

APOLLO PORTABLE LIFE SUPPORT SYSTEMS



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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
BSLSS	Buddy Secondary Life Support System
PCV	Pressure Control Valve

INTRODUCTION

This booklet, intended for field personnel, explains the basic function and operation and lists the salient component parameters for the following Second Generation Apollo Portable Life Support Elements:

- a) Portable Life Support System (PLSS)
- b) Oxygen Purge System (OPS)
- c) Buddy Secondary Life Support System (BSLSS)
- d) Pressure Control Valve (PCV)

These systems are described 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.

A detailed description of all key components is provided with determination of function, operating characteristics, and cross sectional illustrations.

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
Buddy Secondary Life Support System	Gold
Pressure Control Valve	Tan

SECTION 1.0

PORTABLE LIFE SUPPORT SYSTEM DESCRIPTION

1.0 PORTABLE LIFE SUPPORT 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.

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).

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

PLSS mission duration as a function of expendables depletion vs. metabolic load is shown in Figure 1-1

Figure 1-2 shows the interconnections between the PLSS subsystems, the PGA and the LM vehicle.

* The -7 PLSS described here is an extended - duration version of the -6 PLSS which was used on Apollo 11 thru 14. It will be used for remaining Apollo missions 15 thru 17.

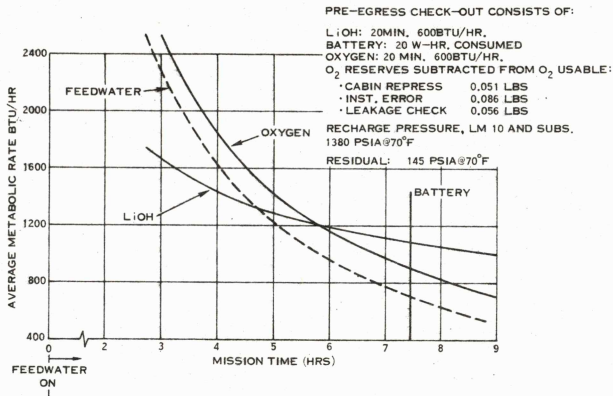


Figure 1 - 1 Expendables vs Metabolic Load

OXYGEN

WATER

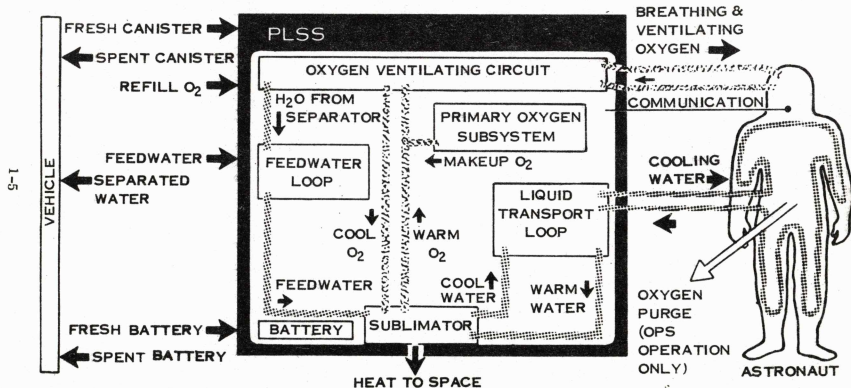


Figure 1-2 PLSS Interfaces & Subsystems

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). Transmitter on 259.7 MHz, receiver on 296.8 MHz.
2. Secondary (backup) mode - Duplex voice communication between either astronaut and the LM (LM must be switched to secondary mode). Transmitter on 296.8 MHz, receiver on 259.7 MHz.
3. Dual mode - Duplex conference between astronaut one, astronaut two, and LM-Earth; simultaneous TM from each astronaut. Transmitter on 259.7 MHz, receiver on 296.8 MHz.

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 1-3, 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.

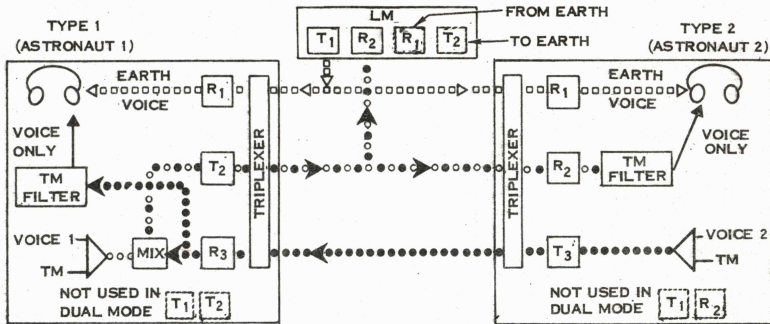


Figure 1-3. Dual EVA EVCS Configuration.

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 ₂ bottle press. transducer	TM
Feedwater press. transducer	TM, warning
LCG differential temp transducer	TM
Sublimator outlet gas temp transducer	TM
High primary O ₂ flow sensor	Warning
Low vent flow sensor	Warning
Battery voltage	TM
CO ₂ sensor	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 feed-water 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 in the EVCS. The specific problem area is indicated by warning flags on the Remote Control Unit (RCU).

Remote Control Unit

The Remote Control Unit (RCU) which is mounted on the chest of the PGA, houses electrical controls for the PLSS, primary oxygen quantity indicator, and visual OPS Actuator mechanism. The controls are: Fan On-Off Switch, Pump On-Off Switch, Push-to-Talk Switch (which can override the voice-operated switch normally used in the communication system), communication system Volume Control and a communication system Mode Selector Switch.

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.

An audible warning signal is given to the astronaut if certain parameters fall outside desired limits, and visual identification of the problem is given by small "flags" or indicators on the RCU. Warnings are sounded for low feedwater pressure, low ventilation flow, low PGA pressure and high oxygen flow.

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.

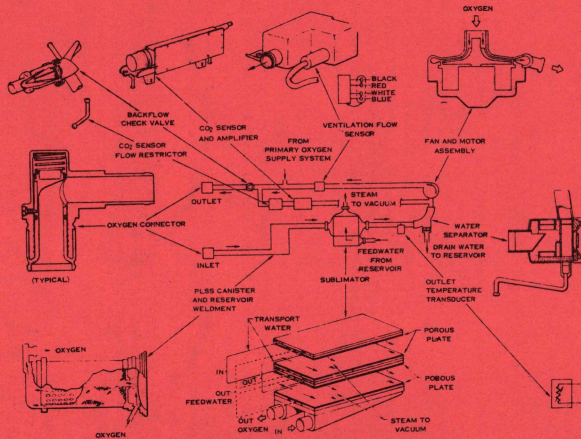
Figures 1-4 and 1-5 are electrical schematics of the mode selector switch and alarm system, and telemetry.

1.2 OXYGEN VENTILATING CIRCUIT

The oxygen ventilating circuit (Fig. 1-6) 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. The oxygen enters the suit ventilation distribution system and picks up heat, moisture, and metabolic byproduct contaminants as it passes through the suit adjacent to the man's body. This warm, moist, contaminated gas then is transported to a contaminant control package, which consists of an activated charcoal bed for absorption of trace contaminant gasses, and a lithium hydroxide bed, which reacts with carbon dioxide to form lithium carbonate. By-products of this chemical reaction are heat and moisture, which are added to that already carried by the recirculating gas stream. The gas stream then enters a heat exchanger where the heat is given up, and the excess moisture in the stream is condensed. Upon leaving the heat exchanger, or sublimator, as it is called, free water is removed from the gas stream by an elbow water separator, and transferred to the backside of the sublimator feedwater reservoir diaphragm. The stream then goes to a centrifugal fan which supplies the energy for overcoming the pressure drop in the PGA-PLSS system. The fan is driven by an electric motor which draws its power from a silver-zinc battery. Some heat is added to the stream due to fan efficiency. After passing through a back flow check valve, the cooled, dried, decontaminated gas is returned to the suit for recycling.

In addition to providing oxygen circulation, the oxygen ventilating circuit pressurizes the feedwater bladder to expel water from the main reservoir and auxiliary reservoir assemblies to the sublimator.



600Y-212

Figure 1-6. Oxygen Ventilating Circuit Schematic

1.3 FEEDWATER LOOP

The feedwater loop (Fig. 1-7) consists of a bladder in a main reservoir and auxiliary reservoir, a water fill connector, two reservoir vent connectors, water drain connector, two feedwater vent indicators (sight glass), main and auxiliary water shutoff and relief valves, 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.

Both feedwater reservoirs are 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 main 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.

The auxiliary water shutoff and relief valve performs the same functions as the main valve when the auxiliary reservoir is in use except that water from the water separator does not flow through the auxiliary water shut-off valve.

