

SATURN

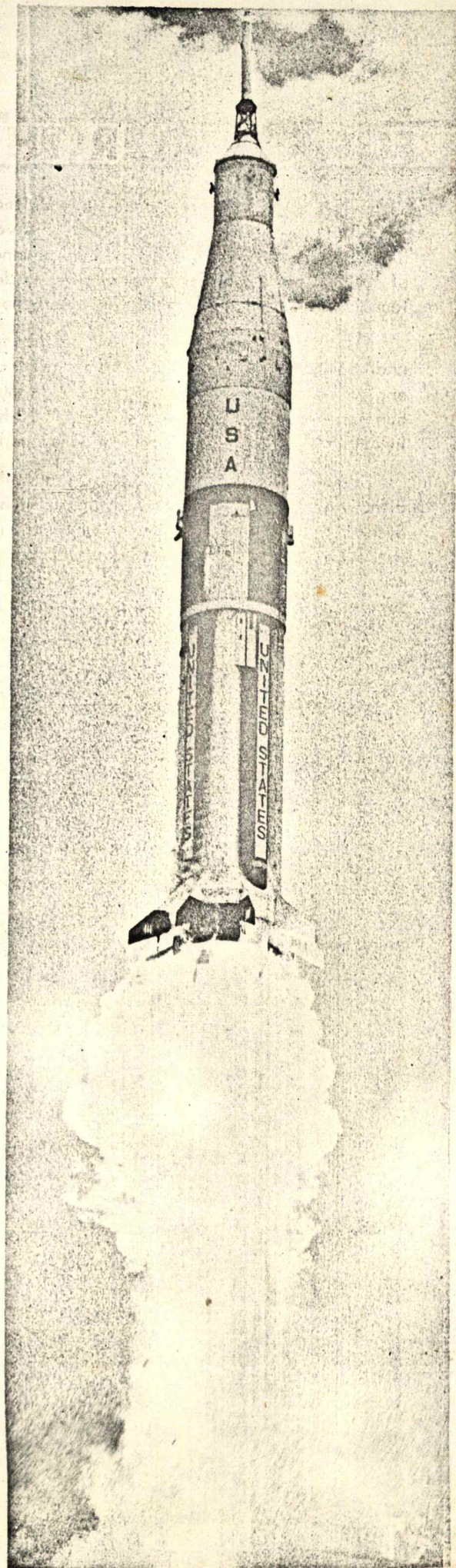
First Apollo Launch Vehicle

STORY OF THE UPDATED SATURN I

(SATURN I-B)

GEORGE C. MARSHALL
SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



FOR GREATER THRUST INTO SPACE

With the Uprated Saturn I, the United States takes a substantial stride forward in payload capability. This versatile launch vehicle can be used for a variety of space missions, manned or unmanned. Development of the Uprated Saturn was undertaken in July, 1962, as an intermediate launch vehicle between the Saturn I and the Saturn V.

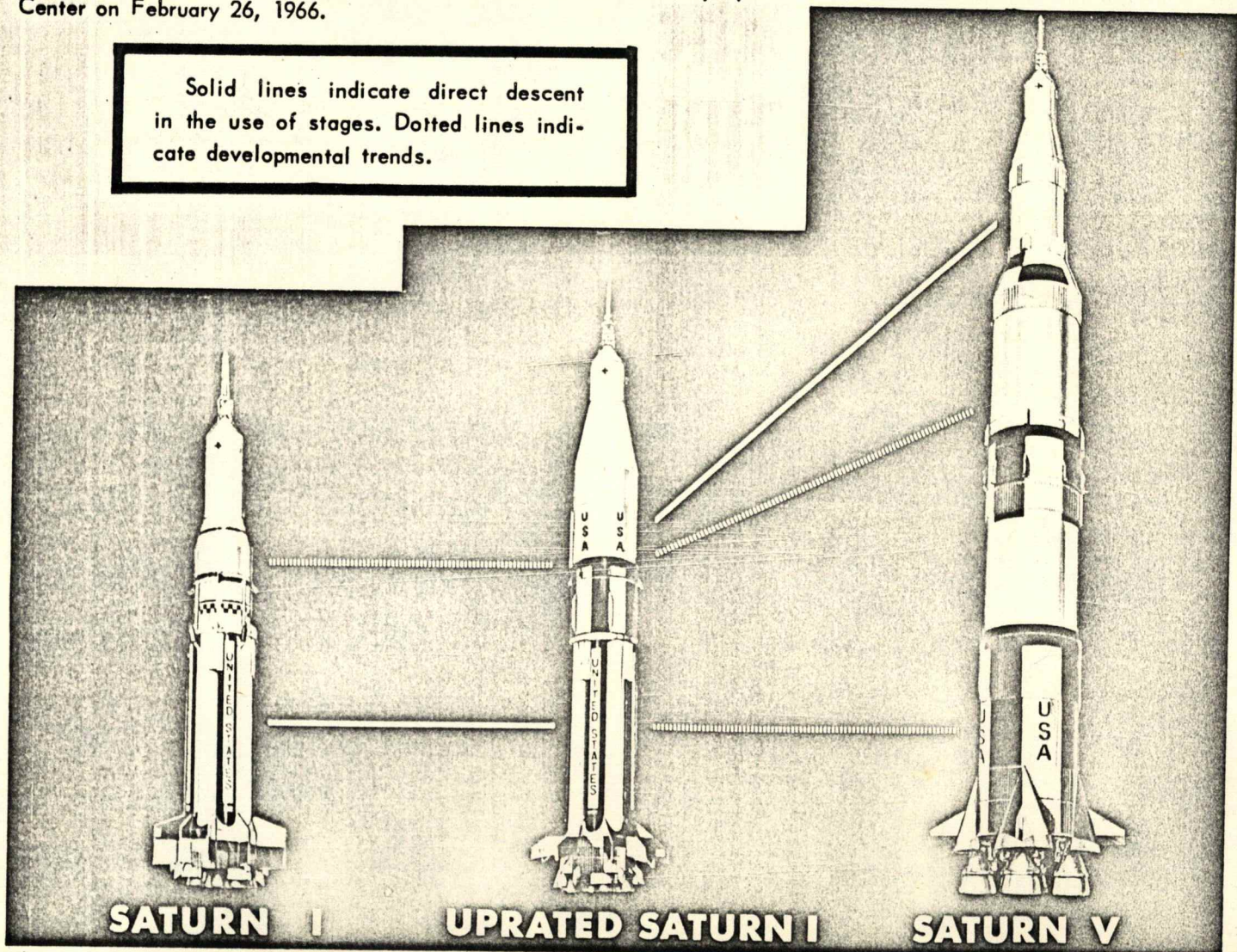
The Uprated Saturn I is heir to the advances in rocket technology chalked up in the development of its predecessor, the Saturn I. Its eight-engine booster is a more powerful, lighter, and improved version of the booster that achieved an unprecedented 10-for-10 successful launch record in Saturn I research, development, and operational flights.

