

# SPACE SUIT

A space suit is a mobile chamber that houses and protects the astronaut from the hostile environment of space. It provides atmosphere for breathing and pressurization, protects him from heat, cold, and micrometeoroids, and contains a communications link.

The suit is worn by the astronauts during all critical phases of the mission, during periods when the command module is unpressurized, and during all operations outside the command and lunar modules whether in space or on the moon.

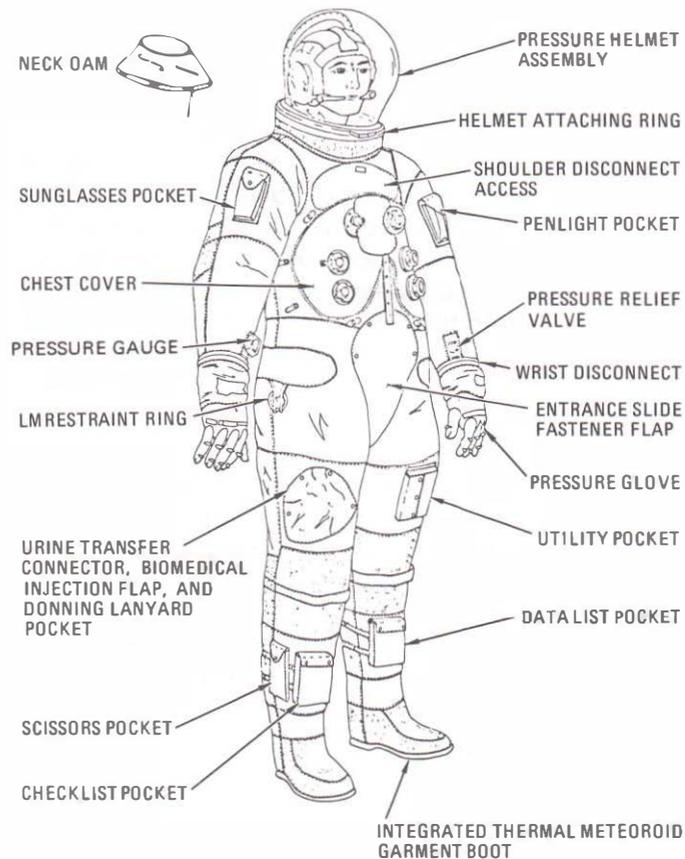
The space suit is produced by the International Latex Corp., an associate contractor directly responsible to NASA.

The suit systems must provide an artificial atmosphere (100-percent oxygen for breathing and for pressurization to 3.7 psi), adequate mobility (lunar gravity is one-sixth that of earth), micrometeorite and visual protective systems, and the ability to operate on the lunar surface for periods of 3 hours. Design of the Apollo spacecraft and suits will permit the crew to operate – with certain restraints – in a decompressed cabin for periods as long as 115 hours.

Insulation must protect the astronaut from temperatures varying from 250°F above (lunar day) to 250° below zero (lunar night). Solar heat flux is calculated at 10,000 Btu per hour. Superinsulation must limit heat leak into the suit to approximately 250 Btu per hour during lunar day and heat out to 350 Btu per hour during lunar night.

The astronauts must be protected from meteoroid particles traveling at speeds up to 64,000 miles per hour and from particles ejected by the meteoroid striking the lunar surface. During the lunar day, the crewmen's faces must be protected from solar ultraviolet, infrared, and visible light radiation.

The complete space suit is called the pressure garment assembly. It is composed of a number of items assembled into two configurations: extravehicular (for outside the spacecraft) and intravehicular. The addition of the backpack to the extravehicular space suit makes up the extravehicular mobility unit. The backpack (called the portable life support system) supplies oxygen, electrical power, communications, and liquid cooling.



NOTE: EXTRAVEHICULAR GLOVES AND LUNAR OVERSHOES NOT SHOWN.

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The intravehicular space suit consists of: fecal containment subsystem, constant wear garment, biomedical belt, urine collection transfer assembly, torso limb suit, integrated thermal micrometeoroid garment, pressure helmet, pressure glove, and communications carrier.

