

# **APOLLO PORTABLE LIFE SUPPORT and OXYGEN PURGE SYSTEMS**



**Hamilton  
Standard**

**U**  
DIVISION OF UNITED AIRCRAFT CORP.  
**A®**

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## ABBREVIATIONS

CEI . . . . .	Contract End Item
CM . . . . .	Command Module
EMI . . . . .	Electromagnetic Interference
EMU . . . . .	Extravehicular Mobility Unit
EVA . . . . .	Extravehicular Activity
EVCS . . . . .	Extravehicular Communications System
LCG . . . . .	Liquid Cooling Garment
LM . . . . .	Lunar Module
OPS . . . . .	Oxygen Purge System
PGA . . . . .	Pressure Garment Assembly
PLSS . . . . .	Portable Life Support System
RCU . . . . .	Remote Control Unit
scc . . . . .	Standard Cubic Centimeter
SCO . . . . .	Signal Conditioning Oscillator
TM . . . . .	Telemetry
TMG . . . . .	Thermal Meteoroid Garment
VOX . . . . .	Voice Operated Relay

## INTRODUCTION

This booklet, intended for field personnel, explains the basic function and operation and lists the salient component parameters of the Portable Life Support System (PLSS) and the Oxygen Purge System (OPS).

These systems are developed through a summary of requirements and a series of simplified block diagrams in which instrumentation and other items unnecessary for understanding of the basic operation are omitted. These are followed by a simplified piping schematic.

Two cross-reference indexes are provided: one by component item number, listing location, name, and page number; the other by function, listing item number and name.

The booklet is divided into sections which are color coded as follows.

Oxygen Ventilating Circuit .....	Red
Feedwater Loop .....	Blue
Liquid Transport Loop .....	Green
Primary Oxygen Subsystem .....	Yellow
Oxygen Purge System .....	Pink

SECTION 1.0

PORTABLE LIFE SUPPORT SYSTEM/OXYGEN  
PURGE SYSTEM DESCRIPTION

## 1.0 PORTABLE LIFE SUPPORT SYSTEM/OXYGEN PURGE SYSTEM DESCRIPTION

The Portable Life Support System (PLSS) is a self-contained life support system that provides life support, voice communications, and telemetry for an astronaut performing Apollo Mission extra-vehicular tasks. The PLSS can support metabolic loads ranging from 400 Btu/hr to short-term peaks of 2000 Btu/hr. Typical three and four-hour mission profiles are shown in Figures 1-1 and 1-2 respectively.

The PLSS performs the following functions.

1. Provides breathing oxygen and controls the pressure of the astronaut's suit.
2. Provides thermal control by recirculating oxygen in the Pressure Garment Assembly (PGA) and water through the Liquid Cooling Garment (LCG).
3. Removes humidity, carbon dioxide, odors, and other contaminants from the recirculating oxygen.
4. Provides communication and telemetry between the astronaut and the Lunar Module (LM).

The Oxygen Purge System (OPS) adds an independent backup life support capability. It provides oxygen for respiration, pressure control, and cooling.

Five main subsystems comprise the PLSS: the extravehicular communications system (EVCS), oxygen ventilating circuit, feed-water loop, liquid transport loop, and primary oxygen subsystem.

Figure 1-3 shows the PLSS and OPS as black boxes and identifies all inputs and outputs required to perform their functions.

Figure 1-4 shows the interconnections between the OPS and the PLSS subsystems, including their inputs and outputs.

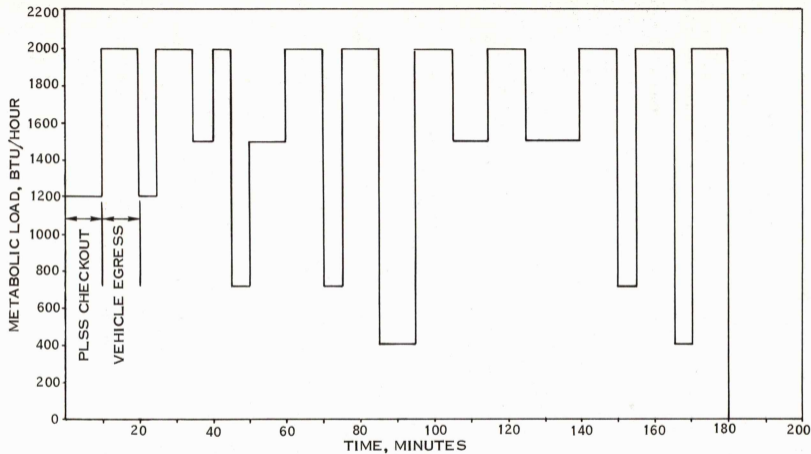


Figure 1-1. Typical Metabolic Mission Profile -- Three-hour Mission,  
Total Metabolic Load of 4816 Btu.

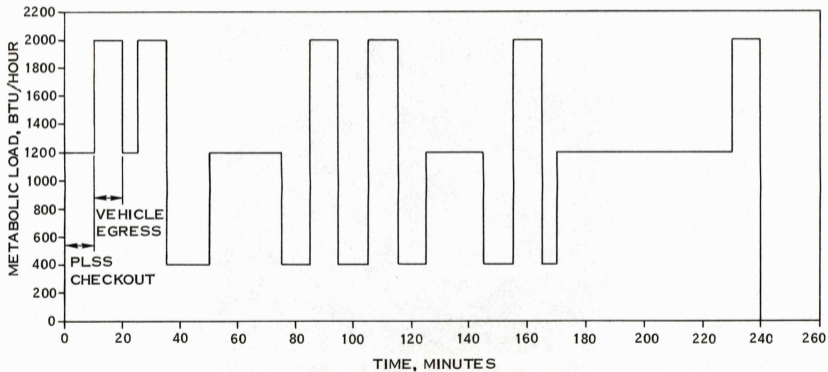


Figure 1-2. Typical Metabolic Mission Profile -- Four-hour Mission, Total Metabolic Load of 4800 Btu.

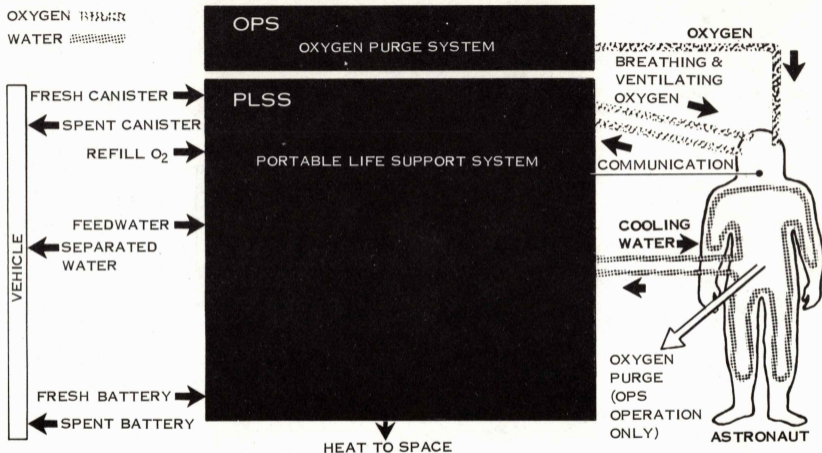


Figure 1-3. PLSS and OPS Interfaces.

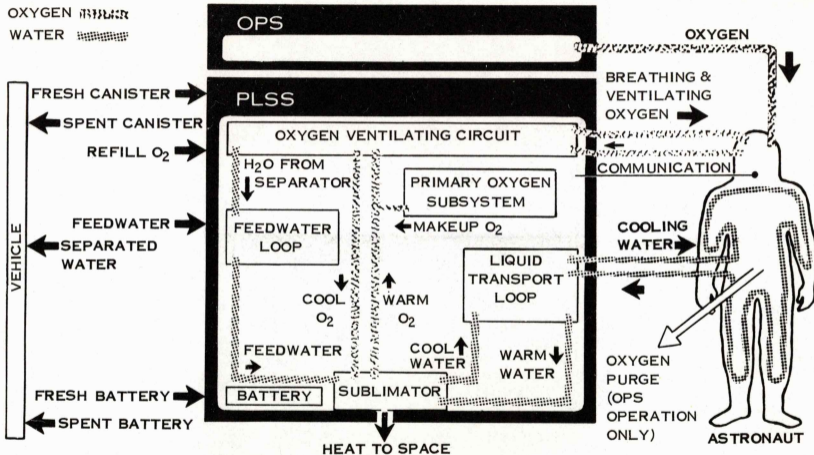


Figure 1-4. OPS and PLSS Subsystems.

## 1.1 EXTRAVEHICULAR COMMUNICATIONS SYSTEM

The Extravehicular Communications System (EVCS) - government-furnished equipment - has two configurations: Type 1 and 2. The type 1 configuration consists of two AM transmitters, two AM receivers, one FM receiver, signal conditioning, a telemetry system, a warning system, and other components required for proper system operation. The type 2 configuration consists of two AM transmitters, one FM transmitter, two AM receivers, signal conditioning, a telemetry system, and other components required for system operation.

The system provides for three modes of operation:

1. Primary mode - Duplex (simultaneous transmission and reception) voice communication between either astronaut and the LM, and telemetry signals (TM).
2. Secondary (backup) mode - Duplex voice communication between either astronaut and the LM (LM must be switched to secondary mode).
3. Dual mode - Duplex conference between astronaut one, astronaut two, and LM-Earth; simultaneous TM from each astronaut.

During normal mission operation with two astronauts on the lunar surface, the dual mode is used for EVCS Types 1 and 2. As illustrated in Figure 1-5, the EVCS permits astronaut two to transmit both voice and telemetry data, via FM transmitter T3, to astronaut one. Astronaut one receives astronaut two's voice and telemetry data via FM receiver R3, modulated along with astronaut one's voice and telemetry. This combined astronaut one and two voice and telemetry signal then is transmitted to the LM by astronaut one's AM transmitter T2. Earth, via the LM, communicates with either or both astronauts through their receivers, R1. Astronaut one communicates with astronaut two via the T2/R2 link. The primary and secondary modes of operation are contingency modes, in case the EVCS dual mode fails or if only one-man extravehicular activity (EVA) is desired.

### System Interfaces

The EVCS provides voltage-regulated power for the oxygen quantity indicator and for the transducers of the PLSS system

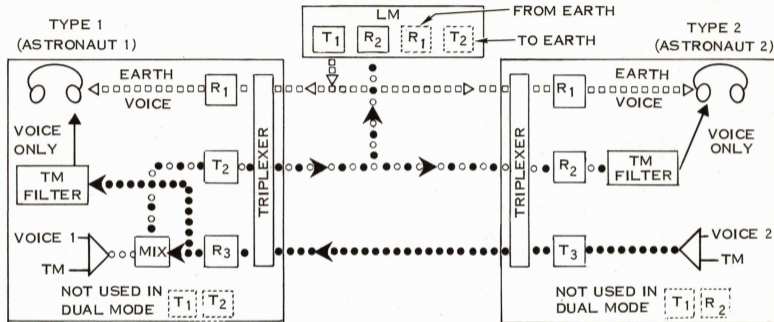


Figure 1-5. Dual EVA EVCS Configuration.

instrumentation. The following table lists the PLSS and Pressure Garment Assembly (PGA) instrumentation signals.

<u>System instrumentation</u>	<u>Type of signal</u>
PGA press. transducer .....	TM, warning
LCG inlet temp transducer .....	TM
Battery current sensor .....	TM
EKG (Electrocardiogram) .....	TM
O <sub>2</sub> bottle press. transducer .....	TM
Feedwater press. transducer .....	TM, warning
LCG differential temp transducer .....	TM
Sublimator outlet gas temp transducer .	TM
High primary O <sub>2</sub> flow sensor .....	Warning
Low vent flow sensor .....	Warning
Battery voltage .....	TM

The EVCS has receptacles for connection to the transducers, microphone, electrocardiogram, antenna, calibration receptacle, mode selector switch, volume control, and power input.

#### Alarm Tone

An alarm tone functions in all modes of operation to warn the astronaut of a dangerous condition. Low suit pressure, low feedwater pressure, high oxygen flow, and low vent flow sensors each send a signal to an alarm control module which activates a 1500 Hz alarm tone generator. The specific problem area is indicated by warning flags on the Remote Control Unit (RCU).

#### Remote Control Unit

The Remote Control Unit (RCU) provides the astronaut with control functions and instrumentation. It contains, in addition to the warning flags, a volume control, O<sub>2</sub> indicator, panel lights, and four switches (fan, pump, mode selector, and push-to-talk). The push-to-talk switch has three positions as follows.

1. MAIN - VOX (voice actuated transmitter) mode. The first syllable of a voice transmission automatically actuates the transmitter. Transmission and reception can occur simultaneously.
2. OFF - VOX is grounded and there is no voice transmission.
3. MOM - Momentary voice communication. Voice transmission and reception is maintained as long as the switch is held in the MOM position. When released, the switch automatically returns to OFF.

#### Telemetry Capability

The EVCS has 30 channels: 26 are available for telemetering, 2 for calibration, and 2 for synchronization with the ground station on Earth. All of the 26 telemetry channels are not needed for this application but enable the unit to be used for future PLSS requirements.

