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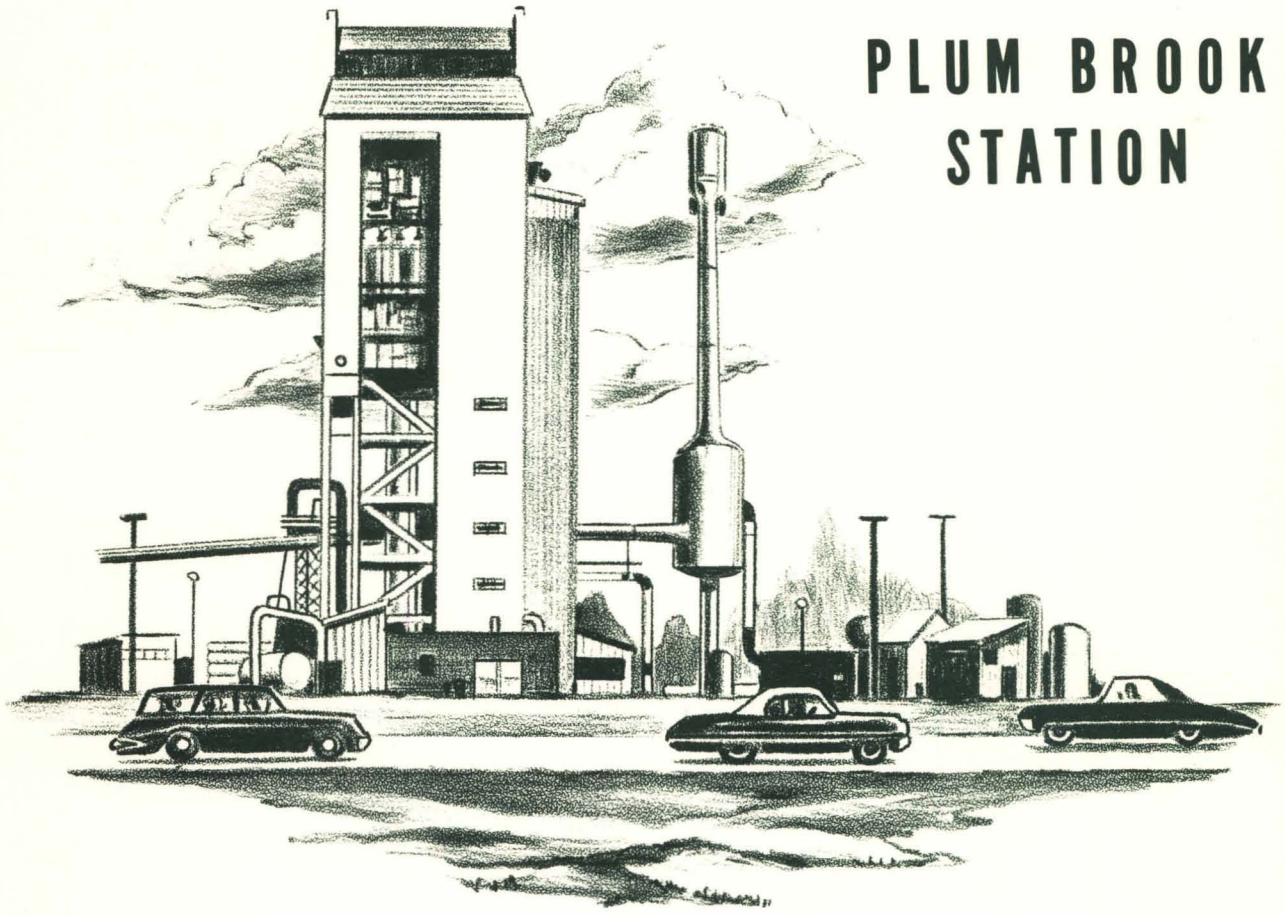
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LEWIS
Research Center

PLUM BROOK STATION



TOUR BROCHURE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER—PLUM BROOK STATION
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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.

