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NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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FOR RELEASE: Tuesday PM's
November 13, 1962

RELEASE NO. 62-237

THIRD SATURN ROCKET TO BE LAUNCHED

The National Aeronautics and Space Administration will launch its third Saturn C-1 space vehicle (SA-3) from Cape Canaveral within the next few days, no earlier than November 16.

A total of 10 C-1 vehicles are to be launched in the research and development portion of the program. The primary mission of the first four is to thoroughly test the first stage cluster. Beginning with flight number five, in the last half of 1963, the first vehicle having a "live" second stage will be flown.

According to the present schedule, the C-1 rocket will be ready for manned space flights, boosting the Apollo three-man spacecraft, by late 1964 or early 1965.

The flight of SA-3 will be similar to that of SA-1 and SA-2 in major aspects, although several new secondary objectives have been added which, in the main, will contribute to the development of the Block II (SA-5 and beyond) version of the vehicle.

The Saturn is being developed under the direction of the NASA Marshall Space Flight Center, headed by Wernher von Braun. The launching will be conducted at Launch Complex 34 by an integrated team of the NASA Launch Operations Center and the MSFC Launch Vehicle Operations Division, headed by Kurt H. Debus. The Saturn program is under the NASA Headquarters direction of D. Brainerd Holmes, director of Manned Space Flight.

Only the Saturn's first stage (S-1), developing 1.3 million pounds thrust from eight H-1 engines, will be powered in this test. Second and third stages (S-IV and S-V) will be inert, ballasted with water to stimulate the propellant weight.

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The rocket will be fired over a trajectory somewhat higher and longer than that of the previous two Saturns. A full load of fuel will be carried in the booster stage.

As in the SA-2 flight, the booster and water-laden upper stages will be destroyed following completion of other missions in a bonus scientific experiment called "Project High Water." About 95 tons of water will be released in the ionosphere at the apex of the trajectory - about 104 miles or some 40 miles higher than the water releases on the Sa-2 flight. (See separate piece on Project High Water).

The Sa-2 vehicle is 162 feet high, with maximum diameter of 21-1/2 feet. It will weigh about 1.1 million pounds at liftoff. In these early (Block I) flights, the H-1 engines are rated at 165,000 pounds thrust each. For flight five and thereafter, they will generate 188,000 pounds thrust each, for a stage thrust of 1.5 million pounds.

The two previous Saturn vehicles were launched on perfect flights Oct. 27, 1961 and April 25, 1962.

The main objectives of the SA-3 flight are:

*Determine the in-flight performance of the eight booster engines, the controlling movements of the four gimballed engines, and engine cutoff and propellant utilization.

*Verify structural integrity of the vehicle's airframe, evaluating stress at critical moments of flight and determining vibration and bending modes.

*Further prove the operation of launch facilities for Saturn vehicles - propellant supply systems, ground support equipment, automatic checkout equipment, instrumentation, and launch pedestal with hold-down arms.

Other flight objectives include confirmation of aerodynamic characteristics, correlation of predicted stability and performance with that encountered in flight, demonstration of the capability of the modified ST-90 stabilized platform in the guidance and control system, and demonstration of the vehicle instrumentation system.

The rocket will be launched on a path 100 degrees east of north. A smooth tilt program will begin about the 10th second of flight and continue until about the 132nd second when the vehicle will be inclined at 44 degrees against the launch vertical. It will pass through the region of maximum dynamic pressure about 78 seconds after liftoff.

New Aspects of This Flight

Following are the major aspects in which this flight differs from the SA-2 mission:

1. The booster will carry a full load of propellant, some 750,000 pounds instead of the 620,000 pounds of SA-2. Engine burning time will extend about 30 seconds. The four inner engines will cut off about 140 seconds after liftoff, and the outer engines about seven seconds later. . This performance would carry the rocket to a maximum altitude of 104 miles, instead of the 85 of SA-2; a range of 270 miles, instead of 225; and a velocity of 4,000 mph instead of 3,600. Flight time to impact would be slightly more than eight minutes.

2. The rocket will climb slowly because of its extra fuel load. The weight of the vehicle is almost as great as that of the later C-1's which will have 188,000 pound thrust engines. SA-3's early rate of acceleration will be less than half as great as that of SA-1 and SA-2. For instance, following ten seconds of flights, SA-3 will be about 300 feet off the pad, compared to 650 feet in the case of the other two. This flight will be a more demanding test of the rocket's control and propulsion systems.

3. An engineering model of the ST-124 stabilized platform which is to be a major component of the final C-1 guidance scheme will be carried on this flight strictly as an inactive passenger. This is a test preparatory to Block II flights which will begin next year. The stabilized platform will be instrumented and its performance monitored throughout the flight, but it will have no control over the vehicle. It will be located in an instrument cannister between the S-1 and S-IV stages.