Figures 1-6 and 1-7 are electrical schematics of the mode selector switch and alarm system, and telemetry.

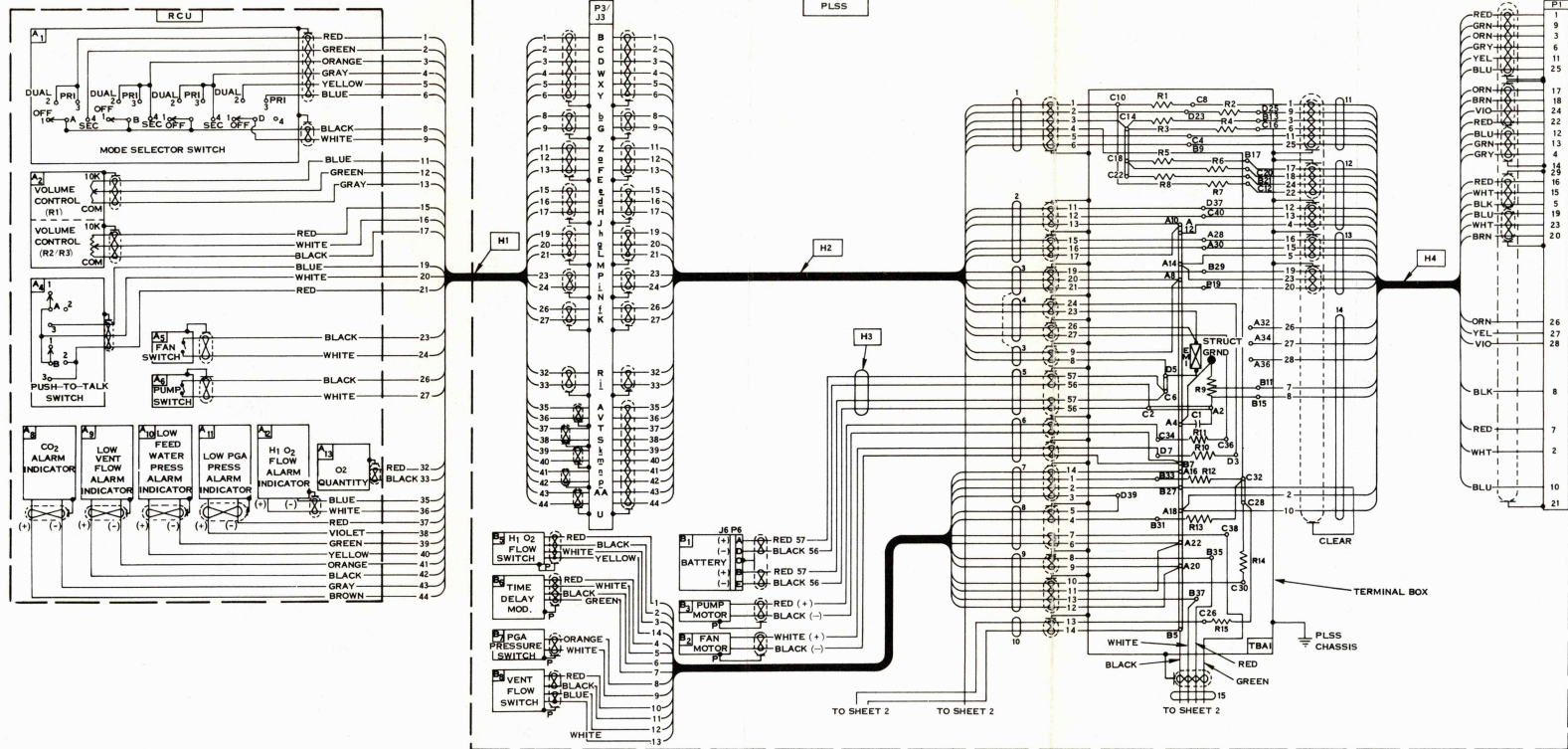


Figure 1-6. EVCS Schematic - Mode Selector Switch and Alarm Circuitry.

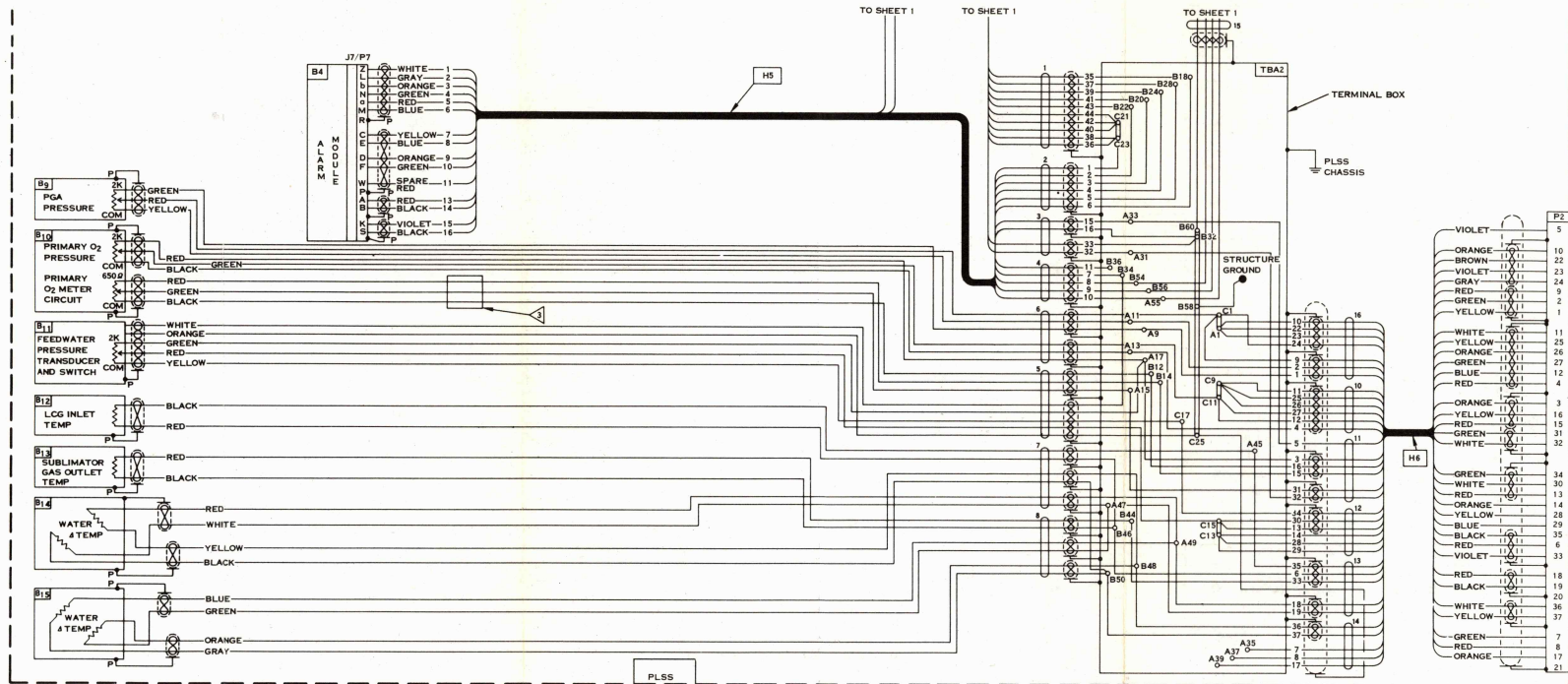


Figure 1-7. EVCS Schematic - Telemetry Circuitry.

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## 1.2 OXYGEN VENTILATING CIRCUIT

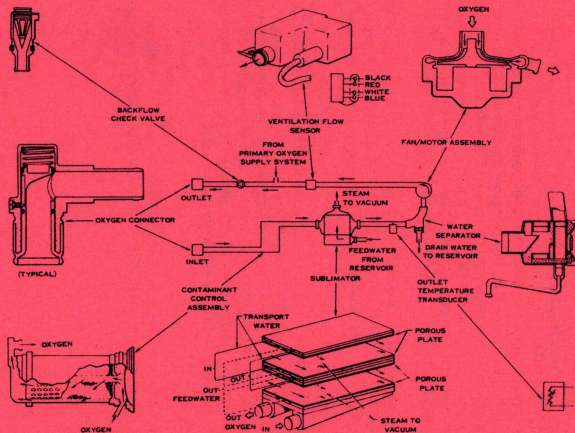
The oxygen ventilating circuit (Fig. 1-8) consists of a contaminant control assembly, section of the sublimator, water separator, fan motor assembly, ventilation flow sensor, back-flow check valve, and PLSS inlet and outlet oxygen connectors.

The oxygen ventilating circuit circulates cool, reconditioned oxygen through the PGA. Oxygen from the PGA enters the oxygen ventilating circuit of the PLSS through the inlet oxygen connector. The oxygen flow then passes through the contaminant control assembly where odors are removed by activated charcoal. Carbon dioxide is removed through a chemical reaction with lithium hydroxide, and foreign particles are filtered out by a Teflon felt filter.

The oxygen passes from the contaminant control assembly to the sublimator where it is cooled. This water-saturated oxygen then passes to the water separator where condensed water is removed.

The oxygen passes from the water separator to the fan motor assembly. The fan motor assembly forces the oxygen through the vent flow sensor and backflow check valve to the outlet oxygen connector of the PGA. Drainwater is ducted from the water separator to the outer section of the feedwater reservoir, through the water shutoff and relief valve, when the valve is in the on position.

In addition to providing oxygen circulation, the oxygen ventilating circuit pressurizes the feedwater bladder to expel water from the reservoir assembly.



600 Y-19.1

Figure 1-8. Oxygen Ventilating Circuit Schematic.

### 1.3 FEEDWATER LOOP

The feedwater loop (Fig. 1-9) consists of a bladder in a reservoir, a water fill connector, reservoir vent connector, water drain connector, feedwater vent indicator (sight glass), water shutoff and relief valve, flow limiter (orifice), feedwater pressure transducer and switch, check valve, the feedwater loop section of the sublimator, and connecting tubing.

The feedwater loop feeds expendable water to the sublimator where the water freezes. Heat absorbed from the oxygen ventilating circuit and the liquid transport loop causes the ice to sublimate to vacuum.

The sublimator is a device that dissipates heat by sublimating ice. An ice layer formed on a porous plate provides a barrier between the liquid feedwater and space vacuum, thus preventing the loss of free water overboard. The ice film regulates the feedwater flow rate in response to heat load changes without moving mechanical parts. An inherent advantage of the simplicity of the sublimator is its high reliability.

The feedwater reservoir is separated into two sections by a bladder. The inner section stores the expendable water used to operate the sublimator. The outer section stores the drainwater from the water separator.

The water shutoff and relief valve is a two-position valve that permits a flow of water from the bladder to the sublimator, restricted by a flow-limiting orifice downstream of the valve. In the off position, the water shutoff and relief valve relieves excess pressure in the feedwater reservoir and permits simultaneous feedwater filling and draining of the drainwater section of the reservoir. In the on position, the drain from the water separator to the drainwater reservoir is open, permitting the separated water to flow to the feedwater reservoir and allowing the oxygen ventilating circuit pressure to force the feedwater to the sublimator during free space, lunar, and earth-gravity operations.

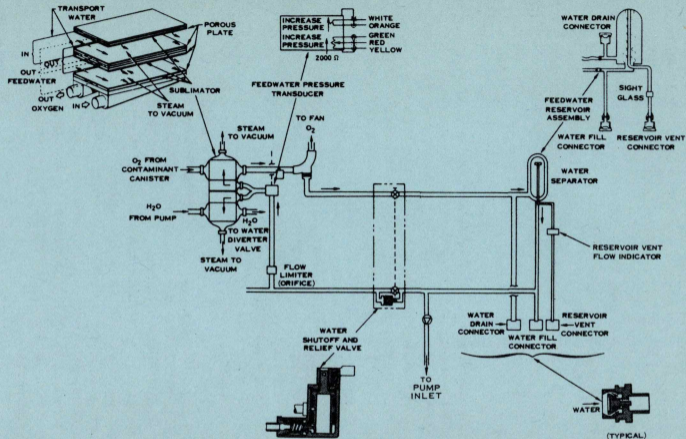


Figure 1-9. Feedwater Loop Schematic.

#### 1.4 LIQUID TRANSPORT LOOP

The liquid transport loop (Fig. 1-10) consists of a pump/motor assembly, water diverter valve, multiple water connector, water differential temperature transducer, LCG inlet water temperature transducer, the transport section of the sublimator, gas trap, and connecting tubing.

The liquid transport section of the sublimator chills the water that circulates through the LCG. The check valve, located between the feedwater loop and the liquid transport loop, maintains proper inlet pressure on the water pump.

The pump/motor assembly circulates the chilled water through the liquid transport loop and the LCG.

The water diverter valve permits the selection of three transport water cooling ranges. The differential temperature of the water entering and leaving the PLSS is sensed by the water differential temperature transducer, which supplies electrical inputs to the telemetry system.

The gas trap removes entrained gas from the LCG to prevent degradation of the pump, sublimator, and LCG performance.

The cooled water from the sublimator circulates around the fan motor to cool the fan electronic package.

