

# **Today In History**

**a series of articles on the Apollo, Skylab and Apollo/Soyuz  
projects compiled and written by Ken Elchert for the  
fiftieth anniversary of North American Aviation in Downey**

## Today In History -- July 20

*"I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth."* With these words to the U.S. Congress on May 25, 1961, **President John F. Kennedy** not only committed the United States to the largest technological project ever attempted by the nation during peacetime but also started the "Moon Race" with the former Soviet Union. That race reached its dramatic climax during July 1969, twenty-seven years ago this month.

Unknown to most of the world, the thirty engines of the first stage of the Soviet Union's giant five-stage Moon rocket, the N-1, ignited at 20:18:32 UT on July 3, 1969, for a circumlunar test flight. However, before it cleared the launch tower, the vehicle exploded and destroyed both the launch complex at the Baikonur Cosmodrome and the Soviet hopes to be the first to land a man on the lunar surface.

Nearly half way around the world, at Launch Complex 39A at the Kennedy Space Center, the United States was preparing its Moon rocket, the mighty Saturn V (AS-506), for its most important mission -- to send three U.S. astronauts on their way to the Moon for an attempt to land two of them on its surface for the first time. Unlike the Soviet launch, however, this mission was to be witnessed by most of the world.

The second stage of the Saturn V, the S-II, was designed and built by **North American Rockwell Space Division** and was the largest hydrogen-fueled rocket stage ever built up to that time. Fully fueled, it weighed 1,059,171 pounds and was powered by five **Rocketdyne** J-2 engines producing a total thrust of 1,135,000 pounds. Sitting atop the vehicle was the Apollo 11 spacecraft, also designed and built by **North American Rockwell Space Division**. It consisted of Command/Service Module 107, code-named *Columbia*. With the Launch Escape Subsystem, it was 65 feet long and weighed 74,000 pounds.

The crew chosen to carry out the mission consisted of **Neil A. Armstrong**, the commander, **USAF Col. Edwin E. "Buzz" Aldrin, Jr.**, the Lunar Module Pilot, and **USAF Lt. Col. Michael Collins**, the Command Module Pilot. Armstrong and Aldrin were to land on the Moon while Collins orbited the Moon awaiting their return. Each had been in space once before as a pilot on a Gemini mission -- Neil Armstrong's total time aboard Gemini 8 was 10.7 hours.

The launch window for Apollo 11 opened at 9:32:00 am EDT (13:32:00 UT) on July 16. However, at 2:55 UT on July 13, the Soviet Union launched the Luna 15 spacecraft to the Moon. Its mission: to land on the Moon and return the first lunar soil back to the Earth to upstage the Apollo 11 mission. At 10:00 UT on July 17 it successfully went into orbit around the Moon.

The launch of Apollo 11 occurred on schedule on July 16. Four days later, with less than thirty seconds of propellant remaining, Neil Armstrong and Buzz Aldrin announced “Houston, Tranquility Base here, the *Eagle* has landed.” They had successfully landed the Lunar Module *Eagle* on the Sea of Tranquility at 20:17:42 UT on July 20, 1969. Neil was the first one to make his footprint in the lunar soil at 02:56:19 UT on July 21, 1969, when he said “*That’s one small step for [a] man--one giant leap for mankind.*”

Half of the goal set by President Kennedy over eight years before had been achieved for they still had to make it safely back to Earth to accomplish their mission. At 17:54:01 UT on July 21, after 21.6 hours on the Moon, the crew launched themselves from the Moon’s surface to start their journey home. Just two hours earlier, at 15:51 UT, Luna 15 had crashed into the Sea of Crises (17N, 60W) at 300 mi/hr about 600 nautical miles northeast of Tranquility Base after completing 52 lunar orbits.

The crew of Apollo 11 successfully accomplished their mission and the goal set by President Kennedy when they landed aboard *Columbia* in the Pacific Ocean at 16:50:35 UT on July 24 and were recovered by CVS-12, the *USS Hornet*. They had returned with 48.8 pounds of lunar samples and had left behind the American flag along with a plaque with the words

**HERE MEN FROM THE PLANET EARTH  
FIRST SET FOOT UPON THE MOON  
JULY 1969 AD.  
WE CAME IN PEACE FOR ALL MANKIND**

The command module *Columbia*, weighing 11,700 pounds, and the descent stage of the *Eagle*, weighing 5,078 pounds, are the only remaining remnants of the vehicle that originally weighed 6,484,280 pounds. Today, *Columbia* is located in the National Air and Space Museum in Washington, D.C. and *Eagle’s* descent stage is located at 0.647 deg. N latitude, 23.505 deg. E longitude, Tranquility Base.

## Today In History -- July 26

Twenty-five years ago today, at 13:34:00 UT (9:34:00 am EDT) on July 26, 1971, the Apollo 15 mission to perform the fourth manned lunar landing was launched from Launch Complex 39A at Kennedy Space Center. The crew consisted of **David R. Scott**, commander, **Alfred M. Worden**, CM pilot, and **James B. Irwin**, LM pilot.

It was the first “J-type” Apollo mission -- the first true scientific manned mission to the Moon. At the time, it was the heaviest payload to be launched into orbit around both the Earth (309,828 lbs.) and the Moon (74,522 lbs.). To carry out this mission, much of the Apollo hardware and flight procedures, from the spacesuits to the Saturn V (AS-510) launch vehicle, had to be modified. For example, the **North American Rockwell**-built Command/Service Module-112, code-named *Endeavor*, was transformed into a Moon orbital laboratory. The service module was equipped with the Scientific Instrument Module (SIM) for photographing and scanning the Moon and a small subsatellite that was ejected into lunar orbit. In addition, an EVA panel was added inside the CM with a 25 ft. long oxygen umbilical to allow the crew to retrieve cassettes and film magazines from the SIM. To lift the heavy payload, the Saturn V first stage F-1 engines, built by Rocketdyne, were modified for 3 % higher flow rate to produce higher thrust.

The lunar landing site chosen for Apollo 15 was the most dangerous one of all the Apollo missions to reach. It was located at a high (26 degrees) latitude in a valley in the Apennine Mountains cut at one end by a deep lava channel called Hadley Rille. To reach it, the spacecraft had to be put into a non-return trajectory at translunar injection and clear the 13,000 ft. high lunar mountains by less than 8900 feet. The pinpoint landings of Apollo 12 and 14 had given confidence that it could be done.

Despite having the lunar surface obscured by moon dust blown up by the descent stage engine, Dave Scott and Jim Irwin successfully made the pinpoint landing of their LM, *Falcon*, at 22:16:29 UT on July 30. During their 66.9 hour stay on the surface, they performed four EVA's totaling 19 hrs. 8 minutes. The first one was a 33 minute stand-up EVA by Dave Scott who viewed the lunar surface through the top of the LM by standing on the cover of the LM ascent stage engine. The remaining three were surface excursions accomplished in the first Moon car, called the Lunar Roving Vehicle (LRV), in which the crew traveled a total distance of 17.3 miles and gathered 169 pound of lunar samples. This was nearly ten times the distance traveled and twice the amount of samples obtained by the previous Apollo crews. The crew also doubled the scientific payload deployed on the Moon.

Following their departure from the surface and docking with the *Endeavor*, the crew ejected the subsatellite into orbit around the Moon and Al Worden performed the first-ever deep space EVA. The Apollo 15 crew completed their mission after a record 12.3 days when they splashed down in the Pacific ocean at 20:45:53 UT August 7, 1971, and were recovered by LPH-3, the *USS Okinawa*. Fortunately for them, they were the first crew allowed by NASA to return from a lunar landing mission without stringent quarantine regulations.

Today, the *Endeavor* is located at the US Air Force Museum in Dayton, Ohio, and the descent stage of *Falcon* is located at 26.101 deg N, 3.653 deg E on the Moon.

## Today In History -- July 28

Following the successful completion of the Apollo Program with the splashdown of the final Apollo mission, Apollo 17, on December 19, 1972, NASA's focus for manned spaceflight shifted from the Moon to the Earth with the Skylab Program. The objectives of the program were to prove that people could live and work in space for extended periods and to expand our knowledge of the Earth resources and solar astronomy.

Skylab was America's first experimental space station and made extensive use of Apollo and Saturn hardware. It consisted of an Orbital Workshop, an Airlock Module, a Multiple Docking Adapter, an Apollo Telescope Mount, and an Instrument Unit. The 48 ft. long Orbital Workshop was derived from the S-IVB stage, the third stage of the Saturn V. It was the largest satellite launched into orbit up to that time -- it was 84 ft. long, 21.6 ft. in diameter, weighed over 160,000 pounds, and had a habitable volume of 12,200 cubic feet, more than 50 times that of the Apollo command module.

Skylab was launched unmanned into a 269 mile altitude Earth orbit by the only two-stage version of the Saturn V, AS-513, from Complex 39A at Kennedy Space Center on May 15, 1973. The orbital inclination of 50 degrees was the highest inclination of all U.S. manned spaceflights up to that time, allowing observation of 80% of the populated surface of the Earth. A total of three three-man crews were launched from Complex 39B by Saturn IB boosters to Skylab aboard Apollo command/service modules (CSM) built by **Rockwell International Space Division in Downey**. During 171.5 days aboard Skylab, they conducted nearly 300 scientific experiments. Never before had there been so many experiments carried by a single space vehicle. The man-hours in space and in EVA under microgravity conditions during the Skylab missions exceeded the combined totals of all the world's previous space flights up to that time.

The second Skylab crew was launched aboard CSM-117 on the Skylab 3 mission twenty-three years ago today at 11:10:50 UT (7:10:50 am EDT) on July 28, 1973. The crew members were **Alan L. Bean**, commander, **Jack R. Lousma**, pilot, and **Owen K. Garriott**, science pilot. They were the most productive crew ever to fly in space, having exceeded every objective set for the mission. During 858 revolutions around the Earth in which they traveled 24.5 million miles, they performed three EVA's lasting 13.73 hours and made 1084.7 astronaut-utilization hours of solar and Earth experiments. They obtained 74,942 film frames of solar observations as well as 16,800 film frames and 93,600 feet of magnetic tape containing Earth observation data.

When the crew splashed down in the Pacific Ocean at 22:19:54 UT on September 25, 1973, they had set a new record for time spent in space -- 59 days, 11 hours, 9 minutes, 4 seconds -- more than twice the length of any previous mission. They were recovered by LPH-11, the USS New Orleans. Today, the Skylab 3 command module is located at the Lewis Research Center in Cleveland, Ohio. Skylab re-entered the atmosphere on July 11, 1979.

## Today In History -- July 30

Today in history, at 22:16:29 UT (6:16:29 pm EDT) on July 30, 1971, the fifth manned landing on the Moon was accomplished by **Dave Scott** and **Jim Irwin** during the Apollo 15 mission. They were launched with **Al Worden** on the SA-510 Saturn V launch vehicle at 13:34:00 UT on July 26 from Kennedy Space Center, Florida. They rode in the **North American Rockwell**-built Apollo spacecraft CSM-112 which they named *Endeavor*. It was the first J-series Apollo mission carrying the first Moon car.

Scott and Irwin landed in the lunar module, LM-10, code-named *Falcon*, near the 1200 foot deep Hadley Rille on the eastern edge of Mare Imbrium. It was located next to the 8000 foot high Apennine Mountains. Their Moon car was ten feet long, six feet wide, and weighed only about 85 pounds on the Moon! Each of its four wheels was driven by an electric motor powered by two batteries. During three trips on the Moon's surface lasting eighteen and a half hours, they traveled 17.3 miles and collected over 170 pounds of Moon rocks.

Their launch from the Moon was the first televised launching from another world. After Scott and Irwin transferred back into *Endeavor*, the *Falcon's* ascent stage was deliberately crashed into the Moon at 26.36 degrees North, 0.25 degrees East on August 3. Before they left lunar orbit, the crew accomplished the first launch of a satellite by a manned spacecraft on August 4. It was an eighty pound satellite ejected from the service module that remained in orbit around the Moon to obtain data on the interaction between the Earth's magnetic field and the Moon.

