FACILITIES

INTRODUCTION

Assembly, test, and launch facilities for the Saturn V consist of a combination of facilities which existed before the onset of the program as well as many specifically created for its execution.

Included in these facilities are installations set up by the National Aeronautics and Space Administration to meet the greatly increased size and complexity of the Saturn program.

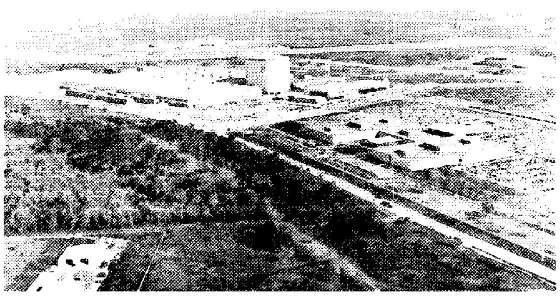
The Marshall Space Flight Center includes installations at Huntsville, Ala., where vehicle development is the prime responsibility; Michoud Assembly Facility, New Orleans, La., where the first stage is fabricated and assembled; and Mississippi Test Facility, Bay St. Louis, Miss., which is responsible for test operations. Launch facilities are located at the NASA Kennedy Space Center, Fla.

Because of the giant size of Saturn launch vehicles and the difficulties in transporting them, fabrication and test facilities were located within easy water shipment to the launch site.

At all of these NASA installations are located employes of the companies which are the prime contractors for building the various stages and components of the Saturn V. Other facilities, including the home bases of the major contractors and subcontractors, are located across the nation.

BOEING FACILITIES

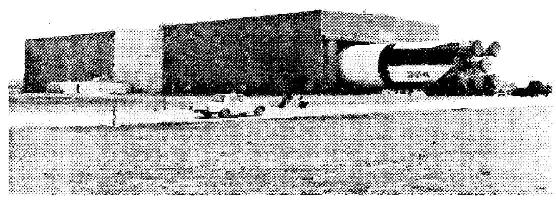
The Boeing Company manufactures the Saturn V first stage at the 900-acre NASA Michoud Assembly Facility in New Orleans. The facility has about 2,000,000 square feet of manufacturing floor space and about 730,000 square feet of office space. About 60 per cent of the manufacturing area is occupied by Boeing.



B-4793-9

Michoud—The Michoud Assembly Facility is the fabrication site of the first stage booster. Dominating the skyline is the Vertical Assembly Building.

The plant is arranged for logical and efficient flow of materials from the loading dock through to final assembly. Paralleling the material flow are the rework and modification area and the test and laboratory areas. There are 50,000 square feet of tooling area in the plant.



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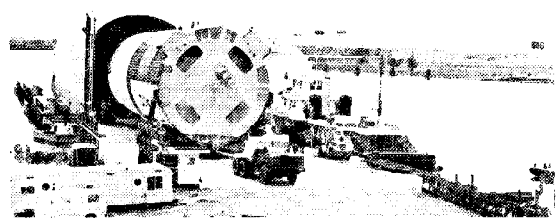
Stage Test—Before leaving Michoud, the completed booster undergoes a simulated firing during which all systems function in the Stage Test Building.



B-8145-2

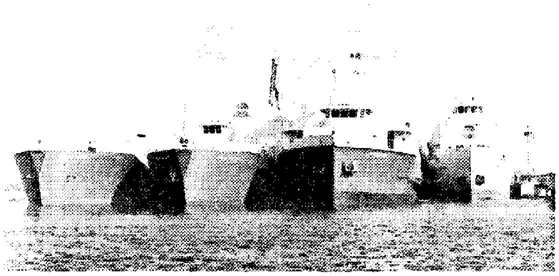
Barge Slip—First stages are loaded onto barges at Michoud and travel by waterways from New Orleans to Huntsville, Mississippi Test Facility, and Kennedy Space Center.

The environmentally controlled portion of the minor assembly area contains facilities for heat treatment, chemical cleaning, conversion coating, and welding of pre-formed metal sections received at the loading dock. Final assembly of the propellant tanks and the joining of the major components into the complete stage occur in the Vertical Assembly Building (VAB).

The VAB is a single-story structure rising the equivalent of 18 stories. A 180-ton overhead crane is used to stack the five large cylindrical segments of the first stage into a vertical assembly position. A $50 million program included the construction of three buildings—the VAB, the Stage Test Building, and the Engineering and Office Building—as well as the renovation of existing facilities at Michoud.

Checkout of the stage's electrical and mechanical systems is performed in the four giant test cells of the Stage Test Building. Each of the test cells is 83 by 191 feet with 51 feet of clear height. Each has separate test and checkout equipment.

Stages leave and enter Michoud by waterways connecting to the Mississippi River or the Gulf of Mexico.



B-8930-10

Unique Vessels—Four of six special barges used to carry Saturn rocket stages are shown moored side-by-side at the Michoud Assembly Facility. From left are the Little Lake, the Promise, the Poseidon, and the Palaemon.

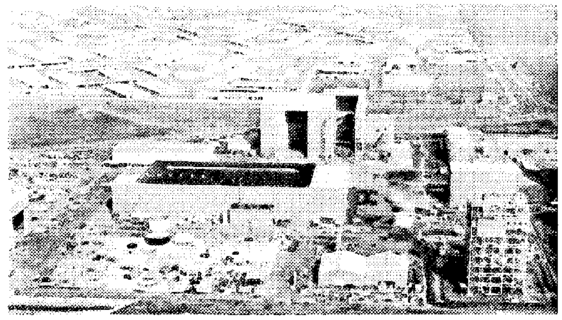
NORTH AMERICAN SPACE DIVISION FACILITIES

The second stage of the Saturn V is manufactured and tested in facilities located from one end of the nation to the other.

The main fabrication and testing facilities are located in Seal Beach, Calif., about 15 miles south of Downey, which is the headquarters of SD operations. SD subcontracts important elements of work to other North American facilities in Los Angeles and Tulsa and McAlester, Okla. The complex of buildings at Seal Beach, all built especially for the second stage, will be complemented by mid-1967 with three North American Aviation-owned buildings which will house all the second stage administrative, engineering, and support personnel who currently are located at Downey.

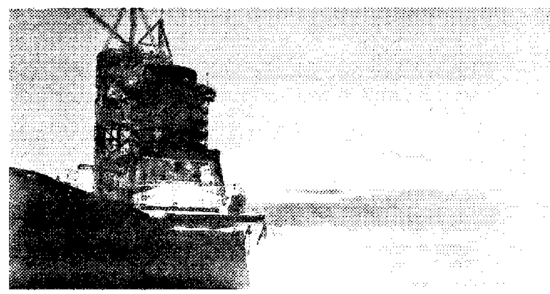
The Seal Beach facility includes a bulkhead fabrication building, 125-foot-high vertical assembly building, 116-foot-tall vertical checkout building, pneumatic test and packaging building, and a number of other structures.

The bulkhead fabrication building is a large, highly specialized structure designed solely for the construction and assembly of the second stage's three bulkheads. Among other tooling it contains an autoclave about 40 feet in diameter with a 40-foot dome for curing the large stage bulkheads.



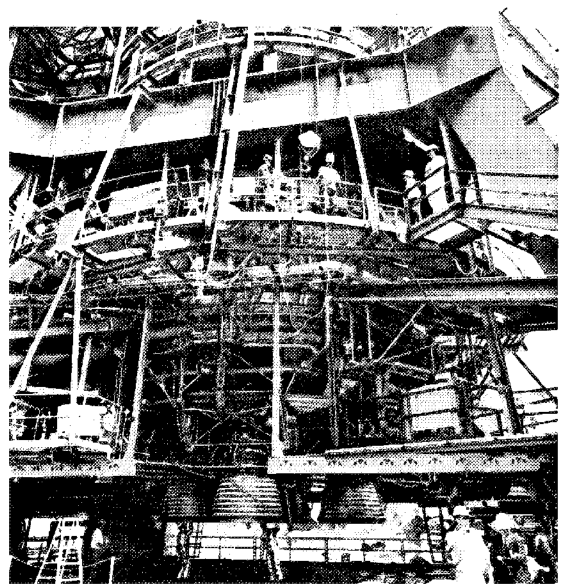
S-27

Over-all View—North American Seal Beach facilities include in-process storage building (left); bulkhead fabrication building (center); vertical assembly building (far right); pneumatic test and packaging building (right center); and structural test tower (right front).