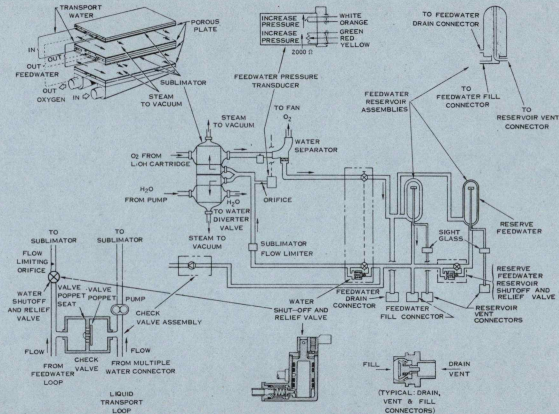


Fig. 1-7 Feedwater Loop Schematic

1.4 LIQUID TRANSPORT LOOP

The liquid transport loop (Fig. 1-8) 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.

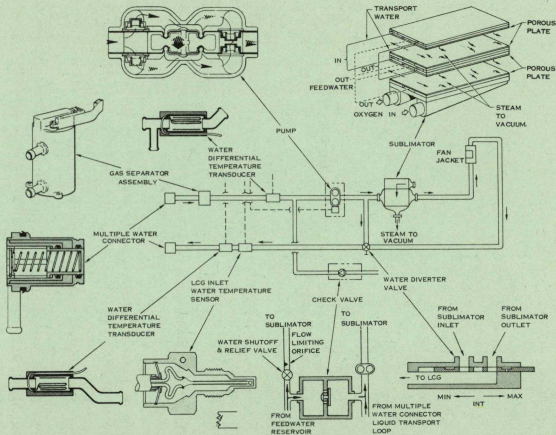


Fig. 1-8 Liquid Transport Loop Schematic

600Y-214A

1.5 PRIMARY OXYGEN SUBSYSTEM

The primary oxygen subsystem (Fig. 1-9) 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.

Pure gaseous oxygen is stored in the primary bottle and admitted to the suit to make up for leakage losses and metabolic consumption. The single-stage in-flow pressure regulator maintains a suit pressure level of approximately 1/4 atmosphere. Recirculation of oxygen is limited to that required for proper carbon dioxide purging from the helmet and defog the visor. 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.

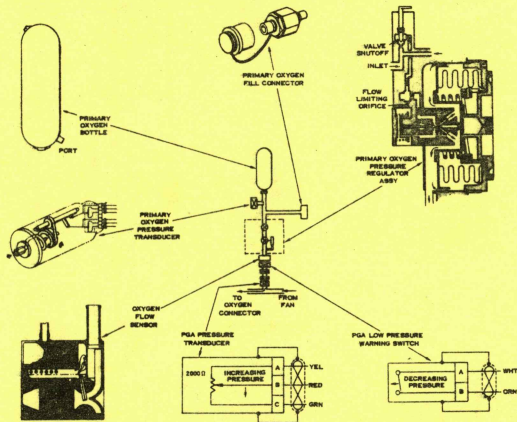
The oxygen shutoff valve is closed when the PLSS is not in use or when the primary oxygen subsystem is being charged. The orifice limits the flow of oxygen to the PGA in the event of regulator failure.

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.



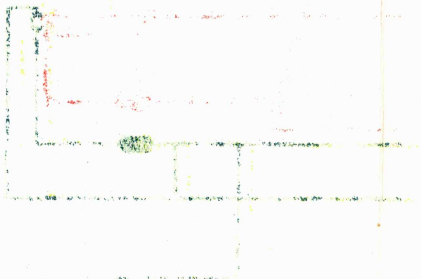
600Y-204

Figure 1-9. Primary Oxygen Subsystem Schematic.

1.6 SYSTEM SCHEMATIC AND HARDWARE

Figure 1-10 is a complete schematic of the Apollo PLSS.

Figures 1-11 through 1-14 show the hardware for the sub-systems discussed previously and actual locations within the PLSS.



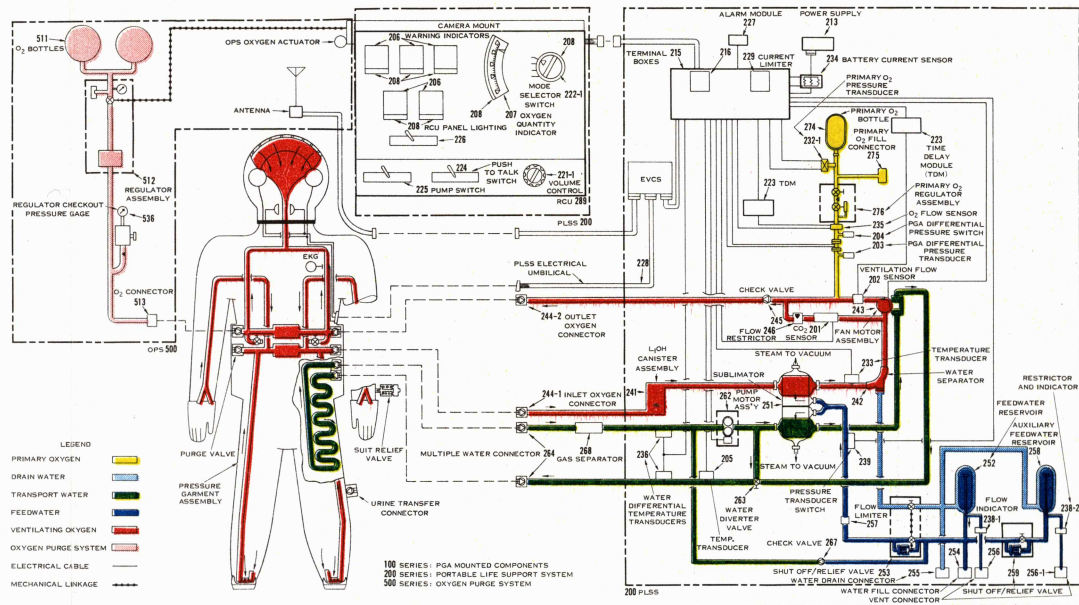


Figure 1-10 Apollo EMU System

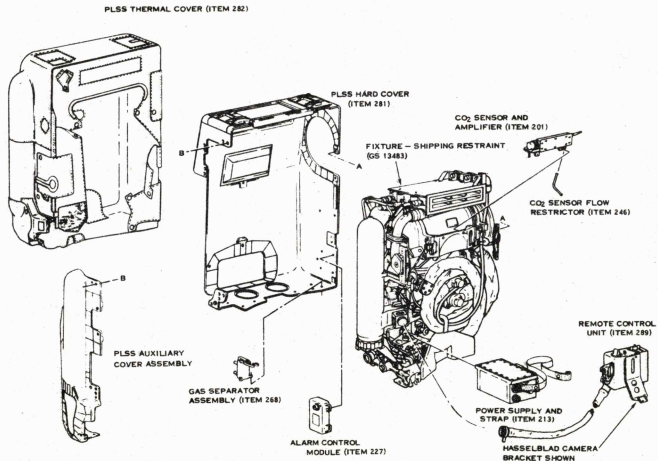
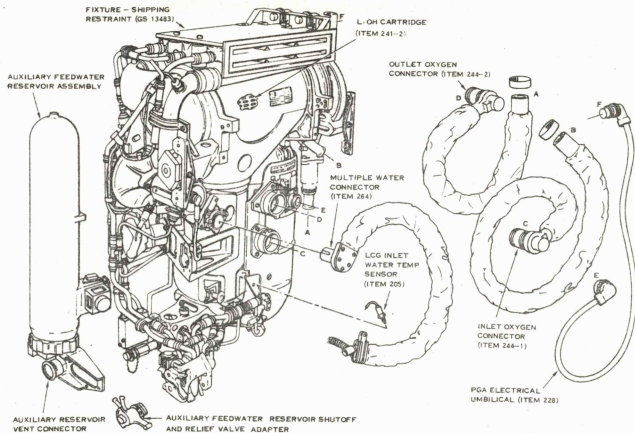


