GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

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SA-5 SATURN I BLOCK II VEHICLE DESCRIPTION

by

ASSEMBLY ENGINEERING SECTION

VEHICLE ENGINEERING BRANCH
VEHICLE SYSTEMS DIVISION
PROPULSION AND VEHICLE ENGINEERING LABORATORY

National Aeronautics and Space Administration

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ABSTRACT

The illustrations and text in this publication briefly describe the SA-5 Saturn I Block II vehicle. The purpose of the manual is to provide interested NASA and contractor personnel with a summary of the vehicle configuration.

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SA-5 SATURN I BLOCK II VEHICLE DESCRIPTION

by

Engineering Communications Department
Chrysler Corporation, Space Division
Huntsville Operations

Under the Technical Supervision of
Assembly Engineering Section

Vehicle Engineering Branch
Vehicle Systems Division
Propulsion and Vehicle Engineering Laboratory

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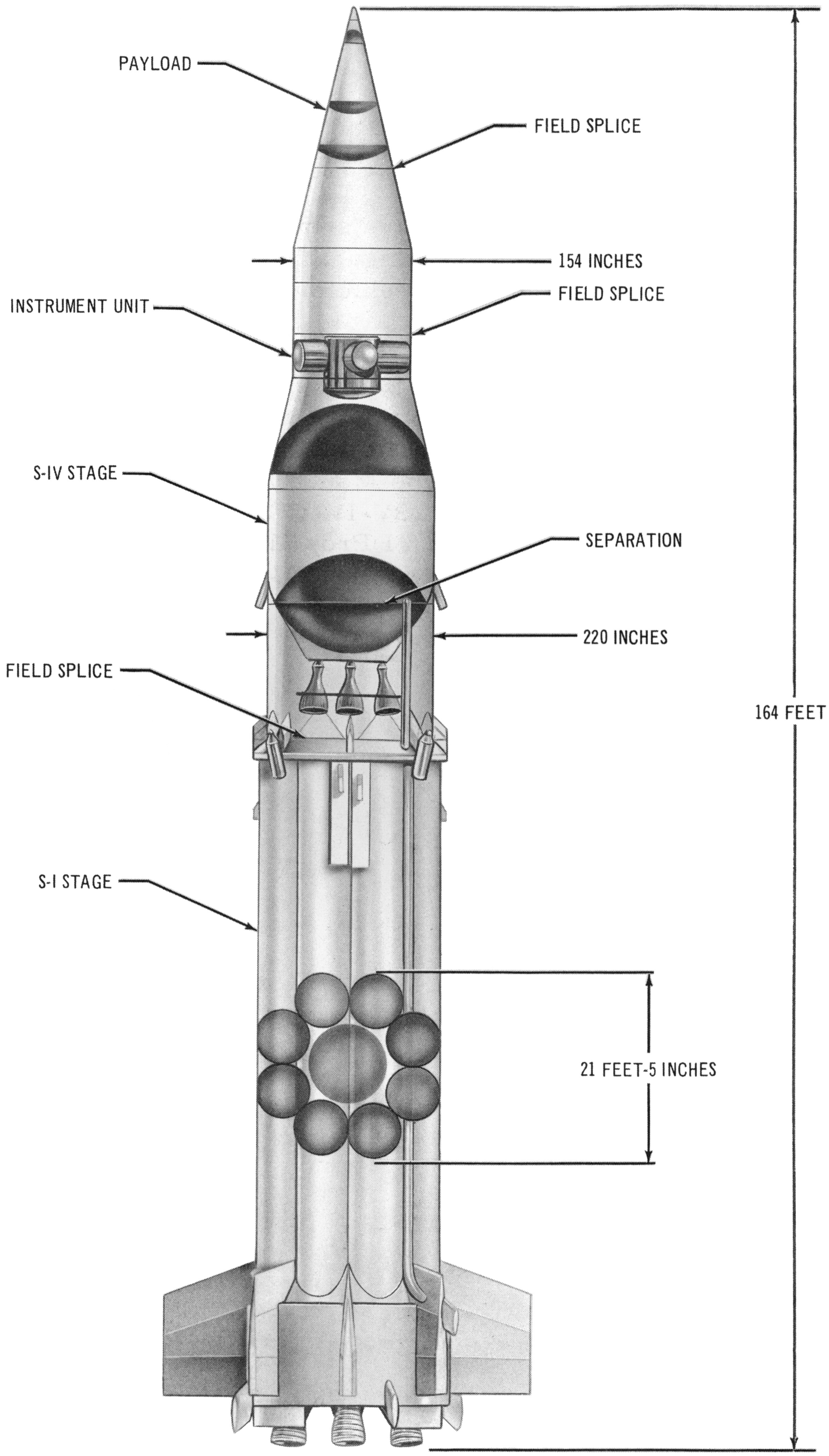
INTRODUCTION

This manual presents a brief descriptive summary of major vehicle assemblies contributing to the Saturn I configuration peculiar to SA-5, and provides a capsule reference guide to the vehicle.

The manual first briefly describes the overall vehicle, then describes the vehicle stages and major assemblies of each stage. For detailed information about certain assemblies, refer to the Saturn I assembly drawings, the Saturn Vehicle Data Book, the Saturn Technical Information Handbook, the Saturn Vehicle Instrumentation Systems Manual, Douglas Aircraft Company's Technical Support Document DSV-IV-I, SA-5 LOX System (Dwg. No. 10M30012), IN-P&VE-V-63-2, Saturn I Propellant Dispersion System, and Saturn I Block II Flight Measurements Manual Volumes I through IV.



SA-5 VEHICLE

C-H 6178

A. GENERAL DESCRIPTION

The frontispiece shows the major characteristics of Saturn I SA-5, which is the first vehicle of the Saturn I Block II configuration. The vehicle is 164 feet long, 21 feet at the largest diameter and weighs approximately 1, 130, 000 pounds at liftoff. Eight tail fins (four large and four stubs) on the S-I stage provide support and hold-down points for launch and, under certain conditions, aerodynamic stability during flight.

Eight liquid-fueled Rocketdyne H-1 engines, each developing 188, 000 pounds of thrust, power the S-I stage. The four outboard engines are gimbal-mounted for directional control. Six liquid hydrogen/liquid oxygen (LH_2/LOX) Pratt and Whitney RL 10-A3 engines power the live S-IV stage. All six engines are canted outboard six degrees and gimbal-mounted.

The S-I stage attaches to the S-IV stage through the S-IV aft interstage. The aft interstage is bolted to the spider beam of the S-I stage. S-I/S-IV separation occurs between the S-IV aft skirt and S-IV aft interstage. For additional information, refer to Paragraphs B and C.

A 154-inch diameter, 58-inch high, GN_2-pressurized, instrument unit (consisting of four horizontal 40-inch tubes attached to a vertical 70-inch center tube with a 154-inch diameter skin joining the radial tubes) is located between and attached to the forward S-IV interstage and the payload adapter assembly. The instrument unit houses the vehicle control system, a developmental guidance and control system, tracking systems, and power supplies. See Instrument Unit, Paragraph D, for additional information on the instrument unit.

A payload assembly; consisting of a modified Jupiter nose cone, aft unit, and adapter, mates to the instrument unit.

Approximately 1, 380 measurements throughout the vehicle are monitored during prelaunch and flight in order to obtain sufficient information to adequately evaluate the vehicle performance. For the approved checkout and calibration procedures of flight instrumentation components, including instruments containing radioactive materials and/or radioactive material excitors, refer to the Saturn I Block II Flight Measurements Manual and Checkout Procedures for S-I and S-IU Measuring Systems, SA-5. Both manuals are available on approved distribution from R-ASTR-IE.

B. S-I STAGE, GENERAL

The S-I stage (Fig. 1) is approximately 80 feet long, 21 feet in diameter, and has a fin span of approximately 40 feet. The following table presents additional data on the S-I stage.

