NASA Apollo Program Historical Information

# Apollo
# Saturn V
# News Reference

August 1967

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NASA

BOEING

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IBM

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# SATURN V

# news REFERENCE

# SATURN V NEWS REFERENCE

AUGUST 1967

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
John F. Kennedy Space Center

The Boeing Company
Launch Systems Branch

Douglas Aircraft Company
Missile & Space Systems Division

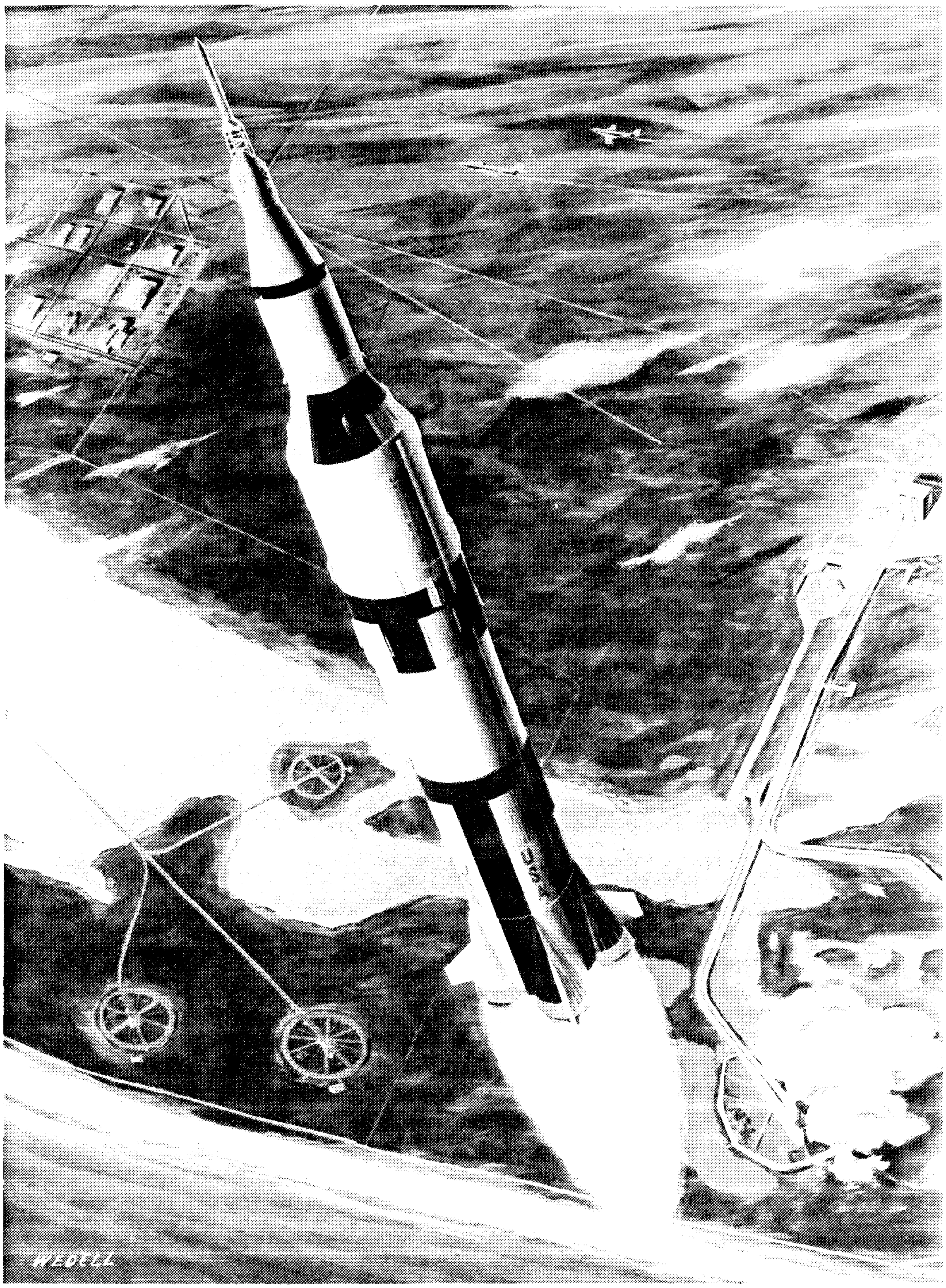
International Business Machines Corporation
Federal Systems Division

Rocketdyne Division
North American Aviation, Inc.

Space Division
North American Aviation, Inc.

Litho in U.S.A.

SATURN V NEWS REFERENCE



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# FOREWORD

This volume has been prepared by the five Saturn V major contractors: The Boeing Company; Douglas Aircraft Company; Space Division of North American Aviation, Inc.; Rocketdyne Division of North American Aviation, Inc.; and International Business Machines Corporation in cooperation with the National Aeronautics and Space Administration.