S-28

Night firing of Test Second Stage at Santa Susana



S-29

Space Truck Readied—The five engines of the Saturn V second stage dwarf technicians preparing the "battleship" vehicle for hot firing at North American's Santa Susana static test lab.

The vertical assembly building, where the stage is assembled, contains six work stations at which successive major parts of the stage are added.

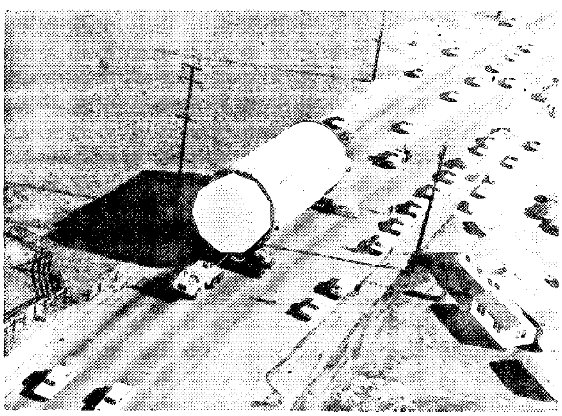
After assembly, the stage is moved to the vertical checkout building, where some final installations are made and where its systems and components are given final tests.

The last stop for a stage is the pneumatic test and packaging building, where stages are turned horizontally for pneumatic tests, painted, and prepared for shipping.

Other buildings at Seal Beach provide for such things as processing and storage of subassemblies and machine and tool shop services.

Second stage engine (J-2) testing is performed at the Rocketdyne Santa Susana facility. The Coca test area at Santa Susana operated by SD was rebuilt for the second stage and is where battleship test firings are conducted.

SD also operates facilities at both Mississippi Test Facility and Kennedy Space Center to provide management and operational support services.



S-30

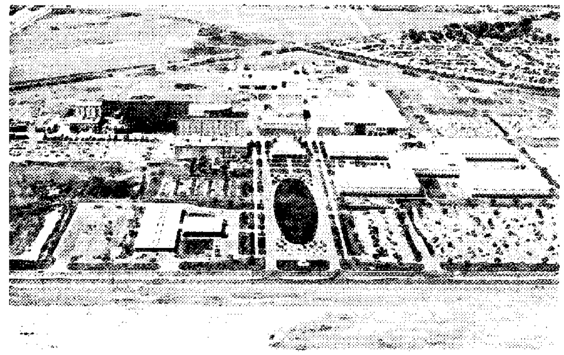
Wide Load—A second stage is transported from Seal Beach to the Navy dock for shipment to Mississippi Test Facility.

DOUGLAS FACILITIES

The Douglas Space Systems Center at Huntington Beach, Calif., is the master facility for engineering and production of the third stage of Saturn V. The center is headquarters for the Missile and Space Systems Division and for direction of Saturn activities in other company facilities at Santa Monica and Sacramento, Calif., and at Cape Kennedy, Fla.

Fabrication

Initial component fabrication for the Saturn V third stage is accomplished at the Santa Monica plant. It produces parts and subassemblies ranging from micro-miniature electronic components to the complete liquid oxygen tank.



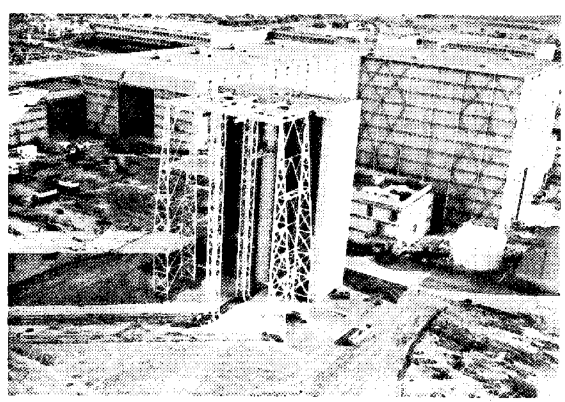
D-NRV-43

Aerial View of Space Systems Center, Huntington Beach, Calif.

Final assembly and factory checkout of the third stage takes place at the Space Systems Center. High-bay manufacturing area is provided for production of propellant tanks, skirts, and interstages. Eight tower positions are available for vertical assembly and checkout of completed vehicles.

The bulk of research and development testing in the third stage program is carried out in laboratory facilities at the Santa Monica plant. There components and subassemblies are put through a complete qualification test program in some 80 different laboratories.

Other test facilities include the Space Simulation Laboratory at the Space Systems Center, where major Saturn subassemblies are subjected to space-



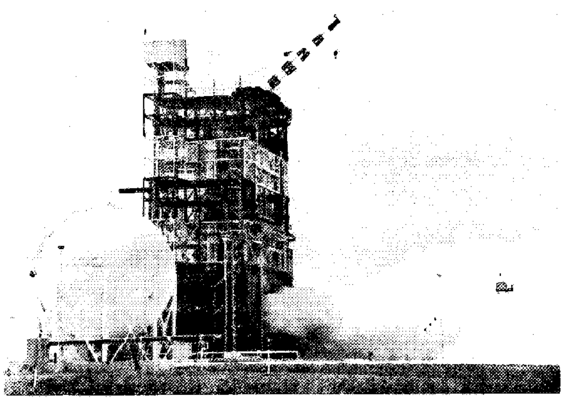
D-012220

Assembly and Checkout Tower, Douglas Space Systems Center like conditions by being placed inside a 39-foot diameter vacuum chamber for extended periods of time. The chamber is capable of simulating the vacuum at an altitude of 500 miles above the earth. Structural tests on major vehicle structures such as the propellant tank, skirt sections, and interstage are conducted in the Structural Test Laboratory at the Space Systems Center.

Two vertical checkout towers at the Space Systems Center provide for the final factory tests on finished third stages, prior to shipment from the plant for test firing. The vertical checkout laboratory is equipped with two complete sets of automatic checkout equipment.

Actual ground test firings of the stages are accomplished at the Douglas Sacramento Test Center, where each stage is delivered following the completion of assembly and checkout at the Huntington Beach plant.

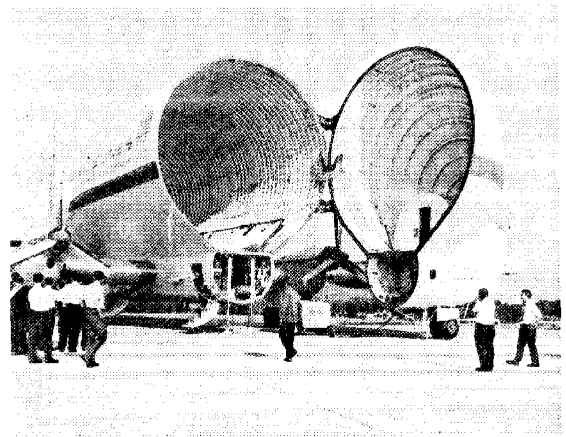
Primary Saturn facilities at Sacramento include a pair of 150-foot-high steel and concrete test stands where the stages are put through the final vehicle acceptance test—a full-duration, full-power static firing, simulating actual launch operations.



D-NRV-48

Static Test Firing of Third Stage at Sacramento

The Super Guppy, the world's largest airplane, is the primary means of transporting the third stage from the Douglas Huntington Beach plant to the Sacramento Test Center, and from Sacramento to KSC. Developed by Aero Spacelines, Inc., for transport of large space hardware, the plane has an inside diameter of 25 feet and a total length of 141 feet. Tail height is 46 feet—almost five stories above the ground. Cubic displacement of the fuselage is 49,790 cubic feet, approximately five times that of most present jet transports. The airplane is powered by four turbo-prop engines, producing a total of 28,000 horsepower.



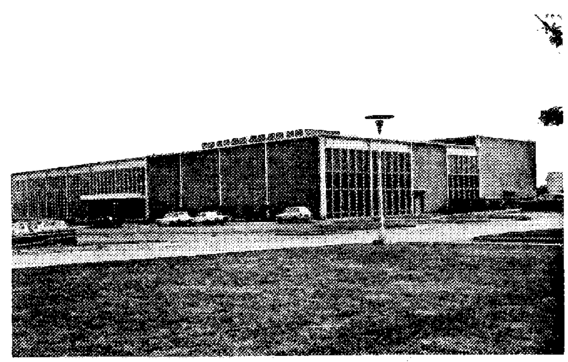
H-5-29646

Super Guppy

IBM FACILITIES

Three IBM-owned buildings at Huntsville comprise the Space Systems Center where component testing, fabrication, assembly, and systems checkout of the instrument unit are completed. Assembly and the majority of the testing activity take place in a 130,000-square-foot building located in Huntsville's Research Park.