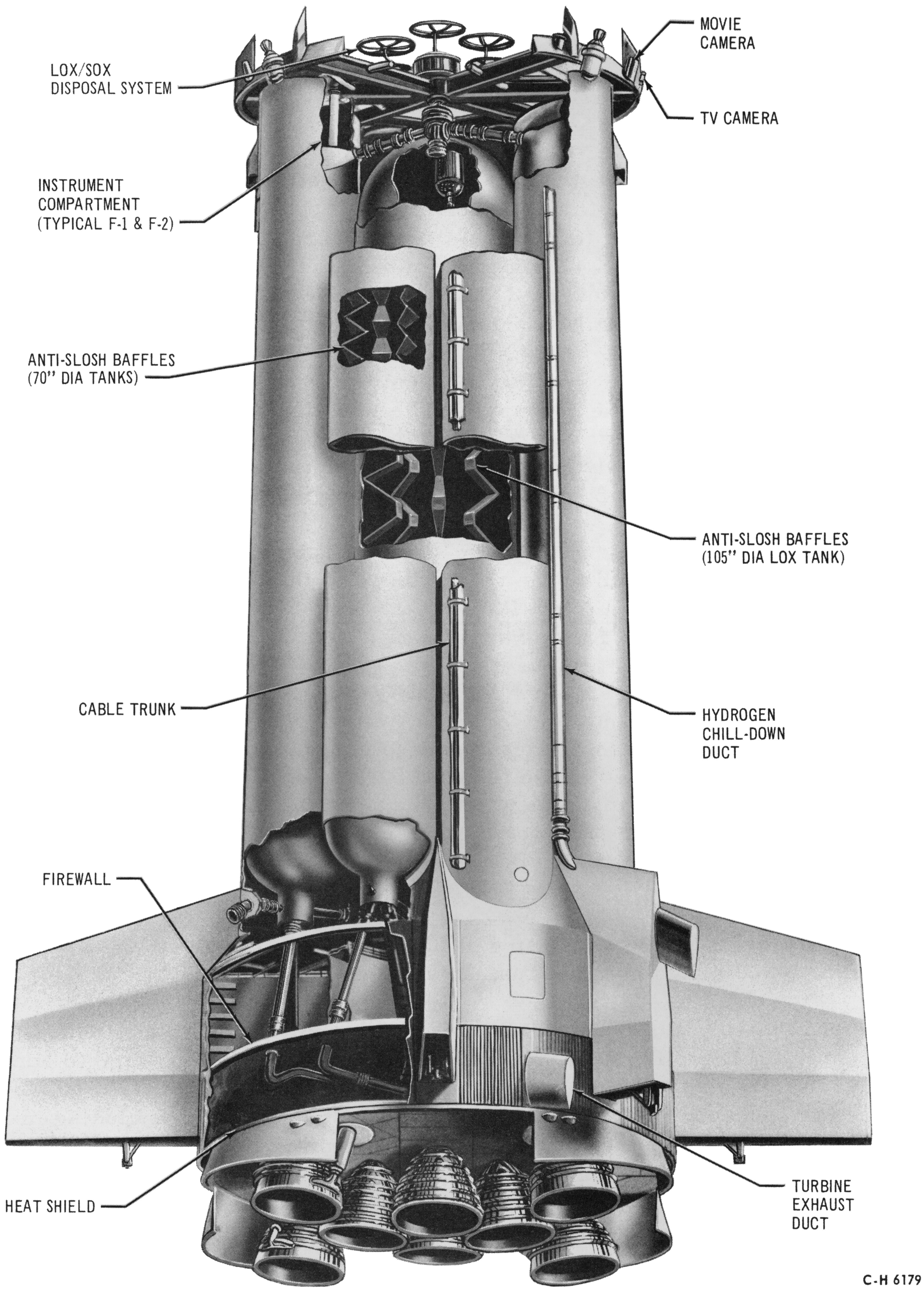


FIGURE 1. S-I STAGE

Table 1. S-I Stage Statistical Data

Gross Weight at Liftoff	980, 000 lbs.
Propellant Weight	850, 000 lbs.
Engines (8)	H-1 Rocketdyne
Thrust per Engine	188, 000 lbs.
Total Thrust (sea level)	1. 5 million lbs.
Propellant use per second/per engine	737 lbs.
Total Propellant Consumption per second	5, 900 lbs.
Valves and Control Devices	320
Measurements during Flight	740 (approx.)
Electrical and Electronic Components	1, 708
Electrical Network Connections (excluding internal) of above components	73, 000
Wiring used	53 miles
Structural Fabrication	27 weeks (approx.)
Final Assembly	17 weeks (approx.)

The base of the S-I stage is the tail section thrust structure assembly. The eight engines attach to the thrust structure aft of the firewall. The engines are partially enclosed by the tail shrouds and heat shield, and only the engine thrust chambers and heat exchangers are visible. Engine thrust is transmitted from the thrust structure through the LOX containers to the spider beam unit assembly.

The container section consists of a 105-inch-diameter center LOX container, four 70-inch-diameter LOX containers, and four 70-inch-diameter fuel containers. The eight 70-inch containers are clustered around the 105-inch container. On Block II vehicles, the propellant containers have been lengthened to provide approximately 100, 000 pounds of additional propellants. The combined LOX capacity of the 105-inch LOX container and the four 70-inch LOX containers is approximately 600, 000 pounds. The combined fuel capacity provided by the four 70-inch fuel containers is approximately 250, 000 pounds. The fuel containers are mounted to the spider beam unit assembly with floating attachments to allow for LOX container shrinkage when the booster is loaded with liquid oxygen. Two 20-cubic-foot capacity, high-pressure GN_2 spheres are mounted in the forward sections of fuel containers F-3 and F-4. Instrument compartments are located in the forward sections of fuel containers F-1 and F-2.

The spider beam forms the forward structure of the stage and serves to anchor the forward end of the propellant containers. Seal plates cover the forward side of the spider beam. A LOX/SOX (liquid oxygen/solid oxygen) disposal system, installed above the seal plates, is used to purge the S-IV interstage area during S-IV engine chilldown.

A camera system, consisting of eight movie cameras and one TV camera, is installed on the spider beam to observe stage separation and propellant sloshing during flight.

1. Tail Area. Installation of the water quench and barrel heater system, engine purge system, LOX and fuel wraparound suction lines, lower LOX replenishing line, and fire detection system, transforms the structural tail section assembly 30M01000 into the tail unit assembly 10M10013. To utilize optimum accessibility, these installations (Fig. 2) are normally performed before the clustering operation.

The boattail conditioning and water quench systems 10M10162 are perforated pipes routed from a quick-disconnect coupling at the heat shield up the shroud and along the thrust outriggers at fins I, II, III, and IV to the center barrel. This is a threefold system: first, it provides the necessary water quench capability for firings; second, it provides a means to purge the tail area by ground source; and third, it provides the necessary ducting for ground heating of the tail area.

The engine purge system provides for the routing of engine purge lines from the two umbilical service plates on the shroud to the purge manifold in the center barrel assembly. Lines extend from the manifold through the firewall to each of the engines. Each engine purge system consists of: LOX pump seal purge and gearbox pressurization, LOX dome purge, gas generator LOX injector manifold purge, and thrust chamber fuel injector manifold purge. The LOX pump seal purge and gearbox pressurization obtains GN_2 from the control pressure spheres. The rest of the purge systems obtain GN_2 from the ground control source.

The 1.5-inch-diameter GOX lines from the GOX manifold to the outboard engines are prefitted for installation after the engines are installed. The mechanical components of the fire detection system are installed, and the inflight heat shield panels and star assembly are prefitted. R-TEST configuration panels are used for static test. The inflight panels are reinstalled during poststatic and preparation for shipment operations.

The component installations in the aft skirts of all the LOX container unit assemblies are almost the same for each container (Fig. 3). Two suction line ball rotor LOX shutoff valves (prevalves) are installed along with the actuating pressure tubing, and various tubing assemblies used for pressure pickup, control, etc. The LOX fill and drain valve and nozzle are installed on the sump of container L-4.

