SPECIAL HONORS: Awarded the Distinguished Flying Cross with one Oak Leaf Cluster, the Air Medal with two Oak Leaf Clusters, the Air Force Commendation Medal, the NASA Exceptional Service Medal and Air Force Command Pilot Astronaut Wings, the NASA Group Achievement Award for Rendezvous Operations Planning Team, an Honorary Life Membership in the International Association of Machinists and Aerospace Workers, and an Honorary Membership in the Aerospace Medical Association.

EXPERIENCE: Aldrin, an Air Force Colonel, was graduated third in a class of 475 from the United States Military Academy at West Point in 1951 and subsequently received his wings at Bryan, Texas, in 1952.

He flew 66 combat missions in F-86 aircraft while on duty in Korea with the 51st Fighter Interceptor Wing and was credited with destroying two MIG-15 aircraft. At Nellis Air Force Base, Nevada, he served as an aerial gunnery instructor and then attended the Squadron Officers' School at the Air University, Maxwell Air Force Base, Alabama.

Following his assignment as Aide to the Dean of Faculty at the United States Air Force Academy, Aldrin Flew F-100 aircraft as a flight commander with the 36th Tactical Fighter Wing at Bitburg, Germany. He attended MIT, receiving a doctorate after completing his thesis concerning guidance for manned orbital rendezvous, and was then assigned to the Gemini Target Office of the Air Force Space Systems Division, Los Angeles, Calfornia. He was later transferred to the USAF Field Office at the Manned Spacecraft Center which was responsible for integrating DOD experiments into the NASA Gemini flights.

He has logged approximately 3,500 hours flying time, including 2,853 hours in jet aircraft and 139 hours in helicopters. He has made several flights in the lunar landing research vehicle.

CURRENT ASSIGNMENT: Colonel Aldrin was one of the third group of astronauts named by NASA in October 1963. He has since served as backup pilot for the Gemini 9 mission and prime pilot for the Gemini 12 mission.

On November 11, 1966, he and command pilot James Lovell were launched into space in the Gemini 12 spacecraft on a 4-day 59-revolution flight which brought the Gemini Program to a successful close. Aldrin established a new record for extravehicular activity (EVA) by accruing slightly more than $5\frac{1}{2}$ hours outside the spacecraft. During the umbilical EVA, he attached a tether to the Agena; retrieved a micro-meteorite experiment package from the spacecraft; and evaluated the use of body restraints specially designed for completing work tasks outside the spacecraft. He completed numerous photographic experiments and obtained the first pictures taken from space of an eclipse of the sun.

Other major accomplishments of the 94-hour 35-minute flight included a third-revolution rendezvous with the previously launched Agena, using for the first time backup onboard computations due to a radar failure, and a fully automatic controlled reentry of a spacecraft. Gemini 12 splashed down in the Atlantic within $2\frac{1}{2}$ miles of the prime recovery ship USS WASP.

Aldrin is currently assigned as lunar module pilot for the Apollo 11 flight. The annual pay and allowances of an Air Force colonel with Aldrin's time in service total $18,622.56.

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June 1969

EARLY APOLLO SCIENTIFIC EXPERIMENTS PACKAGE (EASEP)

The Apollo 11 scientific experiments for deployment on the lunar surface near the touchdown point of the lunar module are stowed in the LM's scientific equipment bay at the left rear quadrant of the descent stage looking forward.

The Early Apollo Scientific Experiments Package (EASEP) will be carried only on Apollo 11; subsequent Apollo lunar landing missions will carry the more comprehensive Apollo Lunar Surface Experiment Package (ALSEP).

EASEP consists of two basic experiments: the passive seismic experiments package (PSEP) and the laser ranging retro-reflector (LRRR). Both experiments are independent, self-contained packages that weigh a total of about 170 pounds and occupy 12 cubic feet of space.

PSEP uses three long-period seismometers and one short-period vertical seismometer for measuring meteoroid impacts and moonquakes. Such data will be useful in determining the interior structure of the Moon; for example, does the Moon have a core and mantle like Earth.

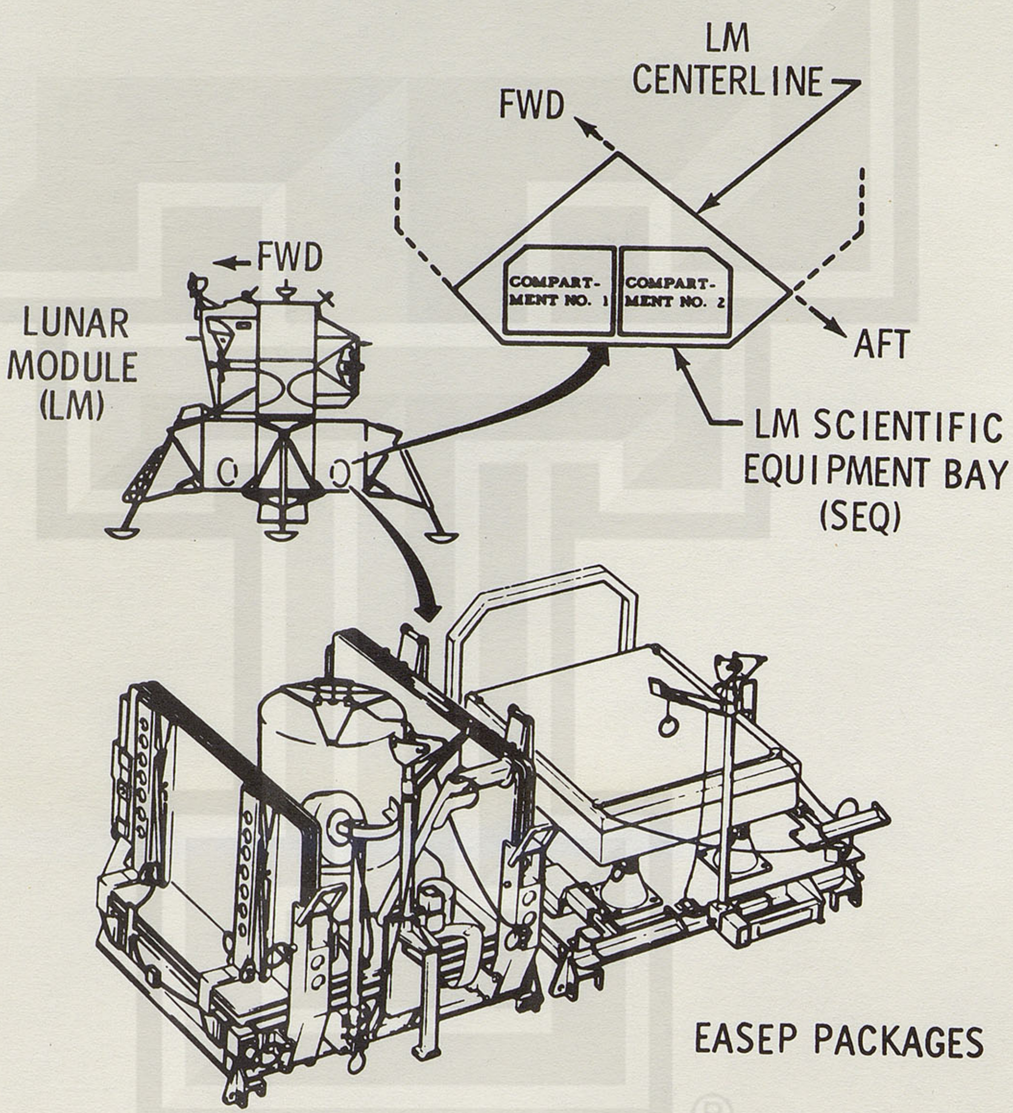
The seismic experiment package has four basic subsystems: structure/thermal subsystem for shock, vibration and thermal protection; electrical power subsystem generates 34 to 46 watts by solar panel array; data subsystem receives and decodes MSFN uplink commands and downlinks experiment data, handles power switching tasks; passive seismic experiment subsystem measures lunar seismic activity with long-period and short-period seismometers which detect inertial mass displacement.

The laser ranging retro-reflector experiment is a retro-reflector array with a folding support structure for aiming and aligning the array toward Earth. The array is built of cubes of fused silica. Laser ranging beams from Earth will be reflected back to their point of origin for precise measurement of Earth-Moon distances, motion of the Moon's center of mass, lunar radius and Earth geophysical information.

Earth stations which will beam lasers to the LRRR include the McDonald Observatory at Ft. Davis, Tex.; Lick Observatory, Mt. Hamilton, Calif.; and the Catalina Station of the University of Arizona. Scientists in other countries also plan to bounce laser beams off the LRRR.

Principal investigators for these experiments are Dr. C. O. Alley, University of Maryland (Laser Ranging Retro Feflector) and Dr. Garry Latham, Lamont Geological Observatory (Passive Seismic Experiments Package).

EASEP/LM INTERFACE



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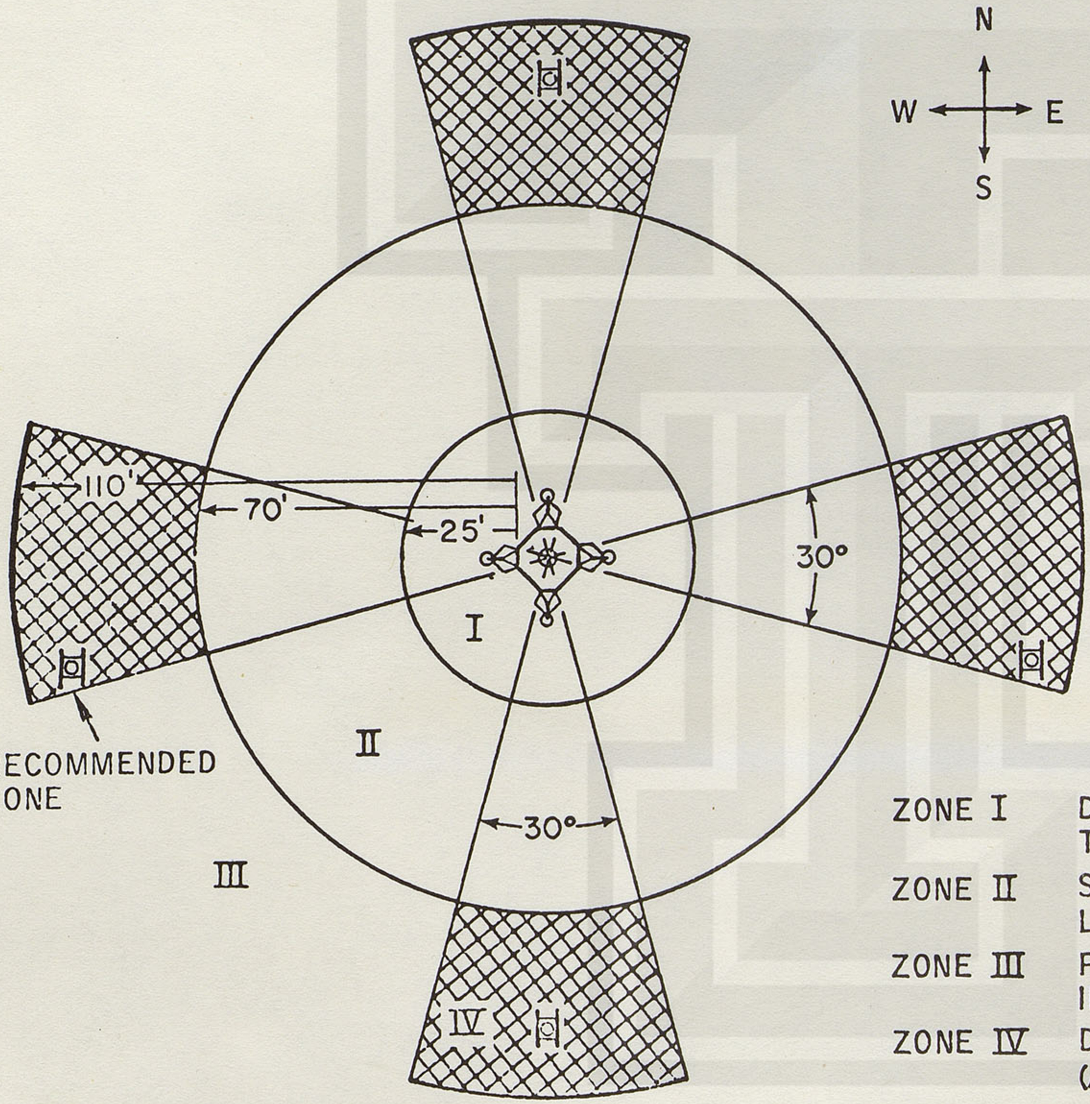
EASEP DEPLOYMENT ZONES



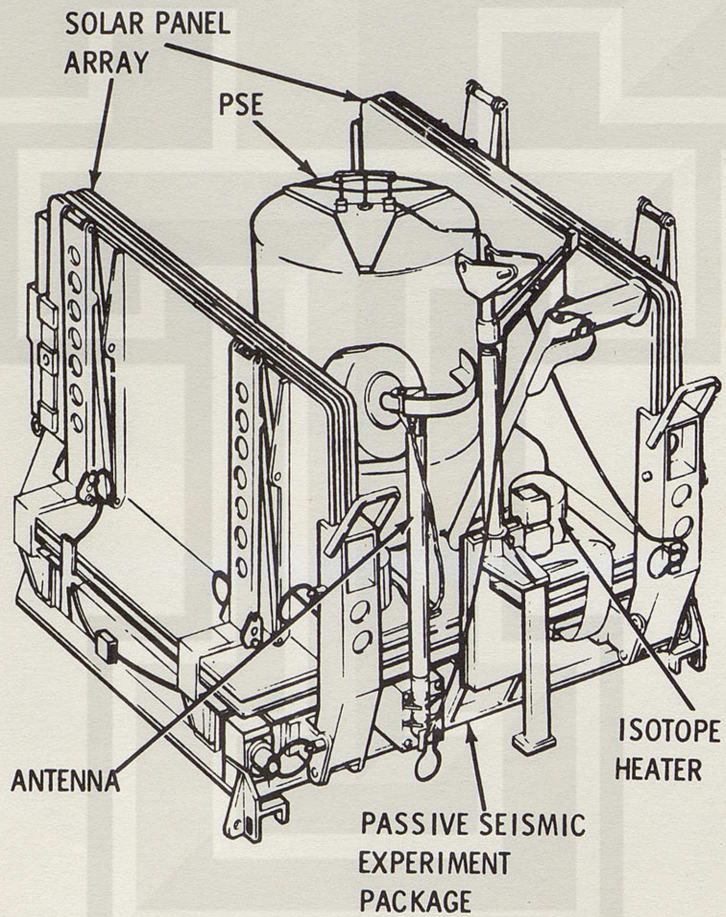
ZONE I — DEPLOYMENT OF EASEP RESTRICTED BY THERMAL RADIATION FROM THE LM

ZONE II — SIGNIFICANT AERODYNAMIC HEATING FROM LM ASCENT ENGINE PLUME

ZONE III — POSSIBLE CONTAMINATION BY KAPTON AND INCONEL DEBRIS

ZONE IV — DESIRABLE DEPLOYMENT ZONES (AVOID LM SHADOW)

