S-IVB separation. | | | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| 578 | Modifies engine prestart conditioning system to utilize recirculation system pump, motor, and connector of types common to both S-II and S-IVB stages. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 579 | Provides new adapters for H7-23 and H7-25. | | | | | | | | | | | | | | | | | |
| 580 | Relocates electrical control modules from panel on forward skirt into thermally controlled container. | | 220 | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 581 | Usage of power connectors at MTF and MILA. | | | | | | | | | | | | | | | | | |
| 582 | Redesigns battleship pressurization lines to accommodate ±3-degree rotational movement of J-2 engine. | | | X | | | | | | | | | | | | | | |
| [illegible] | Provides static firing thermal protection. | X | 631 | | | | | | | | | | | | | | | |
| 584 | Study to determine need for special equipment to facilitate installation of He spheres on battleship. | | | | | | | | | | | | | | | | | |
| 585 | Reduces quantity of H7-27 from 7 to 5. | | | | | | | | | | | | | | | | | |
| 586 | Deletes running gear from S7-34. | | | | | | | | | | | | | | | | | |
| 587 | Eliminates automatic over-pressure shutdown of engine compartment purge system. | | 763 | | | | | | | | | | | | | | | |
| 588 | Modifies [illegible] control modules to provide test points. | | | | | | | | X | X | X | X | X | X | X | X | X | X |
| 589 | Changes to C7-200 per design review report No. 145. | X | | | | | | | | | | | | | | | | |
| 590 | Adds new item: A7-91 forward bulkhead protection set. | | | | | | | | | | | | | | | | | |
| 591 | Implements equivalent parts program (documentation by SCD's). | | | | | | | | | | | | | | | | | |

# Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | Test Stages V7-1 2 | Test Stages V7-1 3 | Test Stages V7-1 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 592 | Revises LH2 tank servicing clean-room implementation. | | | | | | | | | | | | | | | | | |
| 593 | Revises vibration safety cutoff requirements for J-2 engine. | | | | | | | | | | | | | | | | | |
| 594 | Revises electrical module component lead material to comply with NASA welding requirements. | X | | | | | | | | | | | | | | | | |
| 595 | (Not assigned.) | | | | | | | | | | | | | | | | | |
| 596 | Replaces LH fill valve and disconnect with simulated masses for S-II-D. | X | | | | | | | | | | | | | | | | |
| 597 | Automatic checkout for J-2 engine LOX sequence valve and main stage OK pressure switches. | | | | | | | | | | | | | | | | | |
| 598 | Deletes H7-32 and H7-35 (ullage motor handling). | | 698 | | | | | | | | | | | | | | | |
| 599 | Adds isolated d-c source for TLM calibrator and deletes TLM calibration module (its function replaced by latching relay). | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 600 | Provides a last-point electrical ground disconnect at forward skirt umbilical. | | | | | CCP 100 | | X | X | X | X | X | X | X | X | X | X | X |
| 601 | Suspends system proof testing at all systems test stand. | X | | | | | | | | | | | | | | | | |
| 602 | Provides for environmental control system on S-II-F. | X | | | | | | | | | | | | | | | | |
| 603 | Revises switch selector output control circuitry for phase II approval. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 604 | Directs identification of all CDF assemblies and their mating connectors using the legend of common ordnance identification. | | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 605 | Reduces S-II gas reservoir burst pressure factor of safety. | X | 507 | | | | | | | | | | | | | | | |
| 606 | Defines phase II of the MSFC dynamic environment test and analysis program (TD 123). | | | | | | | | | | | | | | | | | |
| 607 | Study of longitudinal oscillation of structure (POGO). | | | | | | | | | | | | | | | | | |