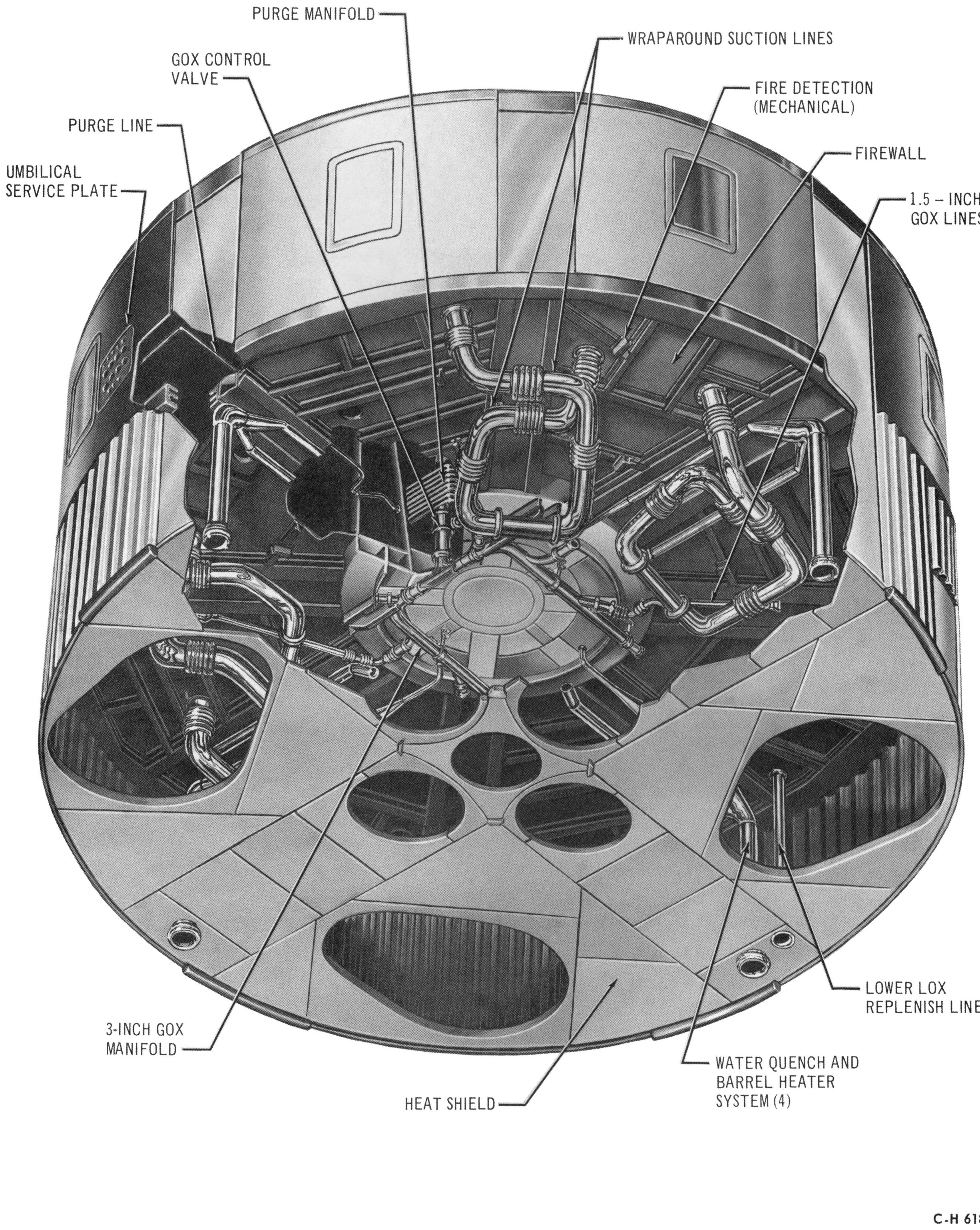


FIGURE 2. TAIL UNIT ASSEMBLY

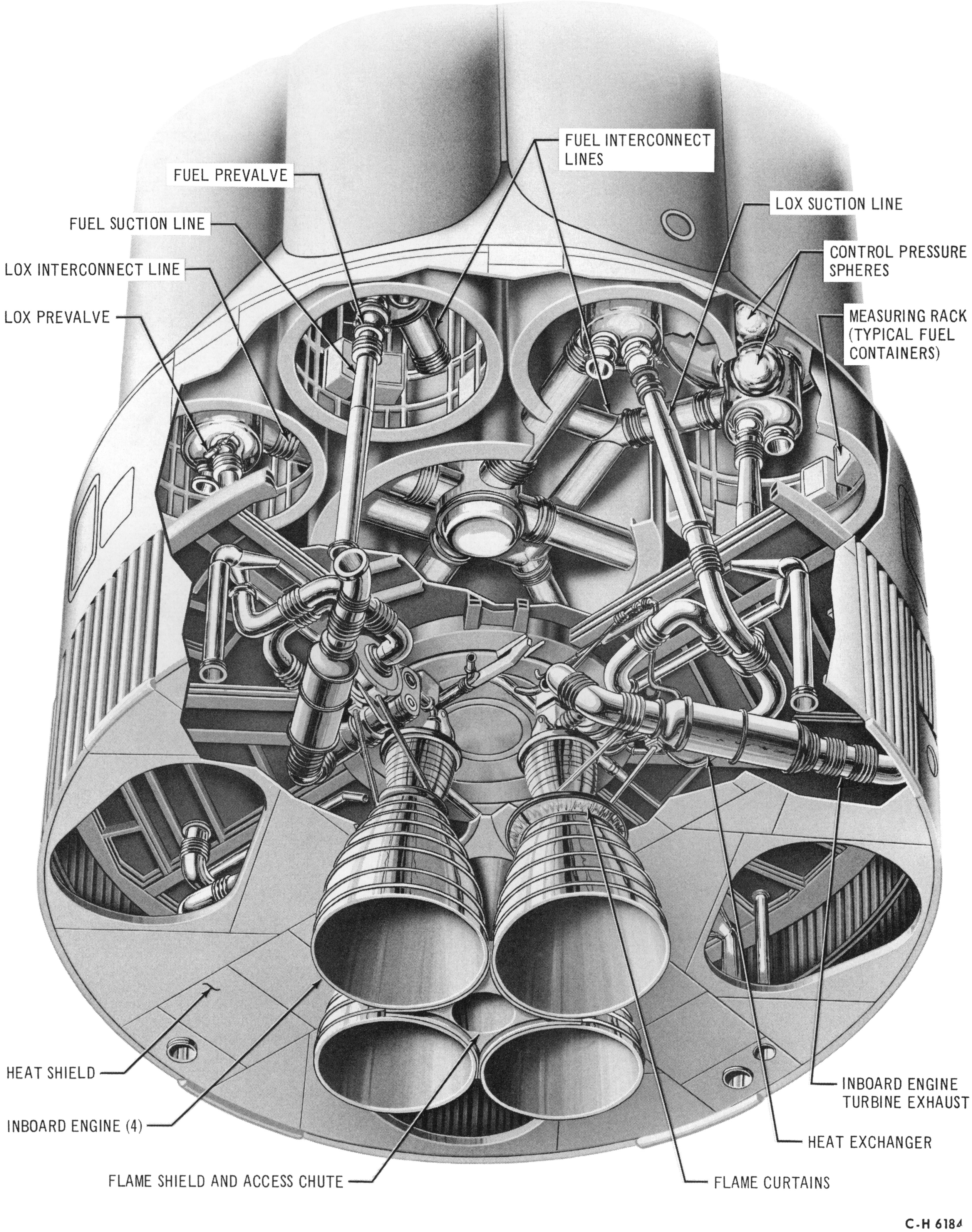


FIGURE 3. TAIL AREA, OUTBOARD ENGINES REMOVED

The aft skirt of fuel container F-3 contains the control pressure GN_2 storage spheres with the associated regulators, control valves, and connecting lines. The control pressure system supplies GN_2 pressure to operate the electrically-controlled pressure-operated LOX replenishing valve, LOX vent valves, and LOX and fuel prevalves. The system supplies pressure for pressurizing the turbopump gearboxes, purging the LOX seals, and purging the calorimeters.

Measurement racks and distributors are located in the aft skirts of all fuel containers. Some of the measuring racks and electrical distributors are shown in figure 3. For additional information refer to the Saturn I Block II Flight Measurements Manual.

Figure 3 shows the LOX and fuel interconnect lines and suction lines. Each outer container supplies one inboard and one outboard engine. The LOX containers are interconnected through the sump of the 105-inch LOX container unit. The LOX replenishing system is routed from the heat shield to the sump of LOX container L-4.

The four inboard engines are rigidly mounted to the thrust structure assembly in a square pattern around the centerline of the vehicle. The engines are canted outward at a slight angle. A flame shield and access chute forms a heat barrier between each of the inboard engines. Additional engine compartment temperature control is provided by the heat shield and the flexible flame curtains. The inboard engines are exhausted through the inboard engine turbine exhaust system and heat exchanger. GOX for pressurizing the LOX tanks is obtained by routing LOX through the heat exchanger and converting it to gaseous oxygen. The gaseous oxygen is routed through a 3-inch GOX manifold to a GOX flow-control valve and then through the center LOX tank to the LOX pressurization manifold (GOX distribution system).

The outboard engines (Fig. 4) are gimbal-mounted to provide a movement of plus or minus 8 degrees in a square pattern. Engine gimbaling is accomplished through two actuators operating in a closed hydraulic system. Gimbaling action is initiated by electrical signal from the guidance system through an electro-hydraulic servo valve on each actuator.

Flexible purge and propellant bubbling lines to the engine from the firewall permit engine gimbaling. The final length of 1.5-inch GOX line to the outboard engine is flexible. The turbine exhaust system is a component part of the outboard engine, and aspirates through a port on the periphery of the engine nozzle. This type of setup for the exhaust system conserves space and permits engine gimbaling. The flexible flame curtains around the engines, while preventing excessive engine compartment temperatures, allow freedom of movement for the engines.