PSEP STOWED CONFIGURATION



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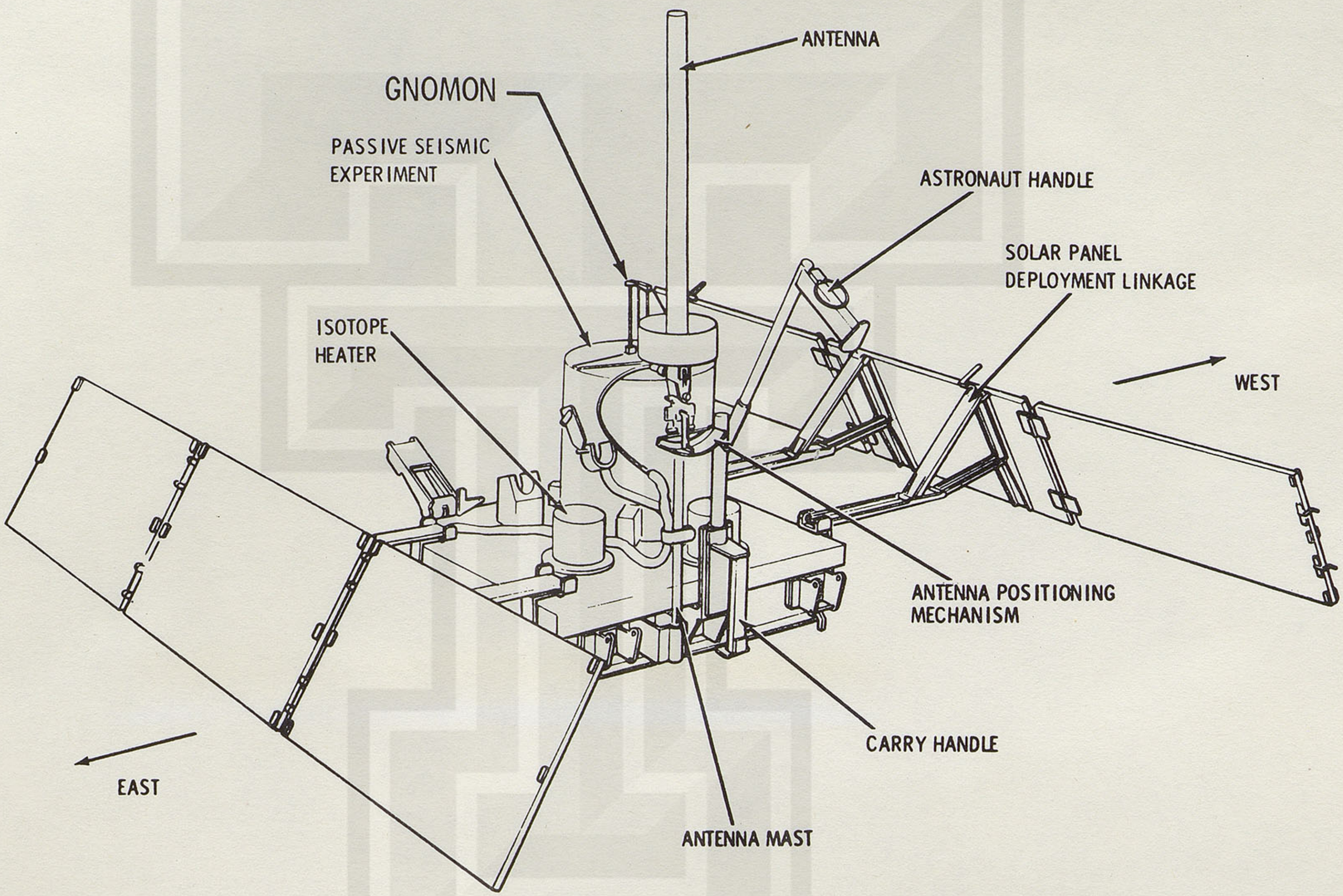
PSEP DEPLOYED CONFIGURATION



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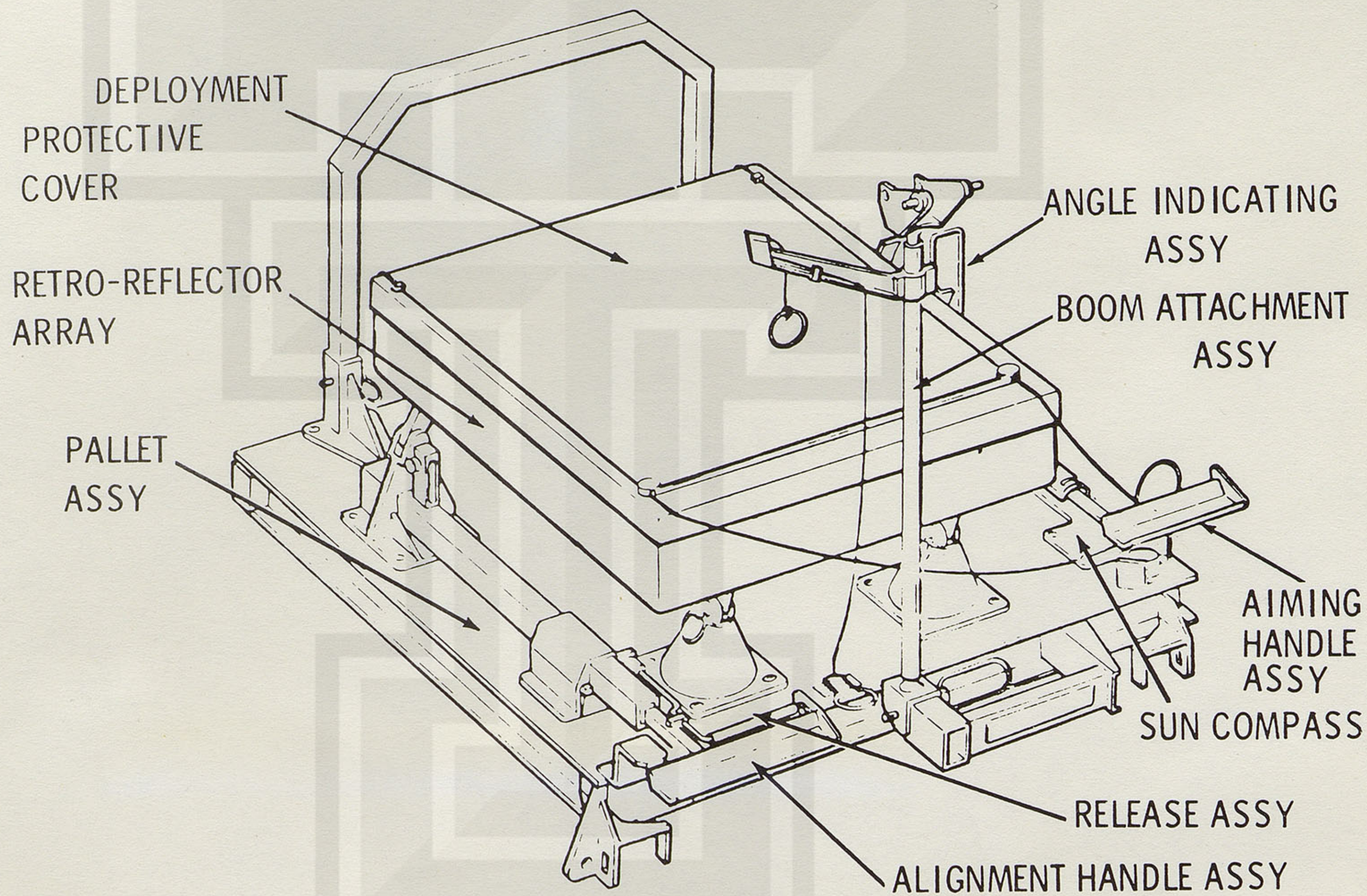
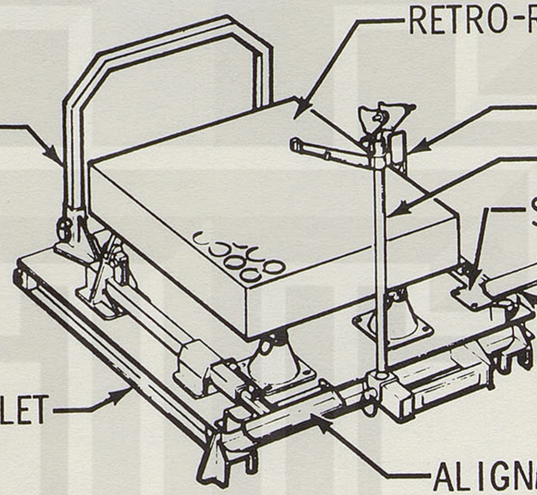
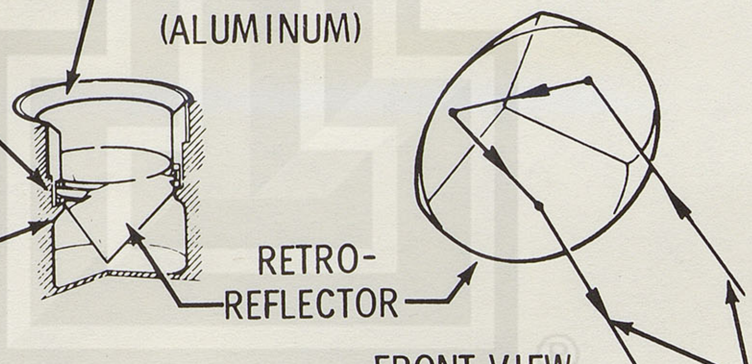
LASER RANGING RETRO-REFLECTOR EXPERIMENT



LRRR DETAILS





SOLAR WIND EXPERIMENT

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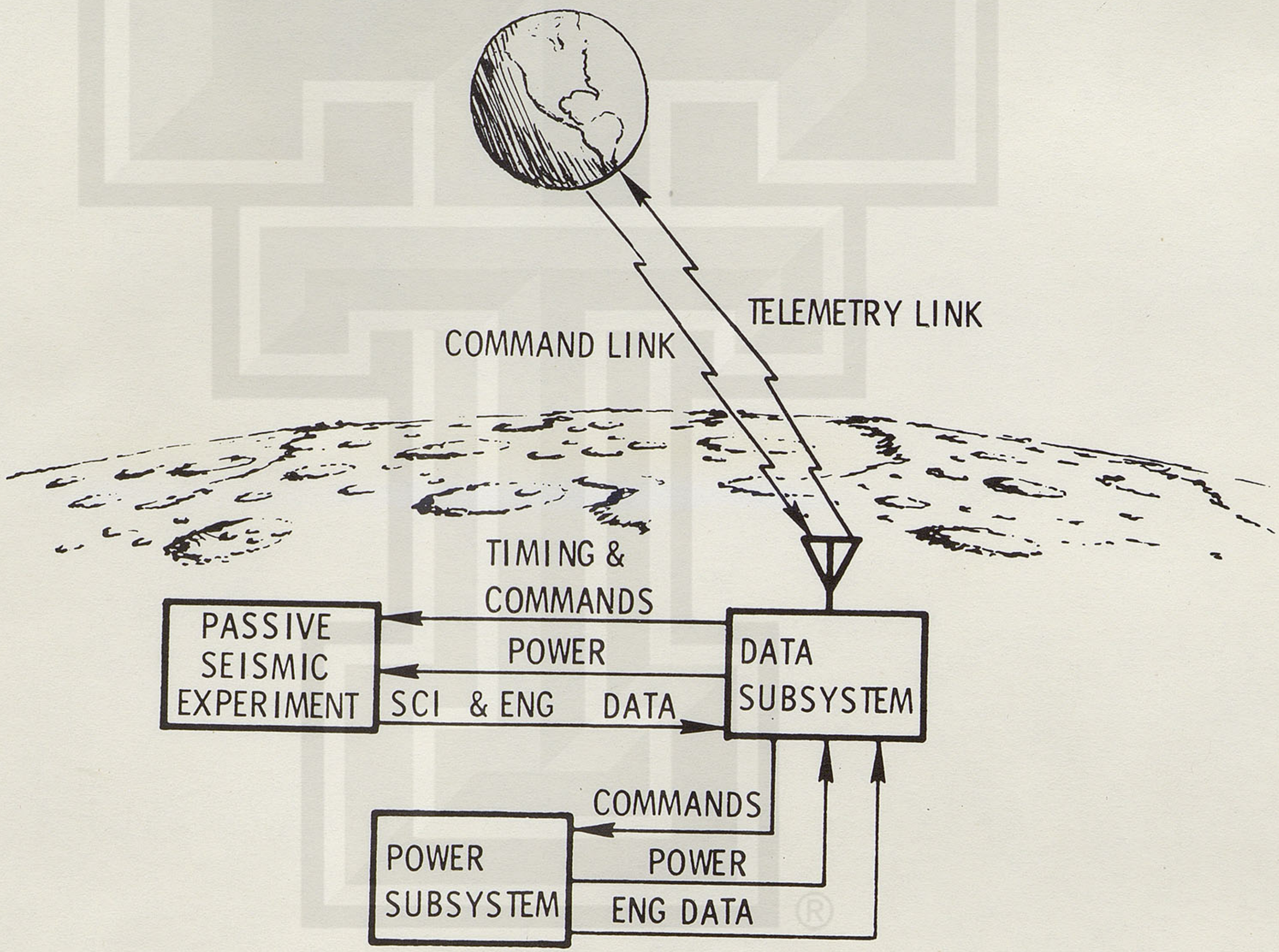
COMMAND AND TELEMETRY LINKS



APOLLO LUNAR RADIOISOTOPIC HEATER (ALRH)

An isotopic heater system built into the passive seismometer experiment package which Apollo 11 astronauts will leave on the Moon will protect the seismic recorder during frigid lunar nights.

The Apollo Lunar Radioisotopic Heater (ALRH), developed by the Atomic Energy Commission, will be the first major use of nuclear energy in a manned space flight mission. Each of the two heaters is fueled with about 1.2 ounces of plutonium 238. Heat is given off as the well shielded radioactive material decays.

During the lunar day, the seismic device will send back to Earth data on any lunar seismic activity or "Moonquakes." During the 340-hour lunar night, when temperatures drop as low as 279 degrees below zero F., the 15-watt heaters will keep the seismometer at a minimum of -65 degrees below zero F. Exposure to lowr temperatures would damage the device.

Power for the seismic experiment, which operates only during the day, is from two solar panels.

The heaters are three inches in diameter, three inches long, and weigh two pounds and two ounces each including multiple layers of shielding and protective materials. The complete seismometer package weighs 100 pounds.

They are mounted into the seismic package before launch. The entire unit will be carried in the lunar module scientific equipment bay and after landing on the Moon will be deployed by an astronaut a short distance from the lunar vehicle. There is no handling risk to the astronaut.

They are mounted into the seismic package before launch. The entire unit will be carried in the lunar module scientific by an astronaut a short distance from the lunar vehicle. There is no handling risk to the astronaut.

The plutonium fuel is encased in various materials chosen for radiation shielding and for heat and shock resistance. The materials include a tantalum-tungsten alloy, a platinum-rhodium alloy, titanium, fibrous carbon, and graphite. The outside layer is stainless steel.

Extensive safety analyses and tests were performed by Sandia Laboratories at Albuquerque, New Mexico, to determine effects of an abort or any conceivable accident in connection with the Moon flight. The safety report by the Interagency Safety Evaluation Panel, which is made up of representatives of NASA, the AEC, and the Department of Defense, concluded that the heater presents no undue safety problem to the general population under any accident condition deemed possible for the Apollo mission.

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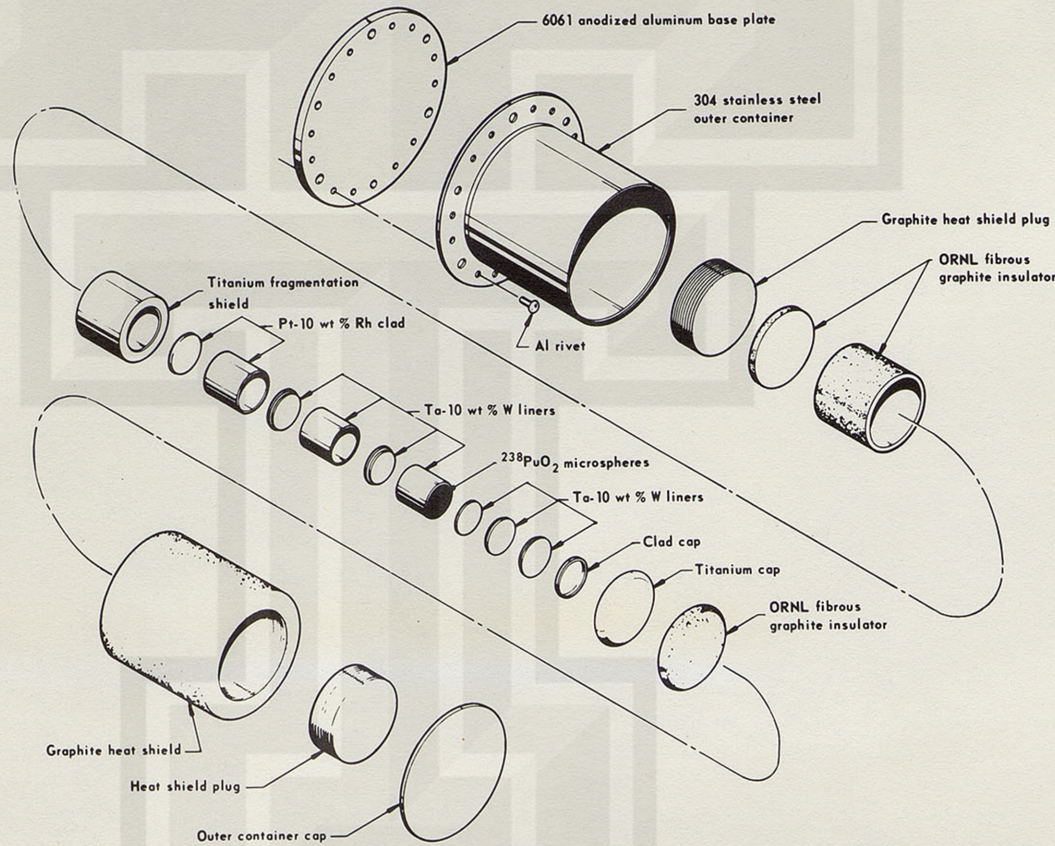
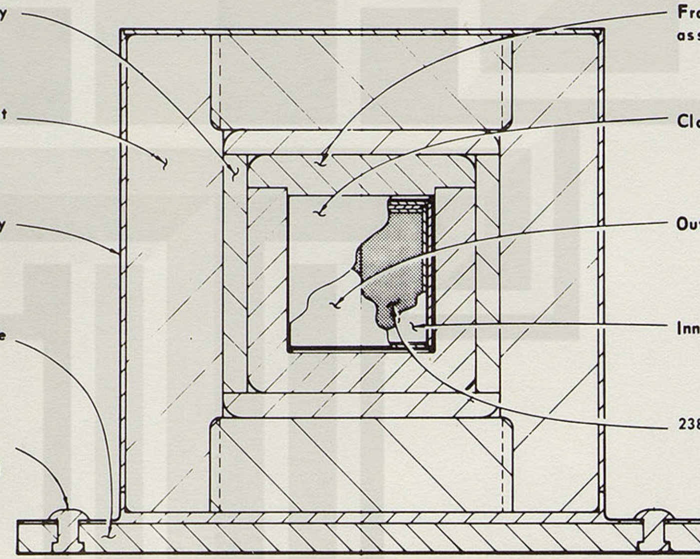


EXPLODED VIEW, APOLLO LUNAR RADIOISOTOPIC HEATER



THE APOLLO LUNAR RADIOISOTOPIC HEATER

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Sandia Laboratories is operated for the AEC by Western Electric Company. The heater was fabricated by AEC's Mound Laboratory at Miamisburg, Ohio, which is operated by Monsanto Research Corporation.

