APOLLO CHRONOLOGY

1960

July 29 - Project Apollo, an advanced spacecraft program to land men on the moon, was announced by NASA.

Oct. 25 - NASA selected General Dynamics, General Electric, and Martin to conduct individual feasibility studies of an advanced manned spacecraft as part of the Apollo project.

1961

Jan. - NASA studies, by a committee headed by George Low (present Apollo spacecraft program manager), of a manned lunar-landing program were completed. Both a direct-ascent trajectory using large Nova-type launch vehicles and an earth-orbit rendezvous technique using Saturn-type launch vehicles were considered.

May 15 - Final reports on Project Apollo study contracts were submitted by General Dynamics, GE, and Martin.

May 25 - President Kennedy presented a plan to Congress for accelerating the space program based on a national goal of landing a man on the moon before the end of the decade.

July 28 - NASA issued a request for proposal to 12 companies for development of the Apollo spacecraft.

Aug. 9 - NASA selected MIT's Instrumentation Laboratory to develop the guidance and navigation system for the Apollo spacecraft.

Sept. 19 - NASA announced that the recently established Manned Spacecraft Center would be located at Houston, Tex.

Nov. 28 - NASA announced that a contract had been awarded to North American's Space Division for the Apollo spacecraft program.

Dec. 21 - The first four major Apollo subcontractors were announced: Collins Radio, telecommunications systems; Garrett Corporation's AiResearch Division, environmental control equipment; Honeywell Inc., the stabilization and control system; and Northrop Corporation's Ventura Division, parachute earth landing system.

1962

Jan. 22 - The first Apollo engineering order was issued, for fabrication of the first mockups of the Apollo command and service modules.

Feb. 9 - NASA announced that GE had been awarded a contract to provide integration analysis of the total Apollo space vehicle, including launch vehicle and spacecraft, to assure reliability of the entire system. GE was also named to develop and operate equipment to check out the Apollo systems.

Feb. 13 - Lockheed Propulsion Company was selected to design and build the solid-propellant launch-escape motor for Apollo.

Mar. 2 - Marquardt Corp. was selected to design and build the reaction-control rocket engines for the Apollo spacecraft.

Mar. 3 - Aerojet-General Corp. was named as subcontractor for the Apollo service propulsion system.

Mar. 9 - Pratt and Whitney was selected to build the Apollo fuel cell.

Mar. 23 - Avco Corp. was selected to design and install the ablative material on the spacecraft outer surface.

April 6 - Thiokol Chemical Corp. was selected to build the solid-propellant rocket motor to be used to jettison the Apollo launch escape tower.

July 11 - NASA announced that the lunar rendezvous mode would be used for the moon mission. This new plan called for development of a two-man lunar module to be used to reach the surface of the moon and return the astronauts to the lunar-orbiting command module. NASA administrator James Webb said this method was the most desirable from the standpoint of "time, cost, and mission accomplishment."

July 16 - Beech Aircraft Corp., was selected to build the spacecraft storage tanks for supercritical gases.

Aug. 22 - The length of the Apollo service module was increased from 11 feet 8 inches to 12 feet 11 inches to provide space for additional fuel.

Sept. 7 - Apollo command module Boilerplate I was accepted by NASA and delivered to a Space Division laboratory for land and water impact tests.

Nov. 7 - Grumman Aircraft was named by NASA to design and build the LM.

1963

Mar. 12 - Apollo Boilerplate 13, the first flight-rated boilerplate to be completed, was accepted by NASA and shipped to MSFC.

July 23 - Dr. George E. Mueller was named director, NASA's Office of Manned Space Flight.

Oct. 8 - Dr. Joseph Shea, previously with NASA Headquarters, was named Apollo program manager at MSC.

Nov. 7 - The first launch test - a pad-abort test of Boilerplate 6 - was conducted at White Sands.

1964

February - A boost protective cover was added to the launch escape system in order to protect the windows of the CM and the heat shield surfaces from soot from the LES motor.