As units are received, they are inspected and then moved to one of the testing laboratories where they are subjected to detailed quality and reliability testing. From component testing, the parts move

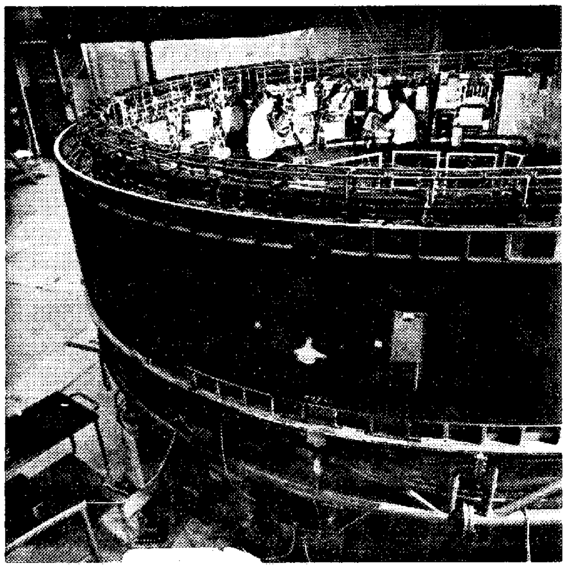


IBM-DR-24

IU Assembly and Test—All instrument unit assembly work and the majority of testing are done in this IBM-owned building in Huntsville's Research Park. The rear of the building is the high-bay area where assembly operations take place.

to inventory until called out for assembly.

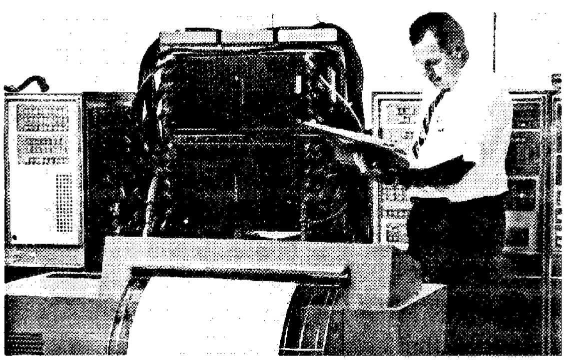
Following assembly operations, the IU is moved to one of two systems checkout stands—one for uprated Saturn I vehicles, the other for Saturn V.



IBM-DR-25

Automatic Checkout—IBM technicians monitor systems checkout tests as another technician optically adjusts the inertial guidance platform, prior to a simulated mission.

A complete systems checkout is performed automatically. Hooked by underground cables, two digital checkout computer systems examine the IU. Each of the IU's six subsystems is tested before the IU is tested as an integrated unit. With independent computers, systems tests for two instrument units can be conducted simultaneously.

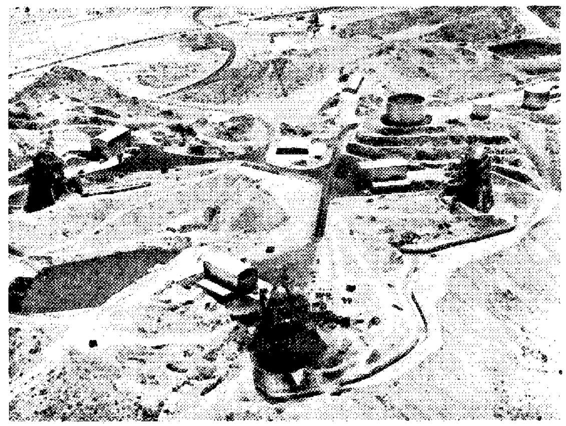


IBM-DR-26

Simulation Laboratory—Saturn V flight guidance and navigation programs as well as launch computer programs are tested in IBM's Engineering Building at Huntsville. Here a technician checks a computer readout of a simulated mission.

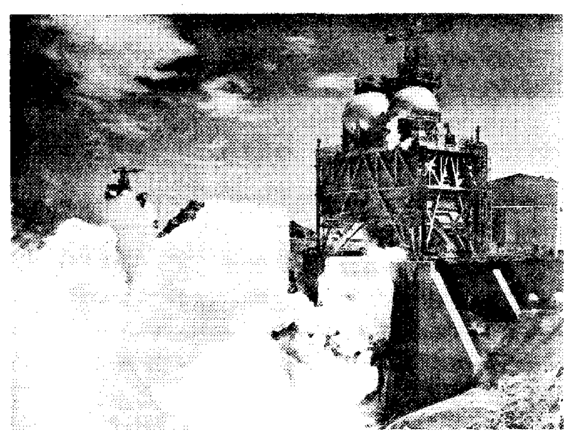
NORTH AMERICAN ROCKETDYNE FACILITIES

F-1 and J-2 engines for the Saturn V launch vehicle are manufactured at Rocketdyne's main complex in Canoga Park, Calif. F-1 static testing is conducted at the Edwards Field Laboratory located at the NASA Rocket Engine Test Site, Edwards, Calif., about 125 miles northeast of Los Angeles, and the J-2 is tested at Rocketdyne's Santa Susana Field Laboratory located about 10 miles from Canoga Park. Rocketdyne operates the Neosho Facility (Missouri), which produces and tests subcomponents of the J-2 and F-1 engines.



R-11

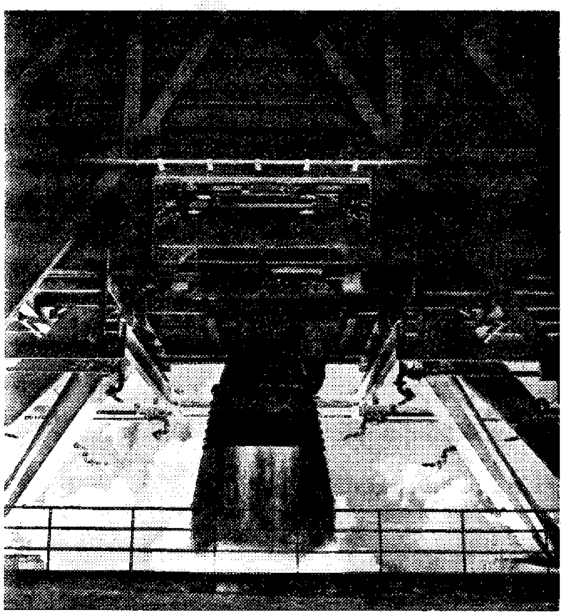
F-1 Test Stands—Three of six stands for testing F-1 rocket engines or components at full thrust are visible in this aerial view of NASA Rocket Engine Test Site.



R-12

F-1 Test Firing—An F-1 rocket engine developing 1,500,000 pounds of thrust is tested at NASA Rocket Engine Test Site. The stand is one of six in the complex.

Manufacturing of components and final assembly of both engines are carried out in eight buildings in the Canoga complex. These facilities are equipped with general purpose machine tools for precision and heavy machining as well as some 20 numerically controlled machines for performing programmed multiple machining operations. Also included are two of the largest gas-fired brazing furnaces of their type for brazing of thrust chamber tubes and injectors, eight units for ultrasonic cleaning, 21 installations for Gamma and X-ray inspection, more than 50 environmentally controlled areas for ultraclean assembly operations, sheet metal preparation, precision cleaning, and receiving inspection.



R-13

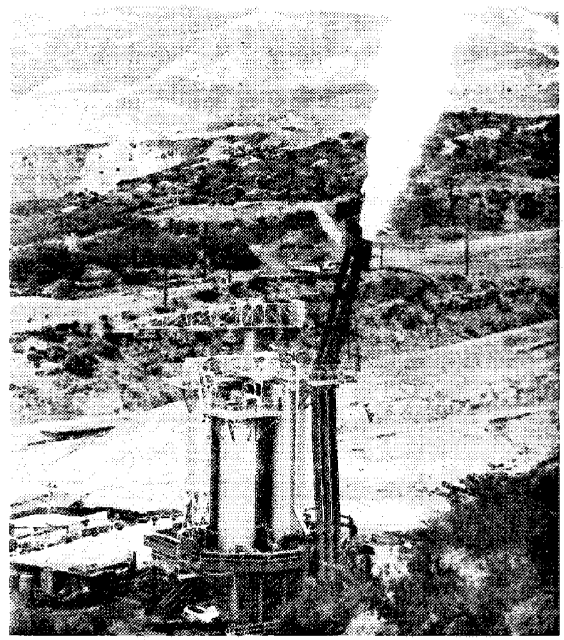
F-1 Flight Engine Firing

An Engineering Development Laboratory provides specialized facilities to support manufacturing programs. These facilities include a high-flow water test facility for checking propellant systems, 12 concrete cells for conducting hazardous tests, 28 environmental test chambers, a photo-elastic laboratory, two pneumatic flow benches, six vibration test rooms, and others for checking components as well as complete engines.