It is designed to serve as an aid to newsmen in present and future coverage of the Saturn V in its role in the Apollo program and as a general purpose large launch vehicle. Every effort has been made to present a comprehensive overall view of the vehicle and its capabilities, supported by detailed information on the individual stages and all major systems and subsystems.

Weights and measurements cited throughout the book apply to the AS-501 vehicle, the first flight version of the Apollo/Saturn V.

All photographs and illustrations in the book are available for general publication. The first letter in each photo number is a code identifying the organization holding that negative: B for Boeing; R for Rocketdyne Division of North American; D for Douglas; IBM for IBM; S for Space Division of North American; H for NASA, Huntsville, Ala.; and K for NASA, Kennedy Space Center, Fla.

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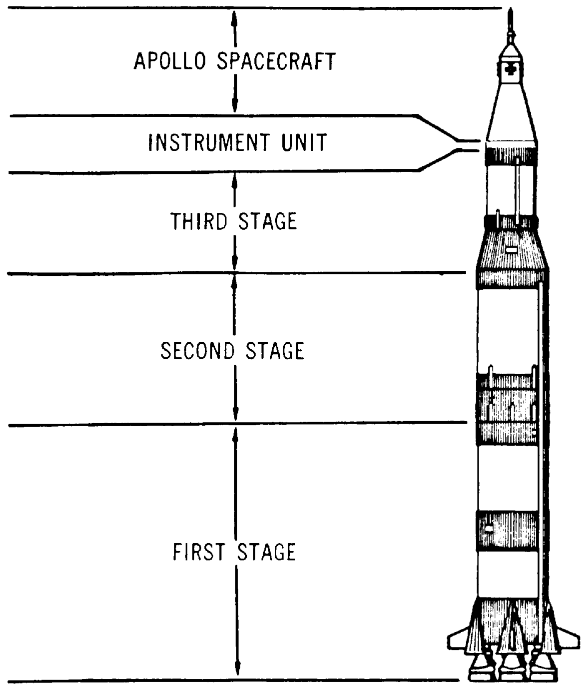
# SATURN V FACT SHEET




**PHYSICAL CHARACTERISTICS**

| | DIAMETER | HEIGHT | WEIGHT |
|---|---|---|---|
| OVERALL VEHICLE | 33 ft. | 364 ft.* | 6,100,000 lb. (total liftoff) |
| FIRST STAGE | 33 ft. | 138 ft. | 300,000 lb. (dry) |
| SECOND STAGE | 33 ft. | 81 ft. 7 in. | 95,000 lb. (dry)** |
| THIRD STAGE | 21 ft. 8 in. | 58 ft. 7 in. | 34,000 lb. (dry)** |
| INSTRUMENT UNIT | 21 ft. 8 in. | 3 ft. | 4,500 lb. |
| APOLLO SPACECRAFT | | 80 ft. | 95,000 lb. |

*SINCE INDIVIDUAL STAGE DIMENSIONS OVERLAP IN SOME CASES, OVERALL VEHICLE LENGTH IS NOT THE SUM OF INDIVIDUAL STAGE LENGTHS

**INCLUDES AFT INTERSTAGE WEIGHT

**PROPULSION SYSTEMS**

FIRST STAGE —Five bipropellant F-1 engines developing 7,500,000 lb. thrust
RP-1 Fuel—203,000 gal. (1,359,000 lb.), LOX—331,000 gal. (3,133,000 lb.)

SECOND STAGE—Five bipropellant J-2 engines developing more than 1,000,000 lb. thrust
$LH_2$—260,000 gal. (153,000 lb.), LOX—83,000 gal. (789,000 lb.)

THIRD STAGE —One bipropellant J-2 engine developing up to 225,000 lb. thrust
$LH_2$—63,000 gal. (37,000 lb.), LOX—20,000 gal. (191,000 lb.)

**CAPABILITY**

FIRST STAGE —Operates about 2.5 minutes to reach an altitude of about 200,000 feet (38 miles) at burnout

SECOND STAGE Operates about 6 minutes from an altitude of about 200,000 feet to an altitude of 606,000 feet (114.5 miles)

THIRD STAGE —Operates about 2.75 minutes to an altitude of about 608,000 feet (115 miles) before second firing and 5.2 minutes to translunar injection

PAYLOAD—250,000 lb. into a 115 statute-mile orbit

# THE SATURN V

## INTRODUCTION

When the United States made the decision in 1961 to undertake a manned lunar landing effort as the focal point of a broad new space exploration program, there was no rocket in the country even approaching the needed capability. There was a sort of "test bed" in the making, a multi-engine vehicle now known as Saturn I. It had never flown. And it was much too small to offer any real hope of sending a trio to the moon, except possibly through as many as a half dozen separate launchings from earth and the perfection of rendezvous and docking techniques, which had never been tried.

That was the situation that brought about the announcement on Jan. 10, 1962, that the National Aeronautics and Space Administration would develop a new rocket, much larger than any previously attempted. It would be based on the F-1 rocket engine, the development of which had been underway since 1958, and the hydrogen-fueled J-2 engine, upon which work had begun in 1960.

