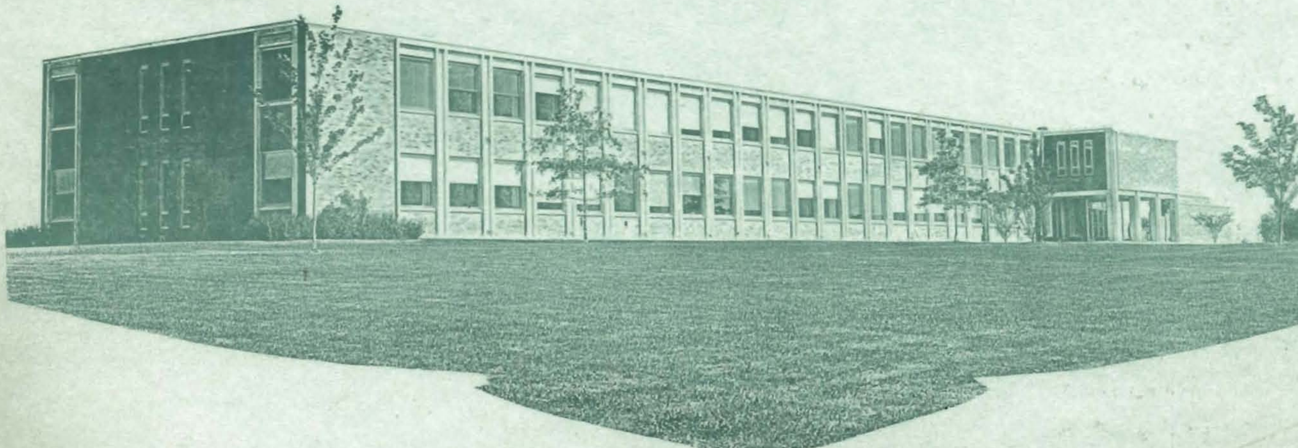
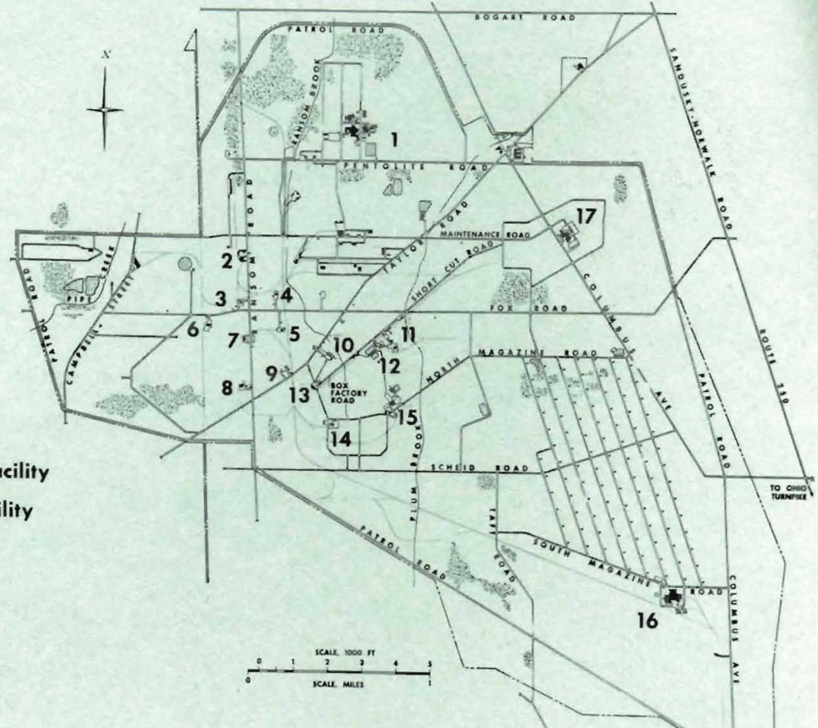
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LEWIS RESEARCH CENTER



PLUM BROOK STATION

1 Reactor Facility
2 Cryogenic Propellant Tank Site
3 Turbine Site
4 Dynamics Stand
5 Liquid Hydrogen Pump Site
6 Hydraulics Lab
7 Control and Instrument Building
8 Turbo Pump Site
9 Fluorine Pump Site
10 Rocket Systems Test Sites
11 Nuclear Rocket Dynamics and Control Facility
12 High Energy Rocket Engine Research Facility
13 Control and Instrument Building
14 Hypersonic Tunnel Facility
15 Spacecraft Propulsion Research Facility
16 Space Power Facility
17 Engineering Building



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IN REPLY REFER TO

From the Director:

It is my pleasure to welcome you today to the Plum Brook Station of the Lewis Research Center, National Aeronautics and Space Administration.

The challenges and promises of space are manifold. Its exploration represents one of the greatest scientific endeavors ever undertaken. The projects and people involved are many.

Plum Brook is one of a number of nation-wide NASA installations concerned with research and development of the technology and equipment necessary to meet the challenges and claim the promises of space.

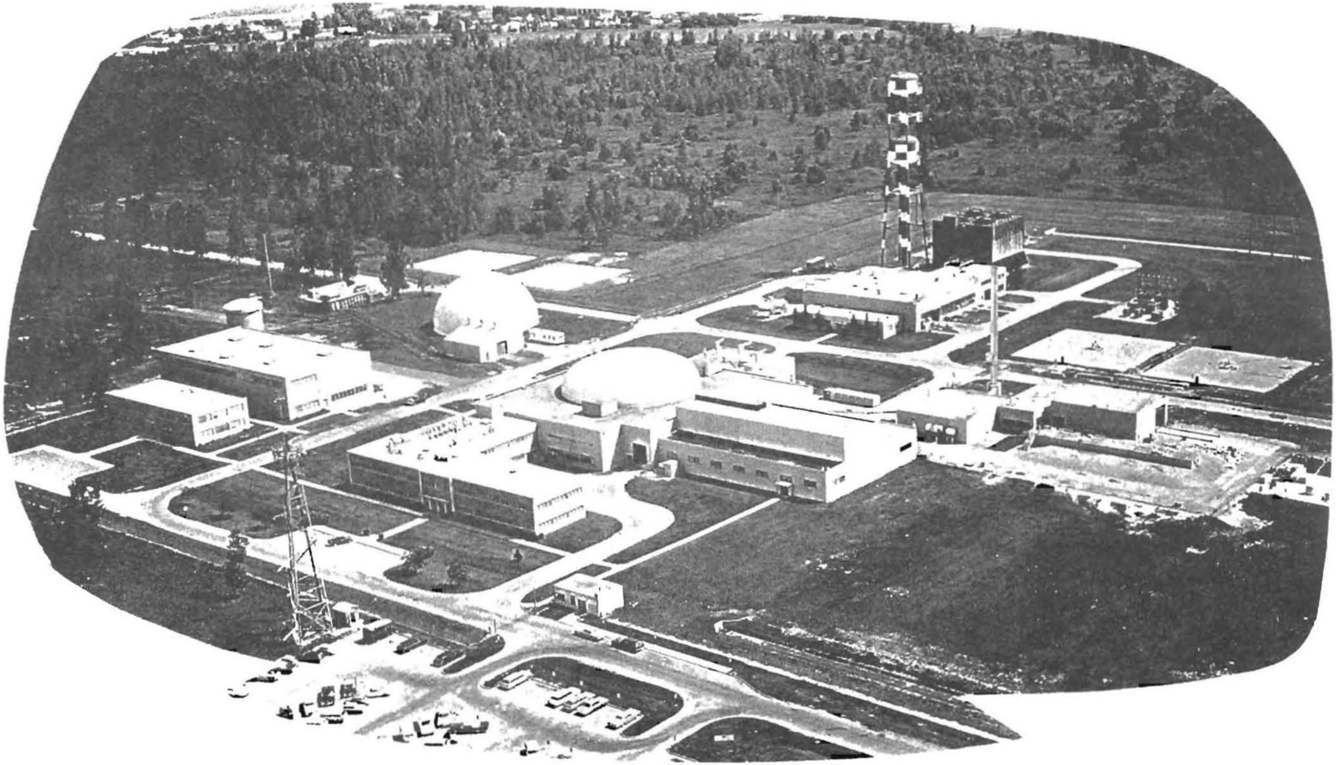
The Plum Brook Staff are among the many thousands of persons working toward these goals.