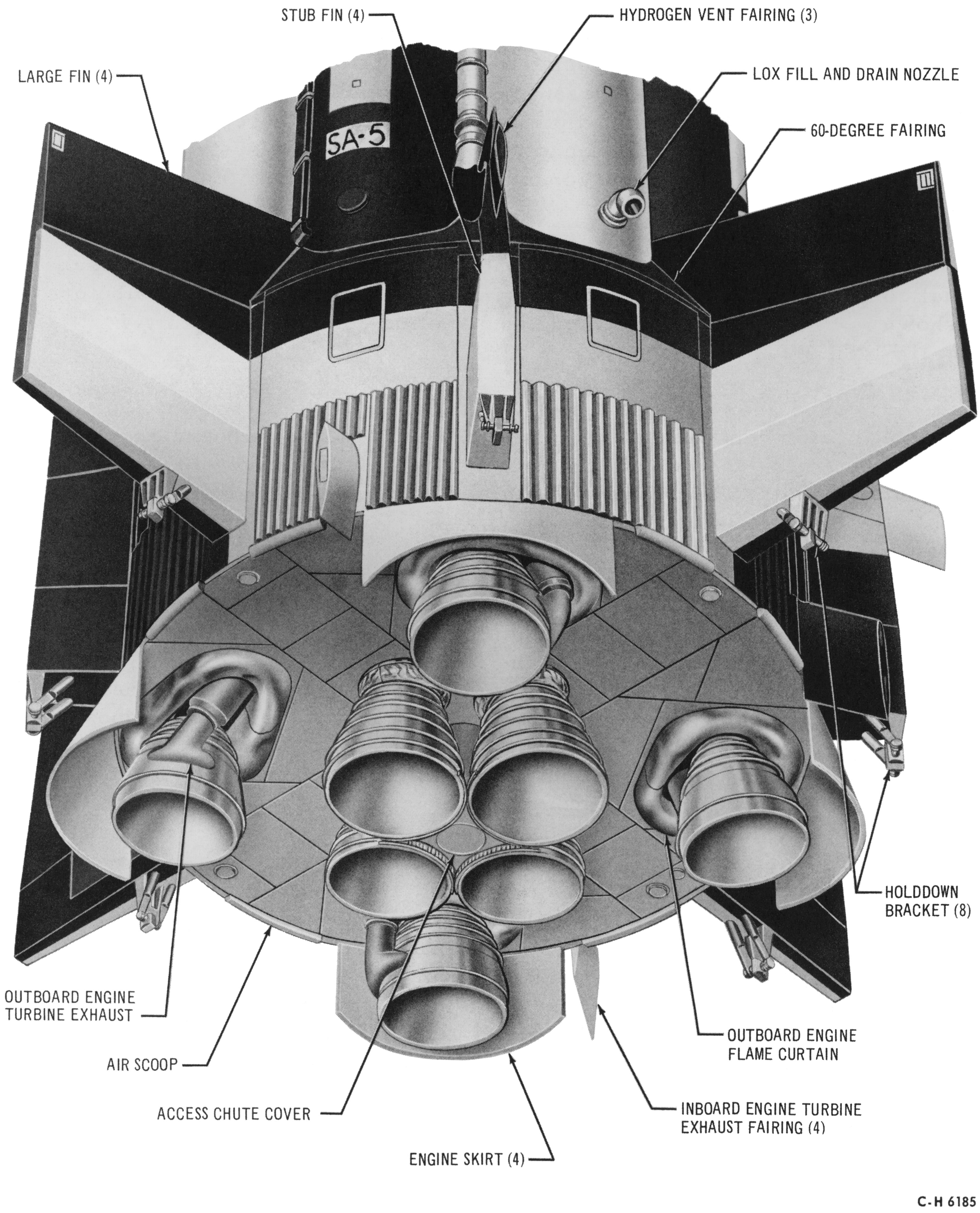


FIGURE 4. TAIL AREA, COMPLETE

Four large fins, four stub fins, four inboard engine turbine exhaust fairings, three hydrogen vent fairings, eight airscoop skins, and four engine skirts are installed on the tail of the S-I stage. Each of the eight fins has a strain gage installation for measurement of stresses during flight. Three of the stub fins (10M10025) have hydrogen vent installations. The hydrogen vent installation, together with the hydrogen vent fairings, serve to aspirate and route away from the vehicle vented hydrogen from the S-IV stage. The turbine exhaust fairings aspirate the exhaust gases from the inboard engines. The airscoops and engine skirts direct the flow of air around the tail section to control tail heating and aerodynamic loading on the engines.

At the forward end of the tail unit 60-degree fairing assemblies provide an aerodynamic seal between the propellant container assembly and the tail unit assembly.

2. Propellant Containers. The container area (Fig. 5) encompasses the four fuel tanks, the five LOX tanks, and pertinent auxiliary components. There are more similarities than differences between the individual containers. For a summation of similar and different characteristics, refer to table 2 and figure 5.

a. The center LOX container unit assembly 10M10130 is 105 inches in diameter and 749.679 inches long. In addition to the components listed in table 2, the center tank has a sump and fuel interconnect manifold located in the aft skirt.

After the auxiliary components (including connecting hardware, tubing, and wiring) are installed in the forward and aft skirts and on the skin, the center LOX container unit assembly becomes the 105-inch-diameter LOX container unit assembly 10M10014. For additional information, refer to LOX container unit assembly drawing 10M10014.

b. The 70-inch LOX containers are 747.43 inches long and 70 inches in diameter. After installation of the auxiliary components, each container weighs approximately 3,900 to 4,100 pounds. A typical internal arrangement of these LOX containers is shown in figure 5.

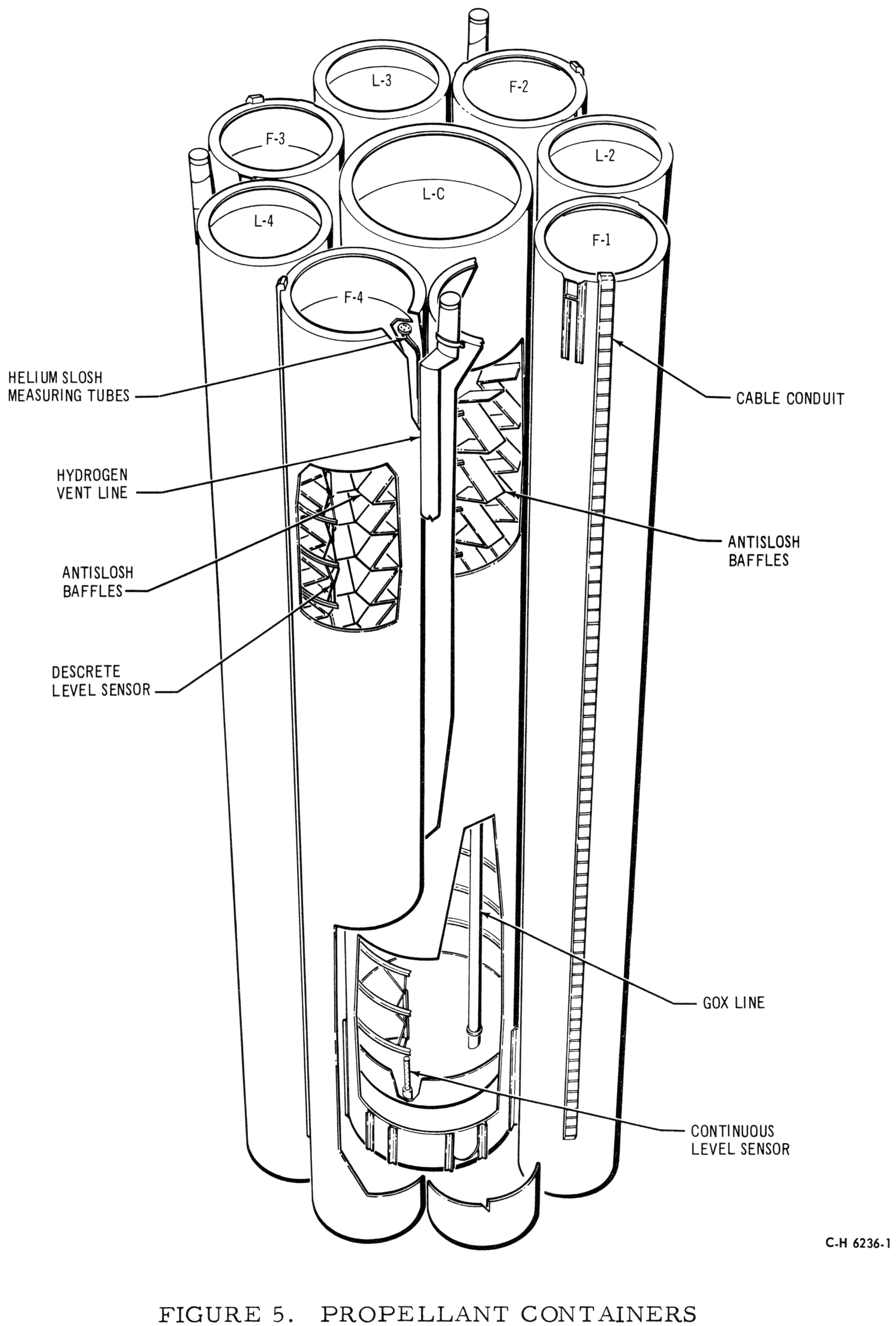


FIGURE 5. PROPELLANT CONTAINERS

Table 2. Major Similarities and Differences of Containers

Component	Purpose and Use	Container
Anti-slosh baffles	To help maintain stable load.	All LOX All Fuel
Continuous and discrete liquid level sensor systems	To indicate coarse and fine liquid quantity	All LOX All Fuel
GOX line	To directly pressurize 105" container, and manifold pressurize the 70" container	LOX, 105"
Hydrogen vent lines, External	To bleed off hydrogen used to precool S-IV engines	LOX, L-1, L-3, and L-4
Engine cutoff sensor system	To initiate power-off flight	LOX, L-2 and L-4, Fuel, F-2 and F-4
Slosh measuring tubes	To indicate amount and severity of liquid slosh	LOX, L-2 and 105" Fuel, F-4
Sumps	To improve propellant transfer characteristics	All Fuel All LOX
20-cubic-foot high-pressure GN_2 spheres	To supply fuel tank pressurizing and the LOX/SOX disposal system GN_2	Fuel, F-3 and F-4
Electrical cable installations	Route cables from aft skirts to instrumentation assemblies	All Fuel
Instrumentation Compartment	Houses instrumentation transmitters	Fuel, F-1 and F-2

After components are installed on the external skin and in the skirts, the containers become 70-inch LOX container unit assemblies. Table 3 is a quick reference to this transformation.

