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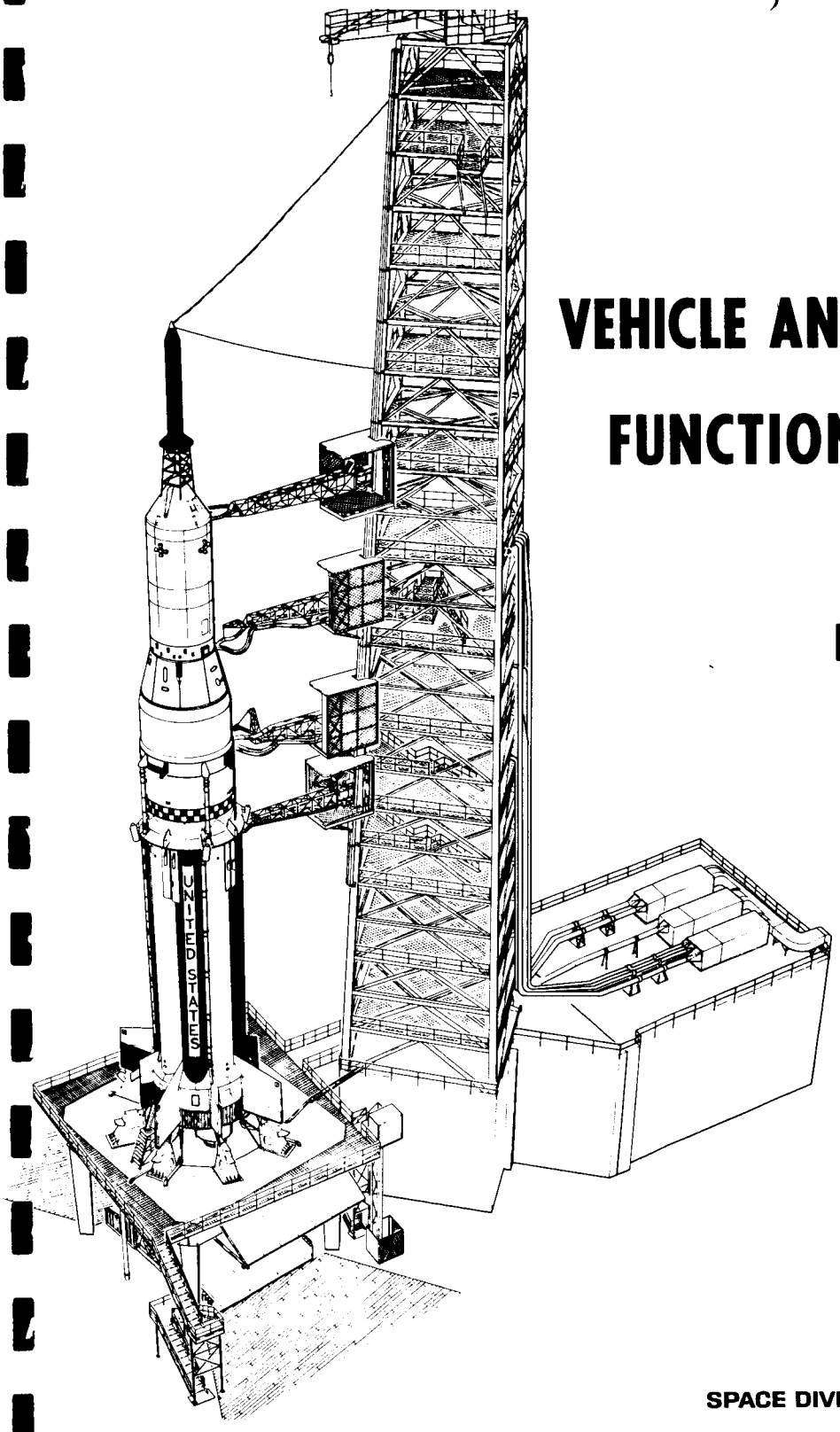


# SA-9
# VEHICLE AND LAUNCH COMPLEX
# FUNCTIONAL DESCRIPTION

## LOX SYSTEM

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SPACE DIVISION CHRYSLER CORPORATION

HUNTSVILLE OPERATIONS

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APRIL 1964

ENGINEERING COMMUNICATIONS DEPARTMENT

SPACE DIVISION CHRYSLER CORPORATION

HUNTSVILLE OPERATIONS

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# FOREWORD

This volume has been prepared for the Functional Integration Section, Systems Integration and Operations Branch, Vehicle Systems Division, Propulsion and Vehicle Engineering Laboratory, by the Engineering Communications Department, Chrysler Corporation Space Division, under contract number NAS8-4016.

The following series, of which this volume is a part, functionally describes the mechanical and electromechanical systems of Saturn I, SA-9 space vehicle and Launch Complex 37:

| | |
|---|---|
| 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 Control System |
| 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 |

Each volume contains mechanical schematics and a list of applicable finding numbers.

Volume II describes those components that are active during countdown, launch, and flight: it specifically excludes maintenance procedures. Only information available by March 1, 1964, has been included.

TABLE OF CONTENTS


| | Page |
|---|---|
| 1. DESCRIPTION | 1 |
| 1.1. Storage Facility | 1 |
| 1.2. Launch Control Center | 2 |
| 1.3. Launch Pad B | 4 |
| 1.4. S-I Stage | 6 |
| 1.5. S-IV Stage | 6 |
| 2. OPERATION | 7 |
| 2.1. Storage Facility | 7 |
| 2.2. Storage Facility, Launcher, LOX Pit, and S-I Stage | 10 |
| 2.3. Launcher, LOX Pit, and S-I Stage | 13 |
| 2.4. Storage Facility, S-IV Tower Complex, and S-IV Stage | 14 |
| 2.5. S-IV Tower Complex and S-IV Stage | 16 |
| 2.6. Flight | 18 |
| LIST OF FINDING NUMBERS | 21 |
| MECHANICAL SCHEMATICS | 63 |
| DISTRIBUTION | 69 |

# 1. DESCRIPTION

The Launch Complex 37 LOX system fills, replenishes, pressurizes, and drains the S-I and S-IV stage LOX containers on Saturn SA-9. The system consists basically of a LOX storage facility approximately 740 feet from the launch pad and of LOX loading equipment in the launch control center (LCC), in the automatic ground control station (AGCS), in the LOX pit, and on launch pad B.

Two independent systems on SA-9 store and supply LOX for engine operation: one on the S-I stage (H-1 engine), the other on the S-IV stage (RL10A-3 engine).

After the LOX storage tanks have been filled and the system checked out, LOX is transferred to the vehicle through an automatic sequence that begins with storage tank pressurization. The fill and drain lines are precooled prior to the fill operations and the replenish lines are precooled prior to the replenish operations. This cooling minimizes pressure buildups and prevents improper LOX flow. Replenish operations start at the completion of main fill operations, approximately two hours before ignition, and terminate at T -30 seconds. Replenish compensates for LOX loss through vaporization and tops off the LOX containers.

Drain operations return LOX to the storage facility at the conclusion of checkout procedures and after an abort.

The master controls for LOX loading are in the LCC. The LOX control panel in the LCC and the LOX tanking computer in the AGCS are the control points for S-I stage LOX loading. Controls and indicators for the S-IV Propellant Utilization (PU) System, provided by Douglas Aircraft Company (DAC) for S-IV stage LOX loading, are an integral part of the Launch Complex 37 LOX system. Since NASA document LTM-4-12 prepared by K-DP describes and illustrates the control panels, and since the LOX transfer is basically an automatic operation, the description of indicators and manual controls in this volume is cursory. Only the information needed to understand the basic system operation is included.

## 1.1. Storage Facility

A main storage tank, sensing panel, and vaporization (tank pressurization) system; a replenish tank, sensing panel, and vaporization (tank pressurization) system; a pneumatic control panel; and transfer lines (some with filters, pumps, valves, and associated components) comprise the LC37 LOX storage facility.

The main storage tank holds 125,000 gallons of LOX with a 12-percent ullage. The 4 1/2 feet of annular space between the steel outer wall and the aluminum inner wall of the spherical tank is filled with perlite insulation.

The replenish tank holds 28,000 gallons of LOX with a five-percent ullage. The one foot of annular space between the steel outer wall and the aluminum inner wall of the cylindrical tank is filled with perlite insulation.

The vaporization systems, one for the main tank and one for the replenish tank, convert LOX to GOX, which pressurizes the tanks' ullage during LOX loading. The main and replenish tank sensing panels have (a) gages that indicate LOX quantity, ullage pressure, and replenish tank annular space vacuum (main tank annular space pressure is indicated by a gage on the main tank); (b) a valve that vents the ullage during tank filling, allows LOX to flow out a line for visual indication when the tank is full, and is then closed to allow ullage pressurization; (c) pressure switches and transducers that provide LOX tank quantity and pressure signals to indicators in the LCC. The panels also contain pressure switches that prevent overpressurization of the tanks, and the main tank panel contains pressure switches that illuminate indicators in the LCC when S-I and S-IV LOX fill pump discharge pressures are adequate.

The pneumatic control console filters and reduces the pressure of $GN_2$ in four steps for actuation of LOX system valves and regulators and for purging LOX lines.

## 1.2. Launch Control Center

The master controls for LOX loading operations are in propellant loading racks numbers 3, 4, 5, and 6 in the LCC. Equipment in these racks initiates and controls LOX transfer operations, displays LOX system conditions, allows manual checkout of components, and initiates and controls simulated LOX transfer. Rack number 3 houses a propellant monitor, sequence recorder readout, component readout distributor, and a computer distributor. Rack number 4 houses a manometer monitor, sequence recorder readout, and a relay distributor. Rack number 5 houses a LOX dc power panel, LOX components panel, LOX control panel, and a relay distributor. Rack number 6 houses the LOX supply monitor, digital indicator, LOX computer, and a relay distributor.

1.2.1. LOX Components Panel. Component condition indicators (lights) and manual controls (toggle switches) for remotely operated LOX system components are on the LOX components panel. The replenish and throttle control valve display consists of two green lights and one white light. Each other component condition display consists of one green or red light and one white light. Nomenclature on the white light indicates the normal or deenergized condition. Nomenclature on the green light indicates the operated position, and, on the red light, indicates the over-pressure or over-fill position. Use of the switches to manually control the components is dependent on the mode selector switch setting on the LOX control panel.

1.2.2. LOX Control Panel. Switches on this panel initiate the automatic filling and draining operations, initiate the simulated LOX transfer operation, and transfer control (manual) to the LOX components panel. System condition indicators (lights similar to those on the LOX components panel), a power switch, and a 'return S-IV control' switch are also on this panel. Indicator

Table 1. Switches and Functions, LOX Control Panel

| Switch | Function |
|---|---|
| Sequence | Selects automatic or semi-automatic mode. The 'auto' position initiates and automatically sequences all LOX transfer operations through completion of S-IV and S-I LOX replenish. The 'semi-auto' position transfers control of LOX transfer operations to five pushbutton switches for semi-automatic sequencing through completion of S-I main LOX fill operation. The pushbutton switches must be operated in sequence; however, the operator can revert to any previous operation (except S-IV main fill). |
| Pressurize push-button | Reverts the LOX filling system to 'pressurized storage tanks' condition. |
| Precool push-button | Initiates the S-IV stage LOX fill line precool operation. |
| Main fill S-IV pushbutton | Initiates the S-IV stage main LOX fill operation. |
| Precool S-I push-button | Initiates the S-I LOX fill line precool operation. |
| Main fill S-I pushbutton | Initiates the S-I stage main LOX fill operation. The remaining LOX transfer operations to the vehicle are automatically sequenced by signals received from the S-I tanking computer and the S-IV propellant utilization system. |
| Ready for final replenish | Indicates on firing panel that the S-I stage is LOX-loaded to 100 $\pm$ 0.10% and that the S-IV stage is ready for final replenishing. |
| Power | Controls power for entire LOX system. |
| S-IV drain | Initiates LOX drain from the S-IV stage LOX container. |
| S-I drain | Initiates LOX drain from the S-I stage LOX containers. |
| Control return | Returns control of S-IV stage umbilical tower and vehicle valves to DAC. |
| Function (mode) selector | Selects one of three modes of operation and off. 'Operate' provides automatic or semi-automatic sequential operation. 'Simulate' is the same as 'operate,' except pump motors do not operate and there is no LOX flow (manual valves remain closed). 'Manual' transfers control to LOX Components Panel for manual operation of remotely operated components. |

lights across the top of the panel sum up all necessary prerequisites for LOX filling and draining. Table 1 lists the switches and their functions.

1.2.3. Computer Distributor Panel. This panel, in propellant loading rack No. 3, distributes signals from the AGCS and the LOX storage facility to the LOX supply monitor, LOX tanking computer panel, RP-1 density computer panel, and RP-1 tanking computer panel.

1.2.4. LOX Computer Panel. This panel provides the controls and indicators for the LOX loading computer system. Two readouts are provided: one displays the precalibrated nominal differential set pressure in psi; the other displays the dialed-in correction to the set pressure in psi and its polarity. A telephone-type dial, a polarity switch, and a 'clear' pushbutton are used to effect pressure corrections within $\pm$ 0.46 psi.

A power switch applies all power to the computer system. Fuses are provided on the panel front only for the power used in the panel. Indicators (lights) for '75% full' and 'stop fast fill' illuminate when energized either from the computer or from manual initiation switches below the lights. A 'computer test' indicator is illuminated when the computer system is in the test sequence. A switch below this light manually initiates the test sequence. A 'replenish rate' potentiometer is used to adjust the LOX replenish valve control signal as necessary to provide LOX to compensate for boiloff.