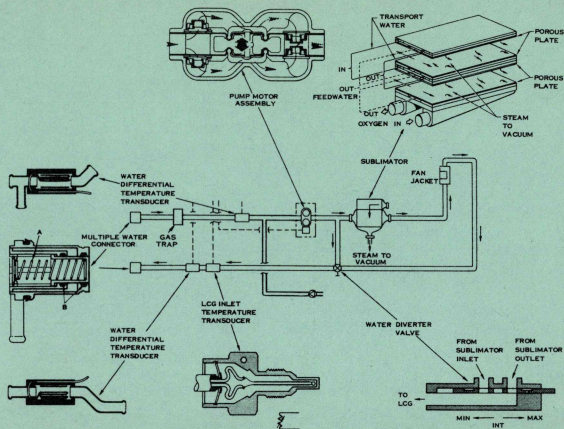


Figure 1-10. Liquid Transport Loop Schematic.

## 1.5 PRIMARY OXYGEN SUBSYSTEM

The primary oxygen subsystem (Fig. 1-11) consists of a primary oxygen bottle, primary oxygen fill connector, primary oxygen regulator assembly, oxygen flow rate sensor, PGA low differential pressure warning switch, PGA differential pressure transducer, primary oxygen pressure transducer, and connecting tubing.

The primary oxygen subsystem provides oxygen for system leakage and metabolic needs, and regulates the pressure in the PLSS oxygen ventilating circuit. This subsystem is rechargeable.

The shutoff valve of the primary oxygen regulator assembly is actuated by a linkage assembly. The linkage is connected to an operating lever at the lower right-front corner of the PLSS.

The oxygen shutoff valve is closed when the PLSS is not in use or when the primary oxygen subsystem is being charged. The orifice limits the flow of oxygen to the PGA in the event of regulator failure.

The primary oxygen fill connector is a quick-disconnect type used for recharging the primary oxygen subsystem.

The oxygen flow sensor and the primary oxygen pressure transducer provide electrical signals to the audio warning system and telemetry system, respectively. The oxygen pressure transducer also sends a signal to a visual display on the RCU.

The PGA differential pressure transducer provides an electrical signal to telemetry for monitoring suit differential pressure.

The PGA differential pressure switch provides a signal to the audio warning system.

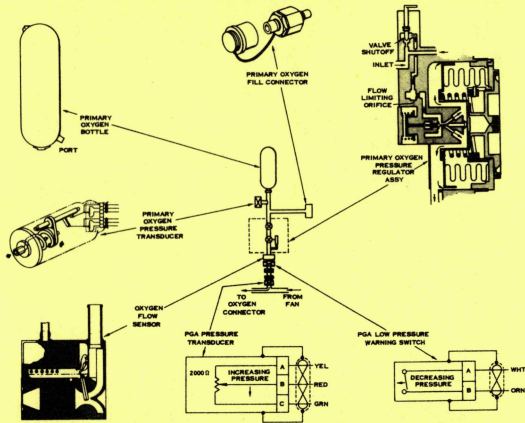


Figure 1-11. Primary Oxygen Subsystem Schematic.

## 1.6 SYSTEM SCHEMATIC AND HARDWARE

Figure 1-12 is a complete schematic of the Apollo PLSS.

Figures 1-13 through 1-17 show the hardware for the subsystems discussed previously and actual locations within the PLSS.

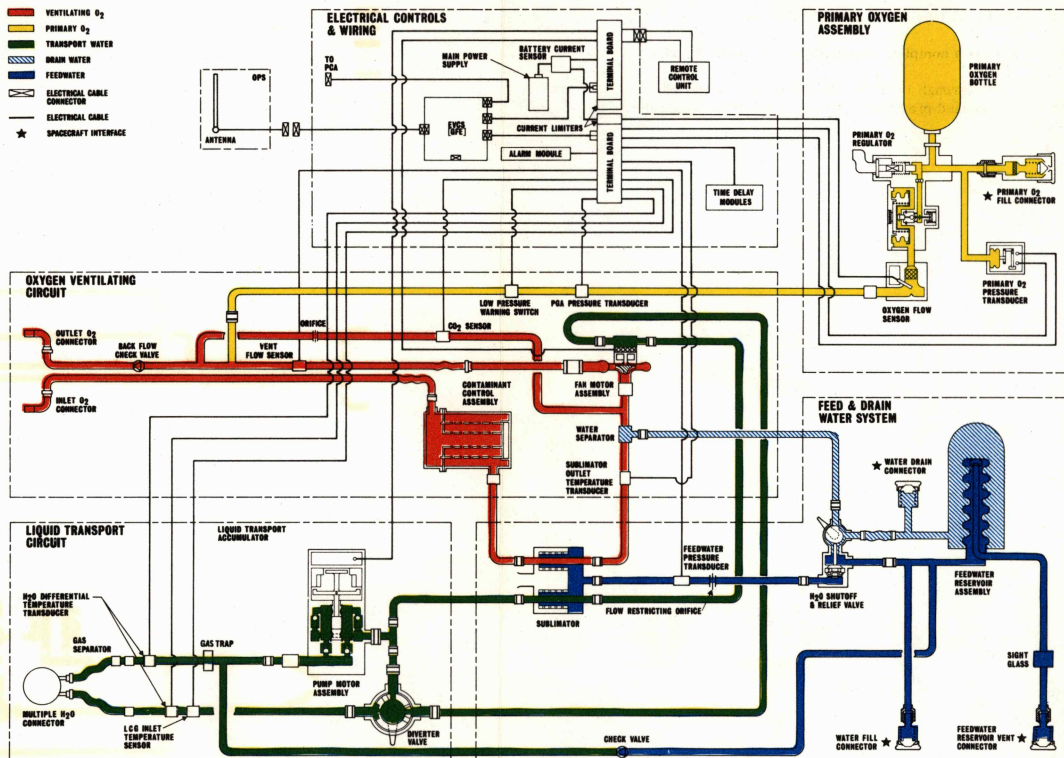
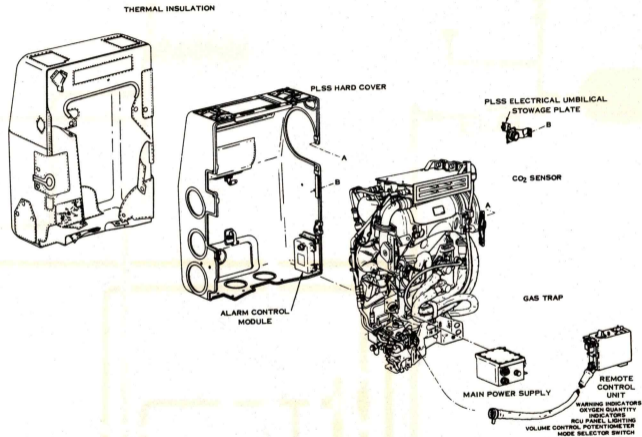
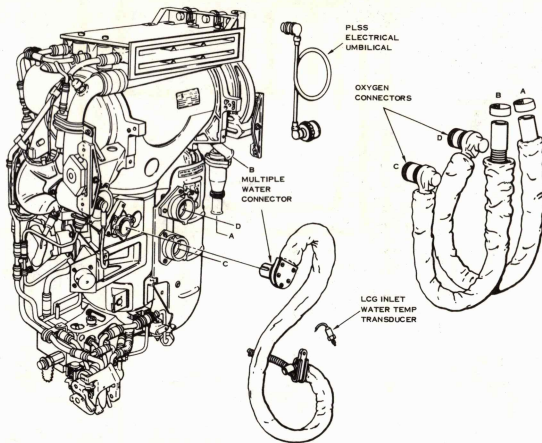


Figure 1-12. Apollo PLSS - SV706100-6.



600D-341

Figure 1-13. Apollo EMU PLSS Equipment.



600D-342

Figure 1-14. Apollo EMU PLSS Equipment.

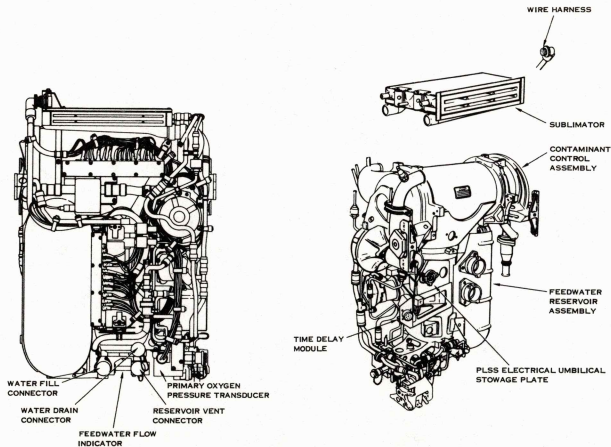
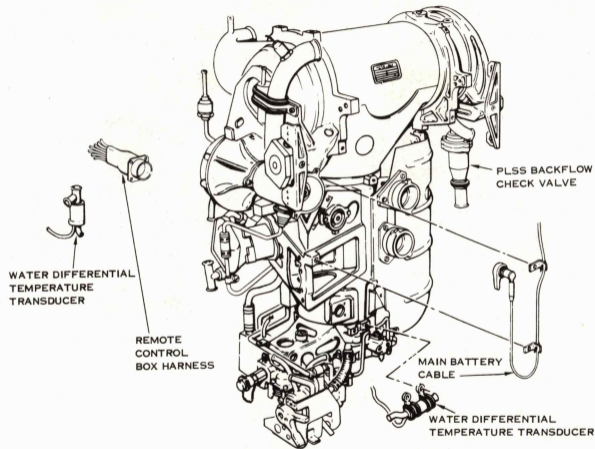


Figure 1-15. Apollo EMU PLSS Equipment.



600D-344

Figure 1-16. Apollo EMU PLSS Equipment.

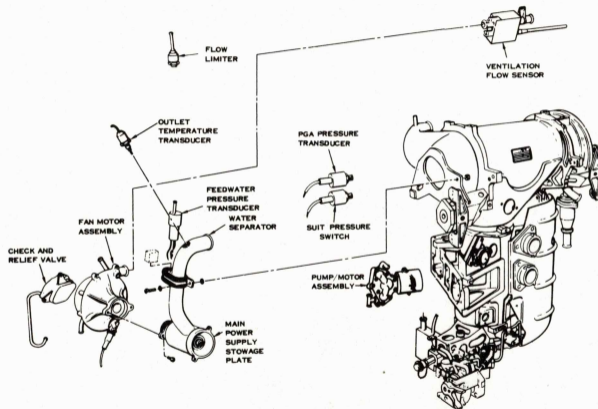


Figure 1-17. Apollo EMU PLSS Equipment.

SECTION 2.0  
OXYGEN PURGE SYSTEM DESCRIPTION

## 2.0 OXYGEN PURGE SYSTEM DESCRIPTION

The oxygen purge system (Fig. 2-1) consists of two oxygen reservoirs (OPS bottles), an OPS bottle pressure gage, high pressure lines and fittings, a valve control mechanism and a regulator assembly, a regulator checkout system, heater, heater checkout system, and heater controller.

The OPS is operational in the following modes.

1. Purge. Used in the event of PLSS ventilation or contaminant control malfunction (suit purge valve open).
2. Makeup. Used to replace O<sub>2</sub> lost due to excessive suit leakage (suit purge valve closed) or a fail-closed primary regulator.

In the event of failure in the PLSS, the OPS is activated by moving a lever on the actuation cable and lever assembly. This actuates the OPS power on-off switch and opens the oxygen shut-off valve, releasing high pressure oxygen into the heater and energizing the heater circuitry. In this mode, the suit purge valve is open. The preheated high pressure oxygen then flows to a regulator where the pressure is dropped to suit pressure, and the gas flows via a flexible hose to the PGA.

The oxygen flow from the OPS provides oxygen for respiration and convective cooling of the astronaut and visor defogging.

Figure 2-2 shows the OPS hardware.

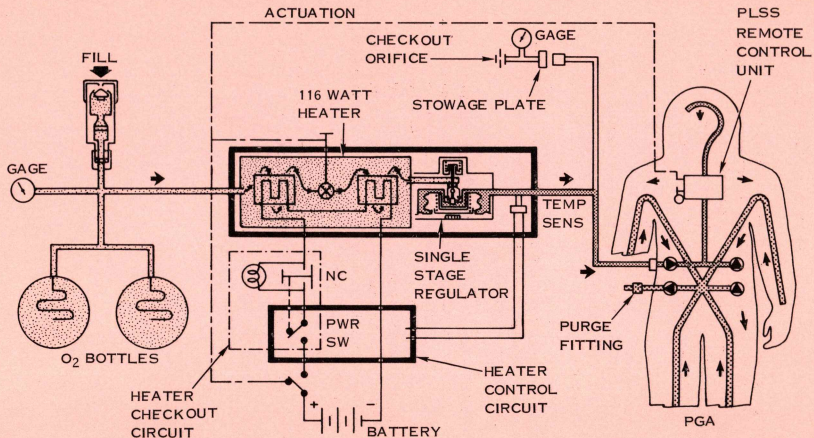
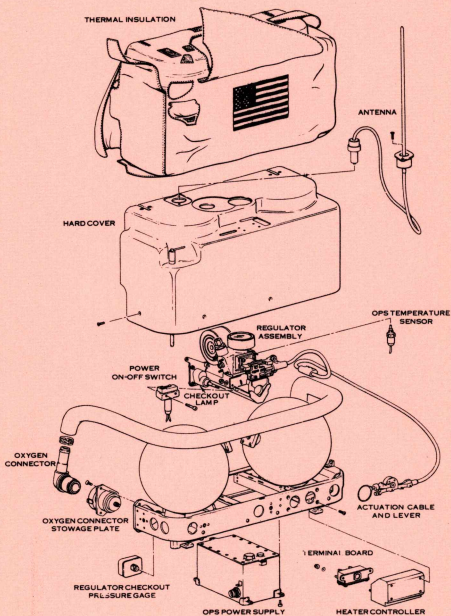


Figure 2-1. Oxygen Purge System - Purge Mode.



