ROCKET ENGINE TEST FACILITY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LEWIS RESEARCH CENTER, CLEVELAND, OHIO

The National Aeronautics and Space Administration (NASA) began construction of the Rocket Engine Test Facility (RETF) in 1955 on land that was formerly part of the Cleveland Municipal Airport. In 1940, the National Advisory Committee on Aeronautics (NACA) selected 200 acres of the airport site for the construction of an Aircraft Engine Research Laboratory. The site of this original lab and the RETF is the present NASA John H. Glenn Research Center at Lewis Field.

The construction of RETF was related to post - war missile development, which required the construction of facilities dedicated to the research and testing of rocket engines and auxiliary equipment. RETF was built between 1955 and 1957 to test rocket engines and to collect the resulting test data. The main rocket engine test stand was located in Building 202, while the control room and data recording equipment were housed in Building 100. Equipment that vaporized and compressed liquid gases and oxidants before they were supplied to the test stand was accommodated in ancillary Buildings 205, 206, and 206A. Photographs taken in 1957 show observers in the Building 100 control room using closed - circuit television to monitor tests. In addition, an observation blockhouse provided a safe location for operators to monitor rocket engine tests during the early years of testing at RETF. In 1972 the installation of a closed - circuit television camera on the roof of the blockhouse reduced the need for observers to eyewitness testing from inside the blockhouse.

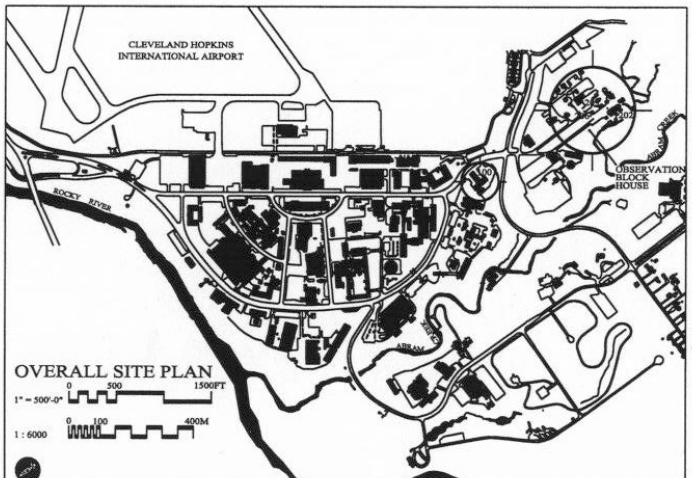
The terrain of the site was suited to its function. Building 202 stands in a remote location, on the east side of a deep ravine adjacent to Abram Creek. Building 100, which houses RETF operations facilities and the control room, was constructed on flat ground 1,600 feet north of the test stands in Building 202.

These tests run in RETF involved the use of hazardous fuels in experimental engine designs, and performance could be unpredictable and dangerous. Test engineers were therefore housed in the protected control room in Building 100, where they could run their rocket engine test at a safe distance. The engineering design information collected at this facility made a significant contribution to developing the technology to use liquid hydrogen as a rocket fuel. The RETF was also instrumental in the development of the Centaur and Saturn rocket engines used in the Apollo space program as well as the engines for the Space Shuttle vehicle.

The testing procedures used at RETF changed regularly to keep pace with the rapid technological advances in the aerospace industry during the facility's active use from 1957 to 1995. Developments in computer technology required frequent upgrades to the control and data acquisition systems used at RETF. Changing technology and the addition of a high-altitude rocket test stand in 1985 required the addition of new control and recording equipment. In addition, the high-altitude test stand was enclosed inside a horizontal chamber that could be evacuated to simulate the vacuum of outer space. Ejectors maintained the vacuum during the test period. Advanced methods for handling cryogenic materials were also incorporated into the test procedures, and in 1991 a test stand was built for the evaluation of cryogenic turbo pump components. RETF personnel designed many of these innovative controls and systems, using technology developed at RETF.

