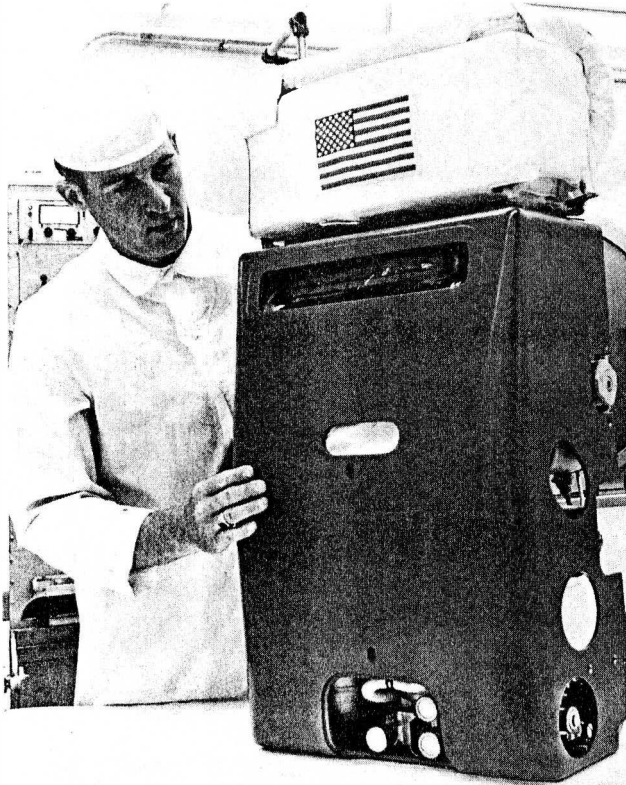


## PORTABLE LIFE SUPPORT SYSTEM

The portable life support system provides an astronaut with a livable atmosphere inside his space suit during excursions on the lunar surface and in space. Worn on the back and connected to the suit's waist by umbilicals, it permits up to four hours of extravehicular activity.

The backpack supplies oxygen for breathing and suit ventilation, and refrigerated water and oxygen for body cooling. It pressurizes the suit to 3.9 psi and removes contaminants from the oxygen circulating through the suit. It also has a communication-telemetry set, controls to operate it, and devices to monitor its functions.

For the lunar mission, the LM will have two of these life support packs. The LM will carry enough supplies to refill each pack's oxygen tank and water reservoir, and replace its battery and two lithium hydroxide cannisters three times. This will allow a total of four extravehicular trips.



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*Portable Life Support System*

The life support pack, with its controls, weighs 84 pounds; it is 26 inches high, 17.8 inches wide, and 10.5 inches deep. It is powered by a 16.8-volt silver-zinc battery. A fiberglass cover protects the pack against micrometeoroids.

Five subsystems make up the portable life support system: primary oxygen supply, oxygen-ventilating circuit, water transport loop, feedwater loop, and space suit communication system. An oxygen purge system with an additional 30-minute supply of oxygen for emergency or backup use is mounted on the pack, but operates separately.

A thermal insulator made of fire-resistant Beta cloth and aluminized Kapton covers the pack and its shell to restrict heat leakage in or out, depending on the moon's temperature. A similar insulator covers the oxygen purge system.

A remote control unit, which is attached to the suit chest, has switches for the life support pack's water pump and oxygen fan, five-position communication selector switch, a radio volume control, an oxygen quantity gage, and an oxygen purge system lever.

### FUNCTIONAL DESCRIPTION

#### PRIMARY OXYGEN SUPPLY

This subsystem supplies oxygen for breathing and pressurizes the space suit and helmet. The oxygen is automatically fed into the suit to maintain a pressure of 3.9 psi. Slightly more than 1 pound (1.06) of gaseous oxygen is stored at between 850 and 950 psi in a tank nearly 6 inches in diameter and slightly more than 17 inches long. The tank is replenished from the LM oxygen supply.

#### OXYGEN-VENTILATING CIRCUIT

This subsystem circulates oxygen through the space-suit pressure garment and purifies recirculating oxygen. It also helps cool the astronaut by evaporating moisture that accumulates on his skin.

