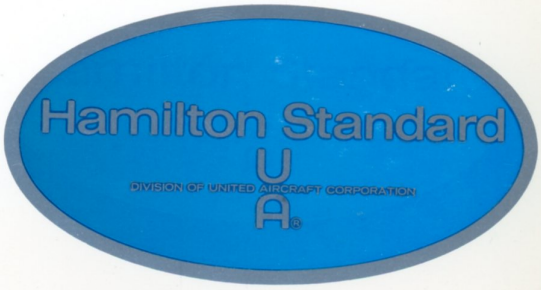
Hamilton Standard
U
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DIVISION OF UNITED AIRCRAFT CORPORATION

News
Hamilton Standard
Windsor Locks, Connecticut
NAtional 3-1621 · Ext. 2268

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LUNAR LIFE SUPPORT MISCELLANY

Despite lunar night's 250-degree below temperatures, the life support backpacks do not have to keep the Apollo 11 astronauts warm. Their bodies will generate so much heat that they only have to be cooled.

-0-

The pack can handle metabolic heat generated by an astronaut at an average rate of 1,600 British Thermal Units an hour. That rate is equivalent to a man shoveling sand. The pack's peak heat-dissipating rate of 2,000 BTUs an hour is similar to the same man sawing wood or walking at a fast-paced 4.3 miles an hour.

-0-

Astronaut Russell L. Schweickart's 38-minute space walk March 6, 1969 during Apollo 9 was the first and only time that the life support pack was used in flight before the Apollo 11 lunar landing. However, it has undergone 148 hours of manned tests at Hamilton Standard and NASA ground chambers under a number of simulated moon conditions.

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2,500,000 man-hours have been spent in the design, test and production of the life support backpack since 1962.

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Development and production of the Lunar Module's environmental control system took 3,100,000 man-hours, beginning in 1963. Manned tests in ground simulators at Grumman and NASA facilities total 220 hours. In flight the system supplied 26 hours of life support during Apollo 9 and 14 1/2 hours during the Apollo 10 lunar orbit.

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Hamilton Standard has built 34 life support backpacks, 32 oxygen purge systems, and 26 LM environmental control systems in its task of providing life support during the lunar landing, exploration, lift-off, and rendezvous with the Command Module.

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With the LM fully stocked with supplies, each life support backpack could be used for four extravehicular missions. This would involve recharging each pack's oxygen and cooling water tanks, and replacing its battery and lithium hydroxide cartridge three times.

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For Apollo 11 there will be no need to recharge the backpacks because Astronauts Armstrong and Aldrin will be on the lunar surface for approximately two hours, 40 minutes. Each pack's consumables will allow up to four hours outside the LM, depending on the level of physical activity.

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Approximately 25 gallons of water will be evaporated into space to cool the astronauts and electronic equipment during the scheduled 33 hours Astronauts Armstrong and Aldrin are scheduled to man the moon-landing craft.

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In that time the LM atmosphere revitalization package, whose main function is to purify the oxygen the astronauts breathe, will process approximately 43,000 cubic feet of oxygen gas, enough to fill two large ranch-style homes.

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71669

News
Hamilton Standard
Windsor Locks, Connecticut
NAtional 3-1621 · Ext. 2268

DIVISION OF UNITED AIRCRAFT CORPORATION

FOR IMMEDIATE RELEASE

The life support needs of Astronauts Neil A. Armstrong and Edwin E. Aldrin, Jr. during their historic 33-hour moon-landing mission will be supplied by Hamilton Standard equipment.

For two and a half of those scheduled hours portable life support systems worn as backpacks will provide a livable environment inside the space suits of the Apollo 11 moon explorers as they collect samples, set up experiments and take photographs on the lunar surface.

And the life-sustaining atmosphere inside the Lunar Module (LM) spacecraft in which Armstrong and Aldrin will land on the moon, eat, sleep and take off for the homeward rendezvous with the Command Module waiting in orbit, will be created and maintained by a Hamilton Standard-built environmental control system.

Each backpack holds enough breathing oxygen, cooling water and other consumables to permit up to four hours of extravehicular activity. It also has voice-telemetry communications and a 30-minute oxygen supply for emergency use. Consumables can be replenished if necessary, but the astronauts' scheduled length of stay will not require backpack recharging from LM supplies.

In preparing for extravehicular activity on the moon, Armstrong and Aldrin will attach the emergency oxygen units, or oxygen purge systems, to the top of their packs, put them on and connect them by oxygen, water and electrical umbilicals to the suits. Remote control units with switches for operating and gauges for monitoring the backpacks will then be attached to the chest area of the suits.

- MORE -

The astronauts will start up the packs by turning on the oxygen flow and a fan which circulates oxygen through the suit. After confirming that the packs are working properly, they will depressurize the LM cabin, disconnect their suits from the craft's environmental control system, and begin their exit.

Because the moon has one-sixth of the earth's gravity, each life support pack with oxygen purge unit attached will weigh slightly more than 20 pounds. On earth it weighs 124 pounds.

The backpack performs the following functions:

Supplies oxygen pressurized at 3.9 pounds per square inch (psi) for astronaut breathing needs and suit ventilation.

Purifies oxygen by removing exhaled carbon dioxide and other contaminants so the astronaut can rebreath it.

Cools the astronaut by pumping cool water through a network of tubing in a liquid cooling garment worn under the space suit. The pack removes body heat absorbed by the water before the water is recirculated through the cooling garment.

Controls oxygen flow temperature and relative humidity.

Provides radio communications between astronauts on the moon, with the LM spacecraft and with earth.

Relays to earth telemetry data on backpack and suit conditions, astronaut heart rate, and provides visual and audible warning signals if an abnormal condition arises.

To cool the astronaut, the pack can handle metabolic heat generated by physical activity at an average rate of 1,600 British Thermal Units (BTUs) per hour and at peak rates up to 2,000 BTUs per hour.

On returning to the LM spacecraft, Armstrong and Aldrin will activate the Hamilton Standard environmental control system to repressurize the cabin before they take off the life support packs.

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Windsor Locks, Connecticut
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DIVISION OF UNITED AIRCRAFT CORPORATION

FOR IMMEDIATE RELEASE

Hamilton Standard has developed and built nine different types of equipment for the Apollo moon-landing program. Apollo 11 marks the third time that all will be used at the same time. A summary of the equipment follows:

Portable Life Support System -- Provides a livable atmosphere inside the astronaut's space suit during space and lunar extravehicular activity. Worn on the back, it permits up to four hours of extravehicular activity and can be recharged for additional missions.