600E-15

Figure 2-2. OPS Hardware.

SECTION 3.0  
COMPONENT ITEM NUMBER INDEX

### 3.0 COMPONENT ITEM NUMBER INDEX

This index is by component item number, listing location, name, and page number.

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203	PGA Differential Pressure Transducer	5-5
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205	LCG Inlet Water Temperature Transducer	5-7
206	Warning Indicator	5-7
207	Oxygen Quantity Indicator	5-8
208	RCU Panel Lighting	5-8
213	Main Power Supply	5-10
215	Terminal Boxes	5-11
216	EMI Suppressor	5-11
221	Volume Control Potentiometer	5-12
222	Mode Selector Switch	5-12
223	Time Delay Module	5-15
224	Push-to-Talk Switch	5-15
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234	Battery Current Sensor	5-22
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244-2	Outlet Oxygen Connector	5-32
245	PLSS Backflow Check Valve	5-34

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263	Water Diverter Valve	5-44
264	Multiple Water Connector	5-47
266	Check Valve Assembly	5-49
268	Gas Separator	5-49
	<u>Primary Oxygen Subsystem</u>	
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	<u>Oxygen System</u>	
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513	Oxygen Connector	5-61
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522	Heater Controller	5-62
523	Power On-Off Switch	5-63
	<u>Checkout Circuitry</u>	
524-1	Checkout Switch	5-63
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525	Terminal Board	5-63
526	OPS Temperature Sensor	5-66
536	Regulator Checkout Pressure Gage	5-67

SECTION 4.0  
FUNCTIONAL CROSS-REFERENCE INDEX

#### 4.0 FUNCTIONAL CROSS-REFERENCE INDEX

This index is by function, listing component item number, name, and page number.

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241-1	LiOH Canister - Reservoir Assembly	5-26
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#### Current limiter

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#### Fan

243	Fan Motor Assembly	5-29
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#### Flow limiter

257	Flow Limiter	5-44
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#### Heater

512-4	Heater (Regulator Assembly)	5-57
-------	-----------------------------	------

#### Hoses

None	SV713097-3 Suit Oxygen Outlet Umbilical (red)	----
None	SV713844-3 Suit Oxygen Inlet Umbilical (blue)	----
None	SV718776-2 Water Hose	----

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<u>Signal conditioners and suppressors</u>	Integral with electrical items, except Item 216.	----
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<u>Function/Item no.</u>	<u>Name</u>	<u>Page</u>
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232	Primary Oxygen Pressure Transducer	5-19
233	Sublimator Outlet Temperature Transducer	5-21
236	Water Differential Temperature Transducer	5-24
239	Feedwater Pressure Transducer and Switch	5-25
<u>Valves, check</u>		
245	PLSS Backflow Check Valve (Oxygen Ventilating Circuit)	5-34
266	Check Valve Assembly (Liquid Transport Loop)	5-49
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253	Water Shutoff and Relief Valve	5-37
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Function/Item no.

Name

Page

Valves, shutoff

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Water Shutoff and Relief Valve

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512-2

OPS Shutoff Valve (Regulator  
Assembly)

5-57

SECTION 5.0  
COMPONENT DESCRIPTION

## 5.1 PLSS COMPONENTS

## 202 VENTILATION FLOW SENSOR

Spec. no: SVHS 4100

Spec. wt: 1.0 lb

Function: Incorporates means of actuating audible and visual warning circuit when flow rate drops below 4.3 to 5.3 acfm.

Description: Vent flow measured by passing it through a venturi. Difference between static and total pressure is sensed across movable plates of variable capacitance element. Output signal used to actuate audible and visual warning circuits.

Construction: Hermetically sealed electronics

Supply voltage: 15.5 to 20.5 Vdc

Supply current: 25 mA max.

Open condition impedance: 100,000 ohm

Closed condition impedance: 100 ohm max. at 10 mA, 150 ohm max. at 1.0 mA

Current limiting: 50 mA max.

Working pressure: 3.1 to 4.2 psia

Working temperature: 35° to 90° F

Setpoint: Actuates and deactuates at mass flow condition of 4.0 to 5.3 acfm.

Pressure drop: 0.10 in. of H<sub>2</sub>O with flow of 8.35 lb/hr O<sub>2</sub> and 0.15 lb/hr water vapor. Gas temperature is 50° F, pressure is 4.1 psia.

## 203 PGA DIFFERENTIAL PRESSURE TRANSDUCER

Spec. no: SVHS 4311

Spec. wt: 2.5 oz excluding lead wires

Function: Used to sense pressure differential between ambient and suit pressure. Output is input signal for telemetry.

Description: A pressure-sensing bellows sensing low pressure O<sub>2</sub> in makeup line and PLSS ambient pressure. Movement of bellows varies potentiometer resistance. Output voltage varies with resistance.

Working temperature: 40° to 85° F

Working pressure: 3.4 to 4.05 psid

Signal output: 0 to 5 Vdc linear output for 2.5 to 5.0 psid input press.

Resistance: 2000 ohm for potentiometer circuit

Performance:

Static error band less than  $\pm 2\%$  of full scale.

Total error band less than 4.0% of output span (absolute error 0.10) psid over operational temperature range (40° to 85° F). Includes effects of friction, linearity, hysteresis, resolution, repeatability, and temperature.

#### 204 PGA DIFFERENTIAL PRESSURE SWITCH

Spec. no: SVHS 4312

Spec. wt: 2.5 oz excluding lead wires

Function: Senses pressure differential between ambient and suit pressure, used to provide input signal to alarm system.

Operating pressure: 3.4 to 4.05 psid

Operating temperature: 40° to 85° F

Closure: 3.2 psid and below

Opening: 3.35 psid and below

## 205 LCG INLET WATER TEMPERATURE TRANSDUCER

Spec. no: SVHS 4149

Spec. wt: 0.5 oz excluding lead wires

Function: Used to sense temperature of main inlet water flow into LCG, providing input signal to telemetry system corresponding to temperature.

Description: A thermistor varying output voltage.

Construction: Hermetically sealed electronics, stainless steel case

Operating temperature: 45° to 90° F

Operating pressure: 3.3 to 50.0 psig

Flow rate: 4.0 lb/min water

Resistance: 141,000 ohm at.....	45° F
60,000 ohm at.....	77° F
43,000 ohm at.....	90° F

Power: 0.7 mW

## 206 WARNING INDICATOR

Spec. no: SVHS 4256

Spec. wt: 1.0 oz

Function: Provides astronaut with visual indication of failure mode.

Description: Located in the RCU. Face exposes black surface with white lettering. Clear white surface visible in normal mode. Remains in energized position until failure is cleared. Lettering is P (Purge), A (Abort), and O (OPS makeup).

Ambient temperature: 30° to 200° F

Ambient pressure: 21 psia to  $10^{-14}$  mm Hg

Voltage: 18 Vdc

Power: 0.60 W max.

Internal resistance: 950 ohm

#### 207 OXYGEN QUANTITY INDICATOR (Fig. 5-1)

Spec. no: SVHS 2844

Spec. wt: Without cable, 3 oz  
Including cable, 5 oz

Function: Senses primary O<sub>2</sub> pressure in PLSS oxygen bottle.

Description: A dc millimeter electrically connected to PLSS O<sub>2</sub> transducer. An indicator is incorporated into PLSS RCU.

Construction: Stainless steel casing

Sensitivity: Full-scale sensitivity is 1.00 mA dc

Impedance: 160 ohm at 70° F

Accuracy: ±4%

Operating temperature: 0° to 200° F

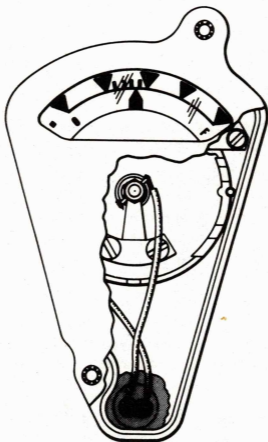
Operating pressure: 21 psia to  $7.5 \times 10^{-14}$  mm Hg

#### 208 RCU PANEL LIGHTING

Function: Illuminates O<sub>2</sub> quantity indicator, five warning indicators, and positions of mode selector switch.

Description: A beta light source mounted in top panel of the RCU package. Beta light consists of phosphor-lined glass tube containing radioactive tritium source. Phosphor coating gives off light when bombarded by beta particles from tritium.

Operating temperature: -80° to 220° F



600D-219

Figure 5-1. Oxygen Quantity Indicator.

Operating pressure: 21.0 psia to  $10^{-14}$  mm Hg

Intensity: 40  $\mu$ L at O<sub>2</sub> quantity indicator, 130  $\mu$ L on all other surfaces

Power: None required

### 213 MAIN POWER SUPPLY

Spec. no: 3221

Spec. wt: 5.4 lb

Function: Provides electrical power for PLSS.

Description: A battery of vented cells, employing silver and zinc electrodes, packaged in leakproof vented container.

Rating:

Battery output, Vdc	Reqd battery discharge, Adc	Battery output, W
16.8 (nominal)	3.57	60.0
20.5 (high)	4.35	89.2
16.0 (low)	3.40	54.4

At intermediate voltage, required discharge current is directly proportional to ratio of that voltage to nominal voltage.

Maximum rating: Capable of delivering total of four 80-W pulses for period of 2.0 sec each to simulate switching on PLSS electrical equipment. Pulses occur at 2 to 5 min intervals within first 15 min of discharge cycle. Each pulse begins at zero power discharge condition, causes no degradation of unit performance or endurance.

Peak voltage: Max. discharge is 20.5 V.

Pressure relief: 8.0 psig

## 215 TERMINAL BOXES

Spec. no: SVHS 4302

Spec. wt: PLSS A1 = 4.48 oz } Both used on PLSS.  
PLSS A2 = 3.52 oz }

Function: Used to interconnect the following.

<u>Item</u>	<u>Nomenclature</u>
—	EVCS Module
202	Ventilation Flow Sensor
203	PGA Differential Pressure Transducer
204	PGA Differential Pressure Switch
205	LCG Inlet Water Temperature Transducer
213	Main Power Supply
223	Time Delay Module
227	Alarm Module
232	Primary Oxygen Pressure Transducer
233	Sublimator Outlet Temperature Transducer
235	Oxygen Flow Sensor
236	Water Differential Temperature Transducer
239	Feedwater Pressure Transducer and Switch
243-1	Fan Motor
262	Pump/Motor Assembly
289	Remote Control Unit

## 216 EMI SUPPRESSOR

Spec. wt: 12.0 grams

Function: Used to filter various EMI generated by wiring harnesses, motor, and other PLSS electronics.

Construction: Aluminum housing

Operating temperature: -55° to 125° C

Voltage: 100 Vdc at 125° C, 125 Vdc at 85° C

Current: 5 A max.

Dc resistance: 0.05 ohm max.

Insertion loss vs frequency:

Frequency.	150 kc	-	300 kc	-	1 Mc	-	10 Mc	-	1 gc	-	2 gc
Decibels.	18	-	25	-	42	-	70	-	70	-	70

## 221 VOLUME CONTROL POTENTIOMETER (Fig. 5-2)

Spec. no: SVHS 4255

Spec. wt: 7 oz without leading shielded cables

Description: Two functionally independent rotary potentiometers packaged together in one hermetically sealed unit. One used to adjust level of voice signal received from extravehicular crewman, other to adjust level of voice signal received from earth via LM or CM.

Working temperature: -30° to 200° F

Working pressure: 21.0 psia to  $10^{-14}$  mm Hg

Resistance: Each potentiometer element is 10,000 ohm at nominal temperature and 50% relative humidity.

Resolution: 0.1% of full travel, min.

Power: 0.1 W continuous dissipation capability at 200° F and ambient press. of  $10^{-14}$  mm Hg

Torque: 3.5 in.-oz max.

## 222 MODE SELECTOR SWITCH (Fig. 5-3)

Spec. no: SVHS 4262

Spec. wt: 6 oz without lead wires in case  
15 oz including lead wires and cable

Function: Selects operational modes of EVCS.