Oxygen entering the backpack from the suit passes through a lithium hydroxide cartridge, where chemicals trap carbon dioxide exhaled by the astronaut. It then goes through an activated-charcoal bed that removes trace contaminants, including body odors. The oxygen flow is cooled by a porous-plate sublimator, a self-regulating heat-rejection device developed by Hamilton Standard. Water in the sublimator absorbs the heat and seeps through the pores of the sublimator's sintered-nickel plates exposed to a passageway where space vacuum enters. The water freezes, forms an ice layer across the plates, then turns from ice to vapor. The rate of this sublimating process is governed by the amount of heat being rejected.

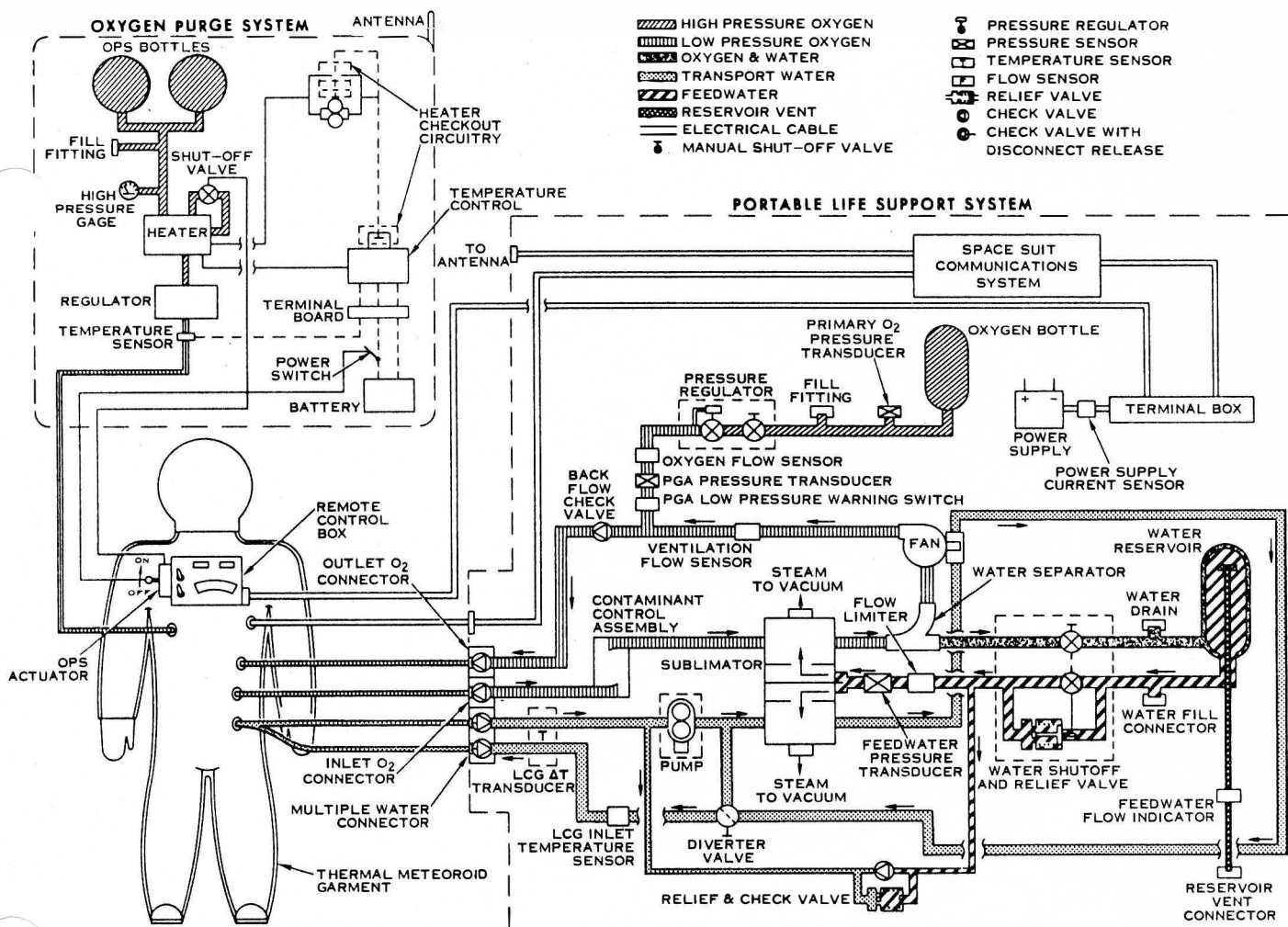
Excess water entering the oxygen flow, mainly from astronaut respiration and perspiration, is removed by a water separator and stored outside

the bladder section of the water reservoir. A fan recirculates oxygen to the space suit at a rate of 6 cubic feet per minute.