After a 1,275,084-mile journey lasting 12.3 days, the crew splashed down at 20:45:53 UT on August 7 in the Pacific Ocean 325 miles north of Hawaii just 6.32 miles off target! The crew and *Endeavor* were recovered by LPH-3, the *USS Okinawa*.

Today, *Endeavor* is on display at the United States Air Force Museum in Dayton, Ohio, and the descent stage of *Falcon* is located on the Moon at 26.1008 degrees North, 3.628 degrees East.

## Today In History -- July 31

On this day in history at 13:56:48 UT (9:56:48 pm EDT) on July 31, 1992, the Space Shuttle was launched into Earth orbit on the STS-46 mission from LC-39B at Kennedy Space Center in Florida. The entire night sky lit up as bright as day when the Space Shuttle's engines ignited. It was the twelfth flight for *Atlantis* built by **Rockwell International**. The crew consisted of commander **Loren Shriver**, pilot **Andrew Allen**, payload commander **Jeffrey Hoffman**, mission specialists **Franklin Chang-Diaz** and **Marsha Ivins**, and payload specialists **Claude Nicollier** and **Franco Malerba**. Nicollier and Malerba were Swiss and Italian astronauts, respectively, who were representing the European Space Agency (ESA).

*Atlantis* carried a 34,090-pound payload consisting of two satellites. The first one was the first tethered satellite system, TSS-1, built by NASA and the Italian Space Agency. It was a satellite that was attached by a 12-mile line to the Orbiter. It was to study the dynamics and electrodynamics of tethered systems in space as well as the physics of the Earth's atmosphere. The second satellite was the 9424-pound European Retrievable Carrier called "Eureca". It was a free-flying reusable platform built by ESA designed to perform microgravity experiments. It could be launched and retrieved by the Space Shuttle.

TSS-1 was reeled out starting at 21:19 UT on August 4 to 816 feet and was reeled back and stowed in the Orbiter's payload bay by 23:00 UT on August 5. Eureca was deployed from the payload bay at 07:06 UT on August 2 and put into a 316 mile-high circular orbit on August 7. It remained in orbit for eleven months and was then retrieved by the Space Shuttle *Endeavor* on June 24, 1993 during the STS-57 mission.

After 127 orbits, *Atlantis* landed on August 8 at the Kennedy Space Center 7 days 23 hours 16 minutes after liftoff to successfully complete the forty-ninth Space Shuttle flight.

## Today In History -- August 16

The Apollo missions leading to the first Moon landing were designated by the following letters in a scheme devised by **Owen Maynard** at NASA's Langley Research Center:

A: unmanned Saturn V test

B: unmanned LM test

C: first manned Apollo flight

D: first manned Saturn V flight with CSM and LM in low Earth orbit

E: manned flight with CSM and LM in high Earth orbit

F: first manned lunar orbit mission with CSM and LM

G: first manned lunar landing.

All the missions had to be performed to achieve the goal of landing a man on the Moon. Although much progress had been made toward achieving the goal within the decade of the 1960's as set by **President Kennedy**, there also were serious setbacks that threatened the program. By August of 1968, only missions A and B had been performed successfully and the C mission, Apollo 7, was 21 months behind schedule.

On January 27, 1967, the Apollo 1 astronauts **Gus Grissom**, **Ed White** and **Roger Chaffee** died in a fire in CM 012 at Pad 34 while preparing for the original C mission. It resulted in an investigation, modifications to the CSM design, and rescheduling of the program.

On April 4, 1968, the day **Dr. Martin Luther King, Jr.**, was killed, the second A mission, Apollo 6, was launched to test the redesigned CSM. Although all major flight test objectives were met, it was not a complete success. There were severe longitudinal oscillations ("POGO") during first stage which caused parts of the spacecraft adapter atop the third stage to break away, two J-2 engines shutdown prematurely during operation of the S-II second stage, and the planned re-ignition of the S-IVB third stage failed.

In addition, LM-3, the lunar module that was scheduled to be flown on the D mission, was behind schedule. Although it had arrived at the Cape in June for a flight in November, it would not be ready for flight until February 1969 at the earliest.

In order to get back on a schedule that would achieve the lunar landing in 1969, **George Low**, head of the Apollo Spacecraft Program office, proposed interchanging missions D and E and turning mission E into a mission "C-prime" -- a manned Saturn V flight which would send the CSM to orbit the Moon without the LM in December. Although all the objectives of mission E could be achieved without the LM and the causes of the Saturn V problems had been determined and fixes made, it was a daring plan. On the first manned Saturn V flight (the first Saturn V to fly after the Apollo 6 failures) and with only the second manned Apollo spacecraft to fly, the crew would go all the way to the Moon to become the first men ever to do so!

In meetings at the Manned Spacecraft Center in Houston, Kennedy Spaceflight Center, Marshall Spaceflight Center, and NASA Headquarters, Low was able to convince the key NASA directors and managers that his plan was viable. **George Mueller**, head of the Office of Manned Spaceflight, and **Jim Webb**, NASA Administrator, who had been attending a conference in Vienna, were then contacted in mid-August for their approval.

On August 16, 1968, twenty-eight years ago today, Jim Webb cabled Washington authorizing preparations for the advanced mission. The plan would be implemented, however, only if the Apollo 7 flight was a complete success. Thus, the success of the first manned mission to the Moon depended on the perfect performance of two spacecraft built by **North American Rockwell Space Division in Downey** -- CSM-101 on Apollo 7 and CSM-103 on Apollo 8, the "C-prime" mission.

## Today In History -- September 11

On the Apollo Project, a “building block” principle was used to build a family of launch vehicles tailored to the needs of particular missions. The family was called “Saturn” and the various configurations were designated as Saturn A, Saturn B, and Saturn C. For each basic configuration, several combinations of upper stages resulting in Saturn A-1, A-2, etc., were assessed. Eventually, it was determined that the Apollo test flights and operational missions could be carried out with three versions of the Saturn C: Saturn C-1, Saturn C-1B, and Saturn C-5 which were later designated Saturn I, Saturn IB, and Saturn V. All the other versions were canceled and never built.

On April 18, 1961, representatives from thirty aerospace firms attended a bidder’s conference on the S-II at MSFC. Three weeks later, on May 15, 1961, initial design and development bids were submitted by seven of the companies: Aerojet General, Chrysler, Convair Astronautics, Douglas Aircraft, Lockheed, Martin Co., and **North American Aviation**. A month after that, on June 15, 1961, NASA asked four of them -- Aerojet, Convair, Douglas, and NAA -- to submit detailed proposals.

On September 11, 1961, thirty-five years ago today, NASA announced that the **NAA Space and Information Systems Division in Downey** had won the contract to build the Saturn S-II stage. At the time, it was to be the second stage of the Saturn C-3 launch vehicle and powered by four Rocketdyne J-2 liquid Hydrogen/liquid Oxygen engines each with a thrust of 200,000 pounds. The Saturn C-3 was subsequently canceled but on November 6, 1961, Marshall Space Flight Center directed NAA to design the S-II with five J-2 engines for use as the second stage of the Saturn C-5, the vehicle which would launch men to the Moon.

Because of its great size, it was decided that the S-II would be constructed vertically and then shipped through the Panama Canal to the Kennedy Space Center by barge on the *USNS Point Barrow* and *SS Steel Structure*. To facilitate this, the stages were built in Seal Beach (instead of Downey) in the world’s largest clean room using what was essentially the world’s largest “pressure cooker” and lathe. Approximately 10,800 NAA personnel worked on the S-II project.

The S-II was the largest, most powerful, and most advanced high-energy rocket system in the world at that time. It was 81.5 ft. long and 33 ft. in diameter. With a loaded weight of 1,074,590 pounds and a dry weight of only 78,050 pounds, it was the most efficient structure ever built up to that time -- it had an inert mass fraction of only 0.0726 and a structural mass fraction better than that of an egg, nature’s perfect design! Its five J-2 engines produced a vacuum thrust of 1,163,854 pounds and 95.4 billion Watts of power, equivalent to 72 Hoover dams! This boosted the Apollo spacecraft and Saturn V third stage from an altitude of 38 nautical miles and speed of 9000 ft/sec at first stage burnout to an altitude of 100 nautical miles and a speed of 23,000 ft/sec.

The first test firing of the S-II was performed at Santa Susana on April 24, 1965, and the first flight was on the Apollo 4 launch vehicle, AS-501, on November 9, 1967.

## Today In History -- October 11

At 15:02:45 UT (10:02:45 am EST) on October 11, 1968, twenty-eight years ago today, the first manned Apollo mission, Apollo 7, was launched into a 154 nmi x 123 nmi Earth orbit with an inclination of 31.6 degrees. The crew was launched on a Saturn IB (AS-205) from Launch Complex 34 at Kennedy Space Center, the first and only time in the Apollo Project that men were launched on a Saturn I vehicle. It was also the first three-man American crew to travel into space. **Wally Schirra**, the commander, was the only astronaut to fly Mercury, Gemini, and Apollo spacecraft. The other crew members were rookies -- **Donn Eisele** was the CM pilot and **Walt Cunningham** was the LM pilot.

The Apollo 7 spacecraft, CSM-101 (unofficially named *Phoenix*), was the first Block II model built by the **North American Rockwell Space Division in Downey**. As a result of the Apollo 1 fire in 1967, it had been redesigned for safety incorporating more than 1800 changes to systems and procedures. The two-piece side hatch had been replaced by a quick-opening one-piece hatch -- it could be opened in less than seven seconds compared to ninety seconds for the previous design. Flammability within the CM was reduced -- nearly all of the 1412 nonmetallic items were replaced by nonflammable materials or shielded by firebreaks, the twenty miles of wiring were redesigned and insulated with Teflon wrapping, and most of the aluminum pipes carrying oxygen were replaced by stainless steel ones. In addition, systems redundancy was increased to reduce single failure points and plumbing joints were “armored” so that damage during assembly and test could not cause leaks.

Amazingly, the modifications were accomplished so that the CM size and weight did not change and, due to the diligence and hard work of NAR’s **John Healy** and his team, CM-101 was the cleanest spacecraft yet delivered to NASA from a contractor. It was cleared with only 13 discrepancies in the final acceptance review, all of which were corrected before it left Downey for KSC on May 29, 1968.

The primary objectives for this flight were to demonstrate the performance of the CSM with crew and the ground support facilities. This included simulating docking and LM extraction to demonstrate rendezvous capability with the S-IVB upper stage and test the rendezvous radar transponder, testing the environmental control system radiator, and testing the Service Propulsion System (SPS). To test the SPS, the engine performed eight firings (the largest number of in-flight restarts performed to that time) ranging from minimum impulse burns of 0.5 second to the longest planned burn of 67.6 seconds. These included the first digital-autopilot-controlled engine burn ever accomplished. During the mission, the first live in-flight television (the “Wally, Walt and Donn Show” from “The Lovely Apollo Room High Atop Everything”), the first hot meals in space, and the first manned S-band communications were also accomplished.

Apollo 7 splashed down at 11:11:48 UT on October 22 in the Atlantic Ocean southeast of Bermuda where the CM and crew were recovered by CVS-9, the *USS Essex*. The mission lasted a total of 10 days, 20 hours, 9 minutes and 3 seconds -- more than the time required for a round-trip mission to the Moon. The crew had orbited the Earth 163 times, traveled 4.5 million miles, and accomplished all primary objectives as well as every detailed test objective and three not originally planned. The Director of NASA's Apollo Program Office, **Sam Phillips**, considered Apollo 7 to be a "101%" success. With the successful completion of this mission, the CM and SM designs were qualified for lunar flight. As a result, on November 11, 1968, the acting administrator of NASA, **Tom Paine**, formally assigned the next Apollo flight, Apollo 8, to be the first manned mission to orbit the Moon.

