NASA Apollo Program
Historical Information

NASA Apollo Lunar Module News Reference (1968)

Grumman Aircraft Engineering Corporation
GAEC

APOLLO NEWS REFERENCE

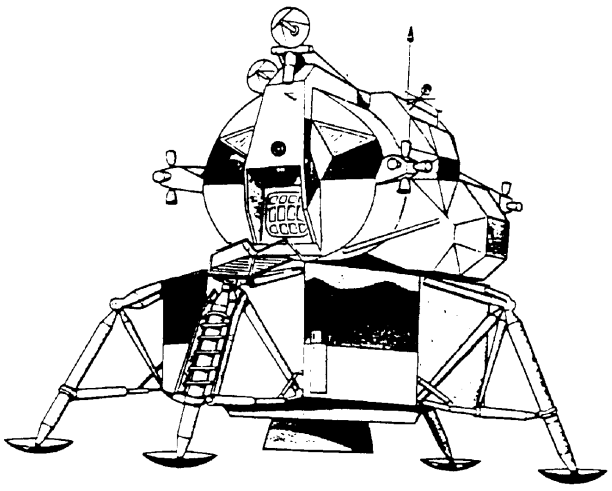
1969 ?

Lunar Module

APOLLO

Man's centuries-old dream of exploring the moon is nearing reality. Preparations for this half-million mile round trip include agencies from virtually all 50 states and the diverse talents of more than 300,000 people in government, industry, and the educational community.

All of them are well aware of their pioneering responsibility. And no matter where the scene may shift – to NASA installations in Washington, at Huntsville or Houston, to Grumman facilities at Bethpage or Cape Kennedy – all share the same objective. The goal is never out of sight. On clear nights it beckons overhead . . . . **the moon.**



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"ApolloNewsRef LM A.00.PICT" 185 KB 1999-01-27 dpi: 360h x 364v pix: 2436h x 3798v

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The Apollo Spacecraft Reference has been prepared by Public Affairs, Space, at Grumman Aircraft Engineering Corporation, Bethpage, New York in cooperation with the National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas.

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MISSION DESCRIPTION

A typical mission of the Lunar Module (LM) begins shortly after its separation from the coupled, orbiting Command/Service Module, continues through lunar descent, lunar stay, lunar ascent, and ends at rendezvous with the orbiting Command/Service Module before the return to earth. The LM mission is part of the overall Apollo Mission, the objective of which is to land two astronauts and scientific equipment on the moon, and return them safely to earth.

The three-stage, Saturn V launch vehicle will be used to boost the Apollo spacecraft into earth orbit and to provide the thrust necessary to propel it into its translunar path. Once on course to the moon, the third, and final propellant stage of the Saturn V is jettisoned, and the spacecraft (consisting of the Command, Service, and Lunar Modules) continues its 3-day journey toward a lunar orbit.

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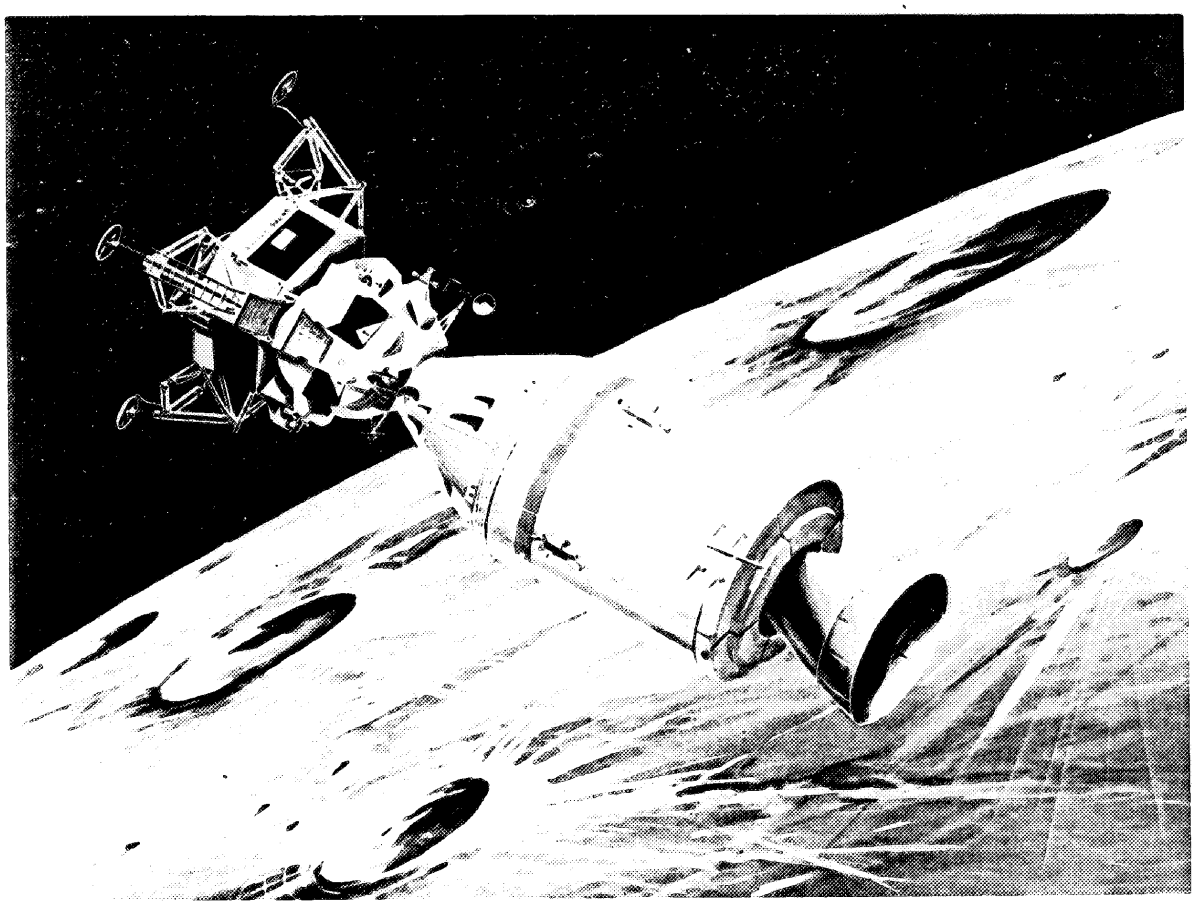

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Upon approach to the moon, the re-ignitable propulsion system contained in the Service Module inserts the spacecraft into a circular orbit approximately 80 nautical miles above the lunar surface. Once orbit is achieved, two of the three astronauts in the Apollo team transfer from the Command Module, where they have been seated since earth launch, to the LM. A thorough checkout of the LM's subsystems is then performed.