| 608 | Provides for installation of power distribution system and cables from the rectifiers to the GSE at MTF. | | | | | | | | | | | | | | | | | |

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# Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages [illegible] 1 | Test Stages [illegible] 1 | 2 | 3 | 4 | Flight Stages 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 609 | Prepares material and process specifications for the MSFC double-seal $LH_2$ tank insulation. | X | | | | | | | | | | | | | | | | |
| 610 | Adds new item: C7-76 fuse rack. | | | | | | | | | | | | | | | | | |
| 611 | Initiates a program for system-level testing of equipment container assemblies. | | | | | | | | | | | | | | | | | |
| 612 | Provides for GETS C7-44 interface cabling. | X | | | | | | | | | | | | | | | | |
| 613 | Adds redundant power input to static firing monitor rack SDD-133. | | | | | | | | | | | | | | | | | |
| 614 | Study for battleship vacuum jacket relief valve system. | X | | | | | | | | | | | | | | | | |
| 615 | Study for alternate design of LOX tank support. | X | | | | | | | | | | | | | | | | |
| 616 | Study for backup method for battleship $LH_2$ tank chilldown. | X | | | | | | | | | | | | | | | | |
| 617 | Study involving application of strain gages in a cryogenic environment. | X | | | | | | | | | | | | | | | | |
| 618 | Study of deletion of engine cutoff sensors from LOX and $LH_2$ tanks. | X | | | | | | | | | | | | | | | | |
| 619 | Installs temperature indicators on heavy-duty thrust structure. | | | X | | | | | | | | | | | | | | |
| 620 | Installs linear potentiometers on LOX tank sliding support. | | | CCP 100 | | | | | | | | | | | | | | |
| 621 | Vibration test program for battleship stand and vessel. | | | | | | | | | | | | | | | | | |
| 622 | Changes document SD 61-340. | X | | | | | | | | | | | | | | | | |
| 623 | Adds new item: model 938 hoist adapter for installation of battleship, [illegible], and all systems bottom spheres. | | | | | | | | | | | | | | | | | |
| 624 | Deletes C7-73; changes cable quantity and storage location. | | | | | | | | | | | | | | | | | |
| 625 | Installs relays in C7-41 for power switching support for C7-307. | | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 626 | Study of manufacturing to launch pad operations with emphasis on influence of recent changes at MTF and MILA. | | | | | | | | | | | | | | | | | |
| 627 | Provides for simulation of separation during automatic integrated systems tests. | X | 690 | | | | | | | | | | | | | | | |
| 628 | Adds flight-type forward skirt environmental control for all systems and MTF. | | | | | | | | | | | | | | | | | |
| 629 | Adds transient-suppression diodes in GSE and 28-vdc return lines for diodes. | | | | | | | | | | | | | | | | | |
| 630 | Transfers certain wires from test connector to aft umbilical connector. | X | | | | | | | | | | | | | | | | |
| 631 | Study of criteria for design of S/F thermal protection; and provides for installation of water-spray heat shield on battleship. | | | X | | | | | | | | | | | | | | |
| 632 | Provides for replacement of all lance-LOX terminals in GSE with solid-type taper pin. | X | | | | | | | | | | | | | | | | |
| 633 | Provides for simulation of PCM and PAM signals for ACE verification and troubleshooting. | X | 796 | | | | | | | | | | | | | | | |
| 634 | Provides for stage weight reduction (supersedes MCR's 504, 506, 508, 515, and 516). | | | | | | | | | | | X | X | X | X | X | X | X |
| 635 | Implements changes to PCM/DDAS receiving stations (C7-403 and C7-519). | | 636 | | | | | | | | | | | | | | | |
| 636 | Implements changes to airborne TLM equipment. | | 652 | | | X | | | | | | | | | | | | |
| 637 | Reduces quantity of C7-28 electrical cable test set to 1; reidentifies one deleted C7-28 as SDD-249. | | | | | | | | | | | | | | | | | |