Second stages of the Saturn I and the Uprated Saturn are vastly different. While both use powerful liquid hydrogen for fuel, the Uprated Saturn I obtains 200,000 pounds of thrust from a single engine, while its predecessor performed with 90,000 pounds of thrust from six smaller engines that pioneered in the liquid hydrogen/liquid oxygen field. This single-engine stage is also used as the third stage of the Saturn V.

The Uprated Saturn I claimed its inheritance of reliable performance from the Saturn I in its first successful launch at the Kennedy Space Center on February 26, 1966.

LAUNCH VEHICLE	PAYLOAD IN ORBIT
Redstone (sub-orbital flight)	3,000 lbs.
Atlas	3,000 lbs.
Titan II	7,000 lbs.
Uprated Saturn I	40,000 lbs.
Saturn V	250,000 lbs.

Solid lines indicate direct descent in the use of stages. Dotted lines indicate developmental trends.



UPDATED SATURN I (SATURN 1-B)

PAYLOAD

The Apollo spacecraft consists of three modules. North American Aviation, Inc., is developing both the Command Module and the Service Module at Downey, Calif. The Lunar Module is being developed by the Grumman Aircraft Corporation, Bethpage, New York.

INSTRUMENT UNIT

The instrument unit, between the spacecraft and S-IVB stage, contains guidance and control equipment for the launch vehicle.

Contractor: International Business Machines Corporation
Weight: 4,100 pounds

SECOND STAGE

Operates approximately 7.5 minutes to achieve orbital speed and altitude

Contractor: Douglas Aircraft Company

Power: Single J-2 engine

205,000 pounds thrust

Propellants: Liquid Hydrogen -- 64,000 gallons or 38,000 pounds

Liquid Oxygen -- 20,000 gallons or 191,000 pounds

Fueled weight of stage: 260,000 pounds (including aft interstage)

FIRST STAGE

Operates approximately 2.5 minutes to reach about 36 miles altitude and a velocity of 5,200 miles per hour at burnout

Contractor: Chrysler Corporation

Power: Eight H-1 engines

1.6 million pounds thrust total

Propellants: RP-1 kerosene, 43,000 gallons or 279,000 pounds

Liquid Oxygen 68,200 gallons or 632,500 pounds

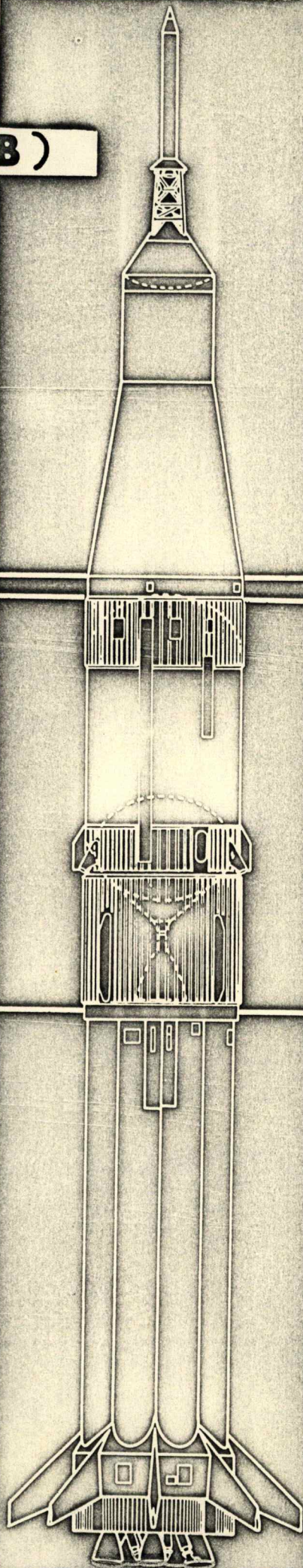
Fueled weight of stage: 992,000 pounds

OVERALL

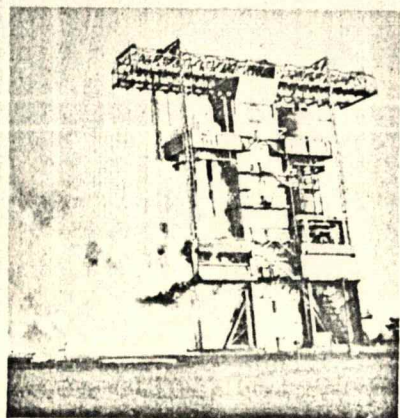
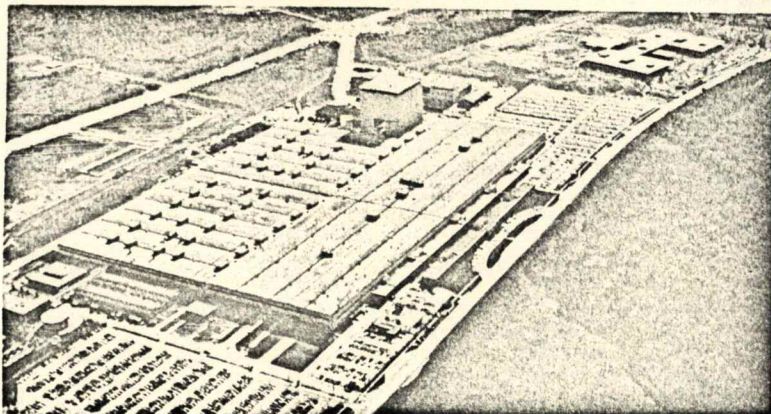
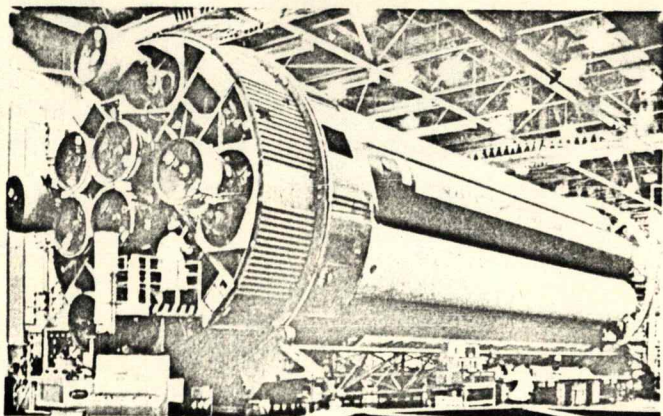
Liftoff Weight: 1.3 million pounds

Payload: 40,000 pounds in earth orbit

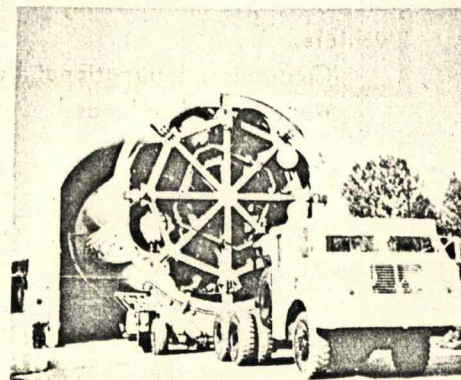
Note: The above characteristics are approximate and will vary with individual vehicles and missions.