At a predetermined point in the Lunar orbit, the LM separates from the Command/Service Module which remains in lunar orbit awaiting the return of the LM at the end of the mission's rendezvous maneuver.

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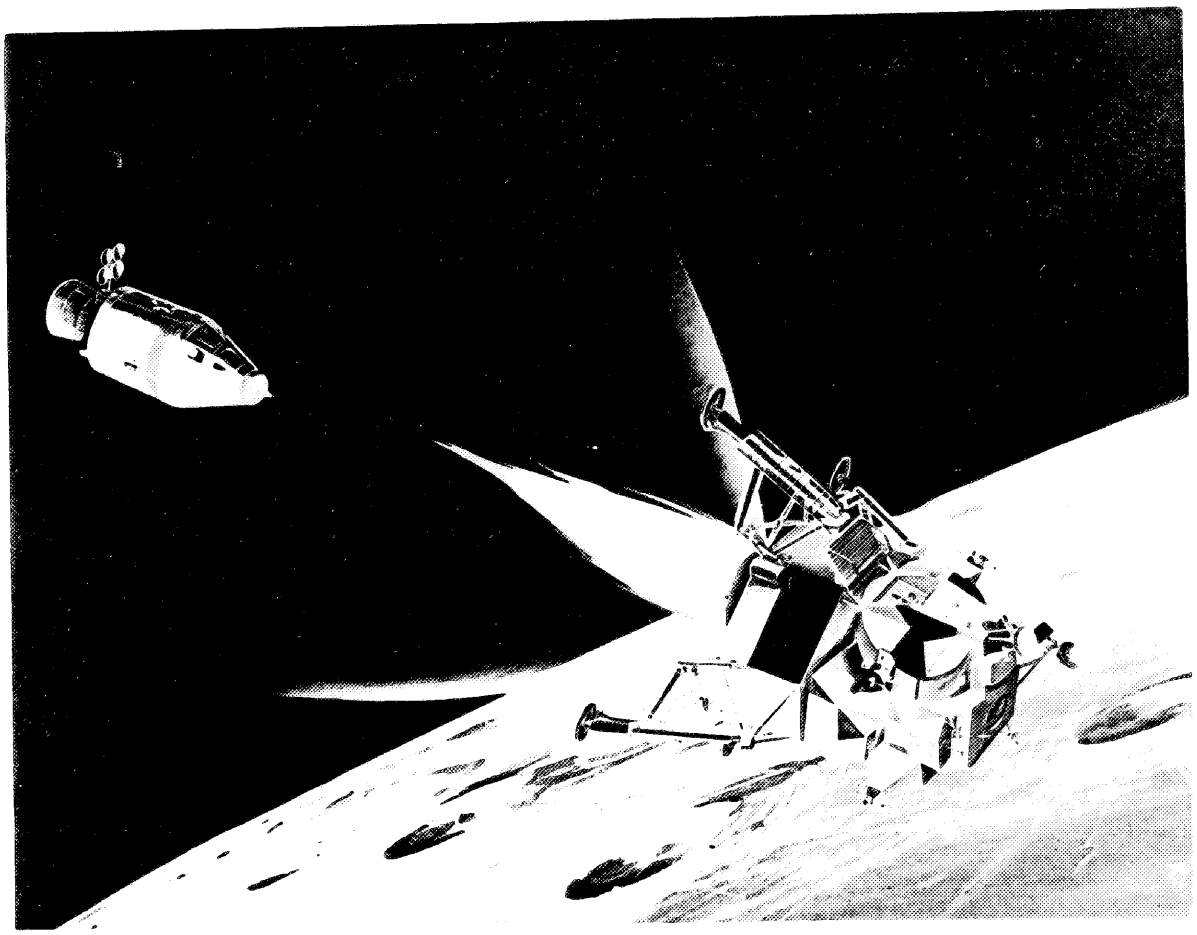

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By igniting the descent engine (contained in the LM's descent stage), the separated LM is inserted into a descent trajectory. Following cutoff of the descent engine, the LM coasts to the low point of its descent trajectory which brings the craft to within 50,000 feet of the lunar surface, and uprange of the proposed landing site. At that time, the descent engine is refired to reduce velocity during the LM's descent to landing.

The LM's descent is automatically controlled to an altitude of a few hundred feet by a Guidance, Navigation, and Control Subsystem. During the final landing phase, the two man crew selects a favorable landing site and, by manual control of the reaction control system jets (clustered at the four corners of the LM ascent stage) and the variable thrust descent engine, the craft is manipulated into the correct attitude over the landing site and landed gently on the moon.

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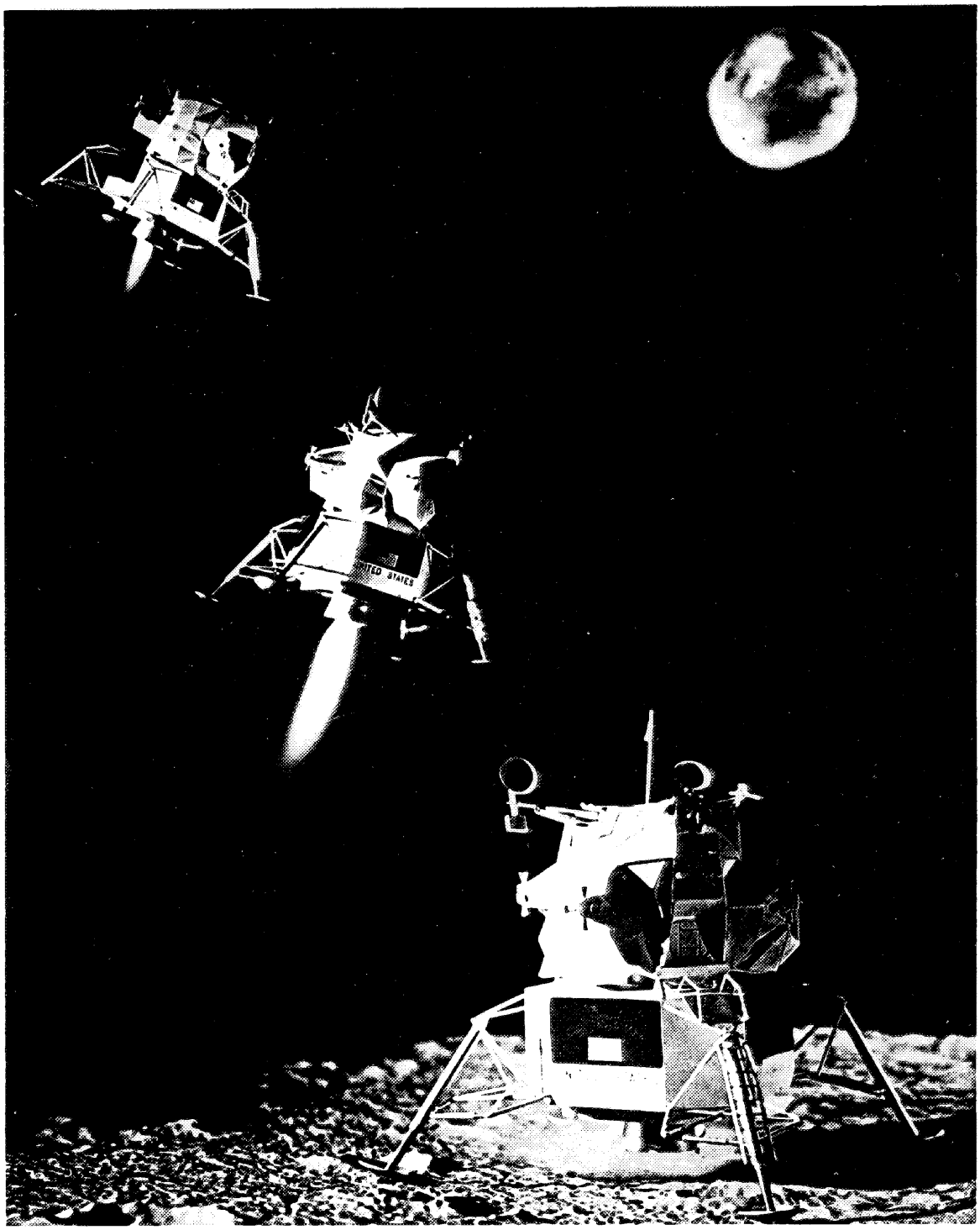