The first major use of nuclear energy in space came in 1961 with the launching of a navigation satellite with an isotopic generator. Plutonium 238 fuels the device which is still operating. Two similar units were launched in 1961 and two more in 1963.

Last April, NASA launched Nimbus III, a weather satellite with a 2-unit nuclear isotopic system for generating electrical power. The Systems for Nuclear Auxiliary Power (SNAP-19) generator, developed by AEC, provides supplementary power.

Apollo 12 is scheduled to carry a SNAP-27 radioisotope thermoelectric generator, also developed by AEC, to provide power to operate the Apollo Lunar Surface Experiments Package (ALSEP). The SNAP-27 also contains plutonium 238 as the heat source. Thermoelectric elements convert this heat directly into electrical energy.

APOLLO LAUNCH OPERATIONS

Prelaunch Preparations

NASA's John F. Kennedy Space Center performs preflight checkout, test and launch of the Apollo 11 space vehicle. A government-industry team of about 500 will conduct the final countdown from Firing Room 1 of the Launch Control Center (LCC).

The firing room team is backed up by more than 5,000 persons who are directly involved in launch operations at KSC from the time the vehicle and spacecraft stages arrive at the Center until the launch is completed.

Initial checkout of the Apollo spacecraft is conducted in work stands and in the altitude chambers in the Manned Spacecraft Operations Building (MSOB) at Kennedy Space Center. After completion of checkout there, the assembled spacecraft is taken to the Vehicle Assembly Building (VAB) and mated with the launch vehicle. There the first integrated spacecraft and launch vehicle tests are conducted. The assembled space vehicle is then rolled out to the launch pad for final preparations and countdown to launch.

In early January, 1969, flight hardware for Apollo 11 began arriving at Kennedy Space Center, just as Apollo 9 and Apollo 10 were undergoing checkout at KSC.

The lunar module was the first piece of Apollo 11 flight hardware to arrive at KSC. The two stages of the LM were moved into the altitude chamber in the Manned Spacecraft Operations Building after an initial receiving inspection in January. In the chamber the LM underwent systems tests and both unmanned and manned chamber runs. During these runs the chamber air was pumped out to simulate the vacuum of space at altitudes in excess of 200,000 feet. There the spacecraft systems and the astronauts' life support systems were tested.

While the LM was undergoing preparation for its manned altitude chamber runs, the Apollo 11 command/service module arrived at KSC and after receiving inspection, it, too, was placed in an altitude chamber in the MSOB for systems tests and unmanned and manned chamber runs. The prime and backup crews participated in the chamber runs on both the LM and the CSM.

In early April, the LM and CSM were removed from the chambers. After installing the landing gear on the LM and the SPS engine nozzle on the CSM, the LM was encapsulated in the spacecraft LM adapter (SLA) and the CSM was mated to the SLA. On April 14, the assembled spacecraft was moved to the VAB where it was mated to the launch vehicle.

The launch vehicle flight hardware began arriving at KSC in mid-January and by March 5 the three stages and the instrument unit were erected on Mobile Launcher 1 in high bay 1. Tests were conducted on individual systems on each of the stages and on the overall launch vehicle before the spacecraft was erected atop the vehicle.

After spacecraft erection, the spacecraft and launch vehicle were electrically mated and the first overall test (plugs-in) of the space vehicle was conducted. In accordance with the philosophy of accomplishing as much of the checkout as possible in the VAB, the overall test was conducted before the space vehicle was moved to the launch pad.

The plugs-in test verified the compatibility of the space vehicle systems, ground support equipment and off-site support facilities by demonstrating the ability of the systems to proceed through a simulated countdown, launch and flight. During the simulated flight portion of the test, the systems were required to respond to both emergency and normal flight conditions.

The move to Pad A from the VAB on May 21 occurred while Apollo 10 was enroute to the Moon for a dress rehearsal of a lunar landing mission and the first test of a complete spacecraft in the near-lunar environment.

Apollo 11 will mark the fifth launch at Pad A on Complex 39. The first two unmanned Saturn V launches and the manned Apollo 8 and 9 launches took place at Pad A. Apollo 10 was the only launch to date from Pad B.

The space vehicle Flight Readiness Test was conducted June 4-6. Both the prime and backup crews participate in portions of the FRT, which is a final overall test of the space vehicle systems and ground support equipment when all systems are as near as possible to a launch configuration.

After hypergolic fuels were loaded aboard the space vehicle and the launch vehicle first stage fuel (RP-1) was brought aboard, the final major test of the space vehicle began. This was the countdown demonstration test (CDDT), a dress rehearsal for the final countdown to launch. The CDDT for Apollo 11 was divided into a "wet" and a "dry" portion. During the first, or "wet" portion, the entire countdown, including propellant loading, was carried out down to T-8.9 seconds, the time for ignition sequence start. The astronaut crew did not participate in the wet CDDT.

At the completion of the wet CDDT, the cryogenic propellants (liquid oxygen and liquid hydrogen) were off-loaded, and the final portion of the countdown was re-run, this time simulating the fueling and with the prime astronaut crew participating as they will on launch day.

By the time Apollo 11 was entering the final phase of its checkout procedure at Complex 39A, crews had already started the checkout of Apollo 12 and Apollo 13. The Apollo 12 spacecraft completed altitude chamber testing in June and was later mated to the launch vehicle in the VAB. Apollo 13 flight hardware began arriving in June to undergo preliminary checkout.

Because of the complexity involved in the checkout of the 363-foot-tall (110.6 meters) Apollo/Saturn V configuration, the launch teams make use of extensive automation in their checkout. Automation is one of the major differences in checkout used in Apollo compared to the procedures used in the Mercury and Gemini programs.

Computers, data display equipment and digital data techniques are used throughout the automatic checkout from the time the launch vehicle is erected in the VAB through liftoff. A similar, but separate computer operation called ACE (Acceptance Checkout-Equipment) is used to verify the flight readiness of the spacecraft. Spacecraft checkout is controlled from separate rooms in the Manned Spacecraft Operations Building.

LAUNCH COMPLEX 39

Launch Complex 39 facilities at the Kennedy Space Center were planned and built specifically for the Apollo Saturn V, the space vehicle that will be used to carry astronauts to the Moon.

Complex 39 introduced the mobile concept of launch operations, a departure from the fixed launch pad techniques used previously at Cape Kennedy and other launch sites. Since the early 1950's when the first ballistic missiles were launched, the fixed launch concept had been used on NASA missions. This method called for assembly, checkout and launch of a rocket at one site--the launch pad. In addition to tying up the pad, this method also often left the flight equipment exposed to the outside influences of the weather for extended periods.

Using the mobile concept, the space vehicle is thoroughly checked in an enclosed building before it is moved to the launch pad for final preparations. This affords greater protection, a more systematic checkout process using computer techniques and a high launch rate for the future, since the pad time is minimal.

Saturn V stages are shipped to the Kennedy Space Center by ocean-going vessels and specially designed aircraft, such as the Guppy. Apollo spacecraft modules are transported by air. The spacecraft components are first taken to the Manned Spacecraft Operations Building for preliminary checkout. The Saturn V stages are brought immediately to the Vehicle Assembly Building after arrival at the nearby turning basin.

The major components of Complex 39 include: (1) the Vehicle Assembly Building (VAB) where the Apollo 11 was assembled and prepared; (2) the Launch Control Center, where the launch team conducts the preliminary checkout and final countdown; (3) the mobile launcher, upon which the Apollo 11 was erected for checkout and from where it will be launched; (4) the mobile service structure, which provides external access to the space vehicle at the pad; (5) the transporter, which carries the space vehicle and mobile launcher, as well as the mobile service structure to the pad; (6) the crawlerway over which the space vehicle travels from the VAB to the launch pad; and (7) the launch pad itself.

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Vehicle Assembly Building

The Vehicle Assembly Building is the heart of Launch Complex 39. Covering eight acres, it is where the 363-foot-tall space vehicle is assembled and tested.

The VAB contains 129,482,000 cubic feet of space. It is 716 feet long, and 518 feet wide and it covers 343,500 square feet of floor space.

The foundation of the VAB rests on 4,225 steel pilings, each 16 inches in diameter, driven from 150 to 170 feet to bedrock. If placed end to end, these pilings would extend a distance of 123 miles. The skeletal structure of the building contains approximately 60,000 tons of structural steel. The exterior is covered by more than a million square feet of insulated aluminum siding.

The building is divided into a high bay area 525 feet high and a low bay area 210 feet high, with both areas serviced by a transfer aisle for movement of vehicle stages.

The low bay work area, approximately 442 feet wide and 274 feet long, contains eight stage-preparation and checkout cells. These cells are equipped with systems to simulate stage interface and operation with other stages and the instrument unit of the Saturn V launch vehicle.

After the Apollo 11 launch vehicle upper stages arrived at Kennedy Space Center, they were moved to the low bay of the VAB. Here, the second and third stages underwent acceptance and checkout testing prior to mating with the S-IC first stage atop the Mobile Launcher in the high bay area.

The high bay provides facilities for assembly and checkout of both the launch vehicle and spacecraft. It contains four separate bays for vertical assembly and checkout. At present, three bays are equipped, and the fourth will be reserved for possible changes in vehicle configuration.

Work platforms -- some as high as three-story buildings -- in the high bays provide access by surrounding the vehicle at varying levels. Each high bay has five platforms. Each platform consists of two bi-parting sections that move in from opposite sides and mate, providing a 360-degree access to the section of the space vehicle being checked.

A 10,000-ton-capacity air conditioning system, sufficient to cool about 3,000 homes, helps to control the environment within the entire office, laboratory, and workshop complex located inside the low bay area of the VAB. Air conditioning is also fed to individual platform levels located around the vehicle.

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There are 141 lifting devices in the VAB, ranging from one-ton hoists to two 250-ton high-lift bridge cranes.

The mobile launchers, carried by transporter vehicles, move in and out of the VAB through four doors in the high bay area, one in each of the bays. Each door is shaped like an inverted T. They are 152 feet wide and 114 feet high at the base, narrowing to 76 feet in width. Total door height is 456 feet.

The lower section of each door is of the aircraft hangar type that slides horizontally on tracks. Above this are seven telescoping vertical lift panels stacked one above the other, each 50 feet high and driven by an individual motor. Each panel slides over the next to create an opening large enough to permit passage of the mobile launcher.

Launch Control Center

Adjacent to the VAB is the Launch Control Center (LCC). This four-story structure is a radical departure from the dome-shaped blockhouses at other launch sites.

The electronic "brain" of Launch Complex 39, the LCC was used for checkout and test operations while Apollo 11 was being assembled inside the VAB. The LCC contains display, monitoring, and control equipment used for both checkout and launch operations.

The building has telemeter checkout stations on its second floor, and four firing rooms, one for each high bay of the VAB, on its third floor. Three firing rooms contain identical sets of control and monitoring equipment, so that launch of a vehicle and checkout of others take place simultaneously. A ground computer facility is associated with each firing room.

The high speed computer data link is provided between the LCC and the mobile launcher for checkout of the launch vehicle. This link can be connected to the mobile launcher at either the VAB or at the pad.

The three equipped firing rooms have some 450 consoles which contain controls and displays required for the checkout process. The digital data links connecting with the high bay areas of the VAB and the launch pads carry vast amounts of data required during checkout and launch.

There are 15 display systems in each LCC firing room, with each system capable of providing digital information instantaneously.

Sixty television cameras are positioned around the Apollo/ Saturn V transmitting pictures on 10 modulated channels. The LCC firing room also contains 112 operational intercommunication channels used by the crews in the checkout and launch countdown.

Mobile Launcher

The mobile launcher is a transportable launch base and umbilical tower for the space vehicle. Three mobile launchers are used at Complex 39.

The launcher base is a two-story steel structure, 25 feet high, 160 feet long, and 135 feet wide. It is positioned on six steel pedestals 22 feet high when in the VAB or at the launch pad. At the launch pad, in addition to the six steel pedestals, four extendable columns also are used to stiffen the mobile launcher against rebound loads, if the Saturn engines cut off.

The umbilical tower, extending 398 feet above the launch platform, is mounted on one end of the launcher base. A hammerhead crane at the top has a hook height of 376 feet above the deck with a traverse radius of 85 feet from the center of the tower.

The 12-million-pound mobile launcher stands 445 feet high when resting on its pedestals. The base, covering about half an acre, is a compartmented structure built of 25-foot steel girders.

The launch vehicle sits over a 45-foot-square opening which allows an outlet for engine exhausts into the launch pad trench containing a flame deflector. This opening is lined with a replaceable steel blast shield, independent of the structure, and is cooled by a water curtain initiated two seconds after liftoff.

There are nine hydraulically-operated service arms on the umbilical tower. These service arms support lines for the vehicle umbilical systems and provide access for personnel to the stages as well as the astronaut crew to the spacecraft.

On Apollo 11, one of the service arms is retracted early in the count. The Apollo spacecraft access arm is partially retracted at T-43 minutes. A third service arm is released at T-30 seconds, and a fourth at about T-16.5 seconds. The remaining five arms are set to swing back at vehicle first motion after T-0.

The service arms are equipped with a backup retraction system in case the primary mode fails.

The Apollo access arm (service arm 9), located at the 320-foot level above the launcher base, provides access to the spacecraft cabin for the closeout team and astronaut crews. The flight crew will board the spacecraft starting about T-2 hours, 40 minutes in the count. The access arm will be moved to a parked position, 12 degrees from the spacecraft, at about T-43 minutes. This is a distance of about three feet, which permits a rapid reconnection of the arm to the spacecraft in the event of an emergency condition. The arm is fully retracted at the T-5 minute mark in the count.

The Apollo 11 vehicle is secured to the mobile launcher by four combination support and hold-down arms mounted on the launcher deck. The hold-down arms are cast in one piece, about 6 x 9 feet at the base and 10 feet tall, weighing more than 20 tons. Damper struts secure the vehicle near its top.

After the engines ignite, the arms hold Apollo 11 for about six seconds until the engines build up to 95 percent thrust and other monitored systems indicate they are functioning properly. The arms release on receipt of a launch commit signal at the zero mark in the count. But the vehicle is prevented from accelerating too rapidly by controlled release mechanisms.

The mobile launcher provides emergency egress for the crew and closeout service personnel. Personnel may descend the tower via two 600-feet per minute elevators or by a slide-wire and cab to a bunker 2,200 feet from the launcher. If high speed elevators are utilized to level A of the launcher, two options are then available. The personnel may slide down the escape tube to the blast room below the pad or take elevator B to the bottom of the pad and board armored personnel carriers and depart the area.

Transporter

The six-million-pound transporters move mobile launchers into the VAB and mobile launchers with assembled Apollo space vehicles to the launch pad. They also are used to transfer the mobile service structure to and from the launch pads. Two transporters are in use at Complex 39.

The transporter is 131 feet long and 114 feet wide. The vehicle moves on four double-tracked crawlers, each 10 feet high and 40 feet long. Each shoe on the crawler track is seven feet six inches in length and weighs about a ton.

Sixteen traction motors powered by four 1,000-kilowatt generators, which in turn are driven by two 2,750-horsopower diesel engines, provide the motive power for the transporter. Two 750-kw generators, driven by two 1,065-horsepower diesel engines, power the jacking, steering, lighting, ventilating and electronic systems.

Maximum speed of the transporter is about one-mile-per-hour loaded and about two-miles-per-hour unloaded. The 3.5 mile trip to Pad A with Apollo 11 on its mobile launcher took about six hours since maximum speed is not maintained throughout the trip.

The transporter has a leveling system designed to keep the top of the space vehicle vertical within plus-or-minus 10 minutes of arc -- about the dimensions of a basketball.

This system also provides leveling operations required to negotiate the five percent ramp which leads to the launch pad and keeps the load level when it is raised and lowered on pedestals both at the pad and within the VAB.