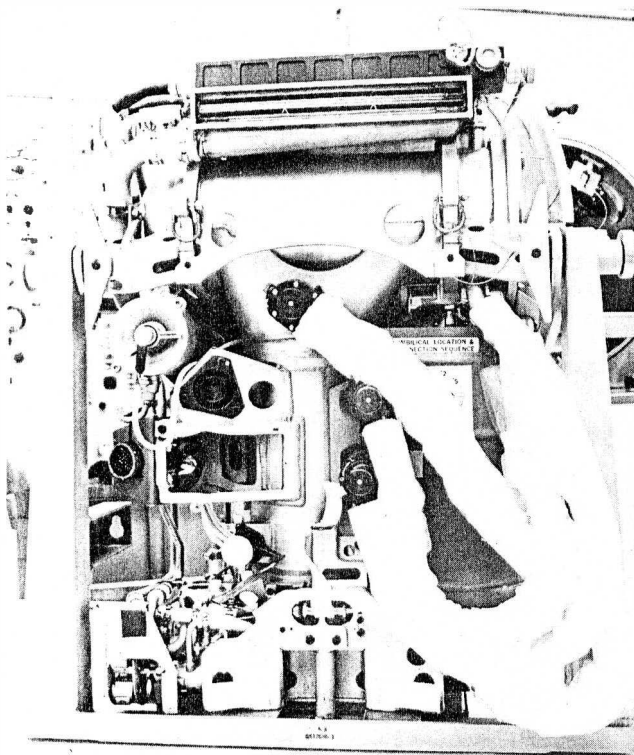
Six extra lithium hydroxide cartridges are carried in the LM to replace used cartridges.

## WATER TRANSPORT LOOP

This loop cools the astronaut by removing his metabolic heat and any heat that leaks into the suit from the hot lunar surface. A battery-operated pump continuously circulates 1.35 pounds of chilled water at a rate of 4 pounds per minute through a network of plastic tubing integrated in the liquid cooling garment worn under the space suit. The pack dissipates metabolic heat at an average of 1,600 Btu per hour and can handle peak rates up to 2,000 Btu.



Portable Life Support System Schematic



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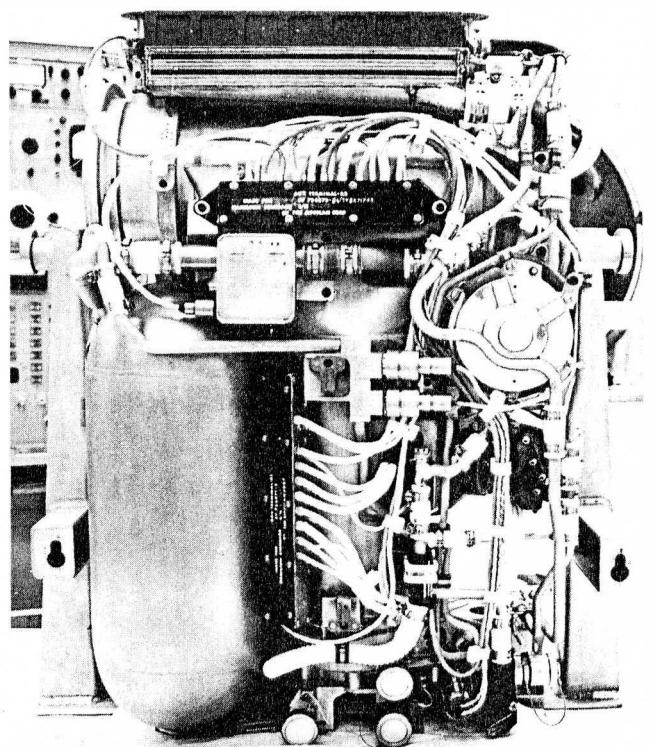
*Front View of PLSS*

The sublimator that cools the oxygen flow extracts heat from the circulating water, which normally leaves the pack at 45° F. To control cooling, the astronaut uses a valve on the pack to select any one of three water temperature ranges (45° to 50°, 60° to 65°, or 75° to 80°). This valve diverts water past the sublimator.