Today, CM-101 is located at the National Museum of Science and Technology in Ottawa, Canada, where it is on public display.

## Today In History -- November 7

Thirty-three years ago today, on November 7, 1963, the first flight test of an Apollo command module boilerplate built by **North American Aviation Space and Information Systems Division in Downey** took place at White Sands Missile Range, New Mexico. The test was known as PA-1 and its purpose was to test the ability of the Launch Escape System (LES) to perform a launch abort while on the launch pad. The hardware consisted of Boilerplate-6 (BP-6) with tower structure, LES motor, pitch control motor, tower-jettison motor, and tower-release mechanism.

The objectives of the test were to: (1) determine aerodynamic stability characteristics of escape configuration during pad abort, (2) demonstrate capability of escape system to propel cm to safe distance from launch vehicle during pad abort, (3) demonstrate launch-escape timing sequence, (4) demonstrate proper operation of tower-release device, (5) demonstrate proper operation of tower-jettison and pitch-control motors, and (6) demonstrate Earth-landing timing sequence and operation of parachute subsystem.

The LES was to be activated automatically by an emergency detection system during the first 100 seconds of flight or manually any time from the pad to jettison altitude. During a successful launch with the Saturn V, it would be jettisoned by the astronauts at about 295,000 ft. altitude about 30 seconds after ignition of the NAA S&ISD - built second stage. During a successful launch with the Saturn IB, it would be jettisoned at about 275,000 ft about 20 seconds after second stage ignition.

It was able to lift the 13,000 pound command module and carry it a mile away from the launch vehicle. It was 33 feet long, had a maximum diameter of 4 feet and weighed 8700 pounds. The LES motor was manufactured by Lockheed Propulsion Co. in Redlands, California. This motor contained solid propellant, was 15.5 feet long, weighed 4700 pounds, and produced 147,000 pounds of thrust over a burn time of 3.2 seconds. By comparison, the Mercury Redstone booster which sent **Alan Shepard** and **Gus Grissom** into space on the MR-3 and MR-4 missions in 1961 had a thrust of only 78,000 pounds.

During the PA-1 test, the LES took BP-6 to a peak altitude of 5250 feet and the boilerplate landed on parachutes 7600 feet downrange. All test objectives were achieved -- it was the first step on a path that led to the Moon. BP-6 was subsequently modified three time for use in parachute recovery tests. Its current location is unknown.

## Today In History -- November 9

*“We shall send to the Moon, more than 240,000 miles from the control center in Houston, a giant rocket more than 300 feet tall, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food, and survival, on an untried mission to an unknown celestial body....”*

President John F. Kennedy  
September 12, 1962

To achieve President Kennedy’s goal of landing men on the Moon in the decade of the 1960’s, **Dr. George Mueller**, NASA’s Associate Administrator for Manned Space Flight, introduced “all-up flight testing”. In this concept, new elements would be flight tested simultaneously instead of individually. This was applied to the development of the largest and heaviest launch vehicle ever to become operational, the Saturn V -- the vehicle which would launch the Apollo astronauts to the Moon. Development of the Saturn V was the responsibility of the Marshall Space Flight Center in Huntsville, Alabama, directed by **Dr. Wernher von Braun**. In 1963 he made **Arthur Rudolph** the Saturn V project manager, said to have been the most complex and difficult job in the aerospace business. They called him “Mr. Saturn.”

The Saturn V was designed to place a payload of 278,700 pounds into Earth orbit and 105,000 pounds to escape velocity. Propellant consisted of 89 trailer-truck loads of liquid oxygen, 28 trailer loads of liquid hydrogen, and 27 rail cars of kerosene. With the Apollo spacecraft, Apollo/Saturn V stood 363 ft. tall and weighed 6,220,000 pounds at ignition. The five **Rocketdyne** F-1 engines in the first stage consumed 29,000 pounds of propellant a second, produced a total thrust of 7,681,000 pounds at liftoff and generated 180 million horsepower -- 85 times as much power as the Hoover dam!

Twenty-nine years ago today at 12:00:01 UT (07:00:01 EST) on November 9, 1967, the first Saturn V launch vehicle, SA-501, was launched from Kennedy Space Center on the unmanned Apollo 4 mission. It was the first launch from LC 39A and the first flight test of the **Boeing** S-IC and **North American Rockwell Space Division-Seal Beach** S-II stages. The objectives were to (1) demonstrate structural and thermal integrity and compatibility of launch vehicle and spacecraft; (2) confirm launch loads and dynamic characteristics, (3) verify operation of Block II CM heatshield for reentry at lunar return conditions, Service Propulsion System (SPS) and selected subsystems, (4) evaluate performance of emergency detection system in open-loop configuration, and (5) demonstrate mission support facilities and operations needed for launch, mission conduct, and CM recovery.

The 81,091 pound payload, consisting of CSM-017 produced by **North American Rockwell Space Division - Downey** and a lunar module test article, LTA-10R, was successfully placed into a 98.8 nmi x 101 nmi orbit around the Earth. After two orbits, the third stage ignited marking the first restart of a **Rocketdyne** J-2 engine in space. During the third orbit, the SPS engine fired for fifteen seconds and the spacecraft coasted to a simulated translunar trajectory, reaching an altitude of 9762 nmi. A second firing during descent accelerated the CM to a reentry speed of 36,335 ft/sec, the lunar return velocity. The peak deceleration reached during reentry was 7.3 g's. At 08:37 UT, the command module splashed down in the Pacific Ocean northwest of Hawaii and was recovered by CVS-20, the *USS Bennington*, 2.5 hours later. All mission objectives were achieved.

Following the mission, **General Sam Phillips**, director of the Apollo program, said:

*"I was tremendously impressed with the smooth teamwork that this combined government/multi-industry team put together. It was smooth, it was professional, it was confident. It was perfect in every respect. It was a powerful operation. You could almost feel the will with which it was being carried out. Apollo is on the way to the Moon."*

The Saturn V was flown twelve more times to send the first men to the Moon and put the first space station in Earth orbit -- all successful. It became the standard for reliability, robustness, on-time launch and heavy-lift capability. Because of this outstanding performance, the U.S. Army awarded Arthur Rudolph the Exceptional Civilian Service Award and NASA honored him with the Distinguished Service Medal. However, in May 1984, the Office of Special Investigations in the Department of Justice took away his American citizenship and deported him to West Germany for alleged war crimes.

Today, CM-017 is on display at the Stennis Space Center in Mississippi. There are also three Saturn V's on display. The one at the Space and Rocket Center in Huntsville, Alabama, SA-500D, consists of stages built for ground tests. In 1987, it became the only launch vehicle ever to be designated as a national historic engineering landmark. The one at the Kennedy Space Center in Florida is composed of two ground test stages and one flight stage. It is now on display in the newly-built 99,000 sq. ft. Apollo/Saturn V Center at KSC. The third one is on display at the Johnson Space Center in Houston, Texas, and is the only "true" Saturn V remaining, each of its stages coming from the last three Saturn V's built. Its first stage is from SA-514, its second stage from SA-515 and its third stage from SA-513. Ironically, it has not been designated as a national landmark and there are no plans for it to be in an enclosed museum.

## Today In History -- November 14

Twenty-seven years ago today, Apollo 12 was launched by the SA-507 Saturn V vehicle from Launch Complex 39A at Kennedy Space Center at 16:22:00 UT (11:22:00 am EST) on November 14, 1969. The crew consisted of Commander **Pete Conrad**, CM pilot **Dick Gordon**, and LM pilot **Alan Bean**. Their spacecraft were **North American Rockwell Space Division**-built CSM-108, *Yankee Clipper*, and LM-6, *Intrepid*. It was the first H-type mission which provided for a longer duration on the Moon. The objective was precision targeting and pinpoint landing at Apollo Landing Site 7 on the Moon about 930 miles west of Tranquillity Base.

During the first minute of launch, the vehicle was struck twice by lightning, the exhaust plume acting as a giant lightning rod. Virtually all the circuit breakers in the command module were tripped and the spacecraft systems were temporarily knocked off line but the launch vehicle's systems were unaffected. Incredibly, a check of the spacecraft's systems in Earth orbit showed the *Yankee Clipper* and *Intrepid* to be in excellent condition and Apollo 12 was given the OK to go to the Moon!

Lunar landing took place on the Oceanus Procellarum (Ocean of Storms) at 06:54:36 UT November 19, just 553 feet from Surveyor 3 which had landed there on April 20, 1967. The region has been known as Mare Insularum since 1976. When Conrad became the third man to set foot upon the lunar surface he said "*Man, that may have been a small one for Neil, but that's a long one for me!*" During their two EVA's lasting 7 hours, 45 minutes, Conrad and Bean set up the first color TV from the Moon (which unfortunately failed), deployed the first Apollo Lunar Surface Experiments Package (ALSEP), collected 75.73 pounds of lunar samples, and retrieved parts from the Surveyor. These parts were later found to contain Earth bacteria which had survived two and a half years of heat, cold, dryness, and vacuum conditions on the Moon!!

After a surface stay of 31.5 hours the crew launched from the Moon to dock with *Yankee Clipper*. Afterwards, they sent *Intrepid* to crash on the Moon with the energy of one ton of TNT and the resulting "moonquake" was sensed by the ALSEP. The crew then performed the transearth injection after 45 lunar orbits lasting 86 hours and 56 minutes. On November 24, after a mission duration of 10 days 4 hours 36 minutes 25 seconds, the crew splashed down in the Pacific Ocean and were recovered by CVS-12, the *USS Hornet*. The goal set by President Kennedy eight and a half years earlier had been exceeded -- by the end of the decade, twelve men on four missions had traveled to the Moon and back and four of them had walked on its surface.

Today, *Yankee Clipper* is on display at NASA Langley Research Center in Hampton, Virginia, and the descent stage of *Intrepid* is located at 3.1975 deg. S, 23.3855 deg. W on the Moon's Ocean of Storms. The television camera that the crew retrieved from Surveyor III is on display at the National Air and Space Museum in Washington, D.C.

## Today In History -- November 16

The launch of the last Skylab mission was planned for November 10, 1973, so that the crew would be able to observe Comet Kohoutek which was predicted to reach perihelion on December 28, 1973. However, the launch was delayed to replace the eight fins on the Saturn IB launch vehicle, AS-208, which were found to have cracks.

**Skylab 4** was launched twenty-three years ago today at 14:01:23 UT (9:01:23 am EST) on November 16, 1973, from LC-39B at Kennedy Space Center. It was the third and final launch of a crew to the Skylab space station. The crew consisted of commander **Jerry Carr**, pilot **Bill Pogue**, and science pilot **Ed Gibson**. They were launched aboard the **Rockwell International Space Division**-built Apollo CSM-118 weighing 34,291 pounds.

During the mission, the crew performed inflight experiments, collected solar and Earth resources data, obtained biomedical data on themselves, and performed 4 EVA's. Comet Kohoutek made its appearance in the inner solar system on schedule and the crew made the first observations of a comet from space using a special ultraviolet camera.

They splashed down in the Pacific Ocean at 15:16:54 UT on February 8, 1974, and were recovered by LPH-11, the *USS New Orleans*. It was the longest U. S. manned space mission until **Dr. Norm Thagard's** flight aboard the Russian Mir space station from March to July, 1995. During 84 days 11 hours 15 minutes 31 seconds of the mission, the Skylab 4 crew traveled 34.5 million miles and orbited the Earth 1,214 times. Due to public apathy, however, this was the first splashdown since 1966 that was not covered on live television. The day after splashdown, the telemetry transmitters on Skylab were commanded off.

After the mission, **Jim Fletcher**, NASA Administrator, said

*"In a very real sense, Skylab can be considered a turning point for it possessed many qualities and ingredients that will characterize missions of the future. It has moved the space program from the spectacular into a new phase. It has contributed to an orderly transition from the Apollo era to the Space Shuttle..."*

Before the Space Shuttle flights, however, Apollo hardware was to be used for one more manned spaceflight -- the Apollo-Soyuz mission with the USSR scheduled for July 1975.