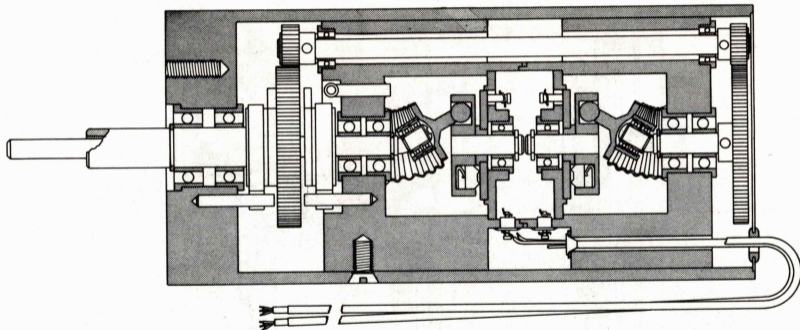
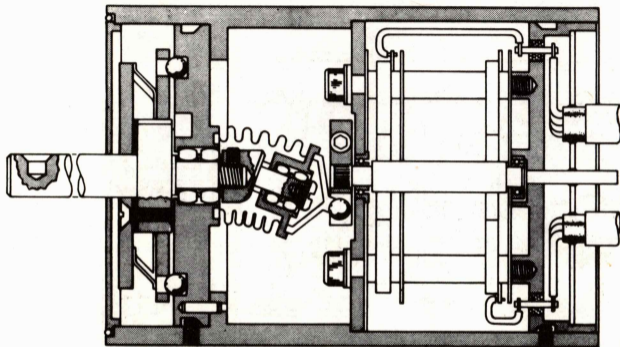


Figure 5-2. Volume Control Potentiometer.



600D-330

Figure 5-3. Mode Selector Switch.

Operating temperature: -30° to 200° F

Operating pressure: 21.0 psia to  $10^{-14}$  mm Hg

Type: 4-position, 4-pole, 2-wafer rotary with positive detent break-before-make switching.

Travel: 120° with nominal 40° spacing

Positions: Full ccw	= OFF	(O)
40° cw from (1)	= Dual	(AR)
80° cw from (1)	= Primary	(A)
120° cw from (1)	= Secondary	(B)

Rating: 22 Vdc, 1.0 A

Contact resistance: 0.020 ohm

Torque: 55 in.-oz

### 223 TIME DELAY MODULE

Spec. no: SVHS 3835

Spec. wt: 0.25 lb

Function: Connected between both O<sub>2</sub> flow rate sensor and vent flow sensor alarm generator, inhibits alarm generator unless signal sustained for more than five seconds.

Performance: Provides five-second delay to single-pole, single-throw, normally-open output switch that closes within  $5 \pm 1$  seconds after initiation of unit-on input signal.

Power: At 15.7 to 20.5 V, supply current does not exceed 40 mA whether unit is on or off.

### 224 PUSH-TO-TALK SWITCH

Spec. No: SVHS 4171

Spec. Wt: 0.32 lb

Function: The switch has three positions:

1. MAIN - VOX (voice actuated transmitter) mode. The first syllable of a voice transmission automatically actuates the transmitter. Transmission and reception can occur simultaneously.
2. OFF - VOX is grounded and there is no voice transmission.
3. MOM - Momentary voice communication. Voice transmission and reception is maintained as long as the switch is held in the MOM position. When released, the switch automatically returns to OFF.

Current rating: 100 mA

Leakage resistance: Between case and heads, 100 M $\Omega$  min. at 100 Vdc.

Actuation force: 1 to 4 lb

Contact resistance: 1.0 ohm max.

#### 225 PUMP SWITCH and

#### 226 FAN SWITCH

Spec. no: SVHS 3302

Spec. wt: 0.003 lb

Function: Pump switch controls power to pump, fan switch controls power to fan.

Construction: Hermetically sealed electronics

Temperature: -58° to 185° F

Current: 5 A

Contact resistance: 0.025 ohm

Actuation force: 1 to 3 lb

## 227 ALARM MODULE

Spec. no: SVHS 4154

Spec. wt: 1.0 lb

Function: Receives inputs from five sensors, provides individual outputs to respective indicators and a common timed output to alarm generator.

Description: Sensor indicating malfunction causes respective indicator to be energized and activates a 10 sec audible warning tone. Indicator remains energized as long as malfunction exists. Should a second malfunction occur while audible warning tone is active then only second indicator is energized. If second malfunction occurs after audible warning tone is deenergized then both second indicator and 10 sec audible warning tone are energized.

Construction: 6061-T6 aluminum sheet housing, hermetically sealed electronics.

Power: Quiescent condition input current less than 50 mA over temperature range of 0° to 140° F over supply voltage range of 15 to 21 Vdc. Max. current condition input current not more than 300 mA when connected to nominal loads over temperature and voltage range for all states of activation.

Inputs: Control package interfaces with PLSS transducer output circuitry. Control package input circuitry interfaces with following transducer circuitry.

Channel 1. Contact type closure. In closed state, control package provides energization to channel 1 output driver line. In open state, channel 1 output driver line is deenergized.

Closed < 10 ohm to input signal common  
Open > 100 k ohm to input signal common

Channel 2. Same as channel 1.

Channel 3. NPN grounded emitter transistor switch with collector-emitter interfaces with control package input cir-

cuit. In closed state, control package provides energization to channel 3 output drive line. In open state, channel 3 output drive line is deenergized.

Closed < 150 ohm to input signal common  
Open > 100 k ohm to input signal common

Channels 4 and 5. Same as channel 3.

Outputs: 5 output lines to 5 indicators and 1 common output line to energize alarm generator.

Off state. Z out > 7100 k ohm  
V out = power supply voltage

On state. 0 to 0.5 Vdc, current sink for currents up to 35 mA

#### 228 PLSS ELECTRICAL UMBILICAL

Spec. no: SVHS 3302

Spec. wt: 1.0 lb

Description: A shielded wiring harness between SCC and PGA.

Construction: Tin-plated copper sheath covered with Teflon

Length: 43 in.

Connectors: PLSS end - Microdot Insert MD-E 15-615 in an Air-lock shell AL 9046  
Suit end - Deutsch 127-12-14D

#### 229 CURRENT LIMITER

Spec. no: SVHS 3302

Description/Function: A fail-open fuse limiting current to PLSS power-consuming devices.

Characteristics:

<u>Part no.</u>	<u>Resistance, ohm</u>	<u>Current rating, A</u>
710978-12	25.0	1/16
710978-13	7.5	1/8
710978-14	2.5	1/4
710978-15	1.0	3/8
710978-16	0.650	1/2
710978-17	0.300	3/4
710978-18	0.200	1
710978-19	0.100	1 1/2
710978-20	0.070	2
710978-21	0.046	3
710978-22	0.022	5
730307	0.022	4

Clearing time (sec):

<u>Minimum</u>	<u>Maximum</u>	<u>Percent rated load at 25°C</u>
0.4	10.000	200
0.0015	0.018	400
0.00025	0.003	600

232 PRIMARY OXYGEN PRESSURE TRANSDUCER (Fig. 5-4)

Spec. no: SVHS 3226

Spec. wt: 4.5 oz without lead wires

Function: Senses pressure in primary oxygen tank, develops two independent signals serving as input to telemetry and a milliammeter.

5-20

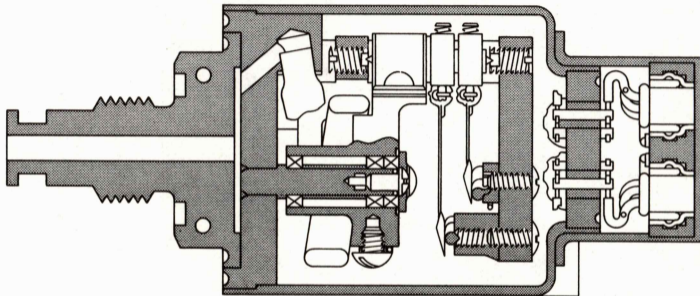


Figure 5-4. Primary Oxygen Pressure Transducer.

Description: A bourdon tube that expands as pressure is applied, actuating a variable resistance resulting in a voltage output corresponding to pressure.

Construction: Stainless steel case

Operating temperature: 0° to 160° F

Operating pressure: 100 to 1110 psia

Signal output: Telemetry circuit produces 0 to 10 V output signal into 100,000 ohm load for 0 to 1020 psia input pressure.  
Meter circuit produces linear 0 to 10 V output signal into 10,000 ohm load for 0 to 1020 input pressure.

Resistance: Total of telemetry circuit is 2000 ohm  
Total of meter circuit is 650 ohm.

Error band: Terminal error band of each output does not exceed 1.5% of full-scale output for telemetry circuit and 2.0% of full-scale output for meter circuit.

Current capacity: 10 mA

### 233 SUBLIMATOR OUTLET TEMPERATURE TRANSDUCER

Spec. no: SVHS 3225

Spec. wt: 1.0 oz without lead wires

Function: Senses temperature of main O<sub>2</sub> flow out of sublimator, provides input signal to telemetry system corresponding to temperature.

Description: A thermistor varying output voltage with temperature.

Construction: Hermetically sealed electronics.

Operating temperature: 0° to 160° F

Operating pressure: 2.5 to 21.0 psia

Resistance: 170,000 ohm at ..... 40° F  
60,000 ohm at ..... 77° F  
43,100 ohm at ..... 90° F

Power: 7 mW.

#### 234 BATTERY CURRENT SENSOR

Spec. no: SVHS 3229

Spec. wt: 0.022 lb including lead wires

Function: Senses battery current, provides input signal to telemetry system proportional to current.

Description: A resistive element where output voltage signal varies with battery current.

Ambient temperature: 0° to 160° F

Ambient pressure: 21.0 psia to  $10^{-14}$  mm Hg

Power: 3 W

Resistance: 0.030 ohm

Load impedance: 6000 ohm

#### 235 OXYGEN FLOW SENSOR (Fig. 5-5)

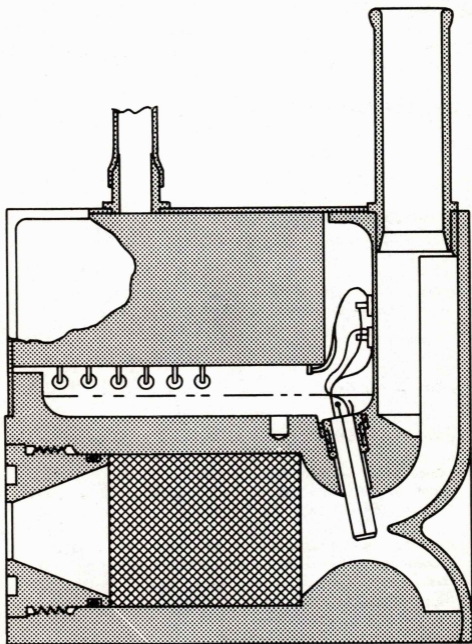
Spec. no: SVHS 3013

Spec. wt: 0.56 lb including 70-in. electrical cable

Function: Measures flow rate downstream of primary O<sub>2</sub> regulator.

Description: Two thermistors located just downstream of primary O<sub>2</sub> regulator. Thermistors have different temperature-resistance characteristics, are located in bridge circuit. Imbalance in bridge is output signal.

Construction: Hermetically sealed electronics



600D-242

Figure 5-5. Oxygen Flow Sensor.

Operating temperature: 40° to 100° F

Operating pressure: 3.5 to 3.9 psia

Pressure drop: 0.02 psi at inlet pressure of 3.7 psia, 70° F, and  
0.07 to 0.7 lb/hr O<sub>2</sub> flow.

Operating voltage: 15.5 to 20.5 Vdc

Current: 25 mA

Switch-on impedance: 100 ohm

Switch-off impedance: 100,000 ohm

Current limiting: Input to 50 mA

Actuation: Switch actuates at 0.65 lb/hr max. of O<sub>2</sub>  
Switch deactuates at 0.50 lb/hr min. of O<sub>2</sub>

#### 236 WATER DIFFERENTIAL TEMPERATURE TRANSDUCER

Spec. no: SVHS 3224

Spec. wt: 5.0 oz including both sensors and lead wires

Function: Senses difference in temperature between suit coolant inlet and outlet streams, provides input signal to telemetry system proportional to difference.

Description: Two matched half-bridge temperature sensors and housings installed in suit coolant inlet and outlet line. Each sensor includes two active arm-half bridges, together forming complete differential bridge.

Operating temperature: 45° to 90° F

Operating pressure: 3.7 to 50 psid

Flow rate: 4.0 lb/min

Excitation: Bridge excited by regulated supply of 10 Vdc with resistance of 8860 ohm in series with supply.

Bridge impedance:  $R_0$  is 2050 ohm

Error band: Less than 3.0% of output at temperature differential of 8.5° F.

Range: 0° to 15° F differential with corresponding output of 0 to 30 mV.

#### 238-1 FEEDWATER FLOW INDICATOR

Spec. no: Dwg SV718724

Spec. wt: Included in canister/reservoir assembly

Function: Indicates when feedwater reservoir is fully charged.

While reservoir is being filled, bubbles appear in sight glass until charging is complete, at which time sight glass becomes clear.

#### 239 FEEDWATER PRESSURE TRANSDUCER AND SWITCH

Spec. no: SVHS 3867

Spec. wt: 3.0 oz excluding lead wires

Function: A pressure-sensing bellows actuating a potentiometer resistance element senses water pressure in feedwater line and develops signal for input to telemetry system.

Construction: Stainless steel case, hermetically sealed vacuum reference chamber.

Operating temperature: 32° to 160° F.