NASA seeks to disseminate, as widely as possible, information concerning its facilities, programs, and progress. Your tour today is but one such informational effort.

It is my hope that you--our neighbors and members of the American public to which this and all Federal facilities belong--will find this introduction to Plum Brook Station both interesting and informative.

Alan D. Johnson

Alan D. Johnson



1 REACTOR FACILITY

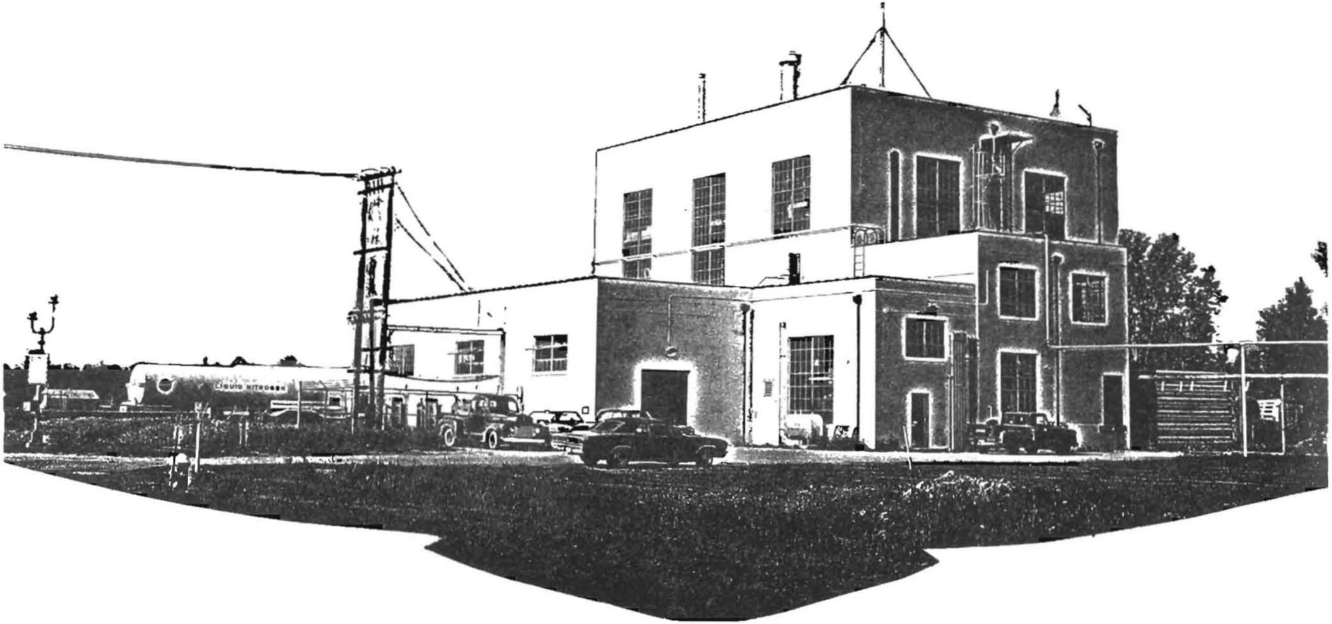
The Plum Brook nuclear reactor produces neutron and gamma radiation. It is used to study materials and spacecraft components in radiation conditions similar to those anticipated in full-scale space nuclear rocket systems and space power systems.

The reactor develops 60,000 kilowatts of thermal power. The reactor core is approximately 1′ wide x 3′ long x 3′ high, and holds 27 enriched uranium aluminum alloy fuel elements.

During reactor operation, 18,000 gallons of highly purified cooling water are circulated per minute through the reactor core. The 60,000 kilowatts of thermal power are dissipated to the atmosphere via a cooling tower.

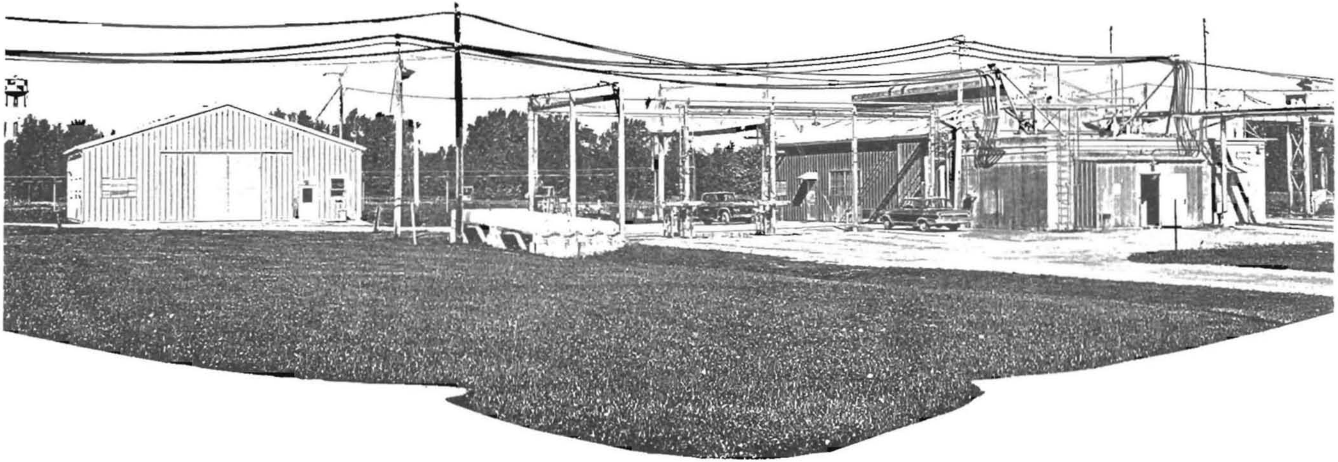
Post-irradiation tests are performed on radioactive test specimens in the facility's hot laboratory. When the radioactive materials are moved from the reactor to other areas, 25-foot deep water canals and lead casks are used for shielding.