Lunar Module (LM) Environmental Control System -- Supplies two astronauts inside the LM spacecraft with oxygen for breathing and ventilating purposes. It also maintains pressure, temperature and relative humidity and supplies water for cooling and drinking.

LM Abort Sensor Assembly -- The heart of the semi-automatic backup guidance system that will allow the LM crew to guide the LM craft in event the primary guidance system malfunctions.

Instrument Unit Porous Plate Sublimator-- A space heat exchanger that cools guidance and telemetry equipment in the instrument unit which controls and monitors the Saturn V launch vehicle's flight.

LM General Purpose Inverter -- Two static inverters change direct current from a battery source into alternating current to power a variety of LM electronic equipment.

S-II Inverter -- Five power supplies operate engine and telemetry monitors on Saturn V launch vehicle's S-II second stage which places the Apollo spacecraft into earch orbit.

Fuel Cell Heater Temperature Controls -- Regulate heaters on three fuel cells that provide electrical power for Command Module. Controls determine fuel cell's heat level to plus or minus 7 degrees Fahrenheit.

Fuel Cell Water Purity Sensor -- Monitors purity of water produced by the fuel cells for drinking and food preparation by astronauts in the Command Module.

Ground Support Equipment -- Test equipment to functionally check astronaut's space suits, backpacks, oxygen purge systems and LM environmental control system. Also includes communication units for use by astronauts and support personnel during ground testing of backpacks and space suits.

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HAMILTON STANDARD
Division of United Aircraft Corporation
Windsor Locks, Connecticut

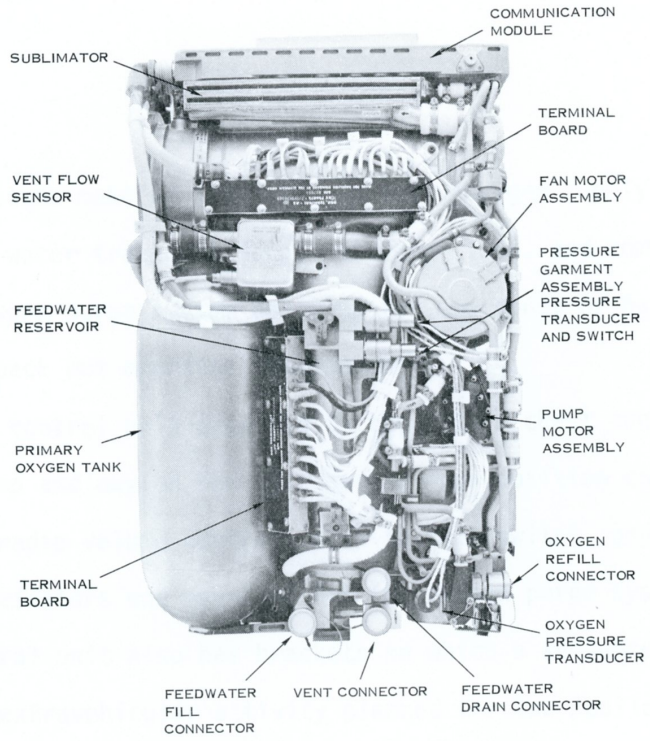
PROJECT APOLLO
PORTABLE LIFE SUPPORT SYSTEM

The Project Apollo portable life support system (PLSS) creates and maintains a livable atmosphere inside the space suit of an astronaut during excursions on the lunar surface or in space. Worn as a backpack and connected to the suit by umbilicals, it permits up to four hours of extravehicular activity, depending on the level of physical activity.

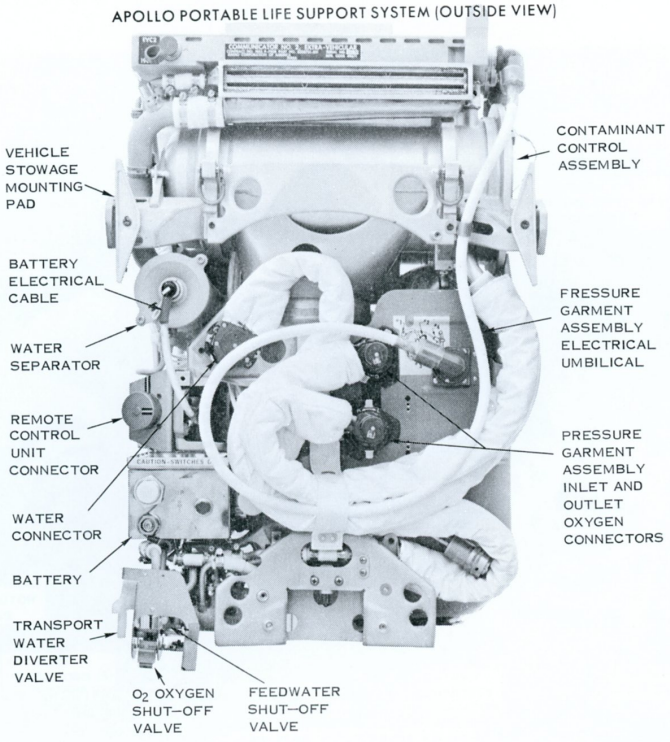
The backpack supplies oxygen for breathing purposes, and suit pressurization and ventilation. It also supplies cool water and oxygen for body cooling, and removes contaminants from the oxygen circulating through the suit. The pack is equipped with operating controls, signal devices for monitoring its functions, and a communications-telemetry set. Mounted on top is an oxygen purge system which holds an extra 30-minute supply of oxygen for emergency purposes.

For the Apollo 11 moon-landing mission, there will be two backpacks and two oxygen purge systems on the LM, one set for each astronaut. Although no revitalization of the backpacks is planned for the mission, the LM will carry an extra lithium hydroxide cartridge and sufficient oxygen and water to allow astronauts to refill each backpack's oxygen tank and water reservoir.

When fully charged, the pack weighs 85 pounds and is 26 inches high, 17.8 inches wide and 10.5 inches deep. A 16.8-volt silver zinc battery operates the oxygen fan, water pump and radio-telemetry unit. A fiberglass cover protects the pack against damage by micrometeoroids, and during crew handling and LM entry and exit operations. 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.