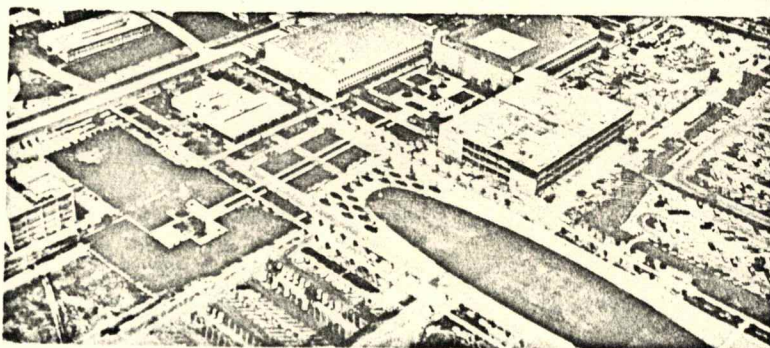
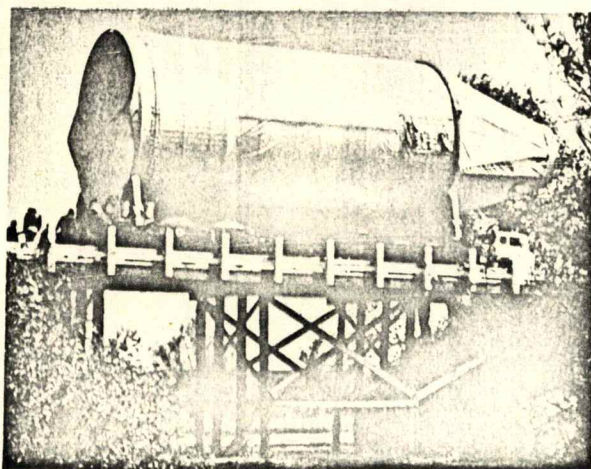
FIRST STAGE



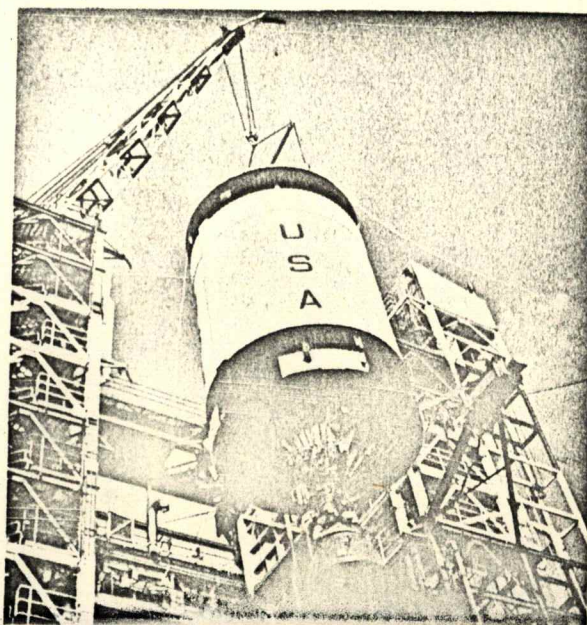
First stages assembled at Michoud Assembly Facility in New Orleans by Chrysler Corporation are shipped by water to the Marshall Center for static firing. They are returned to Michoud for final checkout, then shipped to the Kennedy Space Center for launching.



SECOND STAGE

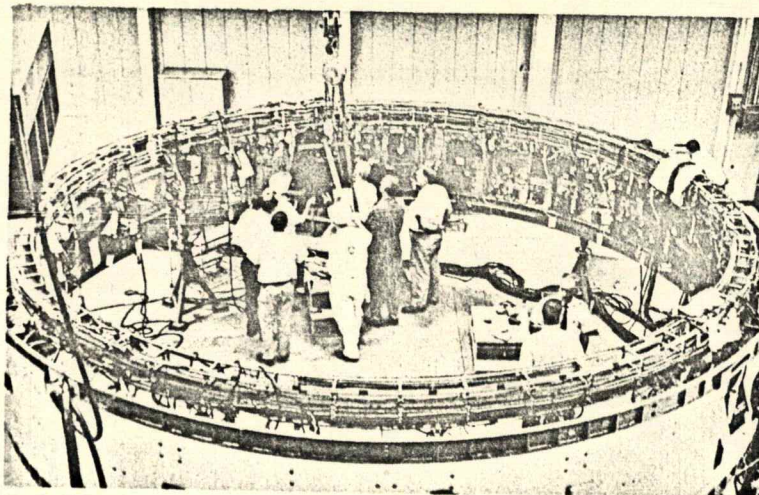


Second stages for the Uprated Saturn I are assembled by Douglas Aircraft Company at Huntington Beach California, and tested at Sacramento, California, before being taken to the Kennedy Space Center for mating with the first stage and payload. The second stages are flown from California to the Cape in a specially modified plane called the Super Guppy.



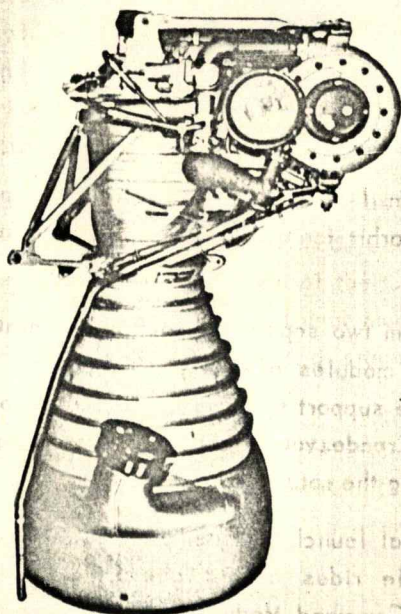
INSTRUMENT UNIT

The Instrument Unit for the Uprated Saturn I was designed by NASA at the Marshall Center and is a direct descendant of instrument units used on the first launch series. The units are assembled at the Huntsville, Alabama, plant of International Business Machines Corporation.