The Saturn V, then, is the first large vehicle in the U. S. space program to be conceived and developed for a specific purpose. The lunar landing task dictated the make-up of the vehicle, but it was not developed solely for that mission. As President Kennedy pointed out when he issued his space challenge to the Congress on May 25, 1961, the overall objective is for "this Nation to take a clearly leading role in space achievement which in many ways may hold the key to our future on earth." He said of the lunar landing project: "No single space project in this period will be more exciting, or more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish . . . "

The Saturn V program is the biggest rocket effort undertaken in this country. Its total cost, including the production of 15 vehicles between now and early 1970, will be above $7 billion.

NASA formally assigned the task of developing the Saturn V to the Marshall Space Flight Center on Jan. 25, 1962. Launch responsibility was committed to the Kennedy Space Center. (The Manned Spacecraft Center, the third center in manned space flight, is responsible for spacecraft development, crew training, and inflight control.)

## DESCRIPTION

Marshall Center rocket designers conceived the Saturn V in 1961 and early 1962. They decided that a three-stage vehicle would best serve the immediate needs for a lunar landing mission and would serve well as a general purpose space exploration vehicle.

One of the more important decisions made early in the program called for the fullest possible use of components and techniques proven in the Saturn I program. As a result, the Saturn V third stage (S-IVB) was patterned after the Saturn I second stage (S-IV). And the Saturn V instrument unit is an outgrowth of the one used on Saturn I. In these areas, maximum use of designs and facilities already available was incorporated to save time and costs.

Many other components were necessary, including altogether new first and second stages (S-IC and S-II). The F-1 and J-2 engines were already under development, although much work remained to be done. The guidance system was to be an improvement on that of the Saturn I.

Saturn V, including the Apollo spacecraft, is 364 feet tall. Fully loaded, the vehicle will weigh some 6.1 million pounds.

The 300,000-pound first stage is 33 feet in diameter and 138 feet long. It is powered by five F-1 engines generating 7.5 million pounds thrust. The booster will burn 203,000 gallons of RP-1 (refined kerosene) and 331,000 gallons of liquid oxygen (LOX) in 2.5 minutes.

Saturn V's second stage is powered by five J-2 engines that generate a total thrust of a million pounds. The 33-foot diameter stage weighs 95,000 pounds empty and more than a million pounds loaded. It burns some 260,000 gallons of liquid hydrogen and 83,000 gallons of liquid oxygen during a typical 6-minute flight.

Third stage of the vehicle is 21 feet and 8 inches in diameter and 58 feet and 7 inches long. An interstage adapter connects the larger diameter second stage to the smaller upper stage. Empty weight of the stage is 34,000 pounds and the fueled weight is 262,000 pounds. A single J-2 engine developing up to 225,000 pounds of thrust powers the stage. Typical burn time is 2.75 minutes for the first burn and 5.2 minutes to a translunar injection.

The vehicle instrument unit sits atop the third stage. The unit, which weighs some 4,500 pounds, contains the electronic gear that controls engine ignition and cutoff, steering, and all other commands necessary for the Saturn V mission. Diameter of the instrument unit is 21 feet and 8 inches, and height is 3 feet.

Directly above the instrument unit in the Apollo configuration is the Apollo spacecraft. It consists of the lunar module, the service module, the command module, and the launch escape system. Total height of the package is about 80 feet.

## TYPICAL LUNAR LANDING MISSION

The jumping-off place for a trip to the moon is NASA's Launch Complex 39 at the Kennedy Space Center. After the propellants are loaded, the three astronauts will enter the spacecraft and check out their equipment.

While the astronauts tick off the last minutes of the countdown in the command module, a large crew in the launch control center handles the complicated launch operations. For the last two minutes, the countdown is fully automatic.