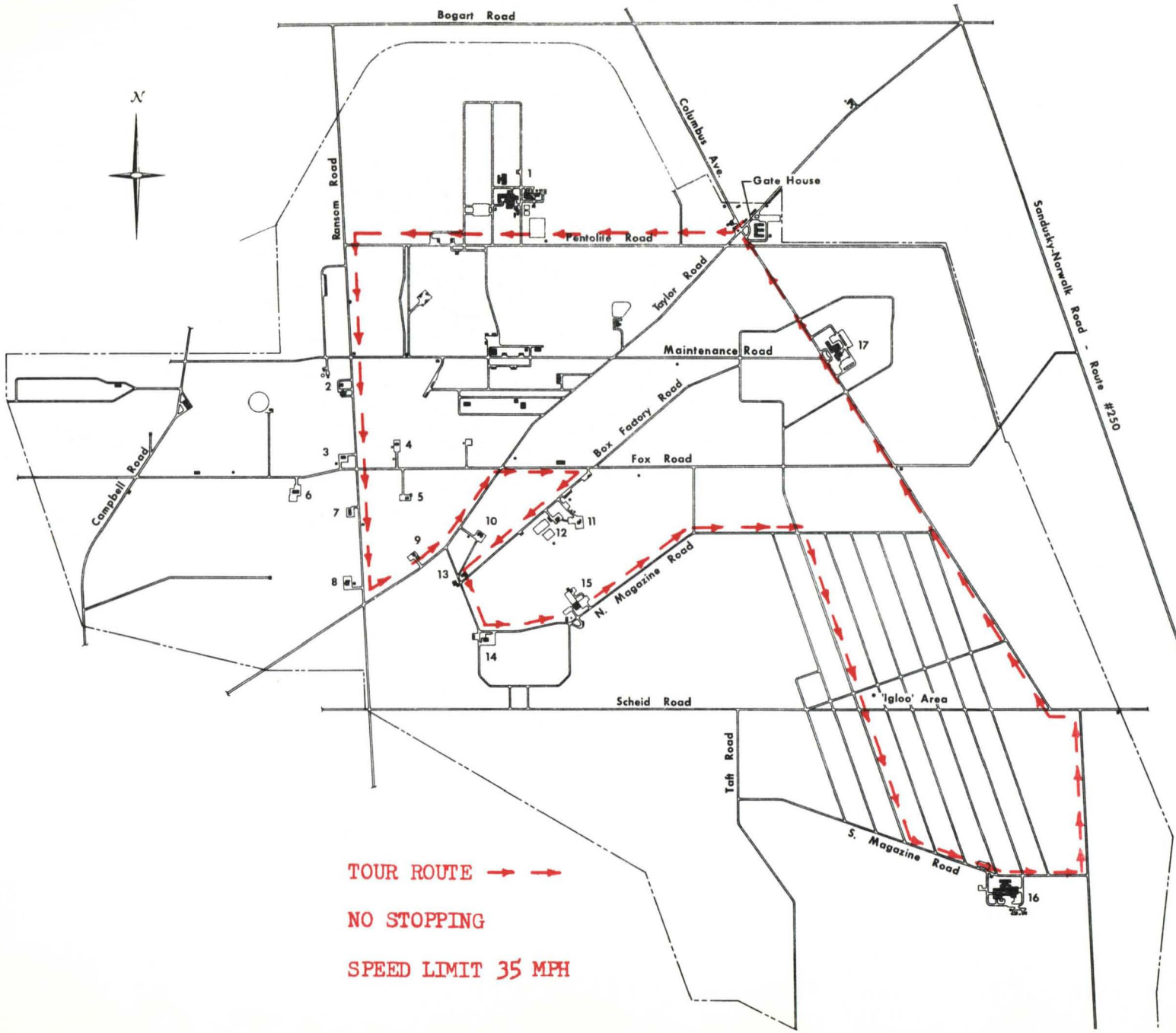
The Plum Brook Staff are among the many thousands of persons working toward these goals.

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

PLUM BROOK STATION - AREA MAP



1 REACTOR FACILITY

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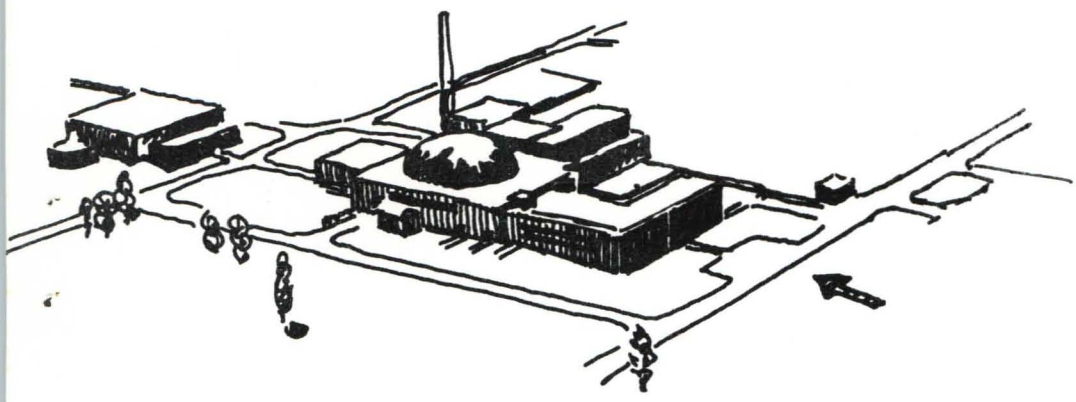
* 'Igloos' - explosive storage structures used during WW II.