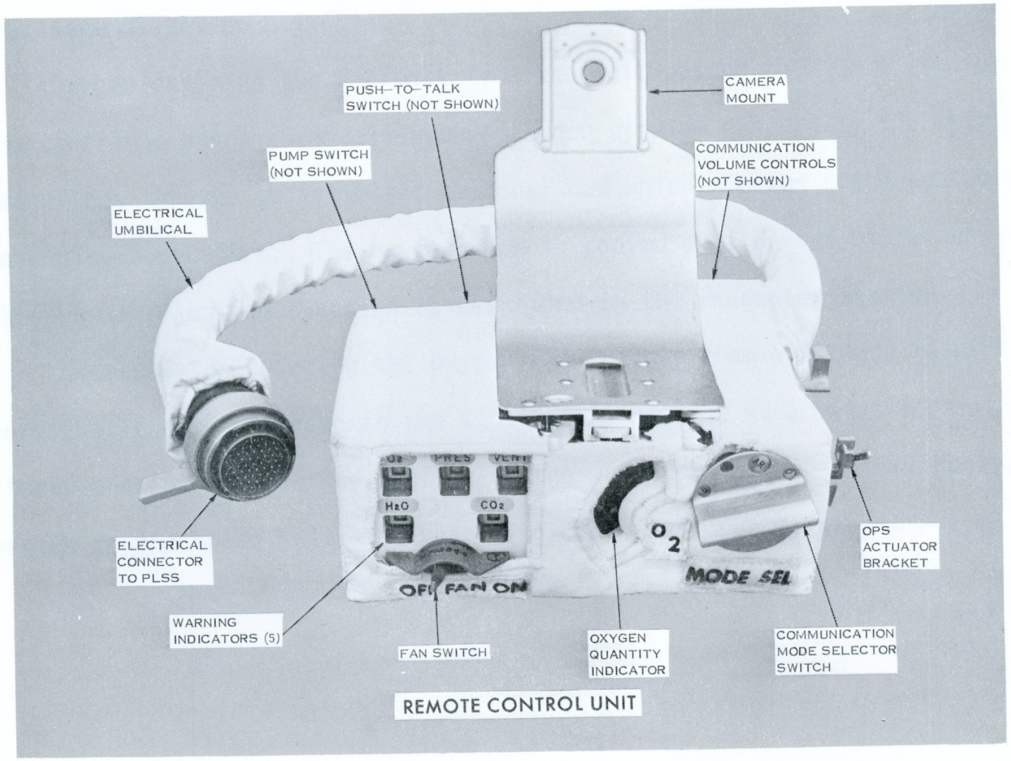
APOLLO PORTABLE LIFE SUPPORT SYSTEM (OUTSIDE VIEW)



APOLLO PORTABLE LIFE SUPPORT SYSTEM (INSIDE VIEW)

Five subsystems make up the PLSS: primary oxygen supply, oxygen ventilating circuit, water transport loop, feedwater loop, and communication system. The oxygen purge system designed for emergency or backup use is mounted on the pack but operates independently.

The remote control unit attached to the suit's chest contains the backpack's water pump and oxygen fan switches, a four-position communications mode selector, dual radio volume control, push-to-talk switch, oxygen quantity gauge, five warning indicators and mounting for the oxygen purge system's actuator. The remote control unit also has brackets on which a sequence camera is mounted for use during extravehicular activity planned for the Apollo 11 mission.



Primary Oxygen Supply

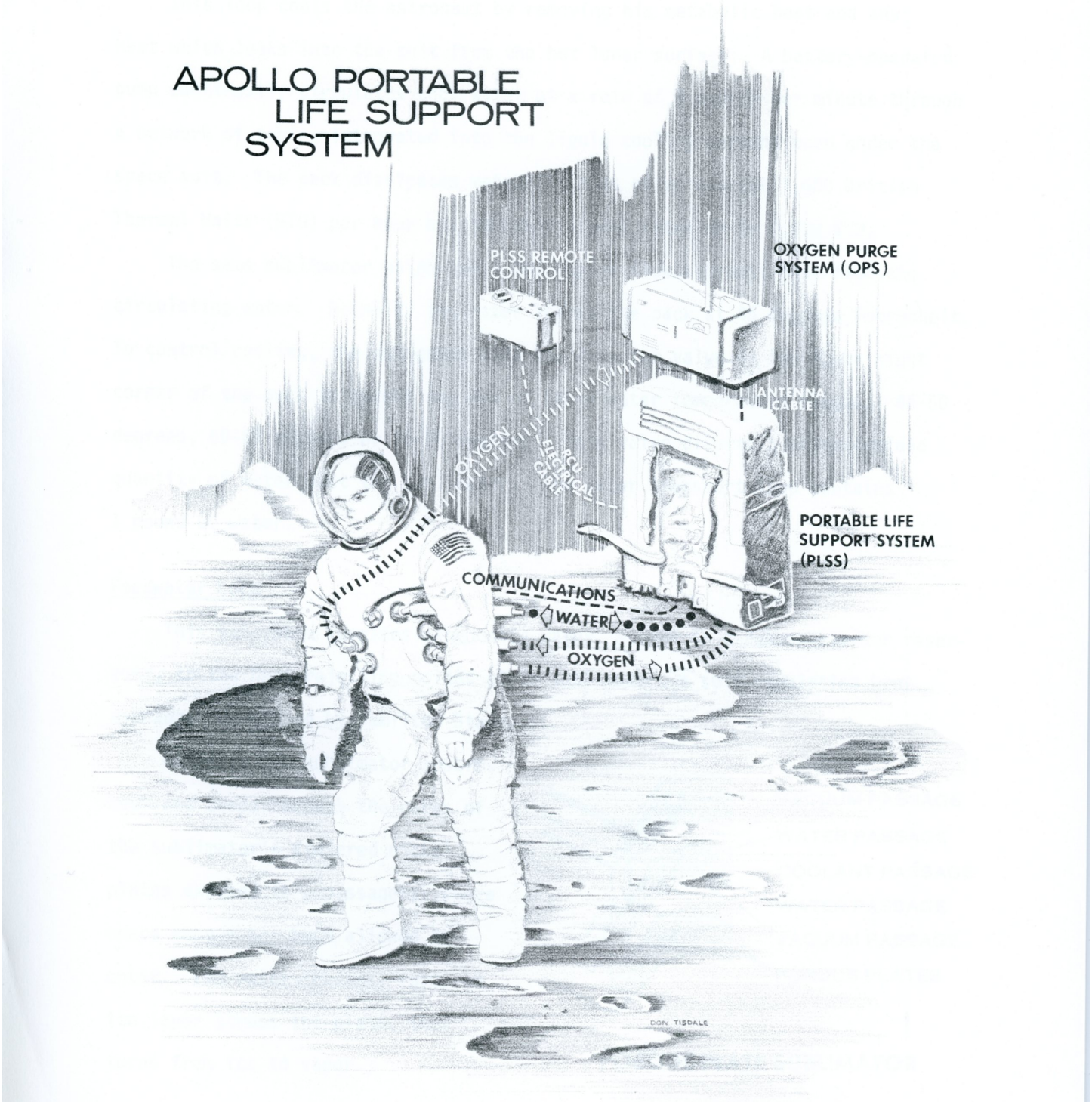
This subsystem supplies oxygen for astronaut breathing and controls pressurization of the space suit. Upon opening the oxygen shut-off valve, oxygen is fed automatically into the suit to maintain a pressure of 3.9 psi. Slightly more than one pound (1.06) of oxygen is stored in gaseous form at between 850-950 psi in a tank nearly 6 inches in diameter and slightly more than 17 inches long. The tank can be replenished from the LM's oxygen supply.

