ABORT MODES

The Apollo 11 mission can be aborted at any time during the launch phase or terminated during later phases after a successful insertion into Earth orbit.

Abort modes can be summarized as follows:

Launch phase --

Mode I - Launch escape system (LES) tower propels command module away from launch vehicle. This mode is in effect from about T-45 minutes when LES is armed until LES tower jettison at 3:07 GET and command module landing point can range from the Launch Complex 39A area to 400 nm downrange.

Mode II - Begins when LES tower is jettisoned and runs until the SPS can be used to insert the CSM into a safe Earth orbit (9:22 GET) or until landing points approach the African coast. Mode II requires manual separation, entry orientation and full-lift entry with landing between 350 and 3,200 nm downrange.

Mode III - Begins when full-lift landing point reached 3,200 nm (3,560 sm, 5,931 km) and extends through Earth orbital insertion. The CSM would separate from the launch vehicle, and if necessary, an SPS retrograde burn would be made, and the command module would be flown half-lift to entry and landing at approximately 3,350 nm (3,852 sm, 6,197 km) downrange.

Mode IV and Apogee Kick - Begins after the point the SPS could be used to insert the CSM into an Earth parking orbit -- from about 9:22 GET. The SPS burn into orbit would be made two minutes after separation from the S-IVB and the mission would continue as an Earth orbit alternate. Mode IV is preferred over Mode III. A variation of Mode IV is the apogee kick in which the SPS would be ignited at first apogee to raise perigee for a safe orbit.

Deep Space Aborts

Translunar Injection Phase --

Aborts during the translunar injection phase are only a remote possibly, but if an abort became necessary during the TLI maneuver, an SPS retrograde burn could be made to produce spacecraft entry. This mode of abort would be used only in the event of an extreme emergency that affected crew safety. The spacecraft landing point would vary with launch azimuth and length of the TLI burn. Another TLI abort situation would be used if a malfunction cropped up after injection. A retrograde SPS burn at about 90 minutes after TLI shutoff would allow targeting to land on the Atlantic Ocean recovery line.

Translunar Coast phase --

Aborts arising during the three-day translunar coast phase would be similar in nature to the 90-minute TLI abort. Aborts from deep space bring into the play the Moon's antipode (line projected from Moon's center through Earth's Center to the surface opposite the Moon) and the effect of the Earth's rotation upon the geographical location of the antipode. Abort times would be selected for landing when the 165 degree west longitude line crosses the antipode. The mid-Pacific recovery line crosses the antipode once each 24 hours, and if a time-critical situation forces an abort earlier than the selected fixed abort times, landings would be targeted for the Atlantic Ocean, West Pacific or Indian Ocean recovery lines in that order of preference. When the spacecraft enters the Moon's sphere of influence, a circumlunar abort becomes faster than an attempt to return directly to Earth.

Lunar Orbit Insertion phase --

Early SPS shutdowns during the lunar orbit insertion burn (LOI) are covered by three modes in the Apollo 11 mission. All three modes would result in the CM landing at the Earth latitude of the Moon antipode at the time the abort was performed.

Mode I would be a LM DPS posigrade burn into an Earth-return trajectory about two hours (at next pericynthion) after an LOI shutdown during the first two minutes of the LOI burn.

Mode II, for SPS shutdown between two and three minutes after ignition, would use the LM DPS engine to adjust the orbit to a safe, non-lunar impact trajectory followed by a second DPS posigrade burn at next pericynthion targeted for the mid-Pacific recovery line.

Mode III, from three minutes after LOI ignition until normal cutoff, would allow the spacecraft to coast through one or two lunar orbits before doing a DPS posigrade burn at pericynthion targeted for the mid-Pacific recovery line.

Lunar Orbit Phase --

If during lunar parking orbit it became necessary to abort, the transearth injection (TEI) burn would be made early and would target spacecraft landing to the mid-Pacific recovery line.

Transearth Injection phase --

Early shutdown of the TEI burn between ignition and two minutes would cause a Mode III abort and a SPS posigrade TEI burn would be made at a later pericynthion. Cutoffs after two minutes TEI burn time would call for a Mode I abort--restart of SPS as soon as possible for Earth-return trajectory. Both modes produce mid-Pacific recovery line landings near the latitude of the antipode at the time of the TEI burn.

Transearth Coast phase --

Adjustments of the landing point are possible during the transearth coast through burns with the SPS or the service module RCS thrusters, but in general, these are covered in the discussion of transearth midcourse corrections. No abort burns will be made later than 24 hours prior to entry to avoid effects upon CM entry velocity and flight path angle.

APOLLO 11 ONBOARD TELEVISION

Two television cameras will be carried aboard Apollo 11. A color camera of the type used on Apollo 10 will be stowed for use aboard the command module, and the black-and-white Apollo lunar television camera will be stowed in the LM descent stage for televising back to Earth a real-time record of man's first step onto the Moon.

The lunar television camera weighs 7.25 pounds and draws 6.5 watts of 24-32 volts DC power. Scan rate is 10 frames-per-second at 320 lines-per-frame. The camera body is 10.6 inches long, 6.5 inches wide and 3.4 inches deep. The bayonet lens mount permits lens changes by a crewman in a pressurized suit. Two lenses, a wideangle lens for close-ups and large areas, and a lunar day lens for viewing lunar surface features and activities in the near field of view with sunlight illumination, will be provided for the lunar TV camera.

The black-and-white lunar television camera is stowed in the MESA (Modular Equipment Stowage Assembly) in the LM descent stage and will be powered up before Armstrong starts down the LM ladder. When he pulls the lanyard to deploy the MESA, the TV camera will also swing down on the MESA to the left of the ladder (as viewed from LM front) and relay a TV picture of his initial steps on the Moon. Armstrong later will mount the TV camera on a tripod some distance away from the LM after Aldrin has descended to the surface. The camera will be left untended to cover the crew's activities during the remainder of the EVA.

The Apollo lunar television camera is built by Westinghouse Electric Corp., Aerospace Division, Baltimore, Md.

The color TV camera is a 12-pound Westinghouse camera with a zoom lens for wideangle or close-up use, and has a three-inch monitor which can be mounted on the camera or in the command module. The color camera outputs a standard 525-line, 30 frame-per-second signal in color by use of a rotating color wheel. The black-and-white signal from the spacecraft will be converted to color at the Mission Control Center.

The following is a preliminary plan for TV passes based upon a 9:32 a.m. EDT, July 16 launch.

TENTATIVE APOLLO 11 TV TIMES

Date	Times of Planned TV (EDT)	GET	Prime Site	Event
July 17	7:32 - 7:47 p.m.	34:00-34:15	Goldstone	Translunar Coast
July 18	7:32 - 7:47 p.m.	58:00-58:15	Goldstone	Translunar Coast
July 19	4:02 - 4:17 p.m.	78:30-78:45	Goldstone	Lunar Orbit (general surface shots)
July 20	1:52 - 2:22 p.m.	100:20-100:50	Madrid	CM/LM Formation Flying
July 21	1:57 - 2:07 a.m.	112:25-112:35	Goldstone	Landing Site Tracking
July 21	2:12 - 4:52 a.m.	112:40-115:20	*Parkes	Black and White Lunar Surface
July 22	9:02 - 9:17 p.m.	155:30-155:45	Goldstone	Transearth Coast
July 23	7:02 - 7:17 p.m.	177:30-177:45	Goldstone	Transearth Coast

* Honeysuckle will tape the Parkes pass and ship tape to MSC.

APOLLO 11 PHOTOGRAPHIC TASKS

Still and motion pictures will be made of most spacecraft maneuvers as well as of the lunar surface and of crew activities in the Apollo 11 cabin. During lunar surface activities after lunar module touchdown and the two hour 40 minute EVA, emphasis will be on photographic documentation of crew mobility, lunar surface features and lunar material sample collection.

Camera equipment carried on Apollo 11 consists of one 70mm Hasselblad electric camera stowed aboard the command module, two Hasselblad 70mm lunar surface superwide angle cameras stowed aboard the LM and a 35mm stereo close-up camera in the LM MESA.

The 2.3 pound Hasselblad superwide angle camera in the LM is fitted with a 38mm f/4.5 Zeiss Biogon lens with a focusing range from 12 inches to infinity. Shutter speeds range from time exposure and one second to 1/500 second. The angular field of view with the 38mm lens is 71 degrees vertical and horizontal on the square-format film frame.

The command module Hasselblad electric camera is normally fitted with an 80mm f/2.8 Zeiss Planar lens, but bayonet-mount 60mm and 250mm lens may be substituted for special tasks. The 80mm lens has a focusing range from three feet to infinity and has a field of view of 38 degrees vertical and horizontal.

Stowed with the Hasselblads are such associated items as a spotmeter, ringsight, polarizing filter, and film magazines. Both versions of the Hasselblad accept the same type film magazine.

For motion pictures, two Maurer 16mm data acquisition cameras (one in the CSM, one in the LM) with variable frame speed (1, 6, 12 and 24 frames per second) will be used. The cameras each weigh 2.8 pounds with a 130-foot film magazine attached. The command module 16mm camera will have lenses of 5, 18 and 75mm focal length available, while the LM camera will be fitted with the 18mm wideangle lens. Motion picture camera accessories include a right-angle mirror, a power cable and a command module boresight window bracket.

During the lunar surface extravehicular activity, the commander will be filmed by the LM pilot with the LM 16mm camera at normal or near-normal frame rates (24 and 12 fps), but when he leaves the LM to join the commander, he will switch to a one frame-per-second rate. The camera will be mounted inside the LM looking through the right-hand window. The 18mm lens has a horizontal field of view of 32 degrees and a vertical field of view of 23 degrees. At one fps, a 130-foot 16mm magazine will run out in 87 minutes in real time; projected at the standard 24 fps, the film would compress the 87 minutes to 3.6 minutes.

Armstrong and Aldrin will use the Hasselblad lunar surface camera extensively during their surface EVA to document each of their major tasks. Additionally, they will make a 360-degree overlapping panorama sequence of still photos of the lunar horizon, photograph surface features in the immediate area, make close-ups of geological samples and the area from which they were collected and record on film the appearance and condition of the lunar module after landing.

Stowed in the MESA is a 35mm stereo close-up camera which shoots 24mm square color stereo pairs with an image scale of one-half actual size. The camera is fixed focus and is equipped with a stand-off hood to position the camera at the proper focus distance. A long handle permits an EVA crewman to position the camera without stooping for surface object photography. Detail as small as 40 microns can be recorded.

A battery-powered electronic flash provides illumination. Film capacity is a minimum of 100 stereo pairs.

The stereo close-up camera will permit the Apollo 11 landing crew to photograph significant surface structure phenomena which would remain intact only in the lunar environment, such as fine powdery deposits, cracks or holes and adhesion of particles.

Near the end of EVA, the film casette will be removed and stowed in the commander's contingency sample container pocket and the camera body will be left on the lunar surface.

LUNAR DESCRIPTION

Terrain - Mountainous and crater-pitted, the former rising thousands of feet and the latter ranging from a few inches to 180 miles in diameter. The craters are thought to be formed by the impact of meteorites. The surface is covered with a layer of fine-grained material resembling silt or sand, as well as small rocks and boulders.

Environment - No air, no wind, and no moisture. The temperature ranges from 243 degrees in the two-week lunar day to 279 degrees below zero in the two-week lunar night. Gravity is one-sixth that of Earth. Micrometeoroids pelt the Moon (there is no atmosphere to burn them up). Radiation might present a problem during periods of unusual solar activity.

Dark Side - The dark or hidden side of the Moon no longer is a complete mystery. It was first photographed by a Russian craft and since then has been photographed many times, particularly by NASA's Lunar Orbiter spacecraft and Apollo 8.

Origin - There is still no agreement among scientists on the origin of the Moon. The three theories: (1) the Moon once was part of Earth and split off into its own orbit, (2) it evolved as a separate body at the same time as Earth, and (3) it formed elsewhere in space and wandered until it was captured by Earth's gravitational field.

Physical Facts

Diameter	2,160 miles (about ¼ that of Earth)
Circumference	6,790 miles (about ¼ that of Earth)
Distance from Earth	238,857 miles (mean; 221,463 minimum to 252,710 maximum)
Surface temperature	+243°F (Sun at zenith) -279°F (night)
Surface gravity	1/6 that of Earth
Mass	1/100th that of Earth
Volume	1/50th that of Earth
Lunar day and night	14 Earth days each
Mean velocity in orbit	2,287 miles per hour
Escape velocity	1.48 miles per second
Month (period of rotation around Earth)	27 days, 7 hours, 43 minutes

Apollo Lunar Landing Sites

Possible landing sites for the Apollo lunar module have been under study by NASA's Apollo Site Selection Board for more than two years. Thirty sites originally were considered. These have been narrowed down to three for the first lunar landing. (Site 1 currently not considered for first landing.)

Selection of the final sites was based on high resolution photographs by Lunar Orbiter spacecraft, plus close-up photos and surface data provided by the Surveyor spacecraft which soft-landed on the Moon.

The original sites are located on the visible side of the Moon within 45 degrees east and west of the Moon's center and 5 degrees north and south of its equator.

The final site choices were based on these factors:

*Smoothness (relatively few craters and boulders)

*Approach (no large hills, high cliffs, or deep craters that could cause incorrect altitude signals to the lunar module landing radar)

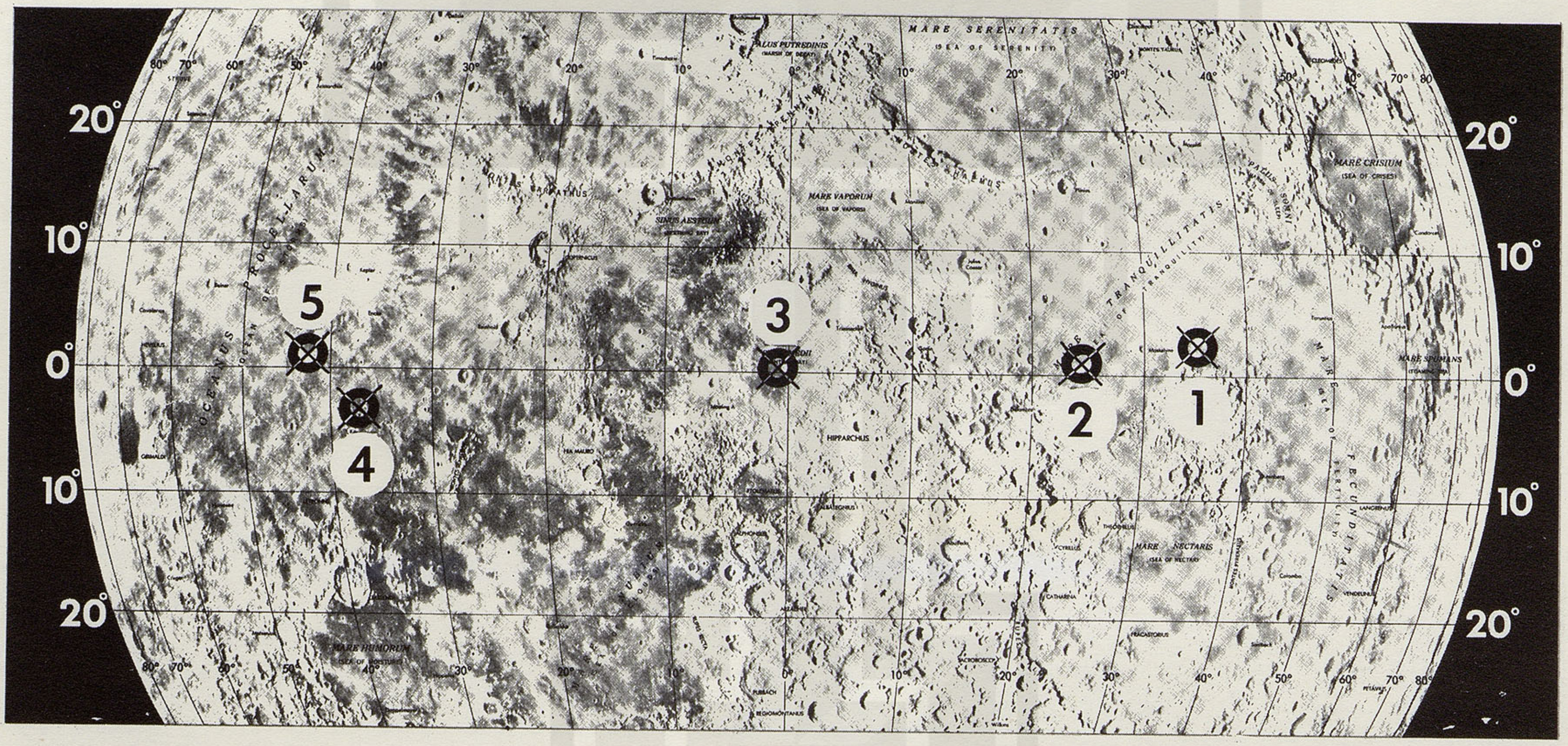
*Propellant requirements (selected sites require the least expenditure of spacecraft propellants)

*Recycle (selected sites allow effective launch preparation recycling if the Apollo Saturn V countdown is delayed)

*Free return (sites are within reach of the spacecraft launched on a free return translunar trajectory)

*Slope (there is little slope -- less than 2 degrees in the approach path and landing area)