REACTOR FACILITY

The $15 million Reactor Facility is used to study materials and components under radiation conditions similar to those anticipated in full-scale space nuclear rocket systems and space power systems.

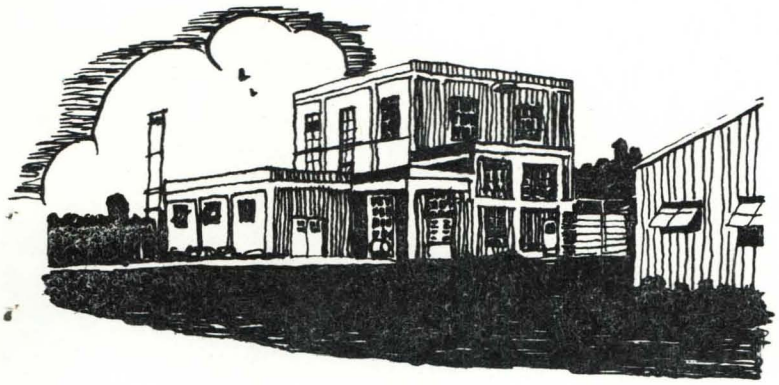
The reactor can develop 60,000 kilowatts of thermal power. Its core is approximately a 30-inch cube and holds 27 fuel elements composed of an enriched uranium-aluminum alloy.

At full power, 10,000,000 X 10,000,000 neutrons are passed through a square centimeter of a test sample's surface every second--or a thermal flux density of 4×10^{14} neutron per square centimeter per second.

During reactor operation, three million gallons of highly purified cooling water are circulated per day through the core and the shielding quadrants around it.

A system of water canals 25 feet deep are used to move radioactive test materials from the reactor to storage areas and to hot laboratories for required testing.

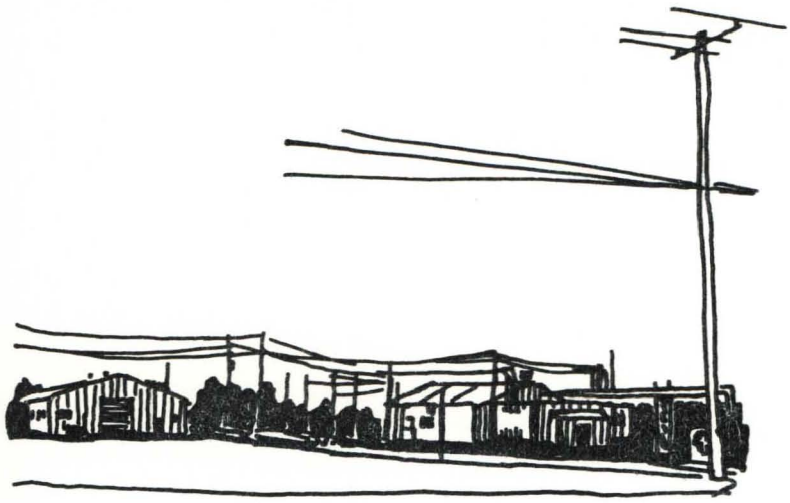
At the present time, many tests are being performed, and resulting data will be used to build nuclear rockets and space power supplies for interplanetary exploration. Some of these tests are made at 400 degrees below zero to simulate space environment temperatures.



2

CRYOGENIC PROPELLANT
TANK SITE

An unused power plant building was renovated to provide space for this research test facility. The power plant equipment was removed and replaced by a 25-foot diameter spherical tank with a 20-foot diameter access door. This tank serves as a research test chamber where liquid hydrogen rocket fuel tanks, up to 18 feet in 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.