Research and development testing of F-1 turbomachinery, gas generators, heat-exchangers, seals, and splines is conducted on two test stands and three components test laboratories at Santa Susana.

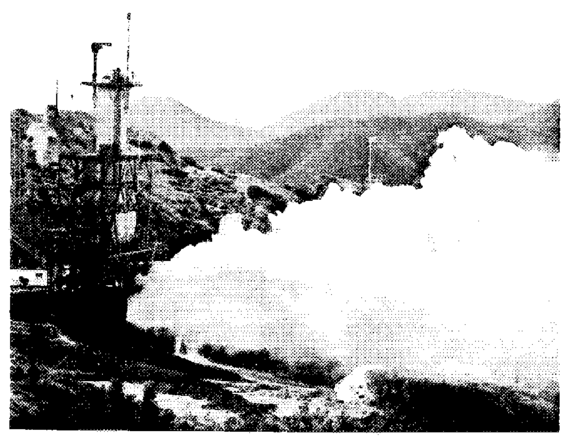
Six large test stands, with a total of eight test positions, and associated shops and support facilities at the Edwards Field Laboratory are used for testing complete F-1 engines as well as injectors.

Six large engine test stand positions at the Santa Susana Field Laboratory are used for testing the J-2. One of these stands is equipped with a steam injection diffuser for altitude simulation testing. J-2 turbopumps, gas generators, valves seals, bearings, and other components are tested in 22 test cells in five component test laboratories in Santa Susana.



R-14

Pump Tests—Flames from gases burned during test of an F-1 engine turbopump shoot more than 150 feet in air.



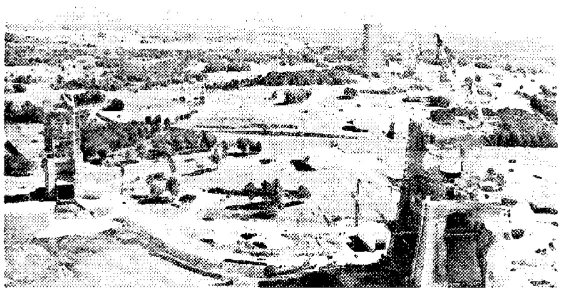
R-15

J-2 Testing—A hydrogen fueled J-2 rocket engine is tested under ambient altitude conditions at Santa Susana.

HUNTSVILLE FACILITIES

New Saturn V facilities built at the Marshall Space Flight Center at Huntsville, Ala., include the first stage static test stand, an F-1 engine test stand, the Saturn V launch vehicle dynamic test stand, a J-2 engine facility, and ground support and component test positions.

The Marshall Center has completed a $39 million addition to its Test Laboratory for captive testing the Saturn V booster and F-1 engines. The Test Laboratory addition is called the West Test Area. The largest structure in the area is the first stage test stand. Completed in 1964, the stand has an overall height of 405 feet.



H-5-31176

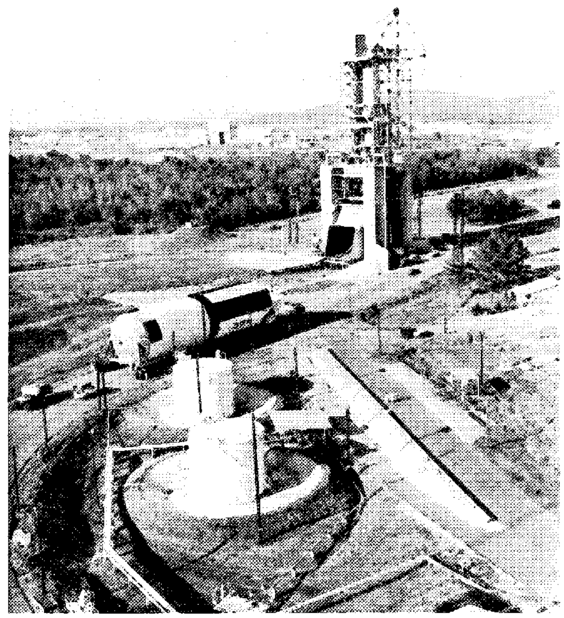
Growth at Huntsville—The growth of rocket testing facilities at the Marshall Space Flight Center is contrasted here by the size of the first Redstone Arsenal test stand, second from left, and stands at right built for the Saturn V program.

The nearby single engine test stand is being used for research and development tests of the 1.5 million pound thrust F-1 engine.

Control and monitoring equipment for the first stage and F-1 engine stands is located in the area's central blockhouse. Water needed to cool the flame deflectors of the two stands is pumped from a nearby high-pressure industrial water station.

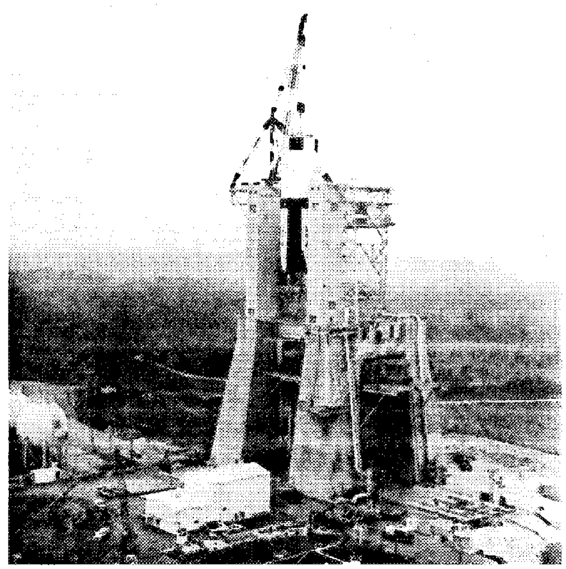
The 365-foot tall Saturn V launch vehicle was placed in another unique Marshall Center test facility — the Dynamic Test Stand. Testing of the complete three stage vehicle and its Apollo spacecraft here was done to determine its bending and vibration characteristics. Tallest of Marshall Center's tall towers, the dynamic test stand is 98 feet square.

Several tests of the liquid hydrogen-liquid oxygen powered engine have been conducted during the past year in Marshall's J-2 engine test facility. Tankage for the facility is a battleship version of the Saturn V third stage. The J-2 engine stand is 156 feet tall and has a base of 34 by 68 feet. It is located in the MSFC's East Test Area.



H-5-31246

Vibration Version—A ground test version of the Saturn V first stage moves through the West Test Area of the Marshall Space Flight Center. The large dynamic test stage was built to undergo vibration and bending tests. Test stand at right is a single F-1 engine facility.



H-40246

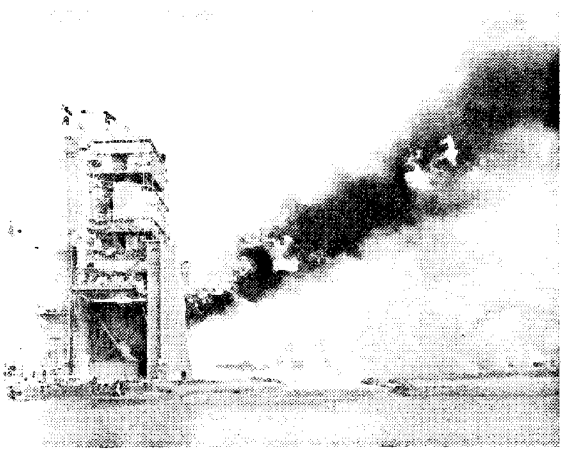
Positioning—A Saturn V first stage is placed into a test stand at Marshall Space Flight Center.

A portion of the Kennedy Space Center "spaceport" has been created at the Marshall Center's ground support equipment test facility to check out giant mechanical swing arms which will be used on Launch Complex 39 to connect the Apollo/Saturn V space vehicle to the launcher tower. The 18-acre facility has eight swing arm test positions and one position for testing access arms to be used by Apollo astronauts.

Also built at Marshall are an F-1 engine turbopump position in the East Test Area and a load test facility in the Propulsion and Vehicle Engineering Laboratory.