Operating pressure: 21 psia to  $10^{-14}$  mm Hg

Excitation: Potentiometer excited by 10 Vdc

Resistance: Total of potentiometer is 2000 ohm

Signal output: Linear 0 to 10 V output into 100,000 ohm load for 0 to 5 psia input pressure.

Error band: Static terminal band does not exceed 2% of output span (absolute error = 0.075 psia).

Current capacity: 10 mA

Switch actuation: 1.3 to 1.6 psia.

#### 241-1, 252 LiOH CANISTER - RESERVOIR ASSEMBLY

Spec. no: SVHS 3230

Spec. dry wt: 9.56 lb including reservoir assembly, bladder, canister cover, feedwater reservoir vent system, fill, vent and drain fittings, and mounting bolts.

##### Function:

Feedwater reservoir.

1. Supply feedwater to sublimator.
2. Store condensed H<sub>2</sub>O collected by water separator when PLSS is operating.

Canister housing.

1. Enclose LiOH cartridge in leaktight structure during PLSS operation.
2. Provide system gas flow continuity through cartridge during PLSS operation.

Reservoir capacity: 8.65 lb of water, discharge capability of 8.3 lb of water when subjected to 0.6 psi differential pressure.

Pressure drop: 1.10 in. of water with charged cartridge, 7.94 lb/hr gas flow, inlet temperature of 80°F, inlet pressure of 3.7 psia, and inlet dewpoint of 54° to 76°F.

##### Operating temperatures:

Canister = 70° to 90°F inlet, 70° to 140°F outlet.

Reservoir = 33° to 120°F.

## 241-2 LiOH CARTRIDGE

Spec. no: 2836

Spec. wt: 4.5 lb, 5.1 lb in sealed protective container

Function: LiOH removes CO<sub>2</sub>, charcoal removes odors.

Operating pressure: 3.7 to 5.8 psia.

Operating temperature: 45° to 130° F.

Activated charcoal: 0.32 lb

LiOH: 3.0 to 3.2 lb

Pressure drop: 0.75 in. of H<sub>2</sub>O at 7.94 lb/hr and 3.86 psia.

Performance:

<u>Flow,</u> <u>lb/min</u>	<u>Total</u> <u>press.</u>	<u>CO<sub>2</sub>,</u> <u>lb/hr</u>	<u>Inlet</u> <u>temp,</u> <u>° F</u>	<u>Inlet</u> <u>rel.</u> <u>humidity,</u> <u>%</u>	<u>Min.</u> <u>endurance,</u> <u>hr*</u>
0.7	5.0	0.2	45 to 130	14	5.3
0.7	5.0	0.2	45 to 130	92	5.3
0.52	3.8	0.2	45 to 130	14	5.3
0.52	3.8	0.2	45 to 130	92	5.3

\*Endurance time = time required for outlet CO<sub>2</sub> partial press. to reach 7.6 mm Hg.

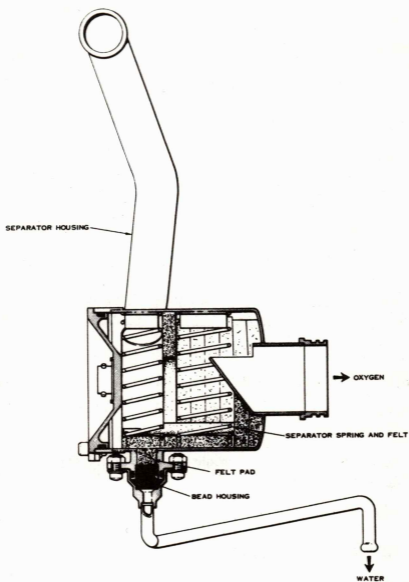
## 242 WATER SEPARATOR (Fig. 5-6)

Spec. no: SVHS 3135

Spec. wt: 0.65 lb

Description: Elbow type, felt wick and glass bead section downstream of wicking.

Construction: Aluminum housing, fused glass bead container is stainless steel.



600D-333

Figure 5-6. Water Separator.

Design condition:

<u>Condition</u>	<u>Requirement</u>
Max. inlet O <sub>2</sub> flow	6.48 lb/hr
Max. inlet CO <sub>2</sub> flow	0.823 lb/hr
Max. inlet steam flow	0.203 lb/hr
Separator orientation	Any orientation
Gravitational field	0 to 1.0 G
Feedwater reservoir quantity	5% to 100% full
Max. sublimator O <sub>2</sub> passage condensing rate	0.508 lb/hr

Max. steady-state water separation rate: 0.508 lb of H<sub>2</sub>O at  
feedwater usage rate of 3 lb of H<sub>2</sub>O/hr.

Water temperature: Separated water is 33° to 65° F.

Pressure drop: 0.36 in. of water

#### 243 FAN MOTOR ASSEMBLY

Spec. no: 3273

Spec. wt: 2.65 lb

Function: Circulates O<sub>2</sub> flow within PLSS and space suit.

Description: Centrifugal fan, brushless dc motor.

Construction: Aluminum housing

Operating fluid temperature: 40° to 90° F.

Operating fluid pressure: 3.3 to 5.0 psia

## Performance:

Fan inlet press. ....	3.61 psia
Fan inlet temp .....	50° F
Fan press. rise .....	4.0 in. H <sub>2</sub> O
Fan O <sub>2</sub> weight flow .....	6.192 lb/hr
Fan CO <sub>2</sub> weight flow .....	0.808 lb/hr
Fan sat. water vapor weight flow .....	0.198 lb/hr
Fan total weight flow .....	7.198 lb/hr
Gas constant (R) of mixture .....	47.8 ft-lbf/lbm-°R
Fan shaft speed .....	16,900 rpm
Fan motor voltage supply .....	16.5 Vdc
Max. power input to motor.....	32.5 W
Motor cooling water flow .....	4.0 lb/min
Motor cooling water inlet press. ....	23.7 psig
Motor cooling water inlet temp.....	45° F
Max. press. drop of cooling water thru motor water cooling compartment .	0.095 psi

High pressure performance: With inlet gas pressure of 5.0 psia, has the performance characteristics listed below.

Fan inlet press. ....	5.0 psia
Fan inlet temp .....	50° F
Fan press. rise .....	4.98 to 5.26 in. H <sub>2</sub> O
Fan total weight flow .....	7.36 to 11.41 lb/hr
Gas constant .....	47.8 ft-lbf/lbm-°R
Fan motor voltage supply .....	16.5 Vdc

### 243-1 FAN MOTOR (Fig. 5-7)

Spec. no: SVHS 3218

Spec. wt: 1.9 lb including 30-in. lead wires

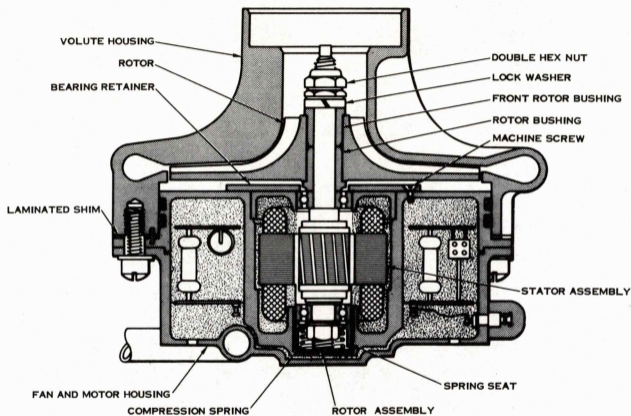


Figure 5-7. Fan Motor.

Function: Powers recirculating fan supplying pressure rise for circulating O<sub>2</sub> flow between suit and PLSS.

Description: An induction-type brushless dc motor, associated electronics packaged within a common housing, and external water cooling jacket.

Working temperature (O<sub>2</sub>): 35° to 125° F.

Working pressure (O<sub>2</sub>): 2.5 to 5.0 psia

Water jacket temperature: 35° to 85° F

Water jacket pressure drop: 0.095 psi at 4 lb/min H<sub>2</sub>O flow and 23.7 psig inlet press.

Voltage: 16.5 Vdc

Speed: 18,000 rpm

Torque: 0.62 in.-oz at 18,000 rpm and 3.61 psia  
0.85 in.-oz at 18,000 rpm and 5.0 psia

Power: 32.5 W

Starting current: 5.75 A at 16.5 Vdc

#### 244-1 INLET OXYGEN CONNECTOR and

#### 244-2 OUTLET OXYGEN CONNECTOR (Fig. 5-8)

Spec. no: SVHS 3822

Spec. wt: 0.14 lb

Function: Manually couple PLSS gas loop to PGA. Shutoff valve in each prevents depressurization of PGA in case of disconnection.

Description: Inlet connector is red, outlet connector blue.

Construction: Aluminum housing

Operating temperature: 0° to 160° F

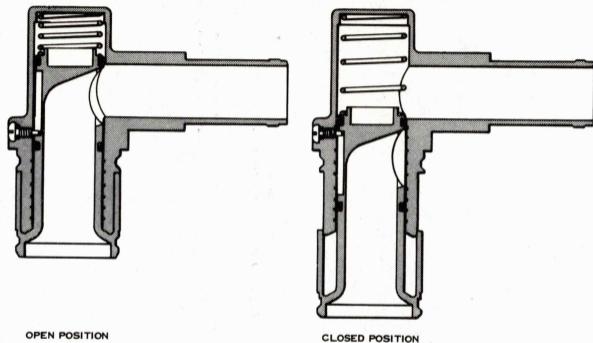


Figure 5-8. Oxygen Inlet (Outlet) Connector.

Operating pressure: 21 psia to  $1 \times 10^{-14}$  mm Hg

Pressure drop: Outlet and inlet no more than 0.31 in. of  $H_2O$  when connected to mating suit connector. Flow rate is 6.5 cfm at 3.9 psia and  $70^\circ$  to  $80^\circ F$ .

Hose: Steel coil frame covered with Dacron, which is covered with silicone rubber. Cuffs at end of hose are also silicone rubber.

Force to couple: Does not exceed 20 lb when pressurized.

#### 245 PLSS BACKFLOW CHECK VALVE

Spec. no: SVHS 4284

Spec. wt: 0.13 lb

Function: Prevents flow split from OPS through PLSS that would reduce amount of  $O_2$  reaching helmet.

Construction: Aluminum housing

Pressure drop: Across body and reeds and housing, does not exceed 0.25 in. of water with max. flow rate of 7.94 lb/hr of  $O_2$  and max. inlet pressure of 3.7 psia at  $70^\circ F$ .

Internal leakage: In reverse flow direction, does not exceed 0.5 lb/hr with back pressure of 3.80 psia and inlet pressure of 3.70 psia at  $70^\circ F$ .

#### 251 SUBLIMATOR (Fig. 5-9)

Spec. no: 3130

Spec. wt: 6.05 lb

Function: Transfers heat from liquid transport water circuit and oxygen circuit to feedwater circuit, rejects heat to space by subliming feedwater.

Construction: Stainless steel fluxless-brazed to nickel porous-plate sections.

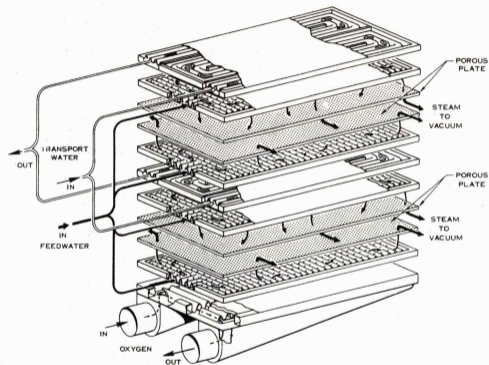
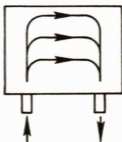


Figure 5-9. Sublimator.

Type of flow:

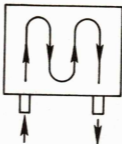
Oxygen

2-pass  
1 path



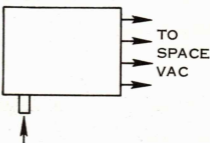
Transport water

4-pass  
2 paths



Feedwater

1-pass elbow bend  
4 paths



Performance:

Design point heat load (transport water circuit). Cools transport  $H_2O$  to  $45^\circ F$  max., with inlet conditions of 4.0 lb/min min. and temperature of  $54.1^\circ F$  min.

Minimum heat load (transport water circuit). Operates with inlet temperature of  $79^\circ F$  and flow rate of 0.14 lb/min without freezing transport water circuit.

Maximum heat load ( $O_2$  circuit). Cools  $O_2$  to  $50^\circ F$  max. with inlet conditions of 7.707 lb/hr min. total weight flow and inlet temperature of  $130^\circ F$  min. and pressure of 3.63 psia.

Minimum heat load ( $O_2$  circuit). Operates with inlet temperature of  $72^\circ F$  max. and weight flow total of 7.707 lb/hr max. which includes 0.23 lb/hr max. of  $H_2O$  without freezing  $H_2O$ .

Pressure drop (transport water circuit). Does not exceed 0.728 psi at a min. flow rate of 4.0 lb/min and mean water temperature of 50° F.

Pressure drop (O<sub>2</sub> circuit). Does not exceed 0.861 in. of water for inlet conditions of 7.707 lb/hr weight flow and inlet temperature of 130° F min.

Feedwater operating pressure. Feedwater is supplied to sublimator from a reservoir. Pressure into sublimator varies from 1.8 to 3.2 psia.