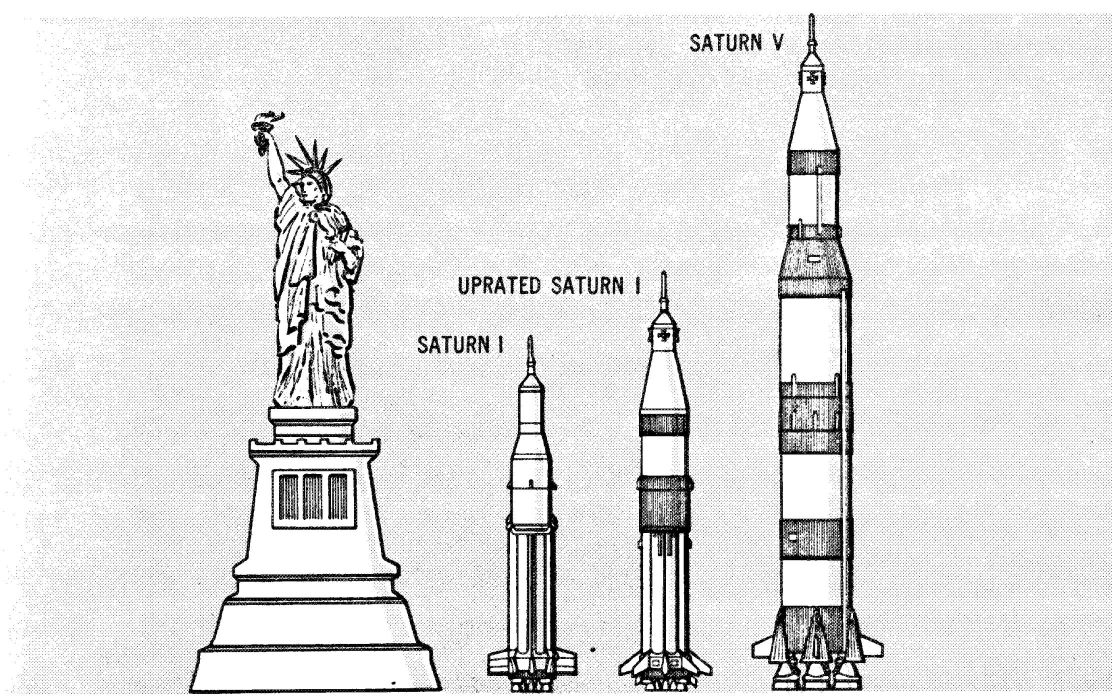
At the end of countdown, the five F-1 engines in the first stage ignite, producing 7.5 million pounds of thrust. The holddown arms release the vehicle, and three astronauts begin their ride to the moon.

Turbopumps, working together with the strength of 30 diesel locomotives, force 15 tons of fuel per second into the engines. Steadily increasing acceleration pushes the astronauts back into their couches as the rocket generates 4-1/2 times the force of earth gravity.

After 2.5 minutes, the first stage has burned its 4,492,000 pounds of propellants and is discarded at about 38 miles altitude. The second stage's five J-2 engines are ignited. Speed at this moment is 5,330 miles per hour.

The second stage's five J-2 engines burn for about 6 minutes, pushing the Apollo spacecraft to an altitude of nearly 115 miles and near orbital velocity of 15,300 miles per hour. After burnout the second stage drops away and retrorockets slow it for its fall into the Atlantic Ocean west of Africa.

The single J-2 engine in the third stage now ignites and burns for 2.75 minutes. This brief burn boosts the spacecraft to orbital velocity, about 17,500 miles an hour. The spacecraft, with the third stage still attached, goes into orbit about 12 minutes after liftoff. Propellants in the third stage are not depleted when the engine is shut down. This stage stays with the spacecraft in earth orbit, for its engine will be needed again.




Saturn Comparisons to Statue of Liberty

Throughout the launch phase of the mission, telemetry systems are transmitting continously, tracking systems are locked on, and voice communications are used to keep in touch with the astronauts. All stage separations and engine thrust terminations are reported to the Mission Control Center at Houston.

The astronauts are now in a weightless condition as they circle the earth in a "parking orbit" until the timing is right for the next step to the moon.

The first attempt at a lunar landing is planned as an "open-ended" mission with detailed plans at every stage for mission termination if necessary. A comprehensive set of alternate flight plans will be laid out and fully rehearsed for use if such a decision should prove necessary. For example, a decision might be made in the earth parking orbit not to continue with the mission. At every stage of the mission, right up to touchdown on the moon, this termination decision can be made and an earth flight plan initiated.

During the one to three times the spacecraft circles the earth, the astronauts make a complete check of the third stage and the spacecraft. When the precise moment comes for injection into a translunar trajectory, the third stage J-2 engine is reignited. Burning slightly over 5 minutes, it accelerates the spacecraft from its earth orbital speed of 17,500 miles an hour to about 24,500 miles an hour in a trajectory which would carry the astronauts around the moon. Without further thrust, the spacecraft would return to earth for re-entry.

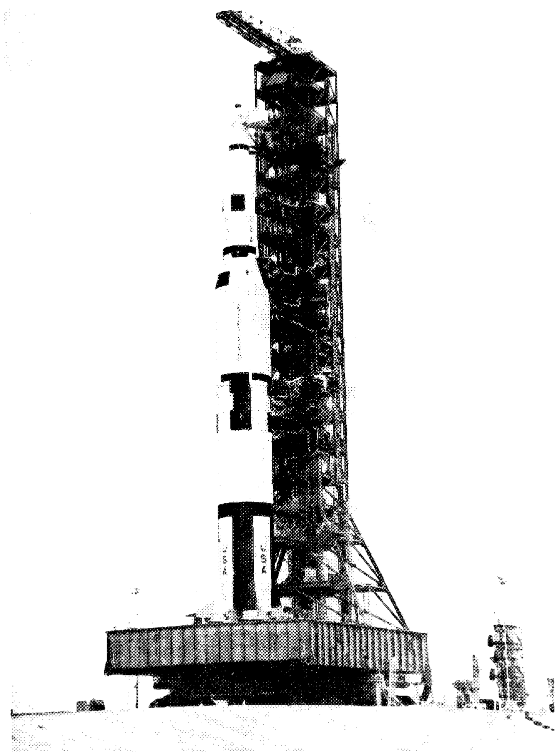
If everything is operating on schedule, the astronauts will turn their spacecraft around and dock with the lunar landing module. After the docking maneuver has been completed, the lunar module will be pulled out of the forward end of the third stage, which will be abandoned. Abandonment completes the Saturn V's work on the lunar mission.