In the extravehicular configuration, the constant-wear garment is replaced by the liquid-cooling garment and four items are added to the intravehicular suit: extravehicular visor, extravehicular glove, lunar overshoe, and a cover which fits over umbilical connections on the front of the suit.

The pressure suit is a white, snowsuit-like garment that weighs about 60 pounds with the integrated thermal meteoroid garment. The latter weighs about 19 pounds.

# SPACE SUIT

The space suit is in a constant state of change as new and improved designs are developed and as new materials become available. Therefore the description in this section will be generalized and can be considered only as typical.

The basic components of the suit or pressure garment assembly are the torso limb suit, the pressure helmet, the pressure glove, the integrated thermal meteoroid garment, and the extravehicular glove. The constant-wear garment, which is worn under the suit in the intravehicular configuration, is described in the Crew section.

## TORSO LIMB SUIT

The torso limb suit is the basic pressure envelope for the astronaut; it encloses all the body except the head and hands. It has three layers: an inner cloth comfort lining, a bladder which serves as the gas-retention layer, and a restraint layer designed to hold elongation to a minimum. The torso section is custom-fitted to each astronaut; the limb sections are graduated in size and adjustable.

The torso limb suit contains cables to sustain axial limb loads and a block and tackle system to foreshorten the suit for sitting or bending. Ducts on the inner surface of the suit direct oxygen to the helmet for breathing and defogging and also permit flow over the body for cooling. Connectors in the suit include those for oxygen (from the spacecraft's environmental control subsystem or the portable life support system), water (for the liquid cooling garment), and urine (to transfer it to the spacecraft's waste management system). An electrical harness in the suit connects communications and biomedical equipment to either the spacecraft or the portable life support system.

The right wrist of the torso limb suit contains a pressure gauge and the left wrist a pressure relief valve which opens to relieve suit pressure of more than 5.5 psi.

## INTEGRATED THERMAL METEOROID GARMENT

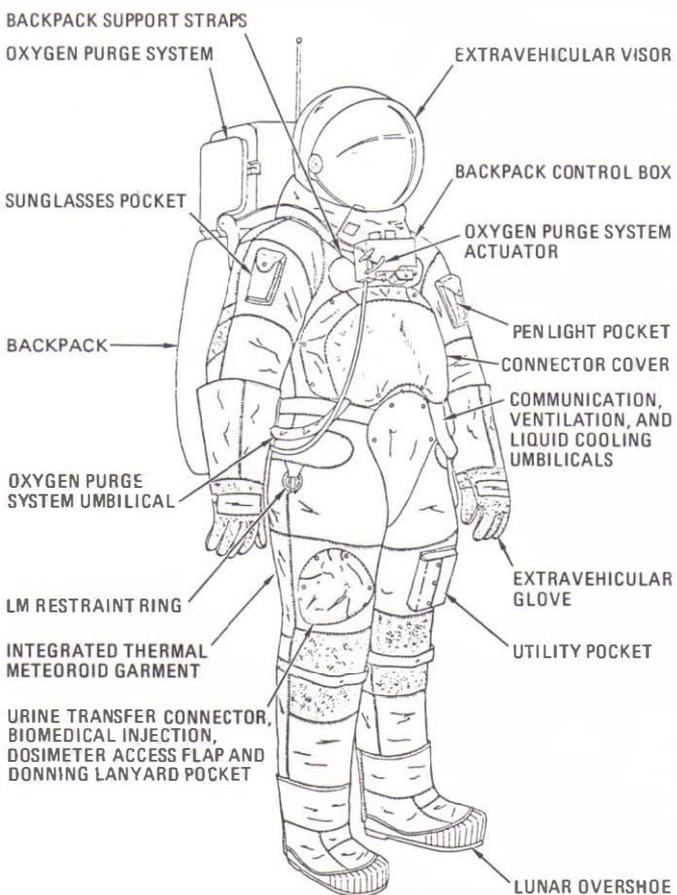
The integrated thermal meteoroid garment is a many-layered structure laced to the torso limb suit. It is composed of an inner and outer shell of Beta cloth, seven layers of aluminized Kapton film separated by six layers of Beta Marquisette, and a liner of two layers of Neoprene-coated nylon Ripstop. A layer of Chromel-R (a woven metal) is added to the knee, elbow, and shoulders to protect the suit against abrasion. Chromel-R also is used to protect the garment's boot from abrasion. The boot is attached to the space suit boot by loop tape.