APOLLO LUNAR LANDING SITES



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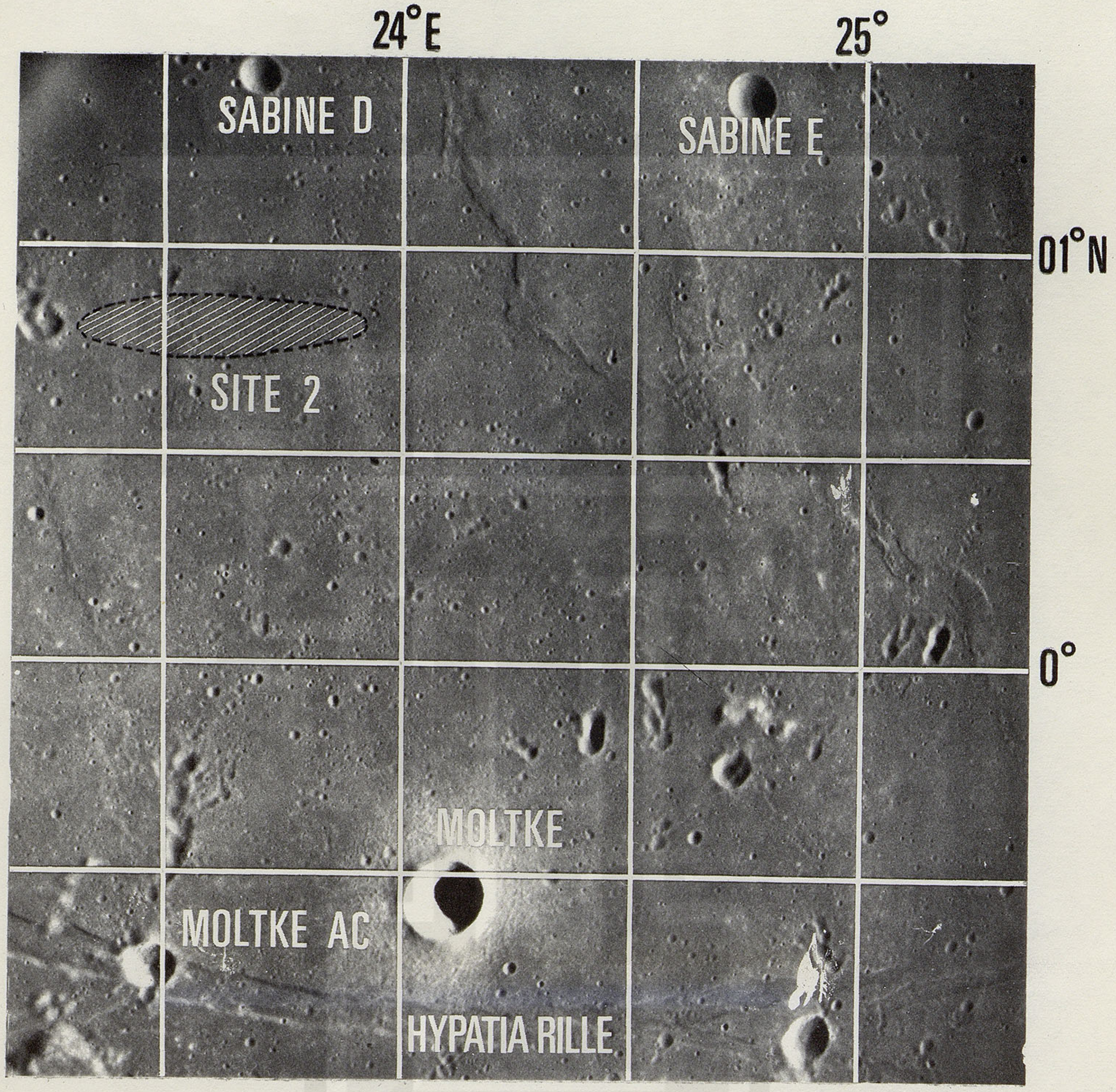
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The Apollo 11 Landing Sites Are:

Site 2

latitude 0° 42' 50" North
longitude 23° 42' 28" East

Site 2 is located on the east central part of the Moon in southwestern Mar Tranquillitatis. The site is approximately 62 miles (100 kilometers) east of the rim of Crater Sabine and approximately 118 miles (190 kilometers) southwest of the Crater Maskelyne.

Site 3

latitude 0° 21' 10" North
longitude 1° 17' 57" West

Site 3 is located near the center of the visible face of the Moon in the southwestern part of Sinus Medii. The site is approximately 25 miles (40 kilometers) west of the center of the face and 21 miles (50 kilometers) southwest of the Crater Bruce.

Site 5

latitude 1° 40' 41" North
longitude 41° 53' 57" West

Site 5 is located on the west central part of the visible face in southeastern Oceanus Procellarum. The site is approximately 130 miles (210 kilometers) southwest of the rim of Crater Kepler and 118 miles (190 kilometers) north northeast of the rim of Crater Flamsteed.

COMMAND AND SERVICE MODULE STRUCTURE, SYSTEMS

The Apollo spacecraft for the Apollo 11 mission is comprised of Command Module 107, Service Module 107, Lunar Module 5, a spacecraft-lunar module adapter (SLA) and a launch escape system. The SLA serves as a mating structure between the instrument unit atop the S-IVB stage of the Saturn V launch vehicle and as a housing for the lunar module.

Launch Escape System (LES) -- Propels command module to safety in an aborted launch. It is made up of an open-frame tower structure, mounted to the command module by four frangible bolts, and three solid-propellant rocket motors: a 147,000 pound-thrust launch excape system motor, a 2,400-pound-thrust pitch control motor, and a 31,500-pound-thrust tower jettison motor. Two canard vanes near the top deploy to turn the command module aerodynamically to an attitude with the heat-fhield forward. Attached to the base of the launch escape tower is a boost protective cover composed of resin impregnated fiberglass covered with cork, that protects the command module from aerodynamic heating during boost and rocket exhaust gases from the main and the jettison motors. The system is 33 feet tall, four feet in diameter at the base, and weighs 8,910 pounds.

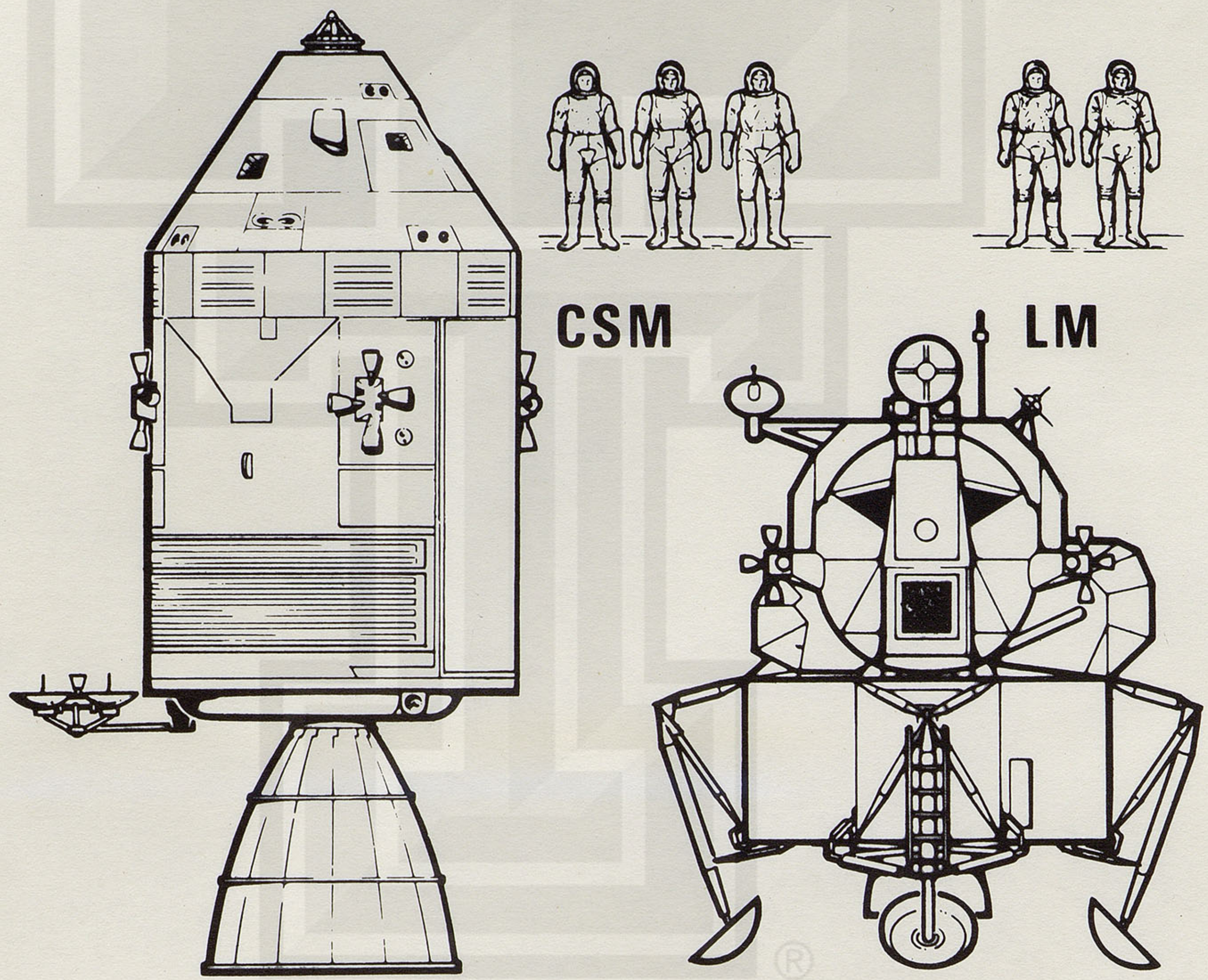
Command Module (CM) Structure -- The basic structure of the command module is a pressure vessel encased in heat shields, cone-shaped 11 feet 5 inches high, base diameter of 12 feet 10 inches, and launch weight 12,250 pounds.

The command module consists of the forward compartment which contains two reaction control engines and components of the Earth landing system; the crew compartment or inner pressure vessel containing crew accomodations, controls and displays, and many of the spacecraft systems; and the aft compartment housing ten reaction control engines, propellant tankage, helium tanks, water tanks, and the CSM umbilical cable. The crew compartment contains 210 cubic feet of habitable volume.

Heat-shields around the three compartments are made of brazed stainless steel honeycomb with an outer layer of phenolic epoxy resin as an ablative material. Shield thickness, varying according to heat loads, ranges from 0.7 inch at the apex to 2.7 inches at the aft end.

The spacecraft inner structure is of sheet-aluminum honeycomb bonded sandwhich ranging in thickness from 0.25 inch thick at forward access tunnel to 1.5 inches thick at base.

APOLLO SPACECRAFT



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CSM 107 and LM-5 are equipped with the probe-and-drogue docking hardware. The probe assembly is a powered folding coupling and impact attentuating device mounted on the CM tunnel that mates with a conical drogue mounted in the LM docking tunnel. After the 12 automatic docking latches are checked following a docking maneuver, both the probe and drogue assemblies are removed from the vehicle tunnels and stowed to allow free crew transfer between the CSM and LM.

Service Module (SM) Strucutre -- The service module is a cylinder 12 feet 10 inches in diameter by 24 feet 7 inches high. For the Apollo 11 mission, it will weigh, 51,243 pounds at launch. Aluminum honeycomb panels one inch thick form the outer skin, and milled aluminum radial beams separate the interior into six sections around a central cylinder containing two helium spheres, four sections containing service propulsion system fuel-oxidizer tankage, another containing fuel cells, cryogenic oxygen and hydrogen, and one sector essentially empty.

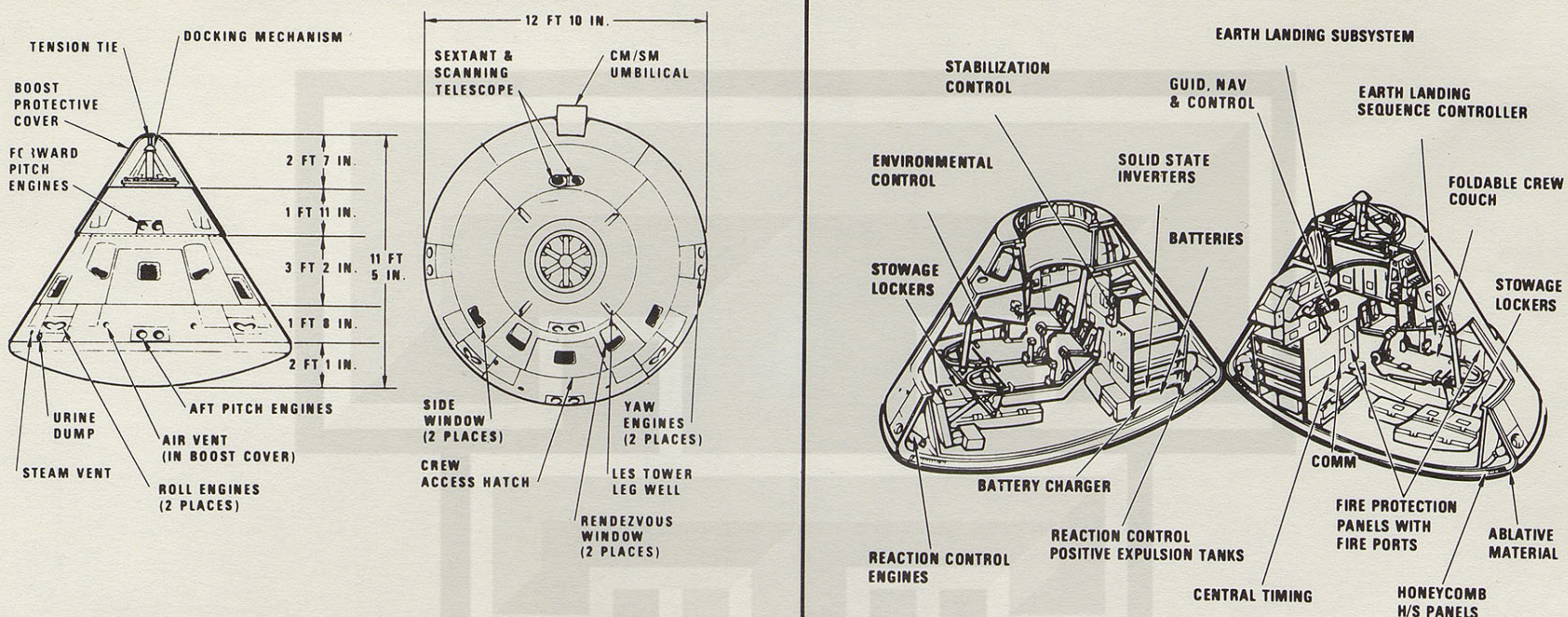
Spacecraft-LM Adapter (SLA) Structure -- The spacecraft LM adapter is a truncated cone 28 feet long tapering from 260 inches diameter at the base to 154 inches at the forward end at the service module mating line. Aluminum honeycomb 1.75 inches thick is the stressed-skin structure for the spacecraft adapter. The SLA weighs 4,000 pounds.

CSM Systems

Guidance, Navigation and Control System (GNCS) -- Measures and controls spacecraft position, attitude, and velocity, calculates trajectory, controls spacecraft propulsion system thrust vector, and displays abort data. The guidance system consists of three subsystems: inertial, made up of an inertial measurement unit and associated power and data components; computer which processes information to or from other components; and optics, including scanning telecope and sextant for celestial and/or landmark spacecraft navigation. CSM 107 and subsequent modules are equipped with a VHF ranging device as a backup to the LM rendezvous radar.

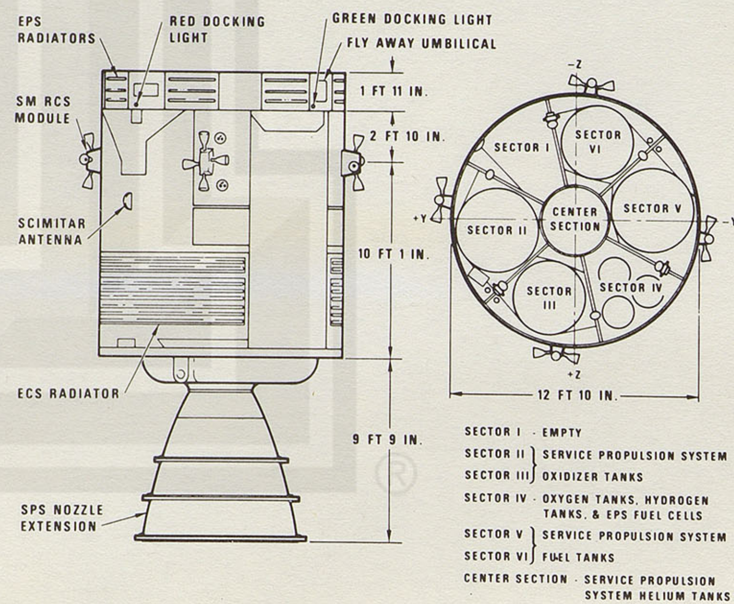
Stabilization and Control Systems (SCS) -- Controls spacecraft rotation, translation, and thrust vector and provides displays for crew-initiated maneuvers; backs up the guidance system. It has three subsystems; attitude reference, attitude control, and thrust vector control.

Service Propulsion System (SPS) -- Provides thrust for large spacecraft velocity changes through a gimbal-mounted 20,500-pound-thrust hypergolic engine using a nitrogen tetroxide oxidizer and a 50-50 mixture of unsymmetrical dimethyl hydrazine and hydrazine fuel. This system is in the service module. The system responds to automatic firing commands from the guidance and navigation system or to manual commands from the crew. The engine provides a constant thrust level. The stabilization and control system gimbals the engine to direct the thrust vector through the spacecraft center of gravity.



COMMAND MODULE

SERVICE MODULE



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Telecommunications System -- Provides voice, television, telemetry, and command data and tracking and ranging between the spacecraft and Earth, between the command module and the lunar module and between the spacecraft and the extravehicular astronaut. It also provides intercommunications between astronauts. The telecommunications system consists of pulse code modulated telemetry for relaying to Manned Space Flight Network stations data on spacecraft systems and crew condition, VHF/AM voice, and unified S-Band tracking transponder, air-to-ground voice communications, onboard television, and a VHF recovery beacon. Network stations can transmit to the spacecraft such items as updates to the Apollo guidance computer and central timing equipment, and real-time commands for certain onboard functions.

The high-gain steerable S-Band antenna consists of four, 31-inch-diameter parabolic dishes mounted on a folding boom at the aft end of the service module. Nested alongside the service propulsion system engine nozzle until deployment, the antenna swings out at right angles to the spacecraft longitudinal axis, with the boom pointing 52 degrees below the heads-up horizontal. Signals from the ground stations can be tracked either automatically or manually with the antenna's gimballing system. Normal S-Band voice and uplink/downlink communications will be handled by the omni and high-gain antennas.

Sequential System -- Interfaces with other spacecraft systems and subsystems to initiate time critical functions during launch, docking maneuvers, sub-orbital aborts, and entry portions of a mission. The system also controls routine spacecraft sequencing such as service module separation and deployment of the Earth landing system.