## EARLIER SATURNS

### Saturn I

Studies which led to the Saturn family of rockets were started by the Wernher von Braun organization in April of 1957. The aim of the program was to create a 1.5 million-pound-thrust booster by clustering previously developed and tested engines.

On Aug. 15, 1958, the Advanced Research Projects Agency (ARPA) formally initiated what was to become the Saturn project. The agency, a separately organized research and development arm of the Department of Defense, authorized the Army Ballistic Missile Agency to conduct a research and development program at Redstone Arsenal for a 1.5



K-107P-66P-258

Test Vehicle—The first assembled Apollo Saturn V vehicle approaches the launch pad at Kennedy Space Center. It was used to verify launch facilities, train launch crews, and develop test and checkout procedures at KSC. It was rolled out on May 25, 1966.

million-pound-thrust vehicle booster. A number of available rocket engines were to be clustered and tested by a full-scale static firing by the end of 1959.

The program objectives were expanded by ARPA in October of 1958 to include a multi-stage carrier vehicle capable of performing advanced space missions. Concurrent with the development of a multistage vehicle, static test facilities at Redstone Arsenal and launch complex facilities at Cape Canaveral—now Cape Kennedy—were being constructed.

The proposed large vehicle project was officially renamed Saturn on Feb. 3, 1959, by ARPA memorandum. The space agency assumed technical direction of the Saturn project in late 1959. The project was transferred officially on Mar. 16, 1960, and the Army development group at Huntsville was transferred to NASA and became the nucleus of the new Marshall Space Flight Center. The first static firing of a Saturn I booster was conducted April 29, 1960.

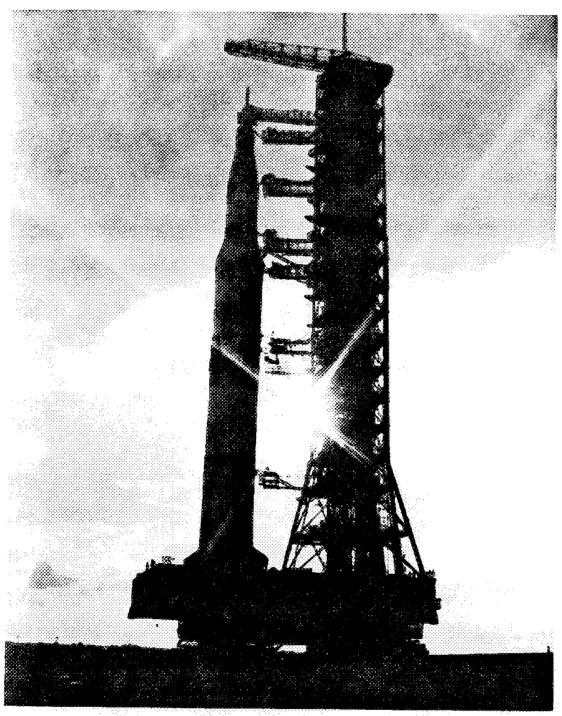
The NASA Saturn Vehicle Evaluation Committee (Silverstein Committee) on Dec. 15, 1959, recommended a long-range development program for a Saturn vehicle with upper stage engines burning liquid hydrogen and liquid oxygen. The initial vehicle, identified as Saturn C-1 and now as Saturn I, was to be a stepping stone to a larger vehicle. A building-block concept was proposed that would yield a variety of Saturn configurations, each using previously proven developments as far as possible.

Early in 1960 the Saturn program was given the highest national priority, and a 10-vehicle research and development program was approved.

The two-stage Saturn I vehicle with the Apollo spacecraft was about 188 feet tall and weighed some 1,125,000 pounds at liftoff.

While plans for the lunar mission were progressing, the Saturn I project made history. On Oct. 27, 1961, the first Saturn I booster was flight tested successfully from Cape Kennedy. The first flight booster with dummy upper stages was called SA-1. This vehicle was followed by successful flights of SA-2 on April 25, 1962, SA-3 on Nov. 16, 1962, and SA-4 on Mar. 28, 1963.

The SA-5 vehicle, combining the first stage (S-1) with the second stage (S-IV), was successfully launched on Jan. 29, 1964, with both stages functioning perfectly to place a 37,700-pound payload into earth orbit. SA-6, launched on May 28, 1964, and SA-7, launched on Sept. 18, 1964, each placed "unmanned" boilerplate configurations of Apollo spacecraft into earth orbit.