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MD-4

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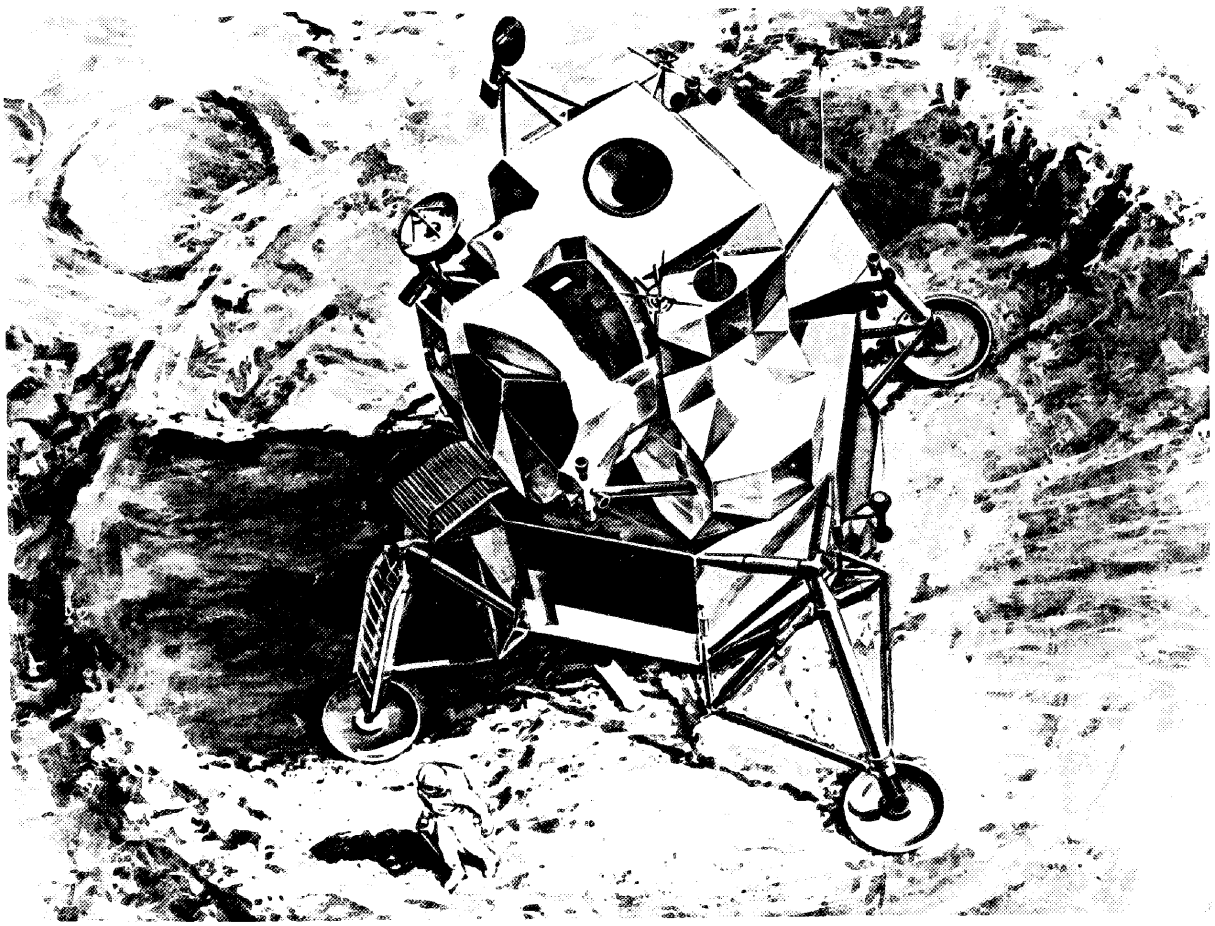

R-109

Following touchdown on the moon, the LM crew checks all subsystems to determine whether damage was incurred during the landing, and to ensure that the subsystems will perform the functions required for a successful departure and rendezvous. All equipment not essential for the lunar stay is turned off.

With the LM secured for the lunar stay, both astronauts don their portable life support system, the LM is depressurized, and one or both leaves the module to inspect the exterior for damage.

After completing his inspection, the astronaut deploys an erectable S-band communications antenna that allows voice and TV transmittal to earth. The TV system sends pictures of the moon's topography back to earth for recording.