Table 3. Container Identification

Container Number	Container Unit Assembly (Internal Arrangement)	Container Unit Assembly (After Component Installation)
LOX	Drawing No.	Drawing No.
L-105	10M10130	10M10014
L-1	10M10131	10M10005
L-2	10M10132	10M10006
L-3	10M10133	10M10007
L-4	10M10134	10M10008
Fuel		
F-1	10M10135	10M10009
F-2	10M10136	10M10010
F-3	10M10137	10M10011
F-4	10M10138	10M10012

c. The 70-inch-diameter fuel container unit assemblies are 743.804 inches long. Table 3 identifies the containers, the internal arrangement drawings, and the containers after component installation. The internal arrangement of the fuel containers is similar for all containers (Fig. 5); however, there are some differences. See table 2. The most obvious difference between the fuel containers is the forward bulkheads of containers F-1 and F-2 that form instrumentation compartments number 13 and 12 respectively. Feed through adapters for the fuel pressurization system are also installed on the forward bulkheads.

The electrical cables for valve control, measurements, guidance control, and other instrumentation are routed along the external skins of the fuel containers and covered with conduit covers. For detailed information on all containers, refer to the drawings listed in table 3.

3. Spider Beam Area. The spider beam unit assembly (Fig. 6), while structurally supporting the S-I stage forward end, adapts the S-I stage to the S-IV aft interstage and transmits thrust to the S-IV stage. The assembly also provides mounting for the retro rockets, film and TV cameras, the LOX/SOX disposal system, five sets of high pressure pneumatic triplex spheres, various measuring components, and control and measuring tubing. Seal plates installed on the forward side of the spider beam protect the S-I stage from the blast of the S-IV engines during S-IV stage ignition. These plates also form the aft seal of the S-IV aft interstage area, and provide an environmentally controlled compartment. Forty-five degree shrouds extend from the cross beams of the spider beam to provide streamlining of the for-

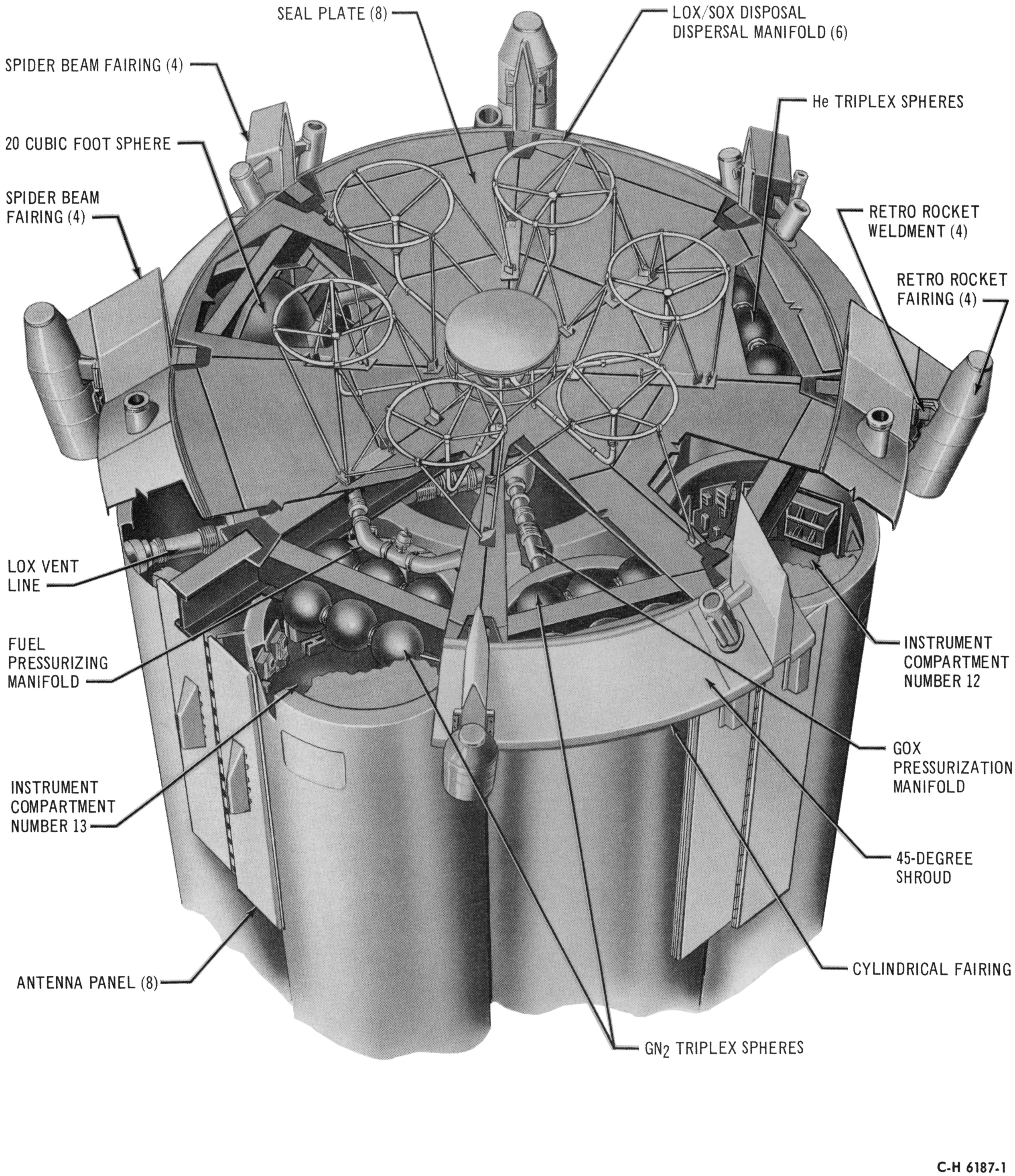


FIGURE 6. SPIDER BEAM AND TOP TANK AREA

ward end of the stage. Additional aerodynamic improvement is provided by a 6-inch cylindrical fairing attached to the shrouds and extending over the tank top area. Also, there are aerodynamic improvement fairings at the ends of the radial beams and over the retro rocket brackets and weldments.

Four solid propellant retro rockets produce the retarding force on the S-I stage to prevent S-I/S-IV interaction during separation. Each retro rocket develops an average of 37,000 pounds of thrust during burning time. The retro rockets ignite during separation 16 to 31 milliseconds after the explosive bolts, which secure the S-IV stage to the S-I, are fired. A high voltage power supply furnishes power to fire four exploding bridge wire (EBW) igniters in the base of the retro rockets. The EBW igniter assemblies ignite the solid propellant in the retro rockets. For more retro rocket information, refer to the Saturn SA-5 Vehicle Data Book and the SA-5 Saturn Technical Information Handbook.

The LOX/SOX disposal system consists of four triplex sphere assemblies, a plenum chamber and manifold assembly, solenoid valves, six dispersal manifold assemblies, connecting lines, temperature gages, and associated tubing and mounting hardware. This system is supplemented by residual GN_2 from the 20-cubic-foot spheres. Each dispersal manifold, one per RL-10A-3 engine, has a line of spray holes drilled around its inner circumference so that each ring area becomes saturated by the GN_2 supplied from the triplex spheres. This gasifies the LOX from the S-IV engines to prevent the formation of solid oxygen (SOX) during the LOX chilldown before S-I/S-IV stage separation.

The LOX pressurizing and vent system (Fig. 6) is interconnected through the pressurization manifold in the forward end of the center LOX container. Prelaunch pressurization is accomplished by using helium from a ground source. Inflight pressurization is maintained by GOX obtained by passing LOX through the heat exchangers in the engine turbine exhaust systems. The GOX flows into a common manifold, through a flow regulator valve, and into the center LOX container. The remaining LOX containers receive GOX from the upper interconnect lines (GOX distribution system) associated with the center LOX container. GOX pressure is bled off by one 7-inch and two 4-inch vent lines to the outside during prelaunch operations. For more information on the LOX pressurization and vent system, refer to the SA-5 LOX System, drawing 10M30012.

The fuel pressurization manifold interconnects the fuel containers at the forward ends. Inflight pressurizing GN_2 is supplied by the two 20-cubic-foot spheres located in the forward skirts of containers F-3 and F-4. Two fuel vent valves are located in the pressurization manifold in containers F-3 and F-4 respectively.