4. Two small plates or panels are mounted on the payload adapter section above the inert third stage. This is a dynamic pressure study conducted in support of the Centaur vehicle program. Eleven special measurements will be taken to determine the amount of pressure experienced and the rate of build-up. (A structural failure in this region is thought to have caused the explosion of the first Centaur vehicle; this study is expected to assist in investigating and overcoming that deficiency.)

5, The S-I retrorockets which will be used on Block II launchings will be tried on SA-3. The four solid propellant retro-rockets, mounted at the top of the booster with nozzle upward, will be fired about 12 seconds after inboard engine cutoff, but there will be no separation of stages.

6. The booster engine cutoff sequence is different. Cutoff previously was done by a timer; on SA-3, propellant level switches will cutoff the inboard engines, and the outboard engines will continue until LOX is depleted, instead of being automatically cut-off six seconds after the inner engine.

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Launch Complex 34, elsewhere on Cape Canaveral, on Merritt Island and the mainland up to a distance of about 20 miles.

This is about 20 more measurements that were made on the two previous flights. The purpose is to gain more experience in such a measuring program, which will become vital in larger rocket projects, and to develop confidence in methods of predicting these phenomena. Results of these activities during the past two firings have substantially confirmed theories concerning rocket sound propagation which have been developed during a three-year study at the Marshall Space Flight Center. These studies are made so that the nature, intensity and transmission of low-frequency rocket sound will be known in order to assist in the location of facilities and, in marginal cases, the selection of acceptable firing times with respect to atmospheric conditions.

These measurements will be made by the Launch Operations Center, the Marshall Space Flight Center and the Air Force Missile Test Center.

Saturn Launch Complex 34

SA-3 will be the third vehicle to be fired from Launch Complex 34. This multi-million dollar facility is located on the north end of Cape Canaveral. It was constructed under the supervision of the Army Corps of Engineers, using criteria established by the NASA Launch Operations Center.

Here is a thumbnail sketch of Complex 34:

*A 45-acre installation, dominated by a movable structure 310 feet high and weighing 2,800 tons.

*A Launch Control Center with walls 12 feet thick having a steel door two feet thick which weighs 23 tons.

*Efficient fuel and liquid oxygen storage facilities which are capable of pumping 750,000 pounds of liquid propellant into the big booster in approximately an hour.

*A launching pedestal foundation reinforced by 4,400 cubic yards of concrete and 580 tons of steel.

*A total of 100 million pounds of concrete used in construction.

*A unique Automatic Ground Control Station, a room 38 feet wide by 215 feet long, located beneath the concrete and steel launching pad.

PROJECT HIGH WATER

NASA will conduct another "bonus" scientific Project High Water experiment in conjunction with the research and development launch of the third flight Saturn vehicle.

After Saturn has completed its mission, the vehicle will be deliberately destroyed. The 95 tons of ballast water carried in its upper stages will be released in the upper atmosphere.

The objective of High Water, as in the first experiment done on SA-2, is to observe the effect of this large mass of water on the upper region of the atmosphere. Scientists hope to extend the atmospheric data obtained from the first experiment and verify some of the observations made in the field of atmospheric physics.

Scientists who have been studying photographs and other data from the first experiment say that much valuable information was gained from the test in addition to the data most persons expected. For instance, information was obtained on the atmospheric processes leading to electrification.

The SA-2 vehicle was exploded at an altitude of 65 miles. In less than five seconds after the water was released, a cloud of ice particles $5\frac{1}{2}$ miles across was formed. This cloud was visible from the launching site at Cape Canaveral. The cloud moved down the normal trajectory of the Saturn vehicle. As it moved, scientists observed definite electrical disturbances in the formation very much like those observed in connection with a thunder cloud.

The water is released by explosive rupture of the water-filled upper stages. Primacord charges will be attached to the Saturn. These charges will be connected to the vehicle's destruct system and no major modifications are required to perform the experiment.

These charges will be exploded when the vehicle has reached the apex of the Saturn's trajectory - 104 miles high. This will be 295 seconds after liftoff. The vehicle will be 130 miles down the Atlantic Missile Range from Cape Canaveral.

Immediately after the explosion, a cloud is expected to form. It will spread out, becoming thin around its edges as it travels down the trajectory.

Persons watching from the Cape should see the cloud immediately after the explosion. It is expected to quickly fade as far as naked-eye observation is concerned, but observations will be made by instruments for some time after the water is released.

The cloud will be observed by electronic devices, cameras and radars operating at Cape Canaveral, nearby on the Florida mainland and on Grand Bahama Island. Also, ten or more aircraft will aid in the camera coverage.

