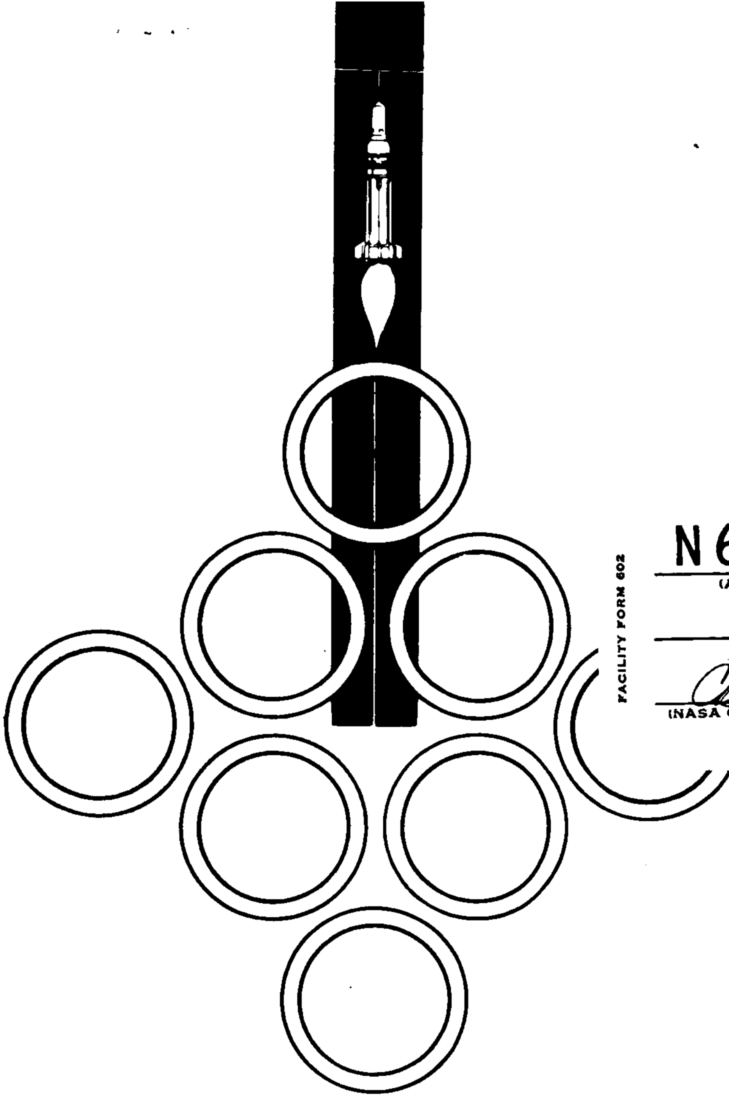

ENGINEERING DEPARTMENT

TECHNICAL MANUAL

SDES-64-415

Saturn I

LAUNCH VEHICLE SA-10
AND LAUNCH COMPLEX 37B
FUNCTIONAL SYSTEMS DESCRIPTION

Volume VIII

H-1 ENGINE AND HYDRAULIC SYSTEM FUNCTIONAL DESCRIPTION, INDEX OF FINDING NUMBERS, AND MECHANICAI SCHEMATICS

SPACE DIVISION CHRYSLER CORPORATION

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LAUNCH VEHICLE SA-10
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VOLUME VIII
H-1 ENGINE AND HYDRAULIC SYSTEM FUNCTIONAL DESCRIPTION, INDEX OF FINDING NUMBERS, AND MECHANICAL SCHEMATICS

JULY 1964

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

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FOREWORD

This volume is one of a set of eleven volumes that describe mechanical and electromechanical systems of the Saturn I, SA-10 launch vehicle and launch complex 37B. The eleven-volume set is prepared for the Functional Integration Section, Systems Integration and Operations Branch, Vehicle Systems Division, P&VE Laboratory, MSFC, by Systems Engineering Branch, Chrysler Corporation Space Division under Contract NAS 8-4016. Volume titles are listed below:

Volume I	RP-1 Fuel System
Volume II	LOX System
Volume III	LH_2 System
Volume IV	Nitrogen and Helium Storage Facility
Volume V	Pneumatic Distribution System
Volume VI	Environmental Conditioning Systems
Volume VII	Launch Pad Accessories
Volume VIII	H-1 Engine and Hydraulic System
Volume IX	RL10A-3 Engine and Hydraulic System
Volume X	Separation and Flight Termination Systems
Volume XI	Supplement: Legend and Composite Schematic

The technical content of this volume reflects the most up-to-date design information available from the S-I/S-IB Project Engineer, R-P&VE on July 1, 1964.

System mechanical schematics are provided in section 3 to support the functional description of the system. The index of finding numbers in section 2 provides physical and functional descriptions of components identified on the mechanical schematics.

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SECTION 1

FUNCTIONAL DESCRIPTION

1.1 INTRODUCTION

The S-I stage of launch vehicle SA-10 is powered by a cluster of eight H-1 engines. The four inboard engines are mounted 90 degrees apart on a radius of 32 inches from the vehicle longitudinal axis and are canted at three degrees outboard from vehicle centerline. The four outboard engines are gimbal mounted 90 degrees apart (rotated 45 degrees from the inboard engines) on a radius of 95 inches from the vehicle longitudinal axis and are canted at six degrees outboard from vehicle centerline. The engine mounting pattern is shown in figure 3-1.

An independent, closed-loop hydraulic system installed on each outboard engine provides power for gimballing the engine. The gimbal mount permits each engine to move in a plus or minus eight-degree square pattern for roll, pitch, and yaw control during S-I powered flight.

The functional description of the H-1 engine covered in this section encompasses detailed major component descriptions and engine operation including launch preparation, engine purges, engine start, mainstage, shutdown, and drain operations. The functional description of the H-1 engine hydraulic system encompasses detailed major component descriptions and hydraulic system operation including prelaunch, flight, filling, and draining operations.

1.2 H-1 ENGINE

The H-1 engine is a single-start, constant-thrust engine that uses LOX and RP-1 as propellant to develop 188,000 pounds of thrust (nominal rating) at sea level. Four RP-1 fuel tanks and five LOX tanks supply propellant to the eight engines. The outboard engines are equipped with a hydraulic system for roll, pitch, and yaw control and an aspirator to aid in the disposal of turbine exhaust and vent line drain products.

1.2.1 Component Description - Major components of the H-1 engine include the thrust chamber, the turbopump assembly, the solid propellant gas generator (SPGG), the liquid propellant gas generator (LPGG), and the fuel additive blender unit (FABU). These components are described in the following paragraphs.

1.2.1.1 Thrust Chamber. The thrust chamber is made up of 292 longitudinal nickel tubes joined by silver brazing. RP-1 fuel is supplied to alternate tubes (down tubes) from a tapered fuel input manifold. Fuel flows through the down tubes, the return manifold, and the up tubes to provide cooling for the thrust chamber walls.