The S-I stage power supply, recording equipment, telemetry equipment, flight sequencing equipment, signal transmitting and receiving equipment, TV transmitting equipment, measuring equipment, vehicle control, and other instrumentation and electrical equipment are mounted in instrumentation compartments 12 and 13 located in the forward skirts of fuel containers F-2 and F-1 respectively. The instrumentation assemblies are first prefitted in an assembly fixture before they are installed in the vehicle. For more detailed information, refer to drawings 10M20003 and 10M20004, the SA-5 Saturn Vehicle Data Book, the Saturn I Block II Flight Measurements Manual and Saturn I Block II Saturn Instrumentation Systems Description. The instrumentation compartments are cooled during countdown through a cooling system that obtains conditioned air and purges GN_2 from the environmental conditioning system of the launch support equipment. Instrumentation, command, TV, and telemetry antennas are installed on panels located at the forward end of the stage along fin lines I, II, III, and IV.

One set of triplex spheres supplies helium for purging the three hydrogen vent lines. The camera lenses viewing the insides of LOX container L-3 and the center LOX container are helium purged by a separate bottle mounted on the side of the I-beam.

The helium slosh measuring system measures the amount of inflight sloshing occurring in the center LOX container, LOX container L-2 and fuel container F-4. Supply helium is contained in the sphere located in the forward skirt of LOX container L-2. For more detailed information, refer to the SA-5 Saturn Vehicle Data Book.

An optical instrumentation system consisting of four direct-viewing color movie cameras, four indirect-viewing movie cameras (three color and one black and white), four fiber optics bundles, and a TV camera are mounted on the spider beam at fin lines I, II, III, and IV (Fig. 7). One camera with a wide-angle lens and one camera using fiber optics is located at each position. The TV camera is installed on the outer periphery of the spider beam at fin line III. Two camera lights, two strobe lights, and two incandescent lights provide proper illumination for the film and TV cameras.

The film cameras are housed in hermetically sealed capsules designed to withstand the rigors of powered flight, ejection, re-entry, impact, and salt water immersion. The capsules are installed in camera pod assemblies that are canted outward and act as ejection tubes to eject the cameras clear of the vehicle. GN_2 for the camera ejection system is obtained from the GN_2 manifold to the bottle mounted on the I-beam for the camera system. Camera ejection is sequenced to occur 25 seconds after S-I/S-IV stage separation.

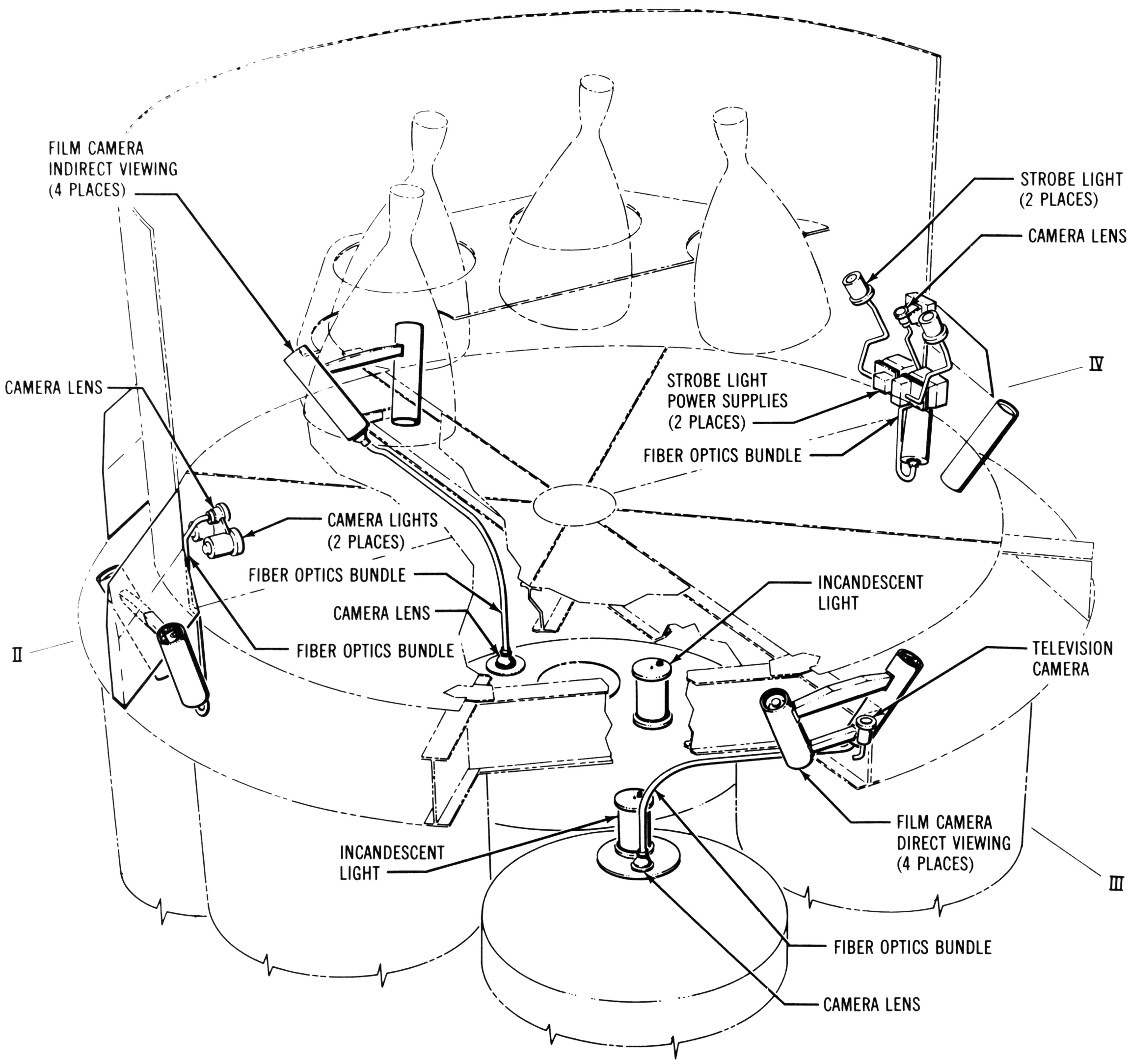


FIGURE 7. MOVIE AND TV CAMERA INSTALLATION

The direct-viewing cameras with wide-angle lenses film retro rocket and ullage rocket firing, S-IV stage coasting, and firing of the S-IV stage engines. Two of the indirect-viewing cameras film S-IV stage engine chilldown and S-I/S-IV stage separation. The remaining two cameras film LOX sloshing in the center LOX container and LOX container L-3. The TV camera viewing forward provides real-time coverage of the S-IV engine compartment. The TV camera monitors ullage rocket ignition, S-I/S-IV separation, ignition and firing of S-IV engines after separation, motion picture capsule ejection and booster tumbling rate. On the SA-5 vehicle, real-time coverage begins before liftoff and continues until impact of the S-I stage. For detailed information, refer to drawings 10M10003, 10M10016, the SA-5 Saturn Vehicle Data Book, and Saturn Instrumentation Systems SA-5.

C. S-IV STAGE, GENERAL

The S-IV stage (Fig. 8) is a self-supporting structure designed for utilization as the second stage of the Saturn I vehicle. The stage, including the forward and aft interstage assemblies, is 41 feet 5 inches long and 18 feet 4 inches in diameter through the center cylindrical portion.

Basically, the stage is a two-section tank structure to which the forward interstage assembly, aft skirt assembly, aft interstage assembly, and engine thrust structure are attached. An insulated common bulkhead divides the tank structure into a forward liquid hydrogen (LH_2) tank and an aft LOX tank. The internal surfaces of the tank cylinders feature a milled waffle surface pattern. Access to the interior of the LH_2 tank is provided through a 28-inch diameter manhole. Access to the interior of the LOX tank is provided through a detachable sump. A ring-type baffle is installed in the LOX tank to minimize sloshing. An external tunnel extending from the forward interstage assembly to the aft skirt assembly houses various interstage tubing and cables, tubing and fittings from the ambient helium spheres mounted in the forward interstage, and lines from the cold helium spheres mounted inside the LH_2 tank.

1. Tail Area. The engine thrust structure (Fig. 8) is a truncated cone of reinforced skin and stringer construction. The large end of the cone is attached to the aft dome of the LOX tank. The six engines, engine hydraulic-actuating components, an ambient helium sphere, a control pressure helium sphere, a helium heater assembly, and a heat shield are mounted on the thrust structure. The heat shield provides protection for components from flame and thermal effects from the engines. The ambient helium sphere supplies helium for LH_2 prepressurization and for sustaining LH_2 tank pressure during engine chilldown. The control pressure sphere supplies ambient helium at 3,000 psig for pneumatic operation of valves in the LH_2 and LOX systems, and supplies constant purge for the engine gearboxes and the propellant utilization assemblies.