Three crews consisting of nine astronauts spent 171 days aboard Skylab -- more time in space than had been accomplished by all previous U.S. manned space flights combined! They traveled over 70 million miles, equivalent to 150 round trips to the Moon, and accomplished the following:

- 941 hours of solar astronomy obtaining 128,000 photos of the sun,
- 569 hours of Earth observations with more than 46,000 photos of the Earth and 45 miles of magnetic tape containing data on Earth resources,
- 274 hours of astrophysics experiments,
- 824 hours of life science investigations,
- 156 hours of Comet Kohoutek observations,
- 29 hours of student experiments, and
- 9 EVA's lasting 41 hours 46 minutes.

The 77-ton Skylab space station disintegrated during reentry into the atmosphere over Australia on July 11, 1979. Today, CM-118 is on display at the National Air and Space Museum in Washington, D.C., along with the backup Skylab Workshop.

## Today In History -- November 22

In a special state of the union address to Congress on May 25, 1961, **President John F. Kennedy** set the goal for the nation to land a man on the Moon and return him safely to the Earth in the decade of the 1960's. On November 22, 1963, thirty-three years ago today, President Kennedy landed in Dallas, Texas, to attend a luncheon at the Dallas Trade Mart where he was to deliver another speech. It went undelivered because he was assassinated during the trip from the airport. The following are excerpts from that speech:

*"...I have spoken at length largely in terms of the deterrence and resistance of aggression and attack. But, in today's world, freedom can be lost without a shot being fired, by ballots as well as bullets. The success of our leadership is dependent upon respect for our mission in the world as well as our missiles -- on a clearer recognition of the virtues of freedom as well as the evils of tyranny.*

*...And that is also why we have regained the initiative in the exploration of outer space, making an annual effort greater than the combined total of all space activities undertaken during the fifties ... and making it clear to all that the United States of America has no intention of finishing second place in space. This effort is expensive -- but it pays its own way, for freedom and for America....*

*There is no longer any fear in the free world that a Communist lead in space will become a permanent assertion of supremacy and the basis of military superiority. There is no longer any doubt about the strength and skill of American science, American industry, American education, and the American free enterprise system. In short, our national space effort represents a great gain in, and a great resource of, our national strength."*

In honor of President Kennedy, **President Lyndon Johnson** signed Executive Order No. 11129 to change the name of the Launch Operations Center at Cape Canaveral, Florida, to the John F. Kennedy Space Center. **Dr. Kurt Debus**, director of KSC, later wrote: *"The renaming of our facilities to the John F. Kennedy Space Center is the result of an executive order, but to me it is also fitting recognition to his personal and intense involvement in the National Space Program."*

## Today In History -- November 28

*“No one could deny that it was a beautiful piece of metal, a metallurgical product that was a great credit to the industrial genius of the Americans.”*

From the Earth to the Moon  
by **Jules Verne**, 1865

Thirty-five years ago today, on November 28, 1961, NASA awarded North American Aviation a design and development contract for the Apollo command and service modules. At the time, the United States had accomplished only two manned suborbital Mercury/Redstone flights lasting a grand total of thirty minutes! Experience with the X-15 put NAA in the leading position for this contract. **NAA's Space and Information Systems Division in Downey** would build the Apollo spacecraft.

The Apollo command module contained over two million functional parts not counting wires and structural components. It also contained 15,000 wires with a total length of 15 miles and used only two kilowatts of electrical power. The panel display had 24 instruments, 566 switches, 40 event indicators, and 71 lights. It had a habitable volume of 210 cubic feet and weighed 12,500 pounds. The service module supplied the electricity, water, oxygen and primary propulsion for the command module. The service propulsion system engine had a thrust of 20,500 pounds with a firing duration from 0.4 to 500 seconds and could be restarted up to fifty times. It had a length of 24 feet 2 inches and a fueled weight of 54,000 pounds. With the launch escape system, the combined spacecraft had a total of 32 rocket engines.

The contract called for development and fabrication of

- 49 manned or test spacecraft command and service modules,
- 30 boilerplate (engineering test) vehicles,
- 23 full-scale mockups,
- accompanying spacecraft-LM adapters,
- 5 test fixtures,
- 4 Apollo mission simulators,
- 3 evaluators,
- 5 trainers,
- 2 miscellaneous spacecraft-LM adapters, and
- tracking and ground support equipment.

The total value of the contract by July 31, 1970 was 3.3 billion dollars.

## Today In History -- December 1

*“As for the Yankees, their sole ambition now was to take possession of that new continent in the sky, to plant on its highest peak the starry flag of the United States of America.”*

From the Earth to the Moon  
by **Jules Verne**, 1865

One hundred and twenty-three years ago today, at 10:46:40 p.m. EST on December 1, 1873, the first men to travel to the Moon were launched--at least according to **Jules Verne** in his novel *“From the Earth to the Moon”* published in 1865. The project was undertaken by The Baltimore Gun Club whose president, Impey Barbicane, was the commander of the voyage. The other two crew members were Captain Nicholl from Philadelphia and Michel Ardan from Paris France. The crew rode in an aluminum capsule shot from a 900 foot long cannon loaded with 400,000 pounds of guncotton!

Even though it was purely fiction, having been written over a hundred years before the actual event, it is amazing how closely some of the details mentioned in the novel matched the Apollo 8 mission which achieved the first manned lunar voyage in reality. Both were post-war projects undertaken by the United States for the peaceful use of technologies developed during war. In addition, consider the following:

	<u>Jules Verne</u>	<u>Apollo 8</u>
Spacecraft		
Manufacturer	Breadwill & Co.	<b>North American Rockwell</b>
Shape	Cylindro-conical	Cylindro-conical
Material	Aluminum	Aluminum, steel, titanium
Height	12 ft.	11 ft. 5 in. (CM)
Diameter	9 ft.	12 ft. 10 in. (max.)
Crew size	3	3
Windows	4	5
Rockets	20	29 (CM + SM)
Crew access	Sealed hatch	Sealed hatch
Empty weight	19,250 lbs.	23,775 lbs. (CM + SM)
Crew members		
Commander	Barbicane	<b>Borman</b>
Age	40	40
Pilot	Capt. Nicholl	<b>Capt. Lovell</b>
Birth year	ca. 1828	1928
Co-pilot	Ardan	<b>Anders</b>
Birth year	1833	1933
Agency membership	32,408	32,000 (end of FY1968)
Vehicle pronounced ready	Sept. 22	Sept. 19
Test flight	Oct. 18	Oct. 11 - 22
Launch date	Dec. 1	Dec. 21
Launch location	Florida	Florida
Initial velocity	36,000 fps	36,228 fps
Splashdown date	Dec. 12	Dec. 27
Splashdown location	Pacific Ocean	Pacific Ocean
Recovery vessel	U.S. naval ship	U.S. naval ship

In his novel, Verne identified the month and days but not the year in which the voyage took place. Based on the clues provided in the story it was probably 1873. Mysteriously however, one of the clues, that the Moon was full when they arrived at midnight on December 4-5, does not quite fit the facts for 1873. Believe it or not, in 1968 when the Apollo 8 astronauts were launched, the full Moon occurred at midnight on December 4-5 -- just as Jules Verne predicted!!!

## Today In History -- December 7

At 09:18:07 UT on November 23, 1972, the fourth and last Soviet N-1 Moon rocket lifted off from the Russian Baikonur Cosmodrome. It was destroyed by range safety 108 seconds later at an altitude of 25 miles after broken fuel lines created fires on board. Meanwhile, at Kennedy Space Center, Apollo 17 was being prepared for the last manned voyage to the Moon in the twentieth century. The commander was **Gene Cernan**, the CM pilot was **Ron Evans** and the LM pilot was **Jack Schmitt**, the only scientist-astronaut ever to go to the Moon.

Twenty-four years ago today, at 05:33:00 UT (12:33:00 am EST) on December 7, 1972, the Apollo 17 crew was launched from Launch Complex 39A at Kennedy Space Center aboard the tenth manned Saturn V, AS-512. It was the only night launch of the Apollo program and was visible as far away as North Carolina! Weight at ignition was 6,530,885 lbs., the largest weight ever lifted off the surface of the Earth by a man-made machine. The 103,232 pound payload consisted of CSM-114, *America*, built by **North American Rockwell Space Division**, and LM-12, *Challenger*. The objectives of the mission were (1) geological surveying and sampling of materials and surface features in a preselected area of the Taurus-Littrow region, (2) deploying and activating surface experiments, and (3) conducting inflight experiments and photographic tasks during lunar orbit and transearth coast.

The sixth and final manned lunar landing took place in the Taurus-Littrow Valley on the Sea of Serenity at 19:54:57 UT December 11, 1972, just 500 feet from the target landing point. The site was bordered to north by massive slopes and undulating hills. It was believed to be a location where rocks both older and younger than those previously returned from other Apollo missions might be found.

During their record 75 hours on the Moon, Cernan and Schmitt made three EVA's lasting over 22 hours. They set up the sixth automated research station, placed 8 explosive charges on the surface to be activated later for a seismographic experiment, drove 21 miles in the third lunar rover vehicle (LRV-3), and collected the largest load of lunar samples -- 243.65 pounds. During one of the EVA's, Cernan and Schmitt made the first automobile repair on the Moon by using some charts as a replacement for one of the rover's fiberglass fenders. The third EVA lasted 7 hours 37 minutes, the longest performed on an Apollo mission.

Liftoff from the Moon occurred at 22:54:37 UT on December 14. After the successful docking with, and crew transfer into, *America*, the ascent stage of *Challenger* was deorbited at 06:31:14 UT on December 15 and impacted on the Moon 19 minutes 7 seconds later with the explosive energy of one ton of TNT. The impact was recorded by the four Apollo 17 geophones and ALSEPs at the Apollo 12, 14, 15 and 16 landing sites.

The crew started their return journey after 75 lunar orbits lasting 6 days 3 hours 48 minutes. On December 17, during the trip home, Evans performed a one hour transearth

EVA to retrieve the lunar sounder film and the panoramic and mapping camera. Splashdown occurred in the Pacific Ocean at 19:24:59 UT on December 19 and the crew and command module were recovered by CVA-14, the *USS Ticonderoga*. They had completed the longest Apollo mission -- 12 days 13 hours 52 minutes -- and achieved all mission objectives successfully. Great nations undertake great adventures and the United States had completed "the most hazardous and dangerous and greatest adventure on which man has ever embarked," Project Apollo.

Today, *America* is on display at Space Center Houston next to Johnson Space Center, Houston, Texas. *Challenger's* descent stage is located at 20.1653 deg. North, 30.7658 deg. East on the Taurus-Littrow Valley of the Moon. A plaque on its number 1 landing gear has the following words inscribed:

**HERE MAN COMPLETED HIS FIRST  
EXPLORATION OF THE MOON  
DECEMBER 1972 AD.  
MAY THE SPIRIT OF PEACE IN WHICH WE CAME  
BE REFLECTED IN THE LIVES OF ALL MANKIND.**

## Today In History -- December 21

The year 1968, by most accounts, was the worst year for the United States since World War II. There were riots, student protests, assassinations, and the war in Viet Nam. In December, the Associated Press voted the assassinations of **Robert Kennedy** and **Dr. Luther King** as the top stories of the year and Time magazine announced it had chosen "The Dissenter" as its "Man of the Year."

However, the Apollo project had recovered from the Apollo 1 disaster with the successful flight of Apollo 7, the first manned Apollo mission, in October. On November 11, 1968, **Tom Paine**, NASA's acting administrator, gave the go-ahead to launch the first men to the Moon on the second manned Apollo mission. The men chosen for the Apollo 8 crew were **Frank Borman**, the commander, **Jim Lovell**, the CM pilot, and **Bill Anders**, the LM pilot.