Fuel and LOX are supplied to alternate rings of the thrust chamber injector. A copper ring baffle and six copper radial baffles are mounted on the face of the injector and divide the injector face into seven separate areas. Annular passages route hypergolic fluid from the hypergol cartridge to a port on the face of each of the seven injector areas.

1.2.1.2 Turbopump. The turbopump assembly consists of a two-stage turbine, a gearbox, a LOX pump, a fuel pump, and a dual accessory drive pad. The LOX and fuel pumps are single entry, centrifugal units containing an axial-flow inducer, a radial-flow impeller, and diffuser vanes. The turbine is a two-stage, pressure compounding unit that develops 3793 hp at approximately 32,000 rpm. The turbine is driven by gases generated in the LPGG. The gearbox provides the necessary linkage and gear reductions to drive the LOX and fuel pumps at approximately 6537 rpm. The dual accessory drives rotate at approximately 4000 rpm. Each outboard engine uses one accessory drive to operate the main pump. An electric heater prevents freezing of the accessory drive bearings.

1.2.1.3 Solid Propellant Gas Generator. The solid propellant gas generator (SPGG) is made up of a sealed propellant cartridge and two initiators. The SPGG is fastened to a flange on the LPGG and supplies power (hot gases) to the turbopump two-stage turbine for engine starting. The solid propellant cartridge is a disposable type that cannot be reloaded or reused.

The SPGG begins operation 20 milliseconds after the start signal is given and delivers a gas flow of approximately 4.68 pounds per second for approximately 1 second. This accelerates the turbine and the LOX and RP-1 turbopumps. The LPGG begins to receive bootstrap propellant from the propellant discharge lines and starts to operate before the SPGG operation cycle is ended.

1.2.1.4 Liquid Propellant Gas Generator. The liquid propellant gas generator (LPGG) burns RP-1 and LOX to generate the hot gases required to operate the two-stage turbine in the turbopump assembly. The LPGG uses a fuel-to-LOX ratio of approximately 2.924 to 1 and begins operation before the solid propellant gas generator operation cycle is terminated. LPGG operation continues for the remainder of H-1 engine operation.

1.2.1.5 Fuel Additive Blender Unit. The fuel additive blender unit (FABU) mixes RP-1 fuel with an oxidation and corrosion inhibitor additive (Oronite 262) and injects the mixture at the required flow rate into the turbopump assembly gearbox for lubrication and cooling. When fuel pressure reaches 70 to 110 psig an internal poppet type check valve opens and fuel enters the FABU. Fuel pressure is applied to the top of a piston in the FABU to force the additive through a metering orifice and add approximately 2.75 percent additive by weight to the fuel flowing (4 to 5 gpm) through the body of the unit. Prior to engine start, an electric heater is used to maintain the additive within the required viscosity range.

1.2.2 <u>Engine Operation</u> - The H-1 engines are started in pairs 100 milliseconds apart to avoid undue structural stress and loading. The four inboard engines are started first.

S-I stage powered flight lasts approximately 150 seconds. S-I stage full powered flight ends when the four inboard engines are simultaneously shut down. Approximately 6 seconds later, the four outboard engines are simultaneously shut down. Start and shutdown sequences are illustrated in figure 1-1.

The following paragraphs cover in detail the various phases of H-1 engine operation including launch preparations, engine purges, engine start, mainstage operation, engine shutdown, and engine drain. A schematic of the H-1 engine is presented in figure 3-1.

1.2.2.1 Launch Preparation. After the vehicle has been assembled on the launch pad, the explosive devices are installed on each H-1 engine. These devices include Solid Propellant Gas Generator B20 with dual Initiators B11, dual Auto Igniters B42, Conax Valve B2, and a hypergol cartridge.

In addition, Fuel Additive Blender Unit B15 is filled with Oronite 262 additive through Quick-Disconnect Coupling B17. The fuel jacket of Thrust Chamber B28 is filled with RP-1 through Quick-Disconnect Coupling B31.

1.2.2.2 Engine Purges. Several GN_2 purges are initiated during the launch preparation sequence to prevent contaminants from entering the engine and to reduce fire hazard. These purges are as follows:

a. Gearbox Pressurization and LOX Pump Seal Purge. These operations are described together since both use GN_2 from a common source. Both operations commence with S-I stage control-system pressurization and continue throughout launch preparation, engine starting, launch, and S-I stage flight. If the launch is aborted, purging is required until all LOX has boiled off from the turbopump. Gaseous nitrogen at 1.5 psig is supplied to the area between the LOX and lube seals in the turbopump to isolate LOX and lubricant leakage. Lubricant and LOX leakage into the area between the seals is kept separate by the GN_2 pressure and drained overboard through separate drain lines. Gearbox pressurization is required to prevent the turbopump gearbox lubricant from foaming at high altitude. Fuel leakage past the turbopump fuel seal is forced out of the lube drain by gearbox pressure and can be visually monitored prior to launch. Gaseous nitrogen for gearbox pressurization and LOX pump seal purge is supplied from the control pressure system and flows through Manual Valve B214 to a ringline manifold. Gaseous nitrogen is distributed from the ringline manifold through Orifice B305 to Turbopump Assembly B8 on each engine. The line downstream from Orifice B305 on each engine branches into a purge line and a pressurization line. Nitrogen in the purge line flows through Orifice B7 into the area between the LOX and lube seals and out of the LOX and lube seal drain lines. Nitrogen in the pressurization line flows through Orifice B3 and Check Valve B5 into the gearbox. Relief Valve B13 in the lube drain line operates to maintain desired gearbox pressure.

b. LOX Dome Purge. The LOX dome purge consists of a bypass purge and a full-flow purge. The bypass purge maintains a slight positive GN_2 pressure in the LOX dome and prevents contaminants from being drawn upwards through the thrust chamber nozzle into the injector plate and LOX dome. The bypass purge also prevents moisture from entering the area. The bypass purge is initiated prior to propellant loading and continues until just prior to engine ignition.