1.2.5. Digital Indicator Panel. This panel indicates the percent LOX level in the S-I stage LOX containers. The percent displayed is based on the algebraic sum of the precalibrated LOX loading computer nominal set point and the set point correction dialed in.

The digital indicator panel receives inputs from the data transmitter at the LOX loading computer in the AGCS. This information is translated and displayed in decimal form. For further information concerning LOX loading panels in the LCC, refer to LTM-4-12.

## 1.3. Launch Pad B

1.3.1. Automatic Ground Control Station. LOX loading equipment in the AGCS consists of panels mounted in the propellant level control system data transmission rack, the propellant level control system calibration and monitor rack, and the launcher accessories rack number 2 - all on the second floor.

1.3.1.1. LOX Loading Computer. The LOX loading computer, in the AGCS propellant level control system calibration and monitor rack, generates an electrical analog of sensed differential pressure. The electrical analog and a reference voltage are presented by the computer to its ratiometer for readout. The sensed differential pressure, proportional to LOX quantity, is brought in through sensing lines from the S-I stage center LOX container.

The computer generates switching points for 75 percent full and stop fast fill, which are monitored from the LOX computer panel indicators in the LCC. (See 1.2.4.). The computer also generates signals that proportionally control the LOX replenish valve.

1.3.1.2. Ratiometer-Data Transmitter. The ratiometer-data transmitter, located in the AGCS propellant level control system data transmission rack, is composed of three modules. A reference voltage and a signal voltage received from the LOX loading computer are compared in the ratiometer and displayed in percent on an indicator. The indication is based on the algebraic sum of the precalibrated LOX loading computer nominal set point and the set point correction dialed in. This indication is electrically transmitted to the LCC where it is displayed on the digital indicator (paragraph 1.2.5.).

1.3.1.3. LOX Level Manometer. The LOX level manometer, in the AGCS manometer rack, is a closed, non-adjustable, cistern-type, mercury pressure gage with a range of 0.0 to 30.6 psi. The manometer senses differential pressure across the LOX loading computer and displays the pressure with an accuracy of 0.02 percent. The differential pressure represented by the mercury column height is automatically sensed and converted into a synchro transmitter position, binary coded decimal, and a digital indication. Visual displays of column height appear in pounds per square inch. The manometer is remotely controlled from either the propellant monitor panel in the LCC or from the propellant calibration panel in the propellant level control system calibration and monitor rack in the AGCS.

1.3.1.4. Propellant Calibration Panel. This panel, located in the AGCS propellant level control system calibration and monitor rack, controls the LOX level manometer and repeats on a counter the manometer sensed differential pressure. The panel also provides a power distribution point for all calibration and monitor system units and assemblies.

For further information concerning AGCS LOX Loading Control, refer to LTM-4-16 and LTM-4-19.

1.3.2. S-IV Tower Complex. LOX loading equipment on the tower includes the main fill and topping control valve complex; the S-IV fill, replenish, and drain line; the S-I and S-IV fill and replenish precool valves; and associated solenoid control valves and plumbing. The main fill and topping control valve complex is installed as a unit at the umbilical tower 108-foot level. The S-IV fill, drain, and replenish line connects the valve complex to the S-IV stage umbilical housing through swing arm number 2 (described in Volume VII). Two other LOX transfer lines connect to the valve complex: one, the S-IV replenish line, from the S-I replenish line; the other, the S-IV fill and drain line, from the main storage tank.

1.3.3. Launcher and LOX Pit. LOX loading equipment on the launcher consists of the S-I fill and drain line, which connects to the S-I stage fill and drain nozzle through the LOX mast as described in Volume VII; the S-I LOX replenish coupling-half (mounted on the launcher), which connects to the S-I stage at fin position IV; pressure sensing lines from the center LOX container to the computer in the AGCS, which connect through coupling-halves on short cable mast number 4 (Volume VII); the LOX container prepressurization lines, the fill and drain valve control pressure line, the replenishing valve opening control pressure line, and the LOX bubbling line, which also connect to the S-I stage through coupling-halves on mast number 4; the main fill and

replenish solenoid control valves, LOX container pressurization solenoid control valves, and the LOX bubbling solenoid control valve.

LOX loading equipment located in the LOX pit near the launcher consists of the computer controlled pneumatic relay, replenish throttle control valve, replenish control solenoid, S-I throttle bypass valve, replenish line drain valve, S-I mast drain valve, and the S-I main fill valve.

## 1.4. S-I Stage

Five cylindrical containers store LOX and, during S-I stage powered flight, supply it to the H-1 engines. The four 70-inch diameter containers (0-1, 0-2, 0-3, and 0-4) are installed 90 degrees apart, between fuel containers, forming a circular pattern around the 105-inch diameter center LOX container (0-C). The LOX containers also provide the structural support between the thrust structure and the spider beam. Each outer LOX container has a volume of 11,000 gallons; the center container has a volume of 24,000 gallons. Four interconnect lines join the outer container ullages to the GOX pressurization manifold, which attaches to the center container forward bulkhead. These lines equalize the ullage pressure in the five containers and allow pressurization through the GOX diffuser line that enters the center container from a manifold to the H-1 engine heat exchangers. Four lines connect the outer container sumps to the center container sump; this allows fill through a single coupling, replenish through a single coupling, and provides equal LOX levels during flight.

Two vent and relief valves and one vent valve provide overpressurization protection for the LOX containers. LOX converted to GOX pressurizes the LOX containers during flight; helium prepressurizes the containers from T -100 seconds until mainstage operation commences.

Eight LOX suction lines, with flexible bellows joints, supply LOX to the engines through prevalves held open by $GN_2$ control pressure. Two lines from each outer container sump lead to the engine turbopumps: one on an outboard engine, the other on an inboard engine.

## 1.5. S-IV Stage

The S-IV LOX system stores and supplies pressurized LOX to the six RL10A-3 engines during S-IV powered flight. The system consists of a 1263-cu ft container; six thermally insulated suction lines with flexible bellows joints; a capacitance-type LOX level sensor; a cold helium system, which supplies high pressure helium for container pressurization; a LOX bubbling system; and associated valves, switches, orifices, and plumbing.

The S-IV umbilical plate provides all necessary connections to GSE through swing arm number 2 for S-IV LOX system operation prior to liftoff.

## 2. OPERATION

Components required for various sequential operations are grouped in this section according to location.

Sequences leading to vehicle launch are described under the area or areas that contain the components required for each sequence. The storage facility, launcher, LOX pit, S-IV tower complex, S-I stage, and S-IV stage comprise the locational areas. Only the information needed to understand the basic system operation is included.

Figures 1, 2, and 3 at the back of this document represent the LOX system and should be used in conjunction with the text.

### 2.1. Storage Facility

Equipment located in the storage facility receives, stores, and transfers LOX to and from the launch pad.

2.1.1. Pneumatic Control Console (PCC). The PCC receives 3500-psig $GN_2$ from the nitrogen and helium storage facility; drops the pressure to 750, then 120, and then 25 psig; and also drops the pressure to 50 psig in one step (figure 2). Pneumatic Filter A2707 removes contaminants from the $GN_2$, thereby providing regulator contamination protection. Orifice A2734 reduces 3500 psig to 50 psig; Regulator A2704 reduces 3500 psig to 750 psig; Regulator A2705 reduces 750 psig to 120 psig; and Regulator A2706 reduces 120 psig to 25 psig. Three outlets supply $GN_2$ to other parts of the LOX system: one at 750, one at 50, and one at 25 psig.

Pressure Gages A2700, A2701, A2702, and A2703 provide pressure indications within each system leg. Pressure Switch A2725 sends a 750-psig OK signal to the LOX control panel in the LCC; Pressure Switches A2711 and A2725 send 750 and 25-psig OK signals to the storage facility pneumatic control cabinet panel. Relief Valves A2708, A2709, A2710, and A2735 provide automatic individual leg relief at 900, 120, 35, and 55 psig, respectively. Manual Valves A2712, A2713, A2714, A2720, A2726, and A2715 allow isolation of various segments of the system. Manual Valves A2718, A2721, A2723, A2724, A2722, A2719, A2717, A2730, and A2716 provide complete system manual venting. (Manual Valve A2771 can be closed to isolate the entire console for maintenance.)

2.1.2. Main Tank Fill. LOX, transported to Complex 37 in trailers, is pumped into Main Storage Tank A300 through hoses that couple to the main tank fill coupling-half assemblies (figure 3).

LOX passes from the trailers through Coupling-Half Assemblies A108, A109, A120, A121, and A122; through Manual Valves A91, A67, A116, A117, and A118; past Relief Valve A80, which relieves at 75 psig; through Strainer A126 and Manual Valve A308; and into the main tank. When the LOX reaches the desired

level, it flows through Trycock Valve A311. The trycock valve is then closed and LOX tank fill terminates. Manual Valve A316 is opened to allow the tank LOX level to be read on Differential Pressure Gage A312. The main tank inlet and outlet lines drain through Manual Valves A127, A128, A129, A130, A131, A113, A68, A70, A71, and A112; into a common line; and through Check Valve A114.

2.1.3. Main Tank Annular Space Pressurization. The annular space between the tank walls receives dry $GN_2$ at 0.1 psig to prevent moisture accumulation in the perlite insulation. Either Storage Cylinder Assembly A339 or A340 supplies the $GN_2$ while the other remains on standby. When Cylinder A340 supplies $GN_2$, Manual Valve A334 remains closed. 2000-psig $GN_2$ from Cylinder A340 is reduced to 50 psig by Regulator A336 and further reduced to 0.1 psig by Regulator A331 before entering the main tank annular space. With Cylinder A340 on standby (Manual Valve A333 closed), 2000-psig $GN_2$ from Cylinder A339 is reduced to 50 psig by Regulator A335 before being reduced to 0.1 psig by Regulator A331 for annular space pressurization. Pressure is displayed on Gages A337, A338, and A344. Pressure and Vacuum Relief Valve A342 maintains a constant $GN_2$ bleed from the annular space.

2.1.4. Main Tank Pressurization. A vaporization system, which converts LOX to GOX, pressurizes the ullage of Main Tank A300 to 30 psig. This ullage pressure minimizes boiloff losses and assists LOX flow from the tank. The sequence switch on the LCC LOX control panel is placed in the automatic position to automatically sequence all LOX transfer operations through completion of S-IV and S-I LOX replenish.

Closure of Valves A309, A307, A308, and A310 precedes main tank pressurization; then Manual Valve A323 is opened to allow LOX to flow from the tank to Heat Exchanger A306 for main tank pressurization. Dc power to Solenoid Valves A2736 and A2737 allows 750-psig $GN_2$ to close normally open Main Tank Vent Valve A1. (Manual Valve A327 provides a means of preventing main tank pressure leakage should Valve A1 fail to close.) Power on Valves A2738 and A2739 allows control pressure to open normally closed Main Tank Pressurization Valve A301. LOX flows from the tank through Manual Valve A323, Valve A301, and Flow Control Valve A306 which is held in the fully open position by 25-psig $GN_2$ control pressure. From Valve A306, LOX flows through Heat Exchanger A305, where it is converted to GOX by ambient air being blown across the heat exchanger coils by two motor-operated fans. The GOX passes through the return line to pressurize the tank's ullage.

A line leading to Controller A328 transmits ullage pressure, which varies the controller's outlet pressure from 3 to 15 psig, thus varying the opening through Valve A306 proportionally. In this way, a relatively constant ullage pressure is maintained. Should the ullage pressure exceed 30 psig, Pressure Switch A447 in the main tank sensing panel would actuate, taking power off Valves A2736 and A2737. This action allows Valve A1 to return to its normally open position so that excess GOX can flow through Check Valve A79 and out the vent stack.

GOX Manifold A314 in the main tank sensing panel provides a common ullage pressure source for monitoring conditions within Main Tank A300. Pressure Switch A448 sends a pressurize complete signal to the LOX control panel in the LCC when ullage pressure reaches 20 psig. Pressure Gage A313 displays the ullage pressure. $\Delta$ P Transducer A438 signals a liquid level indicator that indicates main tank LOX quantity in gallons on the LCC LOX supply monitor panel. Transducer A437 signals a pressure indicator, also on the LOX supply monitor panel, that displays ullage pressure in psig.

The vent line can be drained of foreign accumulations through Manual Valve A133. Relief Valve A317 and Burst Disc A318 mechanically protect Tank A300 from overpressurization. A line containing Manual Valve A320 allows emergency bypass of Valves A301 and A306. Valve A319 allows bypass of Valve A301. Relief Valves A321 and A322 open at 75 psig to prevent Heat Exchanger A305 and line structural failure.

2.1.5. Replenish Tank Fill. LOX, transported to Complex 37 in trailers, is pumped into Replenish Tank A200 through hoses coupled to the replenish tank coupling-half assemblies (figure 2). LOX passes from the trailers through Coupling-Half Assemblies A123 and A124; through Manual Valves A119 and A66; past Relief Valve A92, which relieves at 75 psig; through Strainer A125; through Manual Valve A211; and into Main Tank A200. When the LOX reaches the desired level, it flows through Trycock Valve A230, which is then closed to terminate the replenish fill operation.