The project is being sponsored by the Office of Space Sciences, NASA Headquarters, under the direction of Dr. Homer Newell. Ray Miller is project officer. The Marshall Center's Research Projects Division, directed by Dr. Ernst Stuhlinger, is coordinating the scientific observations. The Physics and Astrophysics Branch of Marshall's RPD, headed by Dr. W. G. Johnson, is in charge of the project. Working closely with Johnson on High Water are Ray V. Hembree, Dr. E. A. Mechtly and Dr. James B. Dozier.

PROJECT BACKGROUND AND VEHICLE FACT SHEET

The National Aeronautics and Space Administration and associated industries are developing three large rockets under the project name Saturn.

The first version, C-1, which is now in the test flight phase, will be followed by the C-IB and C-5. The primary use of the vehicles will be for the manned exploration of the moon -- Project Apollo, which is being directed by the NASA Office of Manned Space Flight, headed by D. Brainerd Holmes.

The Saturn development program is under the technical direction of NASA's George C. Marshall Space Flight Center, Huntsville, Alabama, headed by Dr. Wernher von Braun with launching conducted by the NASA Launch Operations Center, directed by Dr. Kurt H. Debus. Hundreds of industrial contractors and suppliers are participating. The booster or first stage program is centered at the Marshall Center; upper stages are being developed by industry under Marshall's direction.

Background

In the spring of 1957, detailed studies were started by Dr. von Braun's rocket development group at Huntsville on large, cluster-engine rockets.

In the late summer of 1958, the group, then working for the U.S. Army, received authorization from DOD's Advanced Research Projects Agency to proceed with design and development of a 1.5 million-pound thrust booster rocket based on the clustered engine concept.

In 1959 technical direction of the program was transferred from the Department of Defense to the National Aeronautics and Space Administration and on July 1, 1960, the Huntsville development group was transferred to NASA's newly-established Marshall Space Flight Center.

In early 1962, NASA decided to develop a much larger Saturn, the C-5, as the Apollo moon rocket, since the C-1 will not be capable of placing men on the moon. The C-5 first stage has five times the first stage thrust of the C-1 -- 7.5 million pounds thrust. It is in early design stages by the Marshall Center and associated stage contractors, Boeing Co., North American Aviation, Inc., and Douglas Aircraft Co.

In mid-1962, it was decided to put together a rocket with a capability between that of C-1 and C-5, using components from both programs. This will be the C-IB, composed of the first stage of the C-1 and the third stage of the C-5. It will be able to orbit some 16 tons -- six tons more than C-1 -- and will permit earlier orbital testing of the complete Apollo spacecraft, including lunar excursion module, than would be possible with the C-5.

Saturn C-1 Background

The first Saturn configuration, C-1, will consist of two stages, S-I and S-IV. The C-1 vehicles are broken down into two groups, Block I and Block II. There are four vehicles in Block I, the third of which will be fired in the next few days.

The first four rockets in the 10-vehicle research and development flight program simulate three stage rockets, although only the first stage is powered. Beginning with SA-5, the first vehicle in Block II, the C-1 will consist of two live stages. By making certain design changes in the system, it will be possible to accomplish all assigned missions with two stages instead of three.

While the primary purpose of the first 10 flights is to prove the vehicle, flights SA-5 and beyond will have secondary missions of testing early versions of the Apollo three-man spacecraft.

By late 1964 or early 1965, the Saturn C-1 should be ready to place the manned Apollo into earth orbit for extended flights of up to two weeks.

On the first four flights, with inert upper stages, the vehicle is 162 feet high. Beginning with the fifth flight, the vehicle, with Apollo spacecraft mock-up, will be about 184 feet in height. Also beginning with the fifth flight, aerodynamic fins will be added at the booster's tail section to give the Saturn a capability for broadly-varied missions in the future.

Vehicle weight will vary with missions. SA-3 at liftoff will weigh 1,100,000 pounds.

Following are descriptions of the Saturn C-1 stages.

S-I: The Saturn C-1 first stage (S-I) is powered by a cluster of eight Rocketdyne H-1 engines, each of which will ultimately produce 188,000 pounds of thrust to give a total of 1,500,000 pounds. The H-1's in the SA-3 launch are rated at 165,000 pounds thrust each.

The H-1 engine, an advanced and compact offspring of the Jupiter and Thor engine, was selected because of its relative simplicity, early availability, and proven reliability. It burns RP-1 (Kerosene) fuel and liquid oxygen. Major changes incorporated in the H-1 include a simplified start sequence using a solid propellant gas generator and location of the turbopump on the thrust chamber below the gimbal block so that the flexible propellant feed lines to the engine need only carry low pressure propellant.