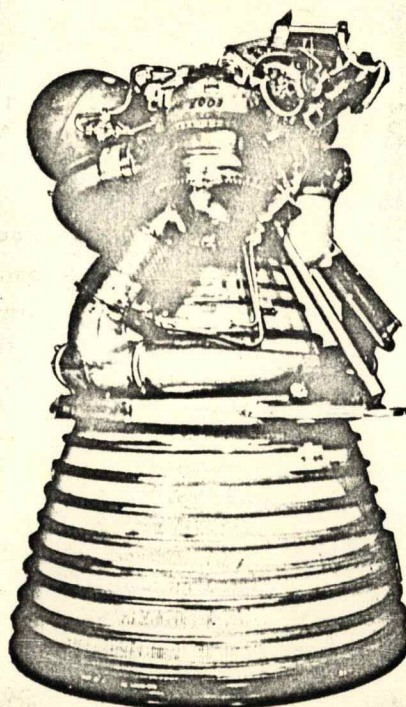
H-1 ENGINE

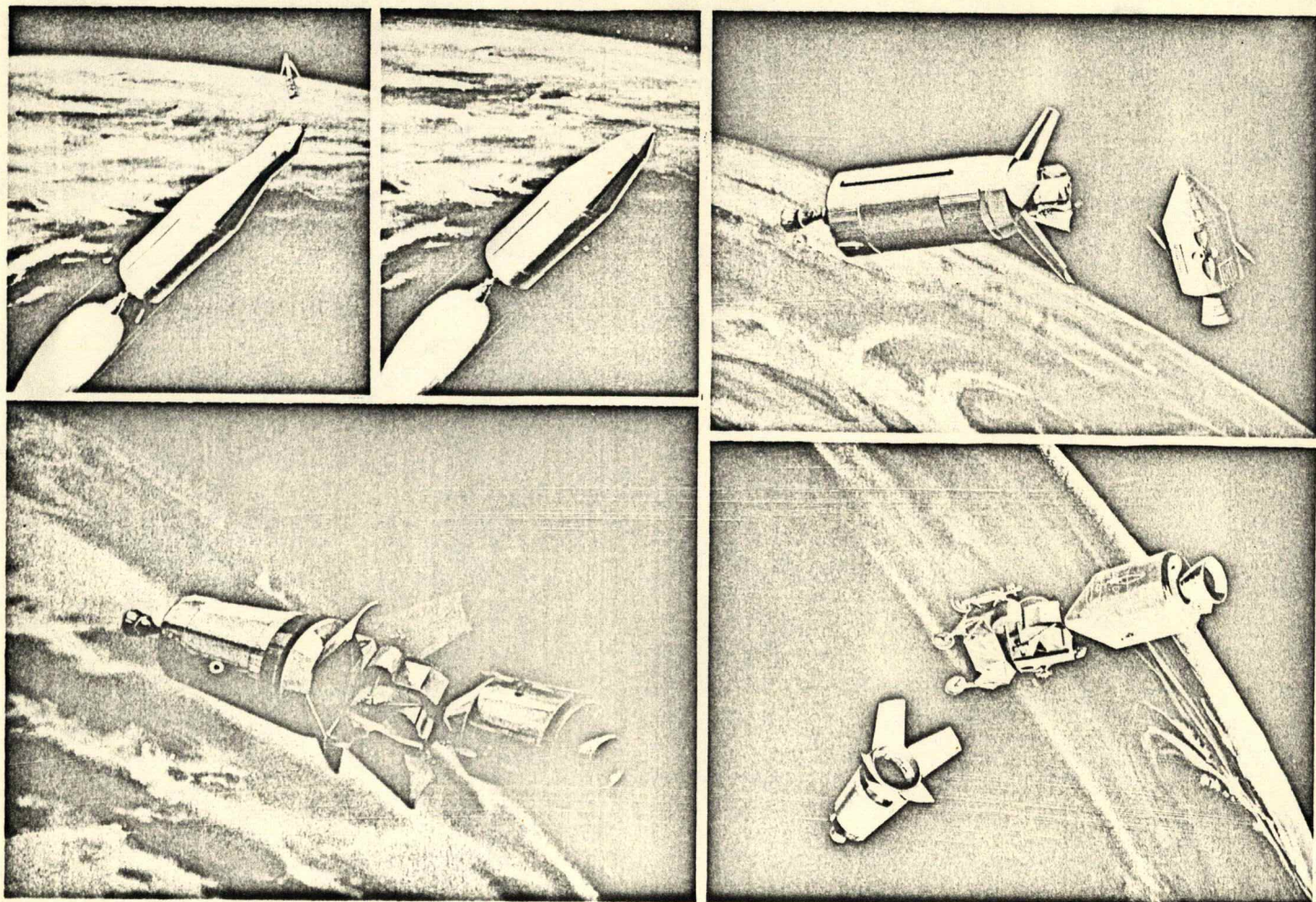
Developing 205,000 pounds thrust, the H-1 engine uses RP-1 kerosene as fuel and liquid oxygen as oxidizer. The engine is assembled by the Rocketdyne Division of North American Aviation, Inc. at Neosho, Missouri. Weighing about 2,000 pounds, the engine is eight and one-half feet high and about five and one-half feet wide. Eight of the engines are clustered in the first stage of the Uprated Saturn I.



J-2 ENGINE

The J-2 engine develops a thrust of 205,000 pounds, using liquid hydrogen as fuel and liquid oxygen as oxidizer. It is assembled at Canoga Park, California, by Rocketdyne. Weighing about 3,480 pounds, the engine is 11 feet high and about six feet, eight and one-half inches wide. A single J-2 powers the Uprated Saturn I second stage.