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Saturn V Launch Vehicle at Sunset

SA-9, launched on Feb. 19, 1965, was the first Saturn I vehicle to launch a Pegasus meteoroid technology satellite into earth orbit.

The SA-8 and SA-10 Saturn I vehicles were successfully launched on May 25, 1965, and July 30, 1965, respectively, also placing a Pegasus satellite into earth orbit to complete the test and launch program with an unprecedented 100 per cent record of success.

## Uprated Saturn I (Saturn IB)

The space agency, using the building-block approach, conceived the Uprated Saturn I as the quickest, most reliable, and most economical means of providing a vehicle with greater payload than the Saturn I. This vehicle was planned for orbital missions with the Apollo spacecraft before the Saturn V vehicle would be available.

The Uprated Saturn I is based on a blending of existing elements of Saturn I and Saturn V. A redesigned Saturn I booster (designated the S-IB stage), and an S-IVB upper stage and instrument unit from the Saturn V are used on this launch vehicle.

Maximum use of designs and facilities available from the earlier approved Saturn programs saved both time and costs.

The Saturn I first stage was redesigned in several areas by NASA and the Chrysler Corporation, the stage contractor, for the expanded role as the Uprated Saturn I booster. Basically, it retained the same shape and size, but required some modification for mating with the upper stage, which has a greater diameter and weight than the Saturn I upper stage.

Stage weight was cut by more than 20,000 pounds to increase payload capacity. The Rocketdyne H-1 engine was uprated to 200,000 pounds of thrust, compared with 188,000 pounds of thrust for each engine in the final Saturn I configuration. The engines will be improved again to 205,000 pounds beginning with the SA-206.

For the Uprated Saturn I, a guidance computer used in the early Saturn I was replaced by another IBM computer of completely new design which incorporates the added flexibility and extreme reliability necessary to carry out the intended Uprated Saturn I missions.

The Uprated Saturn I, topped by the Apollo spacecraft, stands approximately 224 feet tall, and is about 21.7 feet in diameter. Total empty weight is about 85 tons, and liftoff weight fully fueled is approximately 650 tons.

Several uprated Saturn I vehicles have been launched since the original SA 201 launch on Feb. 26, 1966.

## HOW SATURN V DESIGN WAS REACHED

While a major effort of this country's space commitment was to explore the moon, the broader target was to build a capability—people, launch vehicles, propulsion, spacecraft, production, testing, and launching sites—to explore a vast new frontier and develop a long-range spacefaring capability that would establish continuing national preeminence.

The questions facing national space planners in 1961 and 1962 were complex. Although the use of a Saturn I for a manned lunar landing was theoretically possible, it would have been extremely difficult. About six Saturn I launches would have been required, their payloads being assembled in earth orbit to form a moon ship. No space rendezvous and docking had taken place at that time.

During the first half of 1962, two paramount decisions were announced: to develop a new general purpose launch vehicle in the middle range of several under consideration, and to conduct the manned lunar landing by use of a lunar orbit rendezvous (LOR) technique.

The Saturn V, as the chosen vehicle was named, was given the go-ahead in January, 1962.

It was to be composed of three propulsive stages and a small instrument unit to contain guidance and control. It could perform earth orbital missions through the use of the first two stages, while all three would be required for lunar and planetary expeditions. The ground stage was to be powered by five F-1 engines, each developing 1.5 million pounds of thrust, and the stage would have five times the power of the Saturn I booster then under development. The upper stages would use the J-2 hydrogen/oxygen engine, five in the second stage and one in the third. Each would develop up to 225,000 pounds of thrust. Such a rocket would be capable of placing 120 tons into earth orbit or dispatching 45 tons to the moon. (The numbers have been uprated now to about 125 and 47-1/2.)

During its assembly, checkout, and launch, the Saturn V would use a new mobile launch concept. It would be assembled in a huge Vehicle Assembly Building, and then transported in an upright position to a launch pad several miles away.

Propulsion development decisions preceded those for the vehicles.

The need for a building-block rocket engine in the million-pound-thrust class was apparent even as ARPA was ordering work to begin on the first stage cluster of engines for the Saturn I. In January, 1959, NASA contracted with North American Aviation's Rocketdyne Division for development of the F-1.

Late in 1959, the Silverstein Committee recommended the development of a new high-thrust hydrogen engine to meet upper stage requirements. In June, 1960, Rocketdyne was selected to develop the J-2 engine after evaluation of competitive proposals by NASA.

Three proposed Apollo modes which were considered in detail were: the direct flight mode, using a very large launch vehicle called "Nova"; the earth orbital rendezvous (EOR) mode, requiring separate Saturn launches of a tanker and a manned spacecraft; and the lunar orbital rendezvous mode, requiring a single launch of the manned spacecraft and the lunar module.