At the present time many tests are being performed. The resulting data will be used to build nuclear rockets and space power supplies for interplanetary exploration and Earth satellites. To simulate space environment conditions, some tests are made at −430°F.


LIQUID NITROGEN

2 CRYOGENIC PROPELLANT TANK SITE

This facility is used to test propellant tank insulation systems and to determine pressurizing gas requirements during propellant outflow. The main building of this site previously housed an obsolete steam power plant. The power plant equipment was removed and replaced by a 25′ diameter spherical tank with a 20′ diameter access door. This tank serves as a research test chamber where liquid hydrogen rocket fuel tanks up to 18′ diameter can be tested. During research tests the chamber vacuum conditions are maintained and a 10,000 pound hydraulic actuator is used to shake the rocket fuel tanks. The metal building to the right is the steam plant required for building heating and to supply steam to a heat exchanger that is used in the research programs. The concrete building to the right and to the rear is the site control building.

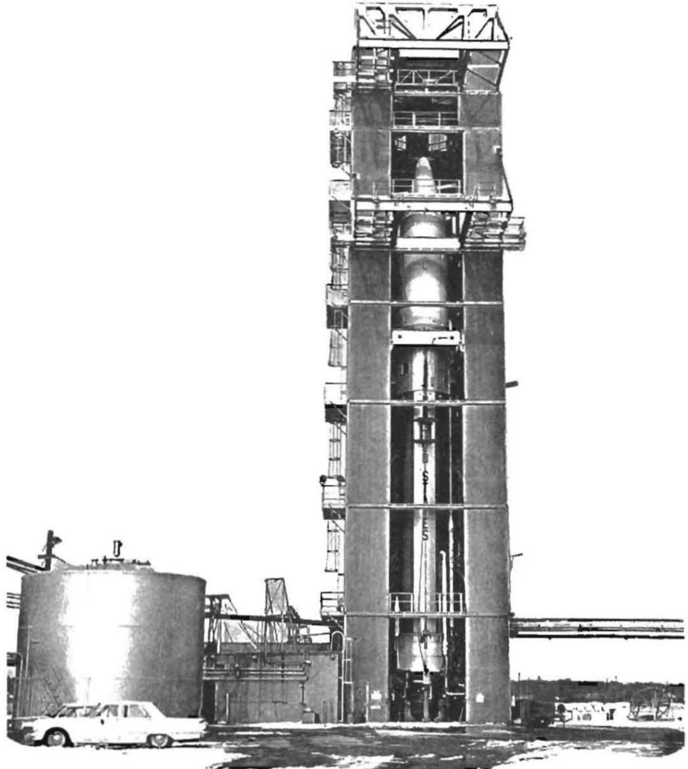


3 TURBINE SITE

This facility is designed to test research turbines. Resulting data from these tests is used to design the drive turbines for rocket propellant pumps for both chemical and nuclear engines.

Turbines capable of developing up to 15,000 horsepower at speeds to 60,000 revolutions per minute can be tested.

High pressure gas is supplied to the turbines by gas generators which operate on hydrogen gas and liquid oxygen.



4 DYNAMICS STAND

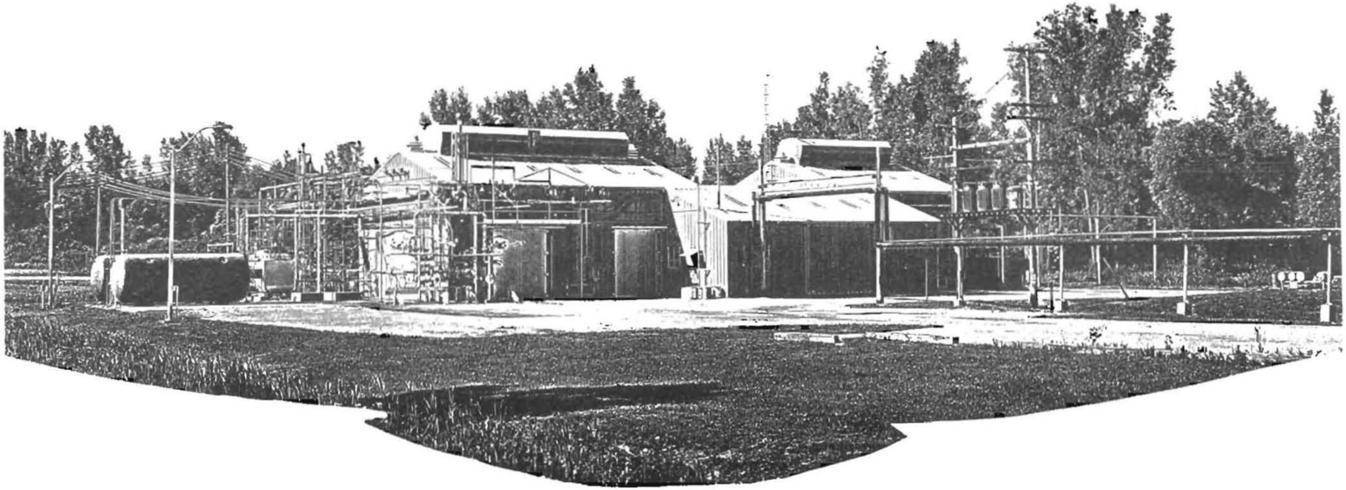
This 144' stand is equipped with electro-magnetic shake devices which simulate forces encountered on a spacecraft during launch and in flight.

Research tests have been run here on the Atlas-Centaur-Surveyor combination. Information from these tests insured the success of the Surveyor project which soft-landed the Surveyor instrument packages on the Moon.

5 LIQUID HYDROGEN PUMP SITE

At this test site, liquid hydrogen research pumps of various designs can be tested at pump speeds up to 60,000 revolutions per minute. Liquid hydrogen is supplied to the research pump via 34,400 gallon railroad dewars.