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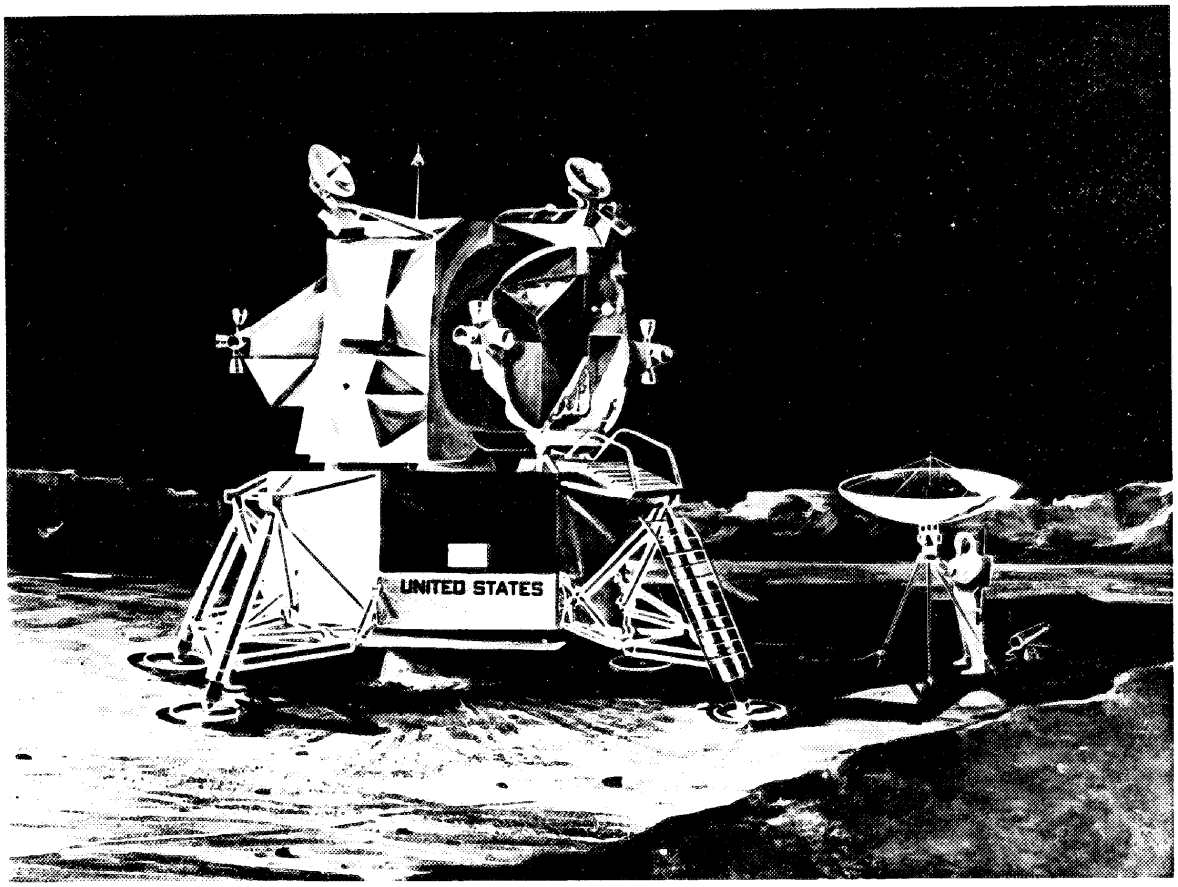

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Extra-vehicular explorations are made by both astronauts, after which the astronauts return to the LM to replenish their portable life support system with on-board supplies.

During their explorations, the astronauts photograph extensively, collect specimens, activate scientific experiments, and transmit verbal reports on observations to the earth.

The lunar stay will last for about 24 hours.

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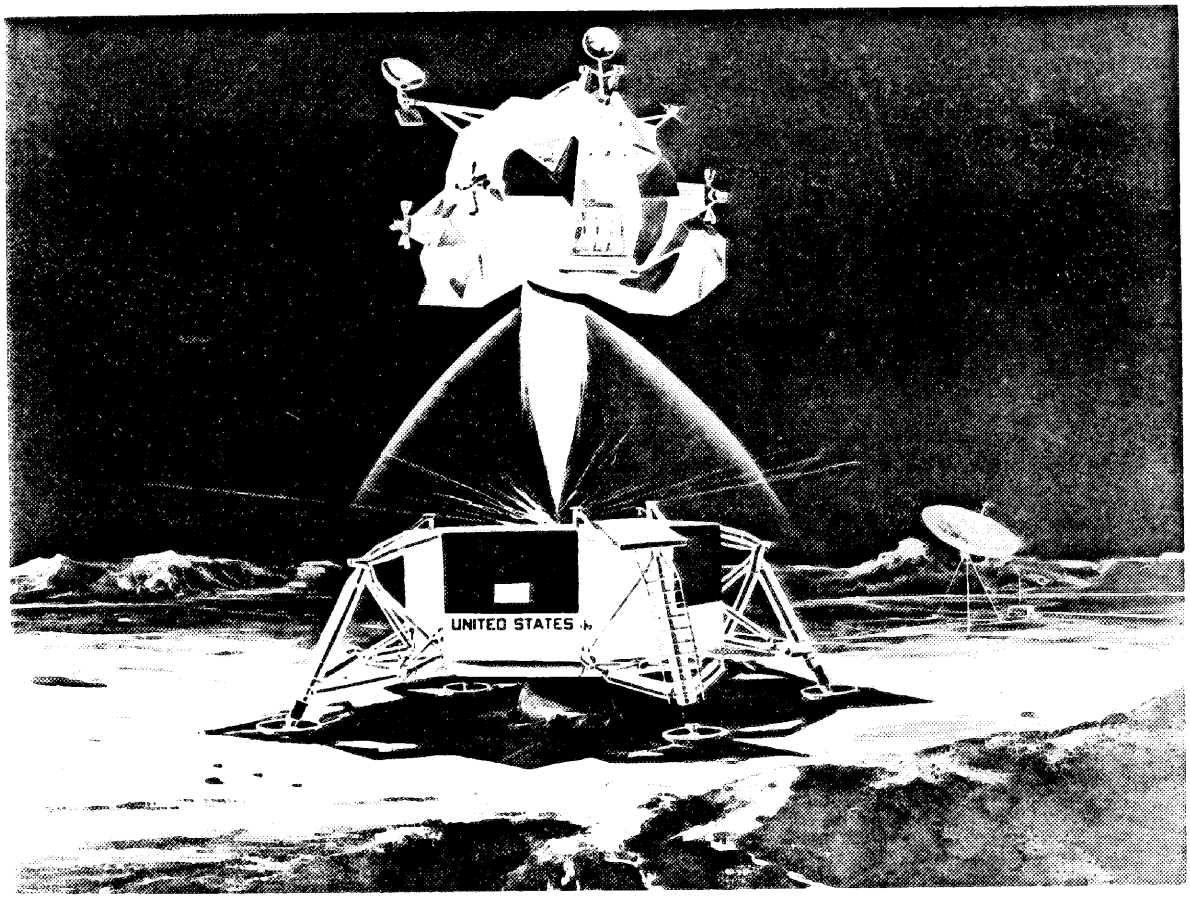

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When the lunar stay is completed, the LM crew must prepare the module for launch and ascent to rendezvous with the orbiting Command/Service Module.