As the bypass purge ends, GN_2 pressure and flow rate are increased and the full-flow purge starts. The full-flow purge continues during engine operation until overcome by increasing LOX pressure in the LOX dome. If the launch is aborted, the LOX dome purge resumes as soon as LOX pressure decays below GN_2 purge pressure. The GN_2 purge pressure expells LOX from the LOX dome and the LOX bootstrap line. The purge also expells any contaminants from the LOX dome. After a short interval, the full-flow purge is replaced by the bypass purge. Gaseous nitrogen for both purges flows from a ground source through short cable mast No. 2 and Quick-Disconnect Couplings B304 into a ringline manifold. From the manifold, separate branch lines lead to each engine. Gaseous nitrogen flows into each branch line through Check Valve B45 and the LOX pump discharge line, to the LOX dome. Gaseous nitrogen also flows through the LOX bootstrap line to the closed LOX poppet valve in the LPGG Control Valve Assembly B23.

c. LPGG LOX Injector Manifold Purge. This purge prevents SPGG combustion products and other contaminants from entering the LPGG LOX injector manifold before LOX enters the manifold. The purge starts 25 seconds before engine ignition and is terminated by LOX pressure buildup in the manifold. If the launch is aborted, this purge starts immediately after engine cutoff and continues until the SPGG solid propellant cartridge is removed. Gaseous nitrogen for this purge flows from a ground source through short cable mast No. 4 and Quick-Disconnect Coupling B301 into a ringline manifold. A separate line leads from the manifold to each LPGG LOX injector manifold. Gaseous nitrogen flows through Check Valve B12 in each branch line into the LOX injector manifold and exits through the gas turbine exhaust duct. This purge is terminated by LOX pressure buildup in the LOX injector manifold and occurs just prior to propellant ignition in Liquid Propellant Gas Generator B22.

d. Thrust Chamber Fuel Injector Manifold Purge. This purge prevents LOX from entering the fuel injector manifold during engine ignition and is initiated 15 seconds before engine ignition. Gaseous nitrogen for this purge flows from a ground source through short cable mast No. 2 to Quick-Disconnect Coupling B303 into a ringline manifold. GN_2 is distributed from the ringline manifold to a manifold on each engine. Gaseous nitrogen is routed from the engine manifold into the fuel injector manifold through three branch lines, each of which has a Check Valve B37. The branch lines intersect the fuel injector manifold at approximately 120-degree spacing intervals. Gaseous nitrogen flows from the fuel injector manifold through Thrust Chamber B28. As mainstage operation begins, fuel pressure buildup in the fuel injector manifold closes Check Valve B37 in each line and terminates the GN_2 flow. The ground supply is then shut off, terminating the purge.

1.2.2.3 Engine Start. The engine start sequence (figure 1-1) begins with primary ignition and continues until normal mainstage operation has been established. During this period, turbopump operation is initiated by a solid propellant charge, engine ignition occurs, and various valves are positioned. In addition, a bootstrap operation is established in which LOX and fuel are bled off from the main engine supply, and burned in the LPGG. The resulting products of combustion are used to continue driving the turbopump.

The engine start sequence occurs when an electrical signal from the start sequencer in the launch control center (LCC) fires two SPGG Initiators B11 on each engine. The initiators ignite the solid propellant in the SPGG and the resultant high-pressure combustion gases are forced through part of Liquid Propellant Gas Generator B22 to Turbine B19. The turbine accelerates the LOX and fuel pumps through a gear train in the gearbox of Turbopump Assembly B8.

Turbopump Assembly B8 draws fuel from the suction line and forces it through Orifice B4 in the fuel discharge line to the inlet side of normally closed Main Fuel Valve B39. At this point, some fuel is diverted through a branch line as a supply for valve actuation, gearbox lubrication, and engine primary ignition. From the branch line, a bleed line connects a fuel discharge line to the fuel suction line. Prior to the start sequence, any air trapped in the fuel discharge line will be bled back to the fuel suction line through Orifice B48. The bleed line has no function after engine start.

Fuel from the branch line flows to Fuel Additive Blender Unit B15 through a manifold to which Conax Valve B2 is attached. Here, the fuel mixes with the Oronite 262 additive and the fuel-Oronite mixture flows through a lube line and Filter B14 to the gearbox located on Turbopump Assembly B8. The fuel-Oronite mixture cools and lubricates the gearbox assembly components, and then discharges overboard through the lube drain line and Relief Valve B13. The relief valve operates to maintain constant gearbox pressure.

In addition, parallel fuel paths lead from the branch line to Fuel Igniter Valve B46 and through Orifice B1 to Main LOX Valve B49. Prior to the application of fuel control pressure to the main LOX valve, Turbopump Assembly B8 draws LOX from the suction line and forces it through the LOX discharge line to the inlet side of the normally closed main LOX valve. As turbopump acceleration causes pressure buildup in the fuel discharge line, increasing pressure is applied to overcome the spring pressure in Main LOX Valve B49. When the discharge line fuel pressure reaches approximately 230 psig, Main LOX Valve B49 begins to open. Liquid oxygen flows through the LOX discharge line, LOX dome, and LOX injector nozzles into Thrust Chamber B28. Liquid oxygen also flows through Check Valve B24 and Orifices B29 to Heat Exchanger Assembly B30. In addition, LOX flows through the LOX bootstrap line and Orifice B21, to LPGG Control Valve Assembly.

When Main LOX Valve B49 has opened approximately 80 percent, a mechanical linkage opens Fuel Igniter Valve B46. Opening the fuel igniter valve allows fuel to flow to Injector and Hypergol Container Assembly B36 and to the inlet port of normally closed Ignition Monitor Valve B38.

The hypergol-cartridge burst diaphragms rupture when fuel pressure reaches 300 psig and hypergol, followed by fuel, flows through the thrust chamber injector into Thrust Chamber B28. The hypergol ignites on contact with previously injected LOX causing primary ignition. Primary ignition produces pressure buildup within Thrust Chamber B28, the fuel injector manifold, and the control line from the manifold to Ignition Monitor Valve B38 and LPGG Control Valve Assembly B23. When pressure in the fuel injector manifold reaches approximately 15 psig, Ignition Monitor Valve B38 opens and fuel channeled from Fuel Igniter Valve B46 exerts pressure on Main Fuel Valve B39. When fuel pressure overcomes spring pressure, the main fuel valve opens and fuel flows into the fuel manifold. From the manifold, fuel flows through the thrust chamber fuel jacket and the fuel injector manifold into Thrust Chamber B28. Since LOX is already present and ignition has occurred, mainstage operation now begins.

As fuel flows from the fuel manifold to the thrust chamber fuel jacket during the start sequence, the fuel bootstrap line allows some fuel to flow through Orifice B32 to LPGG Control Valve Assembly B23. As thrust buildup continues, combustion-chamber pressure is exerted on the control of the LPGG control valve assembly. When this pressure reaches approximately 115 psig, the control valve assembly opens, allowing LOX and fuel to flow into Liquid Propellant Gas Generator B22 where they are ignited by the hot gases from Solid Propellant Gas Generator B20. Two Auto Igniters B42 provide a redundant secondary ignition source in the LPGG to insure starting of the bootstrap cycle.

During the start of the bootstrap cycle, Turbine B19 operates on combined Solid Propellant Gas Generator B20 and Liquid Propellant Gas Generator B22 high-pressure gases. Operation on the combined gases continues until the SPGG ceases operation. The LPGG continues to power the gas turbine for the remainder of engine operation.