May 13 - The second test flight of the Apollo program occurred at White Sands when Boilerplate 12 was launched by a Little Joe II vehicle during a high-stress, high-speed abort test. The launch escape system worked as planned, except that one of the three parachutes cut loose. The CM was landed without damage.

May 28 - Apollo command module Boilerplate 13 was placed in orbit from Cape Kennedy following launch by a Saturn I booster. This was the first Apollo vehicle to be placed in orbit, and the third Apollo test flight.

Sept. 18 - Apollo Boilerplate 15 was successfully orbited at Cape Kennedy by a Saturn I two-stage launch vehicle. This was the fourth Apollo test flight.

Dec. 8 - The fifth Apollo test flight occurred at White Sands when Boilerplate 23 was lifted off the pad by a Little Joe II in a high Q abort test.

1965

Feb. 16 - Apollo Boilerplate 16 was launched from Cape Kennedy in a micrometeoroid test. A Pegasus satellite was carried aloft in a modified Apollo SM. All equipment functioned as planned. This was the sixth Apollo test flight.

May 19 - Apollo Boilerplate 22 was launched at White Sands in a planned high-altitude test of the launch escape system. The Little Joe II disintegrated at low altitude, resulting in an unscheduled but successful low-altitude abort test. This was the seventh test flight.

May 25 - The second Pegasus satellite was put into orbit at Cape Kennedy during the Saturn I launch of Apollo Boilerplate 26. This was the eighth Apollo test flight.

June 29 - Apollo Boilerplate 23A was successfully launched at White Sands during a pad abort test. All systems functioned as planned. This was the ninth Apollo test flight, and the fifth abort test. This boilerplate module, previously designated Boilerplate 23, had been launched at White Sands during a high Q test.

July 30 - Apollo Boilerplate 9A was launched at Cape Kennedy and was used to place the third Pegasus satellite into orbit.

Oct. 20 - The first actual Apollo spacecraft, SC 009, was accepted by NASA and subsequently shipped to Cape Kennedy. All previously completed Apollo vehicles had been boilerplate and mockup articles.

Dec. 26 - Apollo SC 009 was mated with the Saturn IB at the Kennedy Space Center.

Dec. 31 - Command modules accepted by NASA by the end of 1965 included 18 mockups, 18 boilerplates, and 2 spacecraft.

1966

Jan. 20 - A power-on tumbling abort test of the launch escape system was conducted at White Sands with the launch of SC 002. This was the sixth and final launch escape test; the LES was then declared qualified.

Feb. 26 - First unmanned flight of Apollo spacecraft (SC 009) was conducted to test command module's ability to withstand entry temperatures, determine adequacy of command module for manned entry from low orbit, test command and service module reaction control engines and test service module engine firing and restart capability. Recovery was in the South Atlantic, 5300 miles downrange, near Ascension Island.

Aug. 25 - Second unmanned test of Apollo spacecraft (SC 011) was conducted to test command module's ability to withstand entry temperatures under high heat load. After three-quarters of an orbit the spacecraft, which reached an altitude of 700 miles, was recovered 260 statute miles from Wake Island.

Oct. - The first Apollo Block II parachute qualification test was conducted at El Centro, Calif.

1967

Jan. 27 - During a manned ground test of an Apollo spacecraft (SC 012) while the vehicle was atop the Saturn IB booster, a flash fire in the command module resulted in the deaths of Astronauts Gus Grissom, Ed White, and Roger Chaffee. NASA immediately established a review board to determine the cause of the fire and the changes which would be necessary to prevent such fires in the future.

Apr. 9 - The review board presented its findings to the NASA administrator. While the exact cause of the fire was not determined conclusively, the board recommended a number of changes, including the elimination of most of the combustible materials in the spacecraft, the protection of wires in the spacecraft, and the installation of a quick-opening hatch. These and other changes were incorporated in later spacecraft.

Nov. 9 - The Apollo 4 mission, the first using the Saturn V launch vehicle, was considered. The spacecraft reached an altitude of 11,234 miles, entered the atmosphere at a speed of 24,917 mph, and splashed down in the Pacific six miles from the recovery ship after a flight of eight hours 37 minutes. This flight qualified the heat shield for lunar flight.