The overall height of the transporter is 20 feet from ground level to the top deck on which the mobile launcher is mated for transportation. The deck is flat and about the size of a baseball diamond (90 by 90 feet).

Two operator control cabs, one at each end of the chassis located diagonally opposite each other, provide totally enclosed stations from which all operating and control functions are coordinated.

Crawlerway

The transporter moves on a roadway 131 feet wide, divided by a median strip. This is almost as broad as an eight-lane turnpike and is designed to accommodate a combined weight of about 18 million pounds.

The roadway is built in three layers with an average depth of seven feet. The roadway base layer is two-and-one-half feet of hydraulic fill compacted to 95 percent density. The next layer consists of three feet of crushed rock packed to maximum density, followed by a layer of one foot of selected hydraulic fill. The bed is topped and sealed with an asphalt prime coat.

On top of the three layers is a cover of river rock, eight inches deep on the curves and six inches deep on the straightway. This layer reduces the friction during steering and helps distribute the load on the transporter bearings.

Mobile Service Structure

A 402-foot-tall, 9.8-million-pound tower is used to service the Apollo launch vehicle and spacecraft at the pad. The 40-story steel-trussed tower, called a mobile service structure, provides 360-degree platform access to the Saturn launch vehicle and the Apollo spacecraft.

The service structure has five platforms -- two self-propelled and three fixed, but movable. Two elevators carry personnel and equipment between work platforms. The platforms can open and close around the 363-foot space vehicle.

After depositing the mobile launcher with its space vehicle on the pad, the transporter returns to a parking area about 7,000 feet from pad A. There it picks up the mobile service structure and moves it to the launch pad. At the pad, the huge tower is lowered and secured to four mount mechanisms.

The top three work platforms are located in fixed positions which serve the Apollo spacecraft. The two lower movable platforms serve the Saturn V.

The mobile service structure remains in position until about T-11 hours when it is removed from its mounts and returned to the parking area.

Water Deluge System

A water deluge system will provide a million gallons of industrial water for cooling and fire prevention during launch of Apollo 11. Once the service arms are retracted at liftoff, a spray system will come on to cool these arms from the heat of the five Saturn F-1 engines during liftoff.

On the deck of the mobile launcher are 29 water nozzles. This deck deluge will start immediately after liftoff and will pour across the face of the launcher for 30 seconds at the rate of 50,000 gallons-per-minute. After 30 seconds, the flow will be reduced to 20,000 gallons-per-minute.

Positioned on both sides of the flame trench are a series of nozzles which will begin pouring water at 8,000 gallons-per-minute, 10 seconds before liftoff. This water will be directed over the flame deflector.

Other flush mounted nozzles, positioned around the pad, will wash away any fluid spill as a protection against fire hazards.

Water spray systems also are available along the egress route that the astronauts and closeout crews would follow in case an emergency evacuation was required.

Flame Trench and Deflector

The flame trench is 58 feet wide and approximately six feet above mean sea level at the base. The height of the trench and deflector is approximately 42 feet.

The flame deflector weighs about 1.3 million pounds and is stored outside the flame trench on rails. When it is moved beneath the launcher, it is raised hydraulically into position. The deflector is covered with a four-and-one-half-inch thickness of refractory concrete consisting of a volcanic ash aggregate and a calcium aluminate binder. The heat and blast of the engines are expected to wear about three-quarters of an inch from this refractory surface during the Apollo 11 launch.

Pad Areas

Both Pad A and Pad B of Launch Complex 39 are roughly octagonal in shape and cover about one fourth of a square mile of terrain.

The center of the pad is a hardstand constructed of heavily reinforced concrete. In addition to supporting the weight of the mobile launcher and the Apollo Saturn V vehicle, it also must support the 9.8-million-pound mobile service structure and 6-million-pound transporter, all at the same time. The top of the pad stands some 48 feet above sea level.

Saturn V propellants -- liquid oxygen, liquid hydrogen and RP-1 -- are stored near the pad perimeter.

Stainless steel, vacuum-jacketed pipes carry the liquid oxygen (LOX) and liquid hydrogen from the storage tanks to the pad, up the mobile launcher, and finally into the launch vehicle propellant tanks.

LOX is supplied from a 900,000-gallon storage tank. A centrifugal pump with a discharge pressure of 320 pounds-per-square-inch pumps LOX to the vehicle at flow rates as high as 10,000-gallons-per-minute.

Liquid hydrogen, used in the second and third stages, is stored in an 850,000-gallon tank, and is sent through 1,500 feet of 10-inch, vacuum-jacketed invar pipe. A vaporizing heat exchanger pressurizes the storage tank to 60 psi for a 10,000 gallons-per-minute flow rate.

The RP-1 fuel, a high grade of kerosene is stored in three tanks--each with a capacity of 86,000 gallons. It is pumped at a rate of 2,000 gallons-per-minute at 175 psig.

The Complex 38 pneumatic system includes a converter-compressor facility, a pad high-pressure gas storage battery, a high-pressure storage battery in the VAB, low and high-pressure, cross-country supply lines, high-pressure hydrogen storage and conversion equipment, and pad distribution piping to pneumatic control panels. The various purging systems require 187,000 pounds of liquid nitrogen and 21,000 gallons of helium.

Mission Control Center

The Mission Control Center at the Manned Spacecraft Center, Houston, is the focal point for Apollo flight control activities. The center receives tracking and telemetry data from the Manned Space Flight Network, processes this data through the Mission Control Center Real-Time Computer Complex, and displays this data to the flight controllers and engineers in the Mission Operations Control Room and staff support rooms.

The Manned Space Flight Network tracking and data acquisition stations link the flight controllers at the center to the spacecraft.

For Apollo 10 all network stations will be remote sites, that is, without flight control teams. All uplink commands and voice communications will originate from Houston, and telemetry data will be sent back to Houston at high speed rates (2,400 bits-per-second), on two separate data lines. They can be either real time or playback information.

Signal flow for voice circuits between Houston and the remote sites is via commercial carrier, usually satellite, wherever possible using leased lines which are part of the NASA Communications Network.

Commands are sent from Houston to NASA's Goddard Space Flight Center, Greenbelt, Md., on lines which link computers at the two points. The Goddard communication computers provide automatic switching facilities and speed buffering for the command data. Data are transferred from Goddard to remote sites on high speed (2,400 bits-per-second) lines. Command loads also can be sent by teletype from Houston to the remote sites at 100 words-per-minute. Again, Goddard computers provide storage and switching functions.

Telemetry data at the remote site are received by the RF receivers, processed by the pulse code modulation ground stations, and transferred to the 642B remote-site telemetry computer for storage. Depending on the format selected by the telemetry controller at Houston, the 642B will send the desired format through a 2010 data trans mission unit which provides parallel to serial conversion, and drives a 2,400 bit-per-second mode.

The data mode converts the digital serial data to phase-shifted keyed tones which are fed to the high speed data lines of the communications network.

Tracking data are sent from the sites in a low speed (100 words) teletype format and a 240-bit block high speed (2,400 bits) format. Data rates are one sample-6 seconds for teletype and 10 samples (frames) per second for high speed data.

All high-speed data, whether tracking or telemetry, which originate at a remote site are sent to Goddard on high-speed lines. Goddard reformats the data when necessary and sends them to Houston in 600-bit blocks at a 40,800 bits-per-second rate. Of the 600-bit block, 480 bits are reserved for data, the other 120 bits for address, sync, intercomputer instructions, and polynominal error encoding.

All wideband 40,800 bits-per-second data originating at Houston are converted to high speed (2,400 bits-per-second) data at Goddard before being transferred to the designated remote site.

MANNED SPACE FLIGHT NETWORK

Tracking, command and communication -- Apollo 11's vital links with the Earth -- will be performed, in two broad phases.

For the first phase, the Manned Space Flight Network (MSFN) will depend largely on its worldwide chain of stations equipped with 30-foot antennas while Apollo is launched and orbiting near the Earth. The second phase begins when the spacecraft moves out more than 10,000 miles above Earth, when the 85-foot diameter antennas bring their greater power and accuracy into play.

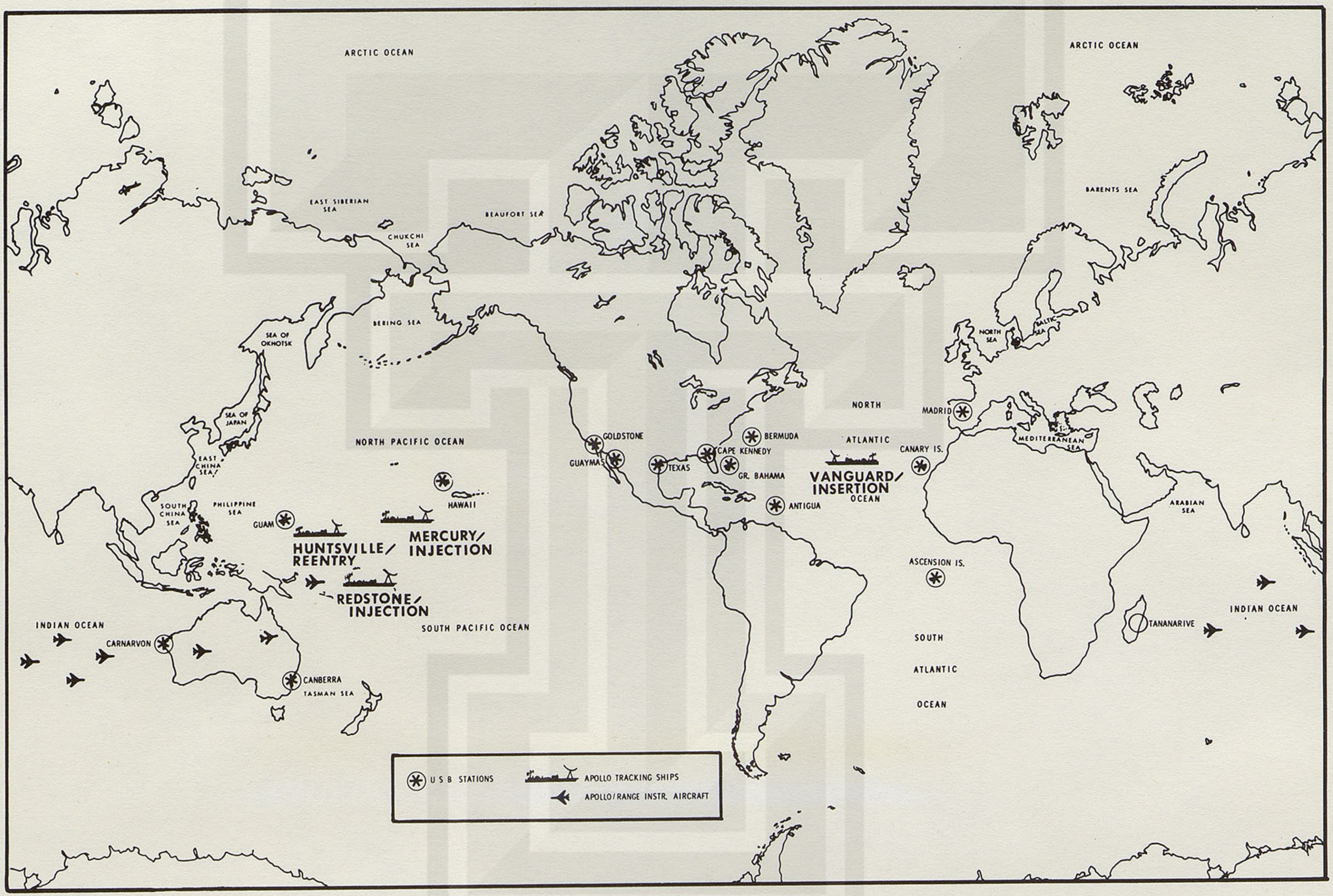
The Network must furnish reliable, instantaneous contact with the astronauts, their launch vehicle and spacecraft, from liftoff through Earth orbit, Moon landing and lunar takeoff to splashdown in the Pacific Ocean.

For Apollo 11, MSFN will use 17 ground stations, four ships and six to eight jet aircraft -- all directly or indirectly linked with Mission Control Center in Houston. While the Earth turns on its axis and the Moon travels in orbit nearly one-quarter million miles away and Apollo 11 moves between them, ground controllers will be kept in the closest possible contact. Thus, only for some 45 minutes as the spacecraft flies behind the Moon in each orbit, will this link with Earth be out of reach.

All elements of the Network get ready early in the countdown. As the Apollo Saturn V ascends, voice and data will be transmitted instantaneously to Houston. The data are sent directly through computers for visual display to flight controllers.

Depending on the launch azimuth, the 30-foot antennas will keep tabs on Apollo 11, beginning with the station at Merritt Island, thence Grand Bahama Island; Bermuda; tracking ship Vanguard; the Canary Islands; Carnarvon, Australia; Hawaii; another tracking ship; Guaymas, Mexico; and Corpus Christi, Tex.

To inject Apollo 11 into translunar flight path, Mission Control will send a signal through one of the land stations or one of the tracking ships in the Pacific. As the spacecraft heads for the Moon, the engine burn will be monitored by the ships and an Apollo range instrumentation aircraft (ARIA). The ARIA provides a relay for the astronauts' voices and data communication with Houston.



MANNED SPACE FLIGHT TRACKING NETWORK

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When the spacecraft reaches an altitude of 10,000 miles the more powerful 85-foot antennas will join in for primary support of the flight, although the 30-foot "dishes" will continue to track and record data. The 85-foot antennas are located, about 120 degrees apart, near Madrid, Spain; Goldstone, Calif.; and Canberra, Australia.

With the 120-degree spacing around the Earth, at least one of the large antennas will have the Moon in view at all times. As the Earth revolves from west to east, one 85-foot station hands over control to the next 85-foot station as it moves into view of the spacecraft. In this way, data and communication flow is maintained.

Data are relayed back through the huge antennas and transmitted via the NASA Communications Network (NASCOM) -- a two-million mile hookup of landlines, undersea cables, radio circuits and communication satellites -- to Houston. This informatin is fed into computers for visual display in Mission Control -- for example, a display of the precise position of the spacecraft on a large map. Or, returning data my indicate a drop in power or some other difficulty in a spacecraft system, which would energize a red light to alert a flight controller to action.

Returning data flowing through the Earth stations give the necessary information for commanding midcourse maneuvers to keep Apollo 11 in a proper trajectory for orbiting the Moon. After Apollo 11 is in the vicinity of the Moon, these data indicate the amount of retro burn necessary for the service module engine to place the spacecraft in lunar orbit.

Once the lunar module separates from the command module and goes into a separate lunar orbit, the MSFN will be required to keep track of both spacecraft at once, and provide two-way communication and telemetry between them and the Earth. The prime antenna at each of the three 85-foot tracking stations will handle one spacecraft while a wing, or backup, antenna at the same site will handle the other spacecraft during each pass.

Tracking and acquisition of data between Earth and the two spacecraft will provide support for the rendezvous and docking maneuvers. The information will also be used to determine the time and duration of the service module propulsion engine burn required to place the command module into a precise trajectory for reentering the Earth's atmosphere at the planned location.

As the spacecraft comes toward Earth at high speed -- up to more than 25,000 miles per hour -- it must reenter at the proper angle. To make an accurate reentry, information from the tracking stations and ships is fed into the MCC computers where flight controllers make decisions that will provide the Apollo 11 crew with the necessary information.

Appropriate MSFN stations, including the ships and aircraft in the Pacific, are on hand to provide support during the reentry. An ARIA aircraft will relay astronaut voice communications to MCC and antennas on reentry ships will follow the spacecraft.

Through the journey to the Moon and return, television will be received from the spacecraft at the three 85-foot antennas around the world. In addition, 210-foot diameter antennas in California and Australia will be used to augment the television coverage while the Apollo 11 is near and on the Moon. Scan converters at the stations permit immediate transmission of commercial quality TV via NASCOM to Houston, where it will be released to TV networks.