| 638 | Reinstates A7-29 and A7-31 as models 930 and 931, respectively. | | 13, 143 | | | | | | | | | | | | | | | |
| 639 | Relocates rate gyro and control accelerometer from systems tunnel to aft skirt, reroutes wiring, and eliminates aerodynamic protrusion on systems tunnel. | X | 795 | | | | | | | | | | | | | | | |
| 640 | Implements facility free-ride instrumentation (flame deflector) at MTF. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 | Test Stages V7-1 | | | | Flight Stages V7-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 641 | Adds new item C7-86; reduces quantity of C7-40 | X | | | | | | | | | | | | | | | | |
| 642 | Modifies electrical circuitry of S-II transporter, type II | | | | | | | | | | | | | | | | | |
| 643 | TVA No. 3233. | | | | | | | | | | | | | | | | | |
| 644 | Adds "PAM Signal Simulator" to C7-310 rack. | X | | | | | | | | | | | | | | | | |
| 645 | Revises separation controller logic to permit second-plane separation to occur if an outboard engine is "out". | | | | | CCP 100 | | | X | X | X | X | X | X | X | X | X | X |
| 646 | Deletes portion of leak detection system related to large seal and dissimilar metal joint monitoring. | X | | | | | | | | | | | | | | | | |
| 647 | Deletes 13 leak detection measurements from each J-2 engine. | | | | | | | | X | X | X | | | | | | | |
| 648 | Study of feasibility of using double-seal insulation concept on S-II. | X | 742, 743 | | | | | | | | | | | | | | | |
| 649 | Conduct test program to develop material and process specifications for double-seal insulation for $LH_2$ tank. | X | 742, 743 | | | | | | | | | | | | | | | |
| 650 | Provides for application of concept defined in phase II of EDC 649. | | 742, 743 | | | | | | | | | | | | X | X | X | X |
| 651 | Reinstates need for 2 each SDD-224 struts for battleship. | | | | | | | | | | | | | | | | | |
| 652 | Implements NASA changes regarding TLM equipment. | | 672 | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 653 | Deletes propellant tank cleanliness requirements from S-II-D. | | | | | | X | | | | | | | | | | | |
| 654 | Provides for test support for DAC structural tests of S-II/S-IVB interstage. | | | | | | | | | | | | | | | | | |
| 655 | Increases range of PU command ratio by adding programed mixture ratio (PMR) control; and cancels EDC 501. | | | | | | | | | | | X | X | X | X | X | X | X |
| 656 | Provides holes in forward skirt for water drainage. | | | | | CCP 100 | CCP 100 | CCP 100 | X | X | X | X | X | X | X | X | X | X |
| 657 | Provides for tests in connection with possible relocation of the upper LOX-tank antislosh baffles. | | 745 | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR | Change Effectivity: Test Stages V7.2 1 | Test Stages V7.1 1 | Test Stages V7.1 2 | Test Stages V7.1 3 | Test Stages V7.1 4 | Flight Stages V7.1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 658 | Provides for alternate locking design on Hadley disconnect couplings. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 659 | Modifies the ARMA filter element assembly, transfer tube, and charge valve fitting. | | | X | | X | | | X | X | X | X | X | X | X | X | X | X |
| 660 | Revises checkout tapes and switch selector operating procedures. | | | | | | | | | | | | | | | | | |
| 661 | Provides for preparation of a drawing requirements manual using NASA S-II contractual documents. | | 671 | | | | | | | | | | | | | | | |
| 662 | Adds engine side load measurement and engine cutoff system. | X | | | | | | | | | | | | | | | | |
| 663 | Relocates third-plane separation EBW firing units and pulse sensors to S-II forward skirt; and first-plane separation items to S-IC stage, for ground checkout until stage reaches VAB at MILA. | | 682 | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| 664 | Provides for road gage modification. | X | | | | | | | | | | | | | | | | |
| 665 | Retention of 3-engine firing capability on battleship. | | | X | | | | | | | | | | | | | | |