1968

Jan 22 - The lunar module was tested during the flight designated Apollo 5. A wrong number in the guidance logic caused immediate shutdown of the descent engine, and led to a series of abnormal events. The LM performed very well, however, and accomplished most of its objectives, including its ability to abort a landing on the moon and to return to the command module during its orbiting lunar flight.

Apr. 4 - Apollo 6, the second test of the Saturn V launch vehicle, although problems developed with the launch vehicle, the spacecraft's accomplishments were impressive. These included the longest single burn in space of the service propulsion engine, proper control of the engine by the guidance and navigation subsystem, and another successful test of the heat shield.

Apr. 29 - NASA announced that next Saturn V/Apollo flight would be manned, and would take place during the latter part of 1968. The next scheduled Apollo flight, designated Apollo 7, will be manned and will use a Saturn IB launch vehicle.

P-301

Apollo spacecraft are shipped to Kennedy Space Center, Fla., by specially converted aircraft from Long Beach Airport

APOLLO BRIEFS

The possibility of a micrometeoroid as big as a cigarette ash striking the command module during an 8-day lunar mission has been computed as 1 in 1230. If a meteoroid did strike the module, it would be at a velocity of 98,500 feet per second. The probability of the command module getting hit is 0.000815. The probability of the command module not getting hit is 0.999185.

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The heat leak from the Apollo cryogenic tanks, which contain hydrogen and oxygen, is so small that if one hydrogen tank containing ice were placed in a room heated to 70 degrees F, a total of 8-1/2 years would be required to melt the ice to water at just above freezing temperature. It would take approximately 4 years more for the water to reach room temperature. The gases in the cryogenic tanks are utilized in the production of electrical power by the Apollo fuel cell system and provide oxygen for the use of the crew.

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When the Apollo spacecraft passes through the Van Allen belts on its way to the moon, the astronauts will be exposed to radiation roughly equivalent to that of a dental X-ray.

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With gravity on the moon only one-sixth as strong as on earth, it is necessary that this difference be related to the Apollo vehicle. A structure 250 feet high and 400 feet long in which cables lift five-sixth of the spacecraft vehicle weight is being used in tests to simulate lunar conditions and their effect on the vehicle.

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The command module panel display includes 24 instruments, 566 switches, 40 event indicators (mechanical), and 71 lights.

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The command module offers 73 cubic feet per man as against the 68 cubic feet per man in a compact car. By comparison, the Mercury spacecraft offered 55 cubic feet for its one traveler and Gemini provided 40 cubic feet per man.

The angular accuracy requirement of midcourse correction of the spacecraft for all thrusting maneuvers is one degree.

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If your car gets 15 miles to a gallon, you could drive 18 million miles or around the world about 400 times on the propellants required for the Apollo/Saturn lunar landing mission. The Saturn V launch vehicle contains 5.6 million pounds of propellant (or 960,000 gallons).

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When the Apollo re-enters the atmosphere it will generate energy equivalent to approximately 86,000 kilowatt hours of electricity - enough to light the city of Los Angeles for about 104 seconds; or the energy generated would lift all the people in the USA 10-3/4 inches off the ground.

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The fully loaded Saturn V launch vehicle with the Apollo spacecraft stands 60 feet higher than the Statue of Liberty on its pedestal and weighs 13 times as much as the statue.

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During its 3.5 second firing, the Apollo spacecraft's solid-fuel launch escape rocket generates the horsepower equivalent of 4,300 automobiles.

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The engines of the Saturn V launch vehicle that will propel the Apollo spacecraft to the moon have combined horsepower equivalent to 543 jet fighters.

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The Apollo environmental control system has 180 parts in contrast to the 8 for the average home window air conditioner. The Apollo environmental control system performs 23 functions compared to 5 for the average home conditioner. There are 23 functions of the environmental control system, which include: air cooling, air heating, humidity control, ventilation to suits, ventilation to cabin, air filtration, CO_2 removal, odor removal, waste management functions, etc.