Emergency Detection System (EDS) -- Detects and displays to the crew launch vehicle emergency conditions, such as excessive pitch or roll rates or two engines out, and automatically or manually shuts down the booster and activates the launch escape system; functions until the spacecraft is in orbit.

Earth Landing System (ELS) -- Includes the drogue and main parachute system as well as post-landing recovery aids. In a normal entry descent, the command module forward heat shield is jettisoned at 24,000 feet, permitting mortar deployment of two reefed 16.5-foot diameter drogue parachutes for orienting and decelerating the spacecraft. After disreef and drogue release, three mortar deployed pilot chutes pull out the three main 83.3-foot diameter parachutes with two-stage reefing to provide gradual inflation in three steps. Two main parachutes out of three can provide a safe landing.

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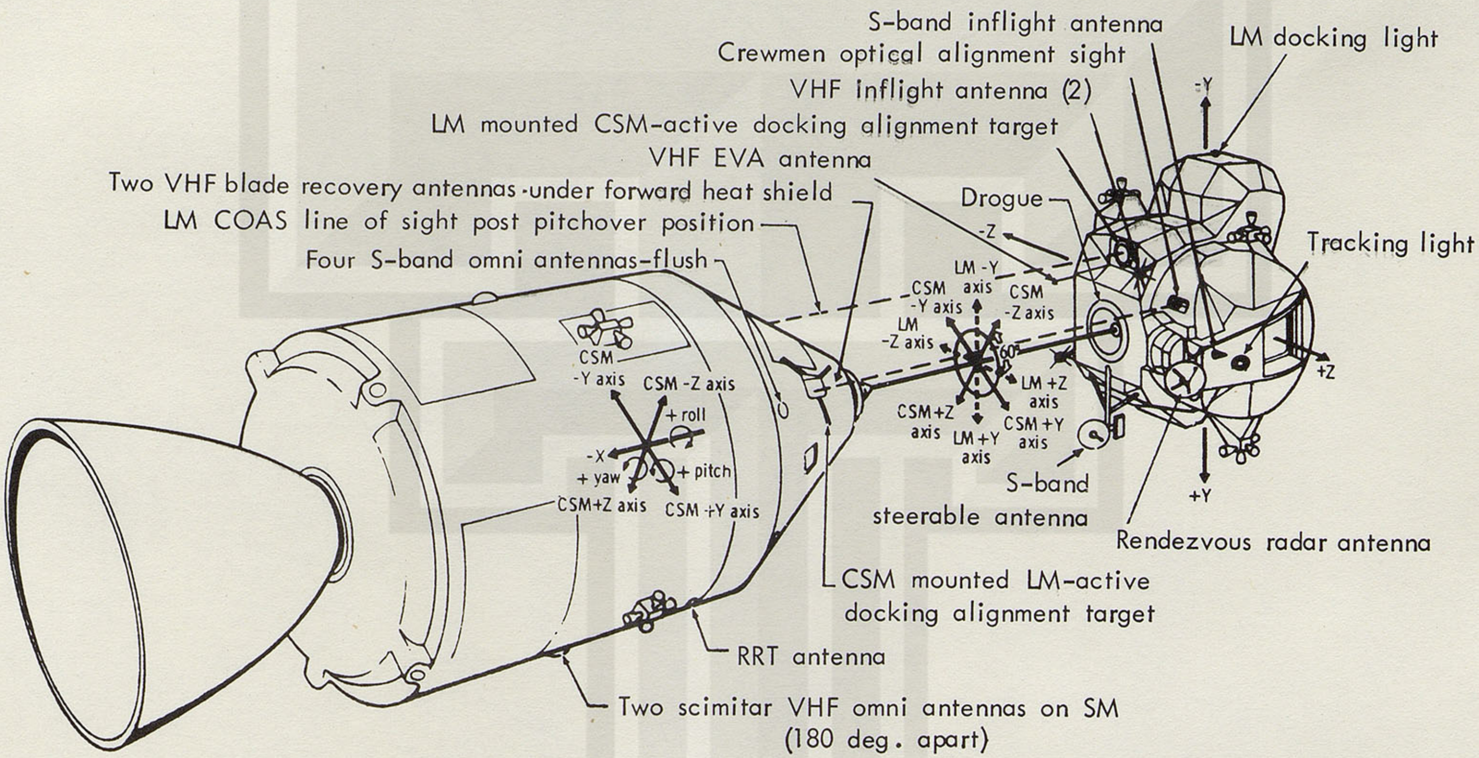
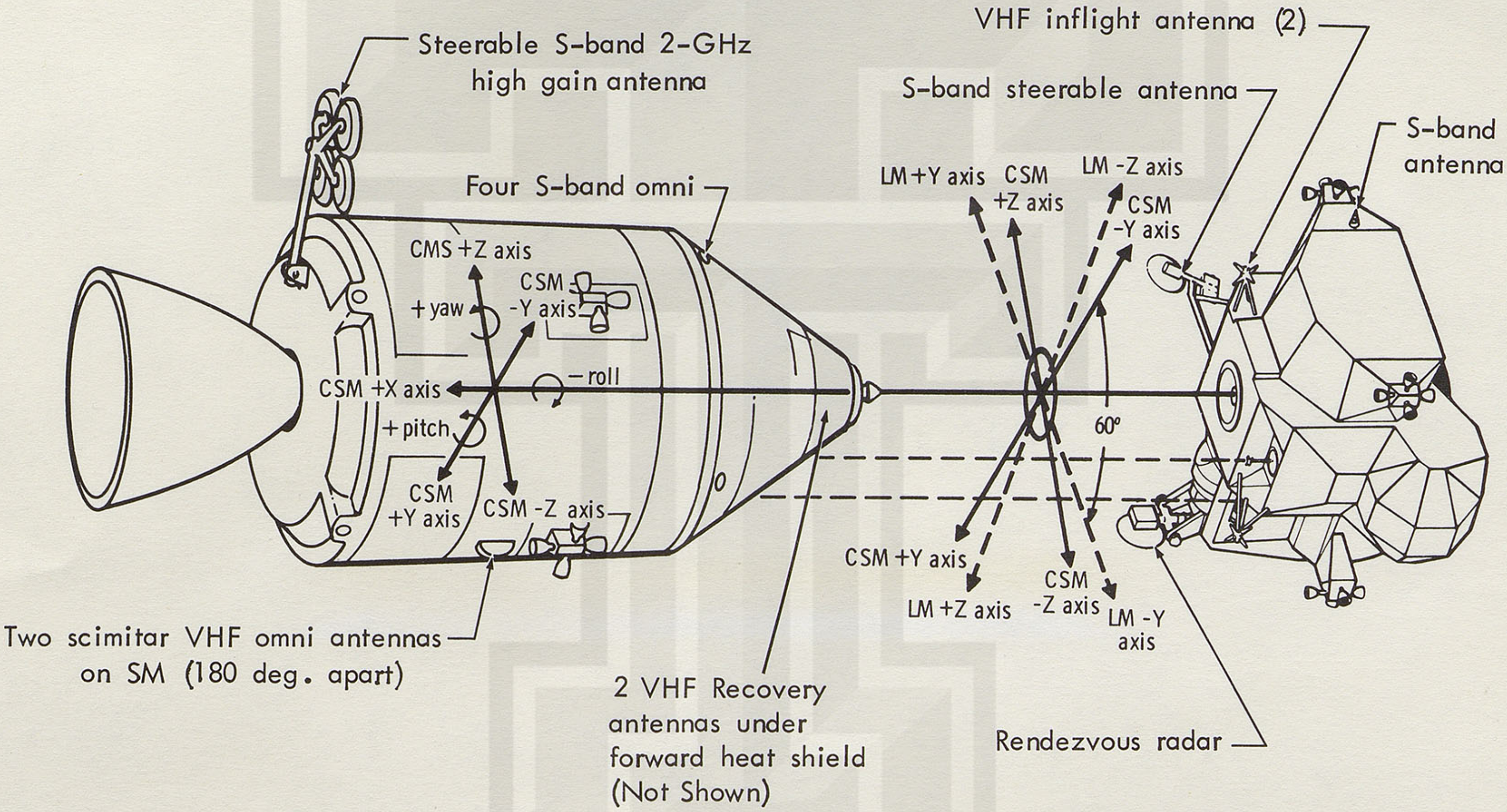


SPACECRAFT AXIS AND ANTENNA LOCATIONS



SPACECRAFT AXIS AND ANTENNA LOCATIONS

Reaction Control System (RCS) -- The command module and the service module each has its own independent system. The SM RCS has four identical RCS "quads" mounted around the SM 90 degrees apart. Each quad has four 100 pound-thrust engines, two fuel and two oxidizer tanks and a helium pressurization sphere. The SM RCS provides redundant spacecraft attitude control through cross-coupling logic inputs from the stabilization and guidance systems. Small velocity change maneuvers can also be made with the SM RCS.

The CM RCS consists of two independent six-engine subsystems of six 93 pound-thrust engines each. Both subsystems are activated just prior to CM separation from the SM: one is used for spacecraft attitude control during entry. The other serves in standby as a backup. Propellants for both CM and SM RCS are monomethyl hydrazine fuel and nitrogen tetroxide oxidizer with helium pressurization. These propellants are hypergolic, i.e., they burn spontaneously when combined without an igniter.

Electrical Power System (EPS) -- Provides electrical energy sources, power generation and control, power conversion and conditioning, and power distribution to the spacecraft throughout the mission. The EPS also furnishes drinking water to the astronauts as a by-product of the fuel cells. The primary source of electrical power is the fuel cells mounted in the SM. Each cell consists of a hydrogen compartment, an oxygen compartment, and two electrodes. The cryogenic gas storage system, also located in the SM, supplies the hydrogen and oxygen used in the fuel cell power plants, as well as the oxygen used in the ECS.

Three silver-zinc oxide storage batteries supply power to the CM during entry and after landing, provide power for sequence controllers, and supplement the fuel cells during periods of peak power demand. These batteries are located in the CM lower equipment bay. A battery charger is located in the same bay to assure a full charge prior to entry.

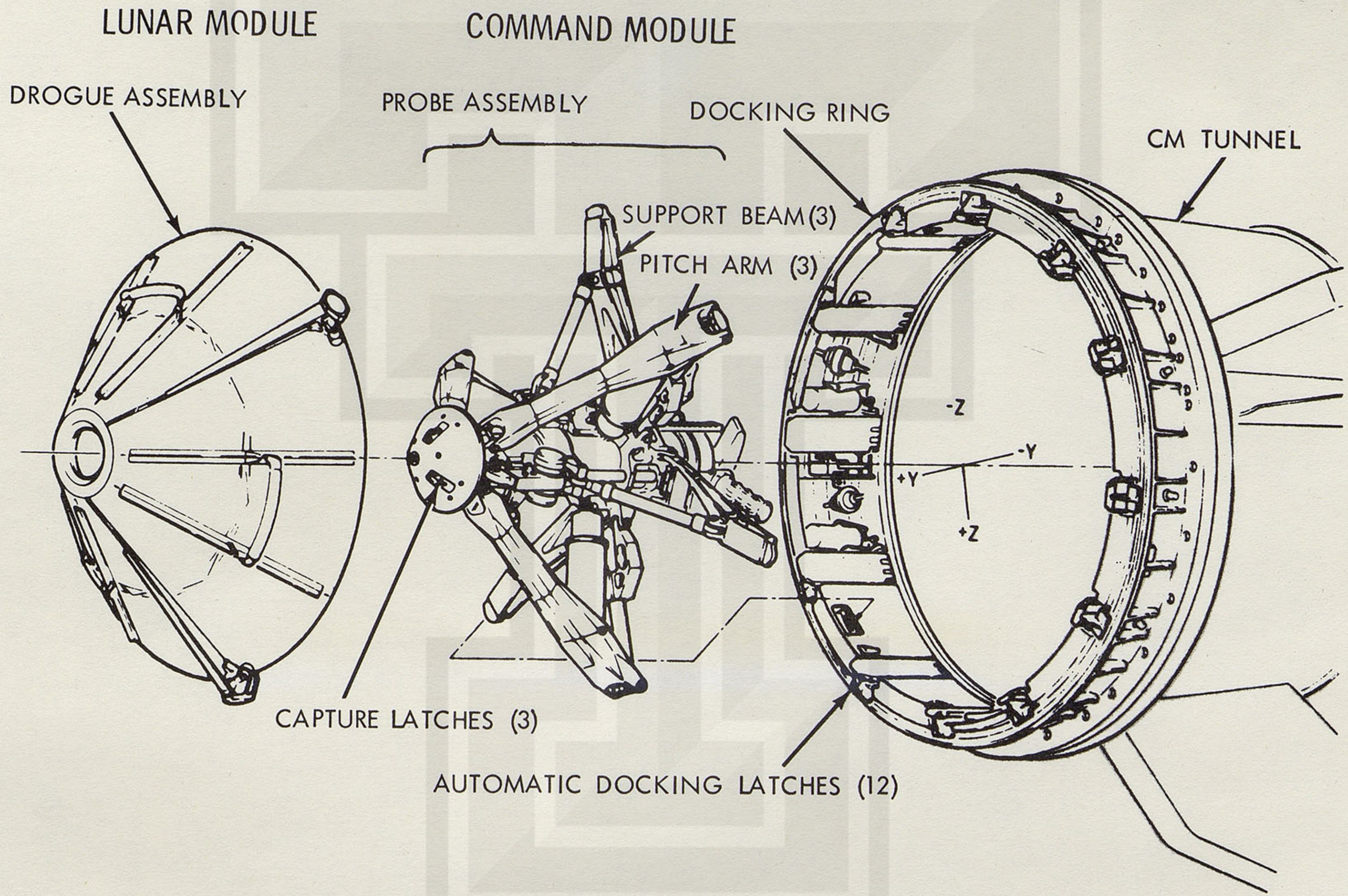
Two other silver-zinc oxide batteries, independent of and completely isolated from the rest of the dc power system, are used to supply power for explosive devices for CM/SM separation, parachute deployment and separation, third-stage separation, launch excape system tower separation, and other pyrotechnic uses.

Environmental Control System (ECS) -- Controls spacecraft atmosphere, pressure, and temperature and manages water. In addition to regulating cabin and suit gas pressure, temperature and humidity, the system removes carbon dioxide, odors and particles, and ventilates the cabin after landing. It collects and stores fuel cell potable water for crew use, supplies water to the glycol evaporators for cooling, and dumps surplus water overboard through the urine dump valve. Proper operating temperature of electronics and electrical equipment is maintained by this system through the use of the cabin heat exchangers, the space radiators, and the glycol evaporators.

Recovery aids include the uprighting system, swimmer interphone connections, sea dye marker, flashing beacon, VHF recovery beacon, and VHF transceiver. The uprighting system consists of three compressor-inflated bags to upright the spacecraft if it should land in the water apex down (stable II position).

Caution and Warning System -- Monitors spacecraft systems for out-of-tolerance conditions and alerts crew by visual and audible alarms so that crewmen may trouble-shoot the problem.

Controls and Displays -- Provide readouts and control functions of all other spacecraft systems in the command and service modules. All controls are designed to be operated by crewmen in pressurized suits. Displays are grouped by system and located according to the frequency the crew refers to them.



APOLLO DOCKING MECHANISMS

LUNAR MODULE STRUCTURES, WEIGHT

The lunar module is a two-stage vehicle designed for space operations near and on the Moon. The LM is incapable of reentering the atmosphere. The lunar module stands 22 feet 11 inches high and is 31 feet wide (diagonally across landing gear).

Joined by four explosive bolts and umbilicals, the ascent and descent stages of the LM operate as a unit until staging, when the ascent stage functions as a single spacecraft for rendezvous and docking with the CSM.

Ascent Stage

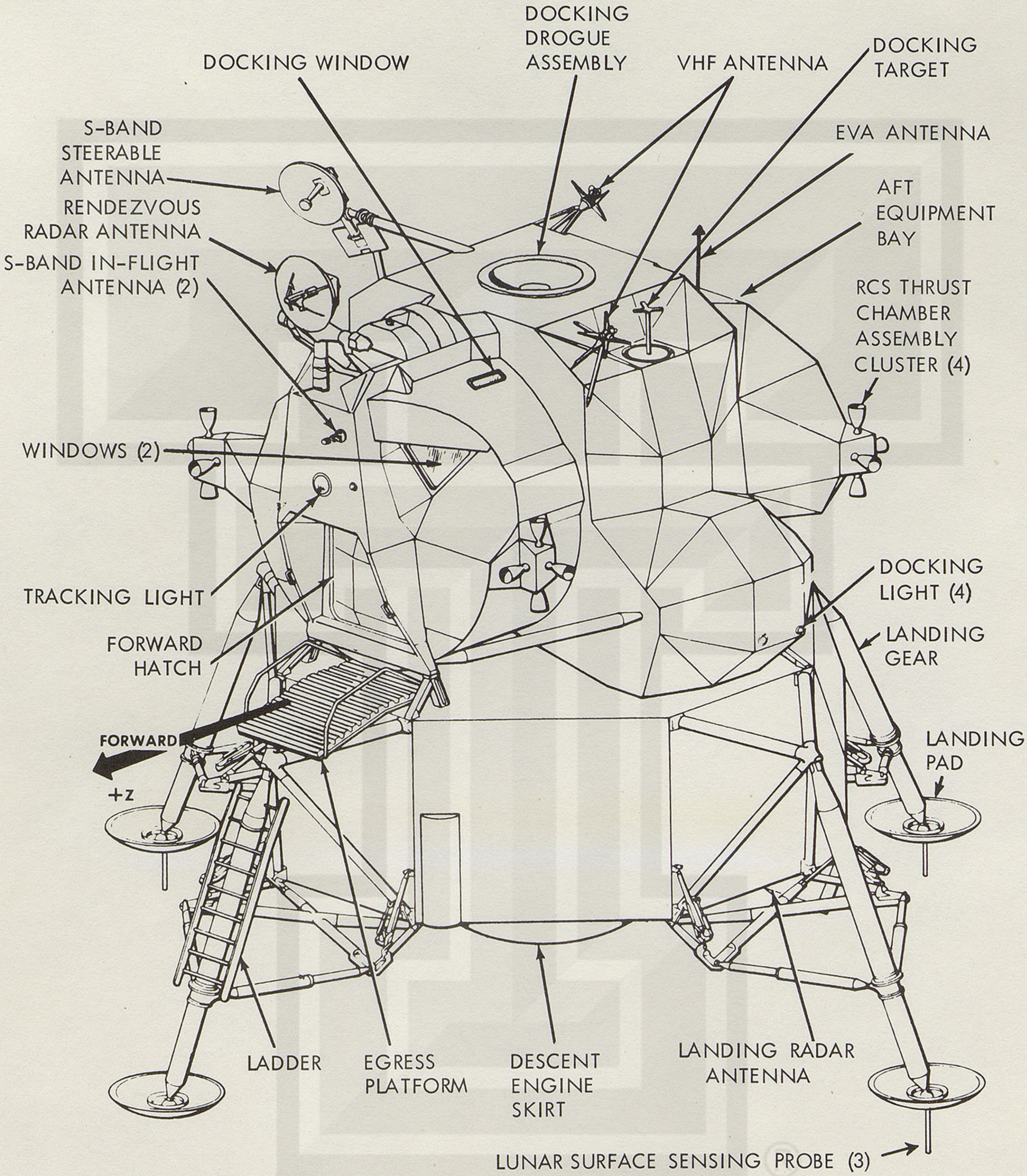
Three main sections make up the ascent stage: the crew compartment, midsection, and aft equipment bay. Only the crew compartment and midsection are pressurized (4.8 psig; 337.4 gm/sq cm) as part of the LM cabin; all other sections of the LM are unpressurized. The cabin volume is 235 cubic feet (6.7 cubic meters). The ascent stage measures 12 feet 4 inches high by 14 feet 1 inch in diameter.