Oxygen Ventilating Circuit

This subsystem circulates oxygen through the space suit and backpack to remove carbon dioxide and contaminants, to cool and dehumidify the ventilating oxygen. The ventilating oxygen cools the astronaut by evaporating any moisture that accumulates on his skin.

Oxygen entering the backpack from the suit passes through a lithium hydroxide cartridge where chemicals remove carbon dioxide exhaled by the astronaut. It then flows through an activated charcoal bed which removes trace contaminants, including body odors. The oxygen flow is cooled by a porous plate sublimator whose heat rejecting function is described in the feedwater section.

Excess water entering the oxygen flow mainly from astronaut respiration and perspiration is condensed in the sublimator, 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.


APOLLO PORTABLE LIFE SUPPORT SYSTEM
PLSS REMOTE CONTROL
OXYGEN PURGE SYSTEM (OPS)
ANTENNA CABLE
OXYGEN
PCU ELECTRICAL CABLE
PORTABLE LIFE SUPPORT SYSTEM (PLSS)
COMMUNICATIONS
WATER
OXYGEN
DON TISDALE

Water Transport Loop

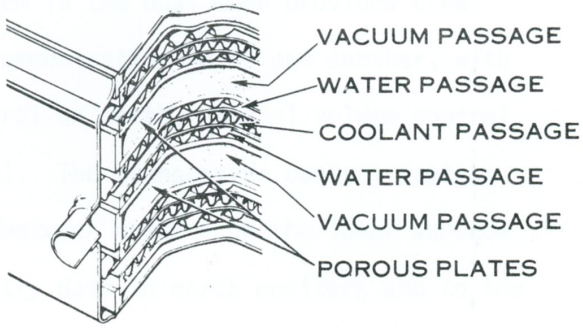
This loop cools the astronaut by removing his metabolic heat and any heat which leaks into the suit from the hot lunar surface. A battery-operated pump continually circulates cool water at a rate of 4 pounds per minute through a network of tubing integrated into the liquid cooling garment worn under the space suit. The pack dissipates metabolic heat at an average 1,600 British Thermal Units (BTU) per hour and can handle peak rates up to 2,000 BTU.

The same sublimator which cools the oxygen flow extracts heat from the circulating water. Normally the water leaves the pack at 45 degrees Fahrenheit. To control cooling, the astronaut uses the diverter valve on the lower right corner of the pack to select any one of three water temperature ranges: 45-50 degrees, 60-65 degrees or 75-80 degrees. This valve diverts a predetermined quantity of water past the sublimator. The water transport loop contains 1 pound of water.

Feedwater Loop

This subsystem supplies expendable water, stored in a rubber bladder reservoir, to the heat-rejecting porous plate sublimator, a self-regulating heat exchanger developed by Hamilton Standard.

Water in the sublimator absorbs heat and seeps through the pores of the sublimator's sintered nickel plates exposed to a passageway where space vacuum has been allowed to enter. The water freezes, forms an ice layer across the plate, then turns from ice to vapor.



POROUS PLATE SUBLIMATOR

The rate of this sublimating process is governed by the amount of heat being rejected. Suit pressure against the rubber bladder forces water into passages between the sublimator's heat transport fluid passages and its porous plates which are exposed to the vacuum. The ice layer formed on the porous plates during the sublimation process prevents the slightly pressurized water from leaking through the metal pores.

The reservoir holds 8.5 pounds of water. Condensed water from the oxygen ventilating circuit is collected between the reservoir bladder and the walls of the aluminum container. Feedwater can be replenished from the LM supply. Refilling the bladder forces the condensed water into the LM waste management system.

Space Suit Communication System

This system, manufactured by Radio Corporation of America, provides primary and backup dual voice transmission and reception, telemetry transmission of physiological and backpack performance data, and audible warning signals. It also regulates the voltage and electrical current used by the oxygen quantity gauge and various sensors.

Operation of the communication system in the dual mode provides crew members with uninterrupted duplex voice communication with one another, with the LM and, via the LM, with Mission Control on earth. A dual volume control permits adjustment of receiver sound level. The transceiver control station aboard the LM is used as a relay station between crewmen on the lunar surface or in space. It also relays radio-telemetry data to earth monitors and to the Command Module (CM) when it is in line of sight of the LM.