Oxygen circuit operating pressure. Inlet pressure is 3.63 psia.

Transport circuit inlet pressure: 3.5 to 21.0 psia.

#### 252 FEEDWATER RESERVOIR ASSEMBLY

See Item 241-1 on p. 5-26.

#### 253 WATER SHUTOFF AND RELIEF VALVE (Fig. 5-10)

Spec. no: 3140

Spec. wt: 0.22 lb

Function: Provides manual on/off feedwater and drainwater control, and means of relieving excess pressure in feedwater loop.

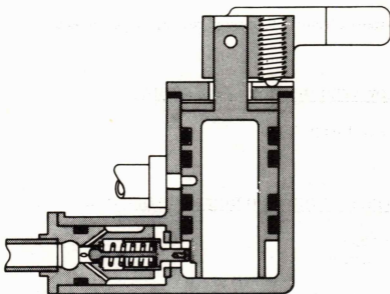
Fluid temperature: Operates with water temperature between 33° and 130° F.

Fluid pressure: Operates with water pressure between 3.7 psia and 50 psig.

Relief valve pressure: Max. of 65 psig.

Reseat pressure: 40 psig min.

Handle torque: 5 in.-lb max.



600D-356

Figure 5-10. Water Shutoff and Relief Valve.

Pressure drop: In the open position, does not exceed 0.07 psi at min. feedwater flow of 3.0 lb/hr and inlet pressure of 3.5 psig.

Leakage:

Feedwater-drainwater. Does not exceed 0.5 cc of H<sub>2</sub>O for 15 min at 66 psig.

Relief valve. Does not exceed 0.3 cc of water for 15 min at 11 psig.

#### 253-1 FLOW LIMITER (Fig. 5-11)

Spec. wt: 0.17 lb

Function: Prevents excessive flow from entering 251 Sublimator.

Construction: Aluminum housing

Flow characteristics: At inlet pressure of 3.0 psig and 75° F, flow rate is 80 to 90 ml/min water.

#### 254 WATER FILL CONNECTOR (Fig. 5-12)

Spec. no: SVHS 2700

Spec. wt: 0.09 lb

Function: Provides means of manually coupling/uncoupling vehicle water supply system to/from feedwater loop and transport water loop of PLSS and drink gun connector.

Construction: Steel housing, aluminum cap.

Operating temperature: 33° to 160° F

Fluid pressure: Operates with fluid at any pressure between 7 and 50 psig.

Force to couple: Does not exceed 24 lb. Force required to couple pressure cap does not exceed 18 lb.

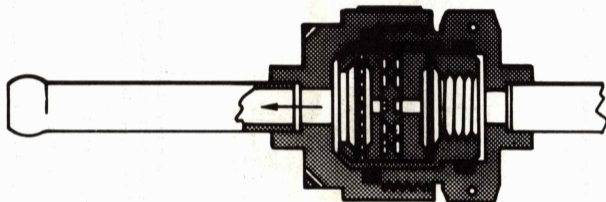


Figure 5-11. Flow Limiter.

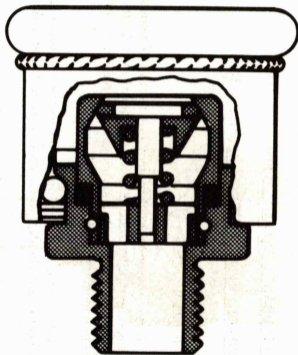


Figure 5-12. Water Fill Connector.

Force to uncouple: Does not exceed 18 lb. Force required to uncouple pressure cap does not exceed 12 lb.

Spillage: Fluid spillage does not exceed 0.01 gram/cycle with connector pressurized with water between 7 and 50 psig.

Air inclusion: Max. inclusion/cycle does not exceed  $1 \times 10^{-3}$  in.<sup>3</sup> with internal water pressures of 7 to 50 psig.

Pressure drop: Does not exceed 1.0 psi with min. water flow rate of 1.6 lb/min.

#### 255 WATER DRAIN CONNECTOR and

#### 256 RESERVOIR VENT CONNECTOR (Fig. 5-13)

Spec. no: SVHS 3142

Spec. wt: 0.095 lb

Function: Water drain connector provides means of manually coupling/uncoupling vehicle waste removal system to/from vehicle relief receptacle and backside of feedwater bladder where condensed water is stored.

Reservoir vent connector bleeds off excess nitrogen gas from reservoir bladder when reservoir is filled with water.

Construction: Steel housing, aluminum cap

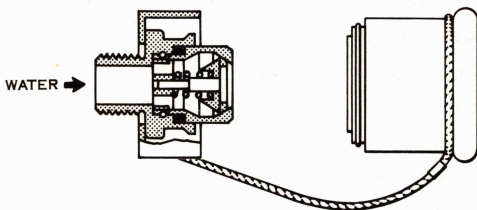
Fluid temperature: 33° to 160° F

Fluid pressure: 0 to 50 psig

Force to couple: Does not exceed 18 lb. Force to mate pressure cap does not exceed 18 lb.

Force to uncouple: Does not exceed 18 lb. Force to disconnect pressure cap does not exceed 18 lb.

Pressure drop: Does not exceed 0.6 psi with min. fluid flow rate of 1.6 lb/min.



600D-178

Figure 5-13. Water Drain (Reservoir Vent) Connector.

## 257 FLOW LIMITER

Function: Limits water flow in feedwater loop prior to sublimator.

## 262 PUMP/MOTOR ASSEMBLY (Fig. 5-14)

Spec. no: SVHS 3318

Spec. wt: 1.4 lb

Function: Circulates liquid coolant through tubing of suit, heat exchanger, and control elements.

Description: Diaphragm pump, brushless motor driven.

Fluid temperature: 35° to 100° F

Fluid pressure: 9.35 to 20 psia

Performance:

Pressure rise across unit .....	5.65 psi
Coolant flow .....	4.0 lb/min
Input voltage .....	16.5 Vdc
Inlet pressure .....	18.7 psig
Power consumption .....	10 W
Inlet temperature .....	53.8° F
Pump/motor can operate at .....	20.5 Vdc
Starting current .....	Not more than 2.0 A

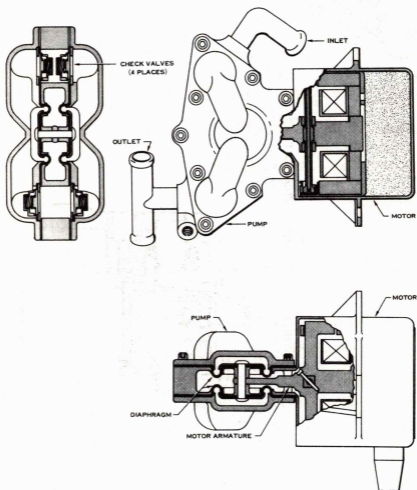
## 263 WATER DIVERTER VALVE (Fig. 5-15)

Spec. no: SVHS 3313

Spec. wt: 0.30 lb

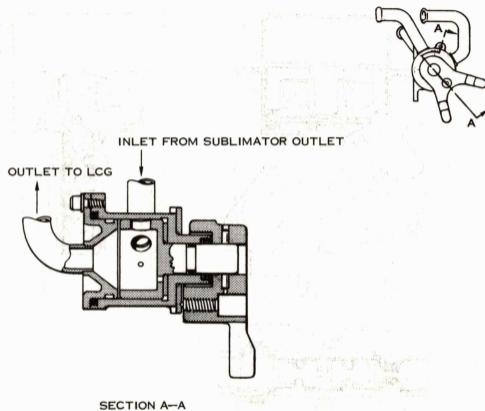
Function: Provides three different mixing ratios of two entering coolant streams to produce coolant temperature desired at inlet to suit.

Construction: Aluminum body



600D-358

Figure 5-14. Pump/Motor Assembly.



600D-349

Figure 5-15. Water Diverter Valve.

Handle rotation: 90°

Handle torque: 3 to 5 in.-lb

Handle position: Full up ..... Minimum cooling  
45° down from Min ..... Intermediate cooling  
90° down from Min ..... Maximum cooling

Pressure drop: With valve in max. position and inlet flow of  
4 lb/min water at room temperature, no more than 0.464 psi.

Steady-state flow rates:

<u>Valve position</u>	<u>Main line inlet, lb/min</u>	<u>Bypass inlet, lb/min</u>	<u>Valve outlet, lb/min</u>
Maximum cooling	4.0	0.00	4.0
Inter- mediate	0.50	3.50	4.0
Minimum	0.14	3.86	4.0

#### 264 MULTIPLE WATER CONNECTOR (Fig. 5-16)

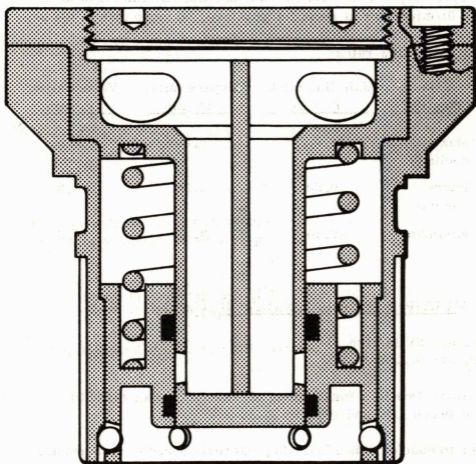
Spec. no: SVHS 3128

Spec. wt: 0.23 lb

Function: Provides for coupling of transport water circuits  
between LCG and PLSS at PGA.

Force to couple: When inserting external connector into housing  
with internal connector in place, does not exceed 27 lb at  
23 psig water press.

When inserting external connector into its stowage pad, does  
not exceed 20 lb at 23 psig water pressure.



600D-230

Figure 5-16. Multiple Water Connector.

## 266 CHECK VALVE ASSEMBLY (Fig. 5-17)

Spec. no: SVHS 4282

Spec. wt: 0.23 lb

Function: Allows feedwater from feedwater supply loop to replenish transport water loop as required, isolates loops from each other when transport water pressure is within acceptable limits.

Check function: Opens and allows flow when pressure in feedwater loop exceeds pressure in transport water loop.

Construction: Aluminum body

Pressure drop: Across check valve, less than 0.144 psi with water flow of 0.03 lb/min, less than 1.0 psi with water flow of 0.85 lb/min.

Relief function:

Cracking pressure. Valve closed at any differential pressure of 18 psi or less, fully open to limit maximum differential pressure to 23 psi.

Pressure drop and flow. Relieves up to 4 lb of water/hour at differential pressure of 23 psi.

Internal leakage: With pressure differential of 0.5 to 18.0 psi, less than 0.12 cc of water/hr.

## 268 GAS SEPARATOR

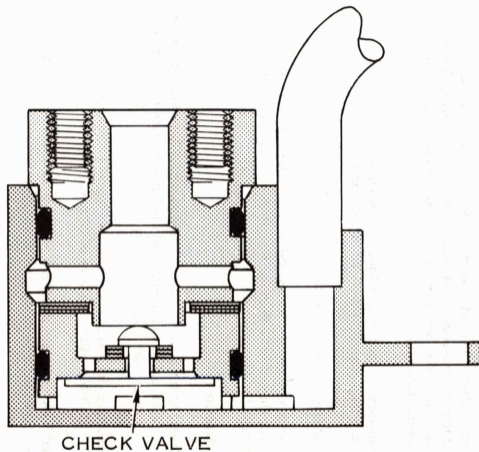
Spec. no: SVHS 4736

Spec. wt: 0.5 lb

Type: Hydrophilic screen

Collection capacity: 30 acc min. at 4.0 lb/min water flow rate

Pressure drop: 0.6 psi max.



600D-2.73

Figure 5-17. Check Valve Assembly.

#### 271 PRIMARY OXYGEN BOTTLE

Spec. no: SVHS 3122

Spec. wt: 3.50 lb

Description: A cylinder with approximately hemispherical ends, one port, and two mounting bosses.

Construction: 302 stainless steel

Capacity: 1.12 lb O<sub>2</sub> at 850 psig and 78° F

Proof pressure: 1665 psig

Temperature limits: -5° to 165° F

#### 272 PRIMARY OXYGEN FILL CONNECTOR (Fig. 5-18)

Spec. no: SVHS 3138

Spec. wt: 0.18 lb

Function: Used to manually connect primary O<sub>2</sub> bottle to LM high-pressure O<sub>2</sub> source.

Operating temperature: 0° to 160° F

Operating pressure: 0 to 1110 psig

Engagement-disengagement force: 25 lb

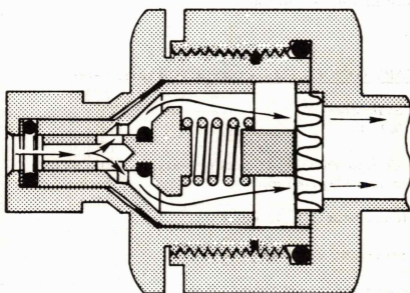
Pressure drop: 20 psi with flow rate of 3 lb/hr O<sub>2</sub> at 70° F and 100 psig.

#### 273 PRIMARY OXYGEN REGULATOR ASSEMBLY (Fig. 5-19)

Spec. no: SVHS 3127

Spec. wt: 1.1 lb

Function: Maintains the O<sub>2</sub> flow.