NASA Communications Network

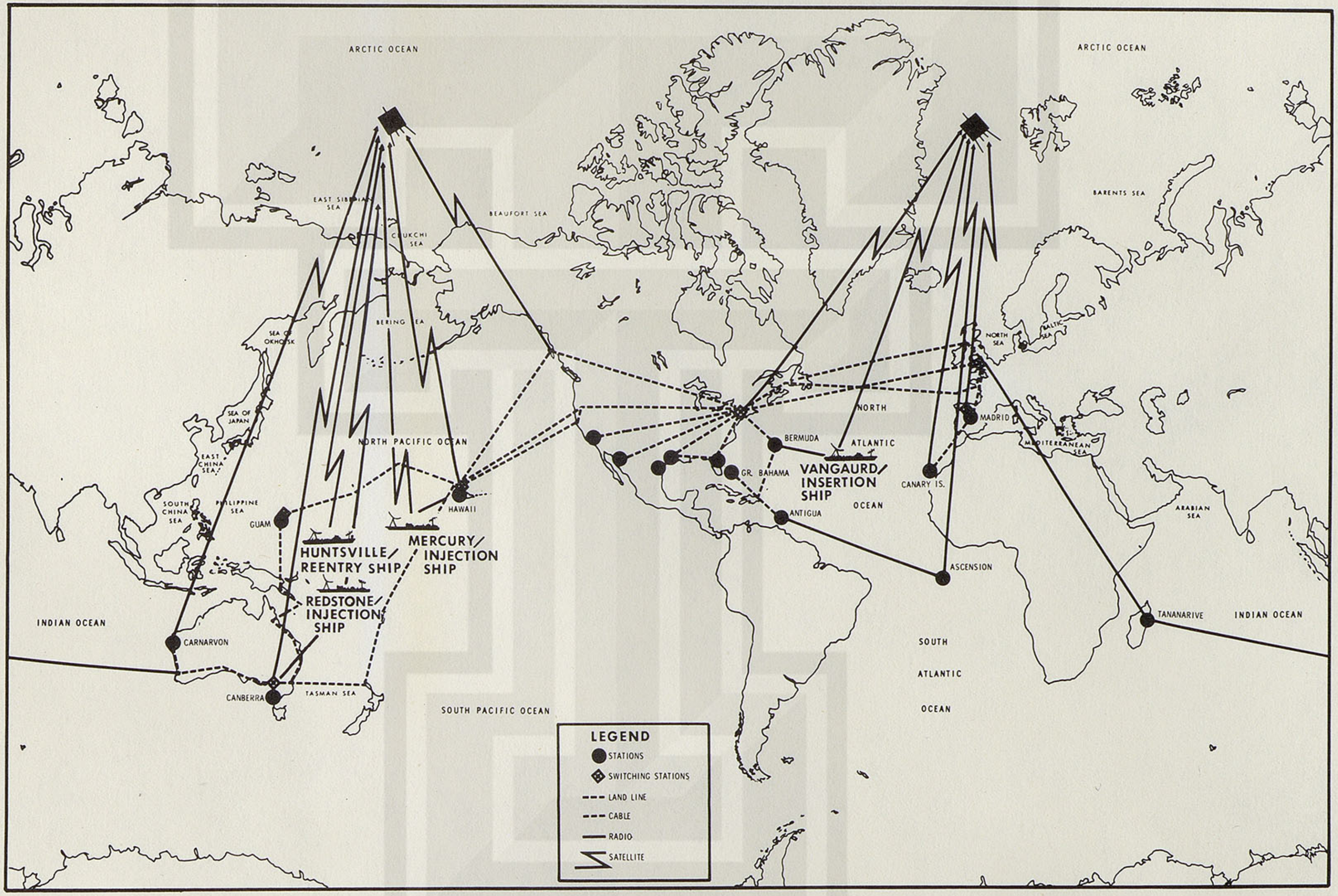
The NASA Communications Network (NASCOM) consists of several systems of diversely routed communications channels leased on communications satellites, common carrier systems and high frequency radio facilities where necessary to provide the access links.

The system consists of both narrow and wide-band channels, and some TV channels. Included are a variety of telegraph, voice, and data systems (digital and analog) with several digital data rates. Wide-band systems do not extend overseas. Alternate routes or redundancy provide added reliability.

A primary switching center and intermediate switching and control points provide centralized facility and technical control, and switching operations under direct NASA control. The primary switching center is at the Goddard Space Flight Center, Greenbelt, Md. Intermediate switching centers are located at Canberra, Madrid, London, Honolulu, Guam, and Kennedy Space Center.

For Apollo 11, the Kennedy Space Center is connected directly to the Mission Control Center, Houston via the Apollo Launch Data System and to the Marshall Space Flight Center, Huntsville, Ala., by a Launch Information Exchange Facility.

After launch, all network tracking and telemetry data hubs at GSFC for transmission to MCC Houston via two 50,000 bits-per-second circuits used for redundancy and in case of data overflow.



NASA COMMUNICATIONS NETWORK

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Two Intelsat communications satellites will be used for Apollo 11. The Atlantic satellite will service the Ascension Island unified S-band (USB) station, the Atlantic Ocean ship and the Canary Islands site.

The second Apollo Intelsat communications satellite over the mid-Pacific will service the Carnarvon, Australia USB site and the Pacific Ocean ships. All these stations will be able to transmit simultaneously through the satellite to Houston via Brewster Flat, Wash., and the Goddard Space Flight Center, Greenbelt. Md.

Network Computers

At fraction-of-a-second intervals, the network's digital data processing systems, with NASA's Manned Spacecraft Center as the focal point, "talk" to each other or to the spacecraft. High-speed computers at the remote site (tracking ships included) issue commands or "up-link" data on such matters as control of cabin pressure, orbital guidance commands, or "go-no-go" indications to perform certain functions.

When information originates from Houston, the computers refer to their pre-programmed information for validity before transmitting the required data to the spacecraft.

Such "up-link"information is communicated by ultra-high-frequency radio about 1,200 bits-per-second. Communication between remote ground sites, via high-speed communications links, occurs at about the same rate. Houston reads information from these ground sites at 2,400 bits-per-second, as well as from remote sites at 100 words-per-minute.

The computer systems perform many other functions, including:

- Assuring the quality of the transmission lines by continually exercising data paths.
- Verifying accuracy of the messages by repetitive operations.
- Constantly updating the flight status.

For "down link" data, sensors built into the spacecraft continually sample cabin temperature, pressure, physical information on the astronauts such as heartbeat and respiration, among other items. These data are transmitted to the ground stations at 51.2 kilobits (12,800 binary digits) per-second.

At MCC the computers:

- Detect and select changes or deviations, compare with their stored programs, and indicate the problem areas or pertinent data to the flight controllers.

- Provide displays to mission personnel.

- Assemble output data in proper formats.

- Log data on magnetic tape for replay for the flight controllers.

- Keep time.

The Apollo Ships

The mission will be supported by four Apollo instrumentation ships operating as integral stations of the Manned Space Flight Network (MSFN) to provide coverage in areas beyond the range of land stations.

The ships, USNS Vanguard, Redstone, Mercury, and Huntsville will perform tracking, telemetry, and communication functions for the launch phase, Earth orbit insertion, translunar injection, and reentry.

Vanguard will be stationed about 1,000 miles southeast of Bermuda (25 degrees N., 49 degrees W.) to bridge the Bermuda-Antigua gap during Earth orbit insertion. Vanguard also functions as part of the Atlantic recovery fleet in the event of a launch phase contingency. Redstone (2.25 degrees S., 166.8 degrees E.); the Mercury (10 N., 175.2 W.) and the Huntsville (3.0 N., 154.0 E.) provide a triangle of mobile stations between the MSFN stations at Carnarvon and Hawaii for coverage of the burn interval for translunar injection. In the event the launch date slips from July 16, the ships will all move generally northeastward to cover the changing translunar injection location.

Redstone and Huntsville will be repositioned along the reentry corridor for tracking, telemetry, and communications functions during reentry and landing. They will track Apollo from about 1,000 miles away through communications blackout when the spacecraft will drop below the horizon and will be picked up by the ARIA aircraft.

The Apollo ships were developed jointly by NASA and the Department of Defense. The DOD operates the ships in support of Apollo and other NASA and DOD missions on a non-interference basis with Apollo requirements.

Management of the Apollo ships is the responsibility of the Commander, Air Force Western Test Range (AFWTR). The Military Sea Transport Service provides the maritime crews and the Federal Electric Corp., International Telephone and Telegraph, under contract to AFWTR, provides the technical instrumentation crews.

The technical crews operate in accordance with joint NASA/DOD standards and specifications which are compatible with MSFN operational procedures.

Apollo Range Instrumentation Aircraft (ARIA)

During Apollo 11, the ARIA will be used primarily to fill coverage gaps between the land and ship stations in the Pacific between Australia and Hawaii during the translunar injection interval. Prior to and during the burn, the ARIA record telemetry data from Apollo and provide realtime voice communication between the astronauts and the Mission Control Center at Houston.

Eight aircraft will participate in this mission, operating from Pacific, Australian and Indian Ocean air fields in positions under the orbital track of the spacecraft and launch vehicle. The aircraft will be deployed in a northwestward direction in the event of launch day slips.

For reentry, two ARIA will be deployed to the landing area to continue communications between Apollo and Mission Control at Houston and provide position information on the spacecraft after the blackout phase of reentry has passed.

The total ARIA fleet for Apollo missions consists of eight EC-135A (Boeing 707) jets equipped specifically to meet mission needs. Seven-foot parabolic antennas have been installed in the nose section of the planes giving them a large, bulbous look.

The aircraft, as well as flight and instrumentation crews, are provided by the Air Force and they are equipped through joint Air Force-NASA contract action to operate in accordance with MSFN procedures.

Ship Positions for Apollo 11

July 16, 1969

Insertion Ship (VAN)	25 degrees N 49 degrees W
Injection Ship (MER)	10 degrees N 175.2 degrees W
Injection Ship (RED)	2.25 degrees S 166.8 degrees E
Injection Ship (HTV)	3.0 degrees N 154.0 degrees E
Reentry Support	
Reentry Ship (HTV)	5.5 degrees N 178.2 degrees W
Reentry Ship (RED)	3.0 degrees S 165.5 degrees E

July 18, 1969

Insertion Ship (VAN)	25 degrees N 49 degrees W
Injection Ship (MER)	15 degrees N 166.5 degrees W
Injection Ship (RED)	4.0 degrees N 172.0 degrees E
Injection Ship (HTV)	10.0 degrees N 157.0 degrees E
Reentry Support	
Reentry Ship (HTV)	17.0 degrees N 177.3 degrees W
Reentry Ship (RED)	6.5 degrees N 163.0 degrees E

July 21, 1969

Insertion Ship (VAN)	25 degrees N 49 degrees W
Injection Ship (MER)	16.5 degrees N 151 degrees W
Injection Ship (RED)	11.5 degrees N 177.5 degrees W
Injection Ship (HTV)	12.0 degrees N 166.0 degrees E
Reentry Support	
Reentry Ship (HTV)	26.0 degrees N 176.8 degrees W
Reentry Ship (RED)	17.3 degrees N 160.0 degrees E

CONTAMINATION CONTROL PROGRAM

In 1966 an Interagency Committee on Back Contamination (ICBC) was established. The function of this Committee was to assist NASA in developing a program to prevent the contamination of the Earth from lunar materials following manned lunar exploration. The committee charter included specific authority to review and approve the plans and procedures to prevent back contamination. The committee membership includes representatives from the Public Health Service, Department of Agriculture, Department of the Interior, NASA, and the National Academy of Sciences.

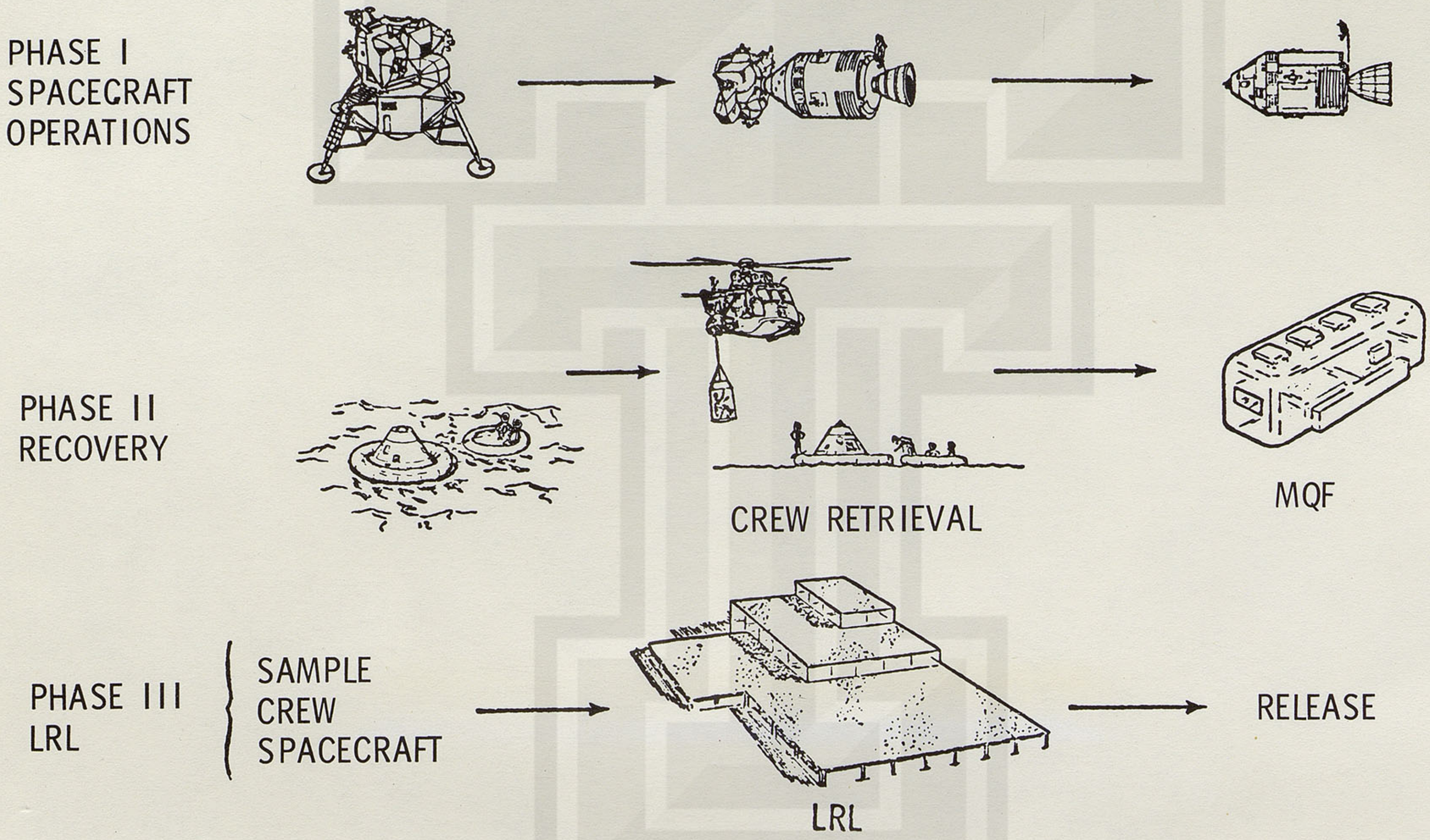
Over the last several years NASA has developed facilities, equipment and operational procedures to provide an adequate back contamination program for the Apollo missions. This program of facilities and procedures, which is well beyond the current state-of-the-art, and the overall effort have resulted in a laboratory with capabilities which have never previously existed. The scheme of isolation of the Apollo crewmen and lunar samples, and the exhaustive test programs to be conducted are extensive in scope and complexity.

The Apollo Back Contamination Program can be divided into three phases. The first phase covers the procedures which are followed by the crew while in flight to reduce and, if possible, eliminate the return of lunar surface contaminants in the command module.

The second phase includes spacecraft and crew recovery and the provisions for isolation and transport of the crew, spacecraft, and lunar samples to the MannedSpacecraft Center. The third phase encompasses the quarantine operations and preliminary sample analysis in the Lunar Receiving Laboratory.

A primary step in preventing back contamination is careful attention to spacecraft cleanliness following lunar surface operations. This includes use of special cleaning equipment, stowage provisions for lunar-exposed equipment, and crew procedures for proper "housekeeping."

<u>Lunar Module Operations</u> - The lunar module has been designed with a bacterial filter system to prevent contamination of the lunar surface when the cabin atmosphere is released at the start of the lunar exploration.



APOLLO BACK CONTAMINATION PROGRAM

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Prior to reentering the LM after lunar surface exploration, the crewmen will brush any lunar surface dust or dirt from the space suit using the suit gloves. They will scrape their overboots on the LM footpad and while ascending the LM ladder dislodge any clinging particles by a kicking action.

After entering the LM and pressurizing the cabin, the crew will doff their portable life support system, oxygen purge system, lunar boots, EVA gloves, etc.

The equipment shown in Table I as jettisoned equipment will be assembled and bagged to be subsequently left on the lunar surface. The lunar boots, likely the most contaminated items, will be placed in a bag as early as possible to minimize the spread of lunar particles.

Following LM rendezvous and docking with the CM, the CM tunnel will be pressurized and checks made to insure that an adequate pressurized seal has been made. During this period, the LM, space suits, and lunar surface equipment will be vacuumed. To accomplish this, one additional lunar orbit has been added to the mission.

The lunar module cabin atmosphere will be circulated through the environmental control system suit circuit lithium hydroxide (LiOH) canister to filter particles from the atmosphere. A minimum of five hours weightless operation and filtering will reduce the original airborne contamination to about 10-15 per cent.

To prevent dust particles from being transferred from the LM atmosphere to the CM, a constant flow of 0.8 lbs/hr oxygen will be initiated in the CM at the start of combined LM/CM operation. Oxygen will flow from the CM into the LM then overboard through the LM cabin relief valve or through spacecraft leakage. Since the flow of gas is always from the CM to the LM, diffusion and flow of dust contamination into the CM will be minimized. After this positive gas flow has been established from the CM, the tunnel hatch will be removed.