The eight H-1 engines are attached to an eight-legged thrust frame on the aft end of the vehicle, arranged in two square patterns.

The four inboard engines are rigidly attached and canted at a three-degree angle to the center line of the booster. The outboard engines are canted at an angle of 6 degrees and mounted on gimbals which permit them to be turned through angles of up to 7-1/2 degrees to provide control of the vehicle during first stage powered flight.

Nine tanks feed the eight H-1 engines. Clustered in a circle about a large center tank of 105 inches in diameter are eight smaller tanks, each 70 inches in diameter. The center tank and four outer ones contain liquid oxygen, while the remaining four outer tanks carry the kerosene fuel. The fuel tanks are pressurized by gaseous nitrogen carried in 48 fiberglass spheres atop the tanks and the liquid oxygen tanks are pressurized by gaseous oxygen obtained by passing liquid oxygen through heat exchangers that are part of each engine package.

The fuel tanks as well as those containing liquid oxygen are interconnected at the base to allow the maintenance of equal levels in all tanks during burning. In case one engine malfunctions and is cut off during flight, this arrangement permits the remaining seven engines to consume the fuel and oxygen intended for the dead engine. Thus, the burning time of the seven remaining engines is increased and there is little loss in overall booster performance.

The nine propellant tanks are attached at the top by an eight-legged spider beam.

One test model and the flight SA-1, SA-3 boosters have been successfully static fired a total of more than 35 times, including several full duration runs of about 120 seconds.

The first several Saturn flight boosters are being produced at MSFC. Later ones will be produced by the Chrysler Corp. at NASA's Michoud Operations plant, New Orleans, Louisiana.

S-IV: The S-IV second stage of the C-1 vehicle will be powered by six 15,000 pound thrust Pratt and Whitney RL-10 liquid hydrogen-liquid oxygen engines.

The S-IV is 18 feet in diameter and about 40 feet in length. Its development was begun two years ago by the Douglas Aircraft Missiles and Space Division in Santa Monica, California.

The S-IV stage uses an interstage structure which provides space for the six engines and transmits the load from the upper part of the rocket to the support points on the stage beneath. This structure will remain with the lower stage upon separation in flight.

The mid-portion of the S-IV is primarily an aluminum cylindrical container composed of the liquid-oxygen tank located behind the larger liquid hydrogen tank.

Attached to the cylindrical section are small ullage rockets to be used in separation of the S-IV from the S-I stage. At the forward

end of the cylindrical container is the structural assembly or forward adapter which will provide support for a spacecraft and instrument unit. The S-IV is in advanced development by Douglas. One test model has been fired many times, including a full duration run of seven minutes. The first "live" S-IV will be flown in the last half of 1963.

Guidance and Control

The initial Saturn guidance and control system (for Block I) is primarily an adaption of Jupiter system components to meet Saturn requirements. One significant departure is the addition of rate gyros as sensing elements. Structural bending of the large and relatively flexible Saturn required rate gyros for stabilization.

Saturn uses all-inertial guidance. More advanced hardware will be introduced into the system as the guidance missions become more demanding. Object of the guidance scheme is to provide a universal system that is capable of performing a variety of mission requirements placed on the vehicle to meet payload objectives. This universal guidance concept will allow a variety of requirements with a minimum of changes.

Heart of the final guidance scheme is a high-speed digital computer incorporating advances techniques of design and packaging and capable of meeting Saturn's high reliability standards and difficult missions in terms of programming.

For S-I, for example, the guidance system will automatically give corrective signals necessary to compensate for deviations resulting from loss of thrust should one of the eight H-1 engines fail to perform properly.

Saturn Missions

The two-stage Saturn C-1 vehicle will be capable of placing a payload of about 20,000 pounds in low orbit.

The Saturn C-5, by comparison, will be able to place 240,000 pounds in low earth orbit or send 90,000 pounds to the vicinity of the moon.

Major early uses of Saturn vehicles will be in connection with manned space exploration. The two-stage C-1 will be used to place Apollo Spacecraft, carrying three men, into earth orbit of up to two weeks' duration. The C-5 will send a later model of the same three-man spacecraft to a moon orbit and return. These two steps are in preparations for a manned lunar landing, which can be accomplished using a C-5 in orbital rendezvous.

Other possible uses of Saturns include launching of soft-landing stationary or roving payloads of instruments on the moon, probes to Venus and Mars, and 24-hour communication satellites. The Saturn C-5 will also be used as a carrier vehicle for nuclear propulsion tests.

Transportation

The size of the Saturn stages posed a unique transportation problem. They are too large for conventional rail, highway or air shipment. Thus water transportation is a necessity and has been a major factor in the selection of manufacture, testing and launch sites.