| 666 | Study to assess effects of deleting "hot gimballing" for S-II flight stages. | | | | | | | | | | | | | | | | | |
| 667 | Deletes "fail-safe" circuitry from C7-41; adds new item: [illegible] to provide deleted circuitry for battleship and all systems. | | | | | | | | | | | | | | | | | |
| 668 | Incorporates emergency detection system (EDS). | | | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| 669 | Adds umbilical wiring and pressure switches for NASA launch pad requirements (pressure switches not used on unit No. 8 and subs). | | | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| 670 | Provides for random vibration test of inert and live ullage motor. | | 715 | | | | | | | | | | | | | | | |
| 671 | Provides for review of 947 contractual specifications and extraction of design criteria. | | 661 | | | | | | | | | | | | | | | |

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Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 | Test Stages V7-1 | | | | Flight Stages V7-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 672 | Incorporates NASA EO's and drawings into airborne and GSE TLM equipment. | | 665 | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 673 | Installs Sparging jets in all systems stage to test effectiveness of bulk mixing in reducing $LH_2$ stratification (He bubbling system). | | 500, 509 | | | X | | | | | | | | | | | | |
| 674 | Study of S-II stage systems design test and checkout requirements, per MSFC drawing No. 10M30109, to identify those components which affect mission success. | | | | | | | | | | | | | | | | | |
| 675 | Deletes H7-81; A7-39 now performs its duty. | | | | | | | | | | | | | | | | | |
| 676 | Reduces quantity of H7-79 from 10 to 2, leaving one each for MTF and PTL. | | | | | | | | | | | | | | | | | |
| 677 | Adds targets on aft interstage for optical alignment operations at MILA (removed prior to flight). | | | | | | | CCP 100 | X | X | X | X | X | X | X | X | X | X |
| 678 | Adds data selection decoders (random access) to TLM checkout station. | | | | | | | | | | | | | | | | | |
| 679 | Reduces quantities of H7-2 (12 to 11), H7-23 (12 to 7), H7-24 (12 to 11), and A7-44 (12 to 11). | | | | | | | | | | | | | | | | | |
| 680 | Adds flight battery loading circuits to prevent excessive voltage application to the buses during system testing. | | | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| 681 | Redesigns LOX recirculation system, removing standpipes and overboard bleed manifold, and relocating the He injection system. | | | CCP 300 | | Note 11 | | | X | X | X | X | X | X | X | X | X | X |
| 682 | Redefines procurement and supply responsibilities for EBW firing units. | | 663 | | | | | | X | X | X | X | X | X | X | X | X | X |
| 683 | Provides additional circuitry to support stage tests at MILA. | | | | | CCP 700 | | | X | X | X | X | X | X | X | X | X | X |
| 684 | Revises second-plane separation EBW firing unit arm logic to arm EBW FU's 25 seconds after first-plane electrical disconnect. | X | | | | | | | | | | | | | | | | |

Note 11: Removes 3 stand pipes only and relocates He injection system immediately; remainder of change incorporated at CCP AA-700.

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2: 1 | Test Stages V7-1: 1 | V7-1: 2 | V7-1: 3 | V7-1: 4 | Flight Stages V7-1: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 685 | Implements NASA changes to TLM equipment. | | 704 | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 686 | Reduces quantity of C7-67 and reidentifies remaining units of C7-67 as SDD-337. | | | | | | | | | | | | | | | | | |
| 687 | Incorporates microelectronic modules into C7-204 rack. | | | | | | | | | | | | | | | | | |
| 688 | Transmittal of electrical system documentation from S&ID to MSFC. | | | | | | | | | | | | | | | | | |