Preparation consists of a recheck of all subsystems, and the computation of relative position information for the execution of the rendezvous with the Command/Service Module.

When the orbiting Command/Service Module is in the proper position overhead, the ascent engine in the LM's upper section is fired for launch. The lower descent stage serves as a launching platform and remains on the moon's surface. The ascent engine inserts the LM into a transfer orbit. Mid-course and rendezvous maneuvers are accomplished with the Reaction Control Subsystem jets.

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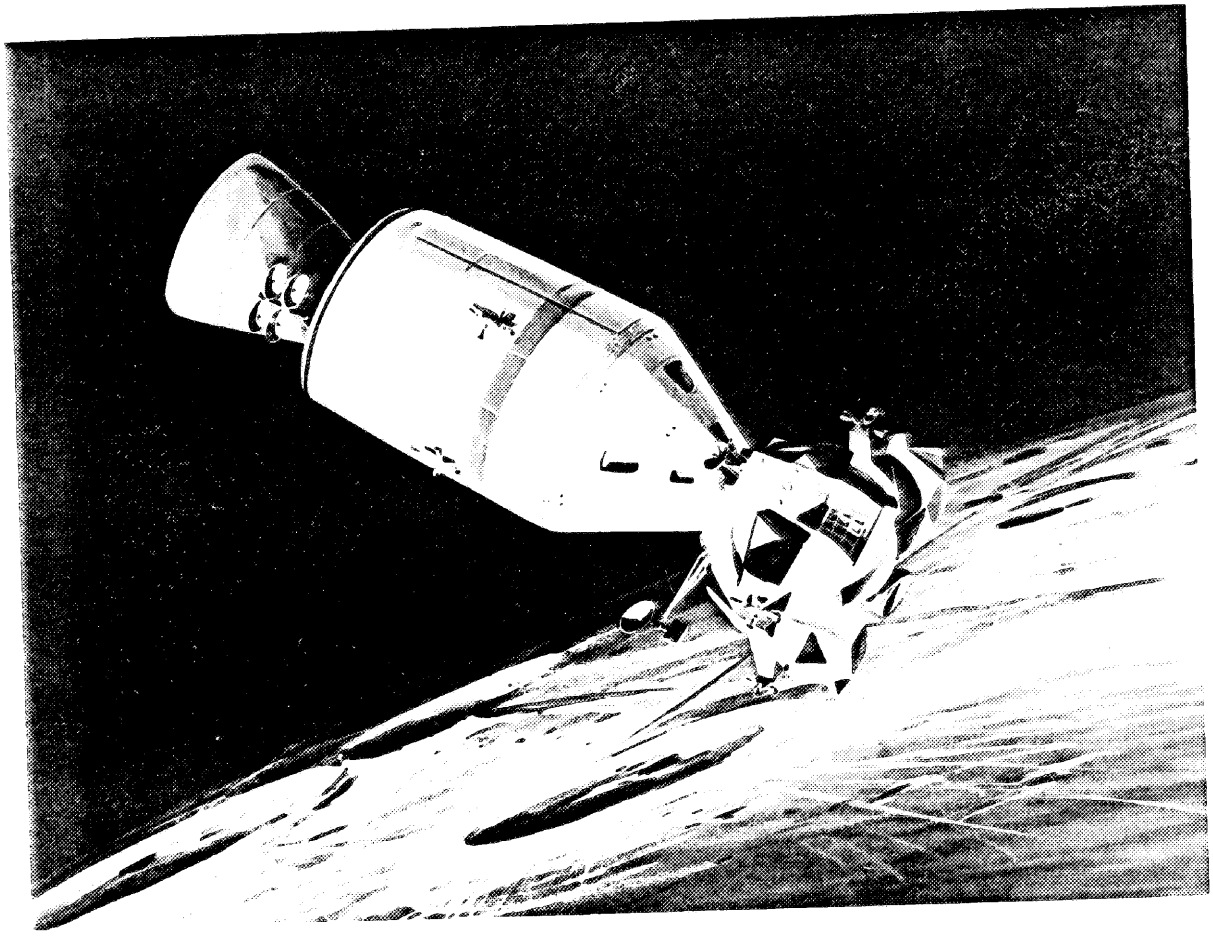

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When the LM is approximately 500 feet from the Command/Service Module, the LM Commander manually maneuvers the module to a docking attitude and increases or decreases the rate of closure until complete docking is accomplished.

Once the coupling process is complete, the two-man LM crew prepares to transfer to the Command Module and rejoin the third member of the Apollo team. Pressures between the modules are equalized, LM subsystems are turned off, and scientific equipment and collected specimens are passed into the Command Module. When the transfer is complete, the LM is jettisoned in lunar orbit and left behind. This concludes the role of the LM in the Apollo mission.

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FINAL APOLLO MISSION PHASE

Following rendezvous and jettisoning of the LM, preparations are made for the return journey to earth. A checkout of the Command/Service Module's systems and computation of the transearth course occur just before firing the Service Module's engine, which provides thrust for the return trip.

As the Command/Service Module nears earth, the Service Module is jettisoned, and the Command Module — bearing the Apollo team's three astronauts — is reoriented for re-entry and final parachute descent to earth landing, thus completing the week-long lunar mission.

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APOLLO SPACECRAFT

The Apollo spacecraft comprises the lunar module, the command module, the service module, the spacecraft-lunar module adapter, and the launch escape system. The five parts, 82 feet tall when assembled, are carried atop the launch vehicle.

After the launch escape system and the launch vehicle have been jettisoned, the three modules remain to form the basic spacecraft. The command module carries the three astronauts to and from lunar orbit. The service module contains the propulsion system that propels the spacecraft during the translunar and transearth flights. The lunar module carries two astronauts, the Commander and the Lunar Module Pilot, to and from the moon, and serves as the base of operations during the lunar stay.

LUNAR MODULE

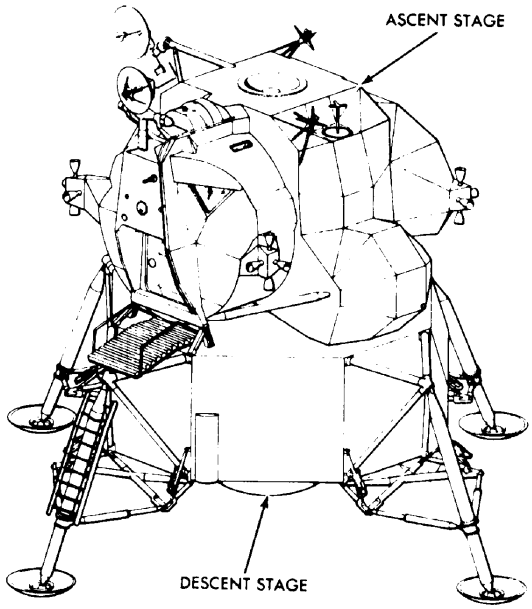
The lunar module will be operated in the vacuum of space; there was no need, therefore, for it to have the aerodynamic symmetry of the command module. The lunar module outer configuration was dictated only by the requirements of component location; cabin configuration was designed to provide a near perfect operating environment for the astronauts.