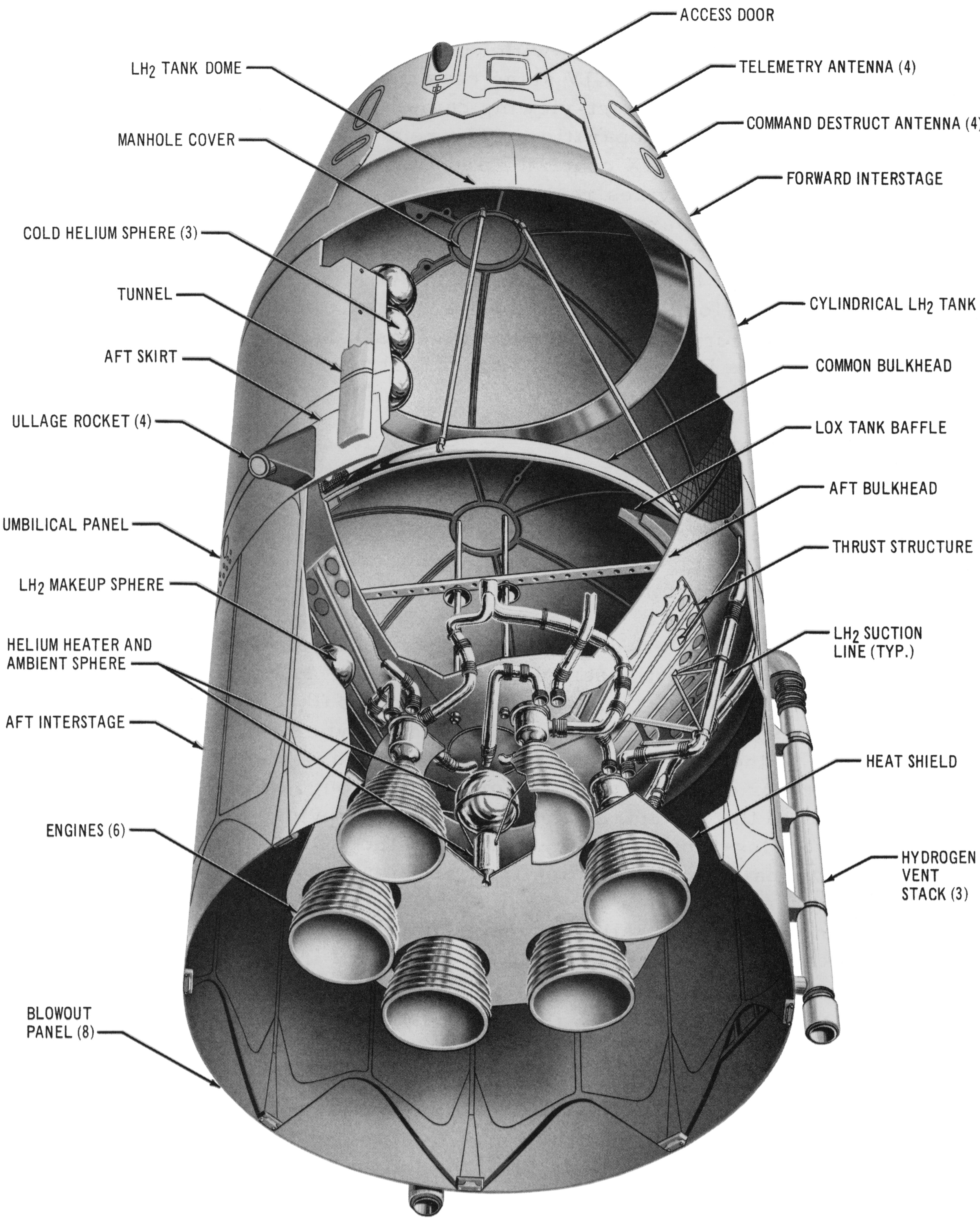


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FIGURE 8. S-IV STAGE

Components of the electrical power system, the flight control system, and part of the telemetry system are also mounted in the thrust structure. For more detailed information about the electrical and instrumentation systems, refer to Douglas drawings 1A00541-503, 1A01560-1, 1A38355, and 7872409.

The aft interstage assembly (Fig. 8), located between the S-I stage seal plate assembly and the S-IV aft skirt assembly, consists of eight mechanically joined aluminum honeycomb panels that provide aerodynamic enclosure for the aft end of the S-IV stage and the LOX/SOX disposal system. Each panel has a triangular blowout panel for venting LOX/SOX or GOX during the LOX chilldown period before S-I/S-IV stage separation and S-IV stage engine ignition. The blowout panels are jettisoned by the force of exploding detonating cord prior to S-IV engine chilldown. All of the panels may be used as access doors during ground operations. Three external hydrogen vent stacks, attached to the interstage, dispose of gaseous hydrogen during chilldown operations. The aft end of the interstage bolts to the S-I stage, and the forward end connects to the aft skirt at the separation plane with frangible nut and bolt assemblies.

The aft skirt assembly (Fig. 8) is a structure of eight mechanically joined aluminum honeycomb panels including an umbilical panel with an air-conditioning manifold opening. The manifold is formed by enclosing the forward area between the aft skirt assembly and the tank structure with a flexible perforated membrane. Warm air or GN_2 distributed into the aft interstage by the manifold maintains proper operating temperatures or area purge during ground operations. Additional ducts from the manifold condition the area between the LOX tank and the thrust structure. Conditioned air or GN_2 is vented through spring-loaded vents located in the blowout panels at fin lines II and IV. Four ullage rockets and their fairings are located on the aft skirt, one at each fin line. Ullage rocket firing is the first step in the separation sequence. The ullage rockets impart forward acceleration when fired; this force settles the fuel to provide a positive turbopump head and aids S-I/S-IV stage separation. The skirt has openings in the skin to accommodate the three chilldown duct elbows. The aft end of the skirt accommodates the frangible nut and bolt installations for stage separation.

2. Propellant Containers. The LH_2 container formed by the forward end of the tank structure and the forward side of the common bulkhead has a capacity of 4, 274 cubic feet. Inside surfaces of the LH_2 container have 3/4-inch polyurethane foam bonded to the walls. Glass cloth, 0. 10-inch thick, coated with a polyurethane sealant, covers the foam. Around pipes and fittings, end grain balsa wood replaces the foam. Mounted inside the tank are fuel mass, temperature, and liquid level sensors for propellant utilization operation and ground monitoring display. Three cold helium spheres are installed in the container to supply helium for inflight LOX tank pressurization. The cold helium is expanded by passing it through the helium

heater (Fig. 8). The container accommodates six LH_2 suction lines (one for each engine). Antivortex screens, mounted on the LH_2 bulkhead at each suction line outlet, prevent turbulence and cavitation in the suction lines. Vent and relief valves are installed in the forward end of the container. LH_2 fill, drain, and replenishing are accomplished through one fill and drain valve located on the bottom of the containers.

The LOX container formed by the aft end of the tank structure and the aft side of the common bulkhead has a capacity of 1, 262 cubic feet. The six suction lines attach to the sump of the LOX container. One antivortex screen is mounted in the sump. Temperature and mass sensors are mounted in the container for propellant utilization operation.

3. Forward Interstage Assembly. The forward interstage assembly (Fig. 9) is a truncated cone formed of eight mechanically joined aluminum honeycomb panels and serves to adapt the instrument unit to the S-IV stage. Although the instrument unit and payload will not separate from the S-IV stage during the SA-5 flight, provisions are made in the interstage assembly for installing two retro rockets, one each at fin lines II and IV. Four telemetry antennas, four command-destruct antennas, and the hydrogen vent coupling are mounted on the external skin. An access door on the exterior skin permits access to equipment mounted on the interior interstage wall. Ten backup helium pressurization spheres, mounted on the interstage interior wall, provide LOX tank pressurization if failure of the primary cold helium pressurization system occurs. Telemetry equipment and the command destruct system firing units, safety and arming devices are mounted on an equipment rack on the interior wall.

D. INSTRUMENT UNIT

The instrument unit on SA-5 contains four horizontal cylindrical compartments and a central vertical cylinder. Compartment I carries an active ST-90S guidance package which provides inertial guidance systems control for the vehicle. The ST-90S maintains programing through a magnetic tape actuator. Compartment II holds an ST-124 passenger guidance package, which is a digital computer guidance system, and the gyro stabilization electronic box. Compartment III contains telemetry equipment to transmit signals for approximately 335 measurements of pressure, temperature, strain, vibration, flight path, and other data from within the instrument unit. Installed in compartment IV is the AZUSA transponder and the power supplies for the instrument unit and other components throughout the vehicle. The guidance signal processors, flight control computers and sequencers, power distributors, the UDOP transponder, and MISTRAM transponder are contained in the center cylinder (compartment V).