Structurally, the ascent stage has six substructural areas: crew compartment, midsection, aft equipment bay, thrust chamber assembly cluster supports, antenna supports and thermal and micrometeoroid shield.

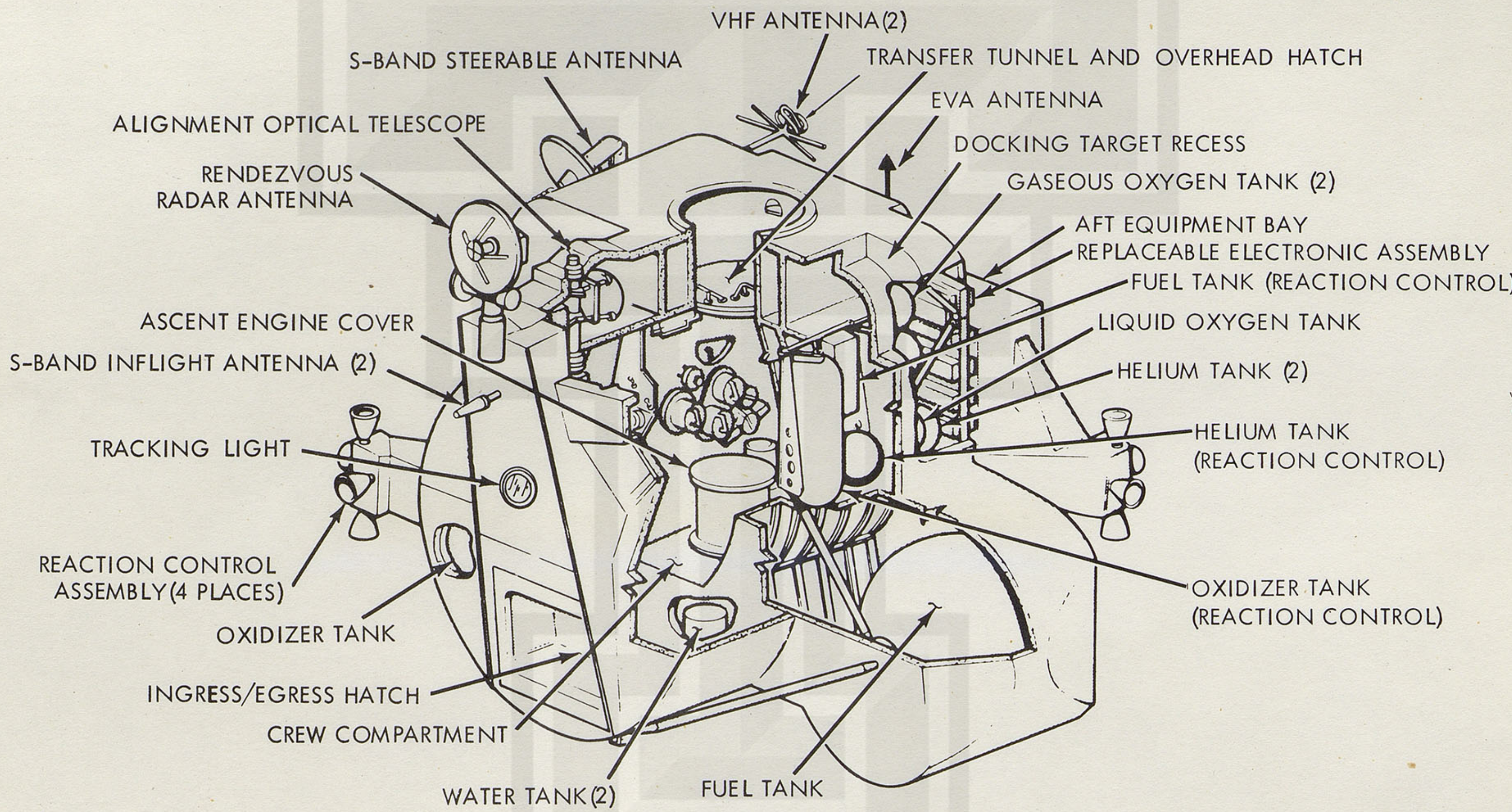
The cylindrical crew compartment is a semimonocoque structure of machined longerons and fusion-welded aluminum sheet and is 92 inches (2.35 m) in diameter and 42 inches (1.07 m) deep. Two flight stations are equipped with control and display panels, armrests, body restraints, landing aids, two front windows, an overhead docking window, and an alignment optical telescope in the center between the two flight stations. The habitable volume is 160 cubic feet.

Two triangular front windows and the 32-inch (0.81 m) square inward-opening forward hatch are in the crew compartment front face.

External structural beams support the crew compartment and serve to support the lower interstage mounts at their lower ends. Ring-stiffened semimonocoque construction is employed in the midsection, with chem-milled aluminum skin over fusion-welded longerons and stiffeners. Fore-and-aft beams across the top of the midsection join with those running across the top of the cabin to take all ascent stage stress loads and, in effect, isolate the cabin from stresses.



APOLLO LUNAR MODULE



APOLLO LUNAR MODULE - ASCENT STAGE

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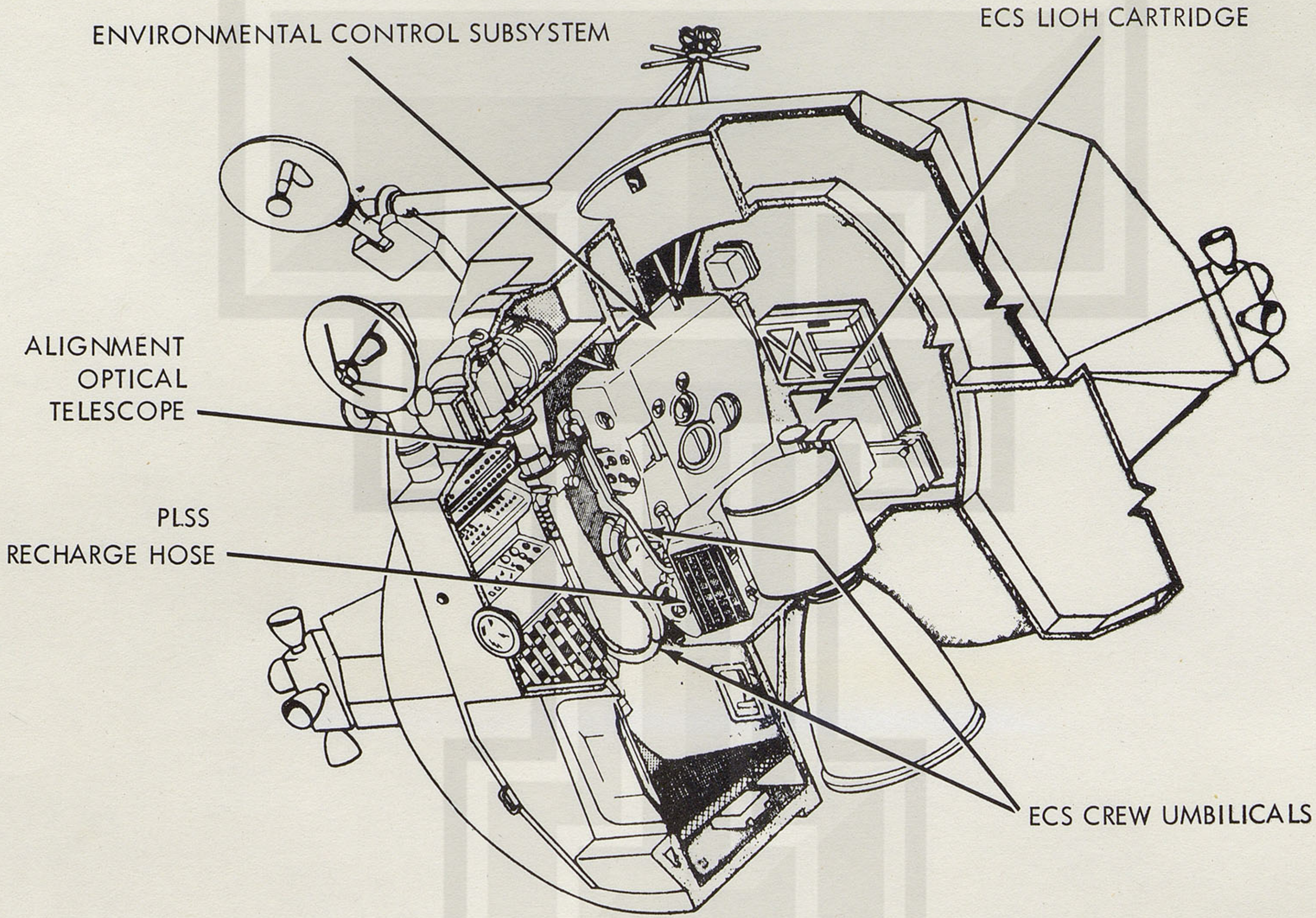

LM CABIN INTERIOR, LEFT HALF

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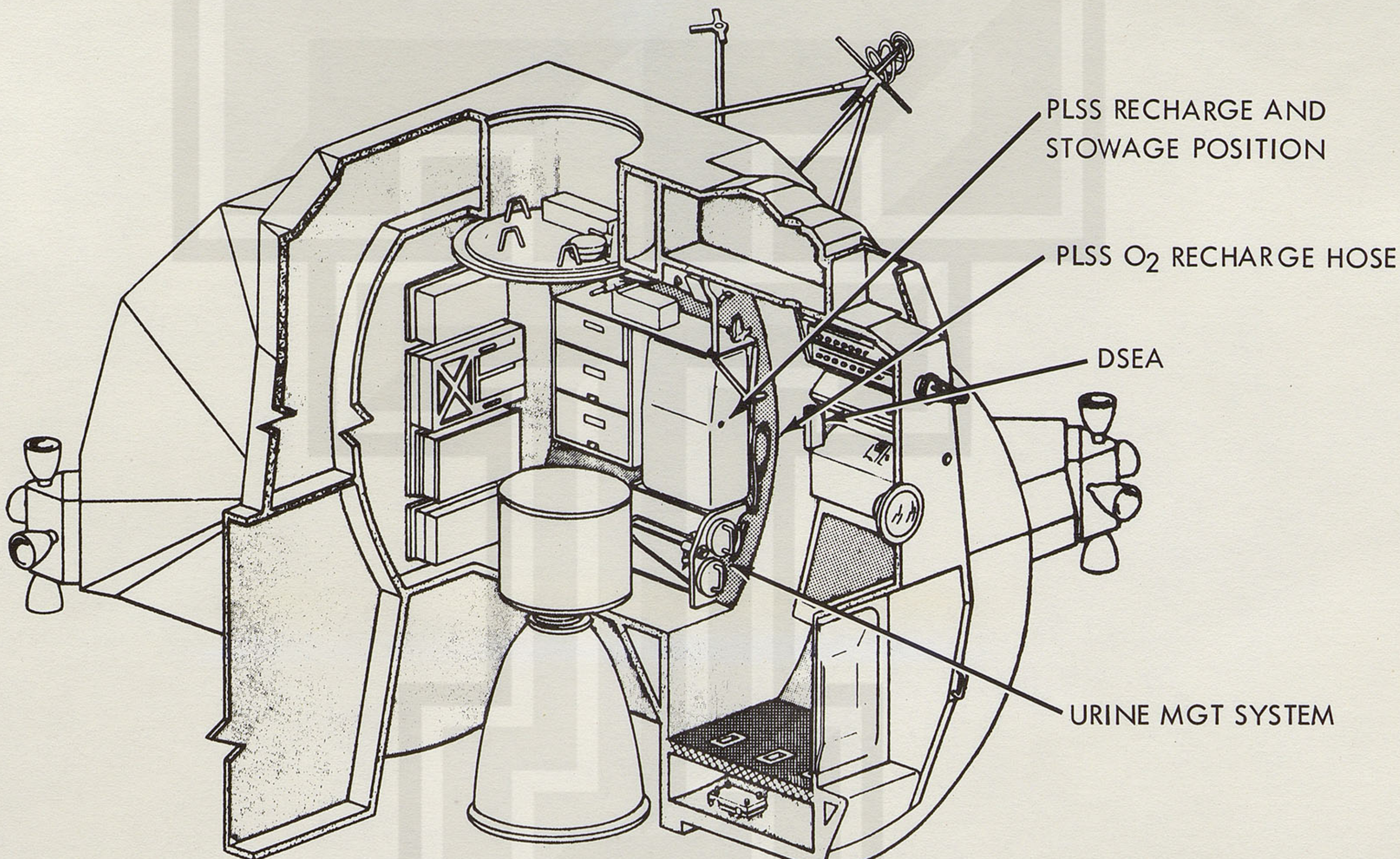

LM CABIN INTERIOR, RIGHT HALF

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The ascent stage engine compartment is formed by two beams running across the lower midsection deck and mated to the fore and aft bulkheads. Systems located in the midsection include the LM guidance computer, the power and servo assembly, ascent engine propellant tanks, RCS propellant tanks, the environmental control system, and the waste management section.

A tunnel ring atop the ascent stage meshes with the command module docking latch assemblies. During docking, the CM docking ring and latches are aligned by the LM drogue and the CSM probe.

The docking tunnel extends downward into the midsection 16 inches (40 cm). The tunnel is 32 inches (0.81 cm) in diameter and is used for crew transfer between the CSM and LM. The upper hatch on the inboard end of the docking tunnel hinges downward and cannot be opened with the LM pressurized and undocked.

A thermal and micrometeoroid shield of multiple layers of mylar and a single thickness of thin aluminum skin encases the entire ascent stage structure.

Descent Stage

The descent stage consists of a cruciform load-carrying structure of two pairs of parallel beams, upper and lower decks, and enclosure bulkheads -- all of conventional skin-and-stringer aluminum alloy construction. The center compartment houses the descent engine, and descent propellant tanks are housed in the four square bays around the engine. The descent stage measures 10 feet 7 inches high by 14 feet 1 inch in diameter.

Four-legged truss outriggers mounted on the ends of each pair of beams serve as SLA attach points and as "knees" for the landing gear main struts.

Triangular bays between the main beams are enclosed into quadrants housing such components as the ECS water tank, helium tanks, descent engine control assembly of the guidance, navigation and control subsystem, ECS gaseous oxygen tank, and batteries for the electrical power system. Like the ascent stage, the descent stage is encased in the mylar and aluminum alloy thermal and micrometeoroid shield.

The LM external platform, or "porch", is mounted on the forward outrigger just below the forward hatch. A ladder extends down the forward landing gear strut from the porch for crew lunar surface operations.