The LM consists of an ascent stage and a descent stage. Both stages perform as a single unit during separation from the CM, lunar descent, and lunar stay. The descent stage serves as a launching platform from which the ascent stage lifts off from the lunar landing site. The ascent stage operates independently during the lunar ascent, rendezvous, and docking phases of the mission.

ASCENT STAGE

The ascent stage is the control center of the LM; it is manned by the Commander, who occupies the left flight station, and the Lunar Module Pilot, who occupies the right flight station. The astronauts transfer to the ascent stage, through the docking tunnel, after the LM has docked with the CM and both have attained lunar orbit. The ascent stage comprises three major areas: crew compartment, midsection, and aft equipment bay. The cabin, comprising the crew compartment and midsection, has an overall volume of 235 cubic feet.

Because the LM is operated in either the weightlessness of space or in lunar gravity, the cabin contains harness-like restraint equipment rather than the foldable couches provided in the CM. The restraints allow the astronauts sufficient freedom of movement to operate all LM controls while in a relatively upright position.



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Lunar Module

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DESCENT STAGE

The descent stage is the unmanned portion of the LM; it represents approximately two-thirds of the weight of the LM at the earth-launch phase. In addition to containing the descent propulsion section, the descent stage is designed to:

Support the ascent stage

Provide storage to support the scientific and communications equipment used on the lunar surface

Provide for attachment of the landing gear

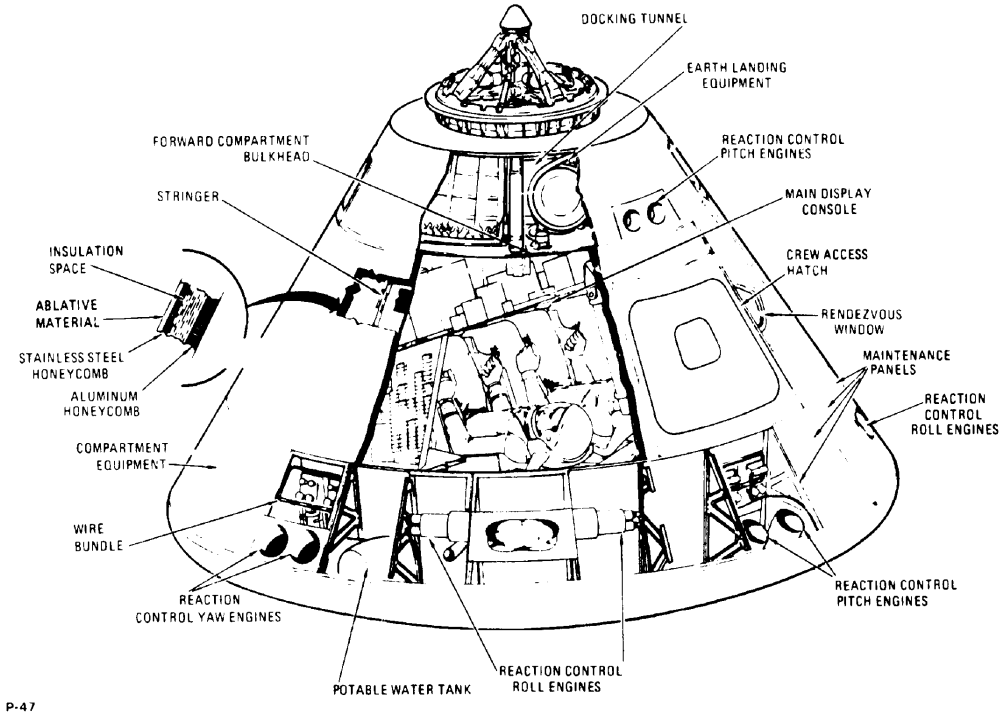
Serve as the ascent stage launching platform

The descent stage is separated into five equally sized compartments that contain descent propulsion section components. The center compartment houses the descent engine; fuel, oxidizer, and water tanks are distributed in the remaining four compartments.

COMMAND MODULE

Dimensions

Height	10 ft 7 in.
Diameter	12 ft 10 in.
Weight (including crew)	13,000 lb
Weight (splashdown)	11,700 lb



Command Module

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Propellant

Reaction control subsystem (fuel--monomethylhydrazine; oxidizer--nitrogen tetroxide)	270 lb

Function

The command module is the control center and living quarters for most of the lunar mission; one man will spend the entire mission in it and the other two will leave it only during the lunar landing. It is the only part of the spacecraft recovered at the end of the mission.

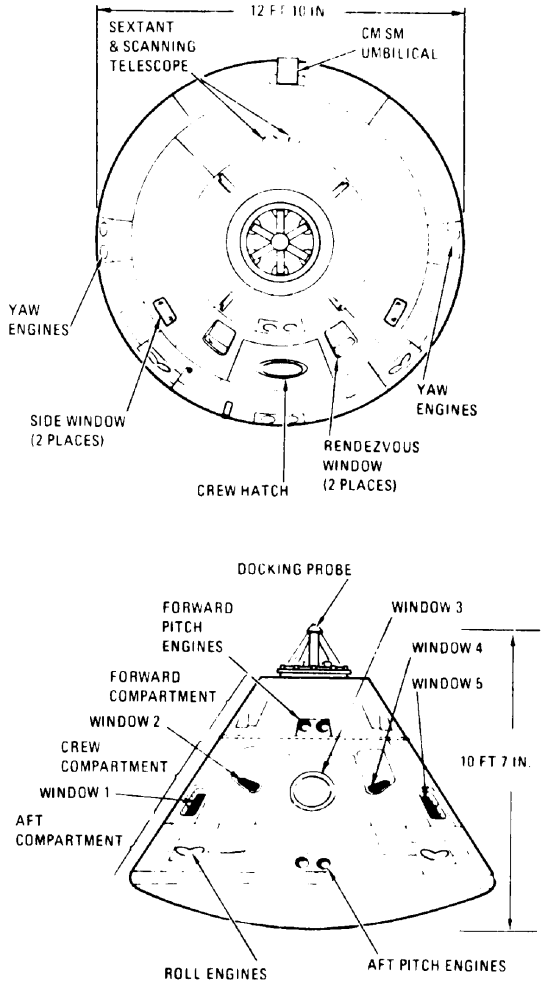
Major Subsystems

Communications
Earth landing
Electrical power
Environmental control
Guidance and navigation
Launch escape
Reaction control
Service propulsion
Stabilization and control
Thermal protection (heat shields)

The CM is divided into three compartments: forward, crew, and aft. The forward compartment is the relatively small area at the apex of the module, the crew compartment occupies most of the center section of the structure, and the aft compartment is another relatively small area around the periphery of the module near the base.