This documentation was initiated on May 15, 2002 in accordance with a Memorandum of Agreement among the Federal Aviation Administration, The National Aeronautics and Space Administration, The Ohio State Historic Preservation Officer, and the Advisory Council on Historic Preservation. These drawings are based on Hardlines Design Company's field inspection, field measurement, and interpretation/integration of personal interviews, historic photographs, and as - built construction drawings retained by NASA Glenn Research Center, Cleveland, Ohio. The drawings were prepared by Stan Popovich, AICP (Planner), Charissa Wang, AIA (Project Architect), Vivian Majtenyi (Architectural Designer), Ira Sudardja (Interior Designer), Feliciano Rahardjo (Intern Architect), Roy A. Hampton III (Architectural Historian), and Amy D. Case (Editor), of Hardlines Design Company, in Columbus, Ohio. Mr. Robert Stewart of Historical Technologies, West Suffield, Connecticut, provided technical assistance and wrote the historical texts.

STATE MAP 1" = 70 mi. 0 35 70MI 1 : 444 0 50 100M



OVERALL SITE PLAN
1" = 500'-0" 0 500 1500FT
1 : 6000 0 100 400M

REGIONAL MAP 1" = 16 mi. 0 8 16MI 1 : 101 0 10 20M

DELINEATED BY: Hardlines Design Company, 2003

NASA ROCKET ENGINE TEST FACILITY RECORDING PROJECT
HISTORIC AMERICAN ENGINEERING RECORD
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

ROCKET ENGINE TEST FACILITY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, LEWIS RESEARCH CENTER
CLEVELAND CUYAHOGA COUNTY OHIO

SHEET 1 of 12

HISTORIC AMERICAN ENGINEERING RECORD OH-124-D

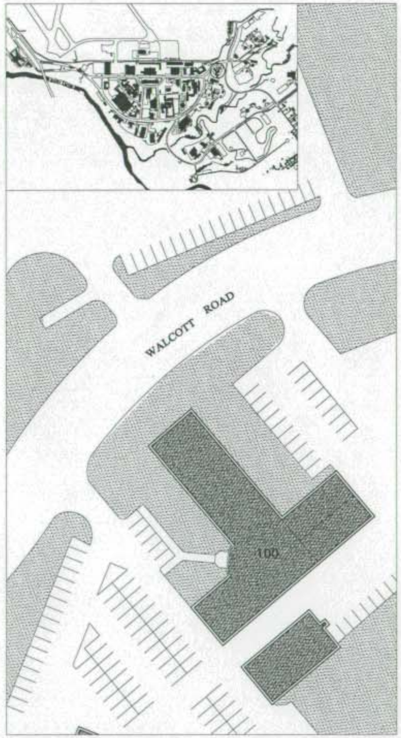
The National Advisory Committee for Aeronautics (NACA) Lewis Flight Propulsion Laboratory began research on liquid rocket propellants shortly after World War II. The small-scale test facilities and laboratory experiments gave engineers and scientists at the research center the necessary experience to develop larger liquid-propelled rockets. Experimental data indicated that a combination of liquid hydrogen and liquid oxygen was the most effective means of powering high-performance upper stage rockets. This conclusion helped justify construction of a full-scale test facility for liquid fuels and oxidizers. The new Rocket Engine Test Facility (RETF) was operational one year after NACA became the National Aeronautics and Space Administration (NASA) in 1958.

The original RETF Building 202 (A) housed a single test cell and rocket exhaust scrubber/ silencer. Gas storage facilities and a shop area adjacent to the stand supported tests, and a large reservoir stored water for the scrubber operation and for fire suppression. Integrated carbon dioxide and water deluge nozzles mounted on the test stand ceiling enabled the emergency fire suppression system in Building 202. Buildings 205, 206, and 206A were located on a nearby hillside and housed pumps, a helium compressor, and a liquid hydrogen pump - vaporizer. An observation blockhouse completed the test stand complex.