1.2.2.4 Mainstage Operation. During mainstage operation, all engine valves are open and LOX and fuel are being discharged at desired flow rates. Fuel is routed through the walls of Thrust Chamber B28 for cooling. Main propellant ignition results in a pressure buildup in the thrust chamber. Thrust O.K. Pressure Switch B41 monitors thrust buildup by measuring a corresponding pressure buildup in the fuel line downstream from Main Valve B39. During mainstage operation, LOX is supplied from a branch line downstream from Main LOX Valve B49 to Heat Exchanger Assembly B30 through three Orifices B29. This LOX is vaporized and routed through Check Valve B173 to provide inflight LOX tank pressurization.

1.2.2.5 Engine Shutdown. Approximately 150 seconds after engine ignition, a signal from the flight computer in the instrument unit initiates engine cutoff. The shutdown sequence is presented in figure 1-1. This signal detonates two explosive charges within Conax Valve B2. The explosive force moves a piston that shears a metal diaphram in the valve body and allows pressurized fuel to flow to the closing control of Main LOX Valve B49. This pressure counteracts the existing fuel pressure on the opening control of the valve and allows the internal valve spring pressure to close the valve and stop the flow of LOX to Thrust Chamber B28 and Liquid Propellant Gas Generator B22. After Main LOX Valve B49 has closed approximately 20 percent, Fuel Igniter Valve B46 closes. The pressure that was holding Main Fuel Valve B39 open is then removed, allowing the main fuel valve to close. The flow of fuel to Thrust Chamber B28 and the LPGG terminates. The time-lag between LOX and fuel shutoff provides a fuel-rich cutoff that prevents an explosive shutdown in both the thrust chamber and the LPGG.

1.2.2.6 Engine Drain Operation. The engine is equipped with manual drains that allow it to be drained in the event of a launch cancellation. A vent and drain system also provides for inflight disposal of purges and combustible fluids leakage.

a. Ground Drain Operation. In the event of launch cancellation, the fuel suction line, fuel pump volute, fuel discharge line, and fuel branch line on each engine are drained through Quick-Disconnect Coupling B18. The fuel pump volute can also be drained through Cap Assembly B10, and the fuel discharge line upstream from the Main Fuel Valve B39 can be drained through Drain Plug B43. The fuel bootstrap line is drained through Quick-Disconnect Coupling B31. The fuel manifold and thrust chamber fuel jacket are drained through four Drain Plugs B26 located on the collector ring at the base of Thrust Chamber B28. Fuel Additive Blender Unit B15 is drained through Drain Plug B16.

b. Inflight Drain Operation. During engine operation, drain lines carry any combustible fluids leakage clear of the engine area. Fuel and lubricant leakage is isolated from LOX leakage by means of separate drain lines. Three drain lines lead from Turbopump Assembly B8: the LOX seal drain, the lube seal drain, and the lube drain. On inboard engines, the LOX seal drain is routed to Manifold B47 which also receives leakage from two LOX drain lines located on Main LOX Valve B49. From the manifold, a single line drains LOX leakage overboard. On outboard engines, LOX leakage is conducted to a common drain line and then drained overboard. Manifold B44 receives fuel and lubricant leakage from six separate lines and drains it overboard through a single line. The six lines are the lube seal drain, the liquid propellant gas generator control valve assembly drain, the fuel drain from the main LOX valve, and the three drain lines from Main Fuel Valve B39. Three other lines drain leakage from the engine area. These are the lube drain line from the turbopump gearbox, and the fuel drain lines from Ignition Monitor Valve B38 and Fuel Igniter Valve B46.

   On outboard engines, all leakage is dumped into the engine thrust chamber from a common point on the edge of Aspirator B27. On inboard engines, all leakage is ducted to aerodynamic fairings (one for each inboard engine) located on the exterior of the vehicle, where it is dumped into the turbine exhaust.

1.3 H-1 ENGINE HYDRAULIC SYSTEM

The four outboard H-1 engines are each equipped with an independent closed-loop hydraulic system. The hydraulic systems provide the necessary motive power for roll, pitch, and yaw control of the launch vehicle during S-I stage powered flight.

The gimbal mounted H-1 engines are moved in proportion to the magnitude of an electrical input signal. The required movement is provided by two hydraulic actuators that are mounted to produce perpendicular planes of motion. The actuators may extend or retract individually or simultaneously.

The high-pressure hydraulic fluid flow required by the actuators is provided, on demand, by the variable-flow, mechanically driven main pump during H-1 engine operation and by the electrically driven auxiliary pump during test operations.

1.3.1 Component Description - Major components of the H-1 engine hydraulic system are main and auxiliary pumps, accumulator-reservoir assembly, and servoactuator assemblies. Descriptions of these components are included in following paragraphs.

1.3.1.1 Main Pump. The main pump is a two-stage, variable-displacement, mechanically-driven unit that operates between 3750 and 4300 rpm to deliver a maximum flow of 18 gpm at a minimum pressure of 2900 psig. Maximum output pressure at zero flow is 3200 (± 50) psig.

1.3.1.2 Auxiliary Pump. The auxiliary pump is a single-stage, variable-delivery unit that is used to supply hydraulic pressure for ground checkout. The auxiliary pump is driven at approximately 10,500 rpm by a 4.5-hp electric motor to deliver a maximum flow of 3.0 gpm at 2900 (± 50) psig. Maximum pressure at zero output is 3000 (± 50) psig.

1.3.1.3 Accumulator-Reservoir Assembly. The three-chamber, accumulator-reservoir assembly serves as a high-pressure accumulator and a low-pressure reservoir. The GN_2 chamber is precharged to 1600 psig prior to filling the system with hydraulic fluid. The high-pressure chamber is pressurized to system pressure whenever the auxiliary pump or the main pump is in operation. The 60-to-1 ratio piston between the low- and high-pressure chambers establishes the low pressure chamber pressure at approximately 53 psig for a system pressure of 3200 psig. The position of the 60-to-1 ratio piston is monitored to provide a system fluid-level indication.

1.3.1.4 Servoactuator. The double-acting servoactuator assembly includes an electrohydraulic servovalve, a micronic filter, a feedback potentiometer, a removable stroke-indicator scale, and a mid-stroke locking device.

The self-contained, four-way, two-stage servovalve is utilized for flow control and features a dynamic pressure feedback loop, a polarized electric torque motor, and two stages of hydraulic power amplification.

Two identical servoactuator assemblies are mounted on each of the four outboard engines for pitch and yaw control.

1.3.2 <u>Hydraulic System Operation</u> - The H-1 engine hydraulic system provides motive power for engine gimballing during S-I stage powered flight and for prelaunch checkouts. Operation of the hydraulic system is discussed in following paragraphs. A schematic of the H-1 engine hydraulic system is presented in figure 3-1.

1.3.2.1 Filling Operation. Accumulator-Reservoir Assembly B86 is charged with GN_2 from a ground source through High-Pressure Charging Valve B88 before the system is filled with hydraulic fluid. The system is then filled with hydraulic fluid through Quick-Disconnect Coupling B84, purged, and bled. Hydraulic fluid is supplied from a ground source through Filter B85 to the accumulator-reservoir assembly and through the system. Excess hydraulic fluid used in the purging operation is returned to the ground source through Quick-Disconnect Coupling B90.