During boost and entry the CM is oriented so that its aft section is down, like an automobile resting on its rear bumper. In this position the astronauts are on their backs; the couches are installed so that the astronauts face the apex of the module. In the weightlessness of space the orientation of the craft would make little difference except in maneuvers like docking, where the craft is moved forward so that the probe at the CM's apex engages the drogue on the LM. Generally, however, the module will be oriented in space so that its apex is forward.

Crewmen will spend much of their time on their couches, but they can leave them and move around. With the seat portion of the center couch folded, two astronauts can stand at the same time. The astronauts will sleep in two sleeping bags which are mounted beneath the left and right couches. The sleeping bags attach to the CM structure and have restraints so that a crewman can sleep either in or out of his space suit.



CM General Arrangement

APOLLO NEWS REFERENCE

Food, water, clothing, waste management, and other equipment are packed into bays which line the walls of the craft. The cabin normally will be pressurized to about 5 pounds per square inch (about a third of sea level pressure) and the temperature will controlled at about 75° F. The pressurization and controlled atmosphere will enable the three crewmen to spend much of their time out of their suits. They will be in their space suits, however, during critical phases of the mission such as launch, entry, docking, and crew transfer.

The astronaut in the left-hand couch is the spacecraft commander. In addition to the duties of command, he will normally operate the spacecraft's flight controls. The astronaut in the center couch is the CM pilot; his principal task is guidance and navigation, although he also will fly the spacecraft at times. On the lunar mission, he is the astronaut who will remain in the CM while the other two descend to the surface of the moon. The astronaut in the right-hand couch is the LM pilot and his principal task is management of spacecraft subsystems.

Although each has specific duties, any of the astronauts can take over the duties of another. The command module has been designed so that one astronaut can return it safely to earth.

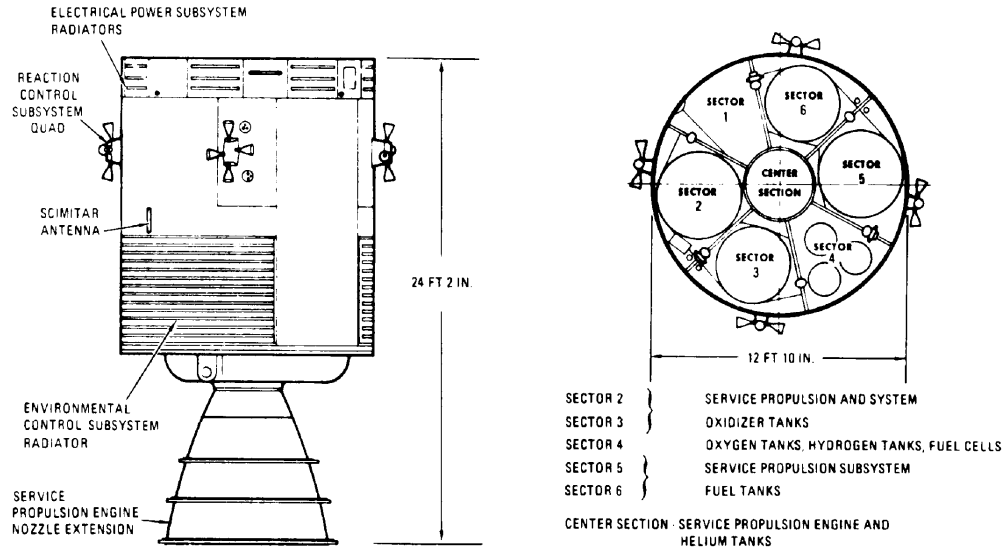
SERVICE MODULE

Dimensions

Height	24 ft 2 in.
Diameter	12 ft 10 in.
Weight (loaded)	55,000 lb
Weight (dry)	11,500 lb

Propellant

SPS fuel	15,766 lb
SPS oxidizer	25,208 lb
RCS	1,362 lb



Service Module

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Function

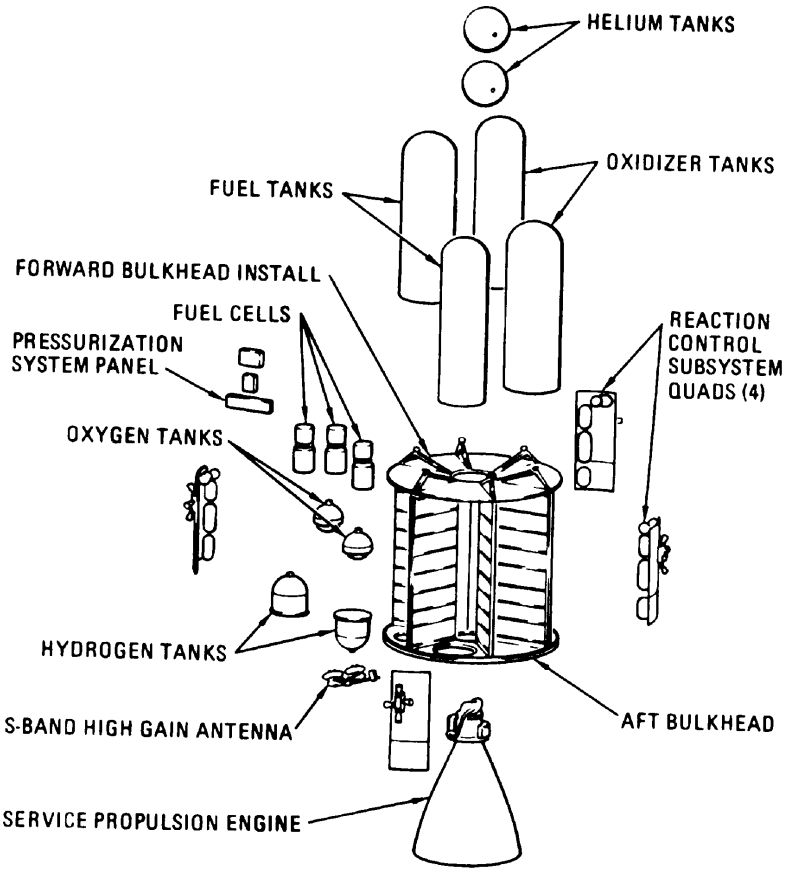
The service module contains the main spacecraft propulsion system and supplies most of the spacecraft's consumables (oxygen, water, propellant, hydrogen). It is not manned. The service module remains attached to the command module until just before entry, when it is jettisoned and is destroyed during entry.