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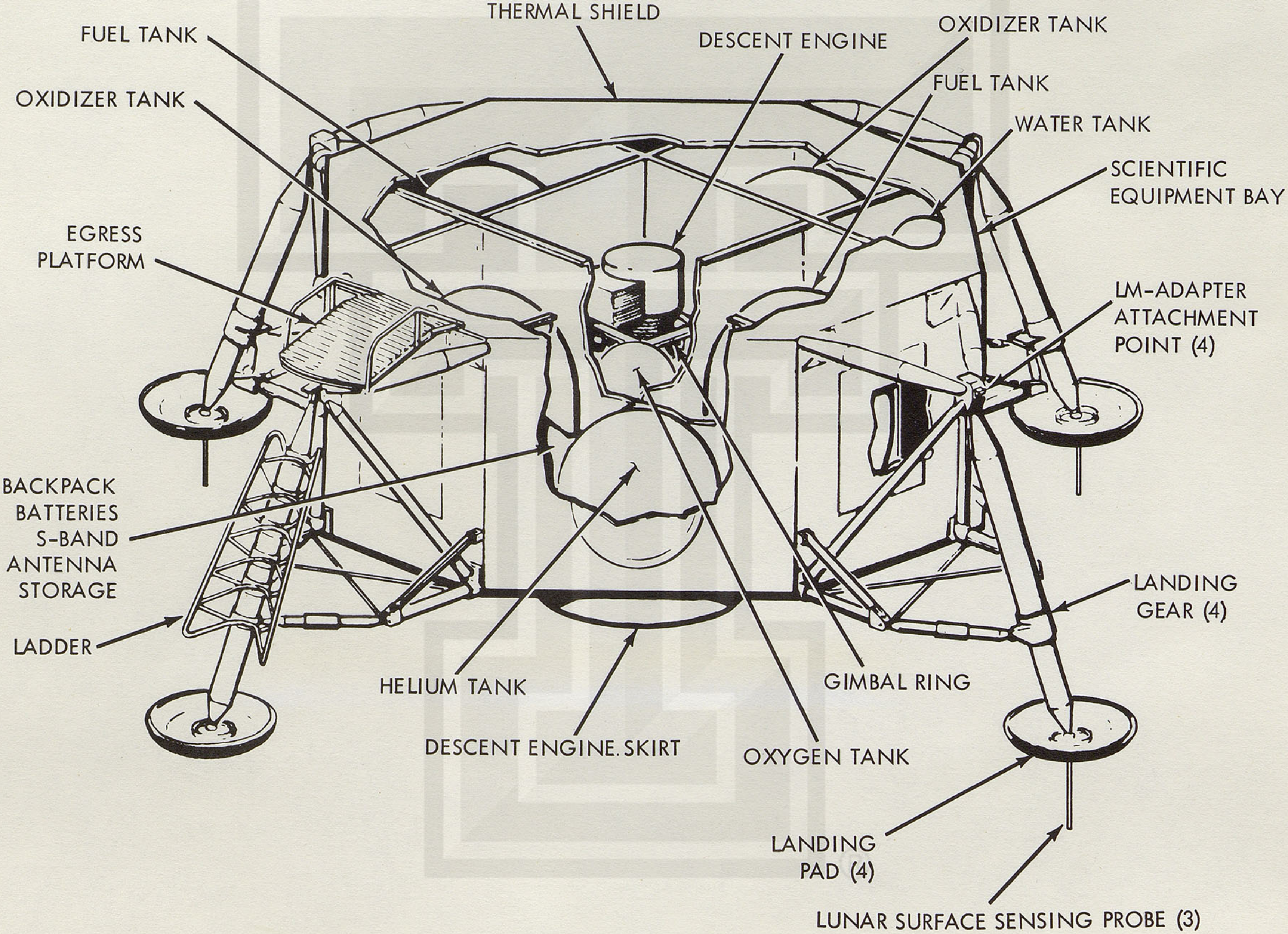
THERMAL SHIELD
FUEL TANK
DESCENT ENGINE
OXIDIZER TANK
FUEL TANK
OXIDIZER TANK
WATER TANK
SCIENTIFIC EQUIPMENT BAY
EGRESS PLATFORM
LM-ADAPTER ATTACHMENT POINT (4)
BACKPACK BATTERIES S-BAND ANTENNA STORAGE
LANDING GEAR (4)
LADDER
HELIUM TANK
GIMBAL RING
DESCENT ENGINE. SKIRT
OXYGEN TANK
LANDING PAD (4)
LUNAR SURFACE SENSING PROBE (3)

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In a retracted position until after the crew mans the LM, the landing gear struts are explosively extended and provide lunar surface landing impact attenuation. The main struts are filled with crushable aluminum honeycomb for absorbing compression loads. Footpads 37 inches (0.95 m) in diameter at the end of each landing gear provide vehicle "floatation" on the lunar surface.

Each pad (except forward pad) is fitted with a lunar-surface sensing probe which signals the crew to shut down the descent engine upon contact with the lunar surface.

LM-5 flown on the Apollo 11 mission will have a launch weight of 33,205 pounds. The weight breakdown is as follows:

Ascent stage, dry	4,804 lbs.	Includes water and oxygen; no crew
Descent stage, dry	4,483 lbs.	
RCS propellants (loaded)	604 lbs.	
DPS propellants (loaded)	18,100 lbs.	
APS propellants (loaded)	5,214 lbs.	
	33,205 lbs.	

Lunar Module Systems

Electrical Power System -- The LM DC electrical system consists of six silver zinc primary batteries -- four in the descent stage and two in the ascent stage, each with its own electrical control assembly (ECA). Power feeders from all primary batteries pass through circuit breakers to energize the LM DC buses, from which 28-volt DC power id distributed through circuit breakers to all LM systems. AC power (117v 400Hz) is supplied by two inverters, either of which can supply spacecraft AC load needs to the AC buses.

Environmental Control System -- Consists of the atmosphere revitalization section, oxygen supply and cabin pressure control section, water management, heat transport section, and outlets for oxygen and water servicing of the Portable Life Support System (PLSS).

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Components of the atmosphere revitalization section are the suit circuit assembly which cools and ventilates the pressure garments, reduces carbon dioxide levels, removes odors, noxious gases and excessive moisture; the cabin recirculation assembly which ventilates and controls cabin atmosphere temperatures; and the steam flex duct which vents to space steam from the suit circuit water evaporator.

The oxygen supply and cabin pressure section supplies gaseous oxygen to the atmosphere revitalization section for maintaining suit and cabin pressure. The descent stage oxygen supply provides descent flight phase and lunar stay oxygen needs, and the ascent stage oxygen supply provides oxygen needs for the ascent and rendezvous flight phase.

Water for drinking, cooling, fire fighting, food preparation, and refilling the PLSS cooling water servicing tank is supplied by the water management section. The water is contained in three nitrogen-pressurized bladder-type tanks, one of 367-pound capacity in the descent stage and two of 47.5-pound capacity in the ascent stage.

The heat transport section has primary and secondary water-glycol solution coolant loops. The primary coolant loop circulates water-glycol for temperature control of cabin and suit circuit oxygen and for thermal control of batteries and electronic components mounted on cold plates and rails. If the primary loop becomes inoperative, the secondary loop circulates coolant through the rails and cold plates only. Suit circuit cooling during secondary coolant loop operation is provided by the suit loop water boiler. Waste heat from both loops is vented overboard by water evaporation or sublimators.

Communication System -- Two S-band transmitter-receivers, two VHF transmitter-receivers, a signal processing assembly, and associated spacecraft antenna make up the LM communications system. The system transmits and receives voice, tracking and ranging data, and transmits telemetry data on about 270 measurements and TV signals to the ground. Voice communications between the LM and ground stations is by S-band, and between the LM and CSM voice is on VHF.

Although no real-time commands can be sent to LM-5 and subsequent spacecraft, the digital uplink is retained to process guidance officer commands transmitted from Mission Control Center to the LM guidance computer, such as state vector updates.

The data storage electronics assembly (DSEA) is a four-channel voice recorder with timing signals with a 10-hour recording capacity which will be brough back into the CSM for return to Earth. DSEA recordings cannot be "dumped" to ground stations.

LM antennas are one 26-inch diameter parabolic S-band steerable antenna, two S-band inflight antennas, two VHF inflight antennas, and an erectable S-band antenna (optional) for lunar surface.

Guidance, Navigation and Control System -- Comprised of six sections: primary guidance and navigation section (PGNS), abort guidance section (AGS), radar section, control electronics section (CES), and orbital rate drive electronics for Apollo and LM (ORDEAL).

* The PGNS is an aided inertial guidance system updated by the alignment optical telescope, an inertial measurement unit, and the rendezvous and landing radars. The system provides inertial reference data for computations, produces inertial alignment reference by feeding optical sighting data into the LM guidance computer, displays position and velocity data, computes LM-CSM rendezvous data from radar inputs, controls attitude and thrust to maintain desired LM trajectory, and controls descent engine throttling and gimbaling.

The LM-5 guidance computer has the Luminary IA software program for processing landing radar altitude and velocity information for lunar landing. LM-4, flown on Apollo 10, did not have the landing phase in its guidance computer Luminary I program.

* The AGS is an independent backup system for the PGNS, having its own inertial sensors and computer.

* The radar section is made up of the rendezvous radar which provides CSM range and range rate, and line-of-sight angles for maneuver computation to the LM guidance computer; the landing radar which provide altitude and velocity data to the LM guidance computer during lunar landing. The rendezvous radar has an operating range from 80 feet to 400 nautical miles. The range transfer tone assembly, utilizing VHF electronics, is a passive responder to the CSM VHF ranging device and is a backup to the rendezvous radar.

* The CES controls LM attitude and translation about all axes. It also controls by PGNS command the automatic operation of the ascent and descent engines, and the reaction control thrusters. Manual attitude controller and thrust-translation controller commands are also handled by the CES.

* ORDEAL, displays on the flight director attitude indicator, is the computed local vertical in the pitch axis during circular Earth or lunar orbits.

Reaction Control System -- The LM has four RCS engine clusters of four 100-pound (45.4 kg) thrust engines each which use helium-pressurized hypergolic propellants. The oxidizer is nitrogen tetroxide, fuel is Aerozine 50 (50/50 blend of hydrazine and unsymmetrical dimethyl hydrazine). Propellant plumbing, valves and pressurizing components are in two parallel, independent systems, each feeding half the engines in each cluster. Either system is capable of maintaining attitude alone, but if one supply system fails, a propellant crossfeed allows one system to supply all 16 engines. Additionally, interconnect valves permit the RCS system to draw from ascent engine propellant tanks.

The engine clusters are mounted on outriggers 90 degrees apart on the ascent stage.

The RCS provides small stabilizing impulses during ascent and descent burns, controls LM attitude during maneuvers, and produces thrust for separation, and ascent/descent engine tank ullage. The system may be operated in either the pulse or steady-state modes.

Descent Propulsion System -- Maximum rated thrust of the descent engine is 9,870 pounds (4,380.9 kg) and is throttleable between 1,050 pounds (476.7 kg) and 6,300 pounds (2,860.2 kg). The engine can be gimbaled six degrees in any direction in response to attitude commands and for offset center of gravity trimming. Propellants are helium-pressurized Aerozine 50 and nitrogen tetroxide.

Ascent Propulsion System -- The 3,500-pound (1,589 kg) thrust ascent engine is not gimbaled and performs at full thrust. The engine remains dormant until after the ascent stage separates from the descent stage. Propellants are the same as are burned by the RCS engines and the descent engine.

Caution and Warning, Controls and Displays -- These two systems have the same function aboard the lunar module as they do aboard the command module. (See CSM systems section.)

<u>Tracking and Docking Lights</u> -- A flashing tracking light (once per second, 20 milliseconds duration) on the front face of the lunar module is an aid for contingency CSM-active rendezvous LM rescue. Visibility ranges from 400 nautical miles through the CSM sextant to 130 miles with the naked eye. Five docking lights analagous to aircraft running lights are mounted on the LM for CSM-active rendezvous: two forward yellow lights, aft white light, port red light and starboard green light. All docking lights have about a 1,000-foot visibility.

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SATURN V LAUNCH VEHICLE DESCRIPTION AND OPERATION

The Apollo 11 spacecraft will be boosted into Earth orbit and then onto a lunar trajectory by the sixth Saturn V launch vehicle. The 281-foot high Saturn V generates enough thrust to place a 125-ton payload into a 105 nm Earth orbit or boost about 50 tons to lunar orbit.

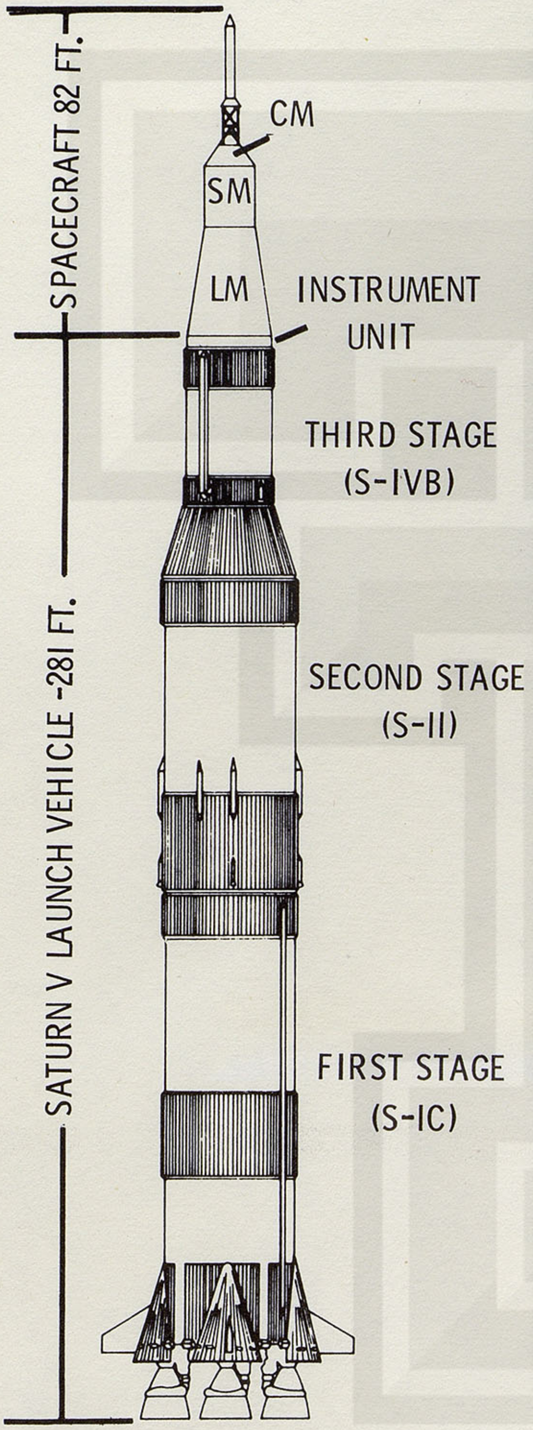
The Saturn V, developed by the NASA-Marshall Space Flight Center, underwent research and development testing in the "all-up" mode. From the first launch all stages have been live. This has resulted in "man rating" of the Saturn V in two launches. The third Saturn V (AS-503) carried Apollo 8 and its crew on a lunar orbit mission.

Saturn V rockets were launched November 9, 1967, April 4, 1968, December 21, 1968, March 3, 1969, and May 18, 1969. The first two space vehicle were unmanned; the last three carried the Apollo 8, 9 and 10 crews, respectively.

Launch Vehicle Range Safety Provisions

In the event of an imminent emergency during the launch vehicle powered flight phase it could become necessary to abort the mission and remove the command module and crew from immediate danger. After providing for crew safety, the Range Safety Officer may take further action if the remaining intact vehicle constitutes a hazard to overflown geographic areas. Each launch vehicle propulsive stage is equipped with a propellant dispersion system to terminate the vehicle flight in a safe location and disperse propellants with a minimized ignition probability. A transmitted ground command shuts down all engines and a second command detonates explosives which open the fuel and oxidizer tanks enabling the propellants to disperse. On each stage the tank cuts are made in non-adjacent areas to minimize propellant mixing. The stage propellant dispersion systems are safed by ground command.

SATURN V LAUNCH VEHICLE



FIRST STAGE (S-IC)	
DIAMETER	33 FEET
HEIGHT	138 FEET
WEIGHT	5,022,674 LBS. FUELED 288,750 LBS. DRY
ENGINES	FIVE F-1
PROPELLANTS	LIQUID OXYGEN (3,307,855 LBS., 346,372 GALS.) RP-1 (KEROSENE) - (1,426,069 LBS., 212,846 GALS.)
THRUST	7,653,854 LBS AT LIFTOFF
SECOND STAGE (S-II)	
DIAMETER	33 FEET
HEIGHT	81.5 FEET
WEIGHT	1,059,171 LBS. FUELED 79,918 LBS. DRY
ENGINES	FIVE J-2
PROPELLANTS	LIQUID OXYGEN (821,022 LBS., 85,973 GALS.) LIQUID HYDROGEN (158,221 LBS., 282,555 GALS.)
THRUST	1,120,216 TO 1,157,707 LBS.
INTERSTAGE	1,353 (SMALL) 8,750 (LARGE)
THIRD STAGE (S-IVB)	
DIAMETER	21.7 FEET
HEIGHT	58.3 FEET
WEIGHT	260,523 LBS. FUELED 25,000 LBS. DRY
ENGINES	ONE J-2
PROPELLANTS	LIQUID OXYGEN (192,023 LBS., 20,107 GALS.) LIQUID HYDROGEN (43,500 LBS., 77,680 GALS.)
THRUST	178,161 TO 203,779 LBS.
INTERSTAGE	8,081 LBS.
INSTRUMENT UNIT	
DIAMETER	21.7 FEET
HEIGHT	3 FEET
WEIGHT	4,306 LBS.

NOTE: WEIGHTS AND MEASURES GIVEN ABOVE ARE FOR THE NOMINAL VEHICLE CONFIGURATION FOR APOLLO 11. THE FIGURES MAY VARY SLIGHTLY DUE TO CHANGES BEFORE LAUNCH TO MEET CHANGING CONDITIONS. WEIGHTS NOT INCLUDED IN ABOVE ARE FROST AND MISCELLANEOUS SMALLER ITEMS.

SPACE VEHICLE WEIGHT SUMMARY (pounds)

Event	Wt. Chg.	Veh. Wt.
At ignition		6,484,280
Thrust buildup propellant used	85,745	
At first motion		6,398,535
S-IC frost	650	
S-IC nitrogen purge	37	
S-II frost	450	
S-II insulation purge gas	120	
S-IVB frost	200	
Center engine decay propellant used	2,029	
Center engine expended propellant	406	
S-IC mainstage propellant used	4,567,690	
Outboard engine decay propellant used	8,084	
S-IC stage drop weight	363,425	
S-IC/S-II small interstage	1,353	
S-II ullage propellant used	73	
At S-IC separation		1,454,014
S-II thrust buildup propellant used	1,303	
S-II start tank	25	
S-II ullage propellant used	1,288	
S-II mainstage propellant and venting	963,913	
Launch escape tower	8,930	
S-II aft interstage	8,750	
S-II thrust decay propellant used	480	
S-II stage drop weight	94,140	
S-II/S-IVB interstage	8,081	
S-IVB aft frame dropped	48	
S-IVB detonator package	3	
At S-II/S-IVB separation		367,053
S-IVB ullage rocket propellant	96	
At S-IVB ignition		366,957
S-IVB ullage propellant	22	
S-IVB hydrogen in start tank	4	
Thrust buildup propellant	436	
S-IVB mainstage propellant used	66,796	
S-IVB ullage rocket cases	135	
S-IVB APS propellant	2	
At first S-IVB cutoff signal		299,586
Thrust decay propellant used	89	
APS propellant (ullage)	5	
Engine propellant lost	30	
At parking orbit insertion		299,562
Fuel tank vent	2,879	
APS propellant	235	
Hydrogen in start tank	2	
O2/H2 burner	16	
LOX tank vent	46	
S-IVB fuel lead loss	5	

Event	Wt. Chg.	Veh. Wt.
At second S-IVB ignition		296,379
S-IVB hydrogen in start tank	4	
Thrust buildup propellant	569	
S-IVB mainstage propellant used	164,431	
APS propellant used	8	
At second S-IVB cutoff signal		139,533
Thrust decay propellant used	124	
Engine propellant lost	40	
At translunar injection		139,369

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First Stage

The 7.6 million pound thrust first stage (S-IC) was developed jointly by the National Aeronautics and Space Administration's Marshall Space Flight Center and the Boeing Co.