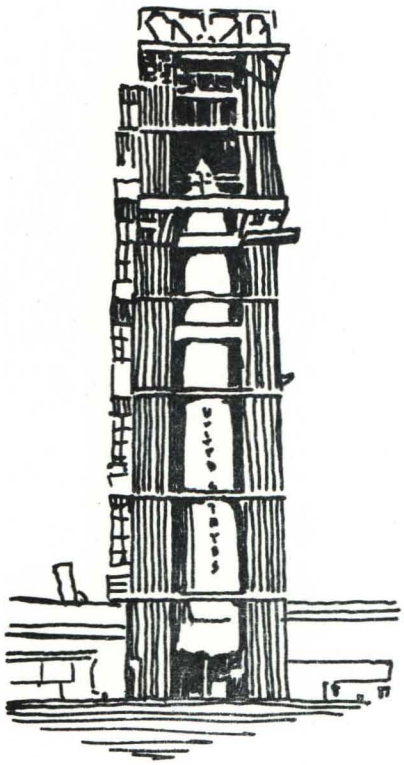
3

TURBINE SITE

Turbines which are used to drive rocket propellant pumps for chemical and nuclear engines can be tested at this test site.

Power is provided by gas generators which operate on hydrogen gas and liquid oxygen.

Turbines developing up to 15,000 horsepower, and speeds up to 60,000 revolutions per minute, can be tested at this site.

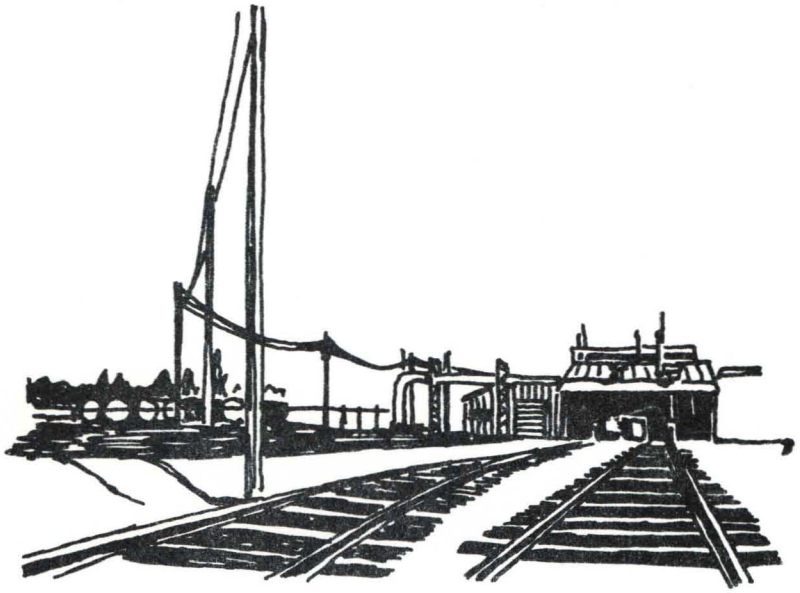


4

DYNAMICS STAND

This 130-foot stand is equipped with electromagnetic shake devices which can simulate forces encountered on lift-off and space missions.

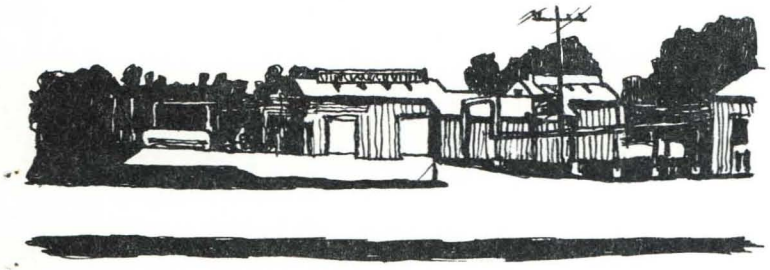
Research tests have been run here on the Atlas-Centaur-Surveyor combination, and information from these tests will help to insure the success of the surveyor project which is to soft-land an instrument package on the moon.



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 can be supplied to the research pump via 6, 10, 13, or 14,000 gallon truck dewars, and also from 34,400 gallon railroad dewars.