The first stage of the C-1 is moved by barge from the Marshall Space Flight Center in Alabama to Canaveral, via the Tennessee, Ohio and Mississippi Rivers and coastal waters. The route is more than 2,000 miles long.

The C-1 second stage will be moved from the West Coast by ship through the Panama Canal.

Saturn C-5 stages will likewise move by water between their several places of fabrication and testing -- MSFC, Michoud Operations in New Orleans, Mississippi Test Facility and Cape Canaveral.

END

SATURN C-1 PROGRAM PARTICIPANTS

The Saturn C-1 space vehicle system is being developed by government agencies and industrial firms under the direction of the National Aeronautics and Space Administration.

Development of the Saturn system is under the technical direction of the George C. Marshall Space Flight Center, Huntsville, Alabama. Dr. Wernher von Braun is director, assisted by Dr. Eberhard F. M. Rees, deputy director for research and development, and Harry H. Gorman, deputy director for administration.

D. Brainerd Holmes, director of NASA's Office of Manned Space Flight, provides NASA Headquarters supervision of the Saturn development program through his Launch Vehicle and Propulsion Office directed by Milton Rosen. Norman Rafel and Egon Kafka are responsible for management of this project under Dr. Rosen.

Dr. Oswald Lange is director of MSFC's Saturn Systems Office. K. K. Dannenberg is his deputy and Robert Lindstrom is C-1 project manager.

Other Marshall technical offices and research and development divisions and their directors are:

Aeroballistics, Dr. Ernst E. Geissler; Computation, Helmut Hoelzer; Manufacturing Engineering, Werner Kuers; Future Projects, Heinz H. Koelle; Astrionics, Dr. Walter Haeussermann; Light and Medium Vehicles, Hans Hueter; Central Planning, Hans H. Maus; Research Projects, Dr. Ernst Stuhlinger; Propulsion and Vehicle Engineering, William A. Mrazek; Quality Assurance, Deiter Grau; Test, Karl L. Heimburg.

Dr. Kurt H. Debus, director of NASA's Launch Operations Center, Cape Canaveral, Fla. also is chief of the Launch Operations Division for Marshall. LOC and LVOD will launch Saturn SA-3 in a joint operation.

Deputy to Dr. Debus within LVOD is Dr. Hans F. Gruene. Albert Zeiler is chief of the mechanical office and Carl Sendler is chief of measurements and tracking. Test supervisor is Robert Moser. Rocco Petrone is chief of the LOC Saturn project office.

The Marshall Center, whose personnel developed the Jupiter C, Juno II and Mercury-Redstone rockets, is fabricating and assembling the first Saturn flight boosters, the four inert second (S-IV) stages and conducting related research throughout the program.

More than 80 per cent of Marshall's Saturn budget, however, is going directly to private industry and other government agencies. And much of the remaining money is awarded outside of NASA to federal agencies for various technical and administrative support.

The following organizations are playing a role in Saturn development. They are listed alphabetically by state, city and name.

ALABAMA:

Auburn -- Auburn Research Foundation, Inc., research and study of telemetering and radar systems, and related engineering and fabrication services.

Birmingham -- General Electric Co., electrical components; H. L. Eskew & Sons, test equipment; Leeds and Northrup Co., strip chart recorders; Linde Co., liquid oxygen and liquid nitrogen; Lynn-Dickerson Machine Co., Inc., mechanical parts and assemblies; Mg Electronics & Equipment Co., electrical measuring instruments; Mill & Textile Supply Co., manufacturing tooling; The Hayes International Corp., engineering man-hours, Saturn tooling, components and launch complex equipment.

Decatur -- Pearce & Gresham Co., modification of test facilities at the Marshall Center.

Huntsville -- Arde Engineering Division of Arde Associates, services related to wind tunnel testing of space vehicle models and components; Brown Engineering Company, Inc., engineering man-hours, research on vehicle components, and manufacture of Saturn booster flight assemblies and related tooling; Electro Mechanical Research, electronic equipment; International Business Machines Corp., electronic equipment; Minneapolis Honeywell Regulator Co., Saturn guidance components; Redstone Machine and Tool Co., fabrication of booster assemblies and related tooling; Space Craft, Inc., design, development and manufacture of electronic components and systems; Spaco Manufacturing Co., fabrication and assembly of components; Southerland Blue Print Co., drafting equipment; Westinghouse Electric Corp., electrical components; Redstone Arsenal, U.S. Army Command, technical and administrative support of Saturn development program.

ARKANSAS:

Little Rock -- A. R. & T. Electronics, Inc., design, fabrication and test of electronic equipment.

ARIZONA:

Scottsdale -- Motorola, Inc., radar equipment and electronic components.