Major Subsystems

Electrical power
Environmental control
Reaction control
Service propulsion
Telecommunications

The service module is a cylindrical structure which serves as a storehouse of critical subsystems and supplies for almost the entire lunar mission. It is attached to the command module from launch until just before earth atmosphere entry.

The service module contains the spacecraft's main propulsion engine, which is used to brake the spacecraft and put it into orbit around the moon and to send it on the homeward journey from the moon. The engine also is used to correct the spacecraft's course on both the trips to and from the moon.



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Main Components of SM

Besides the service propulsion engine and its propellant and helium tanks, the service module contains a major portion of the electrical power, environmental control, and reaction control subsystems, and a small portion of the communications subsystem.

It is strictly a servicing unit of the spacecraft, but it is more than twice as long and more than four times as heavy as the manned command module. About 75 percent of the service module's weight is in propellant for the service propulsion engine.

Information in this section relative to the Command and Service Module was provided by North American Rockwell Corporation, Space Division. Complete details on the Command and Service Modules are contained in North American's Apollo Spacecraft News Reference.

APOLLO NEWS REFERENCE

LUNAR MODULE

QUICK REFERENCE DATA

DIMENSIONS	
LM:	
Height	22 ft. 11 in. (legs extended)
Diameter	31 ft. (diagonally across extended landing gear)
Ascent stage:	
Height	12 ft. 4 in.
Diameter	14 ft. 1 in.
Descent stage:	
Height	10 ft. 7 in.
Diameter	14 ft. 1 in.
GENERAL	
Vehicle weight:	
Earth launch (with crew and propellant)	32,400 lb. (approx.)
LM (dry)	8,600 lb. (approx.)
Ascent stage (dry)	4,500 lb. (approx.)
Descent stage (dry)	4,100 lb. (approx.)
Propellant weight:	
Ascent stage	5,200 lb. (approx.)
Descent stage	18,000 lb. (approx.)
RCS	600 lb. (approx.)
Pressurized volume	235 cu. ft.
Habitable volume	160 cu. ft.
Cabin temperature	75° F
Cabin pressure	4.8 ± 0.2 psia
Batteries:	
Height	3.03 inches
Width	2.75 inches
Length	6.78 inches
Weight (each, filled)	3.50 pounds
Electrical requirements:	
Inputs	
From Electrical Power Subsystem (Commander's and LM Pilot:s buses)	28 volts dc
From Ascent engine latching device of control electronics section	28 volts dc
From Explosive Devices batteries (systems A and B)	37.1 volts dc (open-circuit voltage) 35.0 volts dc (minimum)
From descent engine control assembly	28 volts dc
Outputs	
To initiators (in cartridge assemblies)	3.5 amperes for 10 milliseconds (minimum)
Explosive Devices relay boxes	7.5 to 15.0 amperes dc (for at least 10 milliseconds)

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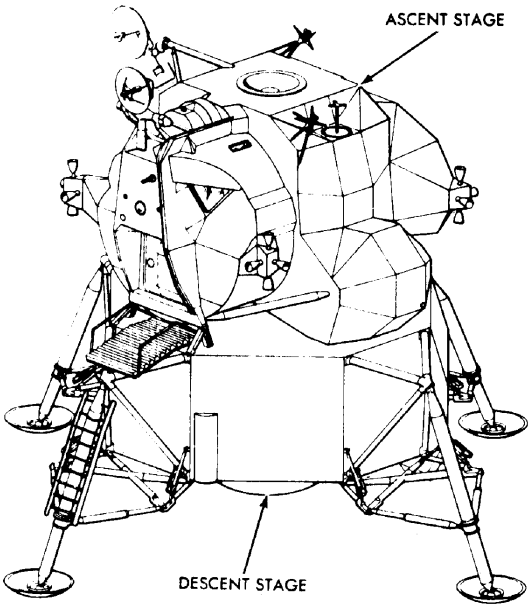
The NASA/Grumman Apollo Lunar Module (LM) will descend to the lunar surface from lunar orbit, provide a base from which the astronauts can explore the landing site and enable the astronauts to take off from the lunar surface to rendezvous and dock with the orbiting Command and Service Modules (CSM). The LM consists of an ascent stage and a descent stage. Both stages function as a single unit during separation from the CM, lunar descent, and lunar stay. The descent stage serves as a launching platform from which the ascent stage lifts off from the lunar surface. The ascent stage operates independently during the lunar ascent, rendezvous, and docking phase of the Apollo mission.

The ascent and descent stages are joined by four interstage fittings that are explosively severed at staging. Subsystem lines and umbilicals required for subsystem continuity between the stages are either explosively severed or automatically disconnected when the stages are separated.

ASCENT STAGE

The ascent stage, control center of the LM, is comprised of three main areas: crew compartment, midsection, and equipment bay.

The crew compartment and midsection make up the cabin, which has an overall volume of 235 cubic feet. The basic structure is primarily aluminum alloy; titanium is used for fittings and fasteners. Aircraft-type construction methods are used. Skin and web panels are chemically milled to reduce weight. Mechanical fasteners join the major structural assemblies with epoxy as a sealant. Structural members are fusion welded wherever possible, to minimize cabin air pressurization leaks. The basic structure includes supports for thrust control engine clusters and various antennas. The entire basic structure is enveloped by thermal insulation and a micrometeoroid shield.



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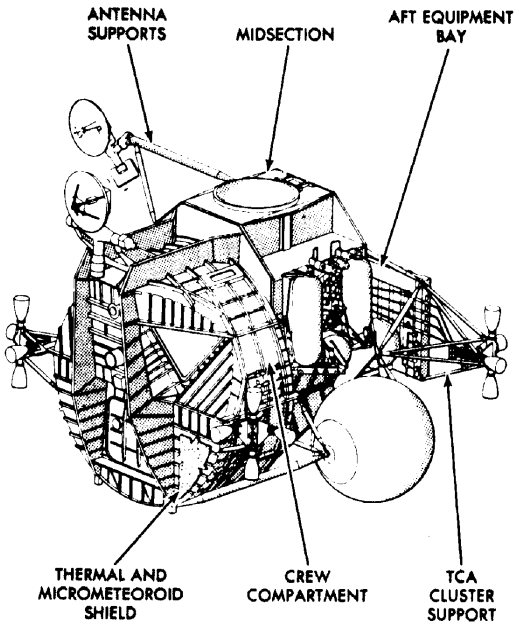
LM Configuration



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Ascent Stage Structure

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