A new Saturn V rocket "electrical simulator" or breadboard facility at the Marshall Center duplicates the electrical operation of the vehicle. Elements simulated include the first stage booster, second stage, third stage, and an instrument unit.

Other Saturn V facilities at the Marshall Center include a booster checkout area, two new assembly areas and a components acceptance building.



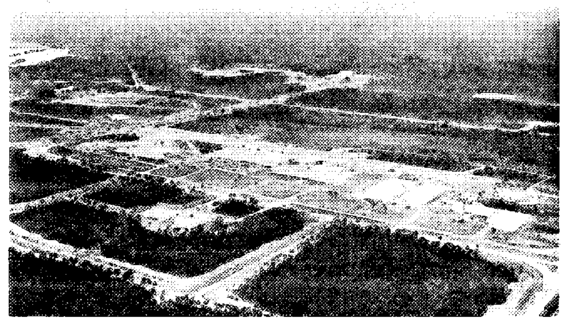
H-5-23531

Static Firing—The Marshall Space Flight Center captive fired all five F-1 engines of the Saturn V S-IC-T for 16½ seconds on May 6, 1965. Later they were fired for 41 seconds.

MISSISSIPPI TEST FACILITY

NASA has developed the Mississippi Test Facility, a field organization of the Marshall Space Flight Center, as a testing site for the Saturn V launch vehicle's two lower stages.

Acceptance testing of first and second stages will be conducted at the $300 million facility. In addition, limited repair and modification of J-2 engines will be performed at MTF on behalf of all NASA operations in the Southeast.



H-MTF-2077

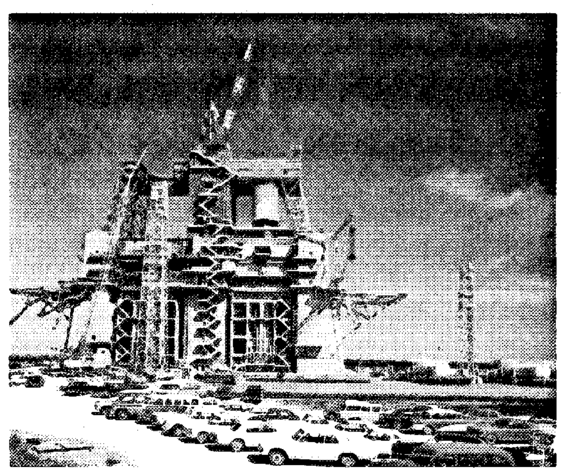
Aerial View of Mississippi Test Facility

The General Electric Co., under a prime contract with NASA, operates and maintains the facility, providing site services, technical systems, and test support to NASA and to stage contractors and other tenants.

North American Aviation, Inc., through its Space Division, is the prime contractor to NASA for developmental and acceptance testing of second stages. SD personnel conduct the tests within the second stage test complex.

The Boeing Company is the prime contractor to NASA for developmental and acceptance testing of first stages. Stages manufactured by Boeing will be tested by the company in the first stage test complex.

The U. S. Army Corps of Engineers is NASA's agent for land acquisition, design engineering, and construction.



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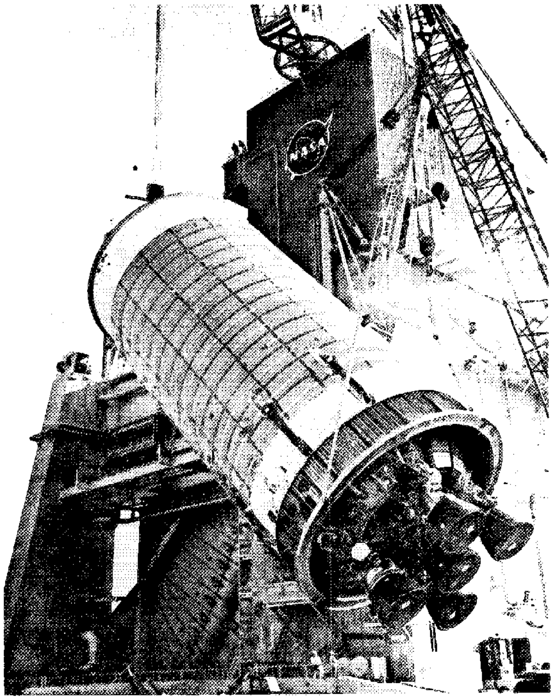
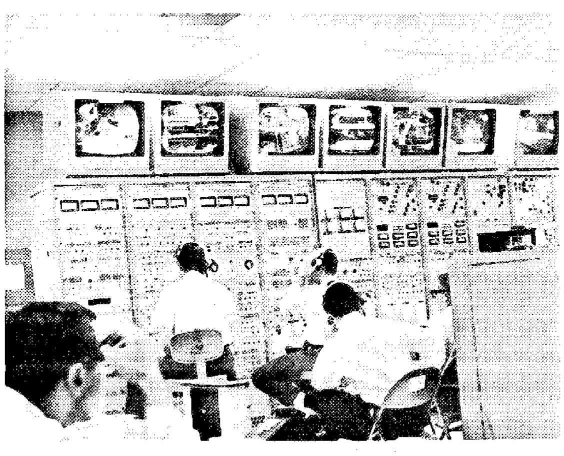
First Stage Test Stand at MTF



H-MTF-4215

Stage Hoisted—The all-systems test version of the second stage is lifted into its test stand at MTF.

Management, operational, and support personnel engaged at the Mississippi Test Facility after its current construction and development work is complete in 1967 will number approximately 3,000.



H-MTF-1432-B7

Checkout—Engineers and technicians of North American are shown in the second stage Test Control Center at the Mississippi Test Facility during final preparation for static firing of all-systems test model of the stage.

The MTF site was selected from 34 areas considered mainly because of its accessibility to water routes and its nearness (45 miles by water) to the Michoud Assembly Facility in New Orleans. The government-owned fee area comprises 13,424 acres and is surrounded by an acoustic buffer zone involving an additional 128,526 acres in Hancock and Pearl River counties and Saint Tammany Parish.

H-MTF-66-1823A

Static Firing—A giant plume of vapor billows skyward during the first static firing test at MTF. The Saturn second stage, built for NASA by North American Aviation, Inc., burned for 15 seconds April 23, 1966.

MTF is composed of three principal complexes including approximately 60 buildings and structures. Among predominant features are the three huge test stands in the Saturn V complex. There are two separate stands for testing second stages. The first stage test stand is a dual-position structure which, with overhead crane, towers over 400 feet. The Laboratory and Engineering Complex houses engineering, administrative, and technical personnel. The Industrial Complex has facilities for equipment and personnel necessary for site and test support maintenance.

The relatively small force of NASA personnel assigned to MTF has overall management and supervisory responsibilities in overseeing the work of the contractors. NASA personnel are also responsible for final evaluation of static firings and issuance of flightworthiness certificates to stage contractors.

KENNEDY SPACE CENTER

Launch Philosophy

Saturn V vehicles are assembled, checked out, and launched at Launch Complex 39 at Kennedy Space Center. Complex 39 embodies a new mobile concept of launch operations which includes superior reliability and time savings offered by assembly and checkout in a protected environment and reduction of actual pad time as much as 80 per cent with a consequent increase in launch rate capability. The ability to adapt economically to future program requirements is another advantage. For example, the service platforms used in the Saturn/Apollo program could be used for other vehicles of similar configuration, and the area can accommodate space boosters with thrusts up to 40 million pounds.

Facilities

The major components of Launch Complex 39 include: (1) the Vehicle Assembly Building, where the space vehicle is assembled and prepared; (2) the mobile launcher, upon which the vehicle is erected for checkout, and from which, later, it is launched; (3) the crawlerway, upon which the fully assembled vehicle is carried by transporter to the launch site; (4) the mobile service structure, which provides external access to the vehicle at the launch site; (5) the transporter which carries the launch vehicle, mobile launcher, and mobile service structure to various positions at the launch complex; and (6) the launch area from which the space vehicle is launched.