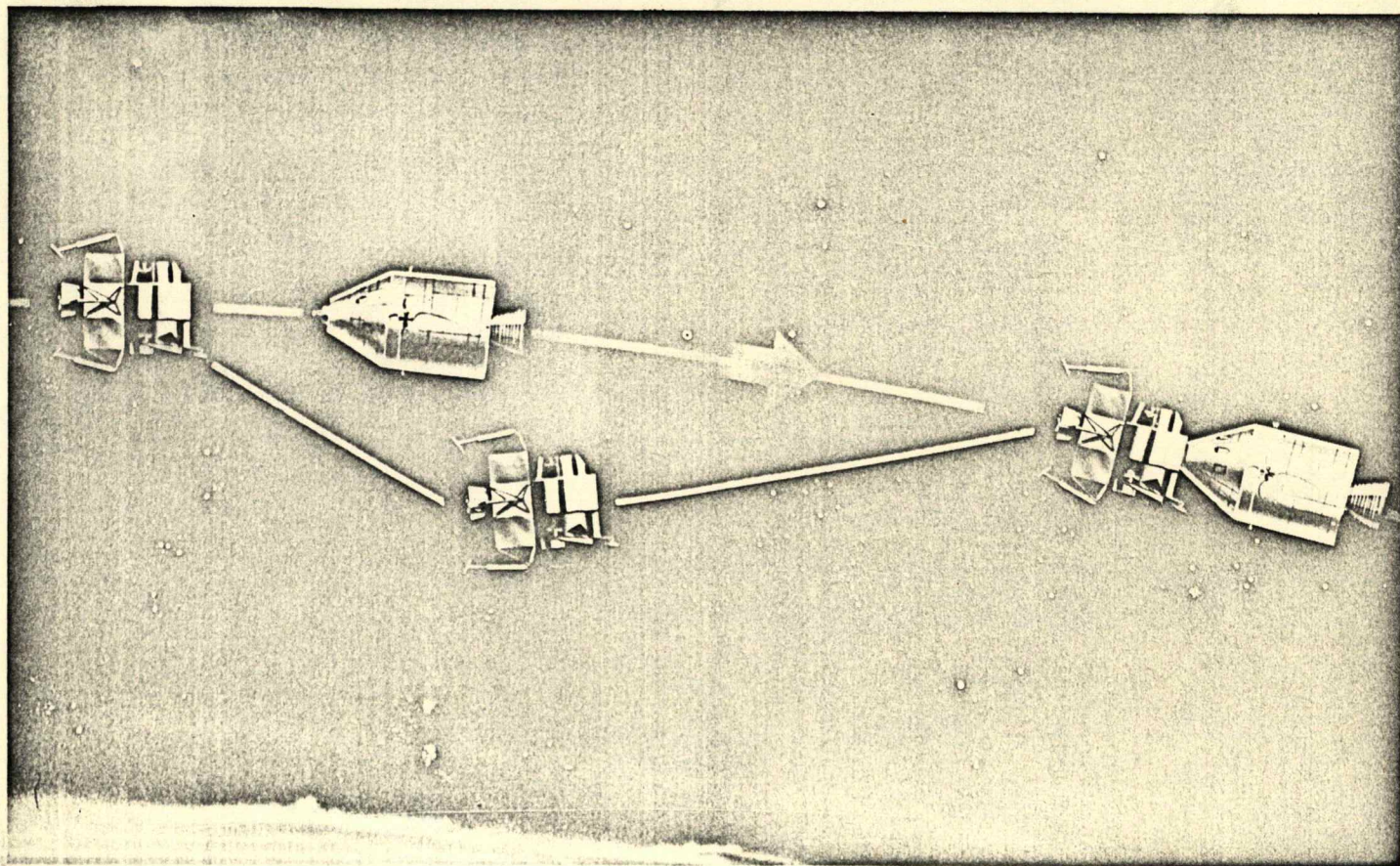
MISSIONS IN SUPPORT OF APOLLO

The Uprated Saturn I will be used initially to place three astronauts into earth orbit for qualification and training with the Apollo spacecraft.

Later in the program two separate launches of Uprated Saturns will place the three modules of the spacecraft into orbit with sufficient fuel and life support systems for long duration missions and for practice of the rendezvous and docking maneuvers that will be required later during the return trip from the moon.

The steps in a dual launch mission are shown above. An unmanned Lunar Module rides aboard one Uprated Saturn. The astronauts inside a Command Module and a Service Module are carried by the second Saturn.

In picture No. 1, with the astronauts aboard, the first Uprated Saturn launches the Command and Service Modules into a low circular orbit.



Picture No. 2 shows the second launch, from a nearby pad, in which the second stage of the Saturn is placing itself and the Lunar Module, enclosed in a nose cone shroud, into a slightly higher circular orbit. The astronauts now climb into a higher orbit for the rendezvous.

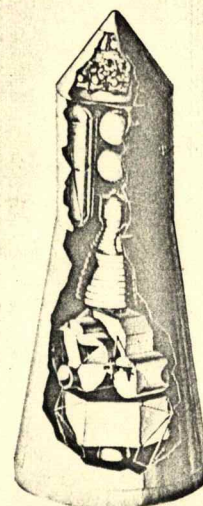
In the third picture the rendezvous has been completed, and the covering over the Lunar Module has opened. The astronauts are turning the nose of the Command Module into position to dock with the Lunar Module, which has remained attached to the second stage of the Saturn rocket.

Picture No. 4 shows the triumphant moment of docking and in the fifth picture the Lunar Module pulls free from the Saturn second stage, which is abandoned in earth orbit.

The rendezvous maneuver is practiced again in the series of illustrations shown in the sixth panel above. First, the Lunar Module separates from the Command and Service Modules. Then it changes orbit, and returns to rendezvous and dock again.

APOLLO SPACECRAFT

1. The Apollo Command Module, with three side-by-side couches, houses the astronauts.
2. The Service Module has a 22,000-pound thrust engine for maneuvering in space and return to earth from lunar orbit.
3. The Lunar Module is used for descent to and return from the lunar surface.



For the trip to the Moon, the three modules of the Apollo spacecraft will be positioned above one another as shown in the picture above for launching aboard a single powerful Saturn V rocket.

STUDIES OF OTHER APPLICATIONS FOR THE

Although all research and development work on the Upgraded Saturn I is funded as a part of Project Apollo costs, the launch vehicle and launch facilities will be available for many types of missions in space long after the manned lunar landing has been accomplished.

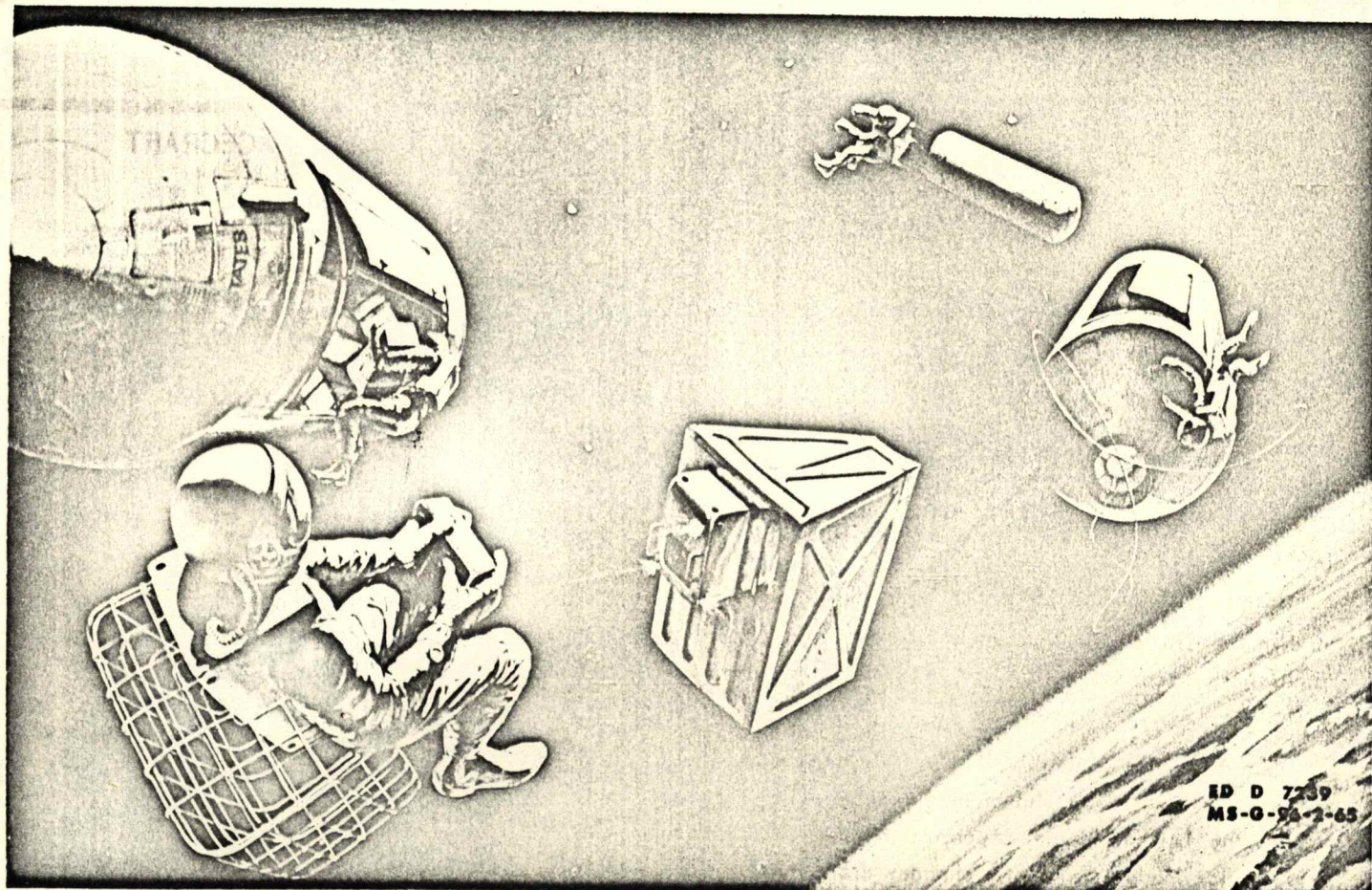
The Saturn vehicles and the Apollo spacecraft can be used to conduct a number of operational, scientific, and technological experiments in earth orbit or on the moon. The knowledge, investment, experience, and capabilities accrued in Project Apollo will be fully exploited to advance the national goal of maintaining U. S. pre-eminence in space.