Figure 1-11 App Apollo EMU PLSS Equipment



600D-412A

Figure 1-12 Apollo EMU PLSS Equipment

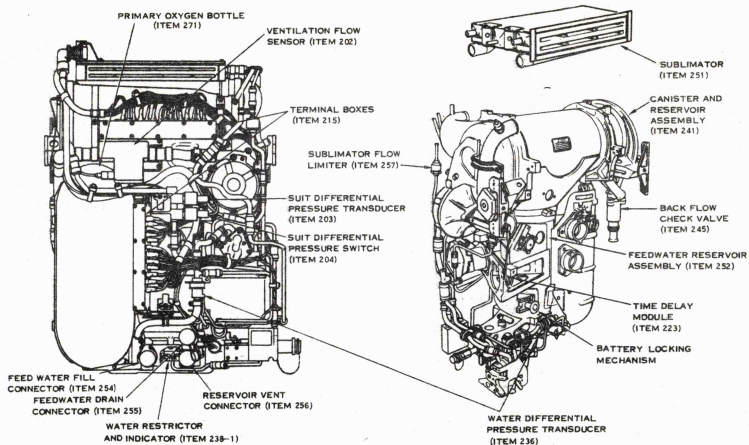


Figure 1-13 Apollo EMU PLSS Equipment

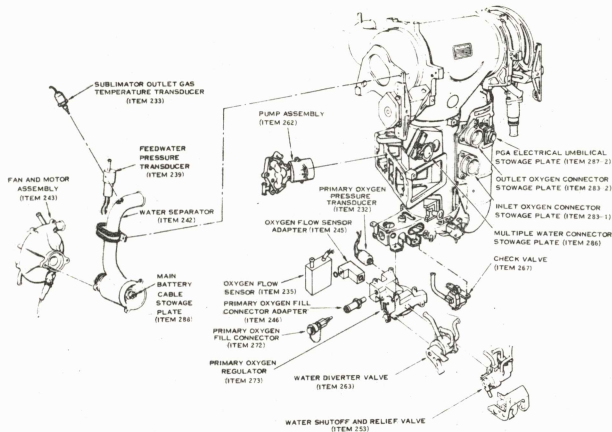


Figure 1-14 Apollo EMU PLSS Equipment

SECTION 2.0

OXYGEN PURGE SYSTEM DESCRIPTION

2.0 OXYGEN PURGE SYSTEM DESCRIPTION

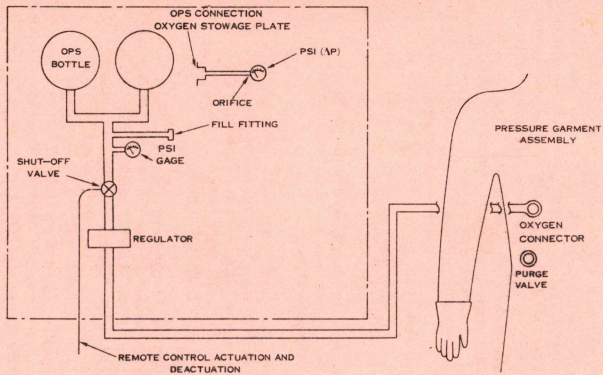
The Oxygen Purge System (OPS), shown in Figure 2-1, consists of a pair of spherical tanks which hold 5.8 pounds of pure gaseous oxygen at 5800 psi, a shut-off valve which is manually operated by means of a flexible cable and actuator lever assembly, and a single-stage in-flow pressure regulator that regulates PGA pressure to approximately $1/4$ atmosphere. A gage indicates the tank pressure level. A second low range gage, along with a fixed orifice, is used to test for proper regulator performance. Both tank pressure and regulator performance are checked before committing to an EVA. The fold down ribbon antenna for the communications system is mounted on top of the OPS.

The OPS can be utilized in three ways:

1. It can serve as a replacement for the primary oxygen supply with the remaining PLSS functions continuing normally;
2. With the "purge" valve in the PGA set on "low", four pounds per hour of oxygen can be passed through the PGA to remove carbon dioxide and humidity with liquid cooling supplied by the BSLSS or PLSS; or
3. With the "purge" valve in the PGA set on "high", eight pounds per hour can be passed through the PGA to remove carbon dioxide and provide cooling when completely independent of the PLSS.

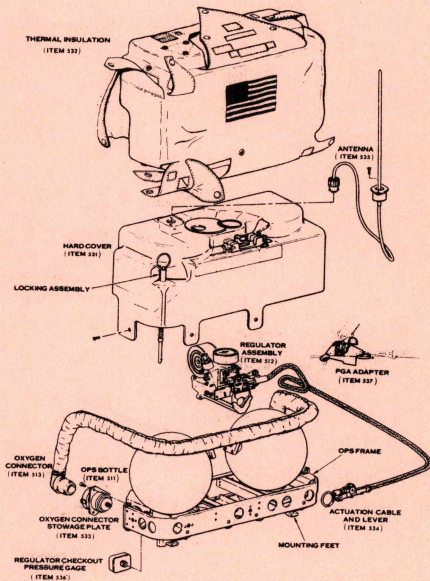
Although normally mounted on top of the PLSS, the OPS can be mounted independently against the back of the helmet or against the abdomen for special zero "G" missions where the PLSS is not required.

Figure 2-2 shows the OPS hardware.



600Y-236

Figure 2-1 Oxygen Purge System



600E-38A

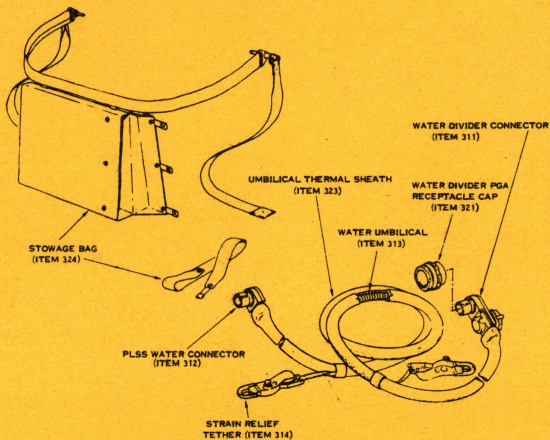
Figure 2-2. OPS Hardware.

SECTION 3.0

BUDDY SECONDARY LIFE SUPPORT SYSTEM DESCRIPTION

3.0 BUDDY SECONDARY LIFE SUPPORT SYSTEM DESCRIPTION

The BLSS, shown in Figure 3-1, consists of a pair of water umbilical hoses with a standard connector on one end and a special divider connector at the other. A tether strap, two snap hooks and an insulation sheath complete the assembly. If one of the crew's PLSS water cooling capacity is impaired or lost, he disconnects the normal PLSS water umbilical and connects the standard connector end of the BSLSS to his suit. The other crewman, whose PLSS is still functioning normally, disconnects his PLSS water umbilical, attaches the divider connector to his PGA, and reconnects the PLSS water umbilical to the other side of the divider connector. The transport water flow from the functioning PLSS is now shared by the two crewmen (see Fig. 3-2). The tether hooks are attached to the PGA walls so that the tether relieves the water hoses of any strain.



600-426

Figure 3-1 Buddy Secondary Life Support System

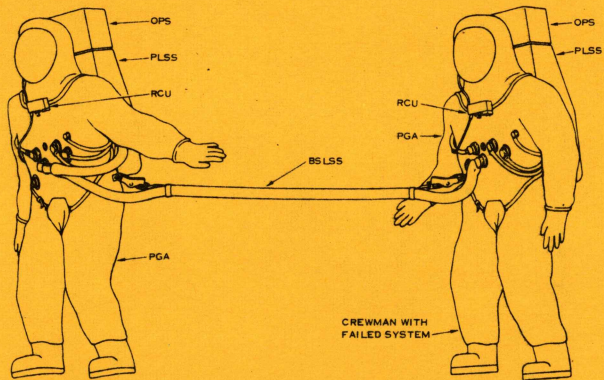


Figure 3-2. Buddy Secondary Life Support System Functional Diagram

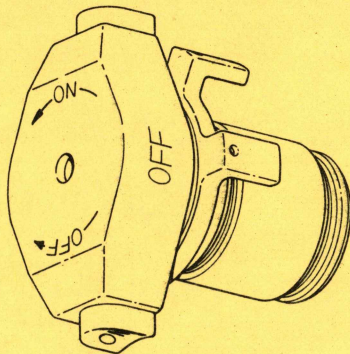
SECTION 4.0

PRESSURE CONTROL VALVE

4.0 PRESSURE CONTROL VALVE DESCRIPTION

The Pressure Control Valve is a manually actuated valve which is installed in the suit outlet connector. When operating, the PCV modulates the flow of oxygen through the valve to maintain the required suit pressure. The CM umbilical contains an orifice to control the oxygen flow rate to the suit. When deactivated, a no-flow pressure seal results. A locking mechanism prevents unintentional change in either valve position. See Fig. 4-1.

The Pressure Control Valve is used in conjunction with an oxygen umbilical (Command Module (CM) supplied) for a CM EVA. The OPS is used as a backup for this EVA which occurs during trans-earth flight. See Fig. 4-2.