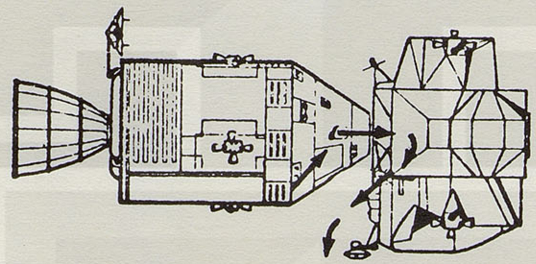
The CM pilot will transfer the lunar surface equipment stowage bags into the LM one at a time. The equipment listed in Table 1 as equipment transferred will then be bagged using the "Buddy System" and transferred back into the CM where the equipment will be stowed. The only equipment which will not be bagged at this time are the crewmen's space suits and flight logs.

LUNAR SURFACE EQUIPMENT - CLEANING AND TRANSFER

Table I

ITEM	LOCATION AFTER JETTISON	EQUIPMENT LOCATION AT LUNAR LAUNCH	LM-CM TRANSFER	REMARKS
Jettisoned Equipment:				
Overshoes (In Container)	Lunar surface			
Portable Life Support System	" "			
Camera	" "			
Lunar tool tether	" "			
Spacesuit connector cover	" "			
Equipment Left in LM:				
EVA tether	RH side stowage container	RH side stowage container		Equipment Brushed prior to stowage for launch
EVA visors	Helmet bag	Helmet bag		
EVA gloves	Helmet bag	Helmet bag		
Purge valve	Interim stowage assy	Interim stowage assy		
Oxygen purge system	Engine cover	Engine cover		
Equipment Transferred to CM:				
Spacesuit	On crew	On crew	Stowed in bag	All equipment to be cleaned by vacuum brush prior to trans= fer to CM
Liquid-cooled garment	On crew	On crew	On crew	
Helmet	On crew	On crew	Stowed in bag	
Watch	On crew	On crew	On crew	
Lunar grab sample	LH stowage	LH stowage	Stowed in bag	
Lunar sample box	SRC rack	SRC rack	Stowed in bag	
Film magazine	SRC rack	SRC rack	Stowed in bag	

POSITIVE GAS FLOW
FROM CM TO LM AFTER POSTLANDING DOCKING



- PROCEDURES
    - PRESSURIZE TUNNEL
    - CM CABIN PRESSURE RELIEF VALVES POSITIONED TO CLOSED
    - LM FORWARD HATCH DUMP/RELIEF VALVE VERIFIED IN AUTOMATIC
    - CM DIRECT O_2 VALVE OPENED TO ESTABLISH CM CABIN PRESSURE AT LEAST 0.5 PSI GREATER THAN LM
    - OPEN PRESSURE EQUALIZATION ON TUNNEL HATCH
    - OBSERVE LM CABIN PRESSURE RELIEF FUNCTION
    - ADJUST CM DIRECT O_2 TO STABLE 0.8 #/HR
    - OPEN TUNNEL HATCH

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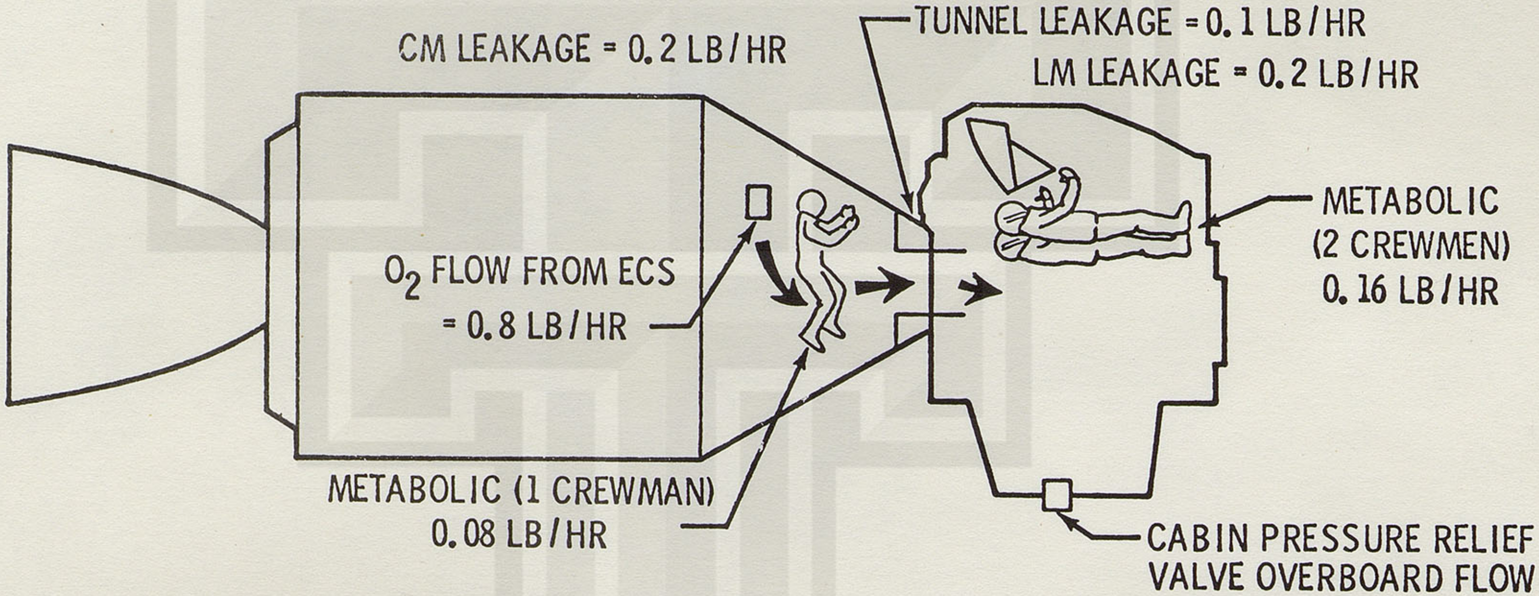
OXYGEN USAGE RATES FOR POSITIVE GAS FLOW FROM CM TO LM



NOMINAL OXYGEN USAGE RATES

CM METABOLIC RATE	0.08 LB/HR
CM LEAKAGE	0.20 LB/HR
TUNNEL LEAKAGE	0.10 LB/HR
LM METABOLIC RATE	0.16 LB/HR
LM LEAKAGE	0.20 LB/HR
FLOW THRU LM CABIN PRESSURE RELIEF VALVE	0.06 LB/HR

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Following the transfer of the LM crew and equipment, the spacecraft will be separated and the three crewmen will start the return to Earth. The separated LM contains the remainder of the lunar exposed equipment listed in Table 1.

Command Module Operations - through the use of operational and housekeeping procedures the command module cabin will be purged of lunar surface and/or other particulate contamination prior to Earth reeentry. These procedures start while the LM is docked with the CM and continue through reentry into the Earth's atmosphere.

The LM crewmen will doff their space suits immediately upon separation of the LM and CM. The space suits will be stowed and will not be used again during the trans-Earth phase unless an emergency occurs.

Specific periods for cleaning the spacecraft using the vacuum brush have been established. Visible liquids will be removed by the liquid dump system. Towels will be used by the crew to wipe surfaces clean of liquids and dirt particles. The three ECS suit hoses will be located at random positions around the spacecraft to insure positive ventilation, cabin atmosphere filtration, and avoid partitioning.

During the transearth phase, the command module atmosphere will be continually filtered through the environmental control system lithium hydroxide canister. This will remove essentially all airborne dust particles. After about 63 hours operation essentially none (10^{-90} per cent) of the original contaminates will remain.

Lunar Mission Recovery Operations

Following landing and the attachment of the flotation collar to the command module, the swimmer in a biological isolation garment (BIG) will open the spacecraft hatch, pass three BIGs into the spacecraft, and close the hatch.

The crew will don the BIGs and then egress into a life raft containing a decontaminant solution. The hatch will be closed immediately after egress. Tests have shown that the crew can don their BIGs in less than 5 minutes under ideal sea conditions. The spacecraft hatch will only be open for a matter of a few minutes. The spacecraft and crew will be decontaminated by the swimmer using a liquid agent.

Crew retrieval will be accomplished by helicopter to the carrier and subsequent crew transfer to the Mobile Quarantine Facility. The spacecraft will be retrieved by the aircraft carrier.

Biological Isolation Garment - Biological isolation garment (BIGs), will be donned in the CM just prior to egress and helicopter pick-up and will be worn until the crew enters the Mobile Quarantine Facility aboard the primary recovery ship.

The suit is fabricated of a light weight cloth fabric which completely covers the wearer and serves as a biological barrier. Built into the hood area is a face mask with a plastic visor, air inlet flapper valve, and an air outlet biological filter.

Two types of BIGs are used in the recovery operation. One is worn by the recovery swimmer. In this type garment, the inflow air (inspired) is filtered by a biological filter to preclude possible contamination of support personnel. The second type is worn by the astronauts. The inflow gas is not filtered, but the outflow gas (respired) is passed through a biological flter to preclude contamination of the air.

Mobile Quarantine Facility - The Mobile Quarantine Facility, is equipped to house six people for a period up to 10 days. The interior is divided into three sections--lounge area, galley, and sleep/bath area. The facility is powered through several systems to interface with various ships, aircraft, and transportation vehicles. The shell is air and water tight. The principal method of assuring quarantine is to filter effluent air and provide a negative pressure differential for biological containment in the event of leaks.

Non-fecal liquids from the trailer are chemically treated and stored in special containers. Fecal wastes will be contained until after the quarantine period. Items are passed in or out of the MQF through a submersible transfer lock. A complete communications system is provided for intercom and external communications to land bases from ship or aircraft. Emergency alarms are provided for oxygen alerts while in transport by aircraft for fire, loss of power and loss of negative pressure.

Specially packaged and controlled meals will be passed into the facility where they will be prepared in a micro-wave oven. Medical equipment to complete immediate postlanding crew examination and tests are provided.

Lunar Receiving Laboratory - The final phase of the back contamination program is completed in the MSC Lunar Receiving Laboratory. The crew and spacecraft are quarantined for a minimum of 21 days after lunar liftoff and are released based upon the completion of prescribed test requirements and results. The lunar sample will be quarantined for a period of 50 to 80 days depending upon the result of extensive biological tests.

The LRL serves four basic purposes:.

The quarantine of the lunar mission crew and spacecraft, the containment of lunar and lunar-exposed materials and quarantine testing to search for adverse effects of lunar material upon terrestrial life.

The preservation and protection of the lunar samples.

The performance of time critical investigations.

The preliminary examination of returned samples to assist in an intelligent distribution of samples to principal investigators.

The LRL has the only vacuum system in the world with space gloves operated by a man leading directly into a vacuum chamber at pressures of 10^{-7} torr. (mm Hg). It has a low level counting facility, whose background count is an order of magnitude better than other known counters. Additionally, it is a facility that can handle a large variety of biological specimens inside Class III biological cabinets designed to contain extremely hazardous pathogenic material.

The LRL, covers 83,000 square feet of floor space and includes several distinct areas. These are the Crew Reception Area (CRA), Vacuum Laboratory, Sample Laboratories (Physical and Bio-Science) and an administrative and support area. Special building systems are employed to maintain air flow into sample handling areas and the CRA to sterilize liquid waste and to incinerate contaminated air from the primary containment systems.

The biomedical laboratories provide for the required quarantine tests to determine the effect of lunar samples on terrestrial life. These tests are designed to provide data upon which to base the decision to release lunar material from quarantine.

Among the tests:

a. Germ-free mice will be exposed to lunar material and observed continuously for 21 days for any abnormal changes. Periodically, groups will be sacrificed for pathologic observation.

b. Lunar material will be applied to 12 different culture media and maintained under several environmental conditions. The media will then be observed for bacterial or fungal growth. Detailed inventories of the microbial flora of the spacecraft and crew have been maintained so that any living material found in the sample testing can be compared against this list of potential contaminants taken to the Moon by the crew or spacecraft.

c. Six types of human and animal tissue culture cell lines will be maintained in the laboratory and together with embryonated eggs are exposed to the lunar material. Based on cellular and/or other changes, the presence of viral material can be established so that special tests can be conducted to identify and isolate the type of virus present.

d. Thirty-three species of plants and seedlings will be exposed to lunar material. Seed germination, growth of plant cells or the health of seedlings then observed, and histological, microbiological and biochemical techniques used to determine the cause of any suspected abnormality.

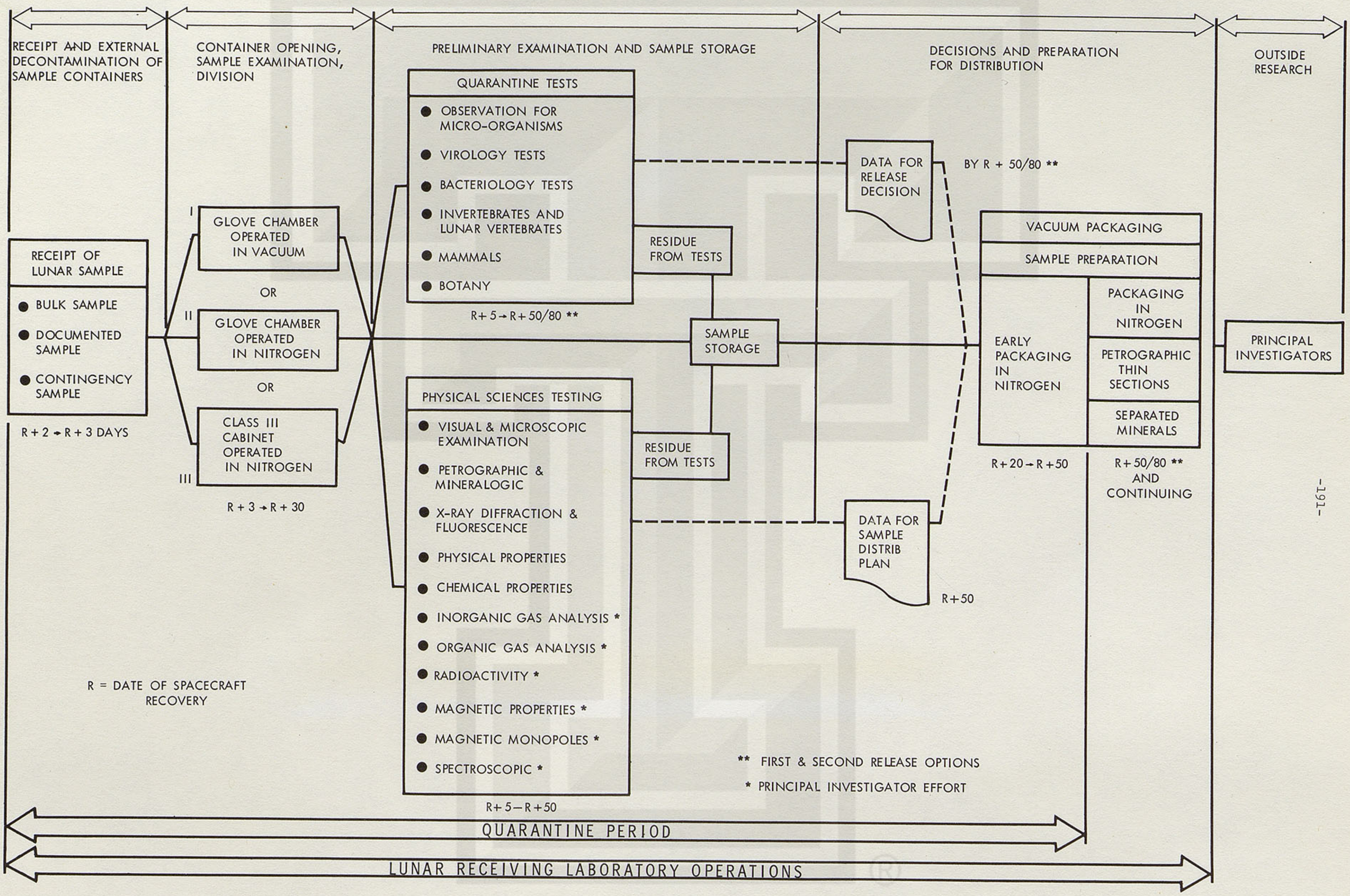
e. A number of lower animals will be exposed to lunar material. These specimens include fish, birds, oysters, shrimp, cockroaches, houseflies, planaria, paramecia and euglena. If abnormalities are noted, further tests will be conducted to determine if the condition is transmissible from one group to another.

The crew reception area provides biological containment for the flight crew and 12 support personnel. The nominal occupancy is about 14 days but the facility is designed and equipped to operate for considerably longer if necessary.

Sterilization And Release Of The Spacecraft

Postflight testing and inspection of the spacecraft is presently limited to investigation of anomalies which happened during the flight. Generally, this entails some specific testing of the spacecraft and removal of certain components of systems for further analysis. The timing of postflight testing is important so that corrective action may be taken for subsequent flights.