The mission objectives were to: (1) demonstrate crew/space vehicle/mission support facilities during manned Saturn V / CSM mission, (2) demonstrate translunar injection (TLI), CSM navigation, communications, and midcourse corrections, (3) assess CSM consumables and passive thermal control, (4) demonstrate CSM performance in cislunar and lunar orbit environment, (5) demonstrate communications and tracking at lunar distances, and (6) return high-resolution photographs of proposed Apollo landing sites and locations of scientific interest.

Twenty-eight years ago today, at 12:51:00 UT (7:51:00 am EST) December 21, 1968, Apollo 8 was launched on the first manned Saturn V, AS-503, from Launch Complex 39A at Kennedy Space Center. It was the first manned use of the Moonport and the first manned operation of the Apollo system under conditions for which it was designed. The crew was aboard the 63,531 pound CSM-103 built by **North American Rockwell Space Division in Downey**. A lunar module test article, LTA-B, weighing 19,900 pounds (equivalent to a real LM) was carried as ballast.

Two hours 27 minutes after liftoff, CapCom **Mike Collins** gave the crew the go-ahead for translunar injection (TLI). Ignition of the **Rocketdyne** J-2 engine on the S-IVB stage occurred at 15:41:37.1 UT over Hawaii. The 318.4 second burn increased their speed by over 10,000 ft/sec to 36,228 ft/sec, the fastest speed anyone had ever experienced up to that time! So began their 66 hour coast to the Moon.

The crew became the first men to leave Earth's gravitational influence and enter the Moon's gravitational sphere of influence at 20:29 UT on December 23. They were 202,850 miles from Earth and 38,900 miles from the Moon. At 9:49:45 UT December 24 Apollo 8 disappeared behind the Moon and 9 minutes 35 seconds later the SPS engine ignited for 246.9 seconds to slow their speed by 2934 ft/sec to enter lunar orbit. They made the first naked-eye close-up observations of the Moon including the far side and the Sea of Tranquillity -- landing site of a future Apollo mission.

The crew made two telecasts from lunar orbit. Their second telecast began at 9:30 p.m. EST Christmas eve during which they read the first ten verses of Genesis, heard live by nearly one billion people in 64 countries on Earth. **Borman** ended the telecast by saying

*“...and from the crew of Apollo 8, we close with good night, a Merry Christmas and God bless all of you - all of you on the good Earth.”*

After ten lunar orbits lasting 20 hours it was time for transearth injection (TEI) to start the journey home. This third burn of the SPS engine was absolutely critical to mission success -- if it failed the crew would be stranded with no hope of rescue. In 3200 attempts during ground tests, the SPS engine had failed to fire only 4 times. The SPS engine came through and ignited precisely on time for 203.7 seconds increasing the velocity by 3522.8 ft/sec. At 06:10 UT on Christmas day, Apollo 8 began its 57.5 hour coast home.

Apollo 8 reentered the Earth's gravitational sphere of influence when it reached the neutral point at 17:38:47 UT on December 25 at a distance of 38,920 miles from the Moon and 201,807 miles from Earth. The crew splashed down in the pre-dawn darkness in the Pacific Ocean southeast of Hawaii at 15:51:42 UT on December 27. The crew had traveled faster and farther from Earth than anyone ever had up to that time -- their maximum distance from Earth was 248,258 statute miles. By television, people had seen the Earth from a distance of 195,000 miles and the Moon's surface from a distance of 60 miles. Following the recovery of the crew by CVS-10, the *USS Yorktown*, acting NASA administrator, **Tom Paine**, said

*“We feel proud that we were the ones to perform this historic feat. It might show the restless students of the world the benefits... the triumph of the ‘squares’ who work with computers and slide rules, of engineering and of science, and of men who read from the Bible on Christmas eve.”*

With all objectives achieved, the mission was a resounding success. Of the 5,600,000 parts that made up the Apollo/Saturn V, only 5 parts were known to have failed -- all non-critical. The New York Times called Apollo 8 “the most fantastic voyage of all times” and Time magazine replaced “The Dissenter” with **Borman, Lovell and Anders** as “Man of the Year”.

Today, CM-103 is on display at the Chicago Museum of Science and Technology in Chicago, Illinois.

## Today In History -- January 20

Thirty-one years ago today, at 15:17:01 UT (8:17:01 am MST) on January 20, 1966, the first **North American Aviation S&ID**-built Block I Apollo command module to be flight-tested, CM-002, was launched at White Sands Missile Range. The launch vehicle was the fourth and last Little Joe II to be launched. The ballistic mission was known as A-004. The Little Joe II was powered by five 33,350-pound thrust Recruit rocket motors, all fired on the pad for 1.5 seconds, and four 103,200-pound thrust Algol rocket motors -- two in the first "stage" and two in the second "stage". The second stage motors were housed with the first stage motors but ignited 37 seconds after launch, three seconds before the first stage motors burned out.

The test objectives were to demonstrate satisfactory launch escape subsystem (LES) performance of abort in the power-on tumbling boundary region, demonstrate the structural integrity of the LES airframe structure for such an abort, and deliver the Apollo spacecraft to the desired conditions for demonstration of the launch escape vehicle. The command module reached a peak altitude of 74,150 feet where the LES demonstrated safe escape from a simulated tumbling and thrusting booster. It landed 21.5 miles downrange and achieved all test objectives in the final suborbital Apollo capsule test, clearing the LES for manned operations.

The command module was subsequently modified twice for land drop tests and designated CM-002B. It was then assigned to POGO tests. CM-002B will soon be on display at Cradle of Aviation Museum in Garden City, New York.

## Today In History -- January 27

*"...No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish...."*

**President John F. Kennedy**  
May 25, 1961

Thirty years ago today, around 18:00 UT (1:00 pm EST) on January 27, 1967, the crew selected for the first manned Apollo mission entered CM-012 atop the Saturn IB launch vehicle, AS-204, at Launch Complex 34. The hatches of the command module were sealed at 19:45 UT to begin a "plugs-out" test to simulate countdown on internal power in preparation for the mission. Their mission was scheduled for launch in three and a half weeks on February 21 to check out the command and service modules in Earth orbit. The crew members were Commander **Gus Grissom**, the second astronaut to fly in space and commander of the first Gemini flight, Gemini 3, CM pilot **Ed White**, the first American astronaut to walk in space during the Gemini 4 mission, and LM pilot **Roger Chaffee**, who had not yet flown in space.

Tragically, there was an electrical short circuit causing a fire to break out in the cabin at 23:30:55 UT and the astronauts died of asphyxiation. The subsequent investigation resulted in extensive modification of the command module to prevent a recurrence. In a previous interview, Gus Grissom had said

*"If we die, we want people to accept it. We are in a risky business and we hope that if anything happens to us it will not delay the program. The conquest of space is worth the risk of life."*

Three months after the fire, **Dr. George Mueller**, NASA's Associate Administrator for Manned Space Flight, announced that the unflown mission would be known as Apollo 1. AS-204 was subsequently reassigned to the unmanned Apollo 5 mission launched on January 22, 1968, with the first lunar module (LM-1) as payload. Then on October 11, 1968, the Apollo 1 back-up crew was launched on the Apollo 7 mission. As a tribute to the Apollo 1 crew, the Apollo 11 astronauts left a medallion with the likeness of the Apollo 1 patch on the surface of the Moon. On May 9, 1991, the Space Mirror memorial to all astronauts who have died and sanctioned by the Astronauts Memorial Foundation was dedicated at the KSC Visitors Center.

Since the investigation, CM-012 has been stored at Langley Research Center in Hampton, Virginia, where it is not on public display.

## Today In History -- January 31

During the Apollo 13 launch, two of the **Rocketdyne** J-2 engines in the **North American Rockwell**-built S-II second stage of the Saturn V had a premature automatic shutdown. This was due to 16 hertz oscillations in the liquid oxygen (LOX) feed lines which created pump cavitation and reduced engine thrust. The S-II stage was subsequently fitted with a LOX line accumulator to decouple the frequency of the line from that of the structure and three new acceleration-sensitive modules were added on the S-II thrust structure to shut down only the center engine in case the problem it recurred.

As a result of the explosion aboard the Apollo 13 service module, modifications were also made to the CSM. An additional 330 pounds of available cryogenic oxygen in the service module ensured sufficient environmental support of the CM from a worst case malfunction, a third heater was added, all fans were removed, stainless steel was substituted for Teflon, two new temperature sensors were added to monitor temperature of the bulk oxygen and of the heater, and a LM descent stage battery was installed in the bottom of sector 4 of the service module to ensure the retention of CSM power if all three fuel cells failed. Finally, five extra one-gallon water bags were filled from the fuel cell water production valve for use by the crew in the event of a failure in the prime system.

Twenty-six years ago today, Apollo 14 was launched from Kennedy Space Center Launch Complex 39A at 21:03:02 UT (4:03:02 pm EST) on January 31, 1971, following a 40-minute launch countdown hold due to weather. The crew consisted of commander **Alan Shepard**, the first American astronaut in space, CM pilot **Stu Roosa**, and LM pilot **Edgar Mitchell**. Although Shepard, at 47 years old, was the oldest person to fly on an Apollo mission, he also had the least space experience of anyone to command an Apollo mission -- only fifteen minutes. They were launched by the AS-509 Saturn V launch vehicle aboard the 64,464 pound **North American Rockwell Space Division**-built CSM-110 code-named *Kitty Hawk*. Their lunar module, LM-8, was named *Antares*. Their mission was to land on a gently sloping plateau in the Fra Mauro highlands region at the eastern edge of the Ocean of Storms -- the site originally assigned to Apollo 13.

The crew began their eighty-hour translunar coast at 22:57:20 UT following a 350.8 second burn of the S-IVB engine. Lunar orbit was achieved at 07:05:55 UT on February 4 after the SPS engine was fired for 372.23 seconds. During their fourteenth revolution around the Moon, at 09:05:29 UT on February 5, Shepard and Mitchell began the powered descent to the surface. However, during the descent, landing radar updates on altitude and velocity were not being received. The landing would have to aborted in 90 seconds if the problem was not solved. Mission Control told the crew to cycle the landing radar circuit breaker switch in an attempt to save the landing. It worked and the third manned lunar landing took place successfully at 09:18:13 UT, only 87 feet from the predesignated target!

Shepard and Mitchell made 2 EVA's lasting 9 hours 22.5 minutes. On the first EVA, they deployed the Apollo Lunar Surface Experiments Package (ALSEP). On the second

EVA, they went on a mini-geological expedition walking 0.9 mile away from the lunar module. They collected 93.25 pounds of lunar samples using their Mobile Equipment Transporter (MET), a two-wheeled handcart, to transport the lunar rocks. Some of the samples turned out to be over 4.6 billion years old. At the end of the EVA, Shepard put the head of a six iron he had brought along onto the end of a rock sampler tool. He became the first lunar golfer by hitting two golf balls from what he called the lunar “sand trap”!

They launched from the Moon after 33.5 hours on the surface and rejoined Stu Roosa in *Kitty Hawk*. Before leaving lunar orbit, a subsatellite was spring-launched from the service module to orbit the Moon and the ascent stage engine of *Antares* was fired for 75.4 seconds to deliberately crash it into the Moon. After 34 lunar orbits, the crew fired the SPS engine at 01:39:04 UT February 7 for 148.1 seconds to begin their journey home. The crew splashed down in the Pacific Ocean at 21:05 UT on February 9, 1971, completing a mission lasting 9 days 1 minute 57 seconds. The crew and *Kitty Hawk* were then recovered by LPH-11, the *USS New Orleans*.

Today, *Kitty Hawk* is located at the U.S. Astronaut Hall of Fame in Titusville, Florida. The descent stage of *Antares* is located at 3.6733 deg. South, 17.4653 deg. West on the Fra Mauro highlands of the Moon.