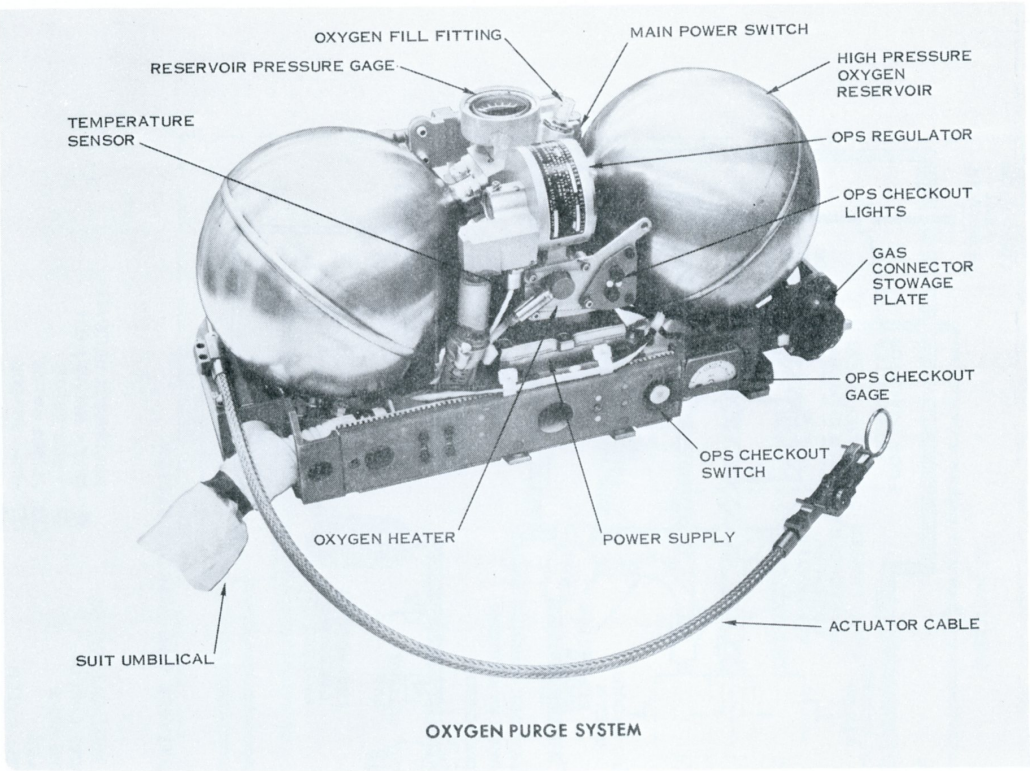
Telemetry information is transmitted without interrupting or interfering with voice communication. Nine telemetry channels transmitted to the LM carry suit operational and environmental data--oxygen supply pressure, suit water and oxygen inlet temperatures, suit pressure, feedwater pressure, suit water temperature rise and backpack battery current and voltage. One channel transmits an electrocardiogram signal.

Indicators mounted on the remote control unit provide the astronaut with a visual warning of high oxygen usage rate, low suit pressure, low ventilation flow and low feedwater pressure. A fifth indicator will be used in future missions to provide warning of high carbon dioxide concentration. Flags trip into view in the indicators' windows and an audible tone sounds to alert the astronaut that an abnormal condition exists.

Oxygen Purge System

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

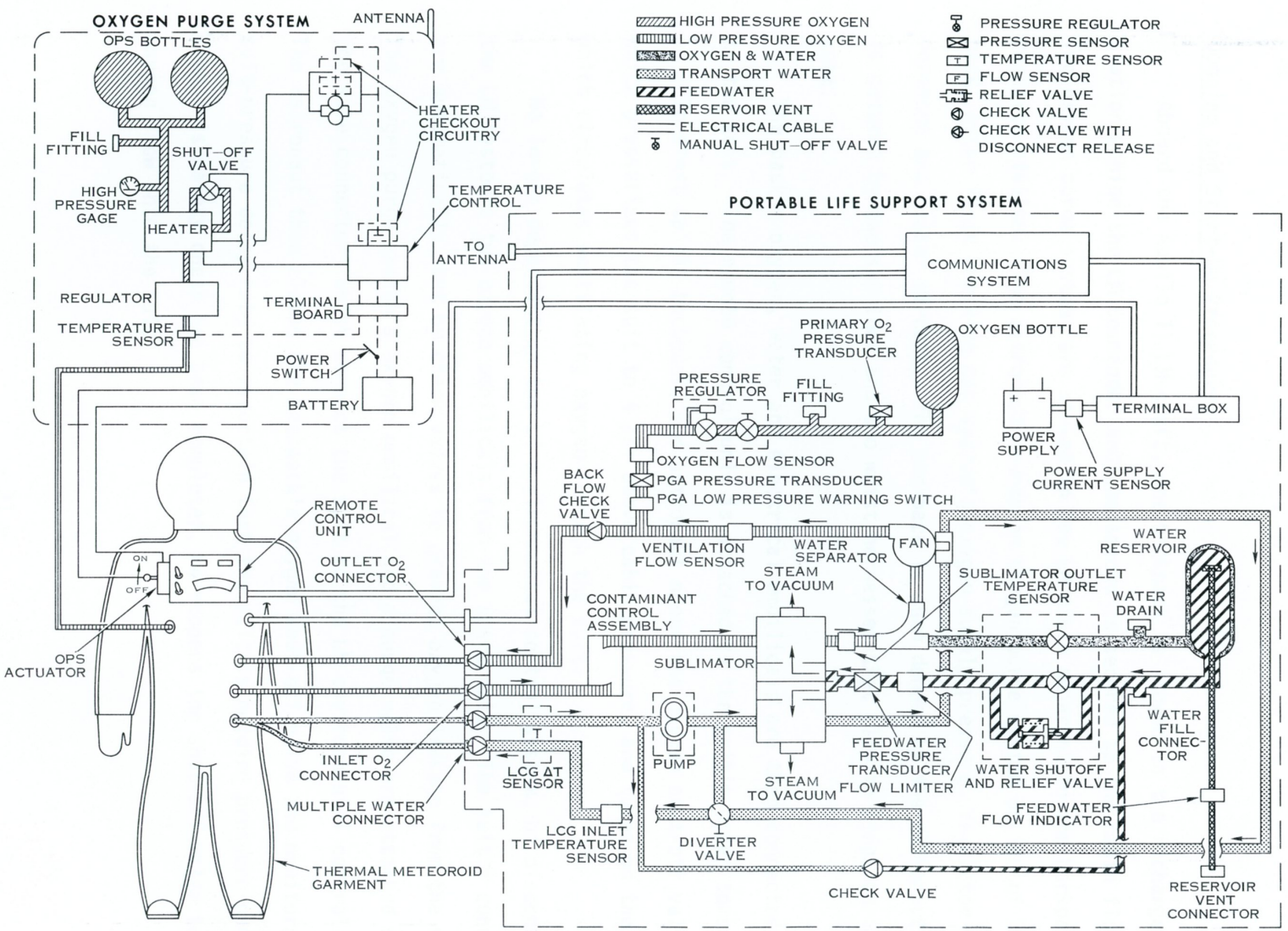
The system supplies either an open loop purge flow or makeup flow directly to the suit. In either case it maintains suit pressure at 3.7 psi. In the purge mode, it provides a 30-minute flow at a rate of 8 pounds of oxygen an hour, fulfilling breathing requirements, flushing out carbon dioxide and defogging the helmet visor.