Manual Valve A216 is opened to allow the replenish tank LOX level to be displayed on Differential Pressure Gage A212. The replenish tank fill lines drain through Manual Valves A132 and A69 into a common line and through Check Valve A28. $\Delta$ P Transducer A441 signals a liquid level indicator that indicates tank quantity in gallons on the LCC LOX supply monitor.

2.1.6. Replenish Tank Annular Space Evacuation. A portable vacuum pump connected through Manual Valve A228, the vacuum line, and Filter A229 pulls a 20-micron-mercury vacuum within the perlite insulated tank walls. Vacuum within the walls is measured through the line containing Manual Valves A218 and A219 and by Vacuum Gage A217. Relief Valve A237 relieves pressure buildup within the walls at 2.3 psig.

2.1.7. Replenish Tank Pressurization. A vaporization system that converts LOX to GOX pressurizes the replenish tank ullage to 195 psig. This ullage pressure minimizes LOX boiloff losses and force-feeds the LOX to the vehicle containers during replenish operations. Closure of Valves A210 and A211 precedes replenish tank pressurization; then Manual Valve A227 is opened to allow LOX flow to Heat Exchanger A205 for replenish tank pressurization. Dc power on Solenoid Valves A2752 and A2753 allows 750-psig $GN_2$ control pressure to close normally open Replenish Tank Vent Valve A4. (Manual Valve A220 provides a means of preventing replenish tank pressure leakage should Valve A4 fail to close.) Power on Valves A2754 and A2755 allows the control pressure to open normally closed Replenish Tank Pressurization Valve A201. LOX flows from the tank through Manual Valve A227, Valve A201, and Flow Control Valve A206 which is held in the fully open position by 25-psig $GN_2$ control

pressure. From Valve A206, LOX flows through Heat Exchanger A205 where it is converted to GOX by ambient air blown across the heat exchanger coils by two motor-operated fans. The GOX passes through the return line to pressurize the tank ullage. A line leading to Controller A235 transmits ullage pressure, which varies Controller A235 outlet pressure from 3 to 15 psig, thus varying the opening through Valve A206 proportionally. In this way a relatively constant ullage pressure is maintained. Should the ullage pressure exceed 195 psig, Pressure Switch A449 in the replenish tank sensing panel would actuate, taking power off Valves A2752 and A2753. This allows Valve A4 to return to its normally open position so that excess GOX can flow through Check Valve A78 and out the vent stack.

GOX Manifold A214, in the replenish tank sensing panel, provides a common ullage pressure source for monitoring conditions within the replenish tank. Pressure Switch A442 sends a pressurize complete signal to the LOX control panel in the LCC when ullage pressure reaches 160 psig. Pressure Gage A213 displays the ullage pressure. Transducer A443 signals an ullage pressure indicator on the LOX supply monitor panel in the LCC.

The vent line can be drained of foreign accumulations through Manual Valve A81. Relief Valve A221 and Burst Disc A222 mechanically protect the replenish tank from overpressurization. A line containing Manual Valve A224 allows emergency bypass of Valves A201 and A206. Valve A223 allows bypass of Valve A201. Relief Valves A225 and A226 open at 300 psig to prevent Heat Exchanger A205 and line structural failure. If a leak should develop between the replenish tank ullage and the hollow manhole cover, Relief Valve A238 would relieve the manhole cover pressure.

2.1.8. Replenish Tank Refill. Should a launch delay occur, Main Tank A300 can refill Replenish Tank A200 through the replenish tank transfer line, which contains Local Transfer Valve A231. Refill operation follows the route from the main tank, through Manual Valve A309, past Relief Valve A90 which cracks at 75 psig to relieve GOX pressure buildup, and into the local transfer line. From the local transfer valve switch in the auxiliary components panel, dc power actuates Valves A2781 and A2782, allowing $GN_2$ control pressure to open Valve A231. LOX flows through Valve A231 and Valve A227 into the replenish tank. The replenish tank quantity indicator in the LCC LOX supply monitor panel, which receives a signal from $\Delta$ P Transducer A441, is monitored to determine when the desired Tank A200 level has been reached.

## 2.2. Storage Facility, Launcher, LOX Pit, and S-I Stage

2.2.1. Fill and Drain Lines Precool. The S-I precool operation, which prevents overpressurization and choking of the S-I fill line with LOX vapor, requires about 6.5 minutes. Prior to fill and drain line precool operation, dc power actuates Solenoid Valves A2748 and A2749, allowing $GN_2$ to close S-I Line Vent Valve A16 (figure 3). $GN_2$ from Manual Valve A5177 in Valve Panel 10 closes S-I Mast Drain Valve A34 through energized Solenoid Valves A2766 and A2767 and opens S-I Main Fill Valve A31 through energized Solenoid Valves A2764 and A2765 (figure 2). $GN_2$ from the LOX pneumatic control console opens S-I Pump Discharge Valve A7 (figure 3) through energized Solenoid Valves

A2746 and A2747. $GN_2$ from Valve Panel 10 (through Manual Valve A5177, open Solenoid Valve A5616, and Coupling Halves A6601 and B154) opens Vehicle Fill and Drain Valve B152 (figure 1). LOX flows from Main Tank A300 through Valve A307 and Strainer A99. Manual Valve A112 remains closed during precool operation. The 30-psig GOX ullage pressure provides flow impetus. LOX continues through inoperative Transfer Pump A105, S-I Pump Discharge Valve A7, Check Valve A115, and Manual Valve A26. Relief Valves A88, A110, A139, A140, A141, and A142 protect the fill line and its components. Flow continues through S-I Main Fill Valve A31, Coupling Assembly A4600, Nozzle Assembly B153, Fill and Drain Valve B152, and into the 0-3 sump.

2.2.2. Fill. Main fill of the S-I stage LOX containers commences approximately 6 hours before launch. Prior to containers fill, LOX Vent Valve B163 and No. 1 LOX Vent and Relief Valve B162-1 (pressure operated through Solenoid Valve B215) open to vent the containers during the fill operation. No. 2 LOX Vent and Relief Valve B162-2 (pressure operated through Solenoid Valve B222) also opens for the same purpose. However, Valve B222 allows the vent function of No. 2 Valve B162-2 to operate only prior to launch since a GSE signal is required to actuate Valve B222. When Valves B215 and B222 close, $GN_2$ trapped between Valves B163, B162-1, and B162-2 and Valves B215 and B222 escapes through the vent ports of Valves B215 and B222 and through Orifices B169.

At the completion of S-I precool operations, Pump A105 starts, drawing LOX from Tank A300, through Valve A307, Strainer A99, through Pump A105, and past Pressure Switch A435, which indicates 'Main Fill in Operation' at the LOX control panel when pump discharge pressure reaches 160 psig. Flow continues through Valve A7, Check Valve A115, Manual Valve A26, Valve A31, Coupling Assembly A4600, Nozzle Assembly B153, Fill and Drain Valve B152, and into the 0-3 sump and to the 0-C sump through the sumps interconnect line. From the 0-C sump, LOX flows to 0-2, 0-1, and 0-4 through the sumps interconnect lines. The containers fill until the operation is terminated by the LOX tanking computer.

The S-I fill and drain line empties through S-I Mast Drain Valve A34 and Check Valves A85 and A150. A $GN_2$ purge to the motors of Pumps A105 and A106, through Orifices A2769 and A2770, prevents internal explosive atmospheres in the motors and warms the valve and motor components.

2.2.3. Replenish Line Precool. When the containers reach the 75-percent-full level during main fill, a command signal from LOX Tanking Computer A83 initiates the replenish line precool operation. The S-I main fill operation continues during precool. Prior to replenish line precool, the following valves actuate:

a. Solenoid Valves A2762 and A2763, allowing $GN_2$ to close Replenish Line Drain Valve A143.

b. Replenish Valve B151, by $GN_2$ pressure from Valve Panel 10 Manual Valve A5177 through energized Solenoid Valve A5618 and Coupling Halves A6604 and B160. Solenoid Valve B216 also

actuates through a GSE signal, allowing $GN_2$ opening pressure to vent through the vent port of Valve B216.

c. Solenoid Valves A2756 and A2757, allowing $GN_2$ to open Replenish Line Control Valve A61. Manual Valve A75 is opened.

d. Solenoid Valves A2760 and A2761, allowing $GN_2$ to open S-I Throttle Bypass Valve A52.

e. Replenish and Throttle Control Valve A55 to the fully open position, by 25-psig $GN_2$ from Valve Panel 5 Regulator A2109.

f. Solenoid Valves A2758 and A2759, allowing $GN_2$ control pressure to close Replenish Line Vent Valve A136.

Pressurized LOX flows from Replenish Tank A200 through Manual Valve A210, Strainer A102, Replenish Line Control Valve A61, and Manual Valve A75. Flow continues through Valves A55 and A52, Coupling Assembly A430, Nozzle Assembly B150, and into the 0-4 sump. GOX and LOX vapor relief is provided by Relief Valves A84, A87, A95, A146 and A147. When the LOX level reaches 95 percent, Tanking Computer A83 terminates the replenish precool operation.

2.2.4. Replenish. LOX Tanking Computer A83 controls replenish of the S-I stage LOX containers. This computer in the AGCS generates an electrical analog of sensed differential pressure. The pressure reaches the computer from the vehicle 0-C container pressure sensing lines through Coupling Halves B156, B157, A6605 and A6602. During main fill and replenish operations, a purge of the bottom sensing line is maintained to keep LOX or GOX from reaching the computer. Solenoid Valve A6030 controls this purge by allowing 450-psig helium to flow from Regulator A5280 in Valve Panel 10, through Orifice A6070, Orifice A6071, and Valve A6030. Pressure Switch A6031 actuates at 45 psig, illuminating the LCC auxiliary components panel 'purge pressure on' indicator; at 100 psig the switch deactuates, illuminating the 'purge pressure off' indicator on the same panel, and closes Valve A6030.

The 195-psig GOX ullage pressure in the replenish tank maintains pressurized flow from the tank to the vehicle. The LOX replenish flow route is identical to the replenish precool flow route (paragraph 2.2.3.). When the container LOX level passes 100 percent, $\Delta$ P Switch B159 signals the LCC LOX components panel, which displays an overfill indication. (Manual Valve B158 provides a calibration port for Switch B159.) Computer A83 in conjunction with Replenish and Throttle Control Valve A55 maintains the containers at the full level until the automatic sequence begins 150 seconds before ignition. Throttle Bypass Valve A52 remains open until the 98-percent-full level is reached. Replenish and Throttle Control Valve A55 functions similarly to Flow Control Valve A206. The 75-percent-full signal puts dc power on the LOX replenish power bus in the LCC, which then energizes Solenoid Valve A2768, thus allowing $GN_2$ flow to Controller A58. LOX Tanking Computer A83 positions the Controller A58 poppet in accordance with sensed differential pressures from the vehicle LOX sensing lines.

Upon S-I replenish termination, S-I Stage Replenish Valve B151 closes and Replenish Line Drain Valve A143 opens, allowing LOX to escape from the replenish line through Check Valves A96 and A150.

2.2.5. Drain. Since the S-I and S-IV drain operations function independently, either can commence at any time. The manually actuated S-I drain sequence switch on the LCC LOX control panel actuates the five-minute drain sequence timer, which starts the S-I drain operation. Mast Drain Valve A34 closes, and Vehicle Vent Valve B163 and Vent and Relief Valves B162-1 and B162-2 open. S-I Main Fill Valve A31 and Vehicle Fill and Drain Valve B152 open. Main Tank Pressurization Valve A301 closes, Replenish Tank Vent Valve A4 opens, and Replenish Tank Pressurization Valve A201 closes. Unless previously completed, the main and replenish tanks depressurize while the timer is counting. At the end of the five-minute time delay, Solenoid Valves A2750 and A2751 are energized, opening S-I Line Drain Valve A19. LOX flows from the vehicle containers through the interconnect lines, Fill and Drain Valve B152, Nozzle Assembly B153, Coupling-Half A4600, Main Fill Valve A31, Manual Valve A26, Drain Valve A19, Check Valve A30, Strainer A104, Manual Valve A310, and into the main tank. Gravity provides flow impetus. Relief Valves A89 and A94 relieve LOX and GOX pressure buildup during LOX drain operations.

## 2.3. Launcher, LOX Pit, and S-I Stage

2.3.1. LOX Bubbling. Helium bubbling through the LOX suction lines prevents temperature stratification within the suction lines and containers. LOX bubbling commences upon initiation of the automatic sequence, continues for 50 seconds, and terminates prior to LOX container prepressurization. 315-psig helium, from valve panel 10 Regulator A5245 (figure 1), flows through Solenoid Valve A5607 and Coupling Halves A6610 and B450 on short cable mast number 4 to the vehicle LOX bubbling ringline which contains eight branch lines, one leading to each LOX suction line. From the ringline, helium flows through Orifice B451 into the suction line and then bubbles up through the LOX in LOX Prevalves B155, the container sump, and the container. The helium vents through No. 1 and 2 LOX Vent and Relief Valves B162-1 and B162-2 and Vent Valve B163, which remain open until container prepressurization begins. The combined flow rate of helium through the LOX is approximately 560 scfm.

2.3.2. Containers Prepressurization. Completion of LOX bubbling and closure of LOX Replenish Valve B151 initiates helium prepressurization of the LOX containers 100 seconds prior to ignition. Valves B162-1, B162-2, and B163 close prior to prepressurization initiation. The containers receive helium from Manual Valve A5242 in valve panel 10 (figure 1) through Solenoid Valve A6029, Orifice A6069, Coupling Halves A6508 and B385 on short cable mast number 2, Check Valve B387, and the O-C diffuser line that leads to the O-C ullage.