| 689 | Modifies SDD-130, SDD-133, and SDD-134 to reduce [illegible] voltage. | | | | | | | | | | | | | | | | | |
| 690 | Provides for simulation of stage separations during automatic integrated systems test. | | | | | | | | | | | | | | | | | |
| 691 | Deletes engine propellant cutoff electronics assembly from S-II-F. | | | | | | | X | | | | | | | | | | |
| 692 | Adds boot between systems tunnel and engine compartment to reduce air leakage area. | | | | | CCP 600 | | CCP 300 | X | X | X | X | X | X | X | X | X | X |
| 693 | Adds new item: A7-75 stage weighing system adapter set for MTF. | | | | | | | | | | | | | | | | | |
| 694 | Deletes S7-42 in lieu of utilizing the C7-802 and C7-713. | X | | | | | | | | | | | | | | | | |
| 695 | Adds countdown clock for static firing at PTL and MTF. | | | | | | | | | | | | | | | | | |
| 696 | Deletes H7-78 and reduces quantity of A7-43 from 4 to 2. | | | | | | | | | | | | | | | | | |
| 697 | Adds sampling line and interface extensions on common bulkhead test. | | | | | | | | | | | | | | | | | |
| 698 | Adds new items: H7-115 and H7-116 (ullage motor handling). | | | | | | | | | | | | | | | | | |
| 699 | Adds A7-38 walkway to EMM. | | | | | | | | | | | | | | | | | |
| 700 | Expands intercommunication system for TLM station at Seal Beach, EMM, and PTL. | | | | | | | | | | | | | | | | | |
| 701 | TVA No. 3313, permitting temporary replacement of [illegible] hardware on SDD-110. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages, V7-2: 1 | Test Stages, V7-1: 1 | Test Stages, V7-1: 2 | Test Stages, V7-1: 3 | Test Stages, V7-1: 4 | Flight Stages, V7-1: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 702 | Adds vacuum pumping system (GSE) and stage provisions for re-establishing the LOX tank internal insulation vacuum LOX leakage through welds occurs. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |
| 703 | Provides for continuous $GN_2$ purge of lower bulkhead on engine J2008 only. | | | X | | | | | | | | | | | | | | |
| 704 | Implements NASA changes to TLM equipment. | | 722 | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 705 | Redesigns battleship recirculation system to more closely simulate the flight article. | | | X | | | | | | | | | | | | | | |
| 706 | TVA No. 3318, permitting temporary wiring for camera operation during cryogenic testing. | | 723 | X | | | | | | | | | | | | | | |
| 707 | Adds new item: A7-97 vent lines overpass ladder. | | | | | | | | | | | | | | | | | |
| 708 | Adds new item: A7-96 forward bulkhead extendable access platform. | | | | | | | | | | | | | | | | | |
| 709 | Adds bypass walkway to forward skirt maintenance walkway (A7-38). | | | | | | | | | | | | | | | | | |
| 710 | Adds new item: SDD-338 time code signal driver and distributor. | | | | | | | | | | | | | | | | | |
| 711 | Adds simulated static firing capability to static firing countdown control equipment. | | | | | | | | | | | | | | | | | |
| 712 | TVA No. 3952, permitting temporary use of replacement cable (SDD-103). | | | | | | | | | | | | | | | | | |
| 713 | TVA No. 3954, permitting temporary trial installation to eliminate intercom cross-talk interference (ITT Kellogg). | | | | | | | | | | | | | | | | | |
| 714 | Removes thermal insulation from EAS and enclosure from ARMA. | | 525 | X | | X | X | | X | X | X | X | X | X | X | X | X | X |
| 715 | | | | | | | | | | | | | | | | | | |
| 716 | Special patch panel for GETE. | | | | | | | | | | | | | | | | | |
| 717 | Implements use of ~~international system of units~~ (SI) for flight measurements rather than the English system. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | V7-1 | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 718 | Provides for installation of G-3107 J-2 component test console at EMM, PFL, MTF, and MILA. | | | | | | | | | | | | | | | | | |
| 719 | Provides d-c power supply and battery control system (GSE). | | | | | | | | | | | | | | | | | |