OXYGEN PURGE SYSTEM

In the makeup mode the unit supplies .07 to .36 pounds of oxygen per hour for breathing as well as pressurization requirements. Flow is supplied to the space suit by operating the oxygen actuator handle on the remote control unit. When used with the backpack, the emergency system is mounted separately on top of the backpack and the oxygen actuator is attached to the remote control unit. Its umbilical is attached to the same connector which connects the suit to the LM environmental control system when the astronaut is inside the spacecraft.

Weighing 40.7 pounds, the unit 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 5,880 psi. A battery-powered, temperature-controlled heater warms the rapidly expanding oxygen to prevent subzero oxygen temperatures at the space suit flow inlet. Like the backpack, the oxygen purge system is protected by a fiberglass shell covered by a thermal insulator made of fire resistant Beta cloth and aluminized Kapton.



APOLLO EXTRAVEHICULAR MOBILITY UNIT SCHEMATIC LUNAR CONFIGURATION

Donning and Start-Up Procedures

Aboard the Apollo 11 LM craft, one backpack is stowed in the recharge station behind the LM commander and the second is secured to the cabin floor. Two oxygen purge systems are stowed in the LM cabin adjacent to the backpack recharge station. The astronaut mounts an oxygen purge system on top of the pack, after first checking the system's oxygen supply pressure, regulator performance and heater circuit. The backpack is then donned by the astronaut and is secured by two shoulder and two waist harnesses that clip to rings on the suit.

The pack's oxygen, water and electrical umbilicals are then connected to the suit. The remote control unit is attached to the suit's upper torso.

To start up the backpack, the astronaut opens the oxygen shut-off valve, which pressurizes the suit to 4 psi above cabin pressure, and turns on the fan which circulates ventilating oxygen through the suit.

No longer dependent on the LM environmental control system, he disconnects the LM system's two oxygen umbilicals from the space suit. The suit's connectors are automatically shut by check valves to prevent oxygen leakage from the suit. The oxygen purge system's oxygen umbilical and a purge valve are attached to the same connectors which connect the suit to the LM environmental control system. The astronaut then closes the backpack's oxygen shut-off valve and monitors the suit-pressure decay rate to ascertain that the suit is holding pressure properly. When this safety check has been completed, he reopens the shut-off valve to allow oxygen flow into the suit.

After the LM cabin is depressurized and the forward hatch opened, the astronaut activates the pump switch on the remote control unit to begin water circulation through the suit's liquid cooling garment. The feedwater valve is then opened to start up the sublimator which cools the circulating water and ventilating oxygen. The astronaut verifies and monitors the performance of the backpack by visual gauges on the remote control unit and telemetry data radioed back to him from earth station. He then is ready to leave the LM cabin for extravehicular activity.

APOLLO PLSS MILESTONES

October 15, 1962	Hamilton Standard selected by the National Aeronautics and Space Administration to develop and build Apollo portable life support system for use by astronauts in extravehicular activity.
September 20, 1963	The first backpack employing oxygen gas cooling is delivered to NASA.
September 1, 1964	Following a design change from oxygen to water cooling, Hamilton Standard begins development of backpack using improved cooling method.
November 11, 1965	Life support pack passes first three-hour manned test in space chamber simulating lunar environment.
May 31, 1966	Hamilton Standard delivers first water-cooled backpack to NASA.
June 3, 1968	First backpack for use on manned flight shipped to NASA after passing first article configuration inspection.
August 17, 1968	Backpack completes system qualification testing.
January 11, 1969	Extravehicular mobility unit (backpack and pressure suit) pass flight qualification testing for Apollo 9 mission.
March 6, 1969	Astronaut Russell L. Schweickart, sustained by Hamilton Standard backpack and a space suit, becomes first U.S. astronaut to walk in space with completely self-contained life support equipment. Schweickart's 38-minute space walk was completed during earth orbital Apollo 9 mission.

HAMILTON STANDARD
Division of United Aircraft Corporation
Windsor Locks, Connecticut

APOLLO LUNAR MODULE
ENVIRONMENTAL CONTROL SYSTEM

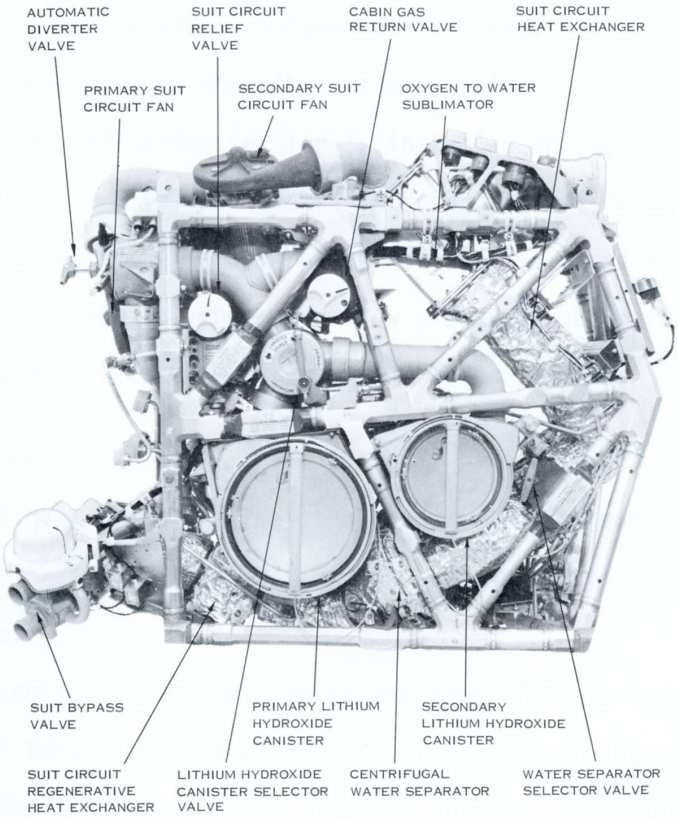
The environmental control system (ECS) will provide two astronauts with a life-sustaining atmosphere inside the Lunar Module (LM) spacecraft for approximately 33 hours during the Apollo 11 mission. The ECS has a maximum operating capability of 49.5 hours. It will supply oxygen for breathing and ventilating purposes to the astronaut space suits and LM cabin. The suits, which are connected to the system, will be worn with helmets and gloves off during certain phases of the LM flight.