The 12-foot-high Apollo spacecraft command module contains about fifteen miles of wire, enough to wire 50 two-bedroom homes.

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The astronaut controls and monitors the stabilization and control system by means of two handgrip controllers, 34 switches, and 6 knobs.

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The command system of the acceptance checkout equipment can generate up to 2048 separate stimuli or 128 analog signals, or combinations of both, and route them to spacecraft and other checkout systems at a million bits per second. In contrast, hand-operated commercial teletype generates 45 bits per second and automatically, over voice channel, it generates 2400 bits per second.

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The Apollo command module can sustain a hole as large as 1/4 inch in diameter and still maintain the pressure inside for 15 minutes, which is considered long enough for an astronaut to put on a spacesuit.

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The boost protective cover will protect the command module from temperatures expected to reach 1200 degrees during the launch phase.

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The power of one Saturn V is enough to place in earth orbit all U.S. manned spacecraft previously launched.

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Here is an analogy pertaining to the benefits of the multistage concept as opposed to the single-stage, brute-force method. If a steam locomotive pulling three coal cars carries all three cars along until all fuel is exhausted, the locomotive could travel 500 miles. By dropping off each car as its coal is expended the locomotive could travel 900 miles.

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The F-1's fuel pumps push fuel with the force of 30 diesel locomotives.

Enough liquid oxygen is contained in the first stage tank to fill 54 railroad tank cars.

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The five F-1 engines equal 160,000,000 horse power, about double the amount of potential hydroelectric power that would be available at any given moment if all the moving waters of North America were channeled through turbines.

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The interior of each of the first stage propellant tanks is large enough to accommodate three large moving vans side by side.

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The Saturn V's second stage construction is comparable to that of an eggshell in efficiency, the amount of weight and pressure constrained by a thin wall.

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Total amount of propellant (fuel and oxidizer) in the Saturn V launch vehicle, service module, and lunar module is 5,625,000 pounds.

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The Apollo spacecraft, including the command and service modules and the adapter which housed the lunar module, is 82 feet tall, only 13 feet shorter than the entire Mercury-Atlas space vehicle used in John Glenn's orbital mission.

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The ratio of propellant to payload in Saturn V is 50 to 1.

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The main computer in the command module occupies only one cubic foot.

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While an automobile has less than 3,000 functional parts, the command module has more than 2,000,000 not counting wires and skeletal components.

The command module uses only about 2000 watts of electricity, similar to the amount required by an oven in an electric range.

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The heat shield and its ablator must resist heat twice as great as that encountered by Gemini and Mercury.

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The configuration of Apollo is designed to give it aerodynamic lift so that it is possible to "fly" it during re-entry. The lift-over-drag ratio is about 0.35.

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The honeycomb aluminum used in Apollo's inner crew compartment is 40-percent stronger and 40-percent lighter than ordinary aluminum.

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There are 50 engines aboard the Apollo spacecraft: 16 reaction control engines on the service module, 16 reaction control engines on the lunar module, 12 reaction control engines on the command module, the service propulsion engine, the lunar module ascent and descent engines, the launch escape motor, the tower jettison motor, and the pitch control motor. The last three are solid-propellant engines and the other 47 all burn a hypergolic liquid propellant composed of nitrogen tetroxide and hydrazine. A hypergolic propellant is one composed of an oxidizer and a fuel which ignite and burn on contact.

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The tanks which hold the cryogenic (ultra-cold) liquid oxygen and liquid hydrogen on the Apollo spacecraft come close to being the only leak-free vessels ever built. If an automobile tire leaked at the same rate that these tanks do, it would take the tire 32,400,000 years to go flat.

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There are approximately 2-1/2 million solder joints in the Saturn V launch vehicle. If just 1/32 of an inch too much wire were left on each of these joints and an extra drop of solder was used on each of these joints, the excess weight would be equivalent to the payload of the vehicle.