600D-427

Figure 4-1 Pressure Control Valve

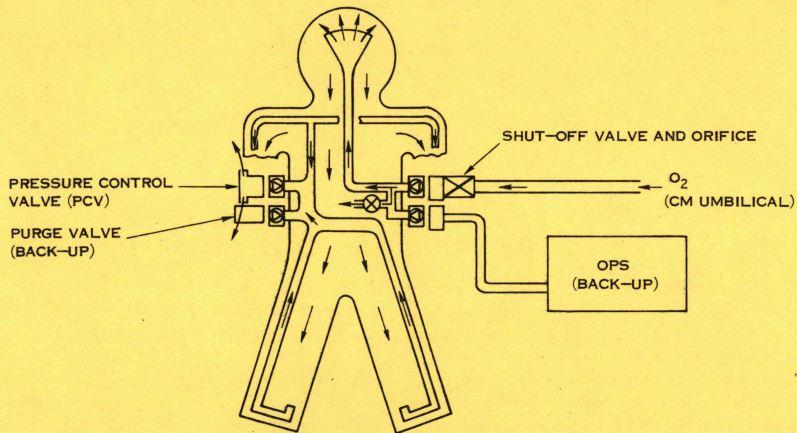


Figure 4-2 PCV System Schematic

SECTION 5.0
COMPONENT ITEM NUMBER INDEX

5.0 COMPONENT ITEM NUMBER INDEX

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

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202	Ventilation Flow Sensor	7-9
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221-1	Volume Control Potentiometer	7-18
222-1	Mode Selector Switch	7-18
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225	Pump Switch	7-22

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276	Primary Oxygen Regulator Assembly	7-67
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	<u>Buddy Secondary Life Support System Umbilical, Tether and H₂O Connector Assembly (310)</u>	
311	Connector, Water Divider	7-83.
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	<u>Oxygen Purge System (OPS)</u>	
	<u>Oxygen System</u>	
511	Oxygen Purge System Bottle	7-75
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SECTION 6, 0

FUNCTIONAL CROSS-REFERENCE INDEX

6.0 FUNCTIONAL CROSS-REFERENCE INDEX

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

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228	PLSS Electrical Umbilical	7-25
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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512	OPS Shutoff Valve (Regulator Assembly)	7-75

SECTION 7.0
COMPONENT DESCRIPTION

7.1 PLSS COMPONENTS

201 CO₂ SENSOR (Figure 7-1)

Spec. no: SVHS 3999

Spec. wt: 1.30 lbs.

Function: Senses the amount of CO₂ in the Oxygen Ventilating Input Loop by an electrochemical process. The sensor develops two independent outputs: (1) 0-5 vdc telemetry and (2) Warning Level Switch.

Description: The CO₂ sensor consists of an electrochemical (pH sensing) sensing element and preamplifier as one integral subassembly connected to the major electronics module by a 4-pin connector. The output of the sensing element is 56MV per decade change in CO₂ partial pressure and is logarithmic. This output is amplified and conditioned to provide an analog output (0-5 vdc) for telemetry and a switch output for an alarm signal.

The sensing element/preamplifier subassembly is removable to allow refurbishment after its operating life (3000 hours) has expired. This subassembly is interchangeable with other CO₂ sensor-electronics modules. The entire CO₂ sensor assembly (sensing element/preamplifier and major electronics module) is self-contained in a tin plated aluminum housing.

Working Fluid (gas composition by weight) - Total 0.1 lb/hr max.

Oxygen	85% - 100%
Carbon Dioxide	0% - 12%
Water Vapor	0% - 3%

Working Temperature: 35°F to 120°F

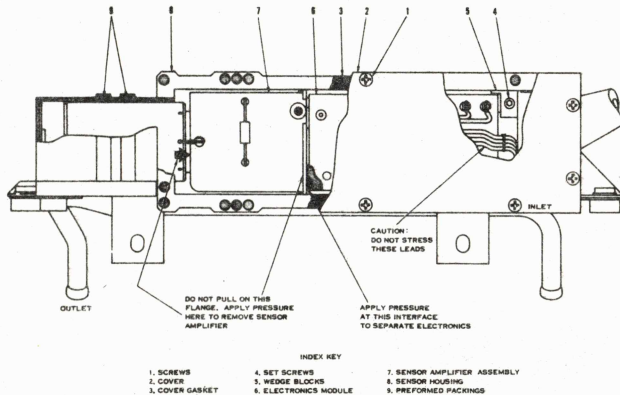
Working Pressure (inlet): 3.1 to 4.2 psia

CO₂ Partial Pressure Range: 0.1 to 30 mmHg

Input Voltage: 10 vdc \pm 0.25%

Power: 1.0 watt, maximum

Current Limiting: 150 MA dc, maximum

Figure 7-1 CO₂ Sensor

Operating Life: 3000 hours

Periodic Calibration: 1000 hour intervals

Warning Switch Point: 10 mmHg

External Load: 100K ohm, minimum

Telemetry Output: 0 to 5 vdc, proportional to the $\log_{10} p\text{CO}_2$

Nominal Output (V_o) = $2.0185 (\log_{10} p\text{CO}_2 + 1.0000)$

Error Bands: Shown on the following page

Nominal		Error Band Limits (From Nominal)			
pCO ₂ (mmHg)	v (Volts)	65 to 95°F		35 to 65°F & 95 to 120°F	
		v (Volts)	pCO ₂ (mmHg)	v (Volts)	pCO ₂ (mmHg)
30	5.000	+0.126/-0.147	+5.46/-4.00	+0.182/-0.230	+9.01/-5.03
10	4.037	+0.126/-0.147	+1.82/-1.33	+0.182/-0.230	+3.00/-1.88
2	2.626	+0.126/-0.147	+0.36/-0.41	+0.182/-0.230	+0.60/-0.55

202 VENTILATION FLOW SENSOR (Figure 7-2)

Spec. no: SVHS 4100

Spec. wt: 1.0 lb

Function: Incorporates means of actuating audible and visual warning circuit when flow rate drops below 4.7 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 4.7 to 5.3 acfm (normal range), 4.0 to 5.3 acfm (extended range)

Pressure drop: 0.10 in. of H₂O with flow of 8.35 lb/hr O₂ and 0.15 lb/hr water vapor. Gas temperature is 50° F, pressure is 4.1 psia.

203 PGA DIFFERENTIAL PRESSURE TRANSDUCER (Figure 7-3)

Spec. no: SVHS 4311

Spec. wt: 2.5 oz excluding lead wires

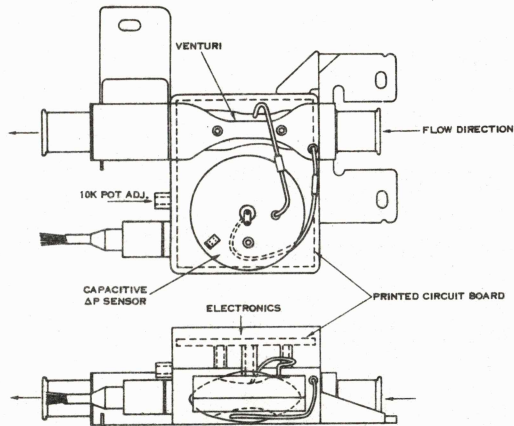


Figure 7-2 Ventilation Flow Sensor

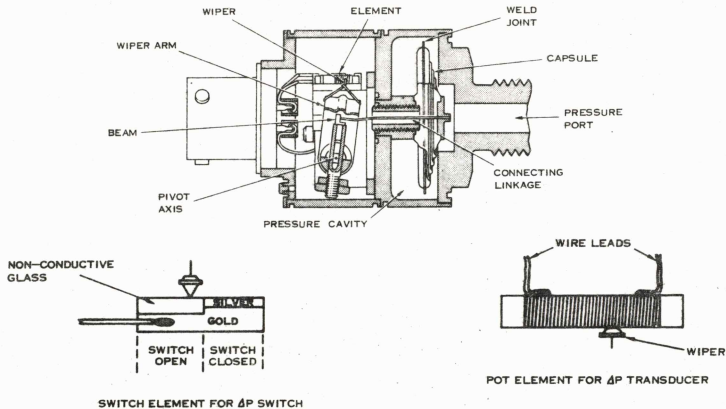


Figure 7-3 PGA Differential Pressure
Switch and Transducer

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 O₂ in makeup line and PLSS ambient pressure. Movement of bellows varies potentiometer wiper. Output voltage varies with wiper position.

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 $\pm 3\%$ 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 (Figure 7.3)

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: 3.40 to 3.10 psid

Opening: 3.10 to 3.40 psid

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: Environmentally sealed in 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 a white letter. 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: 14-22 vdc

Power: 0.60 W max.

Internal resistance: 950 ohm

207 OXYGEN QUANTITY INDICATOR (Figure 7.4)

Spec. no: SVHS 2844

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

Function: Senses primary O₂ pressure in PLSS oxygen bottle.

Description: A dc millimeter electrically connected to PLSS O₂ transducer. An indicator is incorporated into PLSS RCU.

Sensitivity: Full-scale sensitivity is 1.00 ma dc

Impedance: 160 ohm at 70° F

Accuracy: ±4%

Operating temperature: 0° to 200° F

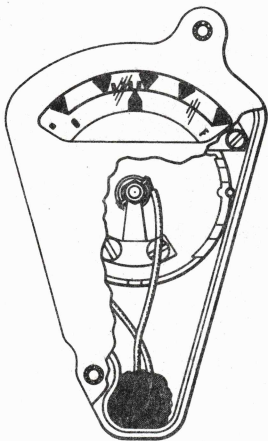
Operating pressure: 21 psia to 7.5×10^{-14} mm Hg

208 RCU PANEL LIGHTING

Function: Illuminates O₂ 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 7-4 Oxygen Quantity Indicator.