The Marshall Center assembled four S-IC stages: a structural test model, a static test version, and the first two flight stages. Subsequent flight stages are assembled by Boeing at the Michoud Assembly Facility, New Orleans.

The S-IC for the Apollo 11 mission was the third flight booster tested at the NASA-Mississippi Test Facility. The first S-IC test at MTF was on May 11, 1967, the second on August 9, 1967, and the third--the booster for Apollo 11--was on August 6, 1968. Earlier flight stages were static fired at the Marshall Center.

The booster stage stands 138 feet high and is 33 feet in diameter. Major structural components include thrust structure, fuel tank, intertank structure, oxidizer tank, and forward skirt. Its five engines burn kerosene (RP-1) fuel and liquid oxygen. The stage weighs 288,750 empty and 5,022,674 pounds fueled.

Normal propellant flow rate to the five F-1 engines is 29,364.5 pounds (2,230 gallons) per second. Four of the engines are mounted on a ring, at 90 degree intervals. These four are gimballed to control the rocket's direction of flight. The fifth engine is mounted rigidly in the center.

Second Stage

The Space Division of North American Rockwell Corp. builds the 1 million pound thrust S-II stage at Seal Beach, California. The 81 foot 7 inch long, 33 foot diameter stage is made up of the forward skirt to which the third stage attaches, the liquid hydrogen tank, liquid oxygen tank (separated from the hydrogen tank by an insulted common bulkhead), the thrust structure on which the engines are mounted, and an interstage section to which the first stage attaches.

Five J-2 engines power the S-II. The outer four engines are equally spaced on a 17.5 foot diameter circle. These four engines may be gimballed through a plus or minus seven-degree square pattern for thrust vector control. As on the first stage, the center engine (number 5) is mounted on the stage centerline and is fixed in position.

The second stage (S-II), like the third stage, uses high performance J-2 engines that burn liquid oxygen and liquid hydrogen. The stage's purpose is to provide stage boost almost to Earth orbit.

The S-II for Apollo 11 was static tested by North American Rockwell at the NASA-Mississippi Test Facility on September 3, 1968. This stage was shipped to test site via the Panama Canal for the test firing.

Third Stage

The third stage (S-IVB) was developed by the McDonnell Douglas Astronautics Co. at Huntington Beach, Calif. At Sacramento, Calif., the stage passed a static firing test on July 17, 1968, as part of Apollo 11 mission preparation. The stage was flown directly to the NASA-Kennedy Space Center by the special aircraft, Super Guppy.

Measuring 58 feet 4 inches long and 21 feet 8 inches in diameter, the S-IVB weighs 25,000 pounds dry. At first ignition, it weighs 262,000 pounds. The interstage section weighs an additional 8,081 pounds.

The fuel tanks contain 43,500 pounds of liquid hydrogen and 192,023 pounds of liquid oxygen at first ignition, totalling 235,523 pounds of propellants. Insulation between the two tanks is necessary because the liquid oxygen, at about 293 degrees below zero Fahrenheit, is warm enough, relatively, to rapidly heat the liquid hydrogen, at 423 degrees below zero, and cause it to turn to gas. The single J-2 engine produces a maximum 230,000 pounds of thrust. The stage provides propulsion twice during the Apollo 11 mission.

Instrument Unit

The instrument unit (IU) is a cylinder three feet high and 21 feet 8 inches in diameter. It weighs 4,306 pounds and contains the guidance, navigation and control equipment to steer the vehicle through its Earth orbits and into the final translunar injection maneuver.

The IU also contains telemetry, communications, tracking, and crew safety systems, along with its own supporting electrical power and environmental control systems.

Components making up the "brain" of the Saturn V are mounted on cooling panels fastened to the inside surface of the instrument unit skin. The "cold plates" are part of a system that removes heat by circulating cooled fluid through a heat exchanger that evaporates water from a separate supply into the vacuum of space.

The six major systems of the instrument unit are structural, thermal control, guidance and control, measuring and telemetry, radio frequency, and electrical.

The instrument unit provides navigation, guidance, and control of the vehicle· measurement of the vehicle performance and environment; data transmission with ground stations; radio tracking of the vehicle; checkout and monitoring of vehicle functions; initiation of stage functional sequencing; detection of emergency situations; generation and network distribution of electric power system operation; and preflight checkout and launch and flight operations.

A path-adaptive guidance scheme is used in the Saturn V instrument unit. A programmed trajectory is used during first stage boost with guidance beginning only after the vehicle has left the atmosphere. This is to prevent movements that might cause the vehicle to break apart while attempting to compensate for winds, jet streams, and gusts encountered in the atmosphere.

If after second stage ignition the vehicle deviates from the optimum trajectory in climb, the vehicle derives and corrects to a new trajectory. Calculations are made about once each second throughout the flight. The launch vehicle digital computer and data adapter perform the navigation and guidance computations and the flight control computer converts generated attitude errors into control commands.

The ST-124M inertial platform--the heart of the navigation, guidance and control system--provides space-fixed reference coordinates and measures acceleration along the three mutually perpendicular axes of the coordinate system. If the inertial platform fails during boost, spacecraft systems continue guidance and control functions for the rocket. After second stage ignition the crew can manually steer the space vehicle.

International Business Machines Corp., is prime contractor for the instrument unit and is the supplier of the guidance signal processor and guidance computer. Major suppliers of instrument unit components are: Electronic Communications, Inc., control computer; Bendix Corp., ST-124M inertial platform; and IBM Federal Systems Division, launch vehicle digital computer and launch vehicle data adapter.

Propulsion

The 41 rocket engines of the Saturn V have thrust ratings ranging from 72 pounds to more than 1.5 million pounds. Some engines burn liquid propellants, others use solids.

The five F-1 engines in the first stage burn RP-1 (kerosene) and liquid oxygen. Engines in the first stage develop approximately 1,530,771 pounds of thrust each at liftoff, building up to about 1,817,684 pounds before cutoff. The cluster of five engines gives the first stage a thrust range of from 7,653,854 pounds at liftoff to 9,088,419 pounds just before center engine cutoff.

The F-1 engine weighs almost 10 tons, is more than 18 feet high and has a nozzle-exit diameter of nearly 14 feet. The F-1 undergoes static testing for an average 650 seconds in qualifying for the 160-second run during the Saturn V first stage booster phase. The engine consumes almost three tons of propellants per second.

The first stage of the Saturn V for this mission has eight other rocket motors. These are the solid-fuel retrorockets which will slow and separate the stage from the second stage. Each rocket produces a thrust of 87,900 pounds for 0.6 second.

The main propulsion for the second stage is a cluster of five J-2 engines burning liquid hydrogen and liquid oxygen. Each engine develops a mean thrust of more than 227,000 pounds at 5:1 mixture ratio (variable from 224,000 to 231,000 in phases of this flight), giving the stage a total mean thrust of more than 1.135 million pounds.

Designed to operate in the hard vacuum of space, the 3,500-pound J-2 is more efficient than the F-1 because it burns the high-energy fuel hydrogen. F-1 and J-2 engines are produced by the Rocketdyne Division of North American Rockwell Corp.

The second stage has four 21,000-pound-thrust solid fuel rocket engines. These are the ullage rockets mounted on the S-IC/S-II interstage section. These rockets fire to settle liquid propellant in the bottom of the main tanks and help attain a "clean" separation from the first stage; they remain with the interstage when it drops away at second plane separation. Four retrorockets are located in the S-IVB aft interstage (which never separates from the S-II) to separate the S-II from the S-IVB prior to S-IVB ignition.

Eleven rocket engines perform various functions on the third stage. A single J-2 provides the main propulsive force; there are two jettisonable main ullage rockets and eight smaller engines in the two auxiliary propulsion system modules.

Launch Vehicle Instrumentation and Communication

A total of 1,348 measurements will be taken in flight on the Saturn V launch vehicle: 330 on the first stage, 514 on the second stage, 283 on the third stage, and 221 on the instrument unit.

Telemetry on the Saturn V includes FM and PCM systems on the S-IC, two FM and a PCM on the S-II, a PCM on the S-IVB, and an FM, a PCM and a CCS on the IU. Each propulsive stage has a range safety system, and the IU has C-Band and command systems.

Note:
FM (Frequency Modulated) PCM (Pulse Code Modulated) CCS (Command Communications System)

S-IVB Restart

The third stage of the Saturn V rocket for the Apollo mission will burn twice in space. The second burn places the spacecraft on the translunar trajectory. The first opportunity for this burn is at 2 hours 44 minutes and 15 seconds after launch.

The primary pressurization system of the propellant tanks for the S-IVB restart uses a helium heater. In this system, nine helium storage spheres in the liquid hydrogen tank contain gaseous helium charged to about 3,000 psi. This helium is passed through the heater which heats and expands the gas before it enters the propellant tanks. The heater operates on hydrogen and oxygen gas from the main propellant tanks.

The backup system consists of five ambient helium spheres mounted on the stage thrust structure. This system, controlled by the fuel re-pressurization control module, can repressurize the tanks in case the primary system fails. The restart will use the primary system. If that system fails, the backup system will be used.

Differences in Launch Vehicles for Apollo 10 and Apollo 11

The greatest difference between the Saturn V launch vehicle for Apollo 10 and the one for Apollo 11 is in the number of instrumentation measurements planned for the flight. Apollo 11 will be flying the operational configuration of instrumentation. Most research and development instrumentation has been removed, reducing the total number of measurements from 2,342 on Apollo 10 to 1,348 on Apollo 11. Measurements on Apollo 10, with Apollo 11 measurements in parentheses, were: S-IC, 672 (330); S-II, 980 (514); S-IVB, 386 (283); and IU, 298 (221).

The center engine of the S-II will be cut off early, as was done during the Apollo 10 flight, to eliminate the longitudinal oscillations reported by astronauts on the Apollo 9 mission. Cutting off the engine early on Apollo 10 was the simplest and quickest method of solving the problem.

APOLLO 11 CREW

Life Support Equipment - Space Suits

Apollo 11 crewmen will wear two versions of the Apollo space suit: an intravehicular pressure garment assembly worn by the command module pilot and the extravehicular pressure garment assembly worn by the commander and the lunar module pilot. Both versions are basically identical except that the extravehicular version has an integral thermal/meteoroid garment over the basic suit.

From the skin out, the basic pressure garment consists of a nomex comfort layer, a neoprene-coated nylon pressure bladder and a nylon restraint layer. The outer layers of the intravehicular suit are, from the inside out, nomex and two layers of Teflon-coated Beta cloth. The extravehicular integral thermal/meteoroid cover consists of a liner of two layers of neoprene-coated nylon, seven layers of Beta/Kapton spacer laminate, and an outer layer of Teflon-coated Beta fabric.

The extravehicular suit, together with a liquid cooling garment, portable life support system (PLSS), oxygen purge system, lunar extravehicular visor assembly and other components make up the extravehicular mobility unit (EMU). The EMU provides an extravehicular crewman with life support for a four-hour mission outside the lunar module without replenishing expendables. EMU total weight is 183 pounds. The intravehicular suit weighs 35.6 pounds.

Liquid cooling garment--A knitted nylon-spandex garment with a network of plastic tubing through which cooling water from the PLSS is circulated. It is worn next to the skin and replaces the constant wear-garment during EVA only.

Portable life support system--A backpack supplying oxygen at 3.9 psi and cooling water to the liquid cooling garment. Return oxygen is cleansed of solid and gas contaminants by a lithium hydroxide canister. The PLSS includes communications and telemetry equipment, displays and controls, and a main power supply. The PLSS is covered by a thermal insulation jacket. (Two stowed in LM).

Oxygen purge system--Mounted atop the PLSS, the oxygen purge system provides a contingency 30-minute supply of gaseous oxygen in two two-pound bottles pressurized to 5,880 psia. The system may also be worn separately on the front of the pressure garment assembly torso. It serves as a mount for the VHF antenna for the PLSS. (Two stowed in LM).

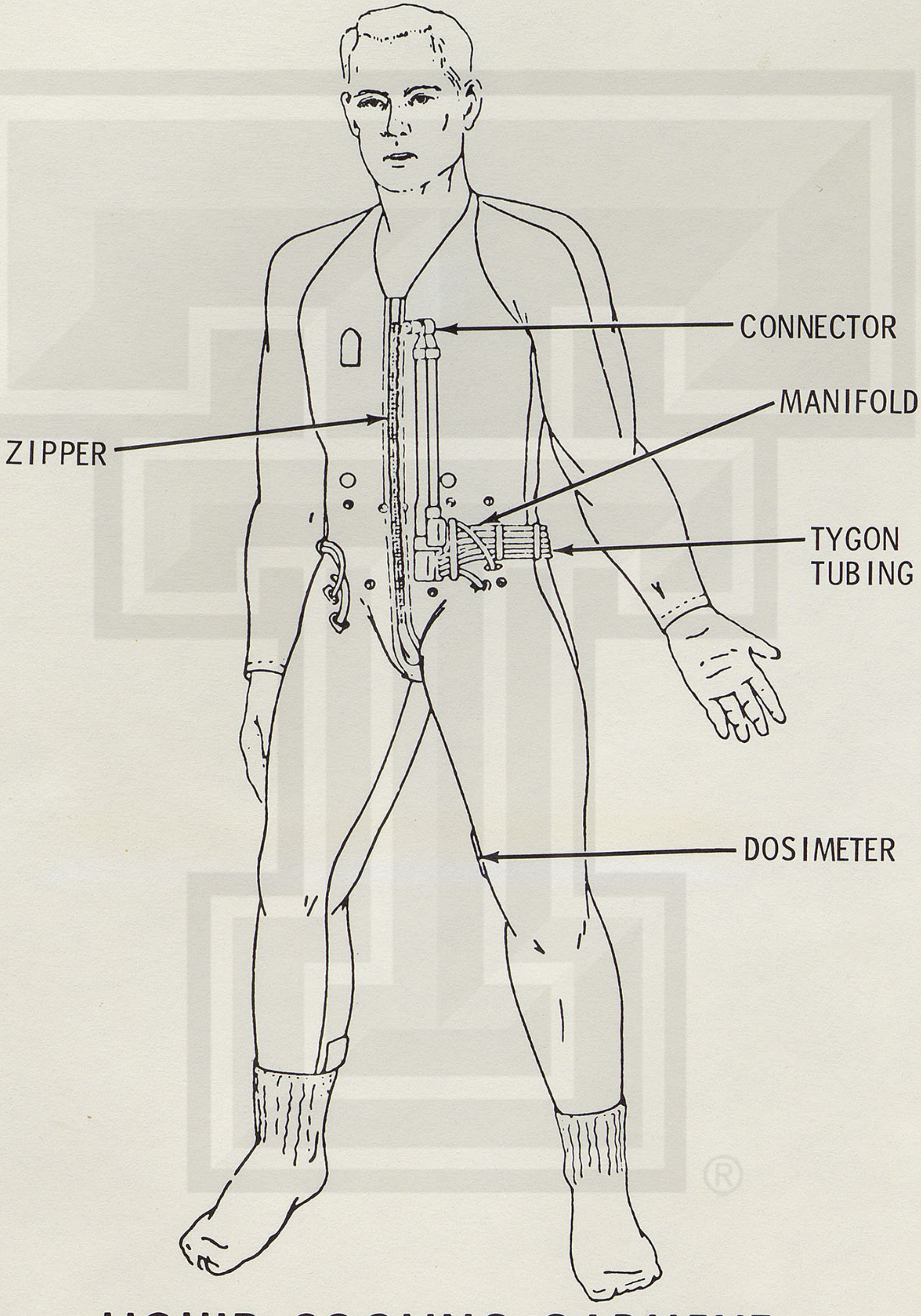
Lunar extravehicular visor assembly -- A polycarbonate shell and two visors with thermal control and optical coatings on them. The EVA visor is attached over the pressure helmet to provide impact, micrometeoroid, thermal and ultraviolet infrared light protection to the EVA crewman.

Extravehicular gloves--Built of an outer shell of Chromel-R fabric and thermal insulation to provide protection when handling extremely hot and cold objects. The finger tips are made of silicone rubber to provide the crewman more sensitivity.

A one-piece constant-wear garment, similar to "long johns", is worn as an undergarment for the space suit in intravehicular operations and for the inflight coveralls. The garment is porous-knit cotton with a waist-to-neck zipper for donning. Biomedical harness attach points are provided.

During periods out of the space suits, crewmen will wear two-piece Teflon fabric inflight coveralls for warmth and for pocket stowage of personal items.

Communications carriers ("Snoopy hats") with redundant microphones and earphones are worn with the pressure helmet; a lightweight headset is worn with the inflight coveralls.