The other LOX containers receive ullage pressure (helium) through the GOX interconnect manifold. When ullage pressure reaches 60.0 psia, Pressure Switch B167 removes power from Solenoid Valve A6029, thus stopping helium flow to the vehicle. Valve A6028 remains closed at this time. Should the ullage pressure reach 67.5 psia, Pressure Switch B166 would signal Solenoid Valve B215

to open, thus opening Valves B162-1 and B163. (Manual Valve B168 provides a calibration port for Switches B166 and B167.) Immediately after ignition, ullage pressure drops rapidly. To make up this pressure loss, both Solenoid Valves A6028 and A6029 are opened by Pressure Switch B167, allowing this pressure to be made up through Orifices A6069 and A6068 before liftoff.

## 2.4. Storage Facility, S-IV Tower Complex, and S-IV Stage

2.4.1. Fill and Drain Line Precool. Prior to precool operation, the following valves actuate:

a. Solenoid Valve A4006, (figure 2) allowing $GN_2$ pressure from Valve Panel B (Volume V) to open LOX Main Fill Valve A4005.

b. Solenoid Valves E319 and E320, (figure 1) allowing helium control pressure from Regulator E206 to open Fill and Drain Valve E151.

c. Solenoid Valves E212 and E214, opening LOX Container Vent Valves E153 and E154.

d. Solenoid Valves A4003 and A4004, (figure 2) opening S-IV Main Fill Precool Valve A148.

e. Solenoid Valves A2744 and A2745, (figure 3) opening Pump Discharge Valve A10.

Actuation of the S-IV precool fill line switch on the LCC LOX control panel initiates S-IV fill line precool upon completion of main and replenish tanks pressurization. Approximately 5 minutes after precool flow starts, Valve A148 closes. The 5-minute open period of Valve A148 allows GOX pressure in the main line to vent through Check Valve A150. Precool flow follows the route from the main tank, through Valve A309, Strainer A100, non-operative Pump A106, Valve A10, Check Valve A45, and Manual Valve A73. Relief Valves A90, A44, A98, A43, and A47 actuate (open) at 300 psig. After Valve A148 closes, flow continues into the Main Fill and Topping Control Valve Complex A4000, through Valve A4005, Filter A4011, Valve A3151, Coupling Assembly A3160, Nipple Assembly E150, Main Fill Valve E151, and into LOX Container E152. As redundant main LOX fill line overpressure protection, Pressure Switch A3172 opens Main Fill Precool Valve A148. Precool takes about five minutes and transfers approximately 4000 pounds of LOX to the S-IV Stage.

2.4.2. Fill. After five minutes of precool flow, the S-IV precool timer shuts off, starting S-IV fill. Upon completion of precool operation, Valve A148 opens and Pump A106 starts. Full flow to the S-IV container begins within 10 seconds after the pump starts and Valve A148 starts closing 30 seconds after the pump starts; thus the main fill line is purged of GOX pressure for 40 seconds. LOX flow follows the precool route described in paragraph 2.4.1. Pressure Switch A436 indicates adequate pump discharge pressure on the LCC LOX components panel.

The S-IV container fills to the 98-percent level at 1000 gpm. LOX Mass Sensor E156 signals Pump A106 shutoff at the 98-percent level, and Solenoid Valves A2740 and A2741 deenergize to open Line Vent Valve A13, allowing LOX to vent to the main tank through Check Valve A76. Fifteen seconds later, Valves A4005 and E151 close and Umbilical Drain Valve A4023 is opened by $GN_2$ through Valve A4024. LOX in the main line from the vehicle to Valve A4005 escapes through Valve A4023 and Check Valve A4027. After fill to the 98-percent level terminates, Pressure Switch A3172 controls Main Precool Valve A148 as redundant overpressure protection. The S-IV stage remains on standby until the S-I stage LOX loads to the 95-percent level. Pressure Transducer A4002 monitors LOX pressure in the main fill line during the fill operation, and transmits a signal to the DAC propellant loading control and monitor panel when the main line switch is depressed. The pressure is displayed on a voltmeter located on the panel.

2.4.3. Replenish. Prior to replenish, the following valves actuate:

a. Solenoid Valves A4005 and A4008, which receive power through a switch on the LCC auxiliary components panel, opening Replenish Precool Valve A149 for 30 seconds.

b. Solenoid Valve A4022, actuated by the DAC PU system to open Replenish Valve A4021.

c. Line Vent Valve A4023 (closes), through an LCC propellant loading panel switch. S-IV Replenish Valve A4021 automatically controls S-IV replenishing.

Replenish commences through Manual Valve A210, Strainer A102, Replenish Line Control Valve A61, Manual Valve A75, (past Valve A149 that closed after 30 seconds open time) Replenish Valve A4021, Strainer A4011, Umbilical Line LOX Valve A3151, Coupling Assembly A3160, Nipple Assembly E150, Fill and Drain Valve E151, and into Container E152. Pressure Transducer A4018 monitors replenish line pressure during the replenish operation, and transmits a signal to the DAC propellant loading control and monitor panel when the LOX topping line switch is depressed. The line pressure is displayed on a voltmeter located on the panel. Replenish flow continues at 100 gpm until the S-IV system indicates 99.75 percent full. At this level, Replenish Valve A4021 closes and the PU system on the S-IV stage signals Valve A4021 to maintain the S-IV LOX container level at 99.25 to 99.75 percent. Upon automatic sequence initiation, Container E152 is topped to 100 percent; Valves E151 and A4021 then close.

2.4.4. Drain. Upon 100 percent LOX Container E152 fill completion, the DAC PU system opens Umbilical Drain Valve A4023, allowing drainage of the upstream replenish line through Check Valve A4027.

The S-IV LOX container can be drained any time in relation to draining the S-I containers. However, before the S-IV LOX container can be drained, it must be pressurized (paragraph 2.5.3.) and Main Storage Tank A300 and Replenish Tank A200 must be depressurized.

The S-IV LOX container is pressurized with 43-psia helium through Solenoid Valve E236, inoperative Helium Heater E241, and Orifice E240. Vent Valves E153 and E154 close. After the S-IV LOX container is pressurized, Pressure Switch E281 starts a five-minute timer and Main Fill Valve A4005 and LOX Fill and Drain Valve E151 are opened by the DAC PU system.

The storage and replenish tanks depressurize as follows: return of the sequence switch on the LCC LOX control panel to the OFF position removes power from the fill bus causing Vent Valve A1 and Vent Valve A4 to open, Main Tank Pressurization Valve A301 and Replenish Tank Pressurization Valve A201 to close, and the vaporizer fan motors to stop.

After five minutes, on signal from the S-IV drain sequence timer, Solenoid Valves A2742 and A2743 are energized to open Drain Valve A22. Pressurized LOX flows from the S-IV container through Fill and Drain Valve E151, Nipple E150, Coupling Assembly A3160, Umbilical Line LOX Valve A3151, Filter A4011, Main Fill Valve A4005, Drain Valve A22, Check Valve A30, Strainer A104, Manual Valve A310, and into Main Storage Tank A300.

S-IV LOX drain terminates when the S-IV drain sequence timer shuts off causing Fill and Drain Valve E151, Main Fill Valve A4005, and Drain Valve A22 to close.

## 2.5. S-IV Tower Complex and S-IV Stage

2.5.1. Cold Helium Fill. Cold Helium Spheres E233, E234, and E235, mounted on the $LH_2$ container inside wall, provide helium for LOX container pressurization during S-IV stage powered flight (figure 1). When the S-IV $LH_2$ fill level reaches approximately 70 percent, 3000-psig helium at -360°F flows through Coupling Halves A3157 and E225 from the pneumatic distribution system (Volume V). Helium flows through Check Valves E226 and E227 into Spheres E233, E234, and E235.

Should a launch abort occur, Solenoid Valve E232 would dump all helium in the cold helium system overboard. Relief Valve E231 relieves excessive line pressure. Cold helium supply Pressure Switch E245 indicates cold helium low limit sphere pressure during countdown by providing an input to DAC panels and to the automatic countdown sequencer. The circuit from Switch E245 becomes inoperative at liftoff.

2.5.2. LOX Bubbling. Approximately ten minutes prior to automatic sequence initiation (12.5 minutes before ignition), LOX bubbling commences (figure 1). With the cold helium bubbling switch on the pneumatic system control panel in the cooldown position, Bleed Valve E166 opens, allowing helium flow from valve panel B (Volume V) through Coupling Halves A3157 and E225, open Bleed Valve E166, and Orifice E163. Thermal Switch E162 deactuates at -298°F, breaking a circuit to the pneumatic system control panel. When this circuit opens, the cold helium bubbling activated light on the panel goes out. When this light goes out, the cold helium bubbling switch is placed in the bubble position, applying power to the cold helium bubbling control Solenoid Valve E167. This opens Valve E167, allowing helium to flow through Coupling

Halves E225 and A3157, Valve E167, Filter E168, Orifice E169, and to a ringline that has a branch leading to each LOX suction line. From the ringline, helium flows through Check Valve E171, Orifice E172, and into the LOX suction line. The helium bubbles upward through the LOX into the container ullage space and out Vent Valves E153 and E154. Cold helium bubbling Pressure Switch E170 actuates at 320 psia, making a circuit to the cold helium bubbling activated light, thus indicating sufficient bubbling pressure on the Pneumatic System Control Panel.

Subcooling of the LOX in the suction lines assures proper LOX temperature at the engine LOX pump inlets after a specified in-flight LOX chilldown period.

2.5.3. Container Prepressurization. Prepressurization begins at the start of the automatic sequence (T -150 seconds). S-IV LOX Container Vent Valves E153 and E154 close through Solenoid Valves E214 and E212 deenergization (figure 1). Five seconds later, Solenoid Valve E213 energizes to ensure and maintain the closure of the LOX container vent valves. Cold helium flows from valve panel B into the vehicle through Quick-Disconnect Coupling Halves A3157 and E225. After entering the vehicle, the helium flows through Check Valve E226, Filter E228, Solenoid Valve E236, Plenum E243, Helium Heater E241 (not in operation), Orifice E240, and into S-IV LOX Container E152. When the pressure in LOX Container E152 reaches 47 psia, Pressure Switch E283 actuates and closes Solenoid Valve E236. Pressure Switch E281 actuates at 44 psia, providing the S-IV LOX tank normal pressurized indication on the Propulsion System Preparation and Control Panel. Pressure Switch E280 actuates at 52 psia to provide a LOX container overpressure indication to the Propulsion System Preparation and Control Panel.

2.5.4. Purges. Just prior to the S-IV fill and drain line precool operation, Solenoid Valve A2563 (Volume V) (figure 2) in valve panel B actuates (is energized), allowing 50-psig $GN_2$ to purge Umbilical Drain Line Solenoid Valve A3151 through Orifice A3171, LOX Coupling Assembly A3160 through Orifice A3170, and swing arm No. 2 umbilical housing through Orifice A3169. These purges prevent development of explosive atmospheres and reduce the probability of components freezing. The S-IV main LOX line purge commences immediately after closure of S-IV Main Fill Valve E151. 50-psig $GN_2$ flows through Solenoid Valve A2561 (Volume V), Filter A2562, Check Valve A3165, and into the main LOX line. This purge 'inerts' the atmosphere within the main fill line and prevents an explosive hazard at the umbilical housing disconnect after Umbilical Valve A3151 closes.

A purge of the transducer box and junction box on Main Fill and Topping Control Complex A4000 'inerts' the internal atmospheres of the boxes. $GN_2$ from valve panel B, through Solenoid Valve A2546 (Volume V) and Filter A2547, flows through Orifice A4031 and into the explosion-proof transducer and junction boxes. Relief Valves A4030 provide overpressure protection of the boxes.

## 2.6. Flight

During vehicle flight, the S-I and S-IV stage LOX systems deliver LOX to the H-1 and RL10A-3 engines respectively. The sequences explained under the heading "Flight" cover the time period from H-1 engine ignition until RL10A-3 engine cutoff.

2.6.1. S-I Containers Pressurization. LOX converted to GOX within Heat Exchangers B30 pressurizes the LOX containers during S-I powered flight. GOX flows from Heat Exchanger B30 through Check Valve B164 to a GOX manifold that collects GOX from all eight Heat Exchangers B30 and transmits it through GOX Flow Control Regulator B170, through the GOX diffuser line into container O-C, and into the O-C ullage. A control line from the O-C ullage to the actuator on Regulator B170 controls the regulator position. In the fully closed position, the regulator delivers GOX at 17.6 pounds per second. As the ullage pressure goes up, the regulator limits flow proportionally. The regulator maintains a pressure of 50 psia within the ullage of all containers through the GOX interconnect lines that connect each outer LOX container ullage to the O-C ullage. Emergency Pressure Switch B166 actuates at 67.5 psia to open, via Solenoid Valve B215, Vent and Relief Valve B162-1 and Vent Valve B163. The vent function of Vent and Relief Valve B162-2 is inoperative during flight. However, mechanical relief setting on Valves B162-1 and B162-2 provides ullage pressure relief at 55 to 62 psig.