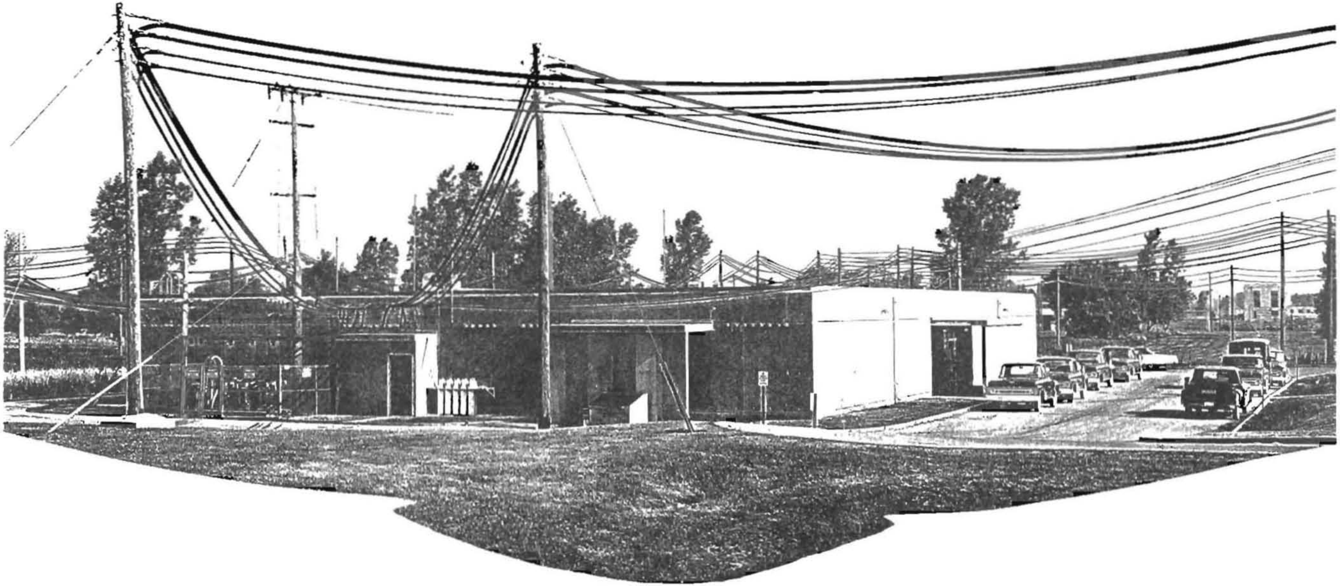
Data from these research programs will be used to design liquid hydrogen pumps for advanced chemical and nuclear rockets.



6 HYDRAULICS LAB

At this test site, cryogenic (low temperature liquids such as liquid hydrogen, liquid nitrogen, etc.) and other fluids are passed through test set-ups. Research data is obtained on the various fluid flow conditions.

Tests were made here using an experimental water-to-liquid-hydrogen heat exchanger. This data was used to support a new nuclear rocket engine concept.



7 CONTROL AND INSTRUMENT BUILDING

In this reinforced concrete building are located the control rooms, control equipment and data recording instruments for six research sites. The data recording instruments are also used by five other sites.

Thousands of electrical lines are contained in the instrument and control cables that can be seen entering the building.

Since no personnel are permitted in the test site during research operations, all test sites must be remotely controlled, and closed circuit television systems are used so that the test operators can visually observe the research tests which are taking place a quarter mile away.

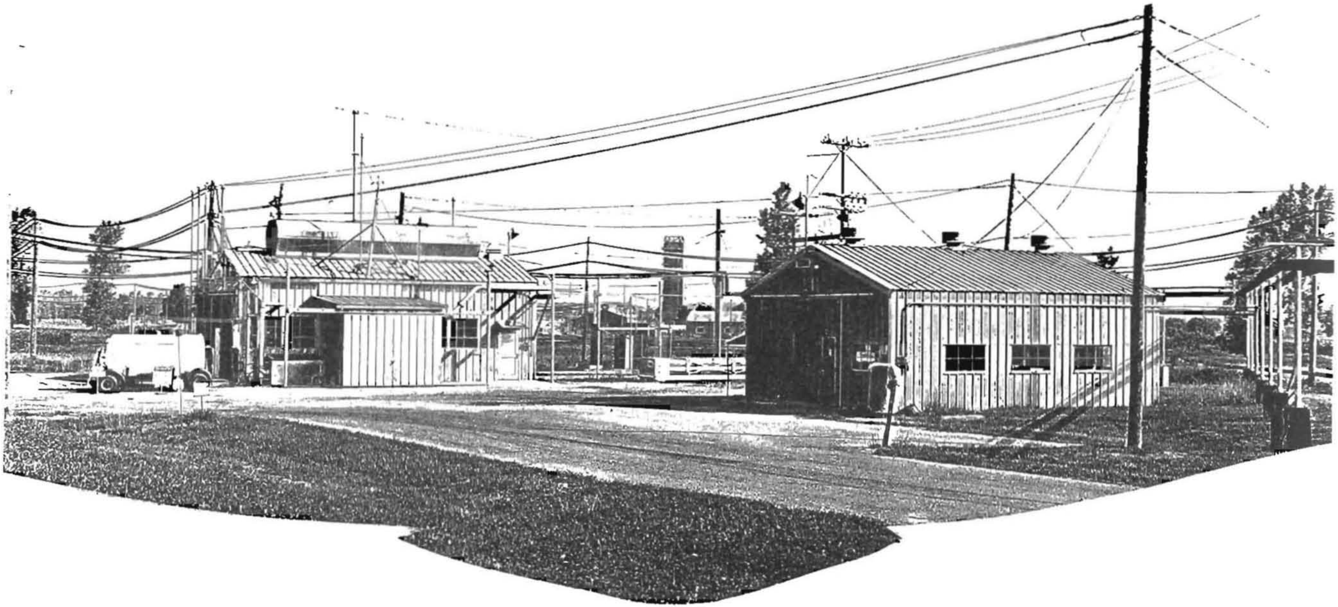
A wide variety of data systems are available to support the many kinds of research tests conducted at the rocket facilities. The fastest system can record over 30,000 readings per second.

8 TURBO PUMP SITE

Research programs on liquid hydrogen turbopumps and pump inducers are performed at this site. One of the projects being investigated is the development of a pump that will operate efficiently in boiling hydrogen. This data is needed to design efficient pumps for nuclear rocket applications.

The turbopump is connected to portable 6000-gallon liquid hydrogen trailers through a vacuum-jacketed stainless steel piping system. The drive turbine is powered by high-pressure hydrogen gas.