1.3.2.2 Prelaunch Operation. During prelaunch testing and checkout, Auxiliary Pump B80, driven by electric Pump Motor B81, supplies the hydraulic pressure for engine gimballing. Check Valve B79 protects Main Pump B75 from high-pressure fluid during auxiliary pump operation. The auxiliary pump is protected by Check Valve B82 from high-pressure fluid during operation of Main Pump B75. Auxiliary pump operation terminates after all engines have reached mainstage operation.

1.3.2.3 Flight Operation. Main Pump B75 is mechanically driven and draws fluid from the low-pressure side of Accumulator-Reservoir Assembly B86. As the turbopump speed increases, fluid pressure increases to approximately 3200 psi, causing the hydraulic fluid to flow through Check Valve B79 and Filter B85 into the high-pressure side of the accumulator-reservoir assembly. The pressurized fluid flows from the accumulator into the servovalve of Hydraulic Actuators B94 and B95.

When the electrohydraulic servovalve in each actuator receives a command from the guidance system it diverts the high-pressure fluid against one side or the other of the actuator piston, causing extension or retraction of the actuator arms. Displaced fluid from Hydraulic Actuators B94 and B95 is returned to the low-pressure side of Accumulator-Reservoir Assembly B86.

The hydraulic system is monitored by various switches and indicators within Accumulator-Reservoir Assembly B86. Differential Pressure Indicator B78 is calibrated to extend a spring-loaded button when the pressure drop across Filter B85 exceeds a predetermined level. An extended button indicates the presence of dirty or clogged filter. Thermal Switch B93 actuates if the fluid temperature increases above a predetermined value. The hydraulic fluid pressure in the high-pressure accumulator is monitored by High-Pressure Transducer B92. The fluid level of the reservoir is monitored at all times by Potentiometer B87. Thermal Switch B96 protects auxiliary Pump Motor B81 from overheating.

The hydraulic system is protected against overpressurization by Relief Valves B89 and B91. Relief Valve B89 protects Accumulator-Reservoir Assembly B86 and the high-pressure side of the system by allowing high-pressure fluid to vent into the low-pressure side of the accumulator-reservoir assembly. The low-pressure side of the system is protected by Relief Valve B91 which vents excess fluid to the atmosphere. During flight Relief Valve B91 is capped and is inoperative.

1.3.2.4 Drain Operation. The system is drained through Quick-Disconnect Coupling B90. Drain plugs are provided in Actuators B94 and B95. Filter B85 can be removed for cleaning. Nitrogen pressure in Accumulator-Reservoir Assembly B86 can be released through High-Pressure Charging Valve B88. Main Pump B75 and Auxiliary Pump B80 are provided with Seepage Plugs B76. Bleed Valves B83 and B98 are provided for both the high- and low-pressure sides of the accumulator-reservoir assembly, the main pump, and the auxiliary pump.

Case Drain Filter B97 removes any auxiliary-pump-generated contaminant before the fluid is returned to the reservoir.

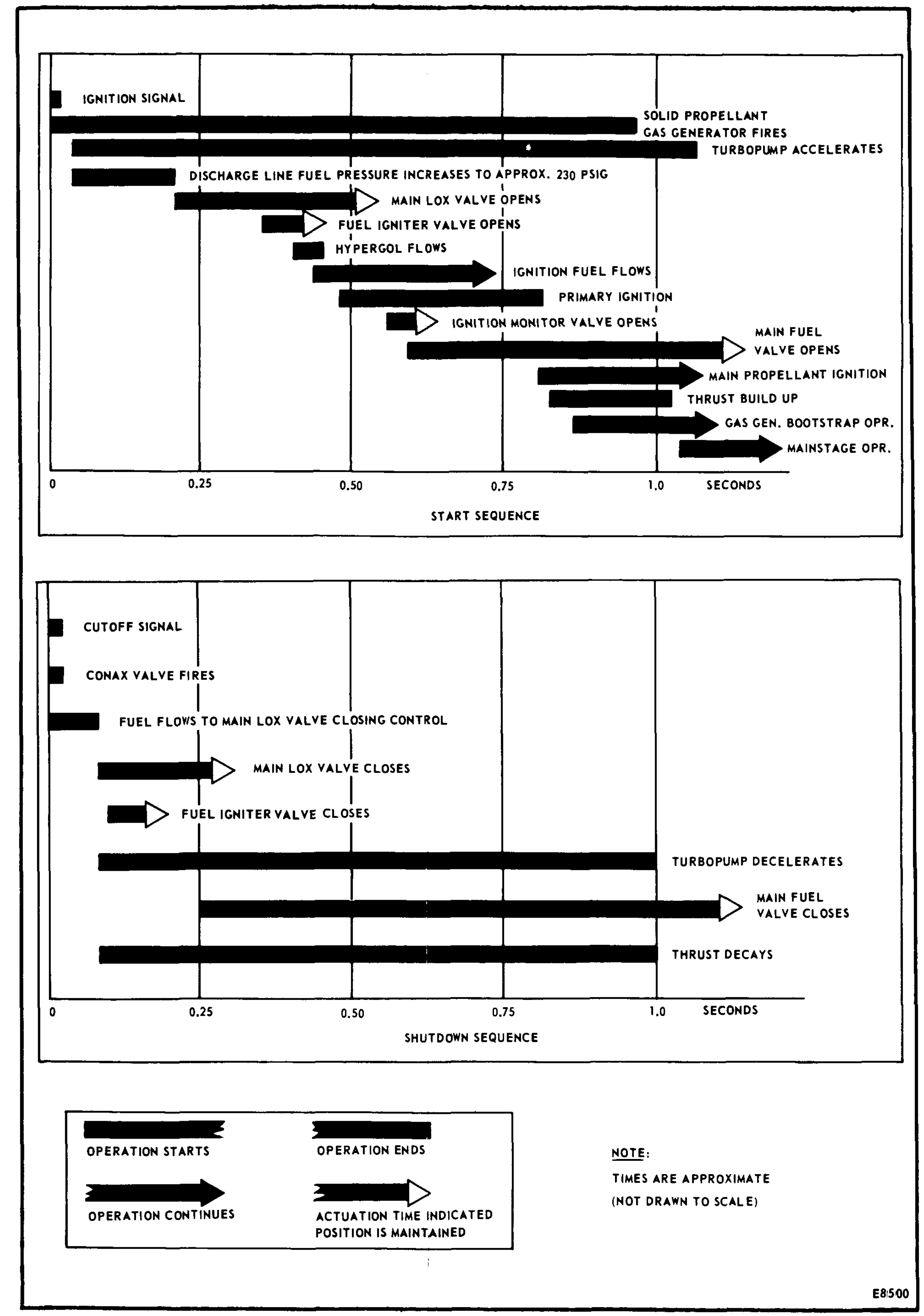

Figure 1-1. H-1 Engine Start and Shutdown Sequences

SECTION 2

INDEX OF FINDING NUMBERS

This section contains an alpha-numerical list, by finding number, of the H-1 engine and hydraulic system components that function during a prelaunch countdown, during vehicle flight, or in the event of a launch abort. The finding numbers listed identify components on the system schematic provided in section 3. Additional columns in the index of finding numbers provide such pertinent information as component description and function, part number, and the supplier's name and part number. A break will occur in the alpha-numeric sequence of finding numbers when a component, or component series is non-functional during the countdown, functional only in the event of a malfunction, functional in terms of a maintenance operation only, or is part of another functional system.