The environmental control system, developed by Hamilton Standard for Grumman Aerospace Corporation, LM prime contractor, also will maintain pressure, temperature and relative humidity at safe and comfortable levels. Carbon dioxide, odors and other contaminants will be removed to allow the reuse of oxygen. Besides oxygen the ECS supplies water for cooling, drinking and food preparation. It has sufficient oxygen and water to recharge the life support backpacks which the astronauts will wear with their space suits when they explore the lunar surface.

Five main sections make up the LM environmental control system: atmosphere revitalization, liquid cooling, heat transport, oxygen supply and cabin pressure control, and water management. The system is powered by LM's 28-volt DC batteries.

Atmosphere Revitalization Section

The heart of the ECS, this section circulates oxygen pressurized at 4.8 psi (pounds per square inch) first through the space suits, then to the cabin. The space suit and cabin oxygen stream circuits are connected. They can be isolated from each other, however, when the cabin is depressurized to allow the astronauts to leave or enter the LM craft. Temperature of the oxygen leaving the environmental control system to the suit is between 45-50 degrees Fahrenheit. It is controlled by a manually adjusted valve. After leaving the suit oxygen passes through a debris-removal trap which filters out foreign particles.



LM ENVIRONMENTAL CONTROL ATMOSPHERE REVITALIZATION SECTION

Oxygen then enters a cartridge containing approximately 5.5 pounds of lithium hydroxide and 0.5 pounds of activated charcoal chemicals which remove carbon dioxide and odors. The section contains a primary cartridge which can be used for approximately 20 hours. A smaller cartridge serves as a backup when the prime cartridge is being replaced. For Apollo 11 one extra primary cartridge will be stored on the LM.

The warm air is circulated by fans and cooled to 40 degrees Fahrenheit by a heat exchanger containing a glycol antifreeze solution. Moisture is removed from the cooled air by the spinning drum of one of two water separators before the air is warmed to the required temperature in a second heat exchanger containing warm glycol. Pure oxygen is automatically introduced to the flow to assure 4.6-5.0 psi pressure when the cabin is pressurized.

The atmosphere revitalization section is installed in the cabin in back of the Lunar Module pilot. Two valves located in front connect to umbilical hoses on the astronaut space suits. These manually operated valves direct oxygen flow to both suits or can be used to bypass the flow around either suit when an astronaut is carrying out extravehicular tasks.

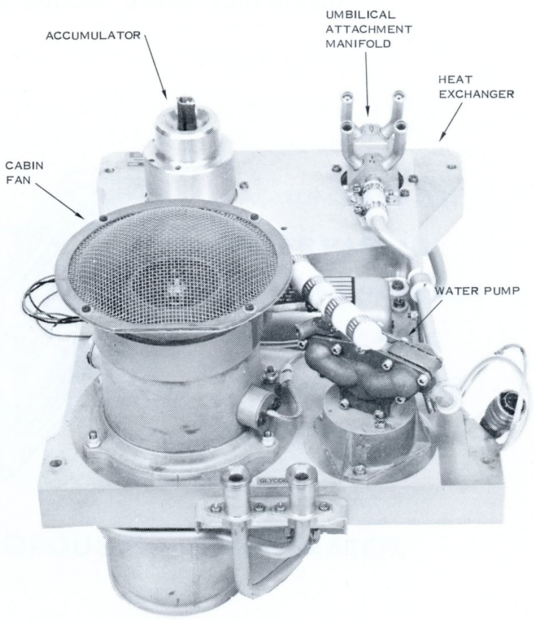
Liquid Cooling Section

The liquid cooling package provides the astronauts with additional cooling if they require more than is available from the environmental control system's ventilating gas flow.

Cool water is continually circulated at the rate of two pounds per minute through a network of tubing integrated into the liquid cooling garment worn under the space suits of the astronauts. The liquid cooling garment is normally used in conjunction with the Hamilton Standard-built portable life support system.

The cooling capacity of the supplemental package combined with the ECS ventilating gas flow is 1,600 British Thermal Units per man per hour, the same as the life support backpack.

The unit uses the same type of water pump and connectors to the suit as the back-pack does.



LIQUID COOLING PACKAGE

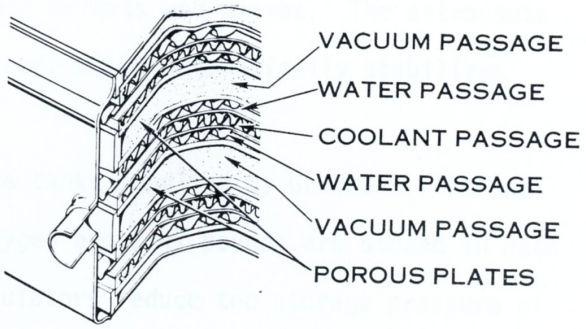
One cubic foot in size the liquid cooling package, which is powered by LM batteries, is mounted on the cabin floor behind the unit's crew station. The astronauts hook in to the package by connecting umbilicals to the liquid cooling garment connectors on their space suits. The liquid cooling package is activated by a switch on the LM's main control panel. It holds 3/10 of a pound of water and can be refilled from the LM's water storage tanks.

Heat Transport Section

This section contains the equipment which heats or cools the oxygen flow to the space suits and cabin, cools the electronic equipment, water in the liquid cooling package and batteries, and rejects heat from the LM vehicle into space. It consists of a primary coolant loop and a redundant loop which cools the back-up guidance system, communications equipment, batteries and other critical electronic equipment in the event the primary system fails.

The primary loop is filled with a water-glycol coolant solution. The coolant circulated through the primary loop absorbs heat from the electronic equipment, cabin and suit heat exchangers, and porous plate sublimator.

During flight the primary porous plate sublimator rejects heat by freezing the heat-carrying water into ice and sublimating the ice directly into vapor which is discharged into space. This cooling device is located the aft equipment bay. Prior to launch heat rejection is performed by ground support equipment.



POROUS PLATE SUBLIMATOR

Heat picked up by the redundant cooling circuit is rejected by a second porous plate sublimator. A pump circulates the glycol coolant through this section and cold plates which serve as heat sinks and mounts for the electronics equipment.