The schedule calls for the spacecraft to be returned to port where a team will deactivate pyrotechnics, flush and drain fluid systems (except water). This operation will be confined to the exterior of the spacecraft. The spacecraft will then be flown to the LRL and placed in a special room for storage, sterilization, and postflight checkout.



LUNAR SAMPLE OPERATIONS

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APOLLO PROGRAM MANAGEMENT

The Apollo Program, the United States effort to land men on the Moon and return them safely to Earth before 1970, is the responsibility of the Office of Manned Space Flight (OMSF), National Aeronautics and Space Administration, Washington, D.C. Dr. George E. Mueller is Associate Administator for Manned Space Flight.

NASA Manned Spacecraft Center (MSC), Houston, is responsible for development of the Apollo spacecraft, flight crew training and flight control. Dr. Robert R. Gilruth is Center Director.

NASA Marshall Space Flight Center (MSFC), Huntsville, Ala., is responsible for development of the Saturn launch vehicles. Dr. Wernher von Braun is Center Director.

NASA John F. Kennedy Space Center (KSC), Fla., is responsible for Apollo/Saturn launch operations. Dr. Kurt H. Debus is Center Director.

The NASA Office of Tracking and Data Acquisition (OTDA) directs the program of tracking and data flow on Apollo 11. Gerald M. Truszynski is Associate Administrator for Tracking and Data Acquisition.

NASA Goddard Space Flight Center (GSFC), Greenbelt, Md., manages the Manned Space Flight Network (MSFN) and Communications Network (NASCOM). Dr. John F. Clark is Center Director.

The Department of Defense is supporting NASA in Apollo 11 during launch, tracking and recovery operations. The Air Force Eastern Test Range is responsible for range activities during launch and down-range tracking. DOD developed jointly with NASA the tracking ships and aircraft. Recovery operations include the use of recovery ships and Navy and Air Force aircraft.

Apollo/Saturn Officials

NASA Headquarters

DR. THOMAS O. PAINE was appointed NASA Administrator March 5, 1969. He was born in Berkeley, Calif., Nov. 9, 1921. Dr. Paine was graduated from Brown University in 1942 with an A.B. degree in engineering. After service as a submarine officer during World War II, he attended Stanford University, receiving an M.S. degree in 1947 and Ph.D. in 1949 in physical metallurgy. Dr. Paine worked as research associate at Stanford from 1947 to 1949 when he joined the General Electric Research Laboratory, Schenectady, N.Y. In 1951 he transferred to the Meter and Instrument Department, Lynn, Mass., as Manager of Materials Development, and later as laboratory manager. From 1958 to 1962 he was research associate and manager of engineering applications at GE's Research and Development Center in Schenectady. In 1963-68 he was manager of TEMPO, GE's Center for Advanced Studies in Santa Barbara, Calif.

On January 31, 1968, President Johnson appointed Dr. Paine Deputy Administrator of NASA, and he was named Acting Administrator upon the retirement of Mr. James E. Webb on Oct. 8, 1968. His nomination as Administrator was announced by President Nixon on March 5, 1969; this was confirmed by the Senate on March 20, 1969. He was sworn in by Vice President Agnew on April 3, 1969.

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LIEUTENANT GENERAL SAMUEL C. PHILLIPS director of the United States Apollo Lunar Landing Program, was born in Arizona in 1921 and at an early age he moved to Cheyenne, Wyoming which he calls his permanent home. He graduated from the University of Wyoming in 1942 with a B.S. degree in electrical engineering and a presidential appointment as a second lieutenant of infantry in the regular army. He transferred to the Air Corps and earned his pilot's wings in 1943. Following wartime service as a combat pilot in Europe, he studied at the University of Michigan where he received his master of science degree in electrical engineering in 1950. For the next six years he specialized in research and development work at the Air Materiel Command, Wright Patterson AFB, Ohio. In June 1956 he returned to England as Chief of Logistics for SAC's 7th Air Division where he participated in writing the international agreement with Great Britain on the use of the Thor IBM. He was assigned to the Air Research and Development Command in 1959 and for four years he was director of the Minuteman program. General Phillips was promoted to Vice Commander of the Ballistic Systems Division in August 1963, and in January 1964 he moved to Washington to become deputy director of the Apollo program. His appointment as Director of the Apollo program came in October of that year.

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GEORGE H. HAGE was appointed Deputy Director, Apollo Program, in January 1968, and serves as "general manager" assisting the Program Director in the management of Apollo developmental activities. In addition he is the Apollo Mission Director.

Hage was born in Seattle Washington, Oct. 7, 1925, and received his bachelor's degree in electrical engineering from the University of Washington in 1947. He joined Boeing that year and held responsible positions associated with the Bomarc and Minuteman systems, culminating in responsibility for directing engineering functions to activate the Cape Kennedy Minuteman Assembly and test complex in 1962. He then took charge of Boeing's unmanned Lunar Reconnaissance efforts until being named Boeing's engineering manager for NASA's Lunar Orbiter Program in 1963.

Hage joined NASA as Deputy Associate Administrator for Space Science and Applications (Engineering) July 5, 1967, and was assigned to the Apollo Program in October 1967 as Deputy Director (Engineering).

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CHESTER M. LEE, U.S. NAVY (RET.) was appointed Assistant Apollo Mission Director in August 1966. He was born in New Derry, Pa., in 1919. Lee graduated from the U.S. Naval Academy in 1941 with a BS degree in electrical engineering. In addition to normal sea assignments he served with the Directorate of Research and Engineering, Office of Secretary of Defense and the Navy Polaris missile program. Lee joined NASA in August 1965 and served as Chief of Plans, Missions Operations Directorate, OMSF, prior to his present position.

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COL. THOMAS H. McMULLEN (USAF) has been Assistant Mission Director, Apollo Program, since March 1968. He was born July 4, 1929, in Dayton, Ohio. Colonel McMullen graduated from the U.S. Military Academy in 1951 with a BS degree. He also received an MS degree from the Air Force Institute of Technology in 1964. His Air Force assignments included: fighter pilot, 1951-1953; acceptance test pilot, 1953-1962; development engineer, Gemini launch vehicle program office, 1964-1966; and Air Force Liaison Officer, 25th Infantry Division, 1967. He served in the Korean and Viet Nam campaigns and was awarded several high military decorations.

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GEORGE P. CHANDLER, JR., Apollo 11 Mission Engineer, Apollo Operations Directorate, OMSF, Hq., was born in Knoxville, Tenn. Sept. 6, 1935. He attended grammar and high schools in that city was graduated from the University of Tennessee with a B.S. degree in electrical engineering in 1957. He received an army ROTC commission and served on active duty 30 months in the Ordnance Corps as a missile maintenance engineer in Germany. From 1960 until 1965 he was associated with Philco Corp. in Germany and in Houston, Texas. He joined the NASA Office of Manned Space Flight in Washington in 1965 and served in the Gemini and Apollo Applications operations offices before assuming his present position in 1967. Chandler was the mission engineer for Apollo 9 and 10.

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MAJOR GENERAL JAMES W. HUMPHREYS, JR., USAF Medical Corps, joined NASA as Director of Space Medicine, on June 1, 1967. He was born in Fredericksburg, Va., on May 28, 1915. Humphreys graduated from the Virginia Military Institute with a BS degree in chemical engineering in 1935 and from the Medical College of Virginia with an MD in 1939. He served as a medical battalion and group commander in the European Theater in World War II and later as military advisor to the Iranian Army. Humphreys was awarded a master of science in surgery from the Graduate school of the University of Colorado in 1951. Prior to his association with NASA, General Humphreys was Assistant Director, USAID Vietmam for Public Health on a two year tour of duty under special assignment by the Department of State.

Manned Spacecraft Center

ROBERT R. GILRUTH, 55, Director, NASA Manned Spacecraft Center. Born Nashwauk, Minn. Joined NACA Langley Memorial Aeronautical Laboratory in 1936 working in aircraft stability and Control. Organized Pilotless Aircraft Research Division for transonic and supersonic flight research, 1945; appointed Langley Laboratory assistant director, 1952; named to manage manned space flight program, later named Project Mercury, 1958; named director of NASA Manned Spacecraft Center, 1961. BS and MS in aeronautical engineering from University of Minnesota; holds numerous honorary doctorate degrees. Fellow of the Institute of Aerospace Sciences, American Rocket Club and the American Astronautical Society. Holder of numerous professional society, industry and government awards and honorary memberships.

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George M. Low, 43, manager, Apollo Spacecraft Program. Born Vienna, Austria. Married to former Mary R. McNamara. Children: Mark S. 17, Diane E. 15, G. David 13, John M. 11, and Nancy A. 6. Joined NACA Lewis Research Center 1949 specializing in aerodynamic heating and boundary layer research; assigned 1958 to NASA Headquarters as assistant director for manned space flight programs, later becoming Deputy Associate Administrator for Manned Space Flight; named MSC Deputy Director 1964; named manager, Apollo Spacecraft Program in April 1967. BS and MS in aeronautical engineering from Renssalaer Polytechnic Institute, Troy, N.Y.

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CHRISTOPHER C. KRAFT, JR., 45, MSC Director of Flight Operations. Born Phoebus, Va. Married to Former Elizabeth Anne Turnbull of Hampton, Va. Children: Gordon T. 17, and Kristi-Anne 14. Joined NACA Langley Aeronautical Laboratory in 1945 specializing in aircraft stability and control; became member of NASA Space Task Group in 1958 where he developed basic concepts of ground control and tracking of manned spacecraft. Named MSC Director of Flight Operations in November 1963. BS in aeronautical engineering from Virginia Polytechnic Institute, Blacksburg, Va. Awarded honorary doctorates from Indiana Institute of Technology and Parks College of St. Louis University.

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KENNETH S. KLEINKNECHT, 50, Apollo Spacecraft Program manager for command and service modules. Born Washington, D.C. Married to former Patricia Jean Todd of Cleveland, Ohio. Children: Linda Mae 19, Patricia Ann 17, and Frederick W. 14. Joined NACA Lewis Research Center 1942 in aircraft flight test; transferred to NACA Flight Research Center 1951 in design and development work in advanced research aircraft; transferred to NASA Space Task Group 1959 as technical assistant to the director; named manager of Project Mercury 1962 and on completion of Mercury, deputy manager Gemini Program in 1963; named Apollo Spacecraft Program manager for command and service modules early 1967 after Gemini Program completed. BS in mechanical engineering Purdue University.

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CARROLL H. BOLENDER, 49, Apollo Spacecraft Program manager for lunar module. Born Clarksville, Ohio. He and his wife, Virginia, have two children--Carol 22 and Robert 13. A USAF Brigadier general assigned to NASA, Bolender was named lunar module manager in July 1967 after serving as a mission director in the NASA Office of Manned Space Flight. Prior to joining NASA, he was a member of a studies group in the office of the USAF chief of staff and earlier had worked on USAF aircraft and guided missile systems projects. During World War II, he was a night fighter pilot in the North African and Mediterranean theaters. He holds a BS from Wilmington College, Ohio, and an MS from Ohio State University.

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DONALD K. SLAYTON, 45, MSC Director of Flight Crew Operations. Born Sparta, Wis. Married to the former Marjorie Lunney of Los Angeles. They have a son, Kent 12. Selected in April 1959 as one of the seven original Mercury astronauts but was taken off flight status when a heart condition was discovered. He subsequently became MSC Director of Flight Crew Operations in November 1963 after resigning his commission as a USAF major. Slayton entered the Air Force in 1943 and flew 56 combat missions in Europe as a B-25 pilot, and later flew seven missions over Japan. Leaving the service in 1946, he earned his BS in aeronautical engineering from University of Minnesota. He was recalled to active duty in 1951 as a fighter pilot, and later attended the USAF Test Pilot School at Edwards AFB, Calif. He was a test pilot at Edwards from 1956 until his selection as a Mercury astronaut. He has logged more than 4000 hours flying time---more than half of which are in jet aircraft.

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CLIFFORD E. CHARLESWORTH, 37, Apollo 11 prime flight director (green team). Born Redwing, Minn. Married to former Jewell Davis, of Mount Olive, Miss. Children: David Alan 8, Leslie Anne 6. Joined NASA Manned Spacecraft Center April 1962. BS in physics from Mississippi College 1958. Engineer with Naval Mine Defense Lab, Panama City, Fla. 1958-60; engineer with Naval Ordnance Lab, Corona, Calif., 1960-61; engineer with Army Ordnance Missile Command, Cape Canaveral, Fla., 1961-62; flight systems test engineer, MSC Flight Control Division, 1962-65; head, Gemini Flight Dynamics Section, FCD, 1965-66; assistant Flight Dynamics Branch chief, FCD, 1966-68.

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EUGENE F. KRANZ, 35, Apollo 11 flight director (white team) and MSC Flight Control Division chief. Born Toledo, Ohio. Married to former Marta I. Cadena of Eagle Pass, Texas, Children: Carmen 11, Lucy 9, Joan 7, Mark 6, Brigid 5 and Jean 3. Joined NASA Space Task Group October 1960. Supervisor of missile flight test for McDonnell Aircraft 1958-1960. USAF fighter pilot 1955-1958. McDonnell Aircraft flight test engineer 1954-55. BS in aeronautical engineering from Parks College, St. Louis University, 1954. Assigned as flight director of Gemini 3,4,7/6, 8, 9 and 12; Apollo 5, 8 and 9.

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GLYNN S. LUNNEY, 32, Apollo 11 flight director (black team). Born Old Forge, Pa. Married to former Marilyn Jean Kurtz of Cleveland, Ohio. Children: Jenifer 8, Glynn 6, Shawn 5 and Bryan 3. Joined NACA Lewis Research Center August 1955 as college co-op employee. Transferred to NASA Space Task Group June 1959. Assigned as flight director of Gemini 9, 10, 11 and 12, Apollo 201,4, 7, 8 and 10. BS in aeronautical engineering from University of Detroit.

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MILTON L. WINDLER, 37, Apollo 11 flight director (Maroon team). Born Hampton, Va. Married to former Betty Selby of Sherman, Texas. Children: Peter 12, Marion 9 and Cary 7. Joined NACA Langley Research Center June 1954. USAF fighter pilot 1955-58; rejoined NASA Space Task Group December 1959 and assigned to Recovery Branch of Flight Operations Division in development of Project Mercury recovery equipment and techniques. Later became chief of Landing and Recovery Division Operational Test Branch. Named Apollo flight director team April 1968.

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CHARLES M. DUKE, 33, astronaut and Apollo 11 spacecraft communicator (CapCom). Born Charlotte, N. C. Married to former Dorothy M. Claiborne of Atlanta, Ga. Children: Charles M. 4, Thomas C. 2. Selected as astronaut in April 1966. Has rank of major in USAF, and is graduate of the USAF Aerospace Research Pilot School. Commissioned in 1957 and after completion of flight training, spent three years as fighter pilot at Ramstein Air Base, Germany. BS in naval sciences from US Naval Academy 1957; MS in aeronautics and astronautics from Massachusetts Institute of Technology 1964. Has more than 24 hours flying time, most of which is jet time.

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RONALD E. EVANS, 35, astronaut and Apollo 11 spacecraft communicator (CapCom). Born St. Francis, Kans. Married to former Janet M. Pollom of Topeka, Kans. Children: Jaime D 9 and Jon P. 7. Selected an astronaut in April 1966. Has rank of lieutenant commander in U.S. Navy. Was flying combat missions from USS Ticonderoga off Viet Nam when selected for the astronaut program. Combat flight instructor 1961-1962; made two West Pacific aircraft carrier cruises prior to instructor assignment. Commissioned 1957 through University of Kansas Navy ROTC program. Has more than 3000 hours flying time, most of which is in jets. BS in electrical engineering from University of Kansas 1956; MS in aeronautical engineering from US Naval Postgraduate School 1964.

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BRUCE McCANDLESS II, 32, astronaut and Apollo 11 spacecraft communicator (CapCom). Born Boston, Mass. Married to former Bernice Doyle of Rahway, N.J. Children: Bruce III 7 and Tracy 6. Selected as astronaut April 1966. Holds rank of lieutenant commander in US Navy. After flight training and earning naval aviator's wings in 1960, he saw sea duty aboard the carriers USS Forrestal and USS Enterprise, and later was assigned as instrument flight instructor at Oceana, Va. Naval Air Station. He has logged almost 2000 hours flying time, most of which is in jets. BS in naval sciences from US Naval Academy (second in class of 899) 1958; MS in electrical engineering from Stanford University 1965; working on PhD in electrical engineering at Stanford.