#### FEEDWATER LOOP

This subsystem supplies 8.5 pounds of expendable water, stored in a rubber bladder reservoir, to the heat-rejecting porous-plate sublimator. Suit pressure against the bladder forces water into passages between the sublimator's heat transport fluid passages and its metal plates, which are exposed to space vacuum. The ice layer formed on the porous plates during sublimation prevents the slightly pressurized water from flowing through the metal pores.

Condensed water from the oxygen-ventilating circuit is collected outside the reservoir bladder. Feedwater is replenished from the LM supply. Refilling the bladder forces water condensed from the oxygen flow into the LM waste management system.



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*Rear View of PLSS*

#### SPACE SUIT COMMUNICATION SYSTEM

This system provides primary and backup duplex voice transmission and reception, telemetering of physiological and suit environmental data, and audible warning signals. It also regulates the voltage and electrical current used by various transducers and the oxygen supply indicator.

The duplex systems enable the astronaut to transmit and receive radio communications simultaneously; a potentiometer controls sound volume. The transceiver control station aboard the LM is used as a relay station between crewmen on the lunar surface. It also relays radio-telemetry data to earth monitors and to the CM when it is in line of sight of the LM.

Telemetry channels are manually selected without interrupting or interfering with voice communication. The primary voice communication system is used for telemetry. Six of the seven telemetry channels transmit suit operational and environmental data — oxygen supply pressure, water inlet temperature, suit pressure, feedwater pressure, suit

water temperature rise, and backpack battery rent — to the LM. The remaining channel transmits an electrocardiogram signal.

Audible tones warn the astronaut of low suit pressure, high oxygen flow, low ventilation flow, and low feedwater pressure conditions.

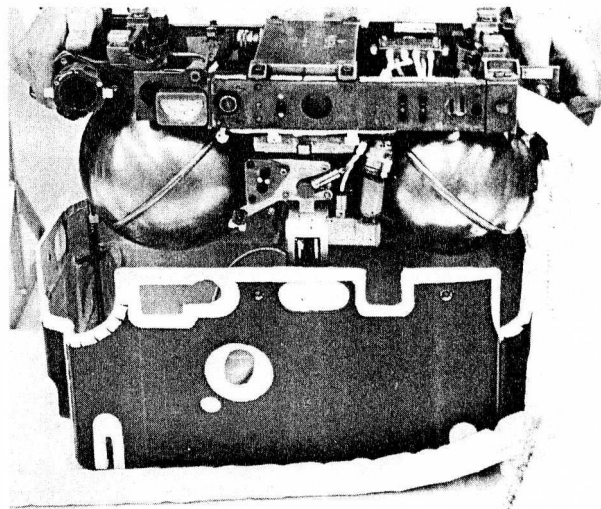
### OXYGEN PURGE SYSTEM

The oxygen purge system, connected to the suit by a separate umbilical, is designed for backup use in the event of emergencies such as loss of suit pressure or depleted oxygen supply. However, an astronaut can use it independently as a life support chest pack during extravehicular transfer between the LM and CM.

The system supplies either an open-loop purge flow or makeup flow directly to the suit. In both cases, it maintains suit pressure at 3.7 psi. In the purge mode, it provides a 30-minute flow at a rate of 8 pounds of oxygen an hour, fulfilling breathing requirements, flushing out carbon dioxide, and defogging the helmet visor. This emergency system, mounted separately on top of the backpack, is operated by a lever, attached to the pack's remote control unit. The system umbilical is attached to

the suit connector that connects the suit to the LM Environmental Control Subsystem when the astronaut is inside the LM.

The purge unit weighs 40.7 pounds; is 18.4 inches long, 10 inches high, and 8 inches deep. Two spherical containers hold a total of 5.7 pounds of oxygen stored at 6,950 psi. A battery-powered, temperature-controlled heater warms the rapidly expanding oxygen to prevent subzero oxygen temperatures at the space-suit flow inlet.



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*Oxygen Purge System*

*Information in this section relative to the Portable Life Support System was provided by Hamilton Standard, Division of United Aircraft. Complete details on the Portable Life Support System can be obtained from Hamilton Standard.*