Covers are provided for the shoulder cable disconnect, LM restraints, the entrance slide, and the urine transfer fitting-medical injection area. The cover for the last-named has four snaps at the top and folds down; the inner side has pockets for a radiation dosimeter and for a lanyard.

Pockets include one on the upper left arm (for two pens and a penlight), one on the upper right arm (for sunglasses), and one on the upper right thigh (a utility pocket about 1-3/4 by 6 by 8-1/4 inches). In addition, there are strap-on pockets for both legs. These contain a data list (left leg) and checklist and scissors (right leg).

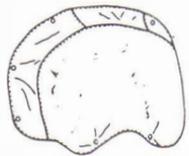
## PRESSURE HELMET

The pressure helmet consists basically of an aluminum neck ring and a transparent shell made of polycarbonate (plastic). The shell is bonded to the neck ring, which fits into and locks with a similar

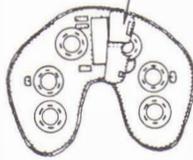


*Extravehicular suit*

HOLD DOWN STRAP ACCESS FLAP



CONNECTOR COVER



CHEST COVER

LOOP TAPE

SHOULDER DISCONNECT ACCESS

SUNGLASSES POCKET

SNAP ASSEMBLY

LM RESTRAINT ACCESS FLAP

LM RESTRAINT ACCESS

ENTRANCE SLIDE FASTENER FLAP

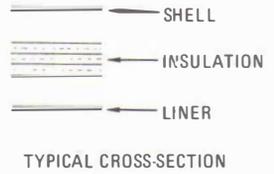
URINE TRANSFER CONNECTOR AND BIOMEDICAL INJECTION FLAP

PENLIGHT POCKET

UTILITY POCKET

WRIST CLAMP

ASSIST STRAP



TYPICAL CROSS-SECTION



BELT ASSEMBLY

DATA LIST POCKET

SLIDE FASTENER

BOOT

LOOP TAPE

SNAP ASSEMBLY

LOOP TAPE

ENTRANCE SLIDE FASTENER FLAP

LM RESTRAINT

ASSIST STRAP

ACTIVE DOSIMETER POCKET

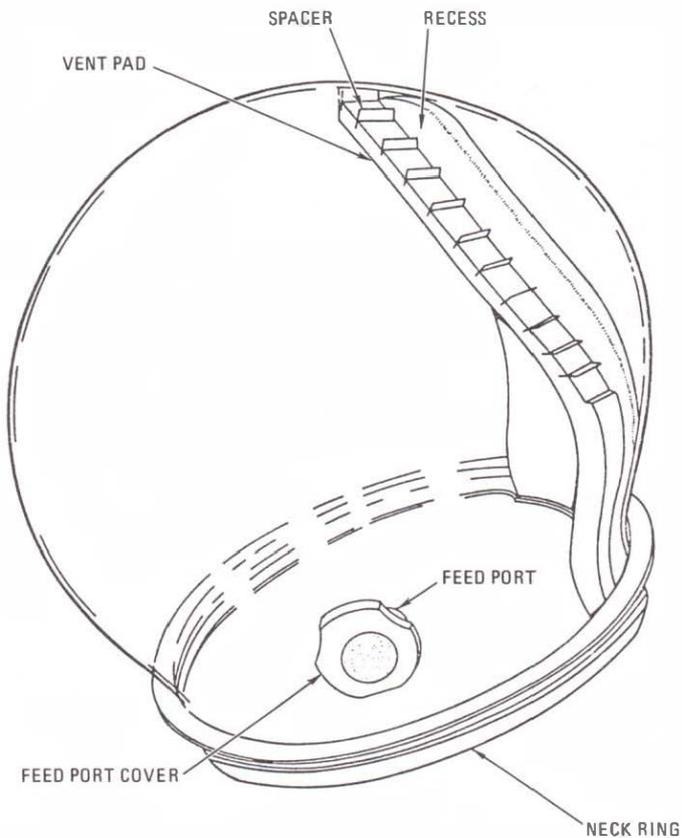


LANYARD POCKET

SCISSORS POCKET



CHECKLIST POCKET



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*Pressure helmet*

neck ring on the torso limb suit. The helmet also contains a feed port and a vent pad. The former is on the left side of the helmet and provides an air-tight attachment for the water and feed probes and for a purge valve. The vent pad (made of synthetic elastomer foam) is bonded to the back of the helmet and has a recess which acts as a ventilation flow manifold.