The letter prefix of a finding number identifies the component with respect to either the launch complex or an area of the launch vehicle. The letter prefixes used in this eleven-volume set are listed below.

FINDING NUMBER PREFIX	DESIGNATED AREA
A	Launch complex
B	S-I stage
E	S-IV stage
G	Instrument unit
H	Payload

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B1	8	Orifice	0.116 in dia; main LOX valve opening control line	Rocketdyne P/N 307404		
B2-1	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		1A8
B2-2	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		2A8
B2-3	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		3A8
B2-4	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		4A8
B2-5	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		5A8
B2-6	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		6A8
B2-7	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		7A8
B2-8	1	Valve, Conax	NC, 2-way, self-contained, pyrotechnic-actuated	Rocketdyne P/N NA5-26594		8A8
B3	8	Orifice	0.013 in dia; gearbox pressurizing	Rocketdyne P/N D04-1.2		
B4	8	Orifice	2.70 in. nom dia; fuel discharge line	Rocketdyne P/N RD251-4013		
B5	8	Valve, Check	1/4 in.; gearbox pressurizing	Rocketdyne P/N NA5-28049		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B6 is not functionally applicable to this system.						
B7	8	Orifice	0.013 in. dia.; LOX seal purge	Rocketdyne P/N D04-1.2		
B8-1	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-31		1A1
B8-2	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-51		2A1
B8-3	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-31		3A1
B8-4	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-51		4A1
B8-5	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-51		5A1
B8-6	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-31		6A1
B8-7	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-31		7A1
B8-8	1	Turbopump Assembly	Rated flow: 3257.4 gpm LOX and 2007.6 gpm fuel at 6506 rpm	Rocketdyne P/N 456405-51		8A1
B9 is not functionally applicable to this system.						
B10	8	Cap Assembly	3/16 in. tube cap, drilled for safety chain; fuel volute drain	AN 929A3C		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B11-1	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		1A6
B11-2	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		2A6
B11-3	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		3A6
B11-4	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		4A6
B11-5	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		5A6
B11-6	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		6A6
B11-7	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		7A6
B11-8	2	Initiator	Actuated by 500 volts ac at 1.5 amps minimum	Rocketdyne NA5-26737		8A6
B12	8	Valve, Check	3/8 in.; gas generator LOX injector manifold purge	Rocketdyne P/N 554121		
B13	8	Valve, Relief	Relieves at 2 to 10 psig; lube drain relief	Rocketdyne P/N 304537		
B14	8	Filter	Rated flow: 5 gpm at approx 722 psig; rated at 40 micron	Rocketdyne P/N NA 5-26723		
B15-1		Fuel Additive Blender Unit	111 cu in. capacity: Oronite 262	Rocketdyne P/N 454075-11		1A3

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B15-2	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		2A3
B15-3	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		3A3
B15-4	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		4A3
B15-5	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		5A3
B15-6	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		6A3
B15-7	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		7A3
B15-8	1	Fuel Additive Blender Unit	111 cu in. capacity; Oronite 262	Rocketdyne P/N 454075-11		8A3
B16	8	Plug, Drain	1/4 in. plug, drilled for lockwire	AN 814-4DL		
B17	8	Coupling, Quick-Disconnect	Bulkhead mounting; self sealing Oronite 262 fill	Aeroquip Corp., Aircraft Div.P/N 340234-4		
B18	8	Coupling, Quick-Disconnect	Bulkhead mounting, self sealing fuel drain	Aeroquip Corp., Aircraft Div. P/N 340234-8		
B19	8	Turbine	Impulse-type, two stage; develops 3793 bhp	Rocketdyne P/N 454204		
B20-1	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		1A6

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B20-2	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		2A6
B20-3	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		3A6
B20-4	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		4A6
B20-5	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		5A6
B20-6	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		6A6
B20-7	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		7A6
B20-8	1	Gas Generator, Solid Propellant		Rocketdyne P/N 651240-41		8A6
B21	8	Orifice	0.320 in. nom dia; LOX bootstrap line	Rocketdyne P/N RD251-4012		
B22	8	Gas Generator, Liquid Propellant	Chamber press.: 612.1 psia	Rocketdyne P/N 307350		
B23	8	Gas Generator Control Valve Assembly	NC; operating press.: 275 psia	Rocketdyne P/N 303600		
B24	8	Valve, Check	3/4 in.; heat exchanger LOX line	Rocketdyne P/N NA5-26032T2L		
B25 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B26	32	Plug, Drain	1/4 in., fillister head, 10-32 thread; fuel jacket drain	AN501A10-4		
B27	4	Aspirator	Outboard engines only	Rocketdyne P/N 204595		
B28-1 thru B28-4	4	Thrust Chamber	Outboard engines	Rocketdyne P/N 206088		
B28-5	1	Thrust Chamber	Outboard engines	Rocketdyne P/N 206076-11		
B28-6 and B28-7	2	Thrust Chamber	Inboard engines	Rocketdyne P/N 206086		
B28-8	1	Thrust Chamber	Inboard engine	Rocketdyne P/N 207076-11		
B29	24	Orifice	0.102 (+ 0.000, - 0.001) in dia; heat exchanger LOX	Part of 10438000	20M01029	
B30	8	Heat Exchanger Assembly	LOX to GOX conversion	Government Furnished Equipment (GFE)	303351	
B31	8	Coupling, Quick-Disconnect	Bulkhead mounting; self sealing; fuel jacket fill	Aeroquip Corp. Aircraft Div.P/N 340234-8		
B32	8	Orifice	0.600 in. nom dia; fuel bootstrap line	Rocketdyne P/N RD251-4005		
B33 through B35 are not functionally applicable to this system.						
B36-1	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		1A7