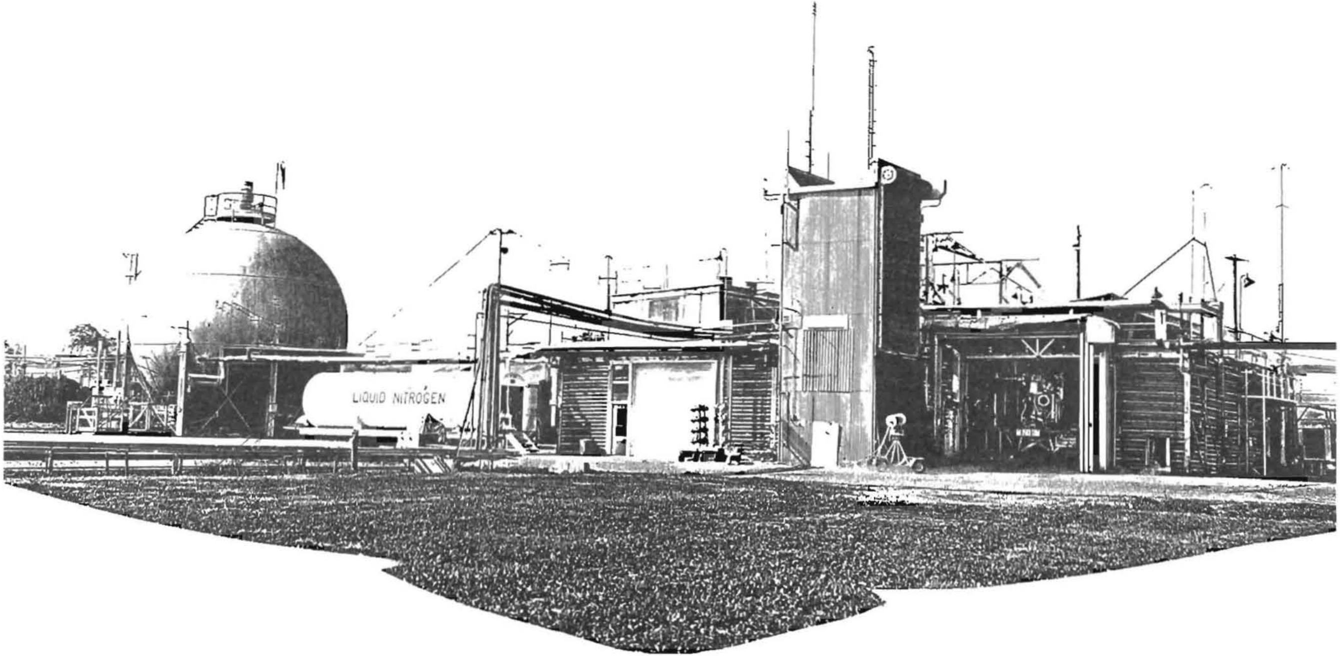
The pump inducer rig is submerged in a 2500-gallon vacuum-jacketed stainless steel liquid hydrogen tank. The inducer is driven by an air turbine which is located on the outside of the tank. A shaft through the bottom of the tank connects the turbine to the inducer.



9 FLUORINE PUMP SITE

Fluorine is the most active oxidizer known. For this reason, its use in the chemical rocketry field is being explored.

At this site, liquid fluorine pumps with speeds up to 20,000 revolutions per minute and flow rates of 50 pounds per second can be tested.

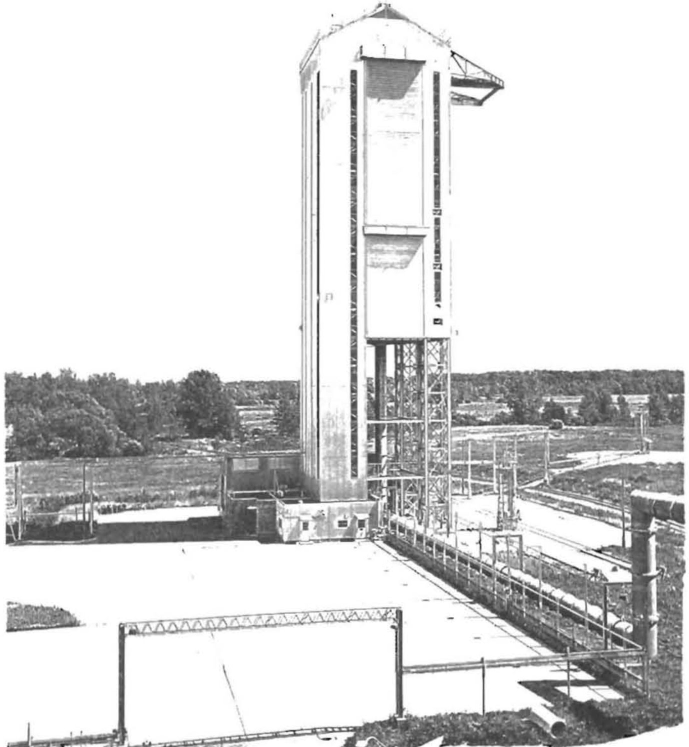

LIQUID NITROGEN

10 ROCKET SYSTEMS TEST SITES

In this area, hydrogen-oxygen rocket engines are fired and data is obtained on heat transfer between the hot exhaust gases and the nozzle walls. Studies are also made on heat transfer from the nozzle wall to the liquid hydrogen used to cool the nozzle. This heat transfer research is being done to support the development of nozzles for nuclear rocket engines.

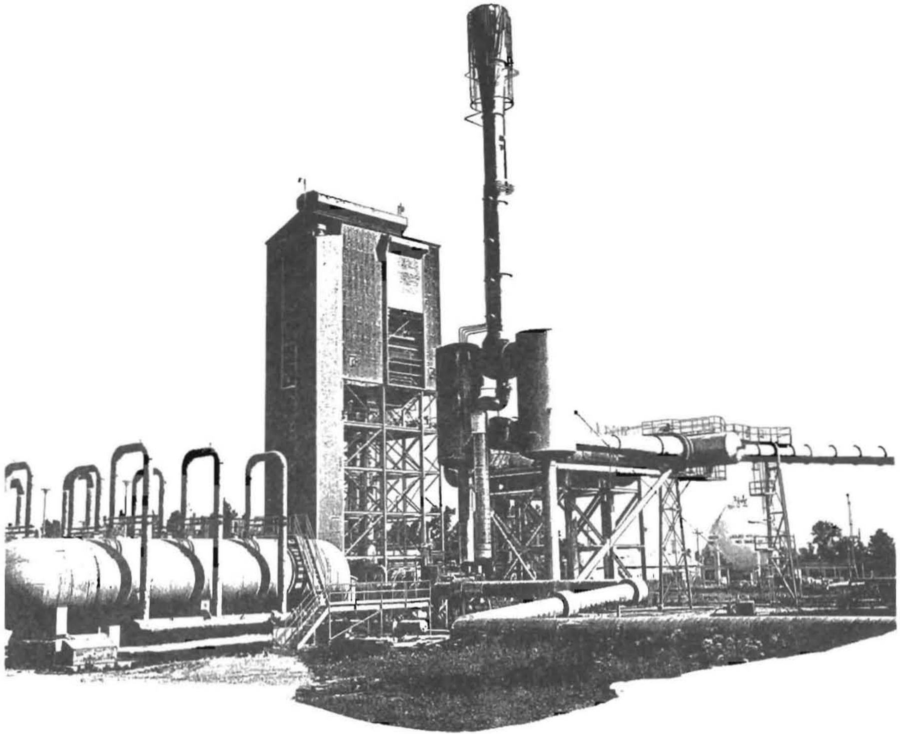
Also located in this area is a space environment tank where different types of liquid hydrogen propellant tanks can be tested at space conditions. Various types of tank insulations are being studied.