CALIFORNIA:

Anaheim -- Beckman Instruments, Inc., radio frequency instrumentation; Ling Temco Electronic, Inc., vibration system for structural testing of flight vehicles.

Arcadia -- D. B. Milliken Co., photographic equipment.

Canoga Park -- Rocketdyne Division, North American Aviation, Inc., development and manufacture of Saturn H-1 engines.

Culver City -- American Electronics, Inc., electrical components; Hughes Aircraft Co., materials research and development; Micro Gee Products, Inc., fabrication and assembly support equipment for Saturn booster.

Downey -- Space and Information Systems Division, North American Aviation, Inc., study of Saturn booster recovery system, study of space vehicles in the two-to-three million pound thrust class, fabrication of interstage fairings between Saturn's first and second stages, and manufacture of electronic components.

Glendale -- Frebank Co., design and manufacture of tank pressure switches; General Precision, Inc., design and development of electronic equipment.

Hawthorne -- Nortronics, engineering and fabrication of Saturn electronic components and systems; Servomechanisms, Inc., electronic equipment.

Long Beach -- Arrowhead Products Division, Federal Mogul Bower Bearings, Inc., development and testing of mechanical components for vent, pressurization and propellant feed lines in booster.

Los Alamitos -- Arrowhead Products Division, Federal Mogul Bower Bearings, Inc., engineering and fabrication services.

Los Angeles -- Acoustics Associates, Inc., production of liquid oxygen and fuel sensing instruments; AiResearch Manufacturing Co., fabrication of air conditioning package; Arnoux Corp., telemetry and related electronic system components; Master Specialities Co., lamp assemblies.

Packard Bell Electronics Corp., automatic checkout system for flight booster; Parker Aircraft Co., design and development of valve systems for flight boosters and related studies of fabrication techniques; Space Technology Laboratories, Inc., study of methods for assembling Saturn-class vehicles in both horizontal and vertical positions.

Manhattan Beach -- U.S. Chemical Milling Corp., manufacture of 70-inch-diameter spherical bulkheads and related structural components.

Monrovia -- Consolidated Systems Corp., high speed data processing system; Spectralab Instrument Co., Ultra-high frequency transmitter.

North Hollywood -- Bendix Corp., electronic components and development of a separation indicating device for use in late live multistage launching of Saturn vehicles.

Oakland -- Noble Co., services and modification on Saturn service structure.

Oxnard -- American Brake Shoe Co., pumps for Saturn hydraulic system.

Palo Alto -- Hewlett Packard Co., electronic components.

Pasadena -- California Institute of Technology, research on failure of equipment when subject to vibration; Resdel Engineering Corp., development and fabrication of radio equipment; Wallace O. Leonard, Inc., liquid oxygen valves; Wiancko Engineering Co., electrical equipment.

Redwood City -- Ampex Corp., tape recording equipment and the maintenance and repair of Marshall Center-owned magnetic equipment tape recorders.

Riverside -- Bourns, Inc., pressure relay systems.

Sacramento --Aerojet General Corp., manufacture and delivery of small solid propellant rocket motors for Saturn vehicles.

San Carlos -- Lenkurt Electric Co., feasibility and development of telemetry system for flight application.

San Diego -- General Dynamics/Astronautics Division, fabrication of four inert third (S-V) stages for early Saturn C-1 research and development flights, research and development of methods for preventing corrosion of metals used in the Saturn vehicle system; Ryan Electronic Division, Ryan Aeronautical Corp. radar altimeter for Saturn vehicles; P. M. Electronics, Inc., electrical components and measuring instruments; Solar Aircraft Co., Saturn assembly components.

San Jose -- Jennings Radio Manufacturing Co., electrical components.

Santa Ana -- Borg, Warner Corp., electronic components.

Santa Monica -- Douglas Aircraft Co., development and fabrication of S-IV and S-IVB stages of Saturn.

Van Nuys -- Networks Electronics Corp., electrical components; Radio Corporation of America, three Saturn ground computer systems, and engineering studies and system modification of Saturn launch computer complex; Waugh Engineering Co., turbine flowmeters.

COLORADO:

Denver -- Cryogenic Engineering Co., high pressure liquid oxygen and liquid hydrogen test systems.

CONNECTICUT:

New Haven -- Textron Electronics, Inc., electronic equipment.

Norwalk -- Perkin-Elmer Corp., optical alignment of instruments.

Wallingford -- Revere Corp. of America, weight measuring system.

DISTRICT OF COLUMBIA:

U.S. Air Force Air Research and Development Command, Saturn rocket fuel, test equipment and related Saturn development items, and administration of funds to develop and/or procure H-1 engines, RL-10 upper stage engines, S-V stage and transportation facilities; U.S. Naval Weapons Plant, Saturn components and test equipment.