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B36-2	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		2A7
B36-3	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		3A7
B36-4	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		4A7
B36-5	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		5A7
B36-6	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		6A7
B36-7	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		7A7
B36-8	1	Injector and Hypergol Container Assembly	Hypergol flame temp 1200 F; energy release 18,300 btu/lb	Rocketdyne P/N 205181		8A7
B37	24	Valve, Check	1/4 in.; fuel injector purge	Rocketdyne P/N NA5-28049		
B38	8	Valve, Ignition Monitor	1/4 in., 3-way, NC; main fuel valve control	Rocketdyne P/N 554838		
B39-1 thru B39-4	4	Valve, Main Fuel	NC; butterfly type w/4.25 in. gate, used on engine H5028	Rocketdyne P/N 406222		
B39-5	1	Valve, Main Fuel	NC; butterfly type w/4.25 in. gate, used on engine H2034	Rocketdyne P/N 406508		
B39-6 and B39-7	2	Valve, Main Fuel	NC; butterfly type w/4.25 in. gate, used on engine H2026	Rocketdyne P/N 406222		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B39-8	1	Valve, Main Fuel	NC; butterfly type w/4.25 in. gate, used on engine H2030	Rocketdyne P/N 406508		
B40 is not functionally applicable to this system.						
B41-1	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	1A11
B41-2	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	2A11
B41-3	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	3A11
B41-4	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	4A11
B41-5	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	5A11
B41-6	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	6A11
B41-7	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	7A11
B41-8	1	Switch, Pressure	Diaphragm actuated toggle mechanism; thrust OK	Southwestern Ind. Inc. P/N PS-5807	60C20278	8A11
B42	16	Auto Igniter	Squibless type;	Rocketdyne P/N 651139		
B43	8	Plug, Drain	1/4 in. plug, drilled for lockwire; fuel discharge line	AN814-4CL		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B44	8	Manifold, Fuel Drain	Inboard and outboard engines	Chrysler Corp. Space Div., Michoud Operations	20C50113	
B45	8	Valve, Check	1/2 in.; LOX dome purge	Rocketdyne P/N NA5-26032T1L		
B46-1	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		1A5
B46-2	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		2A5
B46-3	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		3A5
B46-4	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		4A5
B46-5	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		5A5
B46-6	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		6A5
B46-7	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		7A5
B46-8	1	Valve, Fuel Igniter	NC; cam actuated	Rocketdyne P/N 403520		8A5
B47	4	Manifold, LOX Drain	Inboard engines only	Chrysler Corp., Space Division Michoud Operations	20C50124	
B48	8	Orifice	0.060 in. dia.; fuel bleed line	Rocketdyne P/N NA5-24002-T123		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B49-1	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 405967		1A4
B49-2	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 405967		2A4
B49-3	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 405967		3A4
B49-4	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 405967		4A4
B49-5	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 406677-11		5A4
B49-6	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 405967		6A4
B49-7	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 405967		7A4
B49-8	1	Valve, Main LOX	NC; butterfly-type w/ 4.25 in. dia gate	Rocketdyne P/N 406677-11		8A4
B50 through B74 are not functionally applicable to this system.						
B75	4	Pump, Main	Rated flow: 18 gpm at 4300 rpm	American Brake Shoe Co. Model No. APGV-24K	20C85035	
B76	8	Plug, Seepage	Fabricated from epoxy resin w/ sponge seepage core		20C85056	
B77 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B78	4	Indicator, Differential Pressure	Actuating press.: 80 (± 10) psid	Aircraft Porous Media, Inc. P/N AC-2100-118ONT	20C85074	
B79	4	Valve, Check	Cracking press.: 2 to 8 psid operating press.: 3200 psig	Parker Aircraft Co. P/N 362-0846-8	20C85109-3	
B80	4	Pump, Auxiliary	Rated flow: 3.5 gpm at 11,000 rpm	Vickers Incorp. Model No. PV006L012B	20C85064	
B81-1	1	Motor, Pump	200 volts, 3 phase, 400 cycles	U.S. Electric Motors P/N 406930	20C85065	1A9
B81-2	1	Motor, Pump	200 volts, 3 phase, 400 cycles	U.S. Electric Motors P/N 406930	20C85065	2A9
B81-3	1	Motor, Pump	200 volts, 3 phase, 400 cycles	U.S. Electric Motors P/N 406930	20C85065	3A9
B81-4	1	Motor, Pump	200 volts, 3 phase, 400 cycles	U.S. Electric Motors P/N 406930	20C85065	4A9
B82	4	Valve, Check	Cracking press.: 2 to 8 psid operating press.: 3200 psig	Parker Aircraft Co. P/N 362-0846-6	20C85109-1	
B83	24	Valve, Bleed	Operating press.: 3200 psig	Fluid Regulators Corp. P/N 7579-5	20C85009	
B84	4	Coupling, Quick-Disconnect	Operating press.: 3200 psig	Aeroquip Corp. P/N 340246-8	20C85082	
B85	4	Filter	Rated flow: 10 gpm at 3200 psig; rated at 17 microns absolute, 2 microns nom	Bendix Filter Div. P/N 043581	20C85087	
B86-1	1	Accumulator-Reservoir Assembly	Hydraulic fluid, GN_2	Cadillac Gage Co. P/N 20296	20C85062	1A10

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B86-2	1	Accumulator-Reservoir Assembly	Hydraulic fluid, GN_2	Cadillac Gage Co. P/N 20296	20C85062	2A10
B86-3	1	Accumulator-Reservoir Assembly	Hydraulic fluid, GN_2	Cadillac Gage Co. P/N 20296	20C85062	3A10
B86-4	1	Accumulator-Reservoir Assembly	Hydraulic fluid, GN_2	Cadillac Gage Co. P/N 20296	20C85062	4A10
B87-1	1	Potentiometer	Wire wound; linear actuating	Cadillac Gage Co. P/N 21596		1A463
B87-2	1	Potentiometer	Wire wound; linear actuating	Cadillac Gage Co. P/N 21596		2A461
B87-3	1	Potentiometer	Wire wound; linear actuating	Cadillac Gage Co. P/N 21596		3A463
B87-4	1	Potentiometer	Wire wound; linear actuating	Cadillac Gage Co. P/N 21596		4A461
B88	4	Valve, High-Pressure Charging	1600 psig GN_2	Cadillac Gage Co. P/N 18659		
B89	4	Valve, Relief	Relieves at 3800 (± 100) psig; reseats at 3400 psig min	Fluid Regulators Corp. P/N C485-02	20C85078	
B90	4	Coupling, Quick-Disconnect	Operating press.: 125 psig	Aeroquip Corp. P/N 370250-12	20C85081	
B91	4	Valve, Relief	Relieves at 100 (± 10) psig; reseats at 75 psig min	Parker Aircraft Co. P/N H60C0661	20C85077	
B92-1	1	Transducer, High-Pressure	Press. range: 0 to 4000 psig	Servonic Instruments, Inc. P/N H-204	20C85079	1A427