The pictures on the following pages show some possible missions that could be accomplished with the Upgraded Saturn I and Apollo spacecraft.

The ability to assemble items in earth orbit is necessary if man is to continue to explore and fully use the space environment. Huge space stations may be formed from sections brought up from earth in separate launches. Or spacecraft with several stages and additional fuel tanks or engines could be assembled in earth orbit for launching on journeys into deep space. The Apollo/Saturn systems could be used to advance assembly techniques.

Cargo and personnel could be transferred from one spacecraft to another, or from a spacecraft to a space station, as shown below.

Fresh supplies from earth could be transferred to a crew in orbit on a long duration mission. Orbital maneuvering and docking techniques could be refined.



UPDATED SATURN I

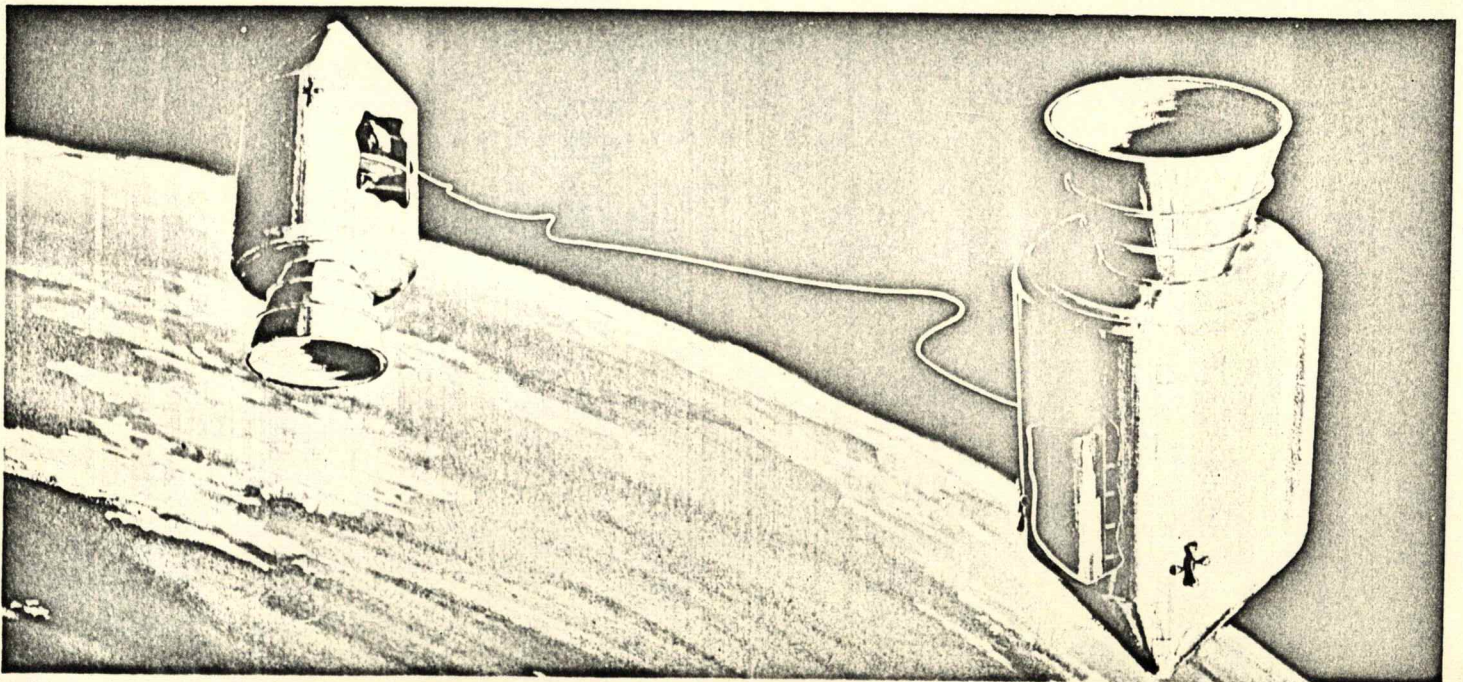
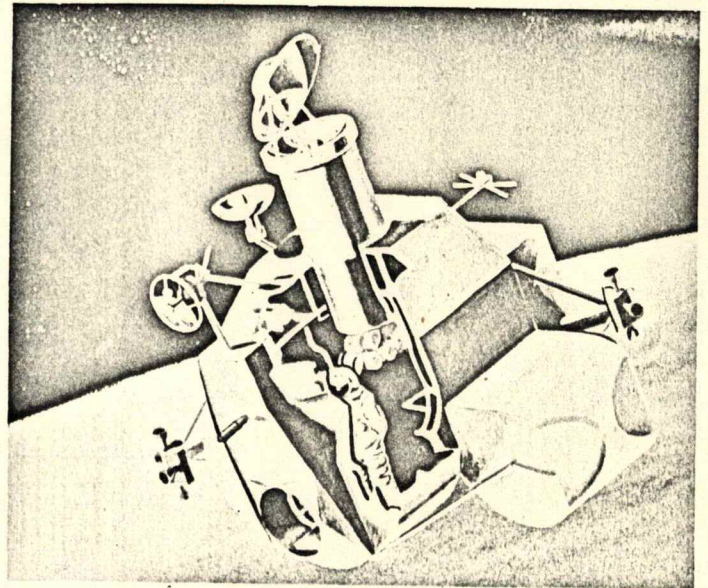
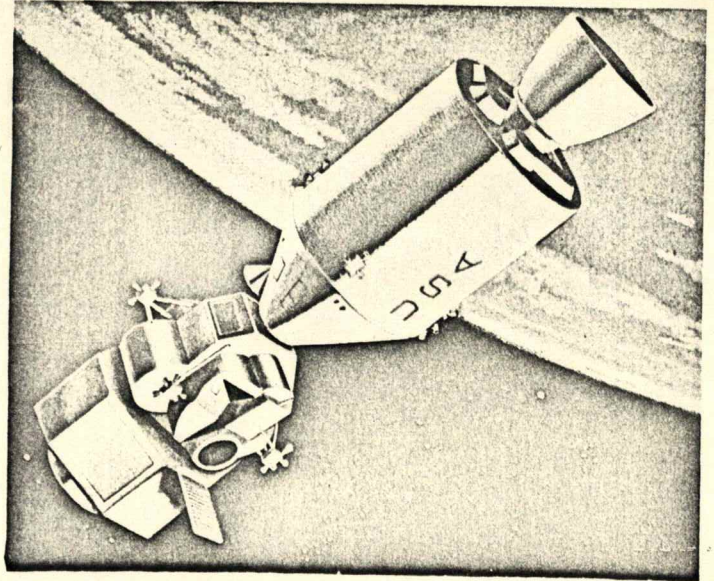
Men in earth orbit could operate optical telescopes to observe the sun and stars, free of atmospheric distortion and filtering that hamper earth-bound astronomers.