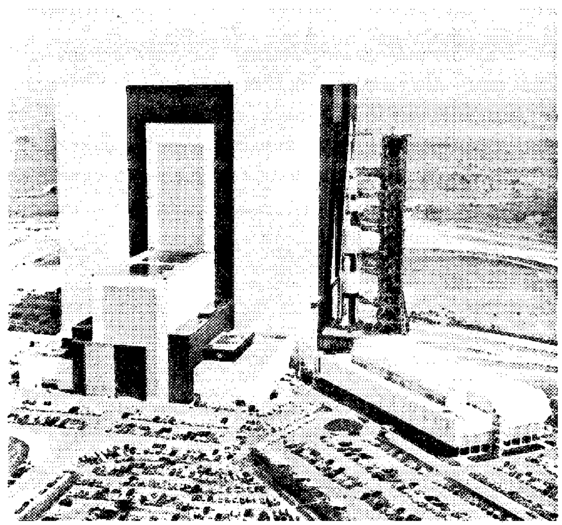
THE VEHICLE ASSEMBLY BUILDING

The Vehicle Assembly Building (VAB) consists of a high bay area 525 feet tall, a low bay area 210 feet tall, and a four-story launch control center (LCC) connected to the high bay by an enclosed bridge. The VAB, with 130 million cubic feet, is the world's largest building in volume. It covers eight acres of land. There are four assembly and checkout bays in the high bay area. The low bay area contains eight stage preparation and checkout cells equipped with systems to simulate stage interface. The launch control center houses display, monitoring, and control equipment for checkout and launch operations. There are four firing rooms in the LCC, one for each high bay and checkout area. Work platforms, mounted on opposite walls in the high bay area, are designed to enclose various work areas around the launch vehicle. Platforms extend or retract in less than 10 minutes. Twenty-ton hydraulic jacks are used to align platforms.

The Saturn V, after prelaunch checkout on its mobile launcher, is carried by the transporter from the VAB through a door shaped like an inverted "T". The door is 456 feet high. The base of the door is 149 feet wide and 113 feet high; the remainder is 76 feet wide. There are four such doors in the VAB, one for each of its four high bays. In keeping with the protective environment of the building, doors were designed to withstand winds of 125 miles per hour.

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

Each pair of high bays shares a bridge crane. The cranes have a lifting height of 456 feet and a travel distance of 431 feet.



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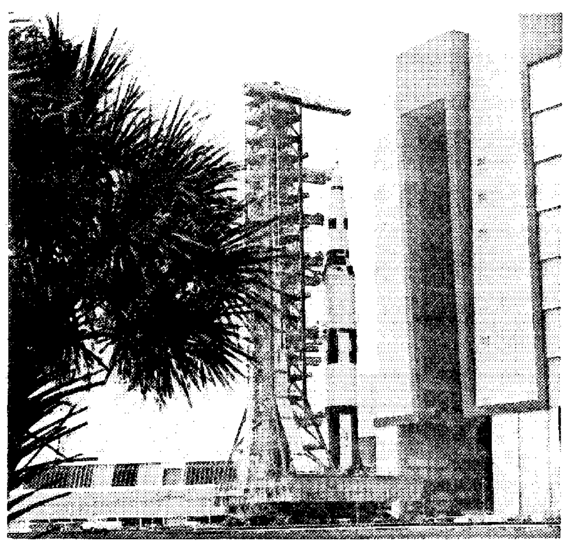
Checkout Vehicle—The Saturn V facilities vehicle begins its journey from the Vehicle Assembly Building to the launch pad. Its purpose was to check out facilities, train launch crews, and verify procedures at KSC.

LAUNCH CONTROL CENTER

Located Southeast of the VAB is the launch control center (LCC). This four-story building is the elec-



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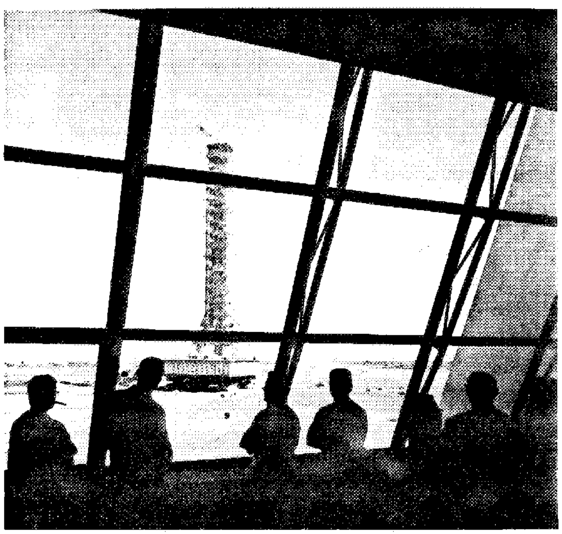
Saturn V Facilities Vehicle Rollout at Kennedy Space Center tronic brain of Launch Complex 39. Here final countdown and launch of Saturn V's will be conducted. The LCC is also the facility from which a multitude of checkout and test operations will be conducted while space vehicle assembly is taking place inside the VAB.

Two separate, automated computer systems are used to check out and conduct the countdown for the Saturn V. The acceptance checkout equipment, or ACE, is used for the Apollo spacecraft. The Saturn ground computer system is used for the various stages of the vehicle.

Located in the launch control center is the heart of the Saturn ground computer system. Here checkout and preflight countdown are conducted.

This system has as its "brain" two RCA 110A computers. One is located in the launch control center and the other is in the mobile launcher upon which the Saturn V is erected.



K-100-66C-813

Moving Tower—Personnel watch a mobile launch tower moving along the crawlerway at Kennedy Space Center.

Through the process control system, all stages are checked, and data from the engines and from the guidance, flight control, propellants, measurement, and telemetry systems is provided.

The Saturn ground computer system also includes a DDP 224 display computer located in the LCC. It can drive up to 20 visual cathode ray display tubes.

The RCA 110A computer is capable of transmitting 2,016 discrete signals to the vehicle where it is possible for the computer in the mobile launcher to return 1,512 discrete signals.

A digital data acceptance system collects and makes available onboard analog data to the computers.

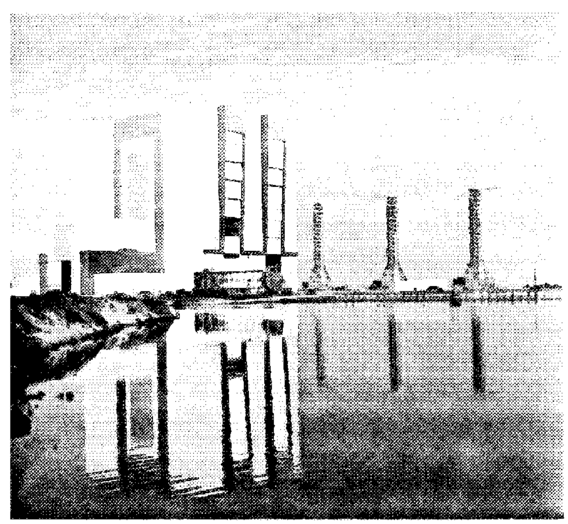
A triply redundant system for discrete output information allows more reliability. There are 1,512 signals going to the mobile launcher showing "on" and "off" commands. If one signal fails or reports a wrong command and the other two signals transmit another command, the majority command is indicated in the display and transmitted to the vehicle.

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

Sixty television cameras are positioned around the Saturn V transmitting pictures on 10 channels.

Additionally, the LCC contains several hundred operational intercommunication channels which enable the launch team and the launch director to be in voice contact with the astronauts aboard the spacecraft.

Automatic checkout of the Apollo spacecraft is accomplished through acceptance checkout equipment (ACE). Through the use of computers, display consoles, and recording equipment, ACE provides an instantaneous, accurate method of spacecraft preflight testing. ACE also is used at the spacecraft contractor plants and in testing at the Manned Spacecraft Center in Houston.



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Vehicle Assembly Building at KSC Viewed From Across the Turning Basin of Launch Complex 39

Computerized checkout of the Saturn stages at the launch pad and the Apollo ACE system at the Manned Spacecraft Operations Building at the Kennedy Space Center are tied together by instrumentation.

The Saturn V employs completely automated computer controlled checkout systems for each of its stages. The system uses a carefully detailed computer program and associated electronic equipment to perform a complete countdown checkout of each stage and all its various systems, subsystems, and components.

With electronic speed, it moves through a thorough and reliable countdown, yet permits test engineers to monitor every step of the operation and to override the computer functions, if necessary.

To monitor fuel and oxidizer mass for the three stages of the Saturn V vehicle, a propellant tanking computer system (PTCS) is used. This system controls propellant tank fill and replenishment. Liquid oxygen and liquid hydrogen must be replenished constantly to compensate for boil-off.

PROPELLANT STORAGE AND TRANSFER

Propellant facilities at Launch Complex 39 include a LOX system, the RP-1 system, the liquid hydrogen system, the propellant tanking computer system, the spacecraft support system, and the data transmission system.