600Z-96

Figure 5-18. Primary Oxygen Fill Connector.

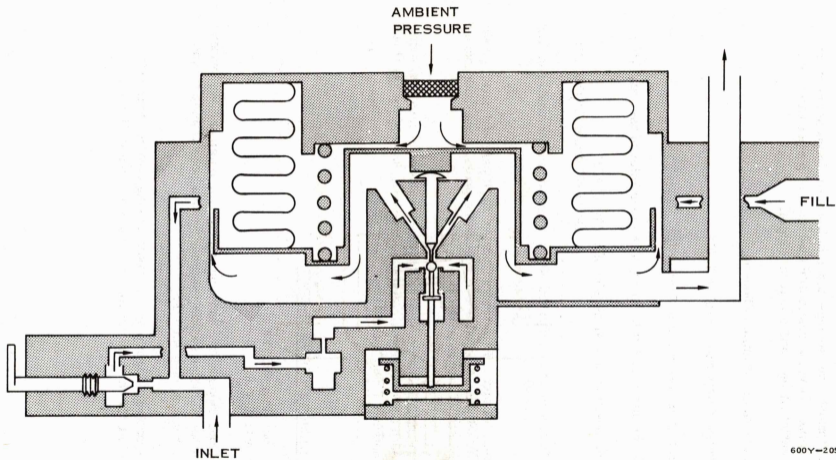


Figure 5-19. Primary Oxygen Regulator Assembly.

Description: One spring-loaded bellows or diaphragm-driven poppet valve, a restrictor upstream of poppet valve, an outlet fitting, and a manual shutoff.

Construction: Aluminum housing

Operating temperature: 0° to 130°F

Operating pressure: 0 to 1110 psig.

Flow capacity: 0.360 lb/hr O<sub>2</sub> at 85 psig inlet press. and 70°F.

Handle position on manual shutoff: Up is OFF  
Down 90° from OFF is ON

Detent must be actuated before valve can be moved from ON to OFF.

Internal leakage: With inlet press. of 1110 psig and outlet press. maintained 0.1 psi above regulating press., does not exceed 25 scc of nitrogen/minute.

Regulating pressure: With reference pressure of lunar vacuum, outlet pressure maintained at 3.75 to 4.05 psid for O<sub>2</sub> flow between 0 and 2.0 lb/hr.

#### 289 REMOTE CONTROL UNIT

Spec. no: Dwg 721783

Spec. wt: 5.0 lb

Function: Houses five warning indicators, pump and fan switches, mode selector switch, volume control potentiometer, and activating ring for OPS.

Construction: Aluminum and epoxy casing covered with beta-cloth thermal insulation and final covering of fire tape.

## 5.2 OPS COMPONENTS

## 511 OXYGEN PURGE SYSTEM BOTTLE

Spec. no: SVHS 4049

Spec. wt: 9.5 lb

Description: A spherical bottle containing two ports, two mounting bosses, and an internal heat exchange tube.

Construction: Inconel 718

Operating temperature: -130° to 130°F

Operating pressure: 0 to 6750 psia

Volume: 2.85 lb O<sub>2</sub> at 5880 psia and 70°F

## 512 REGULATOR ASSEMBLY (Fig. 5-20, -21, & -22)

Spec. no: SVHS 4046

Spec. wt: 4.2 lb

Functions:

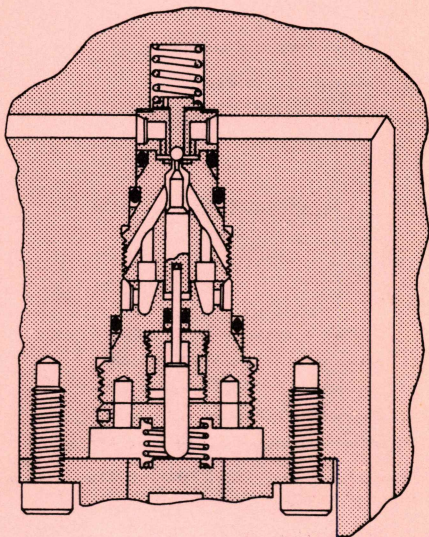
1. Controls O<sub>2</sub> pressure from O<sub>2</sub> bottles to PGA.
2. Activates or deactivates OPS via a cable.
3. Provides facility for charging OPS bottles.
4. Preheats O<sub>2</sub> flowing from bottles to PGA.
5. Indicates pressure during and after charging.

Description: A regulator, shutoff valve, fill valve, pressure gage, and heater assembly.

Construction: Aluminum housing

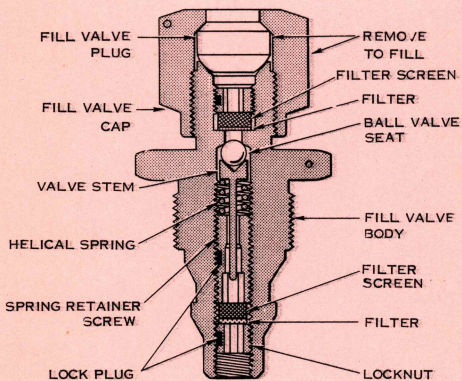
Operating temperature (to heater): -130° to 125°F

Operating pressure: 500 to 6750 psig.



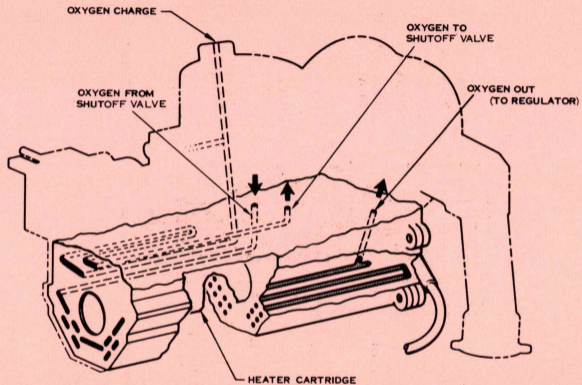
600D-275

Figure 5-20. Regulator Assembly Shutoff Valve.



600D-366

Figure 5-21. Regulator Assembly Fill Fitting.



600D-370

Figure 5-22. Regulator Assembly Heater.

Flow capacity: 9.0 lb/hr O<sub>2</sub> at supply press. of 500 psi.

Internal leakage: With inlet pressure of 8700 psig and outlet pressure maintained 0.1 psi above regulating pressure, does not exceed 25 scc of O<sub>2</sub> or equivalent gas/min.

Leakage across on-off valve, with valve supply pressure of 6750 psig and valve in off position, does not exceed one scc of O<sub>2</sub>/hr.

Pressure gage accuracy: ±750 psi over full scale

Heater: 24.4 to 33.6 Vdc with resistance of 5.0 ohm

### 513 OXYGEN CONNECTOR

See Item 244-1.

Function: Connects OPS oxygen supply to suit inlet in the event of PLSS failure.

### 521 OPS POWER SUPPLY

Spec. no: SVHS 4042

Spec. wt: 5.35 lb when charged with electrolyte

Function: Provides electrical power to operate heating system, controller, and sensors.

Description: A battery of vented cells employing silver and zinc electrodes. Cells are packaged in leak-proof vented container.

Rating:

<u>Battery output, Vdc</u>	<u>Reqd battery discharge, Adc</u>	<u>Battery power output, W</u>
33.7 (max. open circuit)	----	-----
30.6 (max. w/load)	5.84	178.0
27.0 (nominal)	5.15	139.0
25.2 (min. plateau)	4.80	121.0
20.0 (min. initial)	3.81	76.2

At intermediate voltage, required discharge current is directly proportional to ratio of intermediate voltage to nominal voltage.

Discharge voltage variation. Max. discharge voltage does not exceed 33.7 V. Decreases from peak to 28.0 V max. within first five minutes of discharge cycle.

Pressure relief: Internal case pressure does not exceed 8.0 psig.

## 522 HEATER CONTROLLER

Spec. no: SVHS 4153

Spec. wt: 0.95 lb

Function: An on-off device used to switch power to heater to control oxygen temp in OPS.

Construction: Hermetically sealed electronics

Switching point (heater activated): Adjustable within O<sub>2</sub> temperature range of 30° to 80° F. Initial setpoint is 65° F.

Accuracy: Regulates O<sub>2</sub> temperature within maximum dead band error of ±5.5 k ohm at initial setpoint.

Power: 8 W max.

Voltage: 26.5 Vdc at 4.8 A

523 POWER ON-OFF SWITCH (Fig. 5-23),

524-1 CHECKOUT SWITCH

Spec. no: SVHS 4171

Spec. wt: Power on-off switch = 0.216 lb

Checkout switch = 1.5 oz

Current rating: Power on-off switch = 10 A

Checkout switch = 7 A

Leakage resistance: Between case and heads, 100 M $\Omega$  min. as measured with 100 Vdc.

Actuation force: Power on-off switch = 0.65 to 1.4 lb

Checkout switch = 1 to 4 lb

Contact resistance: Power on-off switch = 0.1 ohm max.

Checkout switch = 0.1 ohm max.

524-2 CHECKOUT LAMP (Fig. 5-24)

Spec. no: SVHS 3302

Spec. wt: 0.36 oz

Function: Used to check continuity in OPS heater circuit.

Construction: Environmentally sealed

Voltage: 25 to 31 Vdc

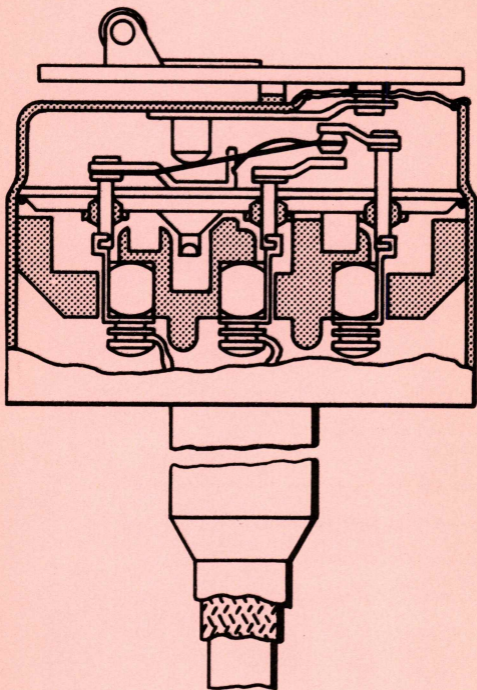
Current: Less than 400 mA

Candlepower: 0.3 min.

525 TERMINAL BOARD

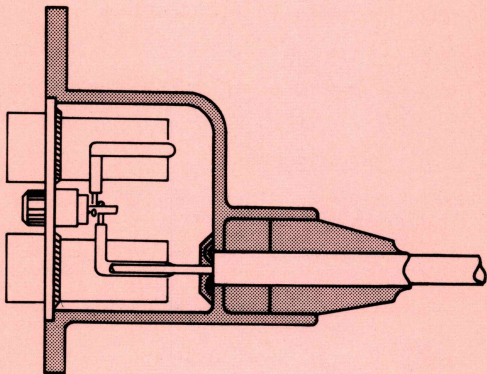
Spec. no: SVHS 4159

Spec. wt: 1.28 oz



600D-259

Figure 5-23. Power On-Off Switch.



600D-263

Figure 5-24. Checkout Lamp.

Function: Interconnects following items.

<u>Item</u>	<u>Nomenclature</u>
521	OPS Power Supply
522	Heater Controller
523	Power On-off Switch
524-1	Checkout Switch
524-2	Checkout Lamp

Voltage: Withstands max. of 34 Vdc and ac

Current: 7.0 A min.

Resistance: Between connected terminals, less than 0.04 ohm.

#### 526 OPS TEMPERATURE SENSOR

Spec. no: SVHS 4206

Spec. wt: 0.063 lb excluding lead wires

Function: Detects temperature of O<sub>2</sub> flow into PGA during use of OPS. Sensor signal used as input to heater controller.

Description: A thermistor that varies output voltage with temperature variations.

Operating temperature: -100° to 90° F

Operating pressure: 2.5 to 21.0 psia

Flow conditions: 0.07 to 8.0 lb/hr O<sub>2</sub> at 3.5 psia

Resistance: 220,000 ohm at 30° F  
93,000 ohm at 60° F  
43,000 ohm at 90° F

Accuracy:  $30^{\circ}$  to  $60^{\circ} \pm 2^{\circ}\text{F}$   
 $60^{\circ}$  to  $80^{\circ} \pm 1^{\circ}\text{F}$   
 $80^{\circ}$  to  $90^{\circ} \pm 2^{\circ}\text{F}$

Power: 0.7 mW

#### 536 REGULATOR CHECKOUT PRESSURE GAGE

Spec. no: SVHS 4205

Spec. wt: 0.25 lb

Function: Used to verify performance of OPS regulator by checking outlet pressures.

Operating temperature:  $-100^{\circ}$  to  $100^{\circ}\text{F}$

Operating pressure: 2.5 psia to 5.0 psid

Dial face and pointer display:  $150^{\circ}$  sweep. Warning indication extends from 3.2 psid to 3.8 psid.

Leakage: Less than  $1.5 \times 10^{-4}$  scc/sec helium

Accuracy:  $\pm 0.02$  psi.

B 231