Selected was the LOR mode, in which the injected spacecraft weight would be reduced from 150,000 pounds to approximately 80,000 pounds by eliminating the requirement for the propulsion needed to soft-land the entire spacecraft on the lunar surface.

A small lunar excursion module, or LEM, now referred to as the lunar module, would be detached after deboost into lunar orbit. The lunar module would carry two of the three-man Apollo crew to a soft landing on the moon and would subsequently be launched from the moon to rendezvous with the third crew member in the "mother ship." The entire crew would then return to earth aboard the command module.

NASA concluded that LOR offered the greatest assurance of successful accomplishment of the Apollo objectives at the earliest practical date.

Members of NASA's Manned Space Flight Management Council recommended LOR unanimously in 1962 because it:

1. Provided a higher probability of mission success with essentially equal mission safety;
2. Promised mission success some months earlier than did other modes;
3. Would cost 10 to 15 per cent less than the other modes; and
4. Required the least amount of technical development beyond existing commitments while advancing significantly the national technology.

As a part of the Saturn V decision, it was determined that elements of the existing Saturn I vehicle and the planned Saturn V would be combined to form a new mid-range vehicle, the uprated Saturn I (Saturn IB). The Uprated Saturn I would have a payload capability 50 per cent greater than the Saturn I and would make possible the testing of the Apollo spacecraft in earth orbit about one year earlier than would be possible with the Saturn V.

By the end of 1962, all elements of the new program were under way, with the Marshall Space Flight Center directing the work for NASA. The Boeing Company; Space Division of North American Aviation, Inc.; and Douglas Aircraft Company were acting as prime contractors for the Saturn V first, second, and third stages, respectively. Engines were being developed by the Rocketdyne Division of North American. MSFC designed the instrument unit and awarded a production contract to International Business Machines Corp. (Chrysler Corp. had been selected to produce the first stage of the Uprated Saturn I.)

A large network of production, assembly, testing, and launch facilities was also being prepared by the end of 1962. Aside from the provision of various facilities at contractor plants and the augmentation of the Marshall Space Flight Center resources, three new government operations were established: the launch complex in Florida operated by the NASA-Kennedy Space Center and two new elements of MSFC—Michoud Assembly Facility in New Orleans, La., for the production of boosters, and Mississippi Test Facility, Bay St. Louis, Miss., for captive firing of stages.

Four years after its establishment, the Saturn V program was progressing on schedule, pointing toward the launch of the first vehicle in 1967 and fulfillment of the manned lunar landing before the end of the decade.

## PROGRAM HIGHLIGHTS

Following are highlights of the Saturn V development program:

1961

Aug. 24 NASA announced the selection of the 88,000-acre site at Merritt Island, Fla., adjacent to Kennedy Space Center, then Cape Canaveral, for the assembly, checkout, and launch of the Saturn V.

Sept. 7 NASA selected the government-owned Michoud plant, New Orleans, as production site for Saturn boosters. It became a part of the Marshall Space Flight Center.

Sept. 11 NASA selected North American Aviation, Inc., to develop and build the second stage for an advanced Saturn launch vehicle (as yet undefined) for manned and unmanned missions. One month later the Marshall Center directed NAA to design the second stage using five J-2 engines. A preliminary contract was signed in February, 1962.

Oct. 6 NASA selected the Picayune-Bay St. Louis, Miss., area for its Mississippi Test Facility—an arm of the Marshall Center—for use in static testing of rocket stages and engines.

Dec. 15 The Boeing Company was selected as prime contractor for the first stage of the advanced Saturn vehicle—not yet fully defined. A preliminary contract was signed in February, 1962, with the work to be conducted at the Michoud Assembly Facility.

Dec. 21 NASA selected the Douglas Aircraft Company to negotiate a contract to develop the third stage (S-IVB) of the advanced Saturn, based on the Saturn I's S-IV stage. A supplemental contract for production of 11 third stages was signed in August, 1962.

1962

Jan. 10 Announcement was made that the advanced Saturn vehicle would have a first stage powered by five F-1 engines, a second stage powered by five J-2 engines, and for lunar missions a third stage with one J-2 engine.

Jan. 25 NASA formally assigned development of the three-stage Saturn C-5 (Saturn V became the name in February, 1963) to MSFC.

April 11 NASA Headquarters gave the Apollo/Saturn I/Saturn V highest national priority.

May 26 Rocketdyne Division of NAA conducted the first full-thrust, long-duration F-1 engine test.

July 11 It was announced that the Saturn IB (Uprated Saturn I) would be developed and that the lunar orbit rendezvous method of accomplishing a lunar landing had been selected.

December The U. S. Army Corps of Engineers awarded a contract for the design of the Vehicle Assembly Building (VAB) at the Florida launch complex.

1963

Feb. 27 The first contract for the Mississippi Test Facility (MTF) Saturn V test facilities was awarded.