| 720 | Modifies 87-41 units at MILA to provide 2-8 psig GHe for anti-collapse pressurizing of the propellant tanks. | | | | | | | | | | | | | | | | | |
| 721 | Provides for stage-oriented hydrogen leak detection system for PFL. | | | | | | | | | | | | | | | | | |
| 722 | Reidentifies one SDD-156 as SDD-188 due to different requirements at all systems test stand. | | | | | | | | | | | | | | | | | |
| 723 | TVA No. 3935, permitting temporary wiring for camera operation during cryogenic mating. | | 706 | X | | | | | | | | | | | | | | |
| 724 | TVA No. 3317, permitting temporary removal of SDD-322 console hardware to allow tiedown until long anchor bolts are received. | | | | | | | | | | | | | | | | | |
| 725 | Provides for transmittal of nonconformance report tapes to MSFC. | | | | | | | | | | | | | | | | | |
| 726 | Provides for tank anti-collapse pressurization control unit for use during loading of stage. | | | | | | | | | | | | | | | | | |
| 727 | TVA No. 3320, permitting temporary power wiring (SDD-107 to SDD-141). | | | | | | | | | | | | | | | | | |
| 728 | TVA No. 3321, permitting temporary power wiring (SDD-107 to SDD-133). | | | | | | | | | | | | | | | | | |
| 729 | TVA No. 3967, permitting temporary replacement of connectors on SDD-103. | | | | | | | | | | | | | | | | | |
| 730 | Study of VAB and launch pad S-II stage handling concept. | | | | | | | | | | | | | | | | | |
| 731 | Provides for incorporation of M-D MA 1400 Apollo test requirements into the S-II program. | | | | | | | | | | | | | | | | | |
| 732 | Implements NASA EO's into airborne and GSE TLM equipment. | | 635 | | | | | | X | X | X | X | X | X | X | X | X | X |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Test Stages | | | | | Flight Stages | | | | | | | | | |
| | | | | V7-2 | V7-1 | | | | [illegible] | | | | | | | | | |
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 733 | Re-evaluation of S-II component qualification test program. | | | | | | | | | | | | | | | | | |
| 734 | Implements static firing leak detection system for stage. | | | | | | | | | | | | | | | | | |
| 735 | TVA No. 3975, permitting temporary change in wiring connections in SDD-103. | | | | | | | | | | | | | | | | | |
| 736 | Modifies C7-603 to delete isolation requirements and to provide monitoring capability for the C7-58 transducer set. | | | | | | | | | | | | | | | | | |
| 737 | Replaces DRW-13 command receivers with digital range safety command system (DRSCS), provided as GFE and installed in container 221. | | | | | X | | | X | X | X | X | X | X | X | X | X | X |
| 738 | Provides TLM frequency conversion system to overcome VHF TLM blackout at time of separation. | | | | | | | | X | X | | | | | | | | |
| 739 | Deletes redundant equipment in GSE and relocates measurement test point selector. | | | | | | | | | | | | | | | | | |
| 740 | Defines revised stage handling and GSE concept at Seal Beach, MTF, and MILA. | | | | | | | | | | | | | | | | | |
| 741 | Increases magnetic core memory in C7-101 from 16,384 to 32,768 words. | | | | | | | | | | | | | | | | | |
| 742 | Provides for analysis, design, test, and application of double-seal insulation concept to $LH_2$ tank. | | 743 | | | | | | | | | X | X | X | X | X | X | X |
| 743 | Provides for analysis, design, test, and application of 1.6-inch lightweight insulation concept to $LH_2$ tank (backup for MCR 742). | | 742 | | | | | | | | | X | X | X | X | X | X | X |
| 744 | TVA No. 3974. | | | | | | | | | | | | | | | | | |
| 745 | Provides for redesign of upper LOX tank antislosh baffle to provide 3 to 5 percent damping during S-IC boost. | | | | | | | | X | X | X | X | X | X | X | X | X | X |
| 746 | TVA No. 3312. | | | | | | | | | | | | | | | | | |
| 747 | TVA No. 3973, permitting temporary substitution of cable for bus bar in control center service tower (PFL). | | | | | | | | | | | | | | | | | |