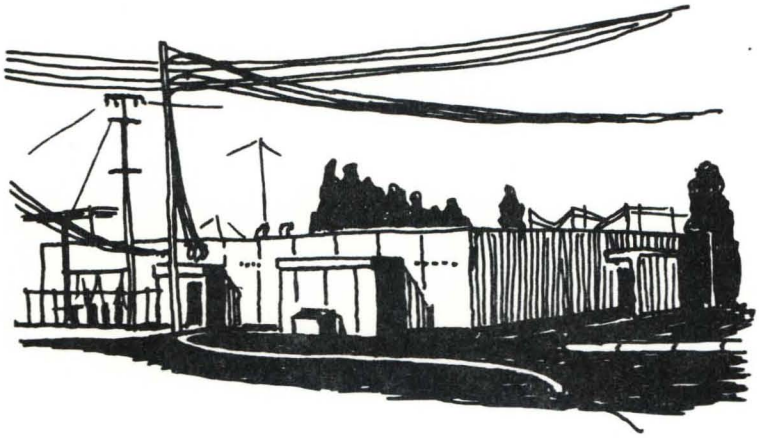
Data from these research programs will be used to design liquid hydrogen pumps for advanced chemical and nuclear rockets.



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.

At the present time, experimental tests are being made with a segment of a water-to-liquid-hydrogen heat exchanger. Data from these tests will aid in the design of a new nuclear rocket engine concept.



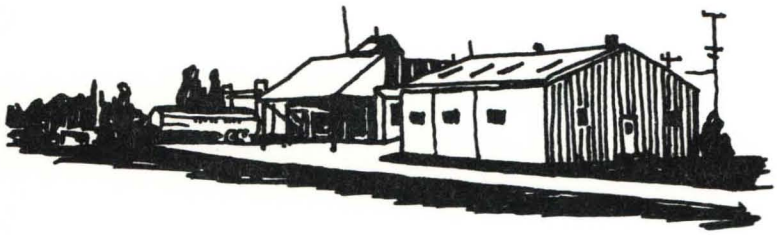
7

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.

Over 13,500 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 have to 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-of-a-mile away.



TURBO PUMP SITE

Research programs on liquid hydrogen turbo pumps and pump inducers are performed at this site.

The turbo pump is connected to portable 6000 gallon liquid hydrogen trailers thru 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.

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.

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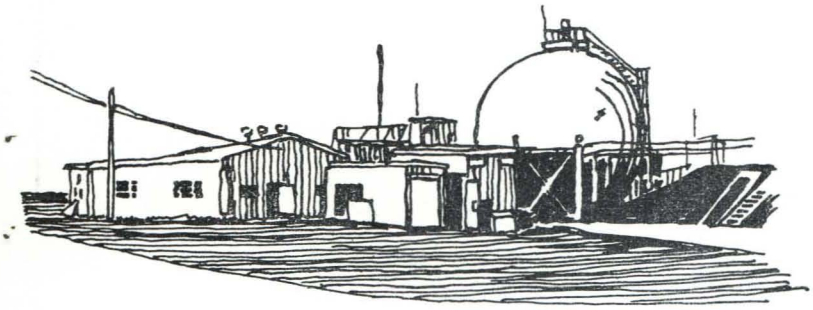
FLUORINE PUMP SITE

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

Because fluorine is the most active oxidizer known, it has great potential in the chemical rocketry field.