The propellant tanking computer system provides a means of monitoring amounts during the fueling operations. It also accurately controls fuel level during the final phase of tank fill and replenish.

The data transmission system provides an accurate method for the transmission of propellant and environmental control system electrical signals from the launch site to the LCC.

The liquid oxygen system provides oxidizer fill and drain for the three stages of the Saturn V. The system includes a storage tank, a vaporizer, two replenishing pumps, transfer lines, vent lines and drain basin, and electric circuitry for monitoring and actuating the pneumatic control system.

The round liquid oxygen storage tank holds 900,000 gallons and is situated 1,450 feet from the launch site. It has a stainless steel inner wall 62 feet 9 inches in diameter. The space between this inner sphere and the outer wall is filled with gaseous nitrogen and perlite for insulation.

To load liquid oxygen, a command originates in the LCC at the LOX control panel. The signal is transmitted to the mobile launcher by the data transmission system and then to the LOX storage area. The electrical signals are converted to pneumatic pressure to operate the valves, and the flow of LOX from the storage tank into the vaporizer begins. The vaporizer converts the liquid oxygen into gaseous oxygen, which then is fed back into the tank to pressurize it to the 10 psig needed to begin the flow. The pumps are started and the LOX is pumped through the transfer lines to the vehicle.

The RP-1 system provides fuel fill, drain, and filtering capabilities for the first stage. The system includes three storage tanks each with a capacity of 86,000 gallons, transfer lines, a launch site facility, and electric circuitry.

The liquid hydrogen system provides fueling and draining for the second and third stages. It includes a storage tank with a capacity of 850,000 gallons, a vaporizer, transfer lines, and a burn pond in which excess propellant is burned.

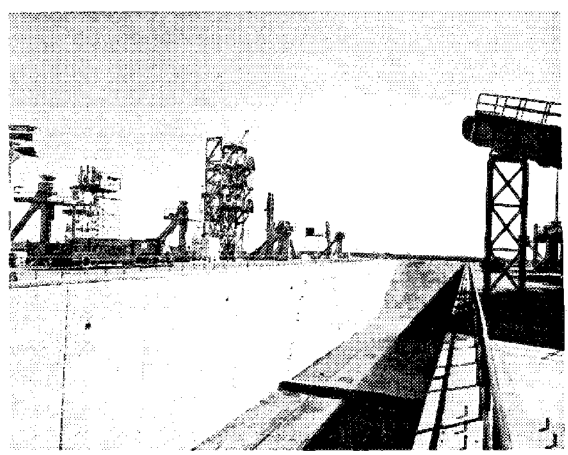
The double walled storage tank, 1,450 feet from the launch site, has a stainless steel inner wall with a diameter of 61 feet 6 inches. The space between the inner and outer walls is filled with perlite.

FLAME DEFLECTOR

To dissipate the rocket exhaust from the F-1 engines, a flame deflector, a flame trench, and a water deluge system are used in the launch area.

The inverted V-shaped steel flame deflector features a replaceable ceramic-coated leading edge. Exhaust from the outer engines strikes the point of the inverted V. At the same time, the deflector is exposed to water deluge during and after liftoff.

The center engine exhaust impinges on the ceramic



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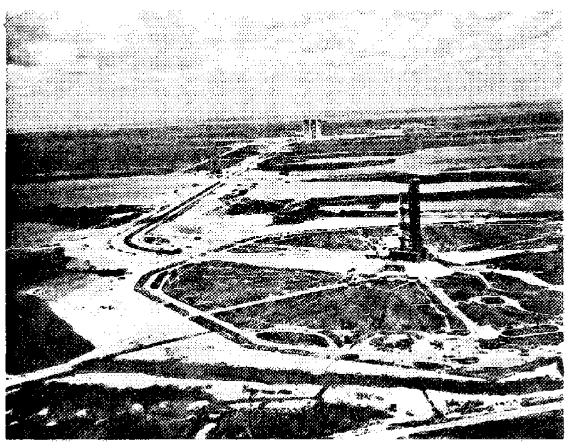
View of Pad 39A East Side at KSC and Flame Trench from North End leading edge. The heat resistant ceramic surfaces erode slowly in the blast. As they do, the great thermal energy generated is carried away in superheated particles. All exhaust and particles are deflected through a flame trench where their energy is dissipated harmlessly into the atmosphere.

The mobile deflector weighs 700,000 pounds and is moved to its position beneath the launch pedestal along a rail system. Two deflectors are available for each launch area, although only one is required per launch.

THE LAUNCH AREA

Final preparation of the space vehicle for launching, including propellant and ordnance loading, final checkout, and countdown takes place in the launch area.



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Aerial of Pad 39A with VAB in Background

There are presently two launch areas on Complex 39. Each area is polygon-shaped with the linear distance from side to side at approximately 3,000 feet. The launch sites are 8,730 feet apart to allow operations on the pads to be handled independently for safety reasons.

Liquid oxygen, RP-1, and liquid hydrogen are stored near the perimeter of the launch sites. Helium and nitrogen gases are stored at 10,000 psi near the center.

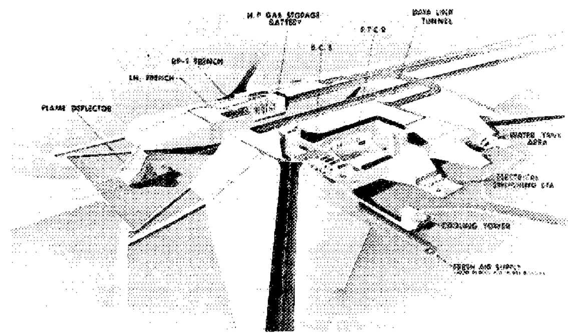
An elevated steel and concrete hardstand is located in the center of each area. Steel support fittings for the mobile launcher and mobile service structure are anchored to the hardstand. The exhaust flame trench runs through the center of the hardstand. Prior to the launch, the wedge-shaped flame deflector is moved along rails into the trench.

The liquid oxygen system consists of a 900,000-gallon LOX storage facility and transfer system.

The RP-1 system consists of a storage area containing three 86,000-gallon tanks and a transfer system. The tanks have a carbon steel shell and a bonded stainless steel lining.

Gaseous nitrogen and helium are stored underground in vessels near the launch pad at pressures of 6,000 psi.

Automation of vehicle prelaunch checkout is expected to uprate mission confidence and to increase launch rate capability. The heart of this automatic checkout system is the computer complex.



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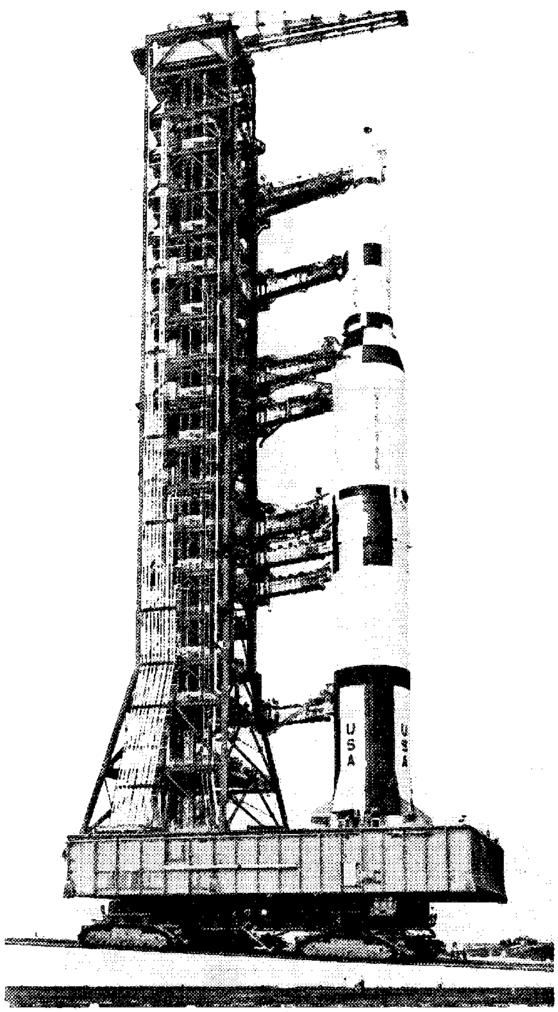
Cutaway Illustration of Pad 39A

Transporter

The capacity to transport the massive mobile launcher with a fully erected Saturn V in launch-ready condition is a key to the mobile concept of Launch Complex 39. This is accomplished by a huge transporter which moves the mobile launcher and vehicle from the VAB to the launch site, approximately 3.5 miles away. The transporter moves at a maximum speed of 1 mile per hour, loaded, or 2 miles per hour, unloaded. The vehicle—131 feet long and 114 feet wide—moves on four double-tracked units, each 10 feet high and 40 feet long. Each unit is driven by an electric motor.