FLORIDA:

Jacksonville -- U.S. Army Corps of Engineers, design and construction of mooring facilities for Saturn barge at Cape Canaveral, Fla.

Melbourne -- Radiation, Inc., development, design and fabrication of analog to digital computer.

Orlando -- Dynatronics, Inc. design, development and fabrication of telemetry playback station and related electronic components; Mechtron Corp., design and fabrication of electronic checkout system for Saturn vehicle; Ortronix, Inc., airborne telemetry systems.

Patrick Air Force Base -- U.S. Air Force Missile Test Center, propellants for rocket and ground support equipment and vehicle test system.

Sarasota -- Electro-Mechanical Research, Inc., electronic equipment.

St. Petersburg -- Electronic Communications, Inc., flight computers and related components; Minneapolis Honeywell Regulator Co., guidance equipment.

Tampa -- Color Corp. of America, photographic reproduction services.

West Palm Beach -- Air Products, Inc., liquid hydrogen rocket fuel; Pratt & Whitney Division, United Aircraft, RL-10 liquid oxygen-liquid hydrogen engine for use in Saturn upper stages.

GEORGIA:

Atlanta -- Ampex Corp., magnetic tape recording systems and supplies; General Services Administration, office supplies and furnishings; Scientific-Atlanta, Inc., automatic tracking antenna system.

Marietta -- Lockheed Aircraft Corp., development of booster pressure and functional checkout equipment, additional engineering and fabrication services in support of booster development.

ILLINOIS:

Bartlett -- Flexonics Division, Calumet & Hecla, Inc., vent pressurizing and propellant feed line assemblies, and related items.

Chicago -- Sciaky Brothers, Inc., welding system; Vapor Corp., air supply temperature controller for air bearing systems.

Joliet -- A. L. Mechling Barge Lines, Inc., towing of Saturn barges from Huntsville to Cape Canaveral.

Lebanon -- Herrington Co., Inc., compressor system.

Morton Grove -- Cook Electric Co., ejectable, recoverable movie camera packages for Saturn vehicle.

INDIANA:

Fort Wayne -- I. T. T. Industrial Laboratories, controlled storage television equipment.

Indianapolis -- Hugh J. Baker Co., Saturn booster assembly gantries.

Muncie -- Lift-A-Loft Co., mobile personnel lifter.

IOWA:

Davenport -- Bendix Corp., liquid level gaging systems and sensors.

KENTUCKY:

Lexington -- Mason-Rust, support services for NASA Michoud Operations where Saturn C-1 and C-5 boosters will be manufactured.

LOUISIANA:

Harvey -- Avondale Shipyard, Inc., modification of Saturn barge.

MARYLAND:

Averdeen Proving Grounds, wind tunnel tests of Saturn configuration models.

Baltimore -- Martin Co., heat exchanger assemblies for boosters.

Rockville -- Defense Electronics, Inc., telemetry pre-detection recording system; International Business Machines Corp., study for application of automatic data processing and digital computing systems, and furnishing of test equipment for IBM machines.

MASSACHUSETTS:

Ashland -- Fenwal, Inc., heat measuring instruments, and general engineering and fabrication services.

Boston -- Minneapolis Honeywell Regulator Co., gyro packages.

Burlington -- Dunametrics Corp., automatic calibration system for pressure relay systems; Radio Corp. of America, conceptual study of Saturn operation flight control scheme; Trans-Sonics, Inc., leak detector system.

Cambridge -- American Science & Engineering, Inc., study of venting and disposal of hydrogen from Saturn C-1 vehicle; Arthur D. Little, Inc., study of blast effect of Saturn rocket; Bolt, Beranek & Newman, Inc., investigation of acoustic environment of large booster systems; Dunn Engineering Corp., fabrication and assembly tooling.

Lexington -- Trans-Sonics, Inc.,.design, development and fabrication of digital liquid level system, and furnishing heat measuring instruments.

Lowell -- Standard Steel Corp., large scale liquid hydrogen spill test package, hydrogen fuel semi-trailer, and fabrication of liquid hydrogen storage tanks.

Newton -- G. P. S. Instrument Co., Inc. analog compressed time system computer.

Pittsfield -- General Electric Co., investigation of gyro gas lubricated gimbal bearing.

Stoneham -- Dynamics Research Corp., fabrication of data coding equipment.

MICHIGAN:

Detroit -- Chrysler Corp., testing of Saturn booster and ground support equipment and components, fabrication of vehicle structural assemblies, investigation of corrosion prevention in various components and materials, studies of steering in space flight operations, investigation of the age deterioration of lubricants subsequent to storage on launch vehicle valves, research and investigation of redundant structures, engineering man-hours at the Marshall Center and preparatory work on the manufacture of the booster stage.