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

Intensity: 40 μ L at O₂ quantity indicator, 130 μ L on all other surfaces

Power: None required

213 POWER SUPPLY

Spec. no: 4968

Spec. wt: 9.5 lbs.

Function: Provides electrical power for PLSS.

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

Performance for 7.85 hour period:

Battery output, vdc	Reqd battery discharge, adc	Battery output, W
16.8 (nominal)	2.73	45.8
17.6 (high)	2.86	50.4
16.0 (low)	2.60	41.6

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

Minimum capacity: 21.4 Amp-Hour

Peak voltage: Max. discharge is 20.5v.

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>
201	CO ₂ Sensor
—	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 -1	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.

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

221-1 VOLUME CONTROL POTENTIOMETER (Figure 7-5)

Spec. no: SVHS 4255

Spec. wt: 13 oz including 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: 9.0 in.-oz max.

222-1 MODE SELECTOR SWITCH (Fig. 7-6)

Spec. no: SVHS 4262

Spec. wt: 15 oz including lead wires and cable

Function: Selects operational modes of EVCS.

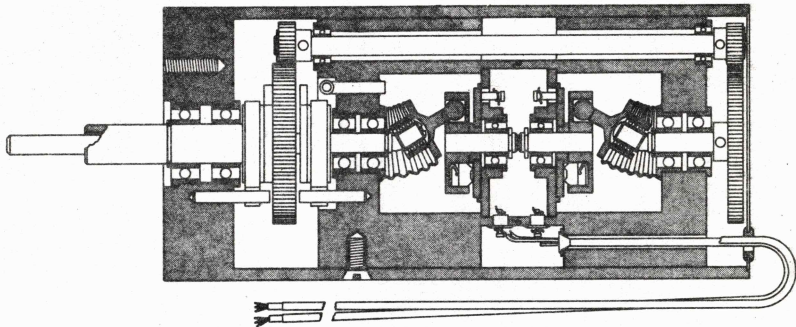
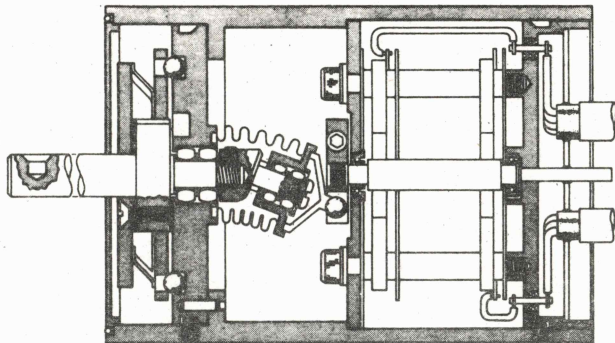


Figure 7.5 Volume Control Potentiometer.



600D-330

Figure 7.6 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 O₂ flow rate sensor and vent flow sensor and 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 ±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 Ω min. at 100 vdc.

Actuation force: 1 to 4 lb

Contact resistance: 1.0 ohm max.

225 PUMP SWITCH and

226 FAN SWITCH (Fig. 7-7)

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

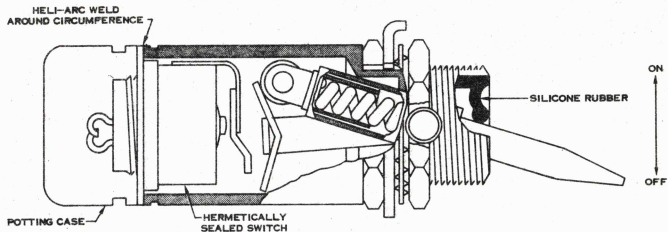


Figure 7-7 Fan Switch And Pump Switch

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 pulse that turns on a 1500 Hz alarm tone generator in the EVCS. 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 EVCS and PGA.

Length: 43 in.

Connectors: PLSS end - Microdot Insert MD-E 15-615 in an Airlock 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

232-1 PRIMARY OXYGEN PRESSURE TRANSDUCER (Fig. 7-8)

Spec. no: SVHS 4901

Spec. wt: 6.4 oz without lead wires

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

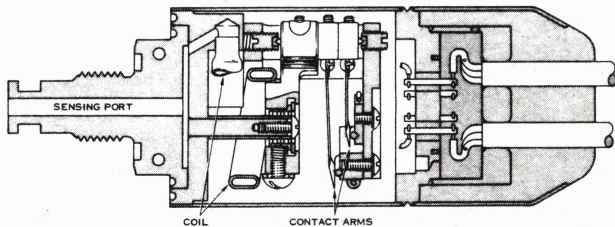


Figure 7-8 Primary Oxygen Pressure Transducer

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

Operating temperature: 0° to 130°F

Operating pressure: 0 to 1500 psia

Signal output: Telemetry circuit produces 0 to 5 V output signal into 100,000 ohm load for 0 to 1500 psia input pressure.
Meter circuit produces linear 0 to 5 V output signal into 5,000 ohm load for 0 to 1500 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 2.75% of full-scale output for telemetry circuit and 4.0% 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 O₂ flow out of sublimator, provides input signal to telemetry system corresponding to temperature.

Description: A thermistor varying output voltage with temperature.

Construction: Environmentally sealed in stainless steel housing

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 (Figure 7-9)

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. 7-10)

Spec. no: SVHS 3013

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

Function: Measures flow rate downstream of primary O₂ regulator.

Description: Two thermistors located just downstream of primary O₂ regulator. Thermistors have different temperature-resistance characteristics, are located in bridge circuit. Imbalance in bridge is output signal.

Construction: Hermetically sealed electronics

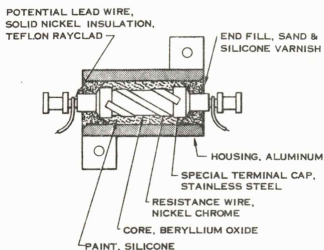
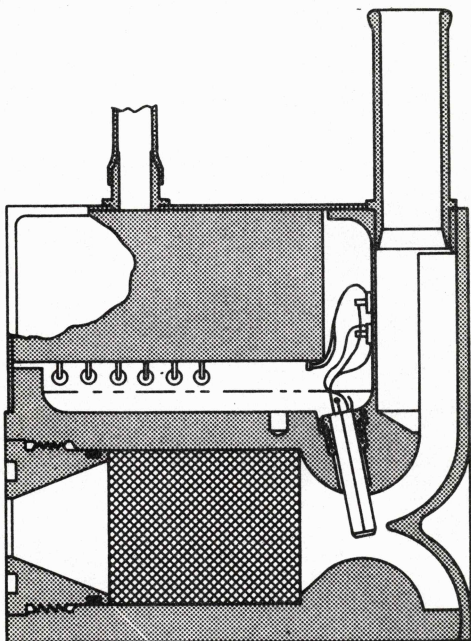


Figure 7-9 Battery Current Sensor

6000-166



600D-242

Figure 7-10 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 O₂ 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 0.64 lb/hr max. of O₂
Switch deactuates at 0.50 lb/hr min. of O₂

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_o is 2050 ohm

Error band: Less than 20% of output at temperature differential of 15°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 (Fig. 7-11)

Spec. no: SVHS 3867

Spec. wt: 6.0 oz including lead wires

Function: A pressure-sensing bellows actuating a potentiometer wiper 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 5 vdc

Resistance: Total of potentiometer is 2000 ohm

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

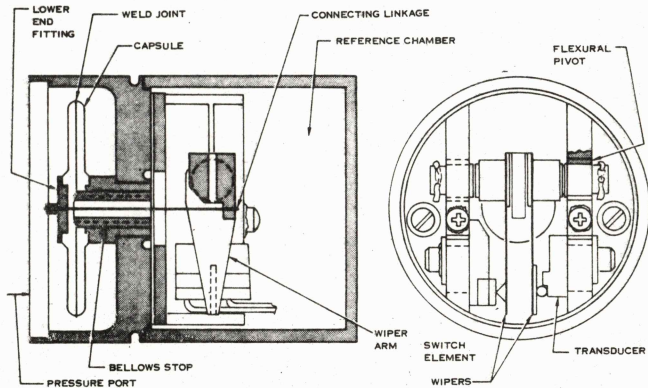


Figure 7-11 Feedwater Pressure Transducer And Switch

Error band: Static terminal band does not exceed $\pm 5\%$ of output span (absolute error = 0.25 psia).

Current capacity: 10 ma

Switch actuation: 1.2 to 1.7 psia.

241-1 LIOH CANISTER 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_2O 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 $80^\circ F$, inlet pressure of 3.7 psia, and inlet dewpoint of 54° to $76^\circ F$.

Operating temperatures:

Canister = 70° to $90^\circ F$ inlet, 70° to $140^\circ F$ outlet.

Reservoir = 33° to $120^\circ F$.

241-2 LiOH CARTRIDGE

Spec. no: SVHS 5103

Spec. wt: 5.0 lb.