The 38′ diameter steel containment vessel is a hydraulics laboratory used to test liquid fluorine and liquid oxygen under pressures up to 1200 pounds per square inch.



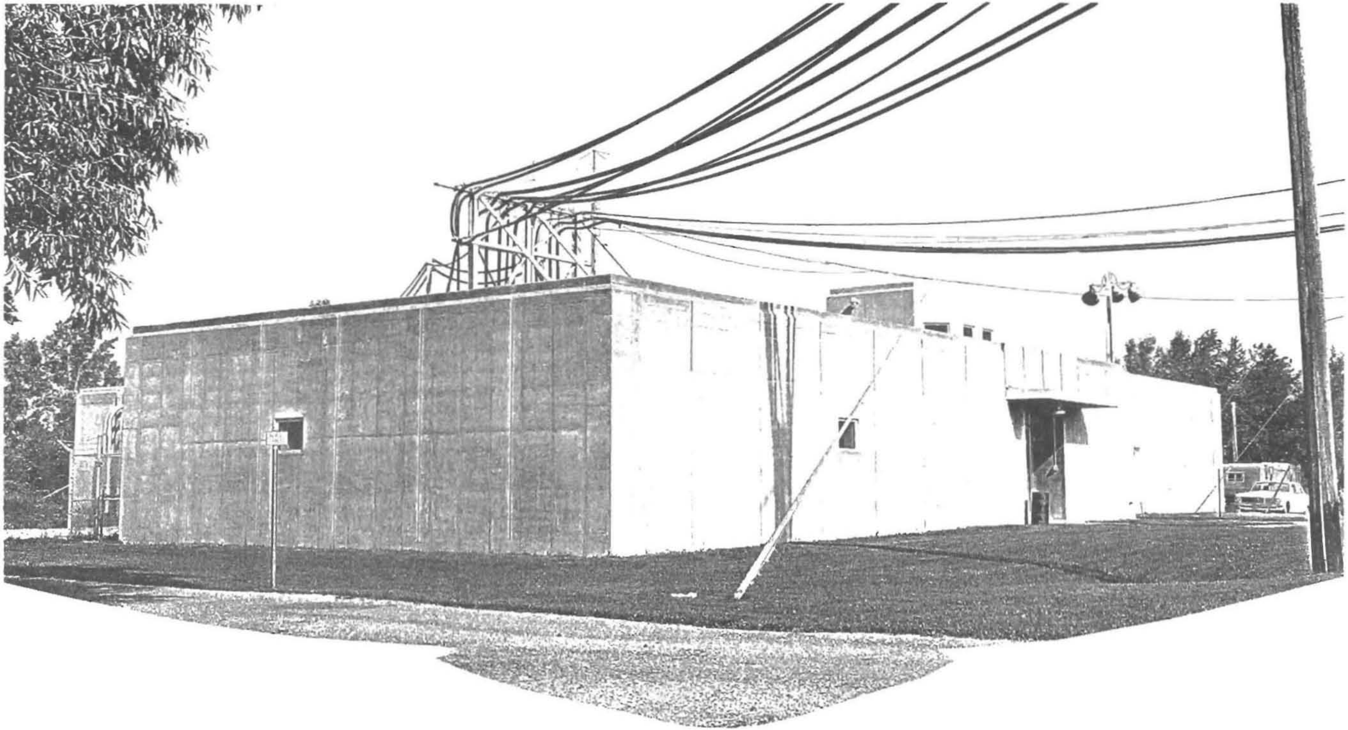
11 NUCLEAR ROCKET DYNAMICS AND CONTROL FACILITY

This 200′ facility is used for non-nuclear altitude tests on various components for large nuclear rocket engines such as will be needed for interplanetary travel. A 46,000 gallon liquid hydrogen run tank is located in the tower, and liquid and high-pressure gas can be supplied by railcar. A 200,000 gallon liquid hydrogen supply tank is located in the front of this facility.



12 HIGH ENERGY ROCKET ENGINE RESEARCH FACILITY

This facility is designed to test propellant systems at altitude conditions. Tests have been run here on the NERVA (Nuclear Engine for Rocket Vehicle Application) propellant feed system. The investigations include turbopump tests, fluid instabilities in the engine flow passages, and equipment performmance evaluations. The pipe structure adjacent to the facility is a steam ejector which is used to obtain the necessary altitude test condition. A nearby steam plant furnishes the required steam for this ejector and also services the ejectors of three other research facilities.