## PRESSURE GLOVE

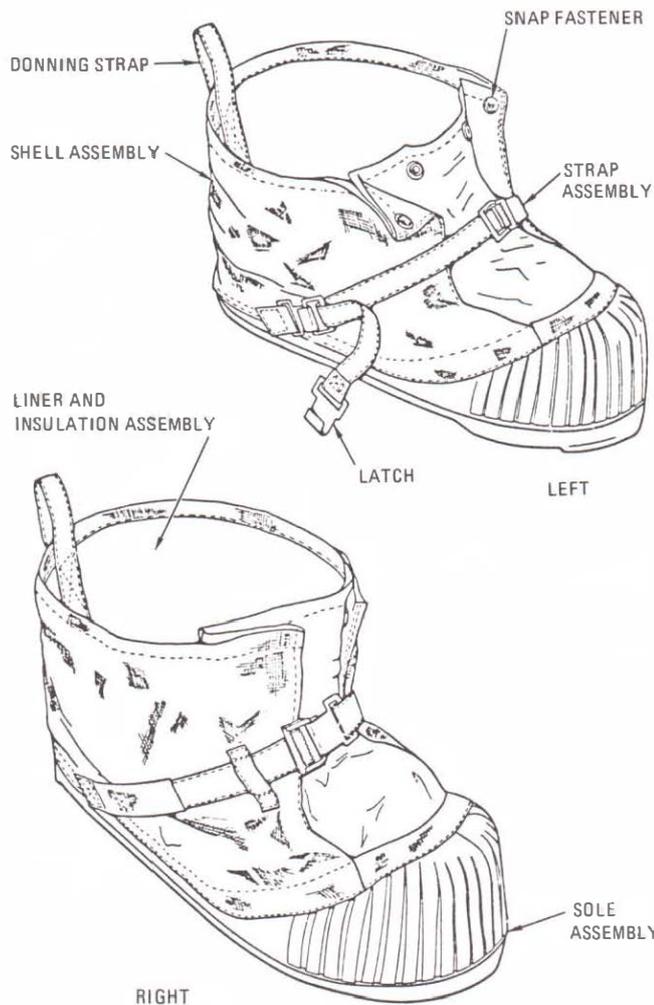
The pressure glove is a flexible gas-retaining device which locks to the torso limb suit. It consists of a bladder, a fingerless glove, inner and outer covers, and a restraint system. The bladder is moulded from a cast of each astronaut's hand. The bladder core, made of nylon tricot dipped in a Neoprene compound, is exposed at the inner thumb and fingertips to give the astronauts feeling in those areas. The fingerless glove is a restraint cemented to the bladder. A restraint strap over the palm minimizes ballooning and thus aids in grip control.

## EXTRAVEHICULAR GLOVE

This glove is used for extravehicular activities and is for thermal protection. It covers the entire hand and has a cuff that extends well above the joint between the torso limb suit and the pressure glove. The extravehicular glove consists of a modified pressure glove (called the thermal meteoroid pressure glove) to which a thermal insulating shell is secured. The shell is similar in construction to the integrated thermal meteoroid garment, with additional layers of insulating material in the palm and fingers. The Chromel-R is coated with a silicon dispersion compound to improve the grip.

## LUNAR OVERSHOE

This fits over both the thermal meteoroid garment boot and the suit boot and is used for extravehic-



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*Lunar overshoe*

lar activity. It consists of an insulation and liner, and an outer shell. The liner is Teflon-coated Beta cloth and the insulation is 13 layers of aluminized Kapton film separated by 12 layers of Beta Marquisette. The sole portion contains two additional layers of Beta felt interspaced between the uppermost film and spacer layers. The outer shell features a silicone rubber sole sewn to a laminated structure made up of four layers of two-ply Beta Marquisette. Chromel-R is used as the outer layer of the shell, except for the tongue, which is Teflon-coated Beta cloth.