## Today In History -- February 26

Thirty-one years ago today at 16:12:01 UT (11:12:01 am EST) on February 26, 1966, the first test flight of a fully-configured Apollo Block I spacecraft, the **North American Aviation**-built CSM-009, took place. It lifted off from Launch Complex 34 of the Eastern Test Range at Cape Canaveral, Florida, on the first Saturn IB launch vehicle, AS-201. This was the most heavily instrumented launch vehicle to date -- 607 measurements from the Apollo spacecraft, alone.

Unofficially designated "Apollo 1A", it was an unmanned suborbital flight with the following objectives:

- 1) to demonstrate structural integrity and compatibility of launch vehicle and spacecraft and confirm launch loads,
- 2) to demonstrate separation of the first and second stages of Saturn, the Launch Escape Subsystem and boost protective cover from the CSM, the CSM from the instrument unit/spacecraft/lunar module adapter, and the CM from the SM,
- 3) to verify operations of Saturn propulsion, guidance and control, and electrical subsystems,
- 4) to verify operation of spacecraft subsystems and adequacy of heatshield for reentry from low Earth orbit,
- 5) to evaluate emergency detection system in open-loop configuration,
- 6) to evaluate heatshield ablator at high reentry rates, and
- 7) to demonstrate operation of mission support facilities.

The mission marked the first use of the Mission Control Center in Houston for Apollo control and during the flight, the first ignition and restart of the SPS engine in space was achieved. The CSM reached a peak altitude of 303 miles and, during reentry, the CM reached a peak deceleration of 14.3 g's.

CM-009 splashed down at 11:49:21 am EST in the Atlantic Ocean 5264 miles downrange near Ascension Island. The precise splashdown point was 8.18 deg. South latitude, 11.15 deg. West longitude -- 44.7 miles from the targeted point. Recovery of the capsule was made by LPH-4, the *USS Boxer*. All objectives, except for two, were completely achieved. Objective 4 was partially achieved and objective 6 was not achieved due to loss of data during maximum heating.

After the mission, CM-009 was modified for use in land impact and structural tests and redesignated CM-009A. CM-009A is currently in storage at the Lincoln Municipal Airport Terminal in Lincoln, Nebraska, awaiting completion of an aviation museum in central Nebraska where it will be displayed..

## Today In History -- February 28

Thirty-four years ago today, on February 28, 1963, the complete mating and alignment of Boilerplate 9 command module, service module, adapter, and launch escape system was accomplished in the Navaho test tower at **North American Aviation in Downey**. This was the first successful mating of a major Apollo vehicle structure. BP-9 was then shipped on March 6, 1963, to NASA's Marshall Space Flight Center for dynamic tests to determine dynamic structural compatibility of the spacecraft with the Saturn I launch vehicle. Following the tests, BP-9 was modified and redesignated BP-9A.

Apollo BP-9A was launched aboard SA-10 Saturn I from LC-37B at Kennedy Space Center on July 30, 1965, to place the third Pegasus Meteoroid Detection Satellite into a 323 x 336 mile orbit on the AS-105 mission. BP-9A housed and protected the Pegasus payload until reaching orbit where the Apollo boilerplate was jettisoned, permitting the satellite to deploy. It was the last boilerplate flight and last launch of the Saturn I. BP-9A was not recovered.

## Today In History -- March 3

Twenty-eight years ago today, at 16:00:00 UT (11:00:00 a.m. EST) on March 3, 1969, Apollo 9 lifted off from Launch Complex 39A at Kennedy Space Center. The crew consisted of Commander **Jim McDivitt**, CM pilot **Dave Scott**, and LM pilot **Rusty Schweickart**. The thirty-three year old Schweickart was the youngest astronaut to fly on an Apollo mission. They were launched on SA-504, the first non-development Saturn V. The S-II stage built by **North American Rockwell/Seal Beach** was 34,000 pounds heavier than previous ones, being outfitted with updated J-2 engines which produced a total stage thrust of 1,150,000 pounds. The crew's call signs for communications identification when undocked were *Gumdrop* for the 59,086-pound **NAR/Downey**-built CSM-104 and *Spider* for the 32,132-pound LM-3.

Apollo 9 was the only D-type Apollo mission ever flown and was the first manned flight of all lunar hardware. The mission objectives were to:

- 1) demonstrate crew/space vehicle/ mission support facilities during a manned Saturn V / CSM / LM mission,
- 2) demonstrate LM/crew performance,
- 3) demonstrate selected lunar orbit rendezvous mission activities including transposition, docking withdrawal, intervehicular crew transfer, EVA, SPS and DPS burns, and LM active rendezvous and docking, and
- 4) assess CSM/LM consumables use.

The S-IVB third stage put the 297,009-pound vehicle into a 118 x 119 mile orbit. The crew separated *Gumdrop* from the spacecraft/LM adapter 2 hours 45 minutes after liftoff and docked with *Spider* 17 minutes later. The 91,218-pound docked CSM/LM then separated from the S-IVB stage and its J-2 engine was fired twice to send it into solar orbit.

On the third day, McDivitt and Schweickart transferred to the LM at 43 hours GET. They fired *Spider's* descent engine for 6 minutes 10 seconds and fired *Gumdrop's* SPS engine for 43.3 seconds while the vehicles were docked. During these maneuvers, they reached a maximum altitude of 313 miles. On the fourth day, McDivitt and Schweickart again moved into *Spider*. Schweickart made a 37-minute EVA from *Spider* to test the Extravehicular Mobility Unit (the lunar spacesuit and its life support system) in the actual space environment and Scott made a one hour stand-up EVA from *Gumdrop*.

On the fifth day, the two spacecraft undocked at 92 hr 39 min 30 sec GET with McDivitt and Schweickart in *Spider* and separated a maximum distance of 113 miles. first demonstration of lunar orbit rendezvous techniques in Earth orbit--rendezvous with seven orbital maneuvers. They redocked after being separated for 6 hours 20 minutes and McDivitt and Schweickart rejoined Scott in *Gumdrop*. For the next five days, the crew performed scientific photography of the Earth and fired the SPS engine twice prior to the deorbit burn after 151 revolutions.

They splashed down after 152 orbits lasting 241 hours 54 seconds at 17:01 UT on March 13 and were recovered by LPH-7, the *USS Guadalcanal*. It was the last manned American spacecraft to land in the Atlantic Ocean. Except for additional EVA's which were canceled due to Schweickart's illness, all objectives were achieved. The crew achieved the first manned flight test of the lunar module, the first manned Apollo LM/CSM docking and undocking, the first docked SPS burn, and the first Apollo EVA.

Today, *Gumdrop* is on display at the Michigan Space Center, Jackson Community College, in Jackson, Michigan.

## Today In History -- April 4

Twenty-nine years ago at 12:00:01 UT (07:00:01 a.m. EST) on April 4, 1968, the Apollo 6 mission was launched by SA-502, the second Saturn V, from Launch Complex 39A at Kennedy Space Center. The total mass in Earth orbit was 264,000 pounds which included the 55,420-pound **North American Rockwell Space Division**-built CM-020/SM-014 and the 26,001-pound Lunar Module Test Article, LTA-2R.

The mission objectives were to:

- 1) demonstrate structure and thermal integrity and compatibility of launch vehicle and spacecraft; confirm launch loads and dynamic characteristics,
- 2) demonstrate separation of launch vehicle stages,
- 3) evaluate performance of emergency detection system in closed-loop configuration,
- 4) verify operation of Saturn V propulsion, guidance and control, and electrical systems, and
- 5) demonstrate performance of mission support facilities.

However, the launch did not go well. One panel of the spacecraft/LM adapter (SLA) broke free at 133 seconds due to a POGO effect during first stage. Then, the number 2 outboard J-2 engine on the second stage shut down at 6 minutes 48.7 seconds (4 minutes 23 seconds after ignition) due to a fuel line rupture. This was followed 1.3 seconds later by shutdown of the number 3 outboard J-2 engine due to an error in wiring the cutoff circuits to that engine. This caused the remaining three second-stage engines to burn 58 seconds longer than planned and the third stage S-IVB to burn 39 seconds longer than planned. Because of the launch anomalies, the payload went into a 110 x 225 mile orbit instead of the planned 100 mile circular orbit.

At 15:13:36 UT during the second revolution, the S-IVB J-2 engine was re-started to inject the payload onto a translunar trajectory. However, 16 seconds after ignition, the engine shut down due to a propellant line rupture and the vehicle remained in low Earth orbit. The spacecraft separated at 15:14:29 UT and, 98 seconds later, the SPS engine fired for 422 seconds to boost the CSM to an apogee of 13,800 miles for a high-speed reentry at 32,830 ft/sec.

After a mission duration of ten hours, the command module splashed down in the Pacific Ocean and was recovered by LPH-3, the *USS Okinawa*. The mission was a partial success -- objective number 4 was not achieved because of early cutoff of two of the S-II stage J-2 engines and failure of the S-IVB J-2 engine. However, all the CSM systems performed normally.

Today, CM-020 is on display at the Fernbank Science Center in Atlanta, Georgia.

## Today In History -- April 11

Twenty-seven years ago today, Apollo 13 was launched by SA-508 from Launch Complex 39A at 13:13 CST (19:13:00 UT) on April 11, 1970, to begin the third U.S. manned lunar landing mission. The spacecraft consisted of **North American Rockwell**-built CSM-109, *Odyssey*, and LM-7, *Aquarius*. The commander was the world's most experienced astronaut, **Jim Lovell**, the CM pilot was **John Swigert**, and the LM pilot was **Fred Haise**. Just a few days before the mission, backup LM pilot **Charlie Duke** inadvertently exposed the crew to German measles. CM pilot **Ken Mattingly** had no immunity to measles and was replaced by Jack Swigert, the backup CM pilot. Their destination was the hilly Fra Mauro uplands region of the Moon.

During launch, the center engine of the S-II stage shut down two minutes early five and a half minutes after liftoff. This caused the remaining four S-II engines to burn 34 seconds longer than planned and the S-IVB engine to burn nine seconds longer to insert the 299,998-pound vehicle into orbit. The S-IVB J-2 engine ignited a second time over the Pacific Ocean at 21:54:47 UT to send the spacecraft and crew on their way to the Moon.

The mission was going smoothly. In fact, at 46 hours 43 minutes into the mission, **Joe Kerwin**, the CapCom on duty, told the Apollo 13 crew "*The spacecraft is in real good shape as far as we are concerned. We're bored to tears down here.*" However, nine hours later, at 55:54:53 GET (about 9:08 pm in Houston on April 13) cryo oxygen tank number 2 ruptured blowing off the panel covering that sector of the service module. The explosion damaged the directional antenna causing all telemetry from the spacecraft to drop out for 1.8 seconds. The crew heard and felt the explosion and the CM caution and warning system alerted the crew to low voltage on DC main bus B. Jack Swigert told Houston, "*we've had a problem here.*"

Two oxygen tanks were mounted on a shelf in the service module, each one holding 320 pounds of supercritical oxygen. They provided the oxygen for the CM atmosphere and the three fuel cells (the primary source of electrical power and drinking water) and provided cooling for electronic components. The number 2 oxygen tank, serial number 10024X-TA0009, had been previously installed in the Apollo 10 service module but was removed for modification. Unknown at the time, it was damaged in the removal process. It was then installed in the Apollo 13 service module.

This oxygen tank was now gone and tank number 1 was leaking -- *Odyssey* would soon be out of both oxygen and electrical power. Two of the three fuel cells were dead and the remaining fuel cell wouldn't last much longer. The only other CM power source was three reentry batteries providing 120 ampere-hours and these had to be saved for reentry. The crew shut down all systems in *Odyssey* and moved into *Aquarius*.