The 38-inch telescopes developed for the unmanned Orbiting Astronomical Observatory program could be adopted for use with the Apollo spacecraft. After setting up the telescope in orbit, the astronaut would adjust, calibrate, and operate it.

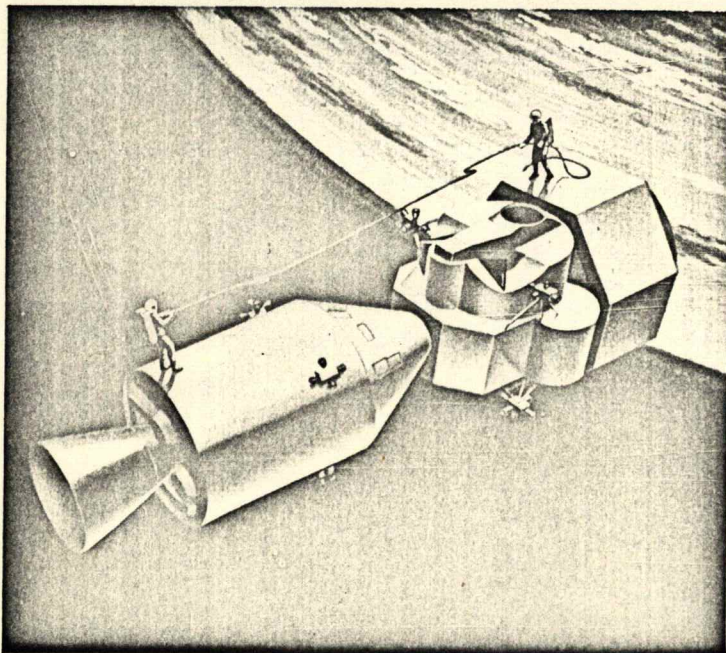
An advanced meteorological research laboratory in synchronous or polar orbit would enable scientists to conduct a number of experiments regarding earth's atmosphere, and to gather data for long-term weather forecasts.

Improved weather forecasting techniques provided by a manned earth-orbital weather station could save the U.S. \$2 to \$2.5 billion annually in such activities as livestock production, fruit-vegetable production, new construction, fuels and electric power, and floods and storms.

Spacecraft could be refueled in orbit, as shown below, for longer duration missions.



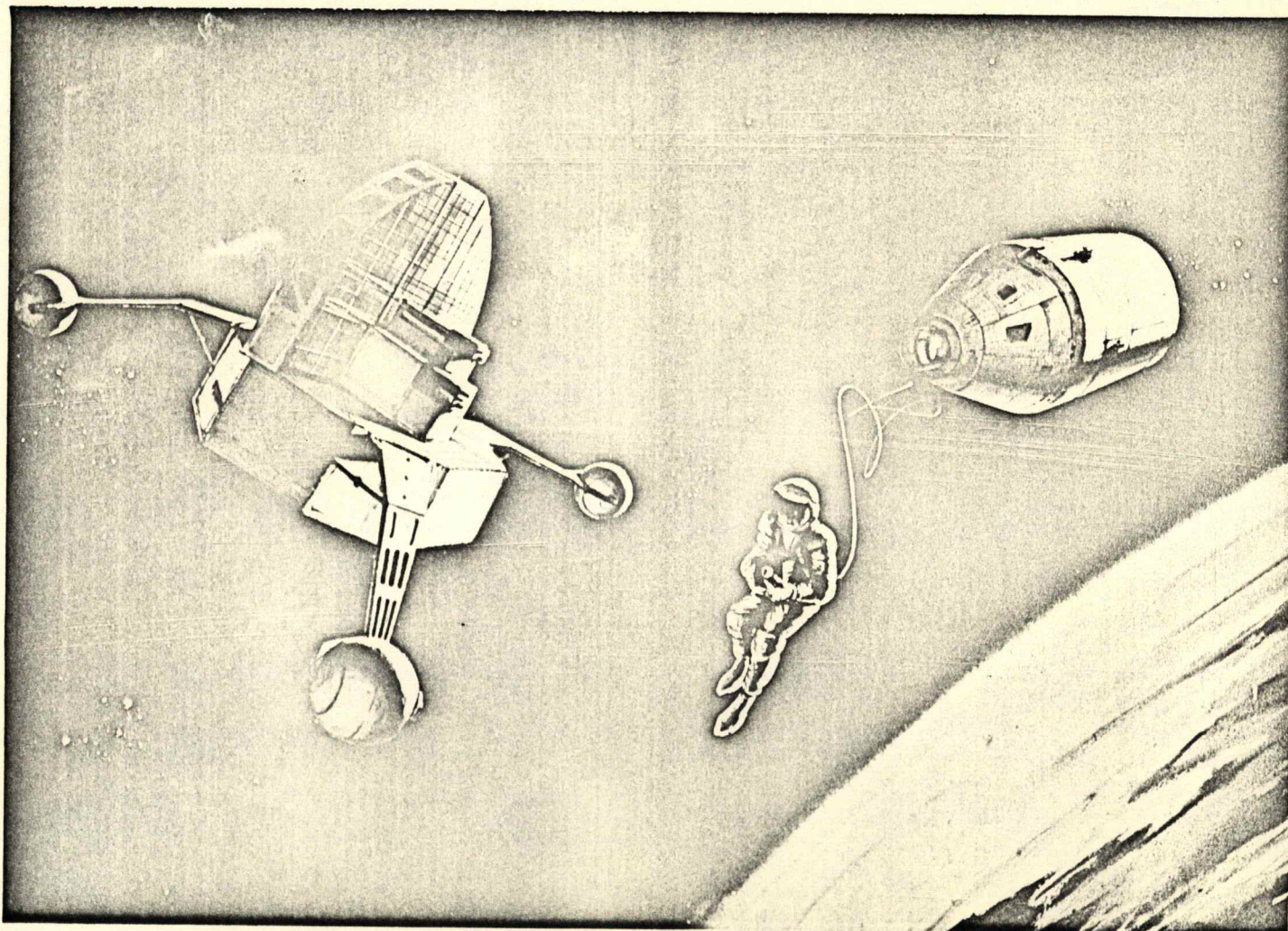
EXTRA VEHICULAR ACTIVITY IN SPACE



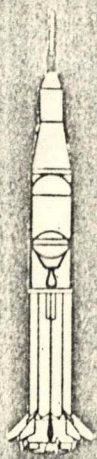
The walks in space taken by the Gemini astronauts demonstrated the feasibility of extra vehicular activity. Extensive activities outside of the spacecraft by astronauts could be performed on long duration manned flight operations made possible by the Saturns.

The ability of astronauts to maneuver and manipulate items in space could be improved, as shown in the top drawing. Large structures such as radio and optical antennas could be assembled and tested.