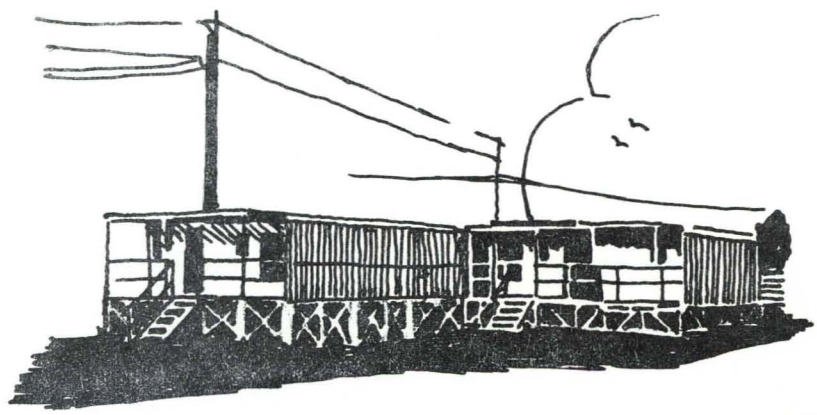
ROCKET SYSTEMS TEST SITES

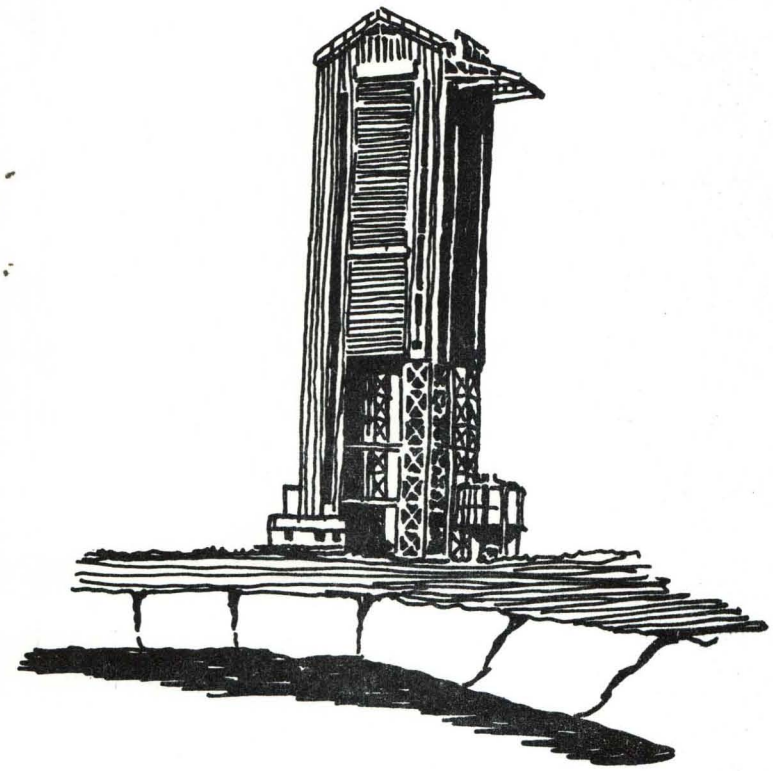
In this area, hydrogen-oxygen rocket engines are fired and data is obtained on heat transfer between the hot gases and the nozzle walls. Also, studies are made on heat transfer from the nozzle wall to the liquid hydrogen used to cool the nozzle. This heat transfer research is being done to support the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

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

The 38-foot 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.

CONTROL AREA

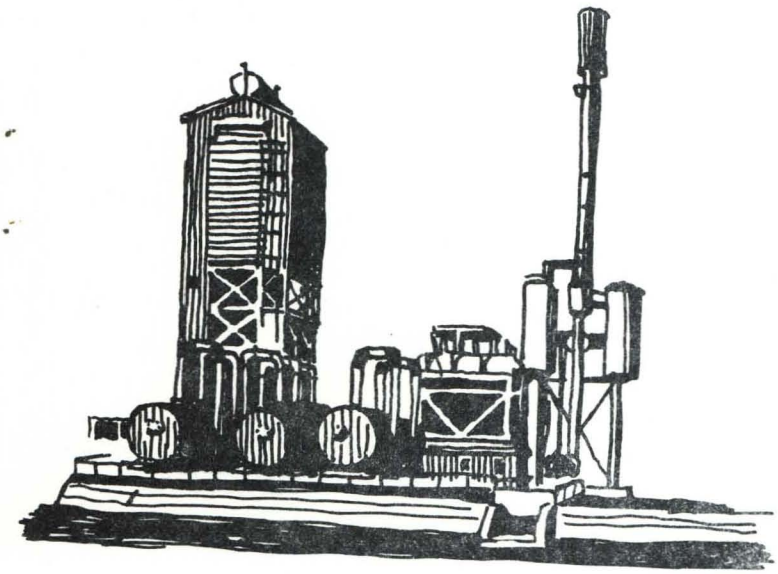




11

NUCLEAR ROCKET DYNAMICS AND CONTROL FACILITY

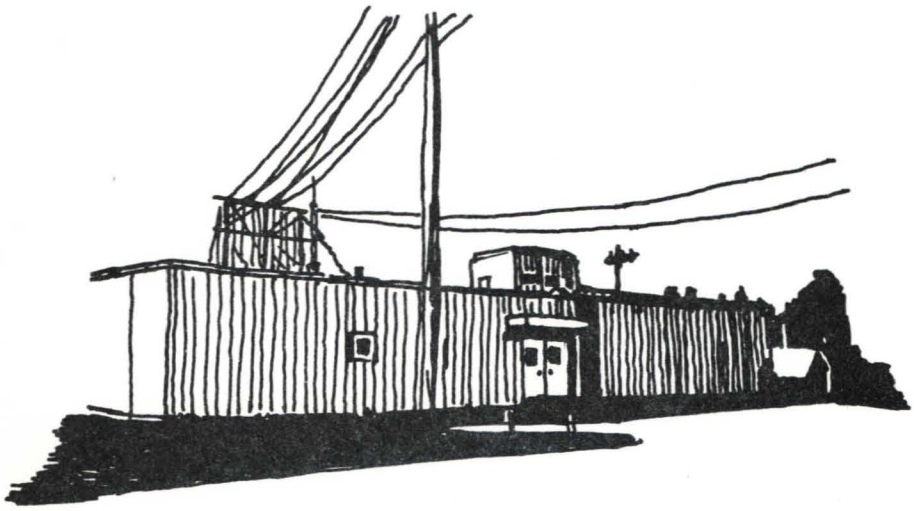
This $3.5 million, 200-foot high, facility is used for non-nuclear altitude tests on various components for large nuclear rocket engines such as will be needed for interplanetary travel. A 46,000 gallon liquid hydrogen run tank is located in the tower, and liquid and high-pressure gas can be supplied by rail car. 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) turbopump. The investigations include turbopump tests, fluid instabilities in the engine flow passages, and equipment performance evaluations. The pipe structure to the right of the facility is a steam ejector which is used to obtain the necessary altitude test condition. This ejector will also be used by two other test facilities in this area.