## EXTRAVEHICULAR VISOR

The extravehicular visor is used over the pressure helmet to protect the astronaut from light, heat, and micrometeoroids, and to protect the pressure helmet. It consists of a polycarbonate shell to which are attached two pivoting visors, one for micrometeoroid protection and one for protection from the sun's rays. Both visors are made of polycarbonate and can be set anywhere from their full-up to full-down positions.

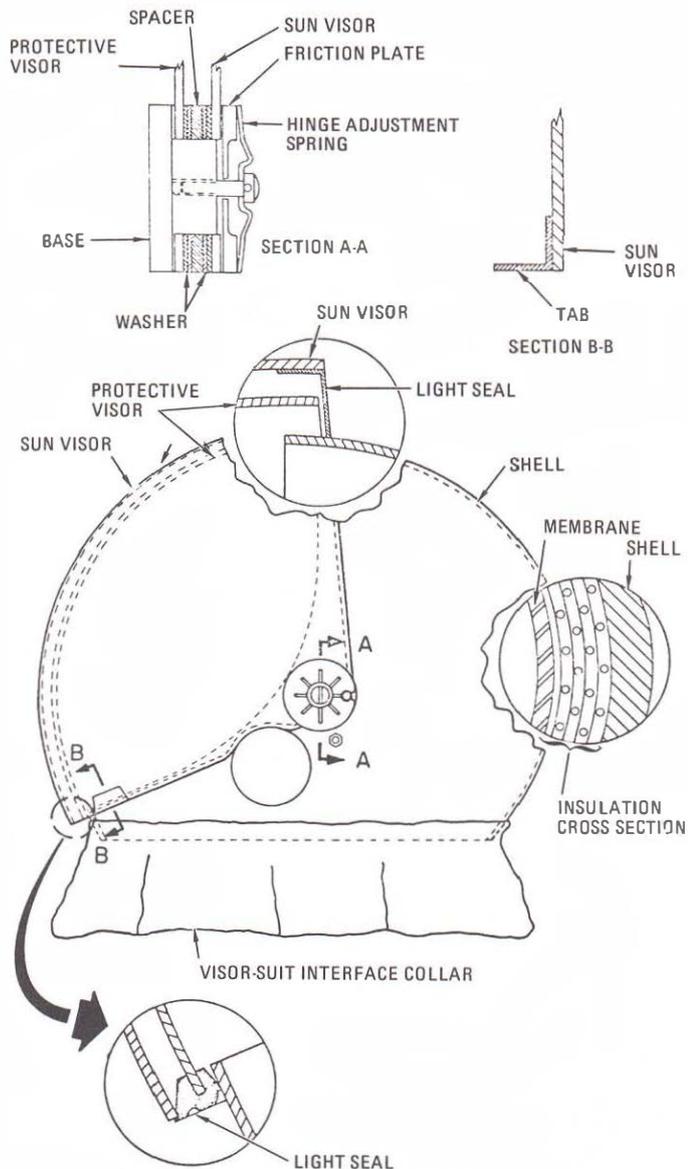
## LIQUID-COOLING GARMENT

The liquid-cooling garment is used to cool an astronaut during extravehicular activity. It consists of a nylon Spandex material which supports a network of Tygon tubing through which water from the portable life support system is circulated. The inner surface of the garment is nylon chiffon. The socks attached to the garment do not contain cooling tubes.

## PORTABLE LIFE SUPPORT SYSTEM

The portable life support system (backpack) is contained in a fiberglass shell contoured to fit the back. It is 26 inches high, 28 inches wide, and 11 inches thick, and has three control valves, 2 control switches, and a 5-position switch for the radio transceiver. Total weight is about 68 pounds. It is produced by the Hamilton Standard Division of United Aircraft Corp., Windsor Locks, Conn.

The system will assimilate an average crewman output of 1600 Btu per hour with peak rates of 2000 Btu per hour. It will operate for 4 hours in a space environment before replenishment of oxygen and replacement of the battery. There are four subsystems of the system: oxygen, liquid, telecommunications, and electrical.