2.6.2. S-I LOX Flow. Each S-I stage outboard LOX container supplies LOX to one inboard and one outboard H-1 engine. After ignition, LOX flows from the 0-1, 0-2, 0-3, and 0-4 sumps, through Prevalves B155 that are held open by 750-psig $GN_2$ (Volume V) through Solenoid Valve B217. After flowing through Prevalves B155, the LOX continues to the inlet side of the H-1 engine turbopumps (Volume VIII). Since all four container sumps connect to the O-C sump through the LOX interconnect lines during flight, the LOX level in each container closely corresponds to the level in the other four containers. Should one engine fail, the LOX in the container that would normally flow to the dead engine would be divided between the remaining seven engines. Prevalves B155 remain open throughout S-I stage powered flight and close simultaneously with the firing of the engine conax valves (Volume VIII and X). Anti-slosh baffles within each LOX container prevent LOX sloshing that might have an adverse effect on vehicle stability.

2.6.3. S-IV Container Pressurization. During S-I powered flight, the S-IV LOX container remains pressurized by Spheres E233, E234, and E235. When the ullage pressure in Container E152 exceeds 46 psia, Pressure Switch E283 signals Solenoid Valve E236 to close. While Solenoid Valve E236 remains open, helium from Spheres E233, E234, and E235 flows through Filter E230, Regulator E229 which drops the pressure to 250 psig, Valve E236, Plenum E243 which reduces line pressure surges, non-operative Helium Heater E241, Orifice E240, and into the ullage of Container E152. Helium also flows through Solenoid Valve E238, Orifice E239, and through the secondary coil of Heater E241.

Warm helium from Heater E241 maintains LOX container pressurization during S-IV powered flight. At a predetermined time after S-I/S-IV separation (Volume X), the flight sequencer signals Solenoid Valve E318 to open, allowing

pneumatic opening of Helium Heater Propellant Valves E215 and E216. $LH_2$ and LOX flow through Valves E215 and E216, respectively, and into the helium heater combustion chamber; the heater exhaust gases pass out the exhaust nozzle and through the S-IV heat shield center. Helium Heater Thermal Switch E246 senses the temperature in Heater E241 and signals the control circuit to open or close Propellant Valves E215 and E216 through Solenoid Valves E318 and E317 according to whether the temperature is above or below 110°F. Heater E241 operates whenever the temperature is below 110°F. During heater operation, cold helium flows from Spheres E233, E234, and E235 through the route described in the first part of paragraph 2.6.3. When the cold helium enters the coils of Heater E241, it warms, expands, and flows through Orifice E240 to Container E152. Upon S-IV powered flight initiation, control of Solenoid Valve E236 switches from Pressure Switch E283 to Pressure Switch E237. When the helium heater inlet line pressure increases to 320 psia, Pressure switch E237 actuates and closes Solenoid Valve E236. When Pressure Switch E283 ceases to control Solenoid Valve E236, it controls Solenoid Valve E238. When the pressure in Container E152 exceeds 46 psia, Pressure Switch E283 signals Solenoid Valve E238, cutting off helium flow to the heater secondary coils and reducing the warm helium flow.

2.6.4. S-IV LOX Flow. During S-IV powered flight, LOX is drawn through six individual LOX suction lines to the six RL10A-3 engines mounted on the S-IV stage thrust structure (Volume IX). The suction lines connect like wheel spokes around the LOX Container E152 base. LOX Sensor E156, a capacitor using LOX as its dielectric, signals the onboard PU system, providing consumption of nearly all LOX to reduce the weight penalty at S-IV engine cutoff (Volumes IX and X). Should Container E152 ullage pressure exceed 50 psia during S-IV powered flight, the mechanical relief setting on Vent and Relief Valves E153 and E154 would open these valves, providing overpressure relief.

LIST OF FINDING NUMBERS

| * FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A1 | 1 | Valve, Pneumatic | 6 in., Ball-type | Hydromatics Inc. Model A132S6 | 10427400 | |
| A2 | | | | | | |
| A3 | | | | | | |
| A4 | 1 | Valve, Pneumatic | 4 in., Ball-type | Hydromatics Inc. Model A132P5 | 10427321 | |
| A5 | | | | | | |
| A6 | | | | | | |
| A7 | 1 | Valve, Pneumatic | 6 in., Ball-type | Hydromatics Inc. Model A132S5 | 10427325 | |
| A8 | | | | | | |
| A9 | | | | | | |
| A10 | 1 | Valve, Pneumatic | 4 in., Ball-type | Hydromatics Inc. Model A132P6 | 10427324 | |
| A11 | | | | | | |
| A12 | | | | | | |

* Location: A = Ground; B = S-I stage; E = S-IV stage; G = Instrument Unit; H = Payload.