Function: LiOH removes CO₂, charcoal removes odors.

Operating pressure: 3.5 to 5.0 psia.

Operating temperature: 70° to 95°F (influent)

Activated charcoal: 0.26 lb/min

LiOH: 3.12 lbs/min

Pressure drop: 0.75 in. of H₂O at 7.94 lb/hr and 3.9 ± 0.15 psia

Performance: See Figure 1-1

241-4 LiOH CARTRIDGE PROTECTIVE CONTAINER

Spec. no: SVHS 5094

Spec. wt: 2.2 lbs.

Function: The LiOH container provides a sealed environment for the PLSS LiOH cartridge to prevent degradation of the cartridge due to exposure to vacuum during an Apollo mission.

Description: The protective container is a closed aluminum cylinder with a manually operated latching mechanism to facilitate LiOH cartridge removal. The container incorporates a pressure indicator, vent mechanism and temperature indicator.

Internal leakage: Leakage into a container assembled at room ambient pressure shall not exceed 0.5 psi when exposed to an external pressure on 1.0 psi greater than internal pressure.

External leakage: The internal pressure of an assembled container shall not decay below 9.2 psia when exposed to space vacuum.

Maximum storage temperature: 120°F

242 WATER SEPARATOR (Fig. 7-12)

Spec. no: SVHS 3135

Spec. wt: 0.65 lb.

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

Design condition:

<u>Condition</u>	<u>Requirement</u>
Max. inlet O ₂ flow	6.48 lb/hr
Max. inlet CO ₂ 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 ₂ passage condensing rate	0.508 lb/hr

Max. steady-state water separation rate: 0.508 lb of H₂O at feedwater usage rate of 3 lb of H₂O/hr.

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

Pressure drop: 0.36 in. of water

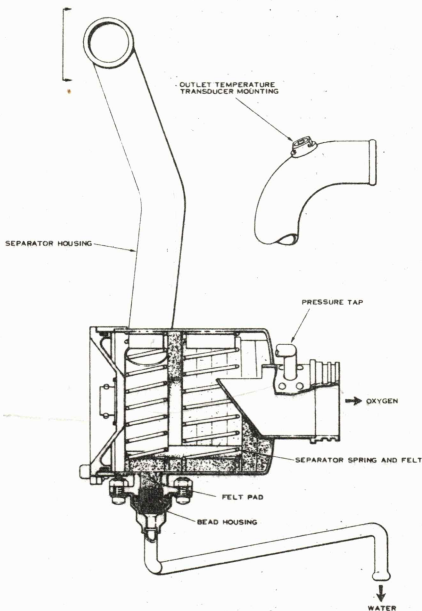


Figure 7-12 Water Separator

600D-333A

243 FAN MOTOR ASSEMBLY

Spec. no: 3273

Spec. wt: 2.65 lb

Function: Circulates O₂ flow within PLSS and space suit.

Description: Centrifugal fan, brushless dc motor.

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 ₂ O
Fan O ₂ weight flow	6.192 lb/hr
Fan CO ₂ 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 ₂ 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. 7-13)

Spec. no: SVHS 3218

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

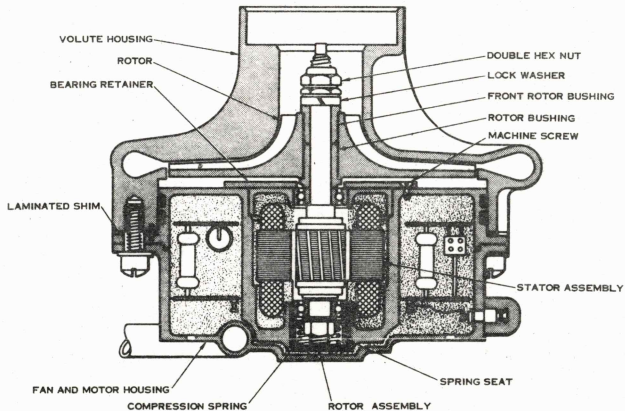


Figure 7-13 Fan Motor.

Function: Powers recirculating fan supplying pressure rise for circulating O₂ 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 (O₂): 35° to 125° F.

Working pressure (O₂): 2.5 to 5.0 psia

Water jacket temperature: 35° to 85° F

Water jacket pressure drop: 0.095 psi at 4 lb/min H₂O 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.7-14)

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.

Operating temperature: 0° to 160° F

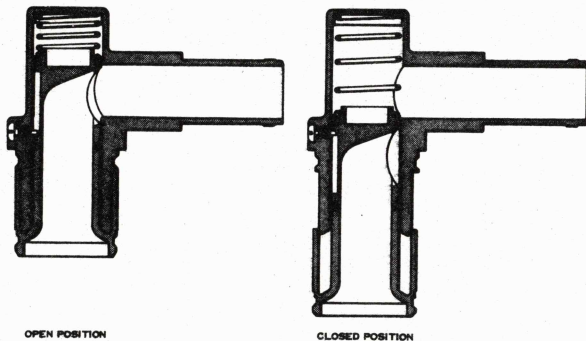


Figure 7-14 . Oxygen Inlet (Outlet) Connector.

Operating pressure: 21 psia to 1×10^{-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° to 80° 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 (Fig. 7-15)

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.

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° 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° F.

251 SUBLIMATOR (Fig. 7-16)

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.

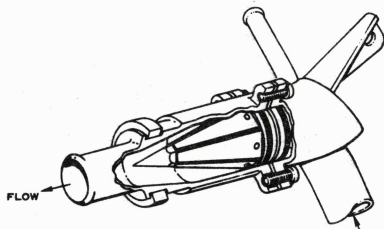
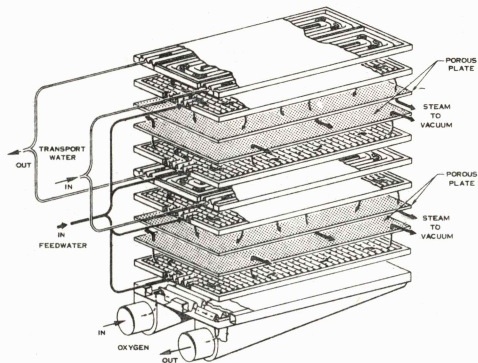


Figure 7-15 PLSS Backflow Check Valve



600Y-183

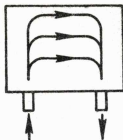
Figure 7-16. Sublimator

Type of flow:

Oxygen

2-pass

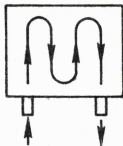
1 path



Transport water

4-pass

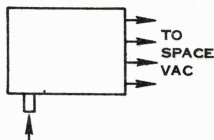
2 paths



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 (O₂ 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. 7-35

253 WATER SHUTOFF AND RELIEF VALVE (Fig. 7-17)

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.

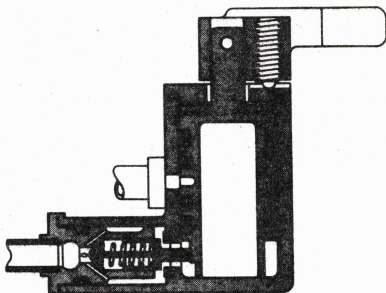
Fluid temperature: Operates with water temperature between 33° and 130° F.

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 7-17 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 H₂O 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. 7-18)

Spec. wt: 0.17 lb

Function: Prevents excessive flow from entering 251 Sublimator.

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. 7-19)

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.

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.

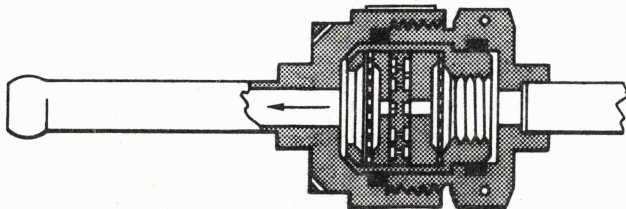
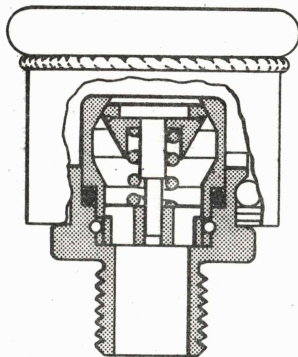


Figure 7-18. Flow Limiter.



6000-82

Figure 7-19. 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 1×10^{-3} in.³ 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. 7-20)

256-1 AUXILIARY FEEDWATER RESERVOIR CONNECTOR

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.

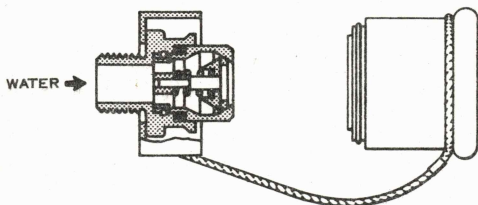
Fluid temperature: 33° to 160°F

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 7-20 Water Drain (Reservoir Vent) Connector.