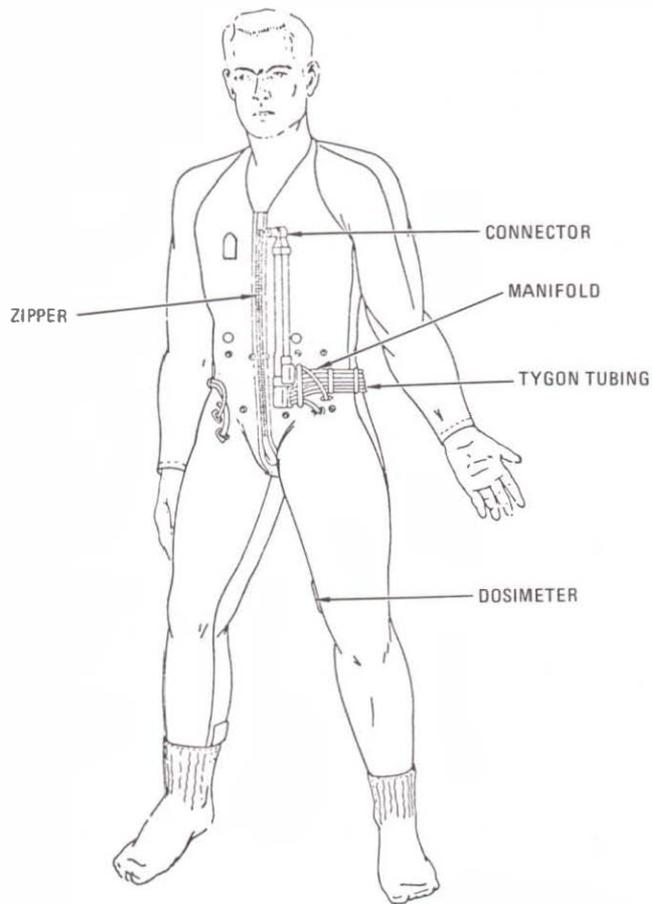


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*Extravehicular visor*

The primary oxygen (1.05 pounds) is supplied from a 46.6-cubic-inch tank pressurized at 900 psi. The system is filled through a quick-disconnect before launch or a CM flex line connection during the mission.

Oxygen flows to the suit via the oxygen supply hose at a temperature of 45 to 50°F and returned from the suit at 80 to 85°F laden with impurities such as carbon dioxide, body odor, and water molecules. It passes through a canister containing deactivated charcoal and lithium hydroxide, which absorbs the carbon dioxide and purifies the gas. The gas is then cooled to 40° to 45°F in the sublimator/heat extractor which, during the process,



*Liquid-cooling garment*

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will condense the water into droplets. As the flow reaches 90 degrees, the heavier water droplets continue straight and impact the water separator wick. The cool and conditioned gas then begins the cycle again.

The transport water subsystem of the backpack absorbs heat from the body surface of the crewman, transports it to the backpack, and loses heat in the sublimator. It is a closed loop with an operating pressure of 20 psi.

The telecommunications subsystem receives biomedical and communications data from the crewman, transmits it to the LM, and receives communications data from the LM, transmitting it to the crewman. The subsystem consists of primary and secondary transceiver (transmitters and receivers in one unit), interconnecting cable, an antenna, and controls. The cable connects the chest connector on the right side of the suit. The antenna is housed in a small fiberglass dome.

The backpack's electrical subsystem distributes power to the other subsystems. It consists of two 16.8-volt batteries, a distribution panel, and power distribution harness. A battery weighs about 4 pounds and has 27 watt-hours of use.

### EMERGENCY OXYGEN SYSTEM

The emergency oxygen system provides an immediate supply of oxygen to maintain suit pressure. It is doughnut shaped, weighs 2.9 pounds, and has an actuating mechanism, a pressure gauge, and a regulator. The system stores 7.2 cubic inches of oxygen at 7500 psig. The units are stowed on the back of the left couch leg pan or stowage mounting plates. When preparing for extravehicular activity or crew transfer, a unit is mounted on the left side of the backpack below the contaminant control canister.



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*Suited astronaut enters spacecraft at Space Division, Downey, Calif.*