The crew had some big problems to overcome. The LM was designed for a 45-hour lifetime which needed to be stretched to 90 hours to save them. The two lithium hydroxide canisters in the LM had been designed to take care of the carbon dioxide output of two people for about 30 hours rather than three people for nearly 90 hours. Also, the crew was on a trajectory that would not allow them to return to Earth without a major engine burn. However, without electrical power, the SPS engine was useless. One by one the problems were solved. Six Royal Navy ships sailed to the spacecraft's standby splashdown area in the Indian Ocean and, in an unprecedented move, two Soviet merchant ships were diverted to the prime splashdown area and Soviet trawlers and whaling ships were ordered to give all possible help in the recovery.

Eighty-seven hours after the explosion, *Odyssey* splashed down successfully in the Pacific Ocean on April 17 within four miles of the recovery ship LPH-2, the *USS Iwo Jima*. The crew and ground team had beaten the odds and the mission was called a successful failure. The crew had traveled deeper into space than anyone has ever gone -- 248,665 miles from Earth. When Navy frogman **Ernest Jahnche** opened *Odyssey's* hatch, he told Swigert that an Internal Revenue Service agent was waiting aboard the recovery ship to see him because of Swigert's failure to file an income tax return before launch!

After splashdown, a bogus invoice from Grumman Aerospace in Bethpage, New York, the manufacturer of *Aquarius*, was presented to **North American Rockwell Space Division in Downey** for the 400,001 mile tow charge! The bill came out to \$400,540.05.

In the Apollo 13 Investigation Report submitted on June 15, 1970, the board pointed out that although the circumstances of the tank failure were highly unusual and that the system had worked flawlessly on six successful missions, the causes had to be eliminated as completely as possible. It recommended that the oxygen tanks be modified to remove all combustible material from contact with oxygen and that all test procedures be thoroughly reviewed for adequacy.

*Odyssey* was later assigned to Skylab tests at the Johnson Space Center. Today, after restoration at the Space Works Facility in Hutchinson, Kansas, *Odyssey* is on display at the nearby Kansas Cosmosphere and Space Center.

## Today In History -- April 16

Twenty-five years ago at 17:54:00 UT (12:54:00 pm EST) on April 16, 1972, AS-511 launched **Apollo 16** from Launch Complex 39A at the Kennedy Space Center on the fifth manned lunar landing mission. Commander **John Young** on his fourth space flight, CM pilot **Ken Mattingly**, and LM pilot **Charlie Duke** who had inadvertently exposed Mattingly to the measles causing him to be replaced by **Jack Swigert** on the Apollo 13 mission. Their destination was the Descartes Highlands and Cayley formation--the first study of a highlands area of the Moon and a place where it was thought that there might be active volcanism. The 67,010-pound **North American Rockwell**-built CSM-113, *Casper*, was the heaviest CSM ever flown. The 36,255-pound LM-11 was called *Orion*. The total CSM/LM mass of 103,265 pounds was the greatest mass ever sent to the Moon.

Lunar orbit insertion occurred at 20:22:28 UT on April 19 -- the 77,595-pound CSM/LM was the most mass ever placed in orbit around the Moon. After Young and Duke transferred to *Orion* and separated from *Casper*, a malfunction in the backup system for *Casper's* SPS engine controls almost scrubbed the landing. It was decided that the problem could be worked around and Young and Duke started their descent to the Moon six hours late. After a 730-second powered descent, they landed on the Moon at 02:23:36 UT on April 21 just 715 feet northwest of the target landing point. At thirty-six, Charlie Duke was the youngest astronaut to land on the Moon.

Young and Duke performed three EVA's lasting 20 hrs 14 min 16 sec. On the first EVA, they deployed the nuclear-powered Apollo Lunar Surface Experiments Package (ALSEP) and an ultraviolet camera/spectrograph used for first time on the Moon -- the first time the Moon was used as an astronomical observatory. The second and third EVA's consisted of geological traverses in the second lunar roving vehicle, LRV-2, in which the crew traveled 16.8 miles at speeds up to 11 mph. During the EVA's the crew deployed over 2200 pounds of equipment and collected 208 pounds of lunar samples, among them was one weighing 23 pounds -- the largest Moon rock ever collected. However, the crew did not find evidence of recent volcanism.

The crew launched from the Moon after 71 hours on the surface. After Young and Duke transferred back into *Casper*, the crew sent *Orion* to impact on the Moon and deployed a P&F subsatellite in lunar orbit. After 64 lunar orbits lasting nearly 126 hours, the SPS engine fired for transearth injection (TEI) at 02:15:33 UT on April 25. On the way back, Mattingly performed a 1 hour 23 minute 42 second in-flight EVA to retrieve panoramic and mapping camera film from the service module. The crew splashed down at 19:45:05 UT on April 27 in the Pacific Ocean where they were recovered by CVA-14, the *USS Ticonderoga* after a mission lasting 11 days 1 hour 51 minutes 5 seconds.

Today, *Casper* is on display at the Alabama Space and Rocket Center in Huntsville, Alabama. The descent stage of *Orion* is located on the Descartes Highlands of the Moon at 8.9914 degrees South latitude, 15.5144 degrees East longitude.

## Today In History -- April 27

On this day in history back in 1968, **Mr. Jim Webb**, the administrator of NASA, made a very difficult and important decision.

During the second launch of the Saturn V launch vehicle on the unmanned Apollo 6 mission on April 4, 1968, the Saturn V experienced severe longitudinal oscillations called "POGO" and three of its engines failed. If a crew had been onboard, they might have been injured and had to abort the mission. Mr. Webb had to choose between another unmanned test and a manned flight of the Saturn V for its next launch.

Mr. Webb's deputy administrator, **Mr. Tom Paine**, was given the job to get the problems solved. The diagnosis and solutions was a big effort and turned out to be one of the greatest engineering investigations undertaken during the Apollo project. Over 125 engineers and 400 technicians spent 31,000 man-hours on the POGO problem alone! The effort paid off because they not only were able to determine the causes of the problems but were also able to determine how to fix them.

On April 27, 1968, Mr. Webb decided in favor of a manned flight for the next Saturn V, SA-503, by approving a change in the Apollo schedule in accordance with a recommendation by Apollo Program director, **General Sam Phillips**. It would fly at the end of the year with a crew onboard if the first manned Apollo mission, Apollo 7, was successful in October. Apollo 7 was so successful and the confidence that the Saturn V had been fixed was so great, that later that year Mr. Webb would decide to send Apollo 8 all the way to the Moon to make the first manned lunar voyage in history!

## Today In History -- May 13

Thirty-three years ago today, at 12:59:59 UT (6:59:59 am MDT) on May 13, 1964, the first boilerplate command/service module to be tested on a test flight was launched at White Sands Missile Range in New Mexico. The **North American Aviation**-built BP-12 with service module and escape system made up the payload on the second Little Joe II. The A-001 test was a transonic abort test of the Launch Escape System (LES) on an unmanned suborbital ballistic flight. The purpose was to demonstrate Apollo spacecraft atmospheric abort system capabilities and verify the dynamic shape of LES.

The test objectives were to

- 1) demonstrate structural integrity of the escape tower,
- 2) demonstrate capability of escape system to propel command module to predetermined distance from launch vehicle,
- 3) determine aerodynamic stability characteristics of escape configuration for abort conditions,
- 4) demonstrate proper separation of command module from service module, and
- 5) demonstrate satisfactory recovery timing sequence in earth-landing subsystem

The vehicle reached a maximum altitude of 15,420 feet and landed 11,580 feet downrange after a flight lasting 5 minutes 50 seconds. The launch escape system worked as planned and all the test objectives were achieved successfully although one of the three parachutes cut loose. BP-12 was recovered undamaged and subsequently modified for water impact tests at the North American Aviation S&ID Impact Test Facility in Downey. The refurbishment was completed in July, 1965, and BP-12 was redesignated BP-12A. BP-12A is currently on display at Apollo County Park in Lancaster, California.

## Today In History -- May 14

Twenty-four years ago today, at 17:30:00 UT (1:30:00 pm EDT) on May 14, 1973, the first U.S. space station, Skylab 1, was launched from LC-39A at Kennedy Space Center. The Saturn V launch vehicle, SA-513, was originally assigned to Apollo 18 which was canceled. It was the last Saturn V to be launched and the only two-stage version of the Saturn V ever flown -- the entire stack was 333 feet high, thirty feet less than the Apollo Saturn V. The S-II second stage built by **North American Rockwell** would put Skylab in orbit.

Called the "Apollo Applications Program" or AAP during early studies, it was officially named "Skylab" in February 1970, a name submitted by **Air Force Lt. Col. Donald Steelman**. Skylab was designed to make maximum use of Apollo technology. The hardware consisted of an orbital workshop, an airlock module, a multiple docking adapter, the Apollo Telescope Mount (ATM), and payload shroud. The Skylab Workshop was built from the S-IVB third stage of the SA-212 Saturn IB launch vehicle. The docking adapter provided the docking port for the Apollo CSM spacecraft. The ATM was the first manned astronomical observatory designed for solar research from Earth orbit.

The overall length with the docked Apollo CSM was 118.5 ft., the maximum diameter was 21 ft. 8 inches and the total weight was 168,100 lbs. The area of the living quarters (wardroom, waste management compartment, sleep compartment, and experiment area) was 380 square feet. The total conditioned work volume was 11,700 cubic feet.

Skylab was damaged during launch as one solar wing and meteoroid shield were lost during the ascent. The problems began 63 seconds after liftoff when a panel protecting the workshop from micrometeoroids and solar radiation ripped off. Then, one of the solar arrays designed to provide electrical power for the workshop was torn away and a second array was only partially deployed.

Skylab was placed successfully into a 269-mile circular orbit but it was seriously overheating. Skylab 2, the first manned Skylab launch scheduled for next day, had to be delayed until methods could be devised to repair and salvage the workshop. The crew would have their work cut out for them.

On July 11, 1979, a little more than six years after launch and 34,981 revolutions around the Earth, Skylab reentered the atmosphere. Some of the debris landed in southwestern Australia and was recovered. A large piece from an oxygen tank is on display at the Alabama Space and Rocket Center in Huntsville, Alabama. The backup Skylab, Skylab 1B which was built from the third stage of the SA-515 Saturn V, is on display at the National Air and Space Museum in Washington, D.C.

## Today In History -- May 18

Twenty-eight years ago today, at 16:49:00 UT (12:49:00 pm EDT) on May 18, 1969, Apollo 10 was launched by the AS-505 Saturn V. It marked the first use of LC-39B and was the only Apollo mission ever launched from that pad. The crew consisted of commander **Tom Stafford**, CM pilot **John Young**, and LM pilot **Gene Cernan**. The call sign chosen for the 63,647-pound CSM-106 was *Charlie Brown* and that of the 30,849-pound LM-4 was *Snoopy*. The POGO oscillations on the **North American Rockwell**-built S-II stage experienced by the two previous Saturn V vehicles was eliminated by early cut-off of the center **Rocketdyne** J-2 engine. Improvements to the J-2 engine increased the total stage thrust to 1,168,694 pounds to help put the 294,949-pound vehicle in Earth orbit.

Apollo 10 was the only F-type Apollo mission ever flown -- a manned test of the lunar module in lunar orbit to test all aspects of an actual manned lunar landing except the landing. It was the first manned CSM/LM operations in cislunar and lunar environment and the first in-flight simulation of the lunar landing profile. The mission objectives were to demonstrate performance of the LM and CSM in lunar gravitational field and evaluate CSM and LM docked and undocked lunar navigation.

The Rocketdyne J-2 engine on the S-IVB third stage was ignited for 344.9 seconds at 19:22:25.1 UT during the second orbit. This increased their velocity by 10,050 ft/sec and put them on a free-return circumlunar trajectory starting a 73-hour translunar coast. About twenty minutes later, the crew sent the first live color television from a manned spacecraft showing transposition and docking of the command module with the lunar module.

The service propulsion system (SPS) engine was ignited behind the Moon at 20:44:53 UT on May 21 for 356 seconds to insert the 69,427-pound CSM/LM into a 196.3 by 69.1 mile lunar orbit. The SPS engine was fired a second time behind the Moon four and a half hours later for 14 seconds to change the orbit to 71.9 by 66.1 miles.