13 CONTROL AND INSTRUMENT BUILDING

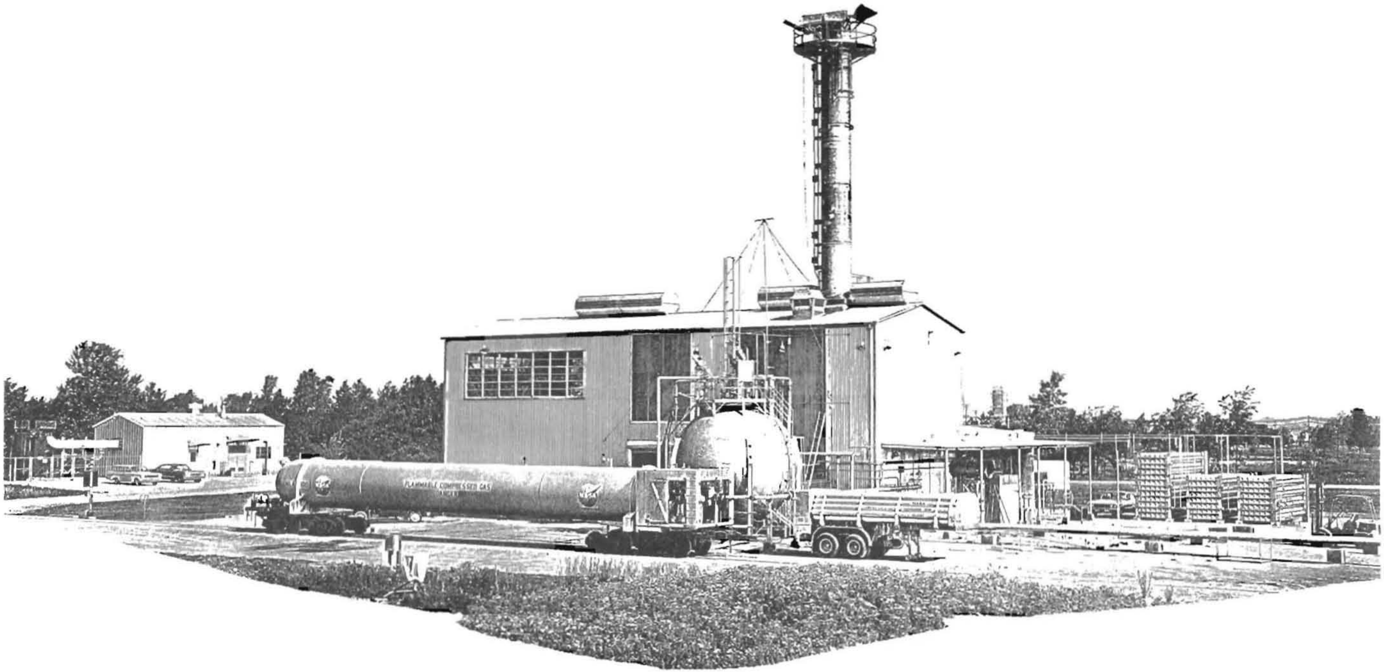
This building is the control and instrument area for four research facilities:

Hypersonic Tunnel Facility

Nuclear Rocket Engine Dynamics Facility

Spacecraft Propulsion Facility

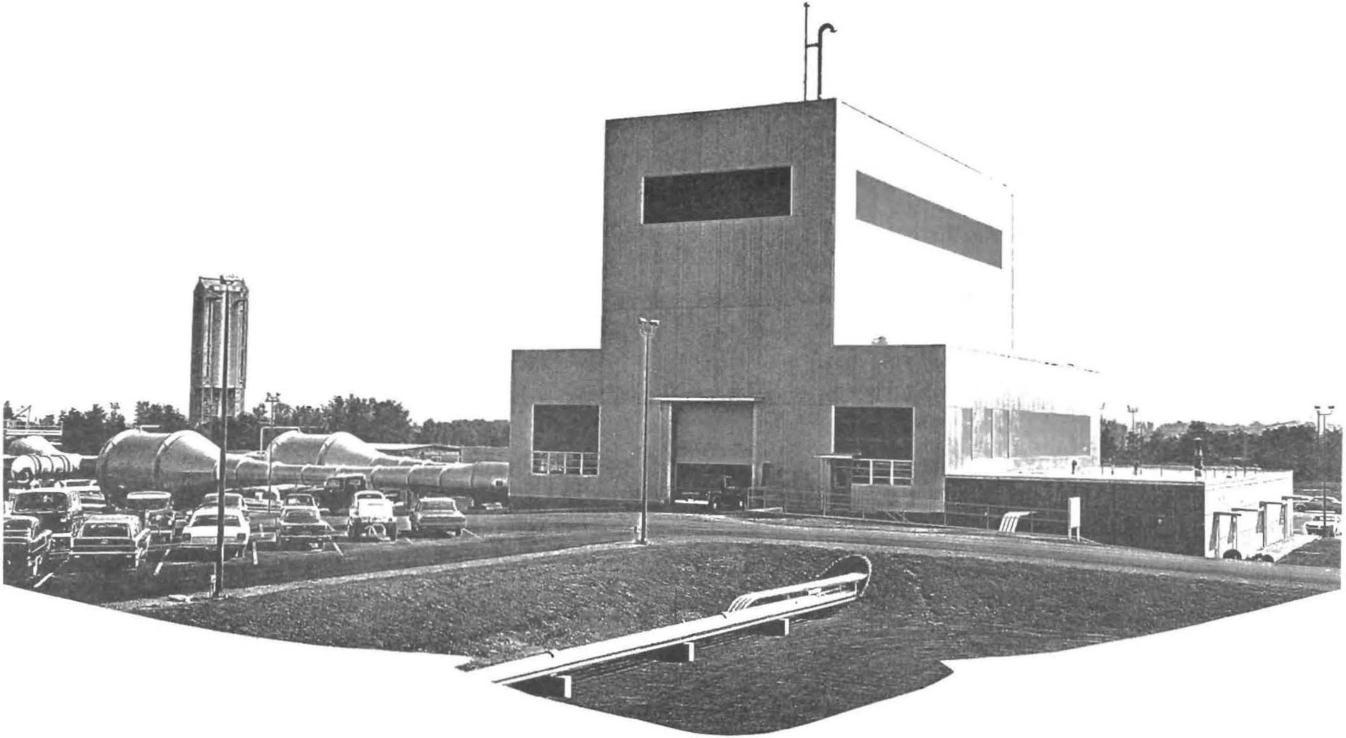
High Energy Rocket Engine Research Facility


FLAMMABLE COMPRESSED GAS

14 HYPERSONIC TUNNEL FACILITY

In this facility, air velocities and temperatures can be created to simulate flight speeds up to seven times the speed of sound, and altitude conditions up to 120,000 feet. The facility's 10′ diameter by 40′ high pebblebed heat exchanger is capable of heating 128 pounds of nitrogen gas per second to 4000 degrees Fahrenheit. A steam ejector system is used to provide the required altitude conditions.

The test chamber is 25′ diameter and 21′ high. The exit diameter of the test section is 42 inches, which means that free-jet testing of ramjet engines up to two feet in diameter is possible.