LIQUID COOLING GARMENT

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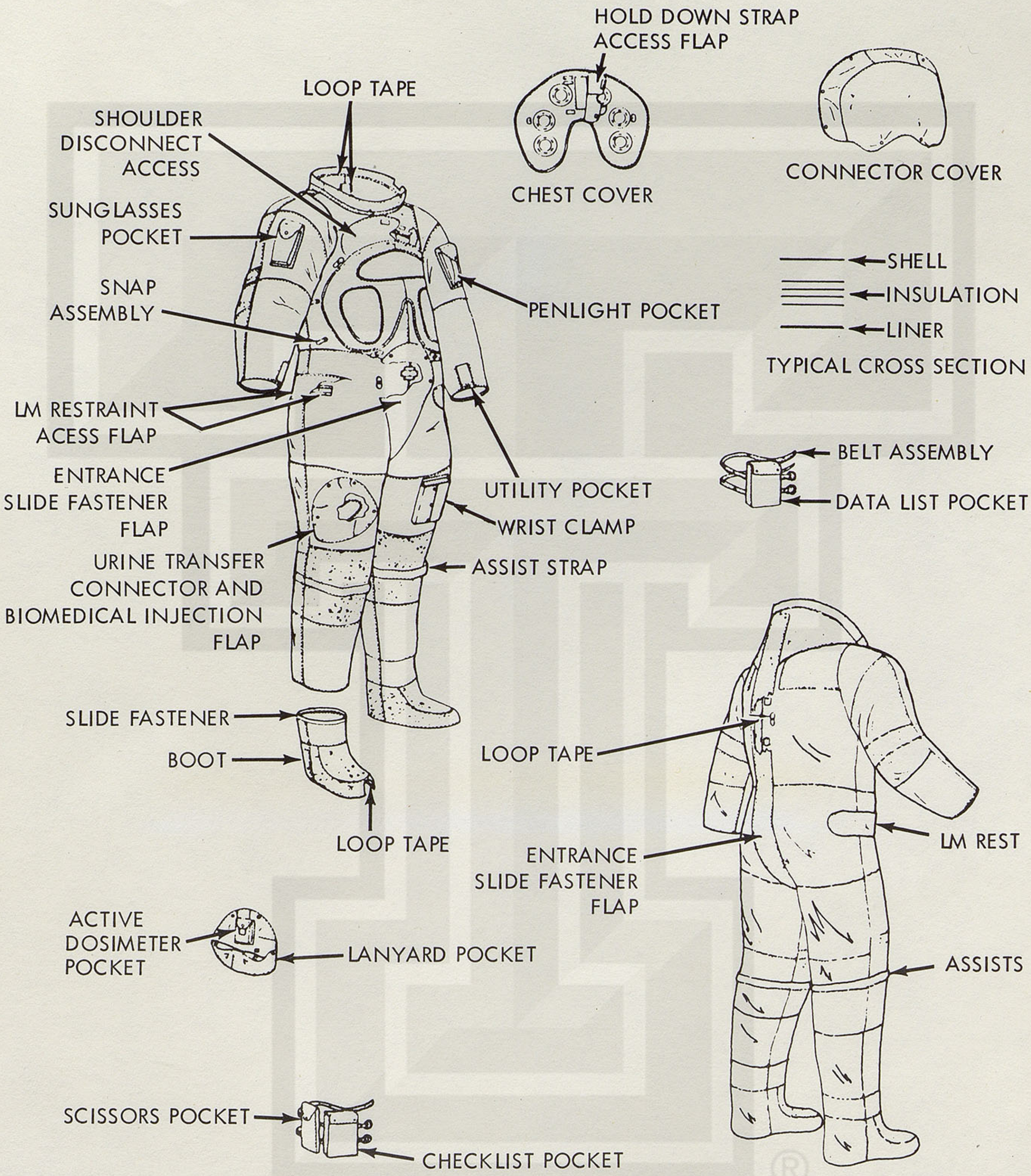
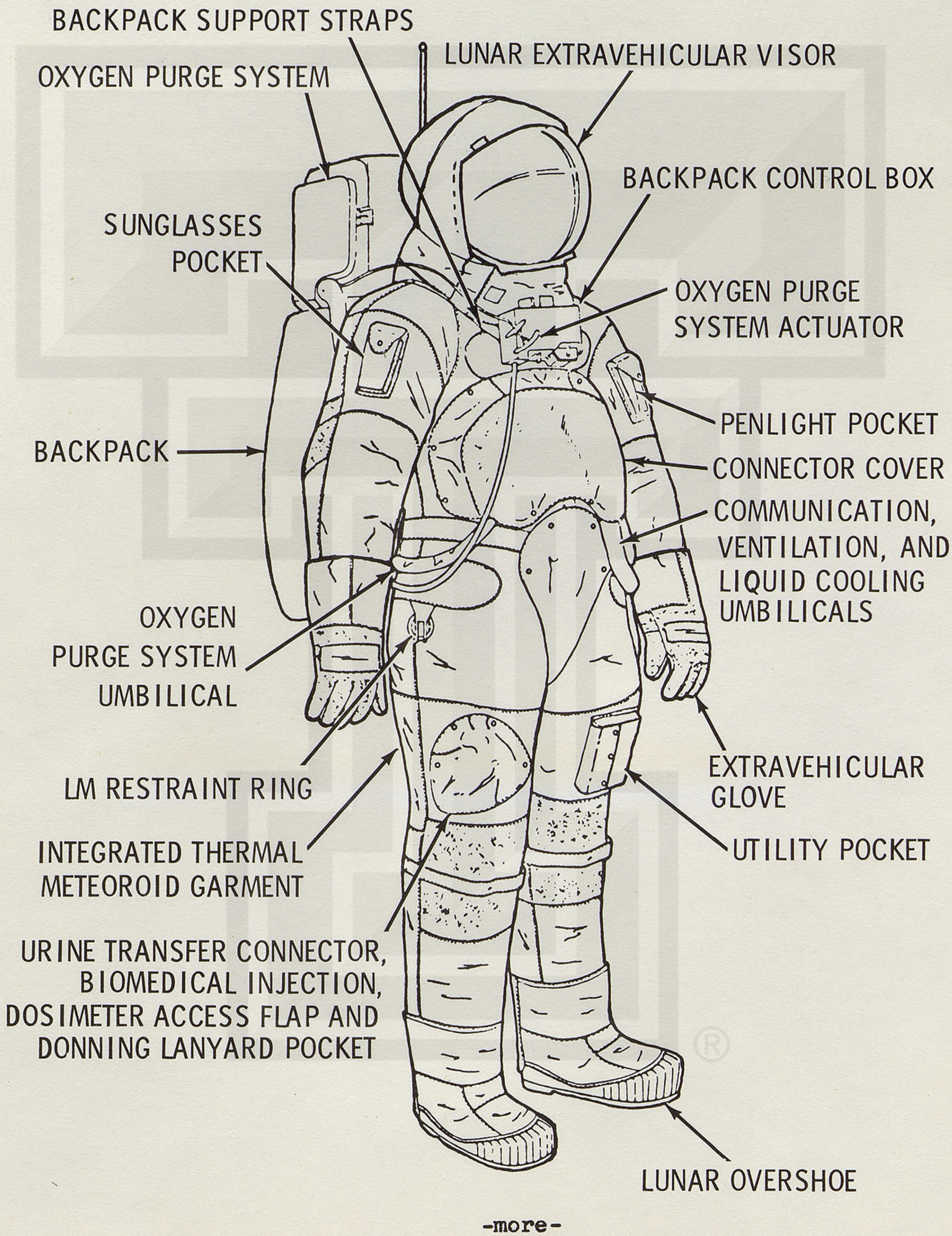
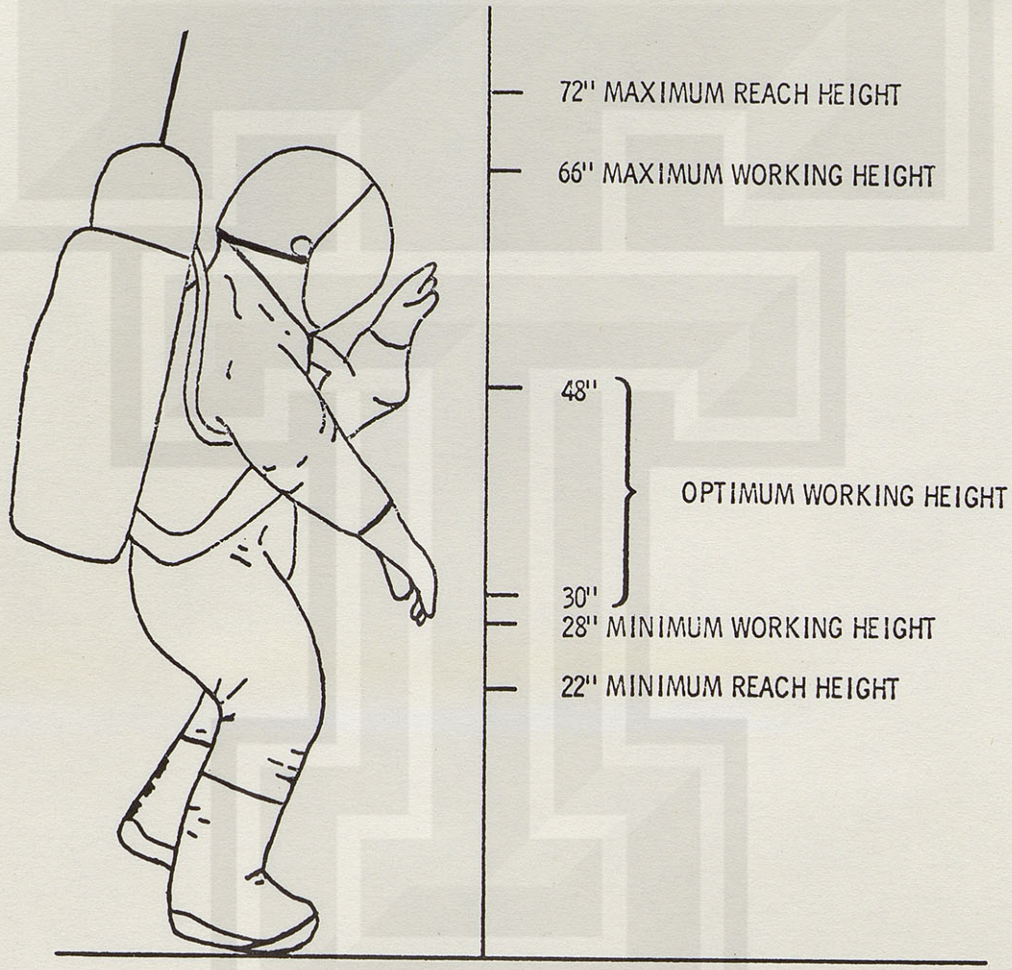


INTEGRATED THERMAL MICROMETEROID GARMENT

EXTRAVEHICULAR MOBILITY UNIT





ASTRONAUT REACH CONSTRAINTS

APOLLO 11 CREW MENU

The Apollo 11 crew had a wide range of food items from which to select their daily mission space menu. More than 70 items comprise the food selection list of freeze-dried rehydratable, wet-pack and spoon-bowl foods.

Balanced meals for five days have been packed in man/day over-wraps, and items similar to those in the dailymenus have been packed in a sort of snack pantry. The snack pantry permits the crew to locate easily a food item in a smorgasbord mode without having to "rob" a regular meal somewhere down deep in a storage box.

Water for drinking and rehydrating food is obtained from three sources in the command module--a dispenser for drinking water and two water spigots at the food preparation station, one supplying water at about 155 degrees F, the other at about 55 degrees F. The potable water dispenser squirts water continuously as long as the trigger is held down, and the food preparation spigots dispense water in one-ounce increments. Command module potable water is supplied from service module fuel cell byproduct water.

A continuous-feed hand water dispenser similar to the one in the command module is used aboard the lunar module for cold-water rehydration of food packets stowed aboard the LM.

After water has been injected into a food bag, it is kneaded for about three minutes. The bag neck is then cut off and the food squeezed into the crewman's mouth. After a meal, germicide pills attached to the outside of the food bags are placed in the bags to prevent fermentation and gas formation. The bags are then rolled and stowed in waste disposal compartments.

The day-by-day, meal-by-meal Apollo 11 menu for each crew-man as well as contents of the snack pantry are listed on the following pages:

APOLLO XI (ARMSTRONG)

MEAL	DAY 1*, 5	DAY 2	DAY 3	DAY 4
A	Peaches Bacon Squares (8) Strawberry Cubes (4) Grape Drink Orange Drink	Fruit Cocktail Sausage Patties** Cinn. Tstd. Bread Cubes (4) Cocoa Grapefruit Drink	Peaches Bacon Squares (8) Apricot Cereal Cubes (4) Grape Drink Orange Drink	Canadian Bacon and Applesauce Sugar Coated Corn Flakes Peanut Cubes (4) Cocoa Orange-Grapefruit Drink
B	Beef and Potatoes*** Butterscotch Pudding Brownies (4) Grape Punch	Frankfurters*** Applesauce Chocolate Pudding Orange-Grapefruit Drink	Cream of Chicken Soup Turkey and Gravy*** Cheese Cracker Cubes (6) Chocolate Cubes (6) Pineapple-Grapefruit Drink	Shrimp Cocktail Ham and Potatoes*** Fruit Cocktail Date Fruitcake (4) Grapefruit Drink
C	Salmon Salad Chicken and Rice** Sugar Cookie Cubes (6) Cocoa Pineapple-Grapefruit Drink	Spaghetti with Meat Sauce** Pork and Scalloped Potatoes** Pineapple Fruitcake (4) Grape Punch	Tuna Salad Chicken Stew** Butterscotch Pudding Cocoa Grapefruit Drink	Beef Stew** Coconut Cubes (4) Banana Pudding Grape Punch

*Day 1 consists of Meal B and C only
**Spoon-Bowl Package
***Wet-Pack Food

APOLLO XI (COLLINS)

MEAL	DAY 1*, 5	DAY 2	DAY 3	DAY 4
A	Peaches Bacon Squares (8) Strawberry Cubes (4) Grape Drink Orange Drink	Fruit Cocktail Sausage Patties** Cinn. Tstd. Bread Cubes (4) Cocoa Grapefruit Drink	Peaches Bacon Squares (8) Apricot Cereal Cubes (4) Grape Drink Orange Drink	Canadian Bacon and Applesauce Sugar Coated Corn Flakes Peanut Cubes (4) Cocoa Orange-Grapefruit Drink
B	Beef and Potatoes*** Butterscotch Pudding Brownies (4) Grape Punch	Frankfurters*** Applesauce Chocolate Pudding Orange-Grapefruit Drink	Cream of Chicken Soup Turkey and Gravy*** Cheese Cracker Cubes (6) Chocolate Cubes (4) Pineapple-Grapefruit Drink	Shrimp Cocktail Ham and Potatoes*** Fruit Cocktail Date Fruitcake (4) Grapefruit Drink
C	Salmon Salad Chicken and Rice** Sugar Cookie Cubes (6) Cocoa Pineapple-Grapefruit Drink	Potato Soup Pork and Scalloped Potatoes** Pineapple Fruitcake (4) Grape Punch	Tuna Salad Chicken Stew** Butterscotch Pudding Cocoa Grapefruit Drink	Beef Stew** Coconut Cubes (4) Banana Pudding Grape Punch

*Day 1 consists of Meal B and C only
**Spoon-Bowl Package
***Wet-Pack Food

APOLLO XI (ALDRIN)

MEAL	DAY 1*, 5	DAY 2	DAY 3	DAY 4
A	Peaches Bacon Squares (8) Strawberry Cubes (4) Grape Drink Orange Drink	Fruit Cocktail Sausage Patties** Cinn. Tstd. Bread Cubes (4) Cocoa Grapefruit Drink	Peaches Bacon Squares (8) Apricot Cereal Cubes (4) Grape Drink Orange Drink	Canadian Bacon and Applesauce Sugar Coated Corn Flakes Peanut Cubes (4) Cocoa Orange-Grapefruit Drink
B	Beef and Potatoes*** Butterscotch Pudding Brownies (4) Grape Punch	Frankfurters*** Applesauce Chocolate Pudding Orange-Grapefruit Drink	Cream of Chicken Soup Turkey and Gravy*** Cheese Cracker Cubes (6) Chocolate Cubes (6) Pineapple-Grapefruit Drink	Shrimp Cocktail Ham and Potatoes*** Fruit Cocktail Date Fruitcake (4) Grapefruit Drink
C	Salmon Salad Chicken and Rice** Sugar Cookie Cubes (4) Cocoa Pineapple-Grapefruit Drink	Chicken Salad Chicken and Gravy Beef Sandwiches (6) Pineapple Fruitcake (4) Grape Punch	Tuna Salad Chicken Stew** Butterscotch Pudding Cocoa Grapefruit Drink	Pork and Scalloped Potatoes** Coconut Cubes (4) Banana Pudding Grape Punch

*Day 1 consists of Meal B and C only
**Spoon-Bowl Package
***Wet-Pack Food

-more-

ACCESSORIES	Unit
Chewing gum	15
Wet skin cleaning towels	30
Oral Hygiene Kit	1
3 toothbrushes	
1 edible toothpaste	
1 dental floss	
Contingency Feeding System	1
3 food restrainer pouches	
3 beverage packages	
1 valve adapter (pontube)	
Spoons	3

-more-

Snack Pantry

Breakfast	Units
Peaches	6
Fruit Cocktail	6
Canadian Bacon and Applesauce	3
Bacon Squares (8)	12
Sausage Patties*	3
Sugar Coated Corn Flakes	6
Strawberry Cubes (4)	3
Cinn. Tstd. Bread Cubes (4)	6
Apricot Cereal Cubes (4)	3
Peanut Cubes (4)	3
	51

Salads/Meats	
Salmon Salad	3
Tuna Salad	3
Cream of Chicken Soup	6
Shrimp Cocktail	6
Spaghetti and Meat Sauce*	6
Beef Pot Roast	3
Beef and Vegetables	3
Chicken and Rice*	6
Chicken Stew*	3
Beef Stew*	3
Pork and Scalloped Potatoes*	6
Ham and Potatoes (Wet)	3
Turkey and Gravy (Wet)	6
	57

*Spoon-Bowl Package

-more-

Snack Pantry

Rehydratable Desserts	Units
Banana Pudding	6
Butterscotch Pudding	6
Applesauce	6
Chocolate Pudding	6
	24

Beverages	
Orange Drink	6
Orange-Grapefruit Drink	3
Pineapple-Grapefruit Drink	3
Grapefruit Drink	3
Grape Drink	6
Grape Punch	3
Cocoa	6
Coffee (B)	15
Coffee (S)	15
Coffee (C and S)	15
	75

-more-

Snack Pantry

Dried Fruits	Units	Stow
Apricots	6	1
Peaches	6	1
Pears	6	1
Sandwich Spread		
Ham Salad (5 oz.)	1	1
Tuna Salad (5 oz.)	1	1
Chicken Salad (5 oz.)	1	1
Cheddar Cheese (2 oz.)	3	1
Bread		
Rye	6	6
White	6	6

-more-

Snack Pantry

Bites	Units
Cheese Cracker Cubes (6)	6
BBQ Beef Bits (4)	6
Chocolate Cubes (4)	6
Brownies (4)	6
Date Fruitcake (4)	6
Pineapple Fruitcake (4)	6
Jellied Fruit Candy (4)	6
Caramel Candy (4)	6

LM-5 Food

Meal A.	Bacon Squares(8)	
	Peaches	
	Sugar Cookie Cubes (6)	
	Coffee	
	Pineapple-Grapefruit drink	
Meal B.	Beef stew	
	Cream of Chicken Soup	
	Date Fruit Cake (4)	
	Grape Punch	
	Orange Drink	

	Units
Extra Beverage	8
Dried Fruit	4
Candy Bar	4
Bread	2
Ham Salad Spread (tube food)	1
Turkey and Gravy	2
Spoons	2

-more-

Personal Hygiene

Crew personal hygiene equipment aboard Apollo 11 includes body cleanliness items, the waste management system and one medical kit.