13

CONTROL AND INSTRUMENT BUILDING

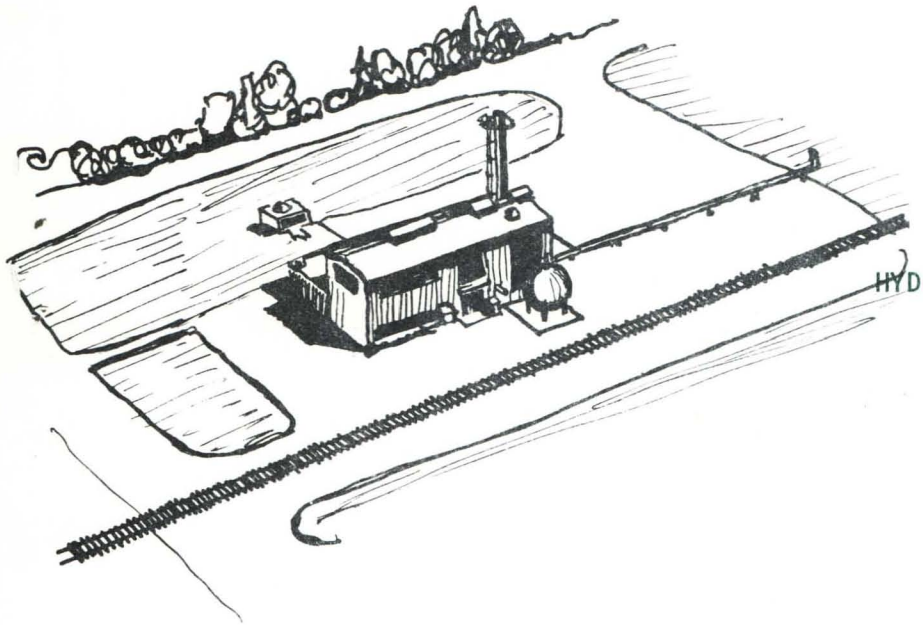
This building is the control and instrument area for four new facilities:

Hydrogen Heat Transfer Facility

Nuclear Rocket Engine Dynamics Facility

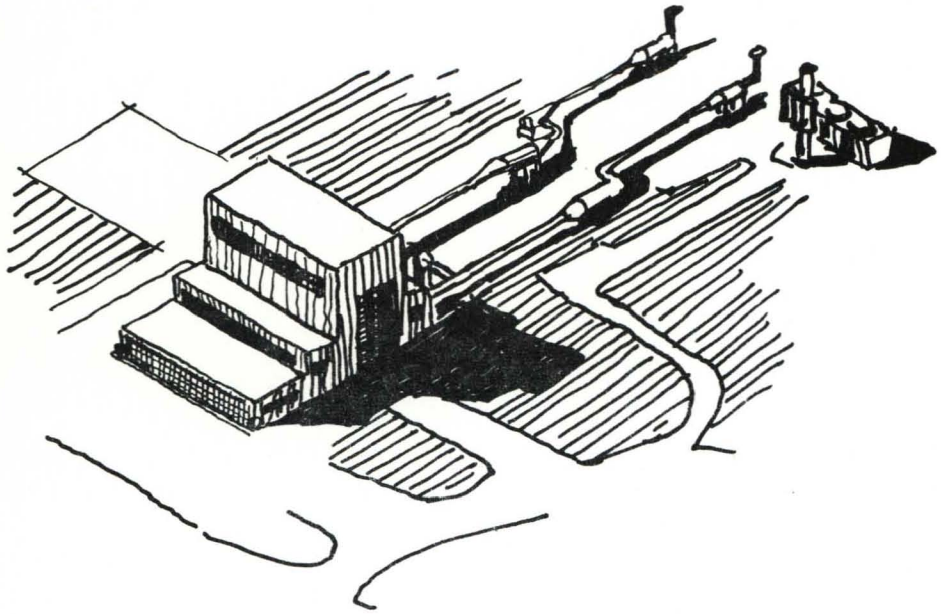
Spacecraft Propulsion Facility

High Energy Rocket Engine Research Facility



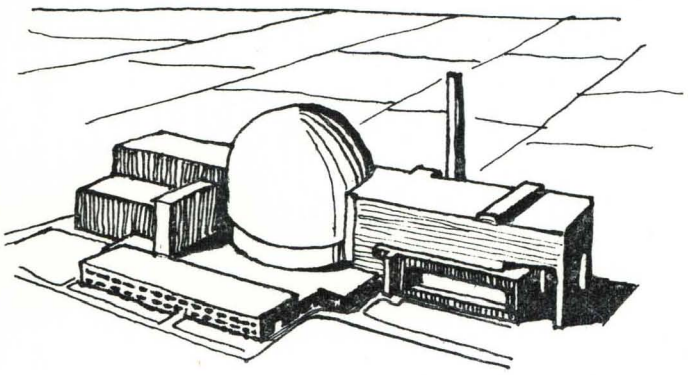
HYDROGEN HEAT TRANSFER FACILITY

This $2.4 million facility provides a test facility where nuclear rocket nozzles and components can be tested. The facility's heat exchanger is able to supply hot hydrogen gas that will simulate the temperatures normally encountered in a nuclear rocket reactor. The heat exchanger's electrical induction-heated core is capable of heating and passing 57,500 standard cubic feet per second of hydrogen gas at 4200°R, with a velocity of 12,000 feet per second. The heat exchanger is 50 feet below ground level and the exhaust stack is 88 feet high. Hydrogen gas will be supplied to this site from 710,000 standard cubic foot, 5000 pounds per square inch, railroad cars. Liquid hydrogen for the research rocket nozzle coolant will be supplied from a 2160 pounds per square inch, 6000 cubic foot dewar.



SPACECRAFT PROPULSION RESEARCH FACILITY

This facility is presently being constructed, and $15 million has been appropriated for its construction. In order to construct this facility, an excavation 73 feet in diameter by 185 feet deep was required. The finished facility will be 70 feet above grade. Space vehicles and upper-stage rocket engines will be tested in a simulated space environment. The vacuum test chamber will be able to accommodate space vehicles up to 22 feet in diameter by 50 feet long. Vacuum startup tests for rocket engines using liquid hydrogen and liquid oxygen, Aerozine 50 and nitrogen tetroxide, and other rocket fuels will be possible. The facility also will have the capacity to test-fire rocket engines for 380 seconds.



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SPACE PROPULSION FACILITY

This $25.7 million facility will be able to test space nuclear power generation systems under simulated space environmental conditions. These conditions include high vacuum thermal environment and the nuclear environment inherent in a nuclear system. Complete spacecraft, rocket stages and components will be evaluated in the facility, over a wide range of operating conditions, from an initial space environment soak to startup and finally, actuation of all systems. Dynamic characteristics, steady-state performance, and reliability of space nuclear power generating systems may be investigated over extended periods of time. Also, large non-nuclear vehicles can be tested in the facility's space environment.

The facility is 280 feet wide by 470 feet long. The inside of the facility's test chamber is a cylinder 100 feet in diameter, and it is 122 feet from the test chamber floor to the top of the hemispherical dome. The inner shell is constructed of aluminum, and the outer shell is constructed of 6-foot thick concrete with a 1/4-inch thick steel membrane embedded in the concrete. The test chamber and shops are connected by 50-foot by 50-foot doors, and railroad tracks run straight through the chamber. The Filter Building exhaust chimney is 246 feet tall, the base diameter is 30 feet, and it tapers to a top diameter of 7-1/2 feet. The facility's 150,000 gallon water tower is 211 feet tall.

ENGINEERING OFFICE BUILDING

The Station Director's Office, personnel from four of the Station's Divisions, and the Station Library will be located in the two-story section of this building. In the one-story section of the building, there will be an assembly and class room, and a cafeteria.