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A13 | 1 | Valve, Pneumatic | 4 in., Ball-type | Hydromatics Inc. Model A132P5 | 10427321 | |
| A14 | | | | | | |
| A15 | | | | | | |
| A16 | 1 | Valve, Pneumatic | 4 in., Ball-type | Hydromatics Inc. Model A132P5 | 10427321 | |
| A17 | | | | | | |
| A18 | | | | | | |
| A19 | 1 | Valve, Pneumatic | 6 in., Ball-type | Hydromatics Inc. Model A132S5 | 10427325 | |
| A20 | | | | | | |
| A21 | | | | | | |
| A22 | 1 | Valve, Pneumatic | 6 in., Ball-type | Hydromatics Inc. Model A132S5 | 10427325 | |
| A23 | | | | | | |
| A24 | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A25 | | | | | | |
| A26 | 1 | Valve, Manual | 8 in., Gate-type | Wm. Powell Co. PN 027209 | 10427454 | |
| A27 | | | | | | |
| A28 | 1 | Valve, Check | 2 in., Swing-type | Wm. Powell Co. Fig. 70-597 | 10427339 | |
| A29 | | | | | | |
| A30 | 1 | Valve, Check | 6 in., Swing-type | Wm. Powell Co. PN 026178 | 10427332 | |
| A31 | 1 | Valve, Pneumatic | 6 in., Ball-type | Hydromatics Inc. Model A132S5 | 10427325 | |
| A32 | | | | | | |
| A33 | | | | | | |
| A34 | 1 | Valve, Pneumatic | 2 in., Ball-type | Hydromatics Inc. Model A132K4 | 10427346 | |
| A35 through A42 are not functionally applicable to this system. | | | | | | |
| A43 | 1 | Valve, Relief | 300 psi Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A44 | 1 | Valve, Relief | 300 psi Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |
| A45 | 1 | Valve, Check | 4 in., 300 psig | Wm. Powell Co. PN 026178 | 10427322 | |
| A46 | | | | | | |
| A47 | 1 | Valve, Relief | 300 psi Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |
| A48 | | | | | | |
| A49 | | | | | | |
| A50 | | | | | | |
| A51 | | | | | | |
| A52 | 1 | Valve, Pneumatic | 3 in., Ball-type | Hydromatics Inc. Model A132M7 | 10427347 | |
| A53 | | | | | | |
| A54 | | | | | | |
| A55 | 1 | Valve, Pneumatic | 25 psig Supply Pressure 3-15 psig Signal Pressure, 2 in. | Annin Company Model 1560 W/Domotor Control | 10427336 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A56 | | | | | | |
| A57 | | | | | | |
| A58 | 1 | Controller, Pneumatic | 25 psig $GN_2$ inlet<br>3-15 psig $GN_2$ outlet | Servomechanisms, Inc.<br>PN 812089 | 10434805 | 53A35A3 |
| A59 | | | | | | |
| A60 | | | | | | |
| A61 | 1 | Valve, Pneumatic | 3 in., Ball-type | Hydromatics Inc.<br>Model A132M7 | 10427347 | |
| A62 through A65 are not functionally applicable to this system. | | | | | | |
| A66 | 1 | Valve, Manual | Shutoff<br>3 in. | Wm. Powell Co.<br>PN B-50700 | 10427341 | |
| A67 | 1 | Valve, Manual | Shutoff<br>3 in. | Wm. Powell Co.<br>PN B-50700 | 10427341 | |
| A68 | 1 | Valve, Manual | 1 in. | Wm. Powell Co.<br>PN D-49008 | 10427343 | |
| A69 | 1 | Valve, Manual | 1 in. | Wm. Powell Co.<br>PN D-49008 | 10427343 | |
| A70 | 1 | Valve, Manual | 1 in. | Wm. Powell Co.<br>PN D-39844 | 10427342 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A71 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-39844 | 10427342 | |
| A72 | | | | | | |
| A73 | 1 | Valve, Manual | 6 in. | Wm. Powell Co. PN 027209 | 10427453 | |
| A74 | | | | | | |
| A75 | 1 | Valve, Manual | 3 in. | Wm. Powell Co. PN 027201 | 10427340 | |
| A76 | 1 | Valve, Check | 4 in., Swing-type | Wm. Powell Co. PN 026178 | 10427322 | |
| A77 | | | | | | |
| A78 | 1 | Valve, Check | 4 in., Swing-type | Wm. Powell Co. PN 026178 | 10427322 | |
| A79 | 1 | Valve, Check | 6 in., Swing-type | Wm. Powell Co. PN 026178 | 10427332 | |
| A80 | 1 | Valve, Relief | 75 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427326 | |
| A81 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A82 | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A83 | 1 | Computer, LOX Tanking | | | 10434613 | 54A8A5 |
| A84 | 1 | Valve, Relief | 300 psig Relief, 1 in. | | Part of 10427331 | |
| A85 | 1 | Valve, Check | 2 in. | Wm. Powell Co. Fig. 70-597 | 10427339 | |
| A86 | | | | | | |
| A87 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |
| A88 | 1 | Valve, Relief | 75 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427326 | |
| A89 | 1 | Valve, Relief | 75 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427326 | |
| A90 | 1 | Valve, Relief | 75 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427326 | |
| A91 | 1 | Valve, Manual | Shutoff, Gate-type, 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |
| A92 | 1 | Valve, Relief | 75 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427326 | |
| A93 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |
| A94 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A95 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |
| A96 | 1 | Valve, Check | 2 in., Swing-type | Wm. Powell Co. Fig. 70-597 | 10427339 | |
| A97 | | | | | | |
| A98 | 1 | Valve, Relief | 300 psig Relief, 1-1/2 in. | Ladewig Valve Co. PN 11160-C | 10427327 | |
| A99 | 1 | Strainer | 2500 gpm, 8 in., 150 Micron | Leslie Company | 10427337 | |
| A100 | 1 | Strainer | 1000 gpm, 6 in., 150 Micron | Leslie Company | 10427323 | |
| A101 | | | | | | |
| A102 | 1 | Strainer | 500 gpm, 3 in., 150 Micron | Leslie Company | 10427334 | |
| A103 | | | | | | |
| A104 | 1 | Strainer | 150 Micron 6-in., 5 psig $\Delta P$ | | 10427323 | |
| A105 | 1 | Pump and Motor | Motor: 350 HP @ 3560 RPM Pump: 2500 gpm, 3 Ph, 60 cps, 440V | Byron-Jackson Pump Inc. MOD 6x8x11DSM(HAC)LOX | 10427328 | 51B1 |
| A106 | 1 | Pump and Motor | Motor: 200 HP 1000 gpm | Byron-Jackson Pump Inc., Type SMI-LOX 4x6x12 1/2 HH | 10427329 | 51B2 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A107 | | | | | | |
| A108 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A109 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A110 | 1 | Valve, Relief | 300 psig Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |
| A111 | | | | | | |
| A112 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A113 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A114 | 1 | Valve, Check | 2 in. | Wm. Powell Co. Fig. 70-597(F.E.) | 10427339 | |
| A115 | 1 | Valve, Check | 6 in. | Wm. Powell Co. PN 026178 | 10427332 | |
| A116 | 1 | Valve, Manual | 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |
| A117 | 1 | Valve, Manual | 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |
| A118 | 1 | Valve, Manual | 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A119 | 1 | Valve, Manual | 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |
| A120 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A121 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A122 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A123 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A124 | 1 | Coupling-Half Assembly | 3 in. | Futurecraft Corp. PN 550043-30-002 | 10427401 | |
| A125 | 1 | Strainer | 500 gpm, 4 in., 150 Micron | Leslie Co. | 10427338 | |
| A126 | 1 | Strainer | 1000 gpm, 6 in., 150 Micron | Leslie Co. | 10427323 | |
| A127 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A128 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A129 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A130 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A131 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A132 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A133 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-49008 | 10427343 | |
| A134 | | | | | | |
| A135 | | | | | | |
| A136 | 1 | Valve, Pneumatic | 1 in. | Hydromatics Inc. Model A132F1 | 10427345 | |
| A137 | | | | | | |
| A138 | | | | | | |
| A139 | 1 | Valve, Relief | 300 psig Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |
| A140 | 1 | Valve, Relief | 300 psig Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |
| A141 | 1 | Valve, Relief | 300 psig Relief, 1½ in. | Gardner Johnson & Co. PN 1192 | 10427327 | |
| A142 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A143 | 1 | Valve, Pneumatic | 2 in. | Hydromatics Inc. Model A132K4 | 10427346 | |
| A144 | | | | | | |
| A145 | | | | | | |
| A146 | 1 | Valve, Relief | 1 in., 300 psig | | Part of 10427331 | |
| A147 | 1 | Valve, Relief | 1 in., 300 psig | | Part of 10427331 | |
| A148 | 1 | Valve, Pneumatic | 4 in., 300 psig | | 10427324 | |
| A149 | 1 | Valve, Pneumatic | 3 in., 300 psig | Hydromatics Inc. Model A132M7 | 10427347 | |
| A150 | 1 | Valve, Check | 300 psig 4-in., Swing-type | | 10427322 | |
| A151 through A199 are not functionally applicable to this system. | | | | | | |
| A200 | 1 | Tank, Replenish | 28,000 Gallons | | 10427472 | |
| A201 | 1 | Valve, Pneumatic | 3 in., Ball-type | Hydromatics Inc. Model A132M7 | 10427347 | |
| A202 | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A203 | | | | | | |
| A204 | | | | | | |
| A205 | 1 | Vaporizer Assembly | | | 10427318 | |
| A206 | 1 | Valve, Flow Control | 3-15 psig Signal, 25 psig Supply, 2 in. | The Annin Co. Model 1660 | 10427335 | |
| A207 | | | | | | |
| A208 | | | | | | |
| A209 | | | | | | |
| A210 | 1 | Valve, Manual | 3 in. | | Part of 10427472 | |
| A211 | 1 | Valve, Manual | 4 in. | | Part of 10427472 | |
| A212 | 1 | Gage, Liquid Level | 0-29500 Gallons | Barton Instrument Co. Model 200-D.P. Type | 10427563 | |
| A213 | 1 | Gage, Pressure | 6 in., 0-300 psig | U. S. Gauge PN 5003 | 10427566 | |
| A214 | 1 | Manifold | GOX | | 10427561-20 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A215 | | | | | | |
| A216 | 1 | Valve, Manual | Shutoff ½ in. | Wm. Powell Co. PN D-39842 | 10427568 | |
| A217 | 1 | Gage, Vacuum | 0-1000 Microns Hg | Consolidated Vacuum Corp., PN TG-025 | 10427567 | |
| A218 | 1 | Valve, Manual | Shutoff, 2 in. | Vacuum Research Co. | Part of 10427472 | |
| A219 | 1 | Valve, Manual | Shutoff | | Part of 10427472 | |
| A220 | 1 | Valve, Manual | Shutoff, 4 in. | | 75M05969 | |
| A221 | 1 | Valve, Relief | Cracks @ 205 psig Inlet 3 in., Outlet 4 in. | | Part of 10427472 | |
| A222 | 1 | Disc, Burst | | | Part of 10427472 | |
| A223 | 1 | Valve, Manual | 3 in. | Wm. Powell Co. PN 027201 | 10427340 | |
| A224 | 1 | Valve, Manual | Bypass 3 in. | Wm. Powell Co. PN 027201 | 10427340 | |
| A225 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |
| A226 | 1 | Valve, Relief | 300 psig Relief, 1 in. | Ladewig Valve Co. PN 1178-C | 10427320 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A227 | 1 | Valve, Manual | 6 in. | | Part of 10427472 | |
| A228 | 1 | Valve, Manual | | | Part of 10427472 | |
| A229 | 1 | Filter | | | Part of 10427472 | |
| A230 | 1 | Valve, Manual | 1 in. | Wm. Powell Co. PN D-39844 | 10427342 | |
| A231 | 1 | Valve, Pneumatic | 6 in., Butterfly-type | | 75M06583 | |
| A232 | | | | | | |
| A233 | | | | | | |
| A234 | | | | | | |
| A235 | 1 | Controller, Pressure, Pneumatic | Output 3-15 psig<br>Supply 25 psig<br>Sensing 0-300 psig | Mason-Neilan Model 2704 | 10427402 | |
| A236 | | | | | | |
| A237 | 1 | Valve, Relief | 2.3 psig Relief | | Part of 10427472 | |
| A238 | 1 | Valve, Relief | 3/4 in., Cracks @ 2 psig | | Part of 10427472 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A239 through A299 are not functionally applicable to this system. | | | | | | |
| A300 | 1 | Tank, LOX Storage | 125000 Gallons | | 10427471 | |
| A301 | 1 | Valve, Pneumatic | 3 in. | Hydromatics Inc. Model A132M7 | 10427347 | |
| A302 | | | | | | |
| A303 | | | | | | |
| A304 | | | | | | |
| A305 | 1 | Vaporizer Assembly | | | 10427318 | |
| A306 | 1 | Valve, Flow-Control | Supply 25 psig, Signal 3-15 psig, 2 in. | The Annin Co. PN 28265 | 10427335 | |
| A307 | 1 | Valve, Manual | Shutoff 8 in. | Wm. Powell Co. PN 027088 | Part of 10427471 | |
| A308 | 1 | Valve, Manual | Shutoff 6 in. | Wm. Powell Co. PN B-40084 | Part of 10427471 | |
| A309 | 1 | Valve, Manual | Shutoff 6 in. | Wm. Powell Co. PN B-40084 | Part of 10427471 | |
| A310 | 1 | Valve, Manual | Shutoff 6 in. | Wm. Powell Co. PN B-40084 | Part of 10427471 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A311 | 1 | Valve, Gate, Manual | 1 in. Trycock | Wm. Powell Co. PN D-49008 | 10427343 | |
| A312 | 1 | Gage, Liquid-Level | 0-140000 Gallons | Barton Instrument Corp. Model 200-D.P. Type | 10427564 | |
| A313 | 1 | Gage, Pressure | 0-100 psig | U.S. Gauge Co. PN 5003 | 10427565 | |
| A314 | 1 | Manifold | GOX | | 10427560-20 | |
| A315 | | | | | | |
| A316 | 1 | Valve, Manual | Shutoff ½ in. | Wm. Powell Co. PN D-39842 | 10427568 | |
| A317 | 1 | Valve, Relief | Cracks @ 45 psig | J. E. Lonergan Co. Model 41W209M | Part of 10427471 | |
| A318 | 1 | Disc, Burst | Bursts at 50 psig | | Part of 10427471 | |
| A319 | 1 | Valve, Manual | Bypass 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |
| A320 | 1 | Valve, Manual | Bypass 3 in. | Wm. Powell Co. PN B-50700 | 10427341 | |
| A321 | 1 | Valve, Relief | 1 in., Cracks @ 75 psig | Gardner Johnson Co. PN 1191 | 10427326 | |
| A322 | 1 | Valve, Relief | 1 in., Cracks @ 75 psig | Gardner Johnson Co. PN 1191 | 10427326 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A323 | 1 | Valve, Manual | Shutoff, 4 in. | | Part of 10427471 | |
| A324 | | | | | | |
| A325 | | | | | | |
| A326 | | | | | | |
| A327 | 1 | Valve, Manual | 6 in. | | Part of 10427471 | |
| A328 | 1 | Controller, Pressure Pneumatic | Output 3-15 psig<br>Supply 25 psig<br>Sensing 0-40 psig | Mason-Neilan Model 2707 | 10427403 | |
| A329 | | | | | | |
| A330 | | | | | | |
| A331 | 1 | Regulator, Manual | Inlet 50 psig, $GN_2$<br>Outlet 2.0 psig | | Part of 10427471 | |
| A332 | 1 | Valve, Check | 1-1/2 psig<br>$GN_2$ | Wm. Powell Co. | Part of 10427471 | |
| A333 | 1 | Valve, Manual | Shutoff, $GN_2$ | Air Reduction Co. PN 8110 | Part of 10427471 | |
| A334 | 1 | Valve, Manual | Shutoff, $GN_2$ | Air Reduction Co. PN 8110 | Part of 10427471 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A335 | 1 | Regulator, Preset | Inlet 2000 psig, $GN_2$<br>Outlet 50 psig | | Part of 10427471 | |
| A336 | 1 | Regulator, Preset | Inlet 2000 psig, $GN_2$<br>Outlet 50 psig | | Part of 10427471 | |
| A337 | 1 | Gage, Pressure | | | Part of 10427471 | |
| A338 | 1 | Gage, Pressure | | | Part of 10427471 | |
| A339 | 1 | Cylinder, Storage | $GN_2$<br>222 cu. ft. @ 2000 psig | | Part of 10427471 | |
| A340 | 1 | Cylinder, Storage | $GN_2$<br>222 cu. ft. @ 2000 psig | | Part of 10427471 | |
| A341 | | | | | | |
| A342 | 1 | Valve, Relief, Vacuum and Pressure | 6 in. | Oceco Model T | Part of 10427471 | |
| A343 | | | | | | |
| A344 | 1 | Gage, Compound | 0 to 15 psig,<br>0 to 30 in. Hg Vacuum | Acco Helicoid | Part of 10427471 | |
| A345 through A429 are not functionally applicable to this system. | | | | | | |
| A430 | 1 | Coupling Assembly | Bellows-type | | 75M03191 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A431 | | | | | | |
| A432 | | | | | | |
| A433 | | | | | | |
| A434 | | | | | | |
| A435 | 1 | Switch, Pressure | Actuates @ 160 psig | | 10465302 | 51A11S1 |
| A436 | 1 | Switch, Pressure | Actuates @ 150 psig | | 10430024 | 51A11S4 |
| A437 | 1 | Transducer, Pressure | | | 10465306 | 51A11MT1 |
| A438 | 1 | Transducer, Differential Pressure | | | 10465305 | 51A11MT2 |
| A439 | | | | | | |
| A440 | | | | | | |
| A441 | 1 | Transducer, Differential Pressure | 0-8 psid | | 10465305 | 51A12MT2 |
| A442 | 1 | Switch, Pressure | Actuates @ 160 psig | | 10430024 | 51A12S2 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A443 | 1 | Transducer, Pressure | 0-300 psig | | 10465306 | 51A12MT1 |
| A444 | | | | | | |
| A445 | | | | | | |
| A446 | | | | | | |
| A447 | 1 | Switch, Pressure | Actuates @ 30 psig | | 10465306 | 51A11S3 |
| A448 | 1 | Switch, Pressure | Actuates @ 20 psig | | 10465301 | 51A11S2 |
| A449 | 1 | Switch, Pressure | Actuates @ 190 psig | | 10465303 | 51A12S1 |
| A450 through A2699 are not functionally applicable to this system. | | | | | | |
| A2700 | 1 | Gage, Pressure | 0-10,000 psig | U. S. Gauge Co. | 10437648 | |
| A2701 | 1 | Gage, Pressure | 0-1500 psig | U. S. Gauge Co. | 10437688 | |
| A2702 | 1 | Gage, Pressure | 0-300 psig | U. S. Gauge Co. | 10437687 | |
| A2703 | 1 | Gage, Pressure | 0-60 psig | U. S. Gauge Co. | 10437686 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A2704 | 1 | Regulator, Pressure | Presets, 3000 - 750 psi, 3/8 in. | Grove Valve & Reg. Co. Model 94X | 10437651 | |
| A2705 | 1 | Regulator, Pressure | Presets, 750 - 120 psi, 3/8 in. | Grove Valve & Reg. Co. Model 94X | 10437651 | |
| A2706 | 1 | Regulator, Pressure | Manual 120 - 25 psig | Moore Products Co. Model 42H50 | 10437679 | |
| A2707 | 1 | Filter, Pneumatic | 30 Micron | Permanent Filter Corp. PN 10813-10/30 | 10437650 | |
| A2708 | 1 | Valve, Relief | 900 ± 50 psig Relief, 750 psig min. Reseat | Republic Mfg. Co. PN 625B-9-6 | 10437652 | |
| A2709 | 1 | Valve, Relief | 120 ±10 psig Relief, 100 psig min. Reseat | Republic Mfg. Co. PN 625B-3-6 | 10437680 | |
| A2710 | 1 | Valve, Relief | 35 ±5 psig Relief, 25 psig min. Reseat | Republic Mfg. Co. PN 625B-2-8 | 10437681 | |
| A2711 | 1 | Switch, Pressure | Actuates 21.5 ± .5 psig Deactuates 20 psig | Southwestern Ind. PN PS-3700A-4 | 10437682 | 51A2S3 |
| A2712 | 1 | Valve, Manual | Shutoff | Robbins Aviation PN SSNA-375A-6T | 10437684 | |
| A2713 | 1 | Valve, Manual | Shutoff | Robbins Aviation PN SSNA-375A-6T | 10437684 | |
| A2714 | 1 | Valve, Manual | Shutoff | Robbins Aviation PN SSNA-375A-6T | 10437684 | |
| A2715 | 1 | Valve, Manual | Shutoff | Robbins Aviation PN SSNA-375A-6T | 10437684 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A2716 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2717 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2718 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2719 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2720 | 1 | Valve, Manual | Shutoff, Button-Operated Poppet | Robbins Aviation PN SSNA-375A-6T | 10437684 | |