Packaged with the food are a toothbrush and a two-ounce tube of toothpaste for each crewman. Each man-meal package contains a 3.5-by-four-inch wet-wipe cleansing towel. Additionally, three packages of 12-by-12-inch dry towels are stowed beneath the command module pilot's couch. Each package contains seven towels. Also stowed under the command module pilot's couch are seven tissue dispensers containing 53 three-ply tissues each.

Solid body wastes are collected in Gemini-type plastic defecation bags which contain a germicide to prevent bacteria and gas formation. The bags are sealed after use and stowed in empty food containers for post-flight analysis.

Urine collection devices are provided for use while wearing either the pressure suit or the inflight coveralls. The urine is dumped overboard through the spacecraft urine dump valve in the CM and stored in the LM.

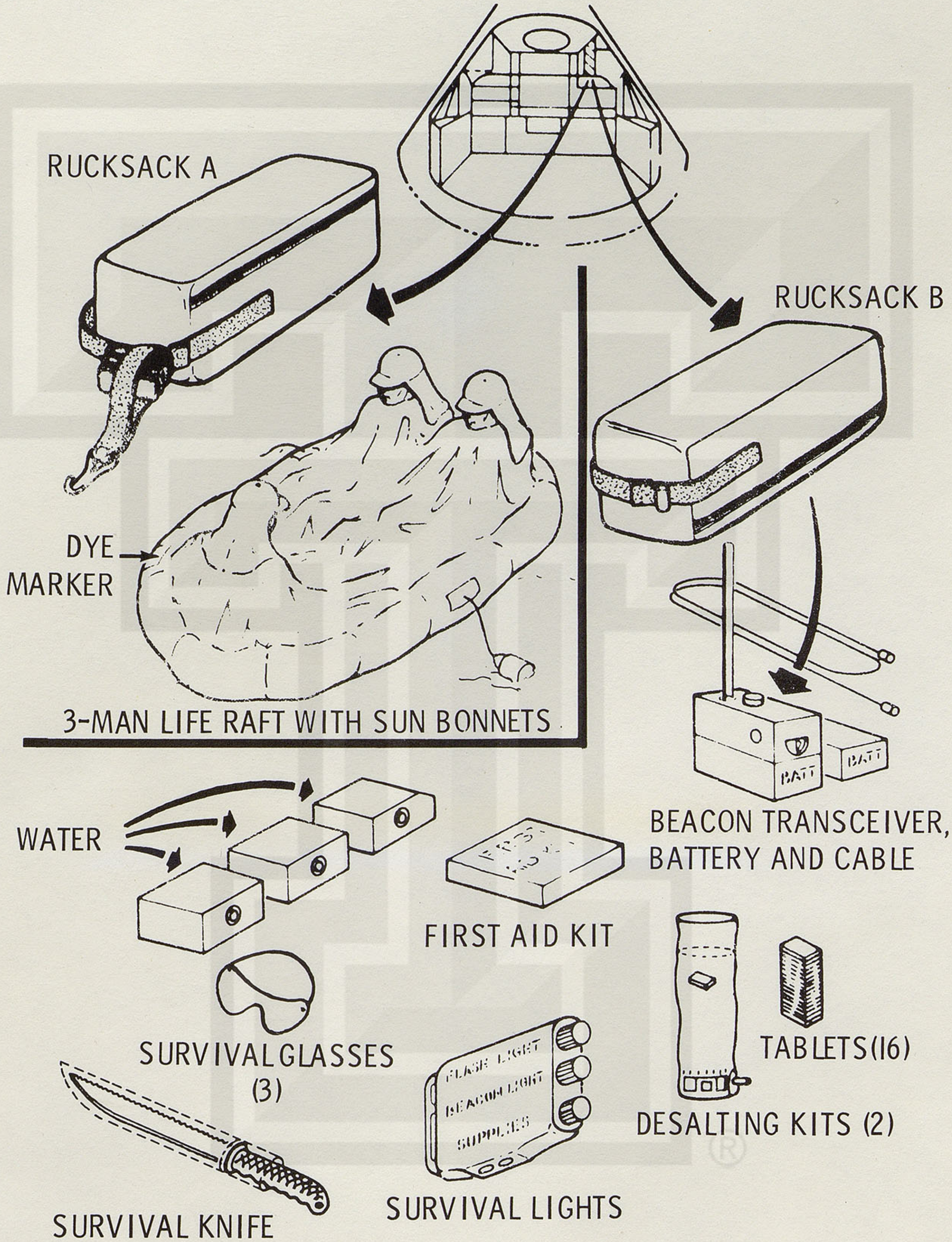
Medical Kit

The 5x5x8-inch medical accessory kit is stowed in a compartment on the spacecraft right side wall beside the lunar module pilot couch. The medical kit contains three motion sickness injectors, three pain suppression injectors, one two-ounce bottle first aid ointment, two one-ounce bottle eye drops, three nasal sprays, two compress bandages, 12 adhesive bandages, one oral thermometer and four spare crew biomedical harnesses. Pills in the medical kit are 60 antibiotic, 12 nausea, 12 stimulant, 18 pain killer, 60 decongestant, 24 diarrhea, 72 aspirin and 21 sleeping. Additionally, a small medical kit containing four stimulant, eight diarrhea, two sleeping and four pain killer pills, 12 aspirin, one bottle eye drops and two compress bandages is stowed in the lunar module flight data file compartment.

Survival Gear

The survival kit is stowed in two rucksacks in the right-hand forward equipment bay above the lunar module pilot.

Contents of rucksack No. 1 are: two combination survival lights, one desalter kit, three pair sunglasses, one radio beacon, one spare radio beacon battery and spacecraft connector cable, one knife in sheath, three water containers and two containers of Sun lotion.


RUCKSACK A
RUCKSACK B
DYE MARKER
3-MAN LIFE RAFT WITH SUN BONNETS
BEACON TRANSCEIVER, BATTERY AND CABLE
BATT
WATER
FIRST AID KIT
SURVIVAL GLASSES (3)
TABLETS (16)
DESALTING KITS (2)
SURVIVAL KNIFE
SURVIVAL LIGHTS
FLASH LIGHT
BEACON LIGHT
SUPPLIES

-more-

Rucksack No. 2: one three-man life raft with CO_2 inflater, one sea anchor, two sea dye markers, three sunbonnets, one mooring lanyard, three manlines, and two attach brackets.

The survival kit is designed to provide a 48-hour postlanding (water or land) survival capability for three crewmen between 40 degrees North and South latitudes.

Biomedical Inflight Monitoring

The Apollo 11 crew biomedical telemetry data received by the Manned Space Flight Network will be relayed for instantaneous display at Mission Control Center where heart rate and breathing rate data will be displayed on the flight surgeon's console. Heart rate and respiration rate average, range and deviation are computed and displayed on digital TV screens.

In addition, the instantaneous heart rate, real-time and delayed EKG and respiration are recorded on strip charts for each man.

Biomedical telemetry will be simultaneous from all crewmen while in the CSM, but selectable by a manual onboard switch in the LM.

Biomedical data observed by the flight surgeon and his team in the Life Support Systems Staff Support Room will be correlated with spacecraft and space suit environmental data displays.

Blood pressures are no longer telemetered as they were in the Mercury and Gemini programs. Oral temperature, however, can be measured onboard for diagnostic purposes and voiced down by the crew in case of inflight illness.

Training

The crewmen of Apollo 11 have spent more than five hours of formal crew training for each hour of the lunar-orbit mission's eight-day duration. More than 1,000 hours of training were in the Apollo 11 crew training syllabus over and above the normal preparations for the mission--technical briefings and reviews, pilot meetings and study.

The Apollo 11 crewmen also took part in spacecraft manufacturing checkouts at the North American Rockwell plant in Downey, Calif., at Grumman Aircraft Engineering Corp., Bethpage, N.Y., and in prelaunch testing at NASA Kennedy Space Center. Taking part in factory and launch area testing has provided the crew with thorough operational knowledge of the complex vehicle.

Highlights of specialized Apollo 11 crew training topics are:

* Detailed series of briefings on spacecraft systems, operation and modifications.

* Saturn launch vehicle briefings on countdown, range safety, flight dynamics, failure modes and abort conditions. The launch vehicle briefings were updated periodcally.

* Apollo Guidance and Navigation system briefings at the Massachusetts Institute of Technology Instrumentation Laboratory.

* Briefings and continuous training on mission photographic objectives and use of camera equipment.

* Extensive pilot participation in reviews of all flight procedures for normal as well as emergency situations.

* Stowage reviews and practice in training sessions in the spacecraft, mockups and command module simulators allowed the crewmen to evaluate spacecraft stowage of crew-associated equipment.

* More than 400 hours of training per man in command module and lunar module simulators at MSC and KSC, including closed-loop simulations with flight controllers in the Mission Control Center. Other Apollo simulators at various locations were used extensively for specialized crew training.

* Entry corridor deceleration profiles at lunar-return conditions in the MSC Flight Acceleration Facility manned centrifuge.

* Lunar surface briefings and 1-g walk-throughs of lunar surface EVA operations covering lunar geology and microbiology and deployment of experiments in the Early Apollo Surface Experiment Package (EASEP). Training in lunar surface EVA included practice sessions with lunar surface sample gathering tools and return containers, cameras, the erectable S-band antenna and the modular equipment stowage assembly (MESA) housed in the LM descent stage.

* Proficiency flights in the lunar landing training vehicle (LLTV) for the commander.

* Zero-g aircraft flights using command module and lunar module mockups for EVA and pressure suit doffing/donning practice and training.

* Underwater zero-g training in the MSC Water Immersion Facility using spacecraft mockups to further familiarize crew with all aspects of CSM-LM docking tunnel intravehicular transfer and EVA in pressurized suits.

* Water egress training conducted in indoor tanks as well as in the Gulf of Mexico, included uprighting from the Stable II position (apex down) to the Stable I position (apex up), egress onto rafts and helicopter pickup.

* Launch pad egress training from mockups and from the actual spacecraft on the launch pad for possible emergencies such as fire, contaminants and power failures.

* The training covered use of Apollo spacecraft fire suppression equipment in the cockpit.

* Planetarium reviews at Morehead Planetarium, Chapel Hill, N.C., and at Griffith Planetarium, Los Angeles, Calif., of the celestial sphere with special emphasis on the 37 navigational stars used by the Apollo guidance computer.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D. C. 20546

BIOGRAPHICAL DATA

NAME: Neil A. Armstrong (Mr.)
NASA Astronaut, Commander, Apollo 11

BIRTHPLACE AND DATE: Born in Wapakoneta, Ohio, on August 5, 1930; he is the son of Mr. and Mrs. Stephen Armstrong of Wapakoneta.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 feet 11 inches; weight: 165 pounds.

EDUCATION: Attended secondary school in Wapakoneta, Ohio; received a Bachelor of Science degree in Aeronautical Engineering from Purdue University in 1955. Graduate School - University of Southern California.

MARITAL STATUS: Married to the former Janet Shearon of Evanston, Illinois, who is the daughter of Mrs. Louise Shearon of Pasadena, California.

CHILDREN: Eric, June 30, 1957; Mark, April 8, 1963.

OTHER ACTIVITIES: His hobbies include soaring (for which he is a Federation Aeronautique Internationale gold badge holder).

ORGANIZATIONS: Associate Fellow of the Society of Experimental Test Pilots; associate fellow of the American Institute of Aeronautics and Astronautics; and member of the Soaring Society of America.

SPECIAL HONORS: Recipient of the 1962 Institute of Aerospace Sciences Octave Chanute Award; the 1966 AIAA Astronautics Award; the NASA Exceptional Service Medal; and the 1962 John J. Montgomery Award.

EXPERIENCE: Armstrong was a naval aviator from 1949 to 1952 and flew 78 combat missions during the Korean action.

He joined NASA's Lewis Research Center in 1955 (then NACA Lewis Flight Propulsion Laboratory) and later transferred to the NASA High Speed Flight Station (now Flight Research Center) at Edwards Air Force Base, California, as an aeronautical research pilot for NACA and NASA. In this capacity, he performed as an X-15 project pilot, flying that aircraft to over 200,000 feet and approximately 4,000 miles per hour.

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Other flight test work included piloting the X-1 rocket airplane, the F-100, F-101, F-102, F-104, F5D, B-47, the paraglider, and others.

As pilot of the B-29 "drop" aircraft, he participated in the launches of over 100 rocket airplane flights.

He has logged more than 4,000 hours flying time.

CURRENT ASSIGNMENT: Mr. Armstrong was selected as an astronaut by NASA in September 1962. He served as backup command pilot for the Gemini 5 flight.

As command pilot for the Gemini 8 mission, which was launched on March 16, 1966, he performed the first successful docking of two vehicles in space. The flight, originally scheduled to last three days, was terminated early due to a malfunctioning OAMS thruster; but the crew demonstrated exceptional piloting skill in overcoming this problem and bringing the spacecraft to a safe landing.

He subsequently served as backup command pilot for the Gemini 11 mission and is currently assigned as the commander for the Apollo 11 mission, and will probably be the first human to set foot on the Moon.

As a civil servant, Armstrong, a GS-16 Step 7, earns $30,054 per annum

 June 1969

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D. C. 20546

BIOGRAPHICAL DATA

NAME: Michael Collins (Lieutenant Colonel, USAF)
NASA Astronaut, Command Module Pilot, Apollo 11

BIRTHPLACE AND DATE: Born in Rome, Italy, on October 31, 1930. His mother, Mrs. James L. Collins, resides in Washington, D.C.

PHYSICAL DESCRIPTION: Brown hair; brown eyes; height: 5 feet 11 inches; weight: 165 pounds.

EDUCATION: Graduated from Saint Albans School in Washington, D.C.; received a Bachelor of Science degree from the United States Military Academy at West Point, New York, in 1952.

MARITAL STATUS: Married to the former Patricia M. Finnegan of Boston, Massachusetts.

CHILDREN: Kathleen, May 6, 1959; Ann S., October 31, 1961; Michael L., February 23, 1963.

OTHER ACTIVITIES: His hobbies include fishing and handball.

ORGANIZATIONS: Member of the Society of Experimental Test Pilots.

SPECIAL HONORS: Awarded the NASA Exceptional Service Medal, the Air Force Command Pilot Astronaut Wings, and the Air Force Distinguished Flying Cross.

EXPERIENCE: Collins, an Air Force Lt. Colonel, chose an Air Force career following graduation from West Point.

He served as an experimental flight test officer at the Air Force Flight Test Center, Edwards Air Force Base, California, and, in that capacity, tested performance and stability and control characteristics of Air Force aircraft--primarily jet fighters.

He has logged more than 4,000 hours flying time, including more than 3,200 hours in jet aircraft.

CURRENT ASSIGNMENT: Lt. Colonel Collins was one of the third group of astronauts named by NASA in October 1963. He has since served as backup pilot for the Gemini 7 mission.

As pilot on the 3-day 44-revolution Gemini 10 mission, launched July 18, 1966, Collins shares with command pilot John Young in the accomplishments of that record-setting flight. These accomplishments include a successful rendezvous and docking with a separately launched Agena target vehicle and, using the power of the Agena, maneuvering the Gemini spacecraft into another orbit for a rendezvous with a second, passive Agena. Collins' skillful performance in completing two periods of extravehicular activity, including his recovery of a micrometeorite detection experiment from the passive Agena, added greatly to our knowledge of manned space flight.

Gemini 10 attained an apogee of approximately 475 statute miles and traveled a distance of 1,275,091 statute miles--after which splashdown occurred in the West Atlantic 529 statute miles east of Cape Kennedy. The spacecraft landed 2.6 miles from the USS GUADALCANAL and became the second in the Gemini program to land within eye and camera range of a prime recovery vessel.

He is currently assigned as command module pilot on the Apollo 11 mission. The annual pay and allowances of an Air Force lieutenant colonel with Collins' time in service totals $17,147.36.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D.C. 20546

BIOGRAPHICAL DATA

NAME: Edwin E. Aldrin, Jr. (Colonel, USAF)
NASA Astronaut, Lunar Module Pilot, Apollo 11

BIRTHPLACE AND DATE: Born in Montclair, New Jersey, on January 20, 1930, and is the son of the late Marion Moon Aldrin and Colonel (USAF Retired) Edwin E. Aldrin, who resides in Brielle, New Jersey.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 feet 10 inches; weight: 165 pounds.

EDUCATION: Graduated from Montclair High School, Montclair, New Jersey; received a Bachelor of Science degree from the United States Military Academy at West Point, New York, in 1951 and a Doctor of Science degree in Astronautics from the Massachusetts Institute of Technology in 1963; recipient of an Honorary Doctorate of Science degree from Gustavus Adolphus College in 1967, Honorary degree from Clark University, Worchester, Mass.

MARITAL STATUS: Married to the former Joan A. Archer of Ho-Ho-Kus, New Jersey, whose parents, Mr. and Mrs. Michael Archer, are residents of that city.

CHILDREN: J. Michael, September 2, 1955; Janice R., August 16, 1957; Andrew J., June 17, 1958.

OTHER ACTIVITIES: He is a Scout Merit Badge Counsellor and an Elder and Trustee of the Webster Presbyterian Church. His hobbies include running, scuba diving, and high bar exercises.

ORGANIZATIONS: Associate Fellow of the American Institute of Aeronautics and Astronautics; member of the Society of Experimental Test Pilots, Sigma Gamma Tau (aeronautical engineering society), Tau Beta Pi (national engineering society), and Sigma Xi (national science research society); and a 32nd Degree Mason advanced through the Commandery and Shrine.