Tractive power is provided by 16 direct current motors served by two diesel-driven direct current generators. The generators are rated at 1,000 kilowatts each and are driven by 2,750 horsepower diesel engines. Speed of the vehicle is controlled by varying the generator fields. Power for the fields is provided by two 750-kilowatt power units which also provide power for pumps, lights, instrumentation, and communications.

The transporter is one of the largest land vehicles ever constructed. Yet, in transit, it must maintain a level platform within 10 minutes of arc and be capable of locating itself at its launch site and VAB positions within a 2-inch tolerance.



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Facility Vehicle at Ramp of Launch Pad

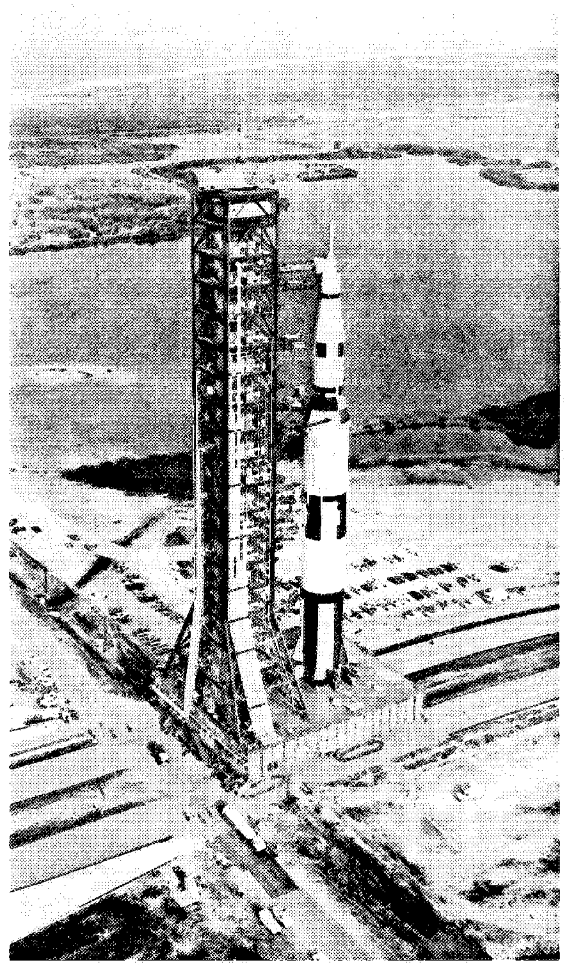
MOBILE SERVICE STRUCTURE

External access to the Saturn V space vehicle at the launch site is provided by the mobile service structure. The steel-truss structure rises more than 400 feet above ground level and more than 350 feet above the deck of the mobile launcher. It has five platforms which close around the vehicle. Two platforms are powered to move up and down. The remaining three are relocatable, but not self-powered. A mechanical equipment room, operations support room, communications and television equipment room, and various other equipment compartments are located in the base.

The service structure is moved to and from the pad by the transporter. Once in position, either at the launch pad or in a parking area, the structure is anchored to support pedestals. The service structure remains in position at the pad until about T-7 hours when it is removed to its parking area 7,000 feet from the pad.

MOBILE LAUNCHER

The mobile launcher is a movable launch platform with an integral umbilical tower. The launcher base



K-107-66PC-91

Arrival to Launch Pad—The facilities vehicle arrives at Launch Complex 39A.

is a two-story steel structure covering more than half an acre. The 380-foot tower, which supports the electrical servicing and fluid lines for the vehicle, is a steel structure mounted on the base. The base and tower weigh 10.5 million pounds and stand 445 feet above ground level.

Among major considerations in design of the mobile launcher were crew safety and escape provisions and protection of the platform and its equipment from blast and sonic damage.

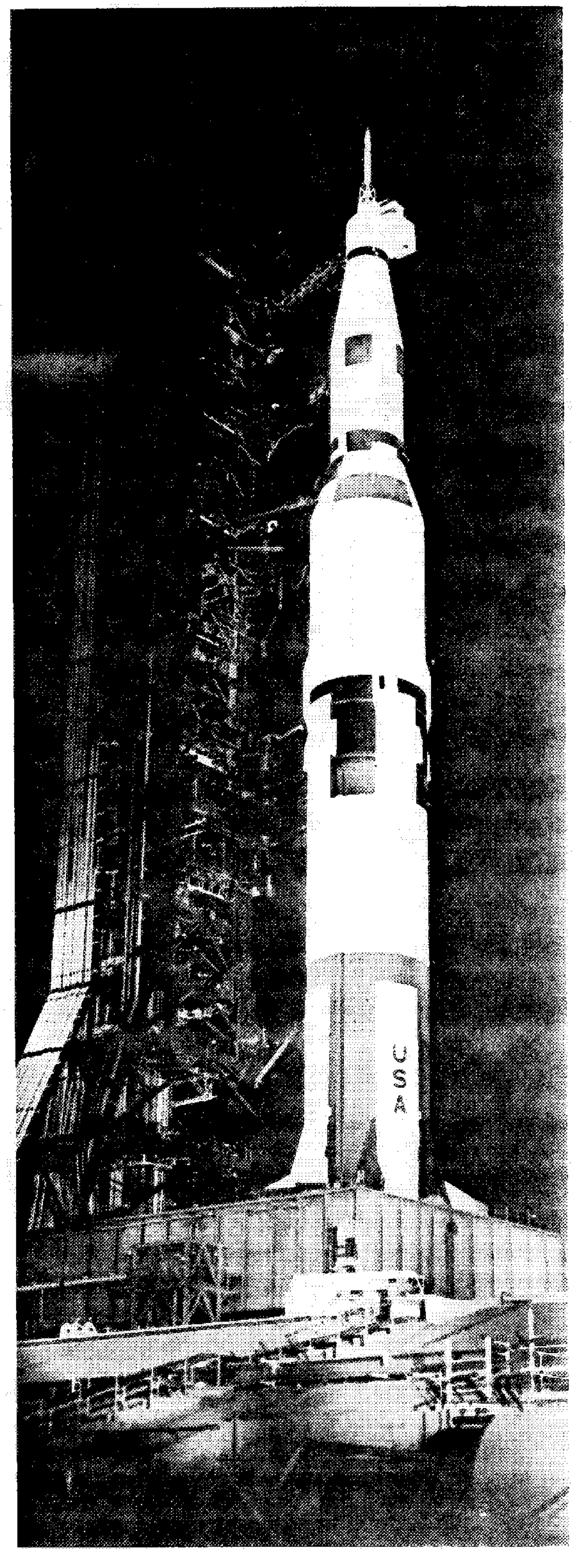
Personnel may be evacuated from upper work levels of the umbilical tower by a high speed elevator, descending at 600 feet per minute. After leaving the elevator, they can drop through a flexible metal chute into a blast and heatproof room inside the base of the pad hardstand.

The mobile launcher provides physical support and is a major facility for checkout of the space vehicle from assembly at the VAB until liftoff at the launch site.

The top level of the launcher base houses digital acquisition units, computer systems, controls for actuation of service arms, communications equipment, water deluge panels, and other control units. Included in the lower level are hydraulic charging units, environmental control systems, electrical measuring equipment, and a terminal room for instrumentation and communications interface. Mounted on the top deck of the base are four vehicle holddown and support arms and three tail service masts.

The umbilical tower is an open steel structure providing support for nine umbilical service arms, 18 work and access platforms, and, for propellant, pneumatic, electrical, water, communications, and other service lines required to sustain the vehicle. A 250-ton capacity hammerhead crane is mounted atop the umbilical tower.

The launcher restrains the vehicle for approximately 5 seconds after ignition to allow thrust buildup and verification of full thrust from all engines. The design "up-load" during the holddown period is 3 million pounds. If one or more of the engines fail to develop full thrust, the vehicle is not released, and all engines automatically are shut down.



Night Shot—A 365-foot-tall Saturn V facilities vehicle is shown in place at Launch Pad 39A.

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