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CHARLES A. BERRY, MD, 45, MSC Director of Medical Research and Operations. Born Rogers, Ark. Married to former Adella Nance of Thermal, Calif. Children: Mike, Charlene and Janice. Joined NASA Manned Spacecraft Center July 1962 as chief of Center Medical Operations Office; appointed MSC Director of Medical Research and Operations May 1966. Previously was chief of flight medicine in the office of the USAF Surgeon General 1959-62; assistant chief, then chief of department of aviation medicine at the School of Aviation Medicine, Randolph AFB, Texas 1956-59 and served as Project Mercury aeromedical monitor; Harvard School of Public Health aviation medicine residency 1955-56; base flight surgeon and command surgeon in stateside, Canal Zone and Carribean Assignments, 1951-1955. Prior to entering the USAF in 1951, Berry interned at University of California: service at San Francisco City and County Hospital and was for three years in general practice in Indio and Coachella, Calif. BA from University of California at Berkeley 1945; MD University of California Medical School, San Francisco, 1947; Master of public health, Harvard School of Public Health, 1956.

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DR. WILMOT N. HESS, 42, MSC Director of Science and Applications. Born Oberlin, Ohio. Married to former Winifred Lowdermilk. Children: Walter C. 12, Alison L. 11 and Carl E. 9. Joined NASA Goddard Space Flight Center 1961 as chief of Laboratory for Theoretical Studies; transferred to NASA Manned Spacecraft Center 1967 as Director of Science and Applications. Previously leader, Plowshare Division of University of California Lawrence Radiation Laboratory 1959-61; physics instructor Oberlin College 1948-1949; physics instructor Mohawk College 1947. BS in electrical engineering from Columbia University 1946; MA in physics from Oberlin College 1949; and PhD in physics from University of California 1954.

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DR. P. R. BELL, 56, chief MSC Lunar and Earth Sciences Division and manager of Lunar Receiving Laboratory. Born Fort Wayne, Indiana. Married to the former Mozelle Rankin. One son, Raymond Thomas 27. Joined NASA Manned Spacecraft Center July 1967. Formerly with Oak Ridge National Laboratories in thermonuclear research, instrumentation and plasma physics, 1946-67; MIT Radiation Laboratories in radar systems development, 1941-46; National Defense Research Committee Project Chicago, 1940-41. Holds 14 patents on electronic measurement devices, thermonuclear reactor components. BS in chemistry and doctor of science from Howard College, Birmingham, Ala.

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JOHN E. McLEAISH, 39, Apollo 11 mission commentator and chief, MSC Public Information Office. Born Houston, Texas. Married to former Patsy Jo Thomas of Holliday, Texas. Children: Joe D. 19, Carol Ann 14, John E. Jr. 14. Joined NASA Manned Spacecraft Center 1962, named Public Information Office chief July 1968. Prior to joining NASA McLeaish was a USAF information officer and rated navigator from 1952 to 1962. BA in journalism from University of Houston. Assigned to mission commentary on Gemini 11 and 12 and Apollo 6 and 8.

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JOHN E. (JACK) RILEY, 44, Apollo 11 mission commentator and deputy chief MSC Public Information Office. Born Trenton, Mo. Married to former Patricia C. Pray of Kansas City, Kans. Children: Kevin M. 17, Sean P. 15, Kerry E. 13, Brian T. 9

and Colin D. 6. Joined NASA Manned Spacecraft Center Public Information Office April 1963. Assigned to mission commentary on Gemini 9, 10 and 11 and Apollo 7, 9 and 10. PIO liaison with Apollo Spacecraft Program Office. Prior to joining NASA was public relations representative with General Dynamics/Astronautics 1961-63; executive editor, Independence, Mo. Examiner 1959-61; city editor, Kansas City Kansan 1957-59; reporter, Cincinnati, Ohio Times-Star 1957; reporter-copy editor, Kansas City Kansan 1950-57. Served in US Navy in Pacific-Asiatic Theaters 1942-46. BA in journalism University of Kansas.

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DOUGLAS K. WARD, 29, born Idaho Falls, Idaho. Married to former Susan Diane Sellery of Boulder, Colorado. Children: Edward 7; Elisabeth, 4; and Cristina, 4. Joined NASA Public Affairs Office June 1966. Responsible for news media activities related to engineering and development and administrative operations at MSC. Assigned to mission commentary on Apollo 7, 8, and 10. BA in political science from the University of Colorado. Before joining NASA worked for two years with the U. S. Information Agency, Voice of America, writing and editing news for broadcast to Latin America and served as assistant space and science editor for the VOA news division.

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(ROBERT) TERRY WHITE, 41, born Denton, Texas. Married to former Mary Louise Gradel of Waco, Texas. Children: Robert Jr., 4, and Kathleen, 2. Joined NASA Manned Spacecraft Center Public Affairs Office April 1963. Was editor of MSC Roundup (house organ) for four years. Assigned to mission commentary on 12 previous Gemini and Apollo missions. BA in journalism from North Texas State University. Prior to joining NASA, was with Employers Casualty Company, Temco Aircraft Corporation, (now LTV), Johnston Printing Company and Ayres Compton Associates, all of Dallas, Texas.

Marshall Space Flight Center

DR. WERNHER VON BRAUN became the director of MSFC when it was created in 1960. As a field center of NASA, the Marshall Center provides space launch vehicles and payloads, conducts related research, and studies advanced space transportation systems. Dr. von Braun was born in Wirsitz, Germany, on March 23, 1912. He was awarded a bachelor of science degree at the age of 20 from the Berlin Institute of Technology.

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Two years later, he received his doctorate in physics from the University of Berlin. He was technical director of Germany's rocket program at Peenemunde. Dr. von Braun came to the U.S. in 1945, under a contract to the U.S. Army, along with 120 of his Peenemunde colleagues. He directed high altitude firings of V-2 rockets at White Sands Missile Range, N.M. and later became the project director of the Army's guided missile development unit in Fort Bliss. In 1950 he was transferred to Redstone Arsenal, Ala. The Redstone, the Jupiter and the Pershing missile systems were developed by the von Braun team. Current programs include the Saturn IB and the Saturn V launch vehicles for Project Apollo, the nation's manned lunar landing program and participation in the Apollo Applications program.

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DR. EBERHARD F.M.REES is deputy director, technical, of NASA-Marshall Space Flight Center. Dr. Rees was born April 28, 1908, in Trossingen, Germany. He received his technical education in Stuttgart and at Dresden Institute of Technology. He graduated from Dresden in 1934 with a master of science degree in mechanical engineering. During World War II, Dr. Rees worked at the German Guided Missile Center in Peenemunde. He came to the United States in 1945 and worked in the Ordnance Research and Development, Sub-Office (rocket), at Fort Bliss. In 1950 the Fort Bliss activities were moved to Redstone Arsenal, Ala. Rees, who became an American citizen in 1954, was appointed deputy director of Research and Development of Marshall Space Flight Center in 1960. He held this position until his appointment in 1963 to deputy director, technical.

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DR. HERMANN K. WEIDNER is the director of Science and Engineering at the Marshall Space Flight Center. Dr. Weidner has had long and varied experience in the field of rocketry. He became a member of the Peenemunde rocket development group in Germany in 1941. In 1945, he came to the United States as a member of the von Braun research and development team. During the years that followed, this group was stationed at Fort Bliss, as part of the Ordnance Research and Development. After the Fort Bliss group was transferred to Huntsville, Dr. Weidner worked with the Army Ballistic Missile Agency at Redstone Arsenal. He was formerly deputy director of the Propulsion and Vehicle Engineering Laboratory. He was also director of propulsion at MSFC. Dr. Weidner received his U.S. citizenship in April of 1955.

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MAJ. GEN. EDMUND F. O'CONNOR is director of Program Management at NASA-Marshall Space Flight Center. He is responsible for the technical and administrative management of Saturn launch vehicle programs and that portion of the Saturn/Apollo Applications Program assigned to Marshall. O'Connor was born on March 31, 1922 in Fitchburg, Mass. He graduated from West Point in 1943, he has a bachelor of science in both military engineering and in aeronautical engineering. During World War II, O'Connor served in Italy with the 495th Bombardment Group, and held several other military assignments around the world. In 1962 he went to Norton Air Force Base, as deputy director of the Ballistic Systems Division, Air Force Systems Command, He remained in that position until 1964 when he became director of Industrial Operations (now designated Program Management) at Marshall Space Flight Center.

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LEE B. JAMES is the manager of the Saturn Program Office in Program Management, Marshall Space Flight Center. A retired Army Colonel, he has been in the rocket field since its infancy. He started in 1947 after graduating in one of the early classes of the Army Air Defense School at Fort Bliss. He is also a graduate of West Point and he holds a master's degree from the University of Southern California at Los Angeles. He joined the rocket development team headed by Dr. Wernher von Braun in 1956. When the team was transferred from the Department of Defense to the newly created NASA in 1960, James remained as director of the Army's Research and Development Division at Redstone Arsenal. In 1961-62, he was transferred to Korea for a one year tour of duty. After the assignment in Korea, he was transferred by the Army to NASA-MSFC. In 1963 he became manager of the Saturn I and IB program. For a year he served in NASA Headquarters as deputy to the Apollo Program manager. He returned in 1968 to manage the Saturn V program.

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MATTHEW W. URLAUB is manager of the S-IC stage in the Saturn Program Office at NASA-Marshall Space Flight Center. Born September 23, 1927 in Brooklyn, he is a graduate of Duke University where he earned his bachelor of science degree in mechanical engineering. Urlaub entered the army in 1950 and finished his tour of duty in 1955. During the period of 1952-1953 he completed a one year course at the Ordnance Guided Missile School at Redstone Arsenal. Upon becoming a civilian he became a member of the Army Ballistic

Missile Agency's Industrial Division Staff at Redstone Arsenal. Specifically, he was the ABMA senior resident engineer for the Jupiter Program at Chrysler Corporation in Detroit. He transferred to MSFC in 1961. The field in which he specializes is project engineering/management.

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ROY E. GODFREY performs dual roles, one as deputy manager of the Saturn program and he is also the S-II stage manager. Born in Knoxville on November 23, 1922, he earned a bachelor of science degree in mechanical engineering at the University of Tennessee. Godfrey served as second lieutenant in the Air Force during WWII and began his engineering career with TVA. In 1953 he was a member of the research and development team at Redstone Arsenal, when he accepted a position with the Ordnance Missile laboratories. When the Army Ballistic Missile Agency was created in 1956 he was transferred to the new agency. He came to Marshall Center in 1962 to become the deputy director of the Quality and Reliability Assurance Laboratory.

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JAMES C. McCULLOCH is the S-IVB stage project manager in the Saturn Program Office at the NASA-Marshall Space Flight Center. A native of Alabama, he was born in Huntsville on February 27, 1920. McCulloch holds a bachelor of science degree in mechanical engineering from Auburn University, and a master's degree in business administration from Xavier University. Prior to coming to the Marshall Center in 1961, he had been associated with Consolidated - Vultee Aircraft Corp.; National Advisory Committee for Aeronautics; Fairchild Engine and Airplane Corp.; and General Electric Co.

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FREDERICH DUERR is the instrument unit manager in the Saturn Program Office at NASA-Marshall Space Flight Center. Born in Munich, Germany, on January 26, 1909, he is a graduate of Luitpold Oberealschule and the Institute of Technology, both in Munich. He holds B.S. and M.S. degrees in electrical engineering. Duerr specializes in the design of electrical network systems for the rocket launch vehicles. Duerr joined Dr. Wernher von Braun's research and development team in 1941 at Peenemuende, and came with the group to the U.S. in 1945. This group, stationed at White Sands, N.M., was transferred to Huntsville in 1950 to form the Guided Missile Development Division of the Ordnance Missile Laboratories at Redstone Arsenal.

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DR. FRIDTJOF A. SPEER is manager of the Mission Operations Office in Program Management at the NASA-Marshall Space Flight Center. A member of the rocket research and development team in Huntsville since March 1955, Dr. Speer was assistant professor at the Technical University of Berlin and Physics Editor of the Central Chemical Abstract Magazine in Berlin prior to coming to this country. He earned both his master's degree and Ph.D. in physics from the Technical University. From 1943 until the end of the war, he was a member of the Guided Missile Development group at Peenemunde. Dr. Speer was chief of the Flight Evaluation and Operations Studies Division prior to accepting his present position in August 1965. He became a U.S. citizen in 1960.

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WILLIAM D. BROWN is manager, Engine Program Office in Program Management at MSFC. A native of Alabama, he was born in Huntsville on December 17, 1926. He is a graduate of Joe Bradley High School in Huntsville and attended Athens College and Alabama Polytechnic Institute to earn his bachelor of science degree in chemical engineering. Following graduation from Auburn University in 1951, he returned to Huntsville to accept a position with the Army research and development team at Redstone Arsenal, where he was involved in catalyst development for the Redstone missile. Shortly after the Army Ballistic Missile Agency was activated at Redstone, Brown became a rocket power plant engineer with ABMA. He transferred enmasse to the Marshall Space Flight Center when that organization was established in 1960.

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Kennedy Space Center

DR. KURT H. DEBUS, Director, Kennedy Space Center, has been responsible for many state of the art advances made in launch technology and is the conceptual architect of the Kennedy Space Center with its mobile facilities suitable for handling extremely large rockets such as the Saturn V. Born in Frankfurt, Germany, in 1908, he attended Darmstadt University where he earned his initial and advanced degrees in mechanical engineering. In 1939, he obtained his engineering doctorate and was appointed assistant professor at the University. During this period he became engaged in the rocket research program at Peenemunde. Dr. Debus came to the United States in 1945 and played an active role in the U.S. Army's ballistic missile development program. In 1960, he was appointed Director of the Launch Operations Directorate, George C. Marshall Space Flight Center, NASA, at Cape Canaveral. He was appointed to his present post in 1962. He brought into being the government/industry launch force which has carried out more than 150 successful launches, including those of Explorer I, the Free World's first satellite, the first manned launch and the Apollo 8 flight, first manned orbit of the moon.

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MILES ROSS, Deputy Director, Center Operations, Kennedy Space Center, is responsible for operations related to engineering matters and the conduct of the Center's technical operations. He has held the position since September 1967. Born in Brunswick, N.J., in 1919, he is a graduate of Massachusetts Institute of Technology where he majored in Mechanical Engineering and Engineering Administration. Prior to his assignment at the Kennedy Space Center, Ross was a project manager of the Air Force Thor and Minuteman Missile systems with TRW, Inc. He was later appointed Director of Flight Operations and Manager of Florida Operations for TRW.

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ROCCO A. PETRONE, Director of Launch Operations, Kennedy Space Center, is responsible for the management and technical direction of preflight operations and integration, test, checkout and launch of all space vehicles, both manned and unmanned. Born in Amsterdam, N.Y., in 1926, he is a 1946 graduate of the U.S. Military Academy and received a Masters Degree in Mechanical Engineering from Massachusetts Institute of Technology in 1951. His career in rocketry began shortly after graduation from MIT when he was assigned to the Army's Redstone Arsenal, Huntsville, Ala. He participated in the development of the Redstone missile in the early 1950's and was detailed to the Army's General Staff at the Pentagon from 1956 to 1960. He came to KSC as Saturn Project Officer in 1960. He later became Apollo Program Manager and was appointed to his present post in 1966.

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RAYMOND L. CLARK, Director of Technical Support, Kennedy Space Center, is responsible for the management and technical direction of the operation and maintenance of KSC's test and launch complex facilities, ground support equipment and ground instrumentation required to support the assembly, test, check-out and launch of all space vehicles - both manned and unmanned. Born in Sentinel, Oklahoma, in 1924, Clark attended Oklahoma State University and is a 1945 graduate of the U.S. Military Academy with a degree in military science and engineering. He received a master of science degree in aeronautics and guided missiles from the University of Southern California in 1950 and was a senior project officer for the Redstone and Jupiter missile projects at Patrick AFB from 1954 to 1957. He joined KSC in 1960. Clark retired from the Army with the rank of lieutenant colonel in 1965.

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G. MERRITT PRESTON, Director of Design Engineering, Kennedy Space Center, is responsible for design of ground support equipment, structures and facilities for launch operations and support elements at the nation's Spaceport. Born in Athens, Ohio, in 1916, he was graduated from Rensselaer Polytechnic Institute in New York with a degree in aeronautical engineering in 1939. He then joined the National Advisory Committee for Aeronautics (NACA) at Langley Research Center, Virginia, and was transferred in 1942 to the Lewis Flight Propulsion Center at Cleveland, Ohio, where he became chief of flight research engineering in 1945. NACA's responsibilities were later absorbed by NASA and Preston played a major role in Project Mercury and Gemini manned space flights before being advanced to his present post in 1967.

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FREDERIC H. MILLER, Director of Installation Support, Kennedy Space Center, is responsible for the general operation and maintenance of the nation's Spaceport. Born in Toledo, Ohio, in 1911, he claims Indiana as his home state. He was graduated from Purdue University with a bachelor's degree in electrical engineering in 1932 and a master's degree in business administration from the University of Pennsylvania in 1949. He is a graduate of the Industrial College of the Armed Forces and has taken advanced management studies at the Harvard Business School. He entered the Army Air Corps in 1932, took his flight training at Randolph and Kelly Fields, Texas, and held various ranks and positions in the military service before retiring in 1966 as an Air Force major general. He has held his present post since 1967.

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