258 AUXILIARY FEEDWATER RESERVOIR ASSEMBLY (Fig. 7-21)

Spec. no: SVHS 5016

Spec. Dry wt: 2.40 lbs including reservoir housing, bladder vent fittings and required mounting hardware.

Function: The Reserve Feedwater Reservoir Assembly stores and supplies feedwater to the Sublimator. It supplements the Feedwater Reservoir Assembly and discharges sufficient feedwater to assure a minimum of 1.0 hour of sublimator operation during EVA, in addition to the Feedwater Reservoir Assembly.

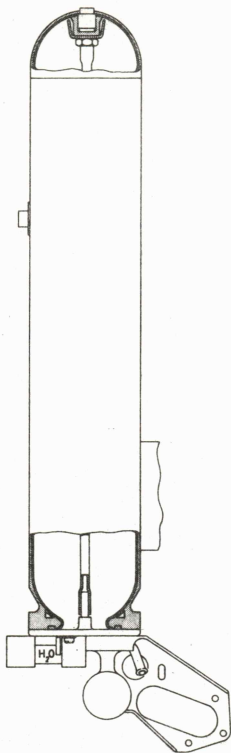
An additional function is storage of condensed water, collected by the Water Separator.

Capacity: 2.92 lbs of water, when bladder is subjected to a maximum differential pressure of 0.6 psid.

Discharge rate: 0.10 lbs/min, when bladder is subjected to a maximum differential pressure of 0.6 psi.

Operating fluid temperature: 33° to 130°F

Operating fluid pressure: 3.0 to 54 psia



6000-417

Figure 7-21 Auxiliary Feedwater Reservoir Assembly

259 AUXILIARY FEEDWATER RESERVOIR SHUTOFF AND
RELIEF VALVE (Figure 7-22)

Spec. no: SVHS 5014

Spec. wt: 0.22 lbs.

Function:

- a. The Reserve Feedwater Reservoir Shutoff and Relief Valve is a manually operated valve and controls the flow of feedwater from the reserve reservoir.
- b. The valve also performs a relief function, preventing reservoir pressure to exceed feedwater line pressure by more than 4 to 10 psi.
- c. Rotation of the handle lowers a probe, depressing a spring-loaded poppet, allowing a flow from the reserve reservoir.

Internal leakage: With valve closed and inlet port pressurized with water to 3.9 ± 0.1 psi, leakage shall be 0.6 cc/hr.

External leakage: 0.28 cc/hr maximum at water pressurized to 40 psig.

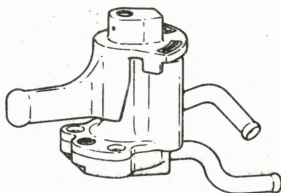
Operating fluid temperature: 33° to 130°F

Operating fluid pressure: 3.0 to 75 psig

Relief pressure: 10 psid maximum

Reseat pressure: 4 psid minimum

Handle torque: 1.5 to 10 in-lbs



600D-422

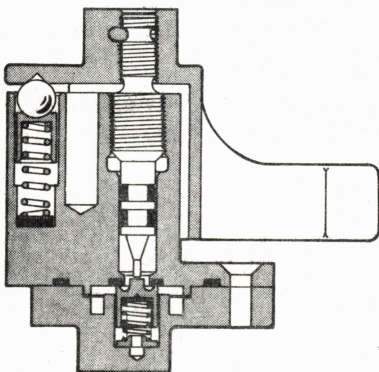


Figure 7-22 Auxiliary Feedwater Reservoir
Shutoff And Relief Valve

262 PUMP/MOTOR ASSEMBLY (Fig. 7-23)

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:

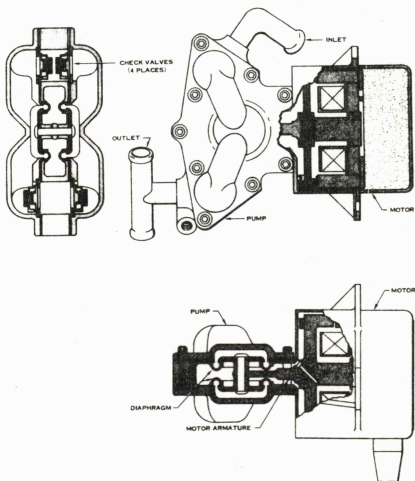
Pressure rise across unit	5.65 psi
Coolant flow	4.0 lb/min
Input voltage	16.5 vdc
Inlet pressure	18.7 psig
Power consumption	10 W
Inlet temperature	53.8° F
Pump/motor can operate at	20.5 vdc
Starting current	Not more than 2.0 a

263 WATER DIVERTER VALVE (Fig. 7-24)

Spec. no: SVHS 3313

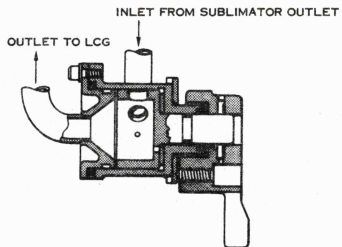
Spec. wt: 0.30 lb

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



600D-358

Figure 7-23 Pump/Motor Assembly.



SECTION A-A



Figure 7-24 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. 7-25)

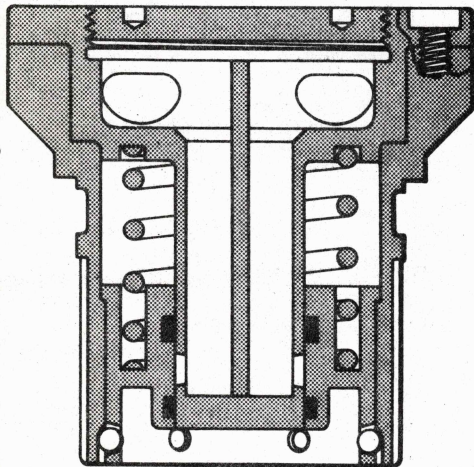
Spec. no: SVHS 3128

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.



6000-230

Figure 7-25 Multiple Water Connector.

267 CHECK VALVE ASSEMBLY (Fig. 7-26)

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 feed-water loop exceeds pressure in transport water loop.

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 (Fig. 7-27)

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.

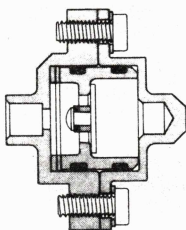


Figure 7-26 Check Valve Assembly

600D-392

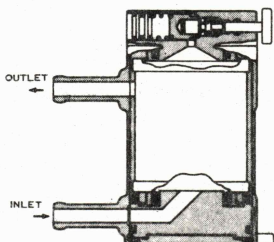


Figure 7-27 Gas Separator

600Y-215

274 PRIMARY OXYGEN BOTTLE

Spec. no: SVHS 4861

Spec. wt: 3.90 lbs.

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

Construction: 301 stainless steel (Cryo-Formed)

Capacity: 1.75 lb/min O₂ at 1410 psi and 70°F

Operating temperature: 0° to 95°F

External leakage: 2 scc/hr maximum at 1500 psia

275 PRIMARY OXYGEN FILL CONNECTOR (Fig. 7-28)

Spec. no: SVHS 4870

Spec. wt: 0.18 lbs.

Function: Used to manually connect primary O₂ bottle to LM high-pressure O₂ source for PLSS recharge.

Operating temperature: 0° to 130°F

Operating pressure: 0 to 1500 psia

Engagement-disengagement force: 33 lbs at 1520 ± 20 psia

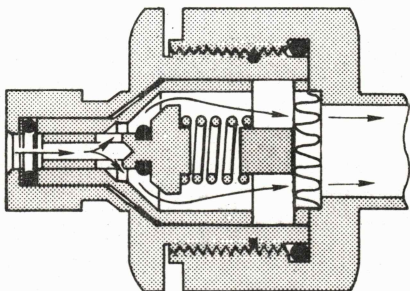
Pressure drop: 20 psi with flow rate of 1.5 lb/hr O₂ at 70°F and 100 psig.

276 PRIMARY OXYGEN REGULATOR ASSEMBLY (Fig. 7-29)

Spec. no: SVHS 4858

Spec. wt: 1.1 lb

Function: Maintains the PLSS O₂ flow.



600Z-96

Figure 7-28 Primary Oxygen Fill Connector.