| 748 | TVA No. 3324, permitting temporary wiring change in SDD-135. | | | | | | | | | | | | | | | | | |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 1 | Test Stages V7-1 1 | 2 | 3 | 4 | Flight Stages V7-1 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 749 | Allocates GSE hoist equipment to support Seal Beach station VIII and IX. | | | | | | | | | | | | | | | | | |
| 750 | Adds isolation circuitry to critical measurement lines originating in S-II stage (GSE). | | | | | | | | | | | | | | | | | |
| 751 | Adds two additional point sensors in each tank at the 7% and 10% levels, but are not wired in until needed. | | | | | X | | | | | | | | | | | | |
| 752 | TVA No. 3968. | X | | | | | | | | | | | | | | | | |
| 753 | TVA No. 3970. | | | | | | | | | | | | | | | | | |
| 754 | TVA No. 3971. | X | | | | | | | | | | | | | | | | |
| 755 | TVA No. 3972. | | | | | | | | | | | | | | | | | |
| 756 | TVA No. 3985. | | | | | | | | | | | | | | | | | |
| 757 | TVA No. 3323, permitting temporary jumper wires in SDD-139. | | | | | | | | | | | | | | | | | |
| 758 | TVA No. 3986, permitting temporary wiring changes in C7-41. | | | | | | | | | | | | | | | | | |
| 759 | TVA No. 4000, permitting temporary jumper wire in SDD-130A. | | | | | | | | | | | | | | | | | |
| 760 | Modifies S-II structural design to relieve and reduce stresses on welds for the forward bulkhead, $LH_2$ cylinders, common bulkhead, and aft bulkhead; and reduces $LH_2$ tank maximum pressure from 39 to 36 psia. | | | | | | | | X | X | X | X | X | X | X | X | X | X |
| 761 | TVA No. 3993. | | | | | | | | | | | | | | | | | |
| 762 | TVA No. 3995. | | | | | | | | | | | | | | | | | |
| 763 | Eliminates automatic overpressure shutdown of S7-40 and SDD-169. | | 507 | | | | | | | | | | | | | | | |
| 764 | TVA No. 3996. | | | | | | | | | | | | | | | | | |
| 765 | TVA No. 3987. | | | | | | | | | | | | | | | | | |

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## Table F-2. Change Descriptions and Effectivities (Cont)

| ECP/MCA No. | Change Description and Remarks | Cancelled | Related to ECP/MCA No. | Change Effectivity: Test Stages, VT-2, 1 | Test Stages, VT-1, 1 | Test Stages, VT-1, 2 | Test Stages, VT-1, 3 | Test Stages, VT-1, 4 | Flight Stages, VT-1, 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 766 | TVA No. 3308. | | | | | | | | | | | | | | | | | |
| 767 | TVA No. 3325. | | | | | | | | | | | | | | | | | |
| 768 | TVA No. 3326. | | | | | | | | | | | | | | | | | |
| 769 | TVA No. 3327. | | | | | | | | | | | | | | | | | |
| 770 | TVA No. 3328. | | | | | | | | | | | | | | | | | |
| 771 | TVA No. 3329. | | | | | | | | | | | | | | | | | |
| 772 | TVA No. 3330. | | | | | | | | | | | | | | | | | |
| 773 | TVA No. 3331. | | | | | | | | | | | | | | | | | |
| 774 | TVA No. 3332. | | | | | | | | | | | | | | | | | |
| 775 | TVA No. 3333. | | | | | | | | | | | | | | | | | |
| 776 | TVA No. 3334. | | | | | | | | | | | | | | | | | |
| 777 | TVA No. 3335. | | | | | | | | | | | | | | | | | |
| 778 | Study for added magnetic core memory in C7-101. | X | 761 | | | | | | | | | | | | | | | |
| 779 | TVA No. 3319. | | | | | | | | | | | | | | | | | |
| 780 | Implements drag-in cables for facility free-ride (off-stage) instrumentation at MTF. | | | | | | | | | | | | | | | | | |
| 781 | Implements facility free-ride (off-stage) instrumentation at MTF. | | | | | | | | | | | | | | | | | |
| 782 | Modifies GFE [illegible] panels in ACE/GSE racks at MTF. | | | | | | | | | | | | | | | | | |
| 783 | Establishes future launch vehicle and Apollo spacecraft coordinate axis notation system. | | | | | | | | | | | | | | | | | |
| 784 | (Not assigned.) | | | | | | | | | | | | | | | | | |
| 785 | Adds new LOX ullage pressure transducer and hardware through umbilical and revises $LH_2$ ullage pressure transducer to permit ullage pressure monitoring with stage power off. | | | | | X | | X | X | X | X | X | X | X | X | X | X | X |

## Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/MCR No. | Change Description and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-1: 1 | Test Stages V7-1: 1 | 2 | 3 | 4 | Flight Stages V7-1: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 786 | TVA No. 3976, 3977, 3978, and 3979. | | | | | | | | | | | | | | | | | |
| 787 | Supplemental ground-supplied $LH_2$ prestart conditioning system for J-2 engine. | | | | | | | | | | | | | | | | | |
| 788 | TVA No. 3339. | | | | | | | | | | | | | | | | | |
| 789 | TVA No. 3340. | | | | | | | | | | | | | | | | | |
| 790 | TVA No. 3341. | | | | | | | | | | | | | | | | | |
| 791 | TVA No. 3342. | | | | | | | | | | | | | | | | | |
| 792 | TVA No. 3343. | | | | | | | | | | | | | | | | | |
| 793 | TVA No. 3344. | | | | | | | | | | | | | | | | | |
| 794 | TVA No. 3345. | | | | | | | | | | | | | | | | | |
| 795 | Delete requirement for all flight control sensor locations on S-II stage. | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 796 | Stage instrumentation simulator at each test site for program tape. | | | | | | | | | | | | | | | | | |
| 797 | TVA No. 3991. | | | | | | | | | | | | | | | | | |
| 798 | Microminiaturization of stage TLM and signal conditioning equipment. | | | | | | | | | | | | | | | | | |
| 799 | Provide capability to address common (C7-211) in local mode of operation and capability of self-test. | | | | | | | | | | | | | | | | | |
| 800 | TVA No. 4040. | | | | | | | | | | | | | | | | | |
| 801 | TVA No. 4041. | | | | | | | | | | | | | | | | | |
| 802 | TVA No. 3346. | | | | | | | | | | | | | | | | | |

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Table F-2. Change Descriptions and Effectivities (Cont)

| EDC/ MCR No. | Change Descriptions and Remarks | Cancelled | Refer to EDC/MCR No. | Change Effectivity: Test Stages V7-2 | Test Stages V7-1 | | | | Flight Stages V1-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 003 | Incorporates modified flight-type pressurization system with external pressure source for S-II-D. | | | | | | X | | | | | | | | | | | |
| 004 | TVA No. 3337. | | | | | | | | | | | | | | | | | |
| 005 | Telemetry drawing changes. | | | | | | | | | | | | | | | | | |
| 006 | (005 last assigned as of 8 October 1964.) | | | | | | | | | | | | | | | | | |
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Table F-3. Glossary of Design Change-Related Abbreviations

| Category | Abbreviation | Definition |
|---|---|---|
| Facilities | AMR | Atlantic Missile Range |
| | EDL | Engineering Development Lab (Los Angeles area) |
| | EMM | Electromechanical Mockup (Downey) |
| | MILA | Merrit Island Launch Area (Florida) |
| | MTF | Mississippi Test Facility |
| | MTO | Mississippi Test Operations (same as MTF) |
| | PFL | Propulsion Field Lab (All systems and battleship test stands) |
| Documents | C/A | Contract advice |
| | C.O. or CO | Change order (NASA) |
| | CCN | Contract change notice |
| | CCP | Contract change proposal |
| | CRN | Contract revision number |
| | EDC | Engineering design change |
| | G.O. | General order |
| | ICA | Item change analysis |
| | MCR | Master change record |
| | PCA | Precontract authorization |
| | QRE | Quick reaction estimate |
| | S/A | Supplementary agreement (NASA) |
| | TD | Technical Directive (NASA) |
| | TR | Technical Request (NASA) |
| | TVA | Temporary variance authorization |
| Meetings | CCB | Configuration control board |
| | DIM | Design input meeting |
| Hardware | C/O | Checkout |
| | CALIPS | Calibratable pressure switch |
| | CCP | Configuration change point |
| | ECO | Engine cutoff |
| | EFSSS | Engine failure sensing and shutdown system |
| | GETS | Ground equipment test stand |
| | RACS | Remote automatic calibration system |
| | SLAM | Side load arresting mechanism |