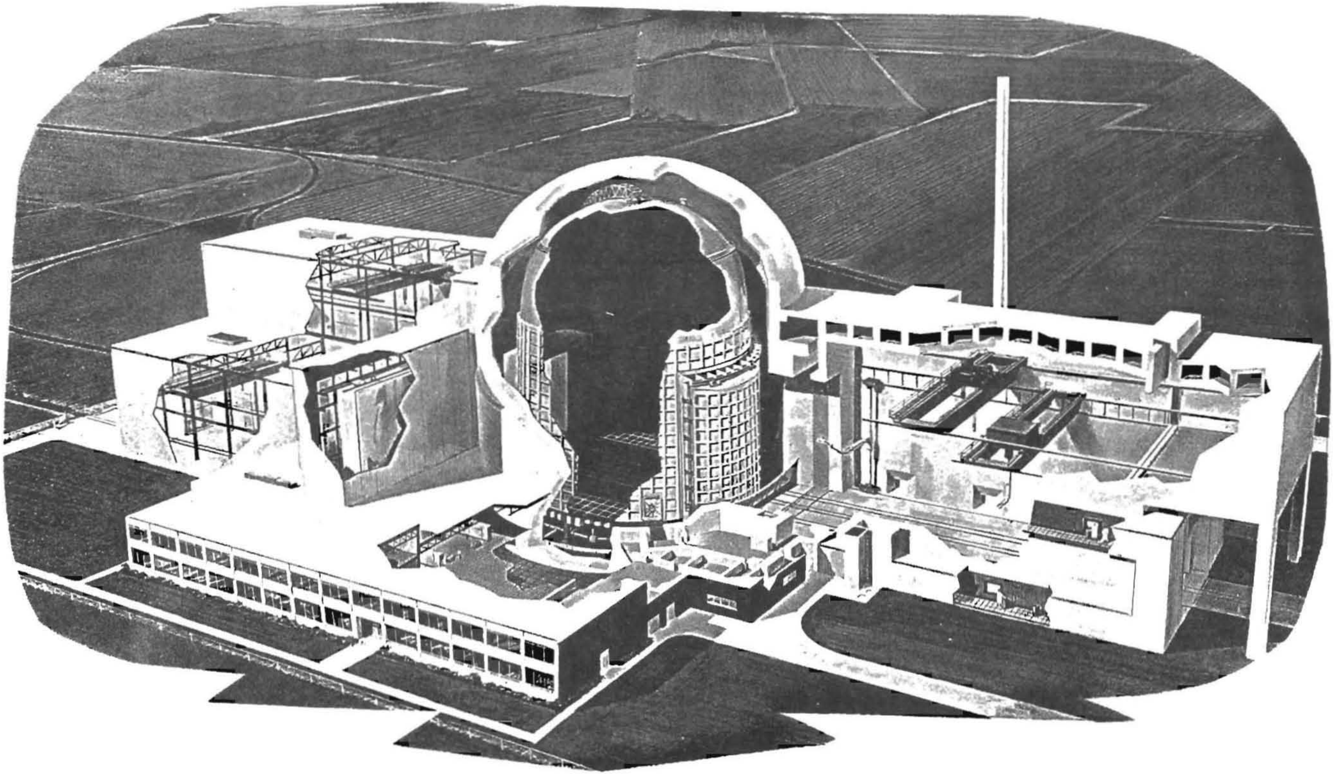


15 SPACECRAFT PROPULSION RESEARCH FACILITY

The primary purpose of this facility is to test space vehicles and upper stage rocket engines in a simulated space environment. The vacuum test chamber can accommodate space vehicles up to 22′ diameter by 50′ long.

Vacuum start-up tests and runs up to 380 seconds with rocket engines using liquid hydrogen and liquid oxygen, Aerozine 50 and nitrogen tetroxide, and other rocket fuels can be run here.

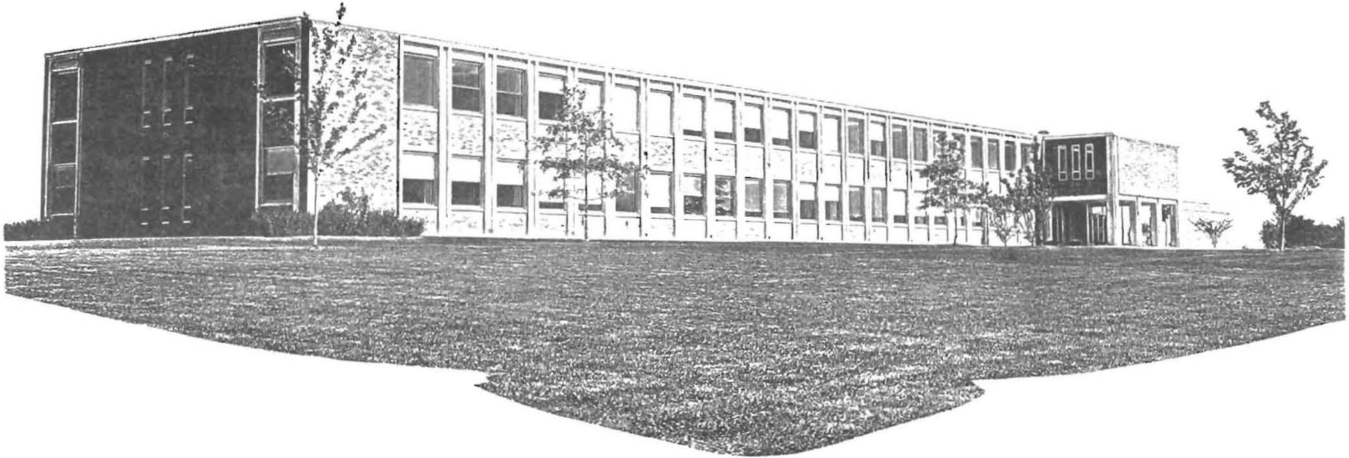
The facility is over 74′ high and extends 176′ below grade. The below-grade spray chamber is 67′ diameter by 119′ and holds 1,750,000 gallons of water. A 2.5 million gallon retention pond is located northeast of the test building. Two three-stage steam ejectors are located in the back of the test building, and an 11′ diameter duct connects them to the spray chamber.



16 SPACE POWER FACILITY

This facility is designed to perform complete integrated systems tests of power generation units and spacecraft. Space devices, including isotopes and reactors, can be subjected to thermal vacuum environment and operated at power levels up to 15 megawatts thermal equivalent. Start-up, performance and confidence tests can be conducted over extended periods of time. The test chamber is designed to have a low neutron activation and a high resistance to corrosion by fluids such as mercury, cesium, etc. Electric propulsion devices can be operated for long periods, if required.

The facility's test chamber is 100 feet in diameter with a height of 122 feet to the top of a hemispherical dome. The inner chamber is constructed of aluminum and the outer concrete shell is 6 feet thick. The test chamber and shops are connected by 50' x 50' doors. Three standard gauge railroad tracks run through the chamber. Vacuum of 10^{-5} torr or lower is obtained by 32 oil diffusion pumps, 48 inches in diameter. Simulated solar heat and cold wall is provided for thermal environment.



17 ENGINEERING BUILDING

The Station Director's Office, personnel from four of the Station's Divisions, and the Station Library are located in the two story section of this building. The one story section houses the Station cafeteria and a multipurpose area which can be used for an assembly area or class rooms.