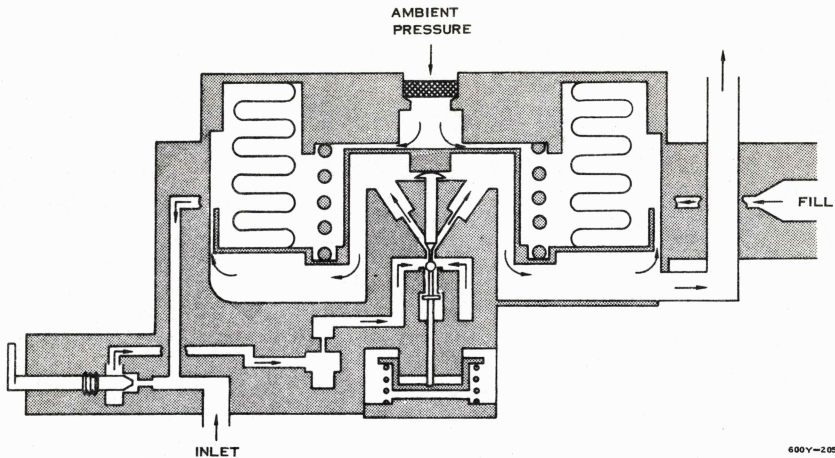


Figure 7-29 Primary Oxygen Regulator Assembly.

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

Operating temperature: 0° to 95°F

Operating pressure: 0 to 1500 psig

Flow capacity: 0.365 lb/hr minimum O₂ at 145 psia inlet press. and 70°F. 0.38 lb/hr maximum O₂ at 1500 psia 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 1500 psia and outlet press. maintained 0.1 to 0.3 psi above regulating press., does not exceed 25 scc of oxygen/minute.

Regulating pressure: With reference pressure of lunar vacuum, outlet pressure maintained at 3.75 to 4.05 psid for O₂ flow between 0 and 3.8 lb/hr.

289 REMOTE CONTROL UNIT (Fig. 7-30)

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.

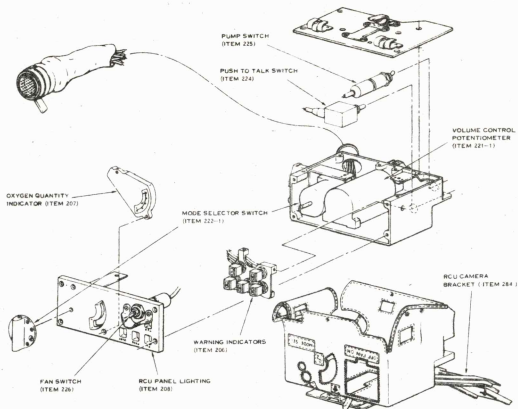


Figure 7-30 Remote Control Unit

7.2 OPS COMPONENTS

511 OXYGEN PURGE SYSTEM BOTTLE

Spec. no: SVHS 4049

Spec. wt: 9.5 lb

Description: A spherical bottle containing two ports and two mounting bosses.

Construction: Inconel 718

Operating temperature: -130° to 130°F

Operating pressure: 0 to 6750 psia

Volume: 2.85 lb O₂ at 5880 psia and 70°F

512 REGULATOR ASSEMBLY (Fig. 7-31, -32, & -33)

Spec. no: SVHS 4046

Spec. wt: 4.2 lb

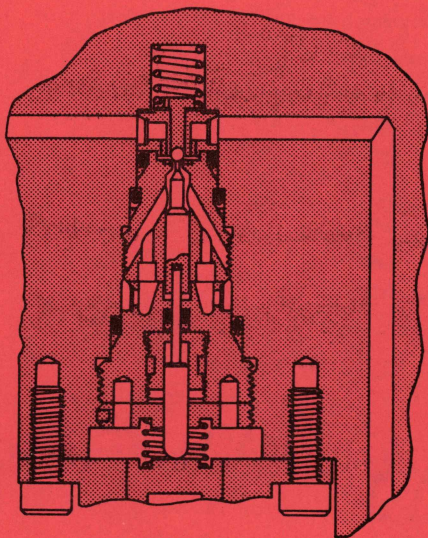
Functions:

1. Controls O₂ pressure from O₂ bottles to PGA.
2. Activates or deactivates Flow of oxygen from bottles to PGA
3. Provides facility for charging OPS bottles.
4. Indicates pressure during and after charging.

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

Operating temperature: -130° to 125°F

Operating pressure: 500 to 6750 psig.



6000-275

Figure 7-31 Regulator Assembly Shutoff Valve.

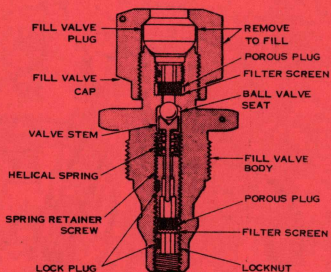


Figure 7-32 Regulator Assembly
Fill Fitting

600D-366A

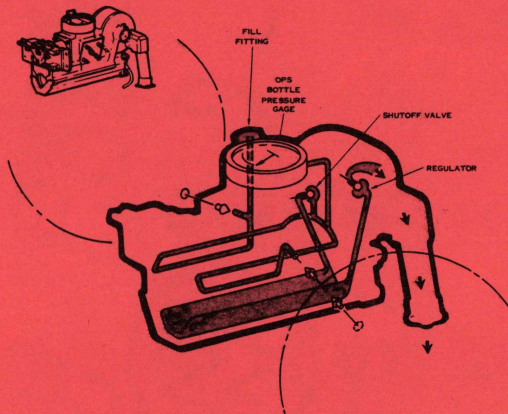


Figure 7-33 Regulator Flow Diagram

Flow capacity: 9.0 lb/hr O₂ at supply press. of 500 psi.

Internal leakage: With inlet pressure of 6950 psig and outlet pressure maintained 0.1 psi above regulating pressure, does not exceed 200 scc of O₂ 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 O₂/hr.

Pressure gage accuracy: \pm 300 psi over full scale

REGULATION: 3.6 to 4.0 psid with flows or 0.07 to 8.4 lbs/hr

& Ambient Pressures Less Than 0.1 psia

513 OXYGEN CONNECTOR

See Item 244-1

Function: Connects OPS oxygen umbilical to suit inlet.

7.3 BSLSS COMPONENTS

311 WATER DIVIDER CONNECTOR (Figure 7-34)

Spec. no: SVHS 5069

Spec. wt: 1.0 lbs including dust covers

Function:

- a. The Water Divider Connector provides a split in flow of transport water, thereby enabling two crewmen to use one PLSS in the event of failure of a PLSS.
- b. The connector is a combination of the Multiple Water Connector and its mating PGA connector, arranged in one unit back-to-back.
- c. The connector interfaces with the Multiple Water Connector and the PGA connector.

Coupling force: 27 lbs maximum when pressurized at 23.0 ± 1.0 psig with water.

Leakage: 1.3 cc per hour maximum at 50 psid.

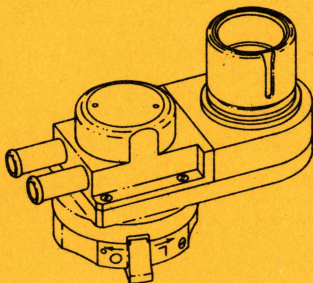
Spillage: 0.2 cc per cycle maximum.

Pressure drop: 2.90 psid at 4.0 ± 0.1 lb/min flow and $70 \pm 5^\circ\text{F}$.

Operating pressure: 0 to 50 psid

312 PLSS WATER CONNECTOR

Same as Item 264 - Multiple Water Connector.



6000-432

Figure 7-34 Water Divider Connector

7.4 PCV COMPONENTS

117 PRESSURE CONTROL VALVE

Spec. no: SVHS 5029

Spec. wt: 0.46 lbs

Function:

- a. The Pressure Control Valve controls the internal pressure of the space suit to a specified level. It is manually operated.
- b. In the "open" position, the air flow exits radially from the valve.
- c. The closed position results in a no-flow pressure seal.
- d. A locking mechanism prevents unintentional change in valve position.

Leakage:

Deactivated: 5 scc of oxygen per minute maximum with an inlet pressure of 4.1 ± 0.1 psid over ambient pressure of 8 mm Hg max.

Activated: 20 scc of oxygen per minute maximum with an inlet pressure of 3.4 ± 0.1 psid over ambient pressure of 8 mm Hg max.

Pressure Relief/Control: 3.75 ± 0.25 psid from 0 to 10 lbs of oxygen per hour and to 3.85 ± 0.15 psid from 10 to 13.15 lbs of oxygen per hour.

Operating pressure range: 10^{-4} mmHg to 5.0 psia

Operating flow range: 11 ± 1 lb/hr m

Operating temperature range: 35° to 90° F GOX

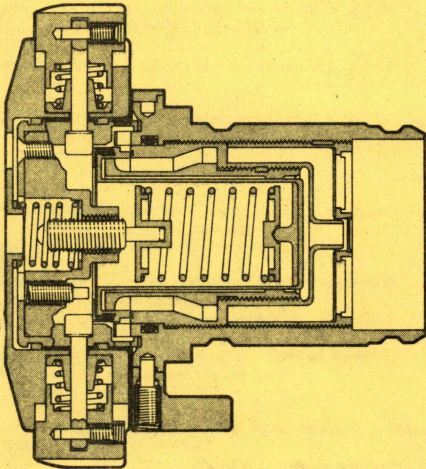


Figure 7-34 Pressure Control Valve (Closed Position)

B 231A