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B92-2	1	Transducer, High-Pressure	Press. range: 0 to 4000 psig	Servonic Instruments, Inc. P/N H-204	20C85079	2A426
B92-3	1	Transducer, High-Pressure	Press. range: 0 to 4000 psig	Servonic Instruments, Inc. P/N H-204	20C85079	3A427
B92-4	1	Transducer, High-Pressure	Press. range: 0 to 4000 psig	Servonic Instruments, Inc. P/N H-204	20C85079	4A426
B93-1	1	Switch, Thermal	Opens at 200 (± 10) F; recloses at 155 (± 10) F	Texas Instruments, Inc. P/N 21400	20C85016	1A10
B93-2	1	Switch, Thermal	Opens at 200 (± 10) F; recloses at 155 (± 10) F	Texas Instruments, Inc. P/N 21400	20C85016	2A10
B93-3	1	Switch, Thermal	Opens at 200 (± 10) F; recloses at 155 (±10) F	Texas Instruments, Inc. P/N 21400	20C85016	3A10
B93-4	1	Switch, Thermal	Opens at 200 (± 10) F; recloses at 155 (± 10) F	Texas Instruments, Inc. P/N 21400	20C85016	4A10
B94-1	1	Actuator, Hydraulic	Operating press.: 3200 psig; pitch control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	1A14
B94-2	1	Actuator, Hydraulic	Operating press.: 3200 psig; pitch control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	2A12
B94-3	1	Actuator, Hydraulic	Operating press.: 3200 psig; pitch control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	3A14
B94-4	1	Actuator, Hydraulic	Operating press.: 3200 psig; pitch control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	4A12
B95-1	1	Actuator, Hydraulic	Operating press.: 3200 psig; yaw control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	1A12

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B95-2	1	Actuator, Hydraulic	Operating press.: 3200 psig; yaw control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	2A14
B95-3	1	Actuator, Hydraulic	Operating press.: 3200 psig; yaw control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	3A12
B95-4	1	Actuator, Hydraulic	Operating press.: 3200 psig; yaw control	Moog Servocontrols, Inc. P/N 010-28482	50C01173	4A14
B96	4	Switch, Thermal	NC Contacts: open at 350 (±18)F, reclose at 310 (±18)F	U.S. Electric Motors Inc. Part of P/N406930	Part of 20C85065	1A9J2
B97	4	Filter, Case Drain	Rated flow: 2 gpm at 100 psig; rated at 17 microns max	Aircraft Porous Media, Inc. P/N AC-4913E-1	20C85085	
B98	4	Valve, Bleed	Operating press.: 53 psig	Fluid Regulators Corp. P/N 7409-5	20C85086	
B99 through B172 are not functionally applicable to this system.						
B173	8	Valve, Check		Precision Equipment Co. P/N 126060	20C30046	
B174 through B213 are not functionally applicable to this system.						
B214	1	Valve, Manual	1/4 in., 3-way, needle	Benton Corp. P/N B-15600	10414087	
B215 through B300 are not functionally applicable to this system.						
B301	1	Coupling, Quick-Disconnect	1 in.	E. B. Wiggins Co. P/N 6005R92A16	20C30165	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B302 is not functionally applicable to this system.						
B303	1	Coupling, Quick-Disconnect	1-1/4 in.	E. B. Wiggins Co. P/N 7005R11A20	20C30166	
B304	2	Coupling, Quick-Disconnect	1 in.	E. B. Wiggins Co. P/N 6005R92A16	20C30165	
B305	8	Orifice	0.042 (+ 0.002, -0.000) in. dia		20C00991	

SECTION 3

MECHANICAL SCHEMATICS

This section contains a mechanical schematic that shows the functional arrangement H-1 engine and hydraulic system components listed in section 2. For a definition of the mechanical symbols used, see MSFC-STD-162A.

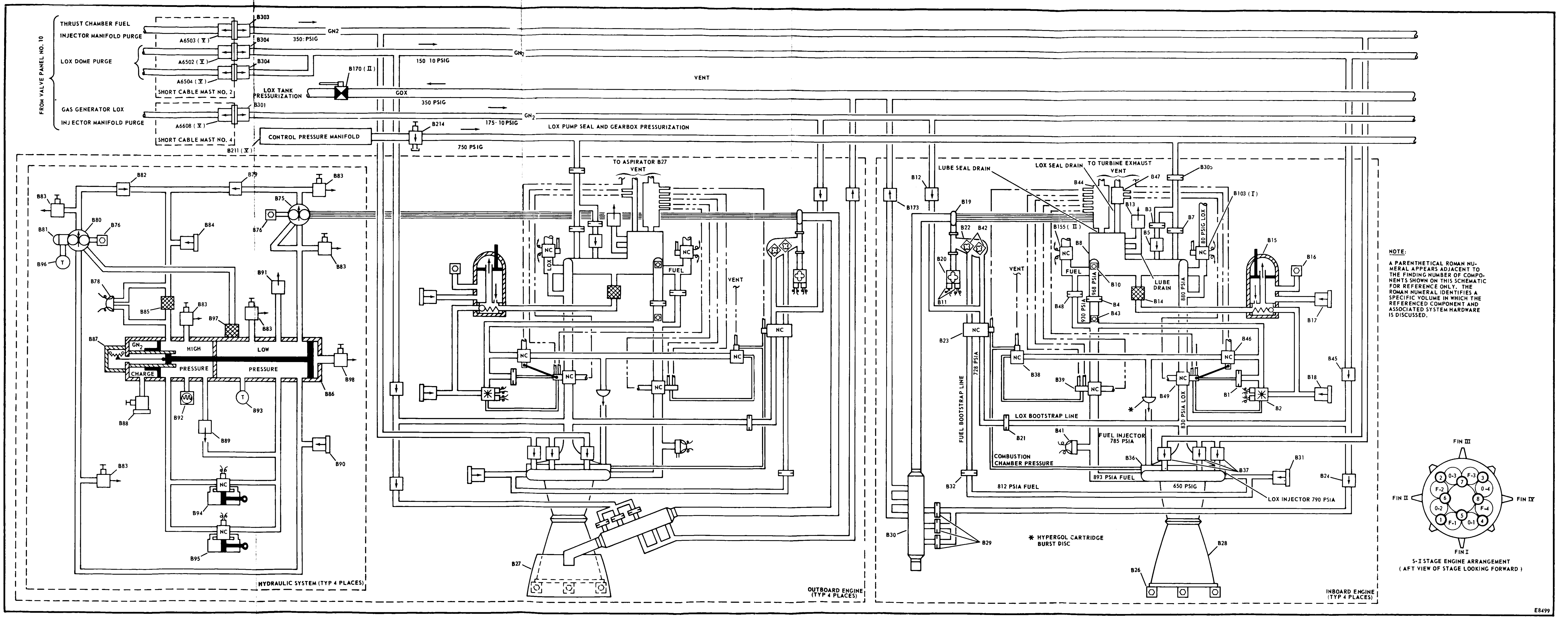

Figure 3-1. H-1 Engine and Hydraulic System - Mechanical Schematic