May The J-2 engine was successfully fired for the first time in a simulated space altitude of 60,000 feet.

Oct. 31 The Marshall Center received the first production model of the F-1 engine.

Nov. 12 NASA contracted for the first Saturn V launch pad at the Kennedy Space Center.

1964

March IBM was awarded an instrument unit contract for the digital computer and data adapter by the Marshall Center. IBM became the prime IU contractor in May.

Oct. 9 The Edwards AFB test facility was accepted as the F-1 test complex, amounting to a cost of $34 million.

Dec. 1 The first mainstage shakedown firing of the third stage battleship was accomplished, lasting 10 seconds.

Dec. 23 First full-duration firing of the third stage battleship occurred.

1965

April 16 All five engines of the S-IC-T, first stage test vehicle, were fired at the Marshall Center for 6.5 seconds.

April 24 The first cluster ignition test of the second stage battleship was successfully completed.

Aug. 5 The first full-duration firing of the first stage was conducted successfully at the Marshall Center.

Aug. 8 Third stage flight readiness test of 452 seconds, fully automated, was accomplished at Sacramento.

Aug. 13 The IU was qualified structurally and man-rated for Saturn V use by withstanding a 140 per cent load limit.

Aug. 17 The third stage battleship was tested in Saturn V configuration for full duration (start-stop-restart).

Dec. 16 The S-IC-T static firings were completed at the Marshall Center with a total of 15 firings—three of full duration.

1966

Feb. 17 & 25 The S-IC-1 underwent static firing at the Marshall Center and required no more static firings.

Mar. 30 The S-IU-500F was mated to the three stages of the Saturn V facilities vehicle at the Kennedy Space Center's VAB.

May 20 First full-duration firing of the second stage flight stage was conducted at MTF.

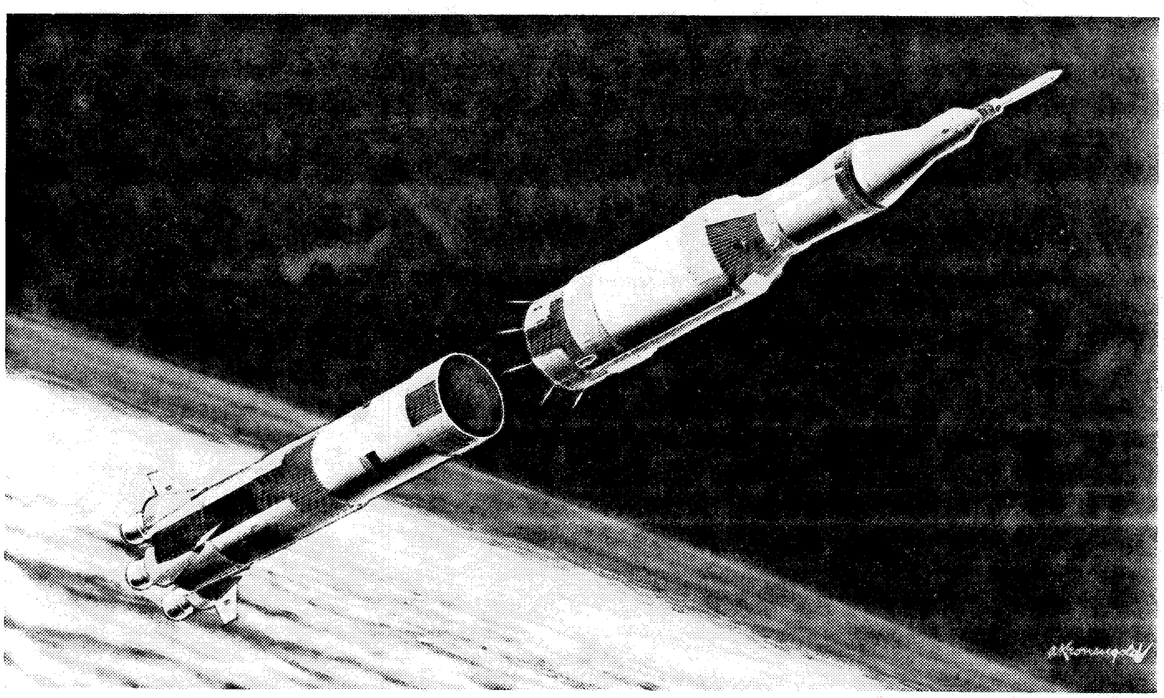
May 25 The Apollo/Saturn V facilities vehicle, AS-500-F, was transported to Pad A at Launch Complex 39, KSC, on the crawler.

May 26 Full-duration acceptance firing of the S-IVB-501, the first flight version of the third stage for Saturn V, was accomplished.

September The F-1 and J-2 engines were qualified for manned flights.

Dec. 1 Initial static firing of the first flight version of the second stage occurred at MTF.

Nov. 15 The first flight version of the first stage was static fired at MSFC.



First Stage Separation During an Apollo/Saturn V Shot

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