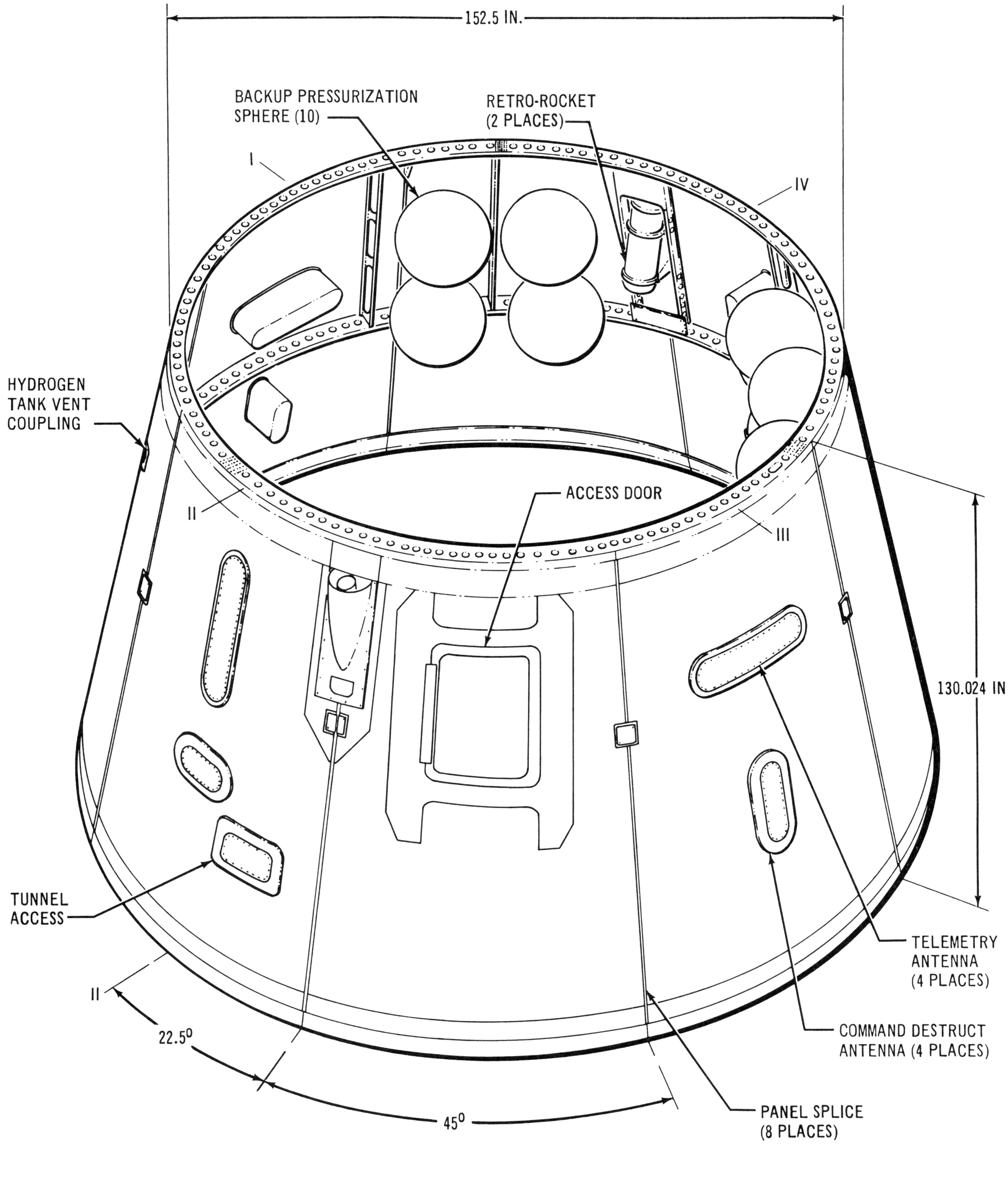

FIGURE 9. S-IV FORWARD INTERSTAGE

The five compartments are air conditioned and pressurized by GN_2 from two high-pressure spheres mounted on the lower outer wall of the central cylinder. The cooling system maintains a stable acceptable temperature within the instrument unit during vehicle preflight and flight.

The instrument unit begins to function before liftoff in order to sequence the S-I engine start and control. Programing and flight control from the unit continues throughout the operational flight of the S-I stage. The instrument unit initiates stage separation sequencing at the termination of the S-I stage operation as well as engine start for the S-IV stage. At the time of separation, control is switched from the S-I stage to the S-IV stage by the instrument unit. Instrument programing and flight control of the S-IV continues during the operation of the S-IV engines. Three telemetering sets are also controlled by the instrument unit.

For detailed information on the instrument unit, refer to drawing 10M20000, the SA-5 Saturn Vehicle Data Book, and the SA-5 Saturn Vehicle Technical Information Handbook.

E. PAYLOAD

The payload assembly for SA-5 consists of a modified Jupiter nose cone and aft unit. The payload mates to the instrument by means of the payload adapter assembly. The adapter assembly has 16,800 pounds of sand ballast to simulate the weight of the Apollo spacecraft. Payload instrumentation includes four angle of attack transducers, Q-ball transducer and minitrack tracking system. The payload is 37.5 feet long, 154 inches in diameter and is designed to burn up at re-entry. For more detailed information about the payload, refer to drawings 10M20002, 30M05199, 10485600 and 8923600.

F. PROPELLANT DISPERSION SYSTEM (DESTRUCT SYSTEM)

The Saturn I Block II propellant dispersion system (Fig. 10) provides a means of terminating vehicle flight by command signals from the ground to the vehicle receiving antennas. Each stage has a separate and independent destruct system consisting of the following major components:

a. Four receiving antennas to receive commands from the ground.

b. Two separate and independent command systems to demodulate, decode, and transmit the signals from the ground.

c. An independent exploding bridgewire (EBW) firing unit linked to each command system, to provide an electrical charge to initiate detonation.

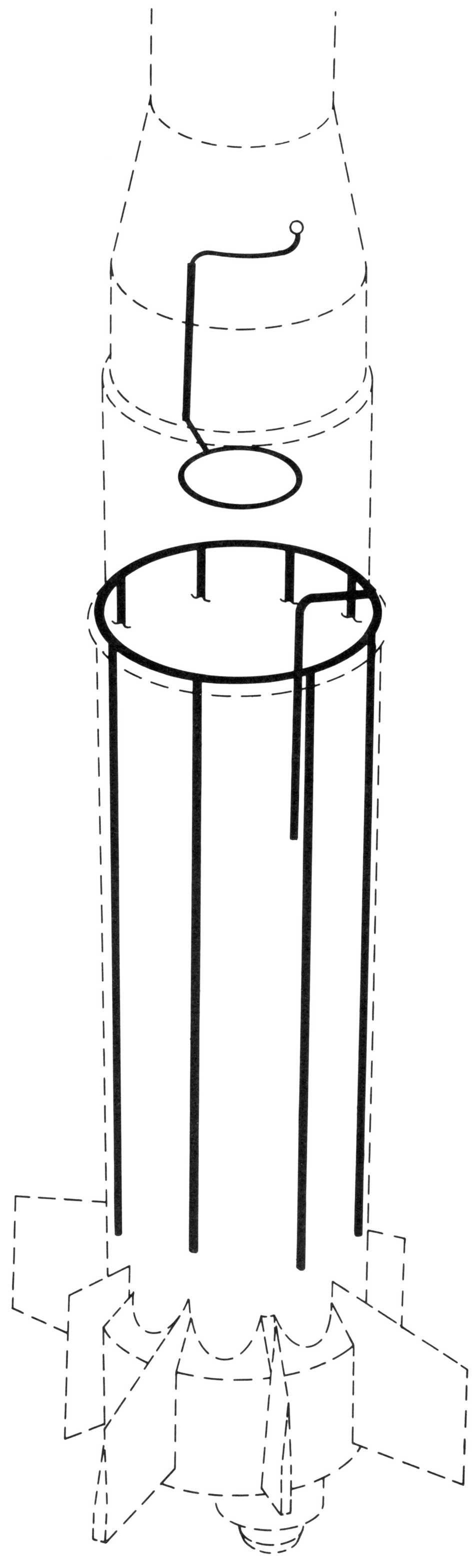

FIGURE 10. PROPELLANT DISPERSION SYSTEM (DESTRUCT SYSTEM)

d. A separate high-voltage detonator linked to each EBW firing unit, to initiate detonation of the explosives.

e. A safety and arming device to complete or interrupt the explosive train.

f. Explosives.

The destruct system explosives for these vehicles consist of 50 and 60 grains per foot (gpf) pentaerythritetetranitrate (PETN) Primacord, nine 100 gpf PETN flexible linear-shaped charges in the S-I stage, and 100 gpf Cyclotrimethylene Trinitramine (RDX) linear-shaped charge in the S-IV stage. The Primacord propagates the explosion to the shaped charges, which cut the propellant containers, thereby dispersing and igniting the propellants and limiting the explosion to a fraction of its possible intensity. The flexible linear-shaped charges (FLSC) on the S-I stage are inserted into conduits extending almost the full length down the outside of the 70-inch diameter propellant containers and approximately 20 feet down the outside of the 105-inch-diameter center LOX container. The linear-shaped charge (LSC) is installed down the outside of the LH_2 container and around the bottom LOX container bulkhead of the S-IV stage.

Detailed information on the propellant dispersion system is found in IN-P&VE-V-63-2, the Saturn I Block II Propellant Dispersion System and drawings 10M11318-1 and 10M11319-1.

APPROVAL

SATURN I BLOCK II VEHICLE
DESCRIPTION

By

Engineering Communications Department
Chrysler Space Division
Huntsville Operations

Under Technical Supervision of

Assembly Engineering Section
Vehicle Engineering Branch
Vehicle Systems Division
Propulsion and Vehicle Engineering Laboratory

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