Oxygen Supply and Cabin Pressure Control Section

This section supplies oxygen to the atmosphere revitalization package to make up for losses due to the metabolic consumption by the astronauts and normal seepage of oxygen out of the cabin. It also has extra oxygen for repressurizing the cabin after is has been depressurized to allow entry into or exit from the LM vehicle, and for refilling the oxygen tanks of the two life support backpacks carried on the Apollo 11 mission.

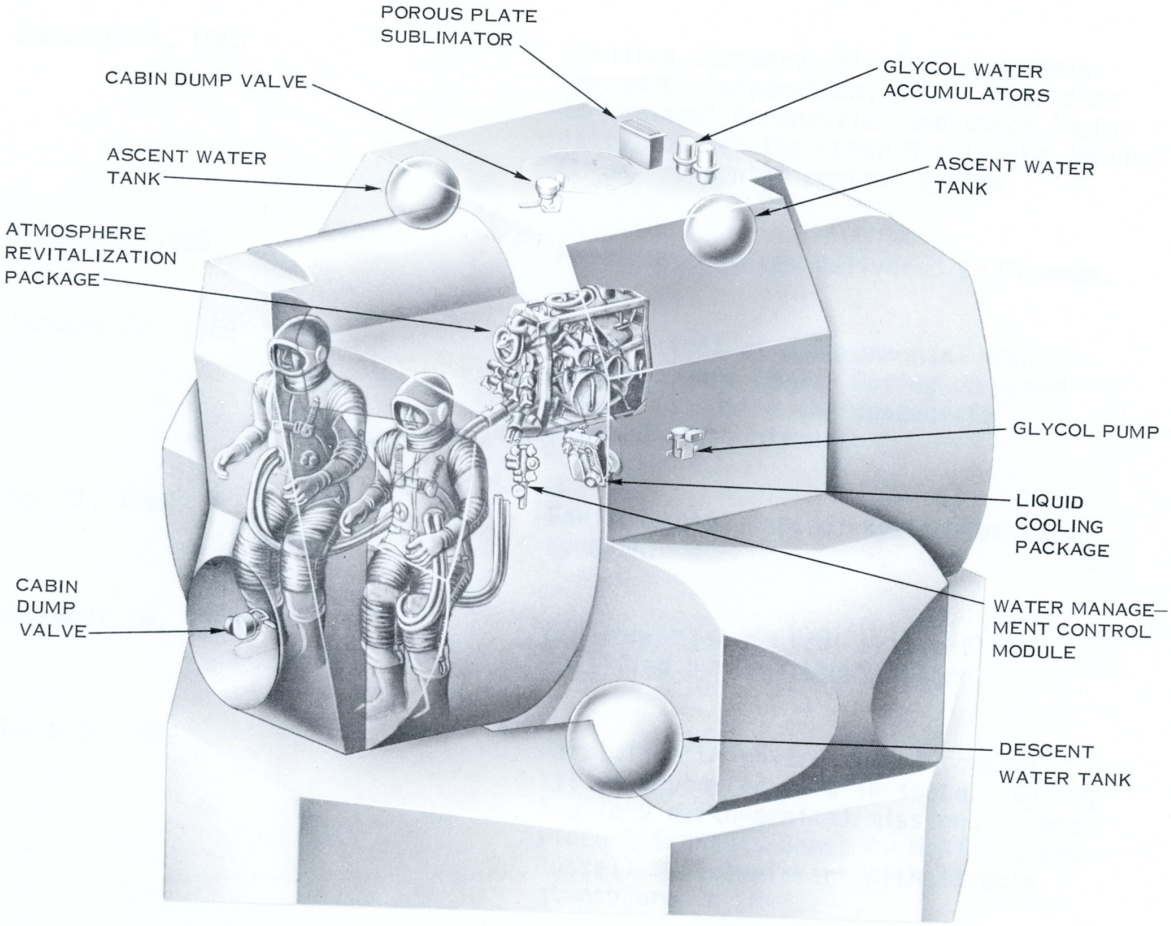
The LM cabin is automatically pressurized when the cabin pressure unintentionally drops below 4.45 psi. When the cabin is intentionally depressurized to allow the astronauts to leave or enter the spacecraft this section maintains pressure in the suit at 3.6 to 4.0 psi. In the event of an emergency such as a cabin puncture this section will maintain the space suits and cabin above 4.4 psi for several minutes while the crew don their helmets and gloves. The astronauts then manually switch to the depressurized mode which automatically stabilizes suit pressure at 3.8 psi.

The oxygen is stored as a gas in three tanks supplied by Grumman. The one descent stage tank holds 48.2 pounds of oxygen and 2.41 pounds are stored in each of the two tanks in the ascent stage. Regulators reduce the storage pressure of the oxygen from 3,000 psi in the descent tank and 1,000 psi in the ascent tanks to 4.8 psi for use by the environmental control system.

Water Management Section

This section supplies pressurized water to the sublimators and for drinking and food preparation. It also delivers the water removed from the atmosphere revitalization section to the heat transport section where it is used in the sublimators. It holds a sufficient supply to refill water tanks on the astronaut's life support packs.

Water is stored in three separate tanks. The largest, located in the descent stage, holds 332 pounds of water and is used throughout most of the mission. Two smaller tanks, carrying 42.5 pounds of water each, are located in the ascent stage and will be used after the LM lifts off the moon. Each tank consists of an aluminum outer shell and a rubber bladder inside that holds the water. Nitrogen pressure between the bladder and shell forces the water out of the tanks to a regulating and distribution system. Instruments mounted on the tanks tell the astronauts how much water they have.



LM ENVIRONMENTAL CONTROL SYSTEM

LM ECS MILESTONES

January 29, 1963	Hamilton Standard selected by Grumman Aerospace Corporation, prime contractor to National Aeronautics and Space Administration for the Lunar Module, to develop LM environmental control system.
March 18, 1966	First test system delivered to Grumman.
January 22, 1968	First flight of environmental control system aboard LM-1. During unmanned flight it cooled the spacecraft's electronics equipment.
May 11, 1968	Environmental control system man-rated by NASA.
November 14, 1968	Environmental control system flight qualified by Hamilton Standard.
March 5, 1969	First time LM environmental control system supported life in space. During Apollo 9 earth-orbital mission, it provided Astronauts James A. McDivitt and Russell L. Schweickart with livable atmosphere in LM-3.
May 22, 1969	Environmental control system supported the lives of Astronauts Thomas P. Stafford and Eugene A. Cernan for the 14-hour lunar orbit of LM-4 during Apollo 10.

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