Stafford and Cernan transferred into the lunar module and *Snoopy* separated from *Charlie Brown* at 18:59:00 UT on May 22. They then fired the lunar module's descent propulsion subsystem (DPS) engine to change the orbit to 70.4 by 9.4 miles and *Snoopy* dropped to within 50,000 feet of the lunar surface! As the lunar module passed over landing site 2 in southwestern Mare Tranquillitatis, the favored site for the first manned landing, the landing radar was tested and the crew took photos of the site. Later, they separated the ascent stage from the descent stage inflight to simulate lunar liftoff, a maneuver unique to Apollo 10. However, a switch was in the wrong position which caused the ascent stage to start spinning. Stafford was able to get it under control quickly, though. *Snoopy* then docked with *Charlie Brown* 8.5 hours after they had separated.

Following crew transfer to the command module, the LM ascent stage was released. The ascent stage engine was then fired to burn its propellant to depletion and eject the LM ascent stage from lunar orbit into solar orbit. The crew then televised close-up views of landing site 2. After 31 orbits of the Moon lasting 2 days 13 hours 31 minutes, the crew fired the SPS engine a third time for 164 seconds to start their journey back to Earth.

Apollo 10 entered the atmosphere at 36,360 ft/sec, a man speed record that still stands today. The crew splashed down in the mid-Pacific 395 miles east of Pago Pago at dawn on May 26, 1969, after a mission duration of 8 days 3 minutes 23 seconds just three miles from their recovery ship, LPH-5, the *USS Princeton*. All mission objectives were achieved and the way was now clear for the next mission -- the first manned landing on the Moon.

Today, *Charlie Brown* is on display at the Science Museum in London, England, and *Snoopy's* ascent stage is in solar orbit awaiting a visit from a future space traveler! According to information provided by **Eric Molle**, Dept. 279, *Snoopy's* ascent stage is the only Apollo spacecraft remaining in orbit; the only other Apollo hardware in space are the third stage S-IVB's from the Apollo 8, 10, 11 and 12 missions.

## Today In History – May 19

Thirty-two years ago today, on May 19, 1965, the third Apollo abort flight test (A-003) with the Little Joe II took place at White Sands, New Mexico. The objective was a high-altitude (120,000 feet) test of the LES. The launch vehicle was the fourth Little Joe II to fly. The boilerplate Apollo spacecraft was the **NAA Space and Information Systems Division**-built BP-22. Liftoff occurred at 13:01 UT under the power of the four Algol first stage motors producing a total thrust of 412,800 pounds.

However, the Little Joe II started to lose control 2.5 seconds later and completely disintegrated 25 seconds after launch. The LES fired at an altitude of 12,400 feet and BP-22 parachuted successfully back to Earth. The test was a successful failure – although it failed to achieve the primary objective, the LES worked as designed.

BP-22 is currently located atop a Little Joe II launch vehicle at NASA's Johnson Space Center.

## Today In History -- May 25

Twenty-four years ago today, at 13:00:00 UT (9:00:00 am EDT) on May 25, 1973, the first manned launch to the Skylab space station took place. Skylab 2 was launched by the AS-206 Saturn IB launch vehicle from a modified Saturn V mobile launcher at Launch Complex 39B at the Kennedy Space Center. Aboard the **North American Rockwell**-built 30,384-pound CSM-116 were commander **Pete Conrad**, science pilot **Joe Kerwin**, and pilot **Paul Weitz**.

During two EVA's totaling 5 hours 41 minutes on June 7 and June 19, the crew repaired damaged solar array wing that was jammed with debris and deployed a parasol-like thermal blanket to replace one torn away during Skylab launch. This was to protect the hull and reduce temperatures within the workshop.

During the mission, the crew collected data solar and Earth resources data and performed biomedical experiments. Their work time was divided as follows:

- 143.3 hours of life science,
- 117.2 hours of solar astronomy,
- 71.4 hours of Earth observations,
- 36.6 hours of astrophysics,
- 12.1 hours of man/systems,
- 5.9 hours of material science, and
- 3.7 hours of student experiments.

During their mission, they produced 28,739 frames of solar observations and 9846 frames and 45,000 feet of magnetic tape of earth observations.

The crew undocked from Skylab after a duration of 654 hours 48 minutes 7 seconds on-board. The conclusion of the mission lasting 28 days 49 minutes 49 seconds came when they splashed down in the Pacific Ocean at 13:49:49 UT on June 22, 1973, and were recovered by CVA-14, the *USS Ticonderoga*. They had traveled 11.5 million miles during 404 orbits of the Earth.

Today, CM-116 is on display at the Naval Aviation Museum in Pensacola, Florida.

## Today In History -- May 28

Thirty-three years ago today, at 17:07:00 UT (1:07:00 pm EDT) on May 28, 1964, the first orbital flight test of a **North American Aviation**-built Apollo boilerplate command module was accomplished. The payload, consisting of BP-13 with a production launch escape system and a service module/launch vehicle adapter, was launched on the SA-6 Saturn I launch vehicle from Launch Complex 37B at the Kennedy Space Center.

The unmanned vehicle development test was to verify compatibility of the structure and aerodynamic design of Saturn I with the Apollo boilerplate capsule. The test was the third Apollo flight test and was known as AS-101. The objectives of the test were to

- 1) demonstrate launch vehicle propulsion, structure, and control,
- 2) flight test closed-loop guidance,
- 3) first flight test of Apollo spacecraft/launch vehicle configuration,
- 4) determine launch escape tower separation characteristics,
- 5) evaluate S-1/S-IV stage separation,
- 6) determine spacecraft launch and exit environmental parameters, and
- 7) demonstrate LES jettison using tower jettison motor.

The payload was successfully inserted into a 124 by 140 mile orbit despite a premature shutdown of engine number 8 on the first-stage. All objectives were completely achieved except objective number 1 which was partially achieved due to the premature engine shutdown. BP-13 was never recovered.

## Today In History – June 11

Thirty-five years ago today, on June 11, 1962, the first Block I Apollo spacecraft mockup, M-1, was completed at the **NAA Space and Information Systems Division in Downey**. A total of twelve wooden Block I mockups of the Apollo spacecraft were eventually built to provide engineering configuration and systems information as well as to develop manufacturing methods. M-1 was a mockup of the command module and was used for cabin exterior equipment and as a CM evaluator. The first drawing for this mockup was received on January 15, 1962, and fabrication began on February 9.

Exactly four years later, in June of 1966, the last of six Block II mockups was completed. M-29 consisted of the Service Module only and was used as the NAA Space & Information Systems Division house test model. Later, the corresponding Command Module mockup, known as 2H-1, was to have been built but the requirement for this was subsequently deleted.

## Today In History – June 29

Thirty-two years ago today, at 13:00 UT on June 29, 1965, the **NAA Space and Information Systems Division**-built BP-23A was successfully launched in the second and final pad abort test (PA-2) at White Sands, New Mexico. The PA-2 vehicle consisted of BP-23A with a boost protective cover, the Launch Escape Subsystem (LES) rocket and support tower. BP-23 had been previously launched by the third Little Joe II in the first test of the Apollo emergency detection system at abort altitude -- a high-dynamic pressure abort test (A-002) -- at White Sands on December 8, 1964. Refurbishment of the capsule was completed in May of 1965 and designated BP-23A.

The LES consisted of a four-nozzle solid rocket motor with a 3 second burn time, a small solid rocket motor for pitch which burned for one second, a two-nozzle separation motor for normal flight, and a pair of canard wings to turn the spacecraft around for parachute deployment. On PA-2, the LES carried BP-23A to an altitude of 9248 feet, the parachute deployed and it landed 7600 feet from the launch site. The test was a complete success and qualified the launch escape and pitch motors, the boost protective cover and the canard surfaces for manned flight. It was the last flight test using an Apollo boilerplate at White Sands.

Today, BP-23A is on display at White Sands Missile Range in New Mexico.

## Today In History -- July 15

Twenty-two years ago today two manned launches took place for the first international manned spaceflight, the joint U.S.-Soviet Apollo-Soyuz Test Project (ASTP). The purpose of the mission was to test the compatibility of rendezvous and docking systems for U.S. and Soviet spacecraft, demonstrate in-flight intervehicular crew transfer, and conduct a series of science and applications experiments. The mission would open the way for international space rescue as well as future joint manned flights.

The Soviet Soyuz 19 was launched first at 12:20:10 UT on July 15, 1975 from the Baikonur Cosmodrome in Kazakhstan with cosmonauts **Alexei Leonov**, commander, and **Valeri Kubasov**, flight engineer, on-board. Soyuz has been the primary spacecraft for Russian manned missions from 1967 to the present time.

Seven and a half hours later, Apollo 18 was launched at 19:50:00 UT (3:50 pm EDT) on the Saturn IB AS-210 launch vehicle from Launch Complex 39B at Kennedy Space Center. It was the last flight of Apollo hardware – the fifteenth manned flight of an Apollo spacecraft, **Rockwell International**-built CSM-111, which weighed 28,054 pounds. In addition, the launch vehicle was also carrying the North American Rockwell-built docking module (DM) which was 10.33 feet long, 4.6 feet in diameter and had a mass of 4435 pounds. The DM served as an airlock and transfer tunnel between Apollo and Soyuz. The CSM/DM was 43 feet long and had a mass of 32,487 pounds. **Tom Stafford** was the commander, **Vance Brand** was the CM pilot, and **Deke Slayton**, one of the original seven Mercury astronauts, was the DM pilot. It was the first spaceflight for Brand and Slayton and the fourth flight for Stafford who had previously flown on the Gemini 6 and 9 and Apollo 10 missions.

Apollo was the active vehicle for rendezvous and docking with Soyuz which was in a 229.6 km circular orbit. Soft dock took place at 16:09:12 UT July 17 and hard dock was achieved 3 minutes 18 seconds later. The combined CSM/DM/Soyuz was 65.6 feet long and had a mass of 46,300 pounds. They were docked 46 hours 44 minutes over two periods. The historic handshake between Stafford and Leonov took place at 19:19:25 UT July 17. The Apollo crew members visited Soyuz and the cosmonauts visited the Apollo ship and conducted a variety of experiments. The Apollo crew presented a gift bag to the cosmonauts which contained a four-part ASTP commemorative plaque, ten 8 x 12 inch American flags, an 8 x 16 inch Soviet Union flag, a box of white spruce tree seeds, and the ASTP certification authorizing the docking.

The two spacecraft undocked at 12:03:12 UT July 19 after 43 hours 50 minutes 42 seconds of docked operations. They then re-docked at 12:34 UT July 19 and the second undocking took place 2 hours 53 minutes later. Soyuz 19 landed in the Kazakh Soviet Socialist Republic in Central Asia 5 days 22 hours 30 minutes 54 seconds after launch at 10:51:04 UT on July 21.

The Apollo crew splashed down in the central Pacific Ocean near the Hawaiian Islands at 21:18:24 UT on July 24, 1975 -- precisely six years after the splashdown of Apollo 11. They were then recovered by LPH-11, the *USS New Orleans*. The Apollo spacecraft made 138 revolutions of the Earth on a flight lasting 9 days 1 hour 28 minutes 24 seconds.

A total of 28 U.S. science experiments were performed, including five with Soyuz. The investigations consisted of five studies of Earth resources, gravity, and atmosphere, five astronomy studies, seven in life sciences, and eleven in material processing. Apollo had begun as a competition with the USSR and ended as a move toward cooperation. It would be eighteen and a half years before there would be another joint manned spaceflight conducted by the United States and Russia. This took place when cosmonaut **Sergei Krikalev** was launched with five American astronauts on February 3, 1994, aboard the Space Division-built Space Shuttle Discovery on the STS-60 mission.

Today, CM-111 is on display at the Visitors Center at Kennedy Space Center in Florida.