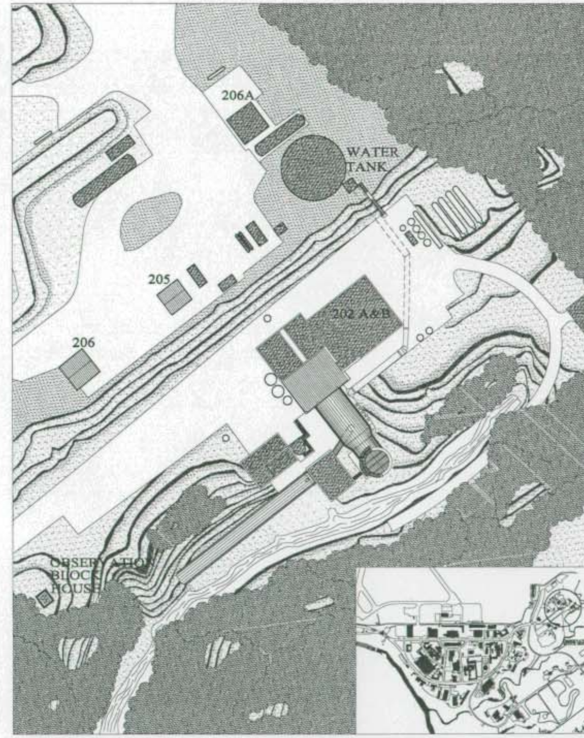
Upgrades to the RETF kept pace with technological development and increased testing capability at the facility. In 1967, a cone and stack were added to the exhaust scrubber/ silencer to accommodate extensive testing of nitrogen tetroxide - hydrazine engines. The additional cone and stack constrained gas flow and guaranteed removal of combustion by - products from the exhaust stream. Building 202 was also expanded to include a larger shop and office area (B). Dramatic developments in computerized control and recording technology from 1960 to 1995 required regular modification of the control room in Building 100. In the late 1970s, programmable logic controllers, or "PLCs" replaced the earlier electro-mechanical devices. The PLCs controlled fuel, oxidant, and ignition sequences according to a predetermined time schedule. Other improvements included the addition in 1972 of new oxygen and fuel tanks to the existing pits. To minimize evaporative loss, the liquid oxygen storage tank and associated piping were enveloped in a liquid nitrogen jacket. Later upgrades involved the replacement of the hydrogen bottle farm with a liquid hydrogen storage facility, and the addition in the early 1980s of liquid oxygen engine cooling capability.

NASA built a new test stand, "Stand B," at the RETF in 1984. This new test stand simulated the vacuum of outer space, and during tests, engines were horizontally mounted on the stand inside a cylindrical chamber. Nitrogen-powered ejectors removed exhaust from the chamber and maintained the vacuum. In 1991 NASA added a freestanding test stand, "Stand C," immediately north of Building 202A. Stand C tested seal materials, liquid oxygen pump designs, and other components. The control and monitoring equipment for Stand C were located in Building 100. The RETF made remarkable contributions to the development of lightweight, regeneratively cooled, hydrogen-fueled engines. This facility was instrumental to the development of engines that powered the upper-stage launch vehicles used in early space exploration.

1" = 40'-0" 0 20 40 80 1:480 0 10 15



BUILDING 100



BUILDING 202, 205, 206 AND OBSERVATION BLOCK HOUSE

EXISTING SITE PLANS CA.2002

DELINEATED BY: Hardlines Design Company, 2003

NASA ROCKET ENGINE TEST FACILITY RECORDING PROJECT

ROCKET ENGINE TEST FACILITY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, LEWIS RESEARCH CENTER

CLEVELAND CUYAHOGA COUNTY OHIO

SHEET 2 of 12

HISTORIC AMERICAN ENGINEERING RECORD OH-124-D

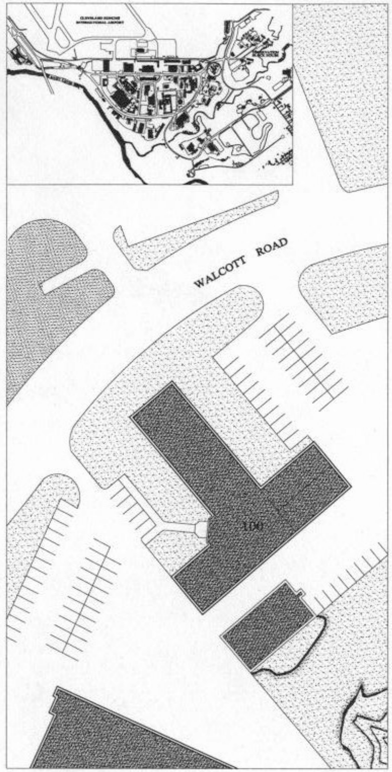
A request authorizing construction of a Rocket Engine Test Facility (RETF) to evaluate high-energy propellants and rocket engine designs was approved in 1952. The facility was designed to allow up to three minutes of operation at a thrust of 89 kilonewtons. RETF was completed in 1957 at a cost of $2.5 million. At that time, it was the largest high-energy rocket engine test facility in the country.