Pontiac -- Progressive Welder & Machine Co., engineering, design and manufacture of fabrication and assembly tooling.

Warren -- Cadillac Gage Co., hydraulic equipment and components.

MINNESOTA:

Minneapolis -- Electric Machinery Manufacturing Co., motor generator set; Minneapolis Honeywell Regulator Co., study of the control and dynamic stability problems of Saturn space vehicle; Rosemount Engineering Co., resistance thermometers.

MISSOURI:

Joplin -- The Eagle Picher Co., batteries.

Kansas City -- Midwest Research Institute, research on loading of space vehicles due to atmospheric turbulence and wind shear.

NORTH CAROLINA:

Ashville -- National Weather Records Center, provide meteorological data on IBM punch cards for selected stations.

NEW JERSEY:

Boonton -- Marotta Valve Corp., valve units and components.

Denville -- Thiokol Chemical Corp., vibration cutoff devices

Eatontown -- Red Bank Div., Bendix Corp., electrical components.

Little Falls -- General Precision, Inc., components for guidance system.

Long Branch -- Electronic Associates, Inc., analog computing system.

Metuchen -- Gulton Industries, Inc., accelerometers for flight vehicles.

Teterboro -- Bendix Corp., major components for Saturn guidance package.

Trenton -- Gulton Industries, Inc., electronic products and recording tape for flight boosters.

Union -- Potter Aeronautical Corp., turbine flowmeter; Tenney Engineering, Inc., environmental space simulation test chamber.

NEW YORK:

East Aurora -- Moog Servocontrols, Inc., hydraulic valves and actuators.

Buffalo -- Cornell Aeronautical Laboratory, Inc., study of configuration effects on rocket vehicle base heating.

Farmingdale, Long Island -- Republic Aviation Corp., fabrication of components.

Flushing -- Filtron Co, Inc., advanced radio frequency interference control systems and techniques.

Garden City -- American Bosch ARMA Corp., accelerometers; Powertown Ultrasonics Corp., ultrasonic cleaning equipment for vehicle components;

New York -- Linde Co., hydrogen recharger.

Rome -- Rome Cable Corp., control cable.

Sidney -- Bendix Corp., electrical connectors.

Utica -- General Electric Co., development of power amplifier for spaceborne power supply system; Bendix Corp., electronic components.

Westbury -- Consolidated Avionics Corp., plotting sub-systems.

OHIO:

Brecksville -- Smith Electronic, Inc., study of radio phase stability.

Cincinnati -- Avco Corp., electronic components, and engineering and fabrication services.

Dayton -- U.S. Air Force Air Material Command, gear tester.

Cleveland -- Lewis Research Center, NASA, purchase of propellants

for static firing liquid oxygen-liquid hydrogen engine; White Sewing Machine Co., fabrication of high pressure spheres.

PENNSYLVANIA:

Harrisburg -- Amp, Inc., electrical supplies; Harsco Corp., hydrogen gas transport trailers.

Philadelphia -- Franklin Institute, study of Saturn hydraulic system reliability.

Pittsburgh -- American Optical Co., optical alignment equipment; Combustion & Explosives Research, Inc., assistance and consultation in the area of ignition and explosives.

Southampton -- Vector Manufacturing Co., Inc., electronic components.

TENNESSEE:

Arnold Air Force Station -- Arnold Engineering Development Center, U.S. Air Force, wind tunnel time for testing and evaluating configurations of Saturn vehicles, and study of base heating effects of Saturn boosters during flight.

Bristol -- Sperry Rand Corp., engineering and fabrication services on various guidance, control and instrumentation systems and components for the Saturn space vehicle.

Nashville -- Avco Corp., engineering, fabrication and related services; Fred D. Wright Co., Inc., mechanical and structural components.

Tullahoma -- Micro Craft, Inc., fabrication of engineering test models and model fixtures.

TEXAS:

Dallas -- Chance Vought Corp., fabrication of 70-inch and 105-inch diameter liquid oxygen and fuel tanks for Saturn C-1 boosters; International Data Systems, Inc., furnishing of electronic systems and components;Temco Electronics and Missile Co., engineering services; Texas Instruments, Inc., amplifiers.

Fort Worth -- General Services Administration, Federal Supply Service, office furnishings.

Freeport -- Reynolds Electrical & Engineering Co., modification, maintenance and checkout of electrical equipment.

VIRGINIA:

Hampton -- Langley Research Center, NASA, modification of wind tunnel facilities to permit testing of Saturn configuration models and components.

WISCONSIN:

Milwaukee -- A. O. Smith Corp., high pressure, spherical gas containers for Saturn vehicle system.

END