| A2721 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2722 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2723 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2724 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2725 | 1 | Switch, Pressure | Actuates 600 $\pm$ 20 psig<br>Deactuates 550 psig | Southwestern Industries PN PS-5100A | 10437683 | 51A2S2 |
| A2726 | 1 | Valve, Manual | Shutoff | Robbins Aviation PN SSNA-250-4T | 10437685 | |
| A2727 | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A2728 | | | | | | |
| A2729 | | | | | | |
| A2730 | 1 | Valve, Manual | Vent, Button-Operated Poppet | Futurecraft Corp. PN 30205 | 10437647 | |
| A2731 | | | | | | |
| A2732 | | | | | | |
| A2733 | | | | | | |
| A2734 | 1 | Orifice | 0.059 in. Dia. | A.U. Stone & Co. Inc. | 10430177 | |
| A2735 | 1 | Valve, Relief | 55 ± 5 psig Relief, 45 psig Min. Reseat | Republic Mfg. Co. PN 6258-3-8 | 10430169 | |
| A2736 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A13 |
| A2737 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A14 |
| A2738 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A17 |
| A2739 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A16 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A2740 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A31 |
| A2741 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A32 |
| A2742 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A35 |
| A2743 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A34 |
| A2744 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A29 |
| A2745 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A28 |
| A2746 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A19 |
| A2747 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A20 |
| A2748 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A22 |
| A2749 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A23 |
| A2750 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A26 |
| A2751 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A25 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A2752 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A37 |
| A2753 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A38 |
| A2754 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A41 |
| A2755 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A40 |
| A2756 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A47 |
| A2757 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A46 |
| A2758 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A43 |
| A2759 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 51A44 |
| A2760 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A7 |
| A2761 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A8 |
| A2762 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A9 |
| A2763 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A10 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A2764 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A16 |
| A2765 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A15 |
| A2766 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A12 |
| A2767 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A13 |
| A2768 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 53A35A2 |
| A2769 | 1 | Orifice | 10-12 SCFH Flowrate @ 20.7 psig | A.U. Stone Co. PN P-881-3 | 10428514 | |
| A2770 | 1 | Orifice | 10-12 SCFH Flowrate @ 20.7 psig | A.U. Stone Co. PN P-881-3 | 10428514 | |
| A2771 | 1 | Valve, Manual | Shutoff, 3000 psig $GN_2$, ½ in. | Robbins Aviation Model SSNG 500A-8T | 10428576 | |
| A2772 through A2780 are not functionally applicable to this system. | | | | | | |
| A2781 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Mod. MV-74 | 10437618 | 51A49 |
| A2782 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Mod. MV-74 | 10437618 | 51A50 |
| A2783 through A3150 are not functionally applicable to this system. | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A3151 | 1 | Valve, Electropneumatic | 3-in. | B. H. Hadley Inc. PN 11409-1 | 75M05605 | 57A12A21 |
| A3152 through A3159 are not functionally applicable to this system. | | | | | | |
| A3160 | 1 | Coupling Assembly | Bellows-type | | 75M04852 | |
| A3161 through A3164 are not functionally applicable to this system. | | | | | | |
| A3165 | 1 | Valve, Check | | Douglas Aircraft PN 3871261-501 | | |
| A3166 through A3168 are not functionally applicable to this system. | | | | | | |
| A3169 | 1 | Orifice-Fitting | 0.040 and 0.125 ± .010 in. I.D. | | 75M06686-1 | |
| A3170 | 1 | Orifice-Fitting | 0.015 and 0.125 ± .010 in. I.D. | | 75M06686-2 | |
| A3171 | 1 | Orifice-Union | 0.020 in. ID | | 75M06713-1 | |
| A3172 | 1 | Switch, Pressure | 50-250 psig | Custom Components Switches Inc. PN 603G3*S MOD | 75M06690 | 57A12A23 |
| A3173 through A3999 are not functionally applicable to this system. | | | | | | |
| A4000 | 1 | LOX Main Fill and Topping Control Assy. | Sled-mounted | Douglas Aircraft PN 7864564-501 | | 429 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A4001 | | | | | | |
| A4002 | 1 | Transducer, Pressure | LOX, 0-150 psia | Giannini PN 4512715-15 | | 429PT10 |
| A4003 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 3000A1 |
| A4004 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 3000A2 |
| A4005 | 1 | Valve, Pneumatic | Y-type, 4-in. 1000 gpm LOX | Pacific Valves Inc. PN 13648-EO | | |
| A4006 | 1 | Valve, Solenoid | 4-way, 2-position | Southwestern Valve Corp PN 804934-1-2 | | 429NS15 |
| A4007 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 3000A5 |
| A4008 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 202873-113 Model MV-74 | 10437618 | 3000A4 |
| A4009 | | | | | | |
| A4010 | | | | | | |
| A4011 | 1 | Filter | LOX | Westward Engr & Fab.Co. PN 25041 | | |
| A4012 through A4017 are not functionally applicable to this system. | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A4018 | 1 | Transducer, Pressure | LOX, 0-150 psia | Giannini PN 4512715-15 | | 429PT11 |
| A4019 | | | | | | |
| A4020 | | | | | | |
| A4021 | 1 | Valve, Pneumatic | Y-type, 2 in., 100 gpm | Pacific Valves Inc. PN 13647-FO | | |
| A4022 | 1 | Valve, Solenoid | 4-way, 2-position | Southwestern Valve Corp., PN 804934-1-2 | | 429NS17 |
| A4023 | 1 | Valve, Pneumatic | Y-type, 2 in. Drain | Pacific Valves Inc. PN 13647-FO | | |
| A4024 | 1 | Valve, Solenoid | 4-way, 2-position | Southwestern Valve Corp., PN 804934-1-2 | | 429NS16 |
| A4025 | 1 | Valve, Relief | | Douglas Aircraft PN 3864299-1 | | |
| A4026 | | | | | | |
| A4027 | 1 | Valve, Check | | Douglas Aircraft PN 7721093-1 | LC-1 | |
| A4028 | | | | | | |
| A4029 | 1 | Switch, Pressure | Actuates @ 720 psig Deactuates @ 650 psig | Custom Component Switches PN 695-E-24 | | 429PJ1 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A4030 | 2 | Valve, Relief | | James, Pond & Clark PN D559T-2M-4 | | |
| A4031 | 1 | Restrictor | | Douglas Aircraft PN DR4-0.5 | | |
| A4032 through A4599 are not functionally applicable to this system. | | | | | | |
| A4600 | 1 | Retractable Coupling Assembly | Bellows-type | Flexonics Inc. PN 107435 | 75M00253 | |
| A4601 through A5606 are not functionally applicable to this system. | | | | | | |
| A5607 | 1 | Valve, Solenoid | 2-way, 2-position 325 psig $GN_2$ | Marotta Valve Corp. PN 212783-1 | 10437739 | 53A67 |
| A5608 through A5615 are not functionally applicable to this system. | | | | | | |
| A5616 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 204424 | 10425701 | 53A26 |
| A5617 | | | | | | |
| A5618 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 204424 | 10425701 | 53A71 |
| A5619 through A6027 are not functionally applicable to this system. | | | | | | |
| A6028 | 1 | Valve, Solenoid | With Manual Override, 2-way, 2-position | Marotta Valve Corp. PN 218914 | 75M02802 | 53A69 |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A6029 | 1 | Valve, Solenoid | With Manual Override, 2-way, 2-position bypass | Marotta Valve Corp. PN 218914 | 75M02802 | 53A70 |
| A6030 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 204424 | 10425701 | |
| A6031 | 1 | Switch, Pressure | Actuates @ 100 psig Deactuates @ 50 psig | Meletron PN M7141EB-32A-2 | 75M50728-1 | |
| A6032 through A6067 are not functionally applicable to this system. | | | | | | |
| A6068 | 1 | Orifice | | A. U. Stone PN H264C-114 | 75M50184-2 | |
| A6069 | 1 | Orifice | Bypass | A. U. Stone PN H-264C-310 | 75M50184-3 | |
| A6070 | 1 | Orifice | | W. O. Leonard PN 156040-5 | 75M50727-2 | |
| A6071 | 1 | Orifice | | A. U. Stone PN P-881-8 | 75M04165-8 | |
| A6072 through A6507 are not functionally applicable to this system. | | | | | | |
| A6508 | 1 | Socket, Quick-Disconnect | 3000 psig | Wiggins PN 6400R107A16 | 75M02214 | |
| A6509 through A6600 are not functionally applicable to this system. | | | | | | |
| A6601 | 1 | Socket, Quick-Disconnect | 750 psig $GN_2$ | Wiggins PN 6300R109A4 | 75M02210 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| A6602 | 1 | Socket, Quick-Disconnect | 100 psig | Wiggins PN 6200R78A4 | 75M02212 | |
| A6603 | | | | | | |
| A6604 | 1 | Socket, Quick-Disconnect | 750 psig $GN_2$ | Wiggins PN 6300R109A4 | 75M02210 | |
| A6605 | 1 | Socket, Quick-Disconnect | 100 psig | Wiggins PN 6200R78A4 | 75M02212 | |
| A6606 through A6609 are not functionally applicable to this system. | | | | | | |
| A6610 | 1 | Socket, Quick-Disconnect | 1/2 in., 325 psig $GN_2$ | Wiggins PN 6200R72A8 | 75M02207 | |
| A6611 through B149 are not functionally applicable to this system. | | | | | | |
| B150 | 1 | Coupling-Half | LOX Replenishing | | 20M30050 | |
| B151 | 1 | Valve, Pneumatic | Ball-type | Hydromatics Inc. PN 131K13B | 20M30045 | |
| B152 | 1 | Valve, Pneumatic | Shutoff, Ball-type | Parker Aircraft Co. PN F61C0017 | 20M30042 | |
| B153 | 1 | Nozzle Assembly | LOX Fill | | 20M30202 | |
| B154 | 1 | Nipple, Quick-Disconnect | 1/4 in., 750 psig $GN_2$ | E. B. Wiggins PN 6105R109A4 | 20M30390 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| B155 | 1 | Valve, Pneumatic | Ball-type | Parker Aircraft Co. PN F61C0017M1 | 20M30042 | |
| B156 | 1 | Nipple, Quick-Disconnect | 1/4 in. | E. B. Wiggins PN 6005R78A4 | 20M30138 | |
| B157 | 1 | Nipple, Quick-Disconnect | 1/4 in. | E. B. Wiggins PN 6005R78A4 | 20M30138 | |
| B158 | 1 | Valve, Needle, Three-way | Calibration Valve | Benton Corp. PN 15600 | 60C27526 | |
| B159 | 1 | Switch, Pressure, Differential | Actuation 22.5 ± .45 psid | Servomechanisms Inc. PN 816105, Type TR2124 | 20M30144 | 9A21 |
| B160 | 1 | Nipple, Quick-Disconnect | 1/4 in. | E. B. Wiggins PN 6105R109A4 | 20M30390 | |
| B161 | | | | | | |
| B162-1 | 1 | Valve, Pneumatic | Vent and Relief Relieves @ 57 +5 -0 psig | | 20M30460 | |
| B162-2 | 1 | Valve, Pneumatic | Vent and Relief Relieves @ 57 +5 -0 psig | | 20M30460 | |
| B163 | 1 | Valve, Pneumatic | Vent Gate-type | North American Aviation PN 9512-48410-61 | 20M30122 | |
| B164 | 8 | Valve, Check | | Precision Equipment Co. PN 126060-2 | 20M30046 | |
| B165 | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| B166 | 1 | Switch, Pressure | Actuates @ 67.5 ±.5 psia<br>Deactuates @ 64.0 psia min. | Southwestern Ind. Inc.<br>PN PS-5704-68 | 60C27761 | 11A57 |
| B167 | 1 | Switch, Pressure | Actuates @ 60 ±.5 psia<br>Deactuates @ 56.5 psia min. | Southwestern Ind. Inc.<br>PN PS-5704-60 | 60C27760 | 11A59 |
| B168 | 1 | Valve, Needle, Three-way | Calibration | Benton Corp.<br>PN 17500 | 60C27547 | |
| B169 | 2 | Orifice-Union Assembly | | | 20M30033 | |
| B170 | 1 | Valve, Butterfly | Fully closed, 17.6 lb/sec<br>Fully open, 22.4 lb/sec | Parker Aircraft Co.<br>PN 5630089 | 60C27835 | |
| B171 through B214 are not functionally applicable to this system. | | | | | | |
| B215 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp.<br>PN 218263 | 20M30128 | 11A55 |
| B216 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp.<br>PN 218263 | 20M30128 | 9A17 |
| B217 through B221 are not functionally applicable to this system. | | | | | | |
| B222 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp.<br>PN 218263 | 20M30128 | 11A53 |
| B223 through B384 are not functionally applicable to this system. | | | | | | |
| B385 | 1 | Nipple, Quick-Disconnect | 1 in., He | E. B. Wiggins<br>PN 6005R92A16 | 20M30165 | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| B386 | | | | | | |
| B387 | 1 | Check Valve Assembly | 1 in., He | James, Pond & Clark PN P220T-16BB(L) | 20M30379 | |
| B388 through B449 are not functionally applicable to this system. | | | | | | |
| B450 | 1 | Nipple, Quick-Disconnect | 1/2 in., He | E. B. Wiggins PN 6005R70A8 | 20M30141 | |
| B451 | 8 | Orifice | .102 Dia, He | | 20M30199 | |
| B452 through E149 are not functionally applicable to this system. | | | | | | |
| E150 | 1 | Quick Disconnect Nipple Assembly | | Douglas Aircraft PN 1A84828-1 | | |
| E151 | 1 | Valve, Pneumatic | | B. H. Hadley PN 11084-11 | | 407A15 |
| E152 | 1 | Container, LOX | 1263 $ft^3$ 45-48 psia ullage | Douglas Aircraft PN 5863804-507 | | |
| E153 | 1 | Valve, Pneumatic | No. 1 Vent and Relief Cracks @ 50 psia Reseats @ 47 psia | Calmec Mfg Corp. PN 230-501 | | 407A11 |
| E154 | 1 | Valve, Pneumatic | No. 2 Vent and Relief Crack 50 psia Reseat 47 psia | Calmec Mfg. Corp. PN 230-501 | | 407A12 |
| E155 | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| E156 | 1 | Sensor, LOX | | Minneapolis Honeywell PN FG359B-1 | | 408A1 |
| E157 through E161 are not functionally applicable to this system. | | | | | | |
| E162 | 1 | Switch, Thermal | Actuates @ 298 ± 15°F<br>Deactuates @ 258 ± 15°F | Douglas Aircraft PN 1A65853-1 | | 407A23 |
| E163 | 1 | Orifice | .093 in. Dia. | Douglas Aircraft PN S0268-C6-093 | | |
| E164 | | | | | | |
| E165 | | | | | | |
| E166 | 1 | Valve, Solenoid | | Douglas Aircraft PN 7851845-511 | | 407L13 |
| E167 | 1 | Valve, Solenoid | | Douglas Aircraft PN 7851845-511 | | 407L14 |
| E168 | 1 | Filter | 10 Micron | Douglas Aircraft PN 7851840-1 | | |
| E169 | 1 | Orifice | .031 in. Dia. | Douglas Aircraft PN S0268-C6-031 | | |
| E170 | 1 | Switch, Pressure | Pickup 320 ± 10 psia<br>Dropout 115 ± 15 psia | Frebank Co. PN 4940-1 | | 407S12 |
| E171 | 6 | Valve, Check | | W. M. Lanagan Co. PN 90048 | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| E172 | 6 | Orifice | .031 in. dia. | Douglas Aircraft PN S0268-C4-031 | | |
| E173 through E211 are not functionally applicable to this system. | | | | | | |
| E212 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L9 |
| E213 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L10 |
| E214 | 1 | Valve, Solenoid | 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L8 |
| E215 | 1 | Valve, Pneumatic | He | Clary Dynamics PN 524122 | | 407A8 |
| E216 | 1 | Valve, Pneumatic | He | Clary Dynamics PN 524122 | | 407A7 |
| E217 through E224 are not functionally applicable to this system. | | | | | | |
| E225 | 1 | Coupling-Half, Quick-Disconnect | 3000 ± 100 psig He | Douglas Aircraft PN 1A84439-1 | | |
| E226 | 1 | Valve, Check | | W. M. Lanagan Co. PN 90065 | | |
| E227 | 1 | Valve, Check | | W. M. Lanagan Co. PN 90065 | | |
| E228 | 1 | Filter | | Aircraft Porous Media Co., AC 4289-61 | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| E229 | 1 | Regulator, Pressure | Inlet 3000 psig He<br>Outlet 250 psig He | B. H. Hadley<br>PN 11089-3 | | |
| E230 | 1 | Filter | | Aircraft Porous Media Co., PN AC 4289-61 | | |
| E231 | 1 | Valve, Relief | | Sterer Engineering Co.<br>PN 20500 | | |
| E232 | 1 | Valve, Solenoid | | Douglas Aircraft<br>PN 7851845-511 | | 407L5 |
| E233 | 1 | Sphere | 3.5 Cu. Ft., 3000 psig He | Douglas Aircraft<br>PN 7851834-501 | | |
| E234 | 1 | Sphere | 3.5 Cu. Ft., 3000 psig He | Douglas Aircraft<br>PN 7851834-501 | | |
| E235 | 1 | Sphere | 3.5 Cu. Ft., 3000 psig He | Douglas Aircraft<br>PN 7851834-501 | | |
| E236 | 1 | Valve, Solenoid | Pilot-operated | Douglas Aircraft<br>PN 7851845-509 | | 407L6 |
| E237 | 1 | Switch, Pressure | Pickup 320 $\pm$ 10 psia<br>Dropout 115 $\pm$ 15 psia | Frebank Co.<br>PN 4940-1 | | 407S3 |
| E238 | 1 | Valve, Solenoid | Pilot-operated | Douglas Aircraft<br>PN 7851845-509 | | 407L7 |
| E239 | 1 | Orifice | 0.250 in. Dia. | Douglas Aircraft<br>PN 4851838-C8-250 | | |
| E240 | 1 | Orifice | 0.375 in. Dia. | Douglas Aircraft<br>PN S4851838D12-375 | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| E241 | 1 | Helium Heater Assembly | | Douglas Aircraft PN 5851759-503 | | |
| E242 | | | | | | |
| E243 | 1 | Chamber, Plenum | | Tavco Inc. PN 23711496 | | |
| E244 | 2 | Igniter | | General Lab Associates Part of 30104E | | |
| E245 | 1 | Switch, Pressure | Pickup 2940 ± 25 psia Dropout 2840 ± 25 psia | Frebank Co. PN 8008-1 | | 407S9 |
| E246 | 1 | Switch, Thermal | Actuates @ 110 ± 10°F | Giannini Controls PN 49849 | | 407A22 |
| E247 through E279 are not functionally applicable to this system. | | | | | | |
| E280 | 1 | Switch, Pressure | Pickup 52.0 ± 1.0 psia Dropout 50.0 ± 1.0 psia | Frebank Co. PN 8015-6 | | 407S8 |
| E281 | 1 | Switch, Pressure | Pickup 44.0 ± 1.0 psia Dropout 42.0 ± 1.0 psia | Frebank Co. PN 8015-4 | | 407S6 |
| E282 | | | | | | |
| E283 | 1 | Switch, Pressure | Pickup 47.0 ± 1.0 psia Dropout 45.0 ± 1.0 psia | Frebank Co. PN 4586-1 | | 407S2 |
| E284 through E316 are not functionally applicable to this system. | | | | | | |