Satellites in orbit could be inspected and techniques developed for repair of satellites in space. Shown below is an artist's conception of an astronaut inspecting NASA's first Orbiting Solar Observatory, which was launched in May, 1962.



MODIFIED UPRATED SATURN I LAUNCH VEHICLES



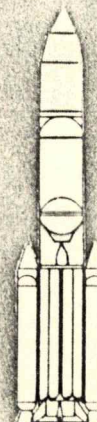
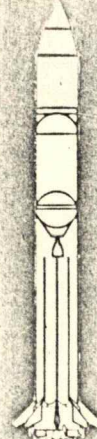
BASIC SATURN



SOLID FIRST STAGE



UPRATED FIRST STAGE



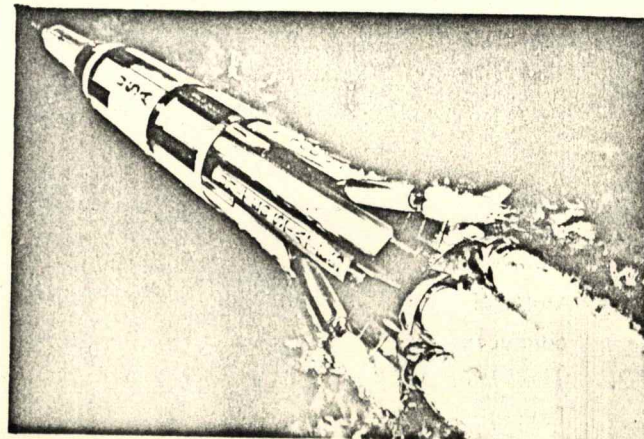
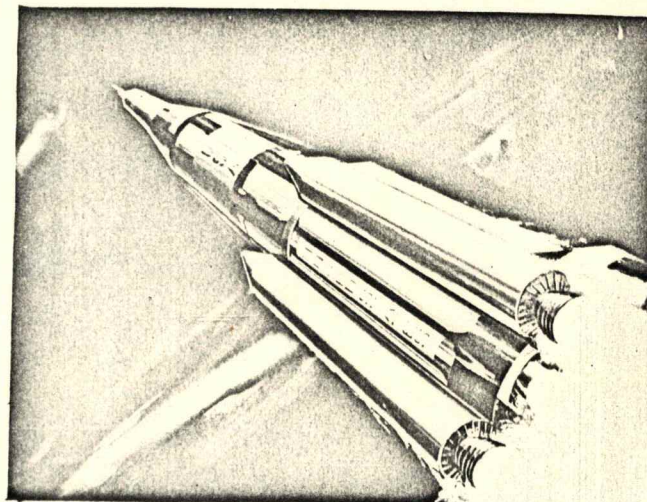
BOOST ASSIST

Studies have shown that performance of the Uprated Saturn I vehicle can be increased from its basic payload capability of 40,000 pounds to a payload capability of more than 100,000 pounds. These studies of Saturn improvement possibilities are on a continuing basis.

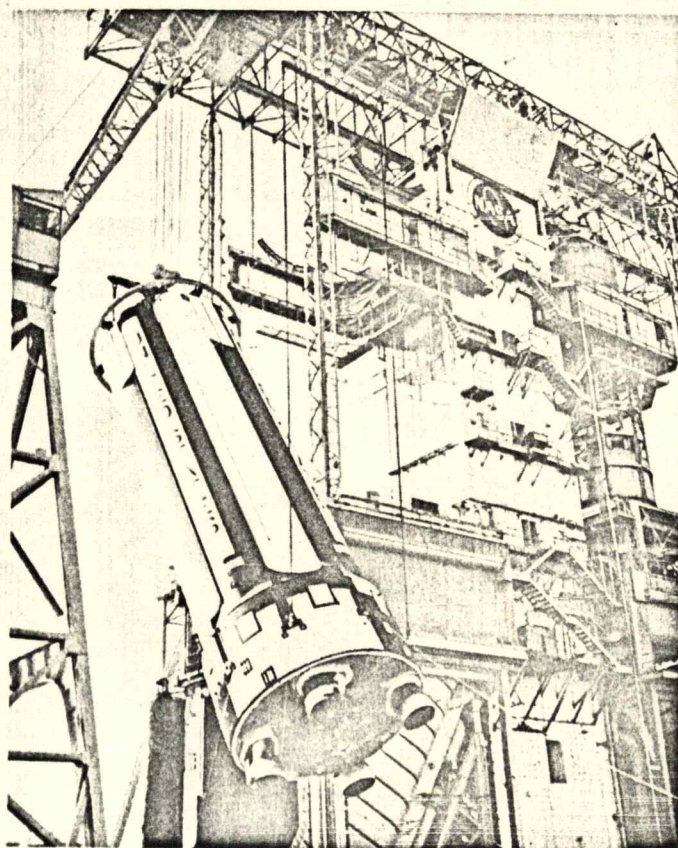
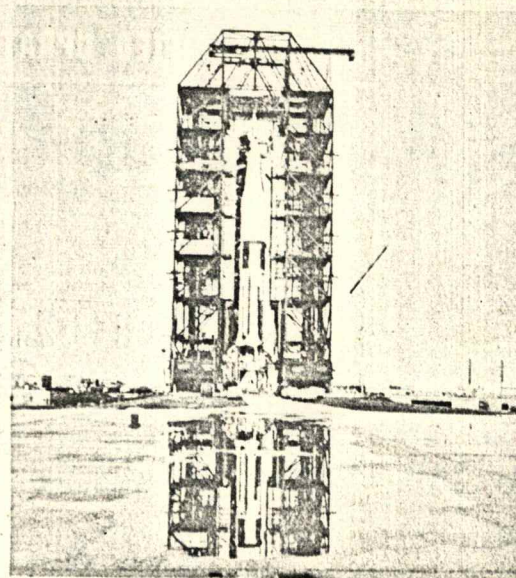
Three basic methods of improvement are being studied:

1. Increased power through engine modification, higher energy fuels, or increased fuel capacity.
2. Increased power through strap-on engines to augment first stage thrust.
3. Addition of a new stage -- either by strap-on method or by substitution of existing stages.

It is possible to attain a flexible payload delivery with a steady progression in capability through the 40,000 to 100,000-pound range. This could be accomplished through use of various sizes and numbers of strap-on units to allow a "tailoring" of the Uprated Saturn I to fit particular needs.



SPACE GROWTH - UPRATING STUDIES



Mission Control
Manned Spacecraft Center
Houston, Texas

Pad Assembly
Kennedy Space Center
Florida

Static Test Stand
Marshall Space Flight Center
Huntsville, Alabama

All NASA manned Apollo missions are directed by the NASA Office of Manned Space Flight in Washington, D.C. Activities are centered at three installations:

1. The Marshall Space Flight Center in Huntsville, Alabama, provides the launch vehicle and conducts related research and support.
2. The Manned Spacecraft Center in Houston, Texas, is responsible for the spacecraft, astronaut training, and mission control.
3. The Kennedy Space Center, Florida, provides vehicle assembly and launch facilities and conducts the checkout and launch.