The complex originally consisted of two major components: a control center housed in Building 100, and a test cell in Building 202. Auxiliary components included an observation blockhouse and equipment located in Buildings 205, 206 and 206A that vaporized and compressed liquid fuel and oxidants before pumping them into Building 202 for the test procedure.

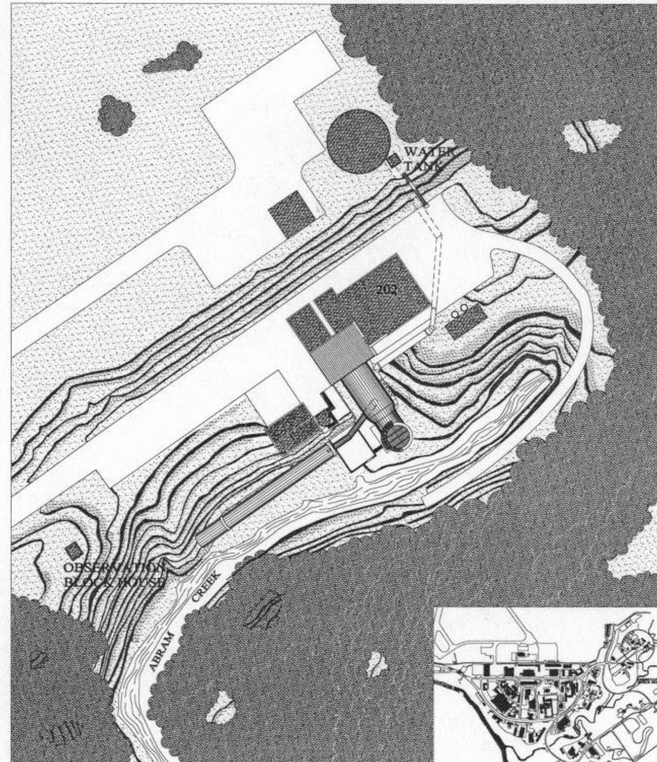
Engineers monitored rocket engines from a control room in Building 100, which is located 1,600 feet north of the rocket engine test cells in Building 202. The engine designs that were tested in Building 202 were experimental, and the test procedure involved the use of hazardous fuels. Performance was therefore unpredictable and potentially volatile. A control room housed in a separate building allowed engineers to monitor rocket engine tests from a protected location. Test controls during the early years of RETF consisted of a combination of manual controls and sequenced electro-mechanical timers. The control room also contained monitoring instrumentation, data acquisition devices, and valve controls. Cut-off switches in the control room and in the test cell allowed the engineer to abort a test in case of emergency. Safety monitoring was also centralized in the control room. Observers in an external blockhouse and in an observation room next to the test cell provided additional information on engine performance. During the early years of operation at RETF, collected test data were prepared for analysis using rules and manual computation. Observers in an external blockhouse and in an observation room next to the test cell provided additional information on engine performance.

Building 202 housed a test cell, a propellant supply system, and a distinctive system for scrubbing exhaust gases to remove the waste products produced by combustion. In addition, the scrubbing system muted the noise of rocket firing. Engines could be assembled in a small shop adjacent to the test cell. Also adjoining the test cell was a tank farm of high-pressure helium bottles. Storage areas for some fuels, liquid oxygen, and water for the scrubber was also supplied by the gravity feed system from a 500,000-gallon tank.

This facility was instrumental in developing the technology for using liquid hydrogen as a rocket fuel. Research and testing completed at RETF contributed to the successful development of the Centaur rocket and upper stages of the Saturn V.



BUILDING 100



BUILDING 202, 205, 206 AND OBSERVATION BLOCKHOUSE

1" = 40'-0" 0 20 40 80FT

1:480 0 10 15M

NORTH

HISTORIC SITE PLANS CA. 1957

DELINEATED BY: Hardlines Design Company, 2003

NASA ROCKET ENGINE TEST FACILITY RECORDING PROJECT

ROCKET ENGINE TEST FACILITY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, LEWIS RESEARCH CENTER

CLEVELAND CUYAHOGA COUNTY OHIO

SHEET 3 of 12

HISTORIC AMERICAN ENGINEERING RECORD

OH-124-D