| FINDING NUMBER | NO. REQD | COMPONENT | REMARKS | VENDOR | DRAWING NUMBER | ELEC SYM |
|---|---|---|---|---|---|---|
| E317 | 1 | Valve, Solenoid | He, 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L18 |
| E318 | 1 | Valve, Solenoid | He, 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L19 |
| E319 | 1 | Valve, Solenoid | He, 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L22 |
| E320 | 1 | Valve, Solenoid | He, 3-way, 2-position | Marotta Valve Corp. PN 223544-1 | | 407L23 |
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FIGURE I. LOX SYSTEM

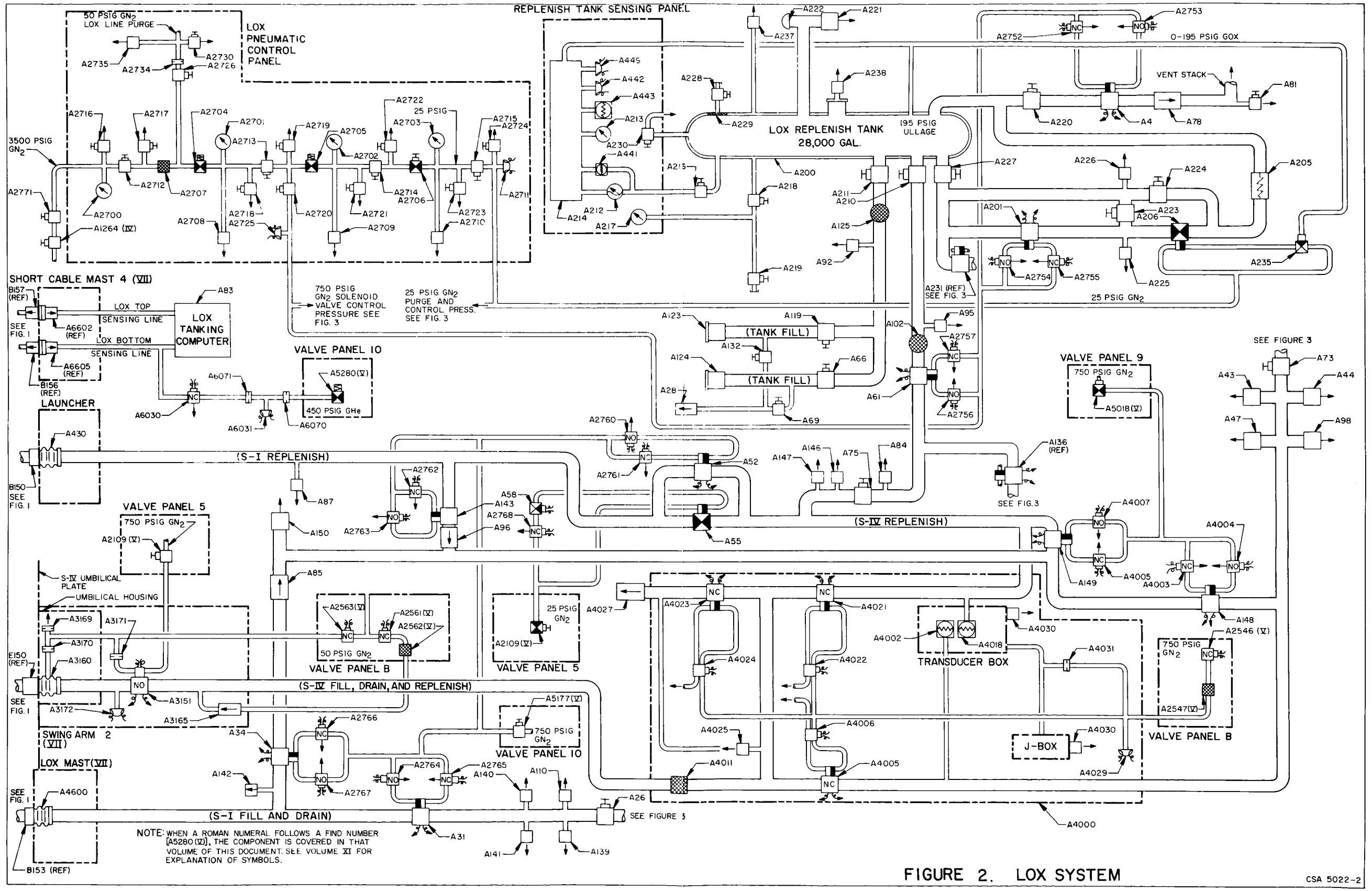


FIGURE 2. LOX SYSTEM

CSA 5022-2

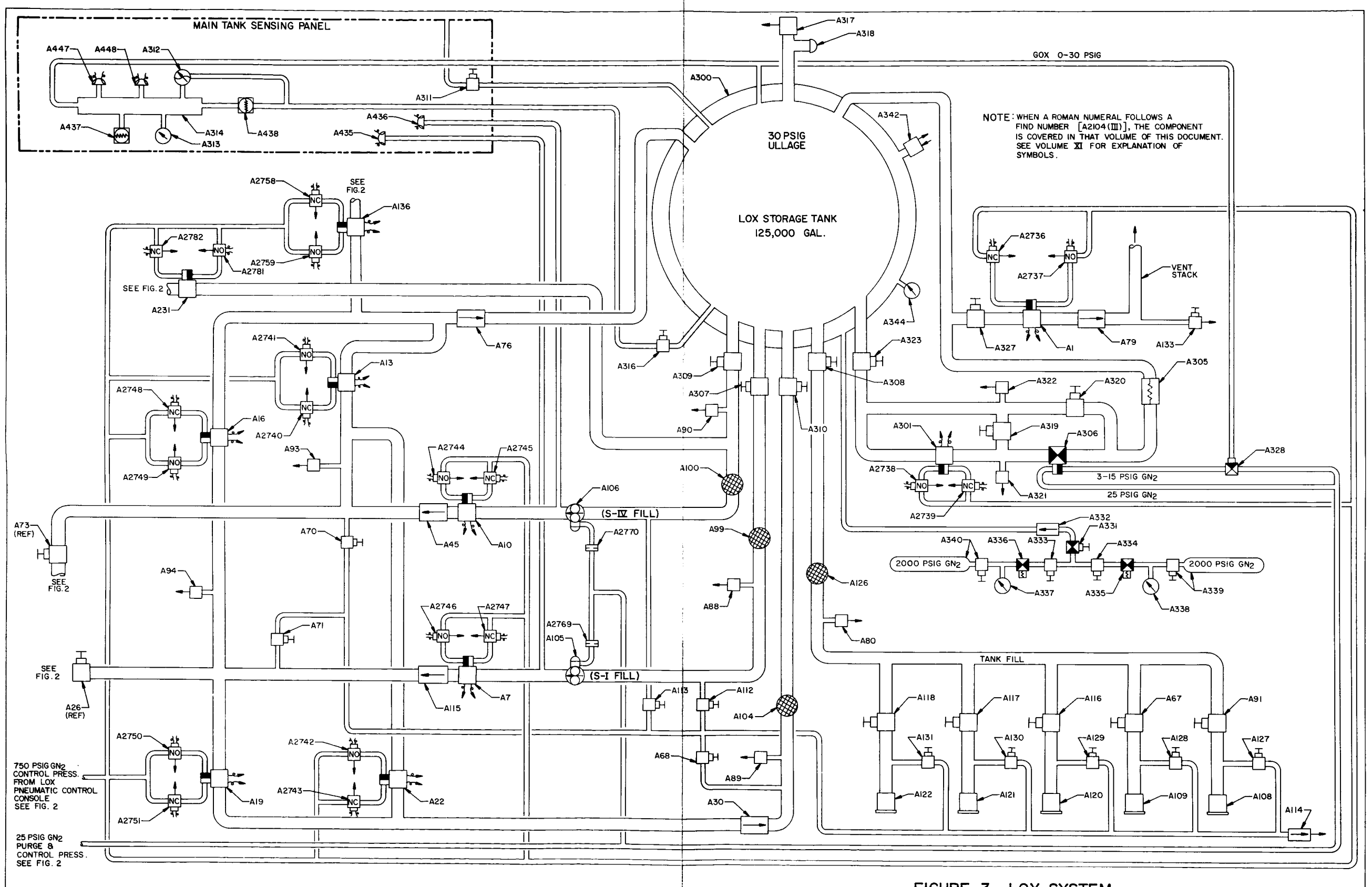


FIGURE 3. LOX SYSTEM

CSA 5023-2

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