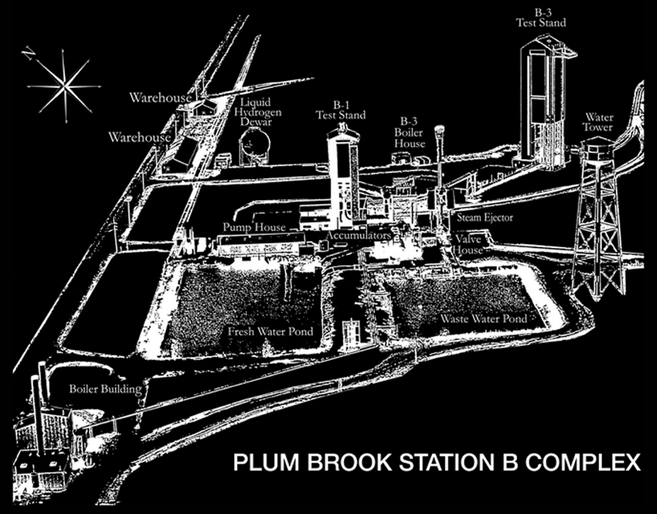
National Aeronautics and Space Administration

NASA Glenn Research Center—B–1 and B–3 Test Stands

View of the B–1 (left) and B–3 test stands near the center of Plum Brook Station off Box Factory Road near its intersection with Fox Road. The stands were designed to test liquid-hydrogen propellant flow systems in simulated altitude conditions.



PLUM BROOK STATION B COMPLEX

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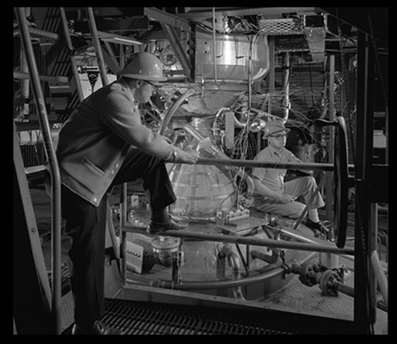
B–1

The High Energy Rocket Engine Research Facility (B–1), which became operational in 1964, could be used to test engines up to 6000 pounds thrust for 6 minutes. A nearby steam plant supplied the steam for the facility's ejector, which produced the simulated altitude conditions for the facility. B–1 included cryogenic run tanks, exhaust gas scrubbers, and large gaseous and cryogenic storage trailers. The facility was tied into Plum Brook Station's data acquisition system and central control building.

The B–1 test stand, also referred to as the NERVA Stand, was used for extensive study of the Nuclear Engine for Rocket Vehicle Application (NERVA) propellant feed system in the mid-1960s. The tests demonstrated that the reactor could be restarted without any external input. The ability to restart the engine was crucial to envisioned long-duration space missions.

Advanced Centaur tests in 1968 and 1969 led to a redesign of the tank insulation that was eventually the standard used on the Centaur D second-stage rocket. The Centaur D was used on over 65 successful launches between 1966 and 1989. The B–1 tests were also an important early step in the eventual elimination of the boost pumps from the Centaur feed system. B–1 was last used in 1969 and was mothballed in 1973 with the closure of Plum Brook Station. The facility was demolished in 2010.

A Kiwi-B nuclear engine is hoisted up into the 135-foot-tall B–1 test stand. The engine was installed on the main test area at the 68-foot level. The propellant tank and turbopump were above, and the nozzle ejected into the exhaust system below.



A researcher examines the instrumentation on the NERVA nuclear engine in the B–1 test stand. B–1 was used to study the operation of the engine's turbopumps, fluid instability in the engine's flow passages, and equipment performance.

The B–1 control room inside the B Control and Data Building. Operators conducted the B–1 tests remotely because of the inherent danger of working with large quantities of liquid hydrogen. The B Control and Data Building was approximately 2300 feet southwest of the test stand.

The B–1 test stand with its steam accumulators to the left, the Valve House near its base, and the steam ejector to the right. The equipment worked in conjunction with the Boiler House to create a vacuum in the B–1 exhaust system to simulate altitude during the tests.

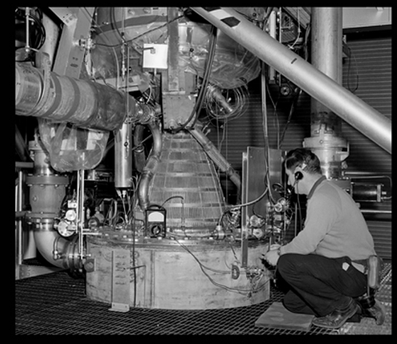
B–3

The Nuclear Rocket Dynamics and Control Facility (B–3), which was initially operated in 1966, was used to study tanking and flow systems for complete rocket systems. The rocket's combustion chamber was pressurized to simulate an actual launch, but the engines were not fired. Researchers could study the effect of combustion chamber pressure on flow dynamics. B–3 had its own gas and cryogenic supply systems, including a 200,000-gallon liquid-hydrogen system. It used B–1's steam system and ejector to simulate altitude conditions and was tied into Plum Brook Station's data acquisition system and central control building.

The B–3 NERVA tests in 1966 and 1967 established the proper startup procedure, which included liquid-hydrogen flow rates, power-cycle time delay, and the powering of the turbine. The use of a realistic feed system helped define the turbopump's overall system performance and mechanical characteristics. B–3 conducted a number of tests in the early 1970s that led to the first Titan-Centaur launch and the Viking mission to Mars. Unlike previous B–1 or B–3 studies, these focused on the protective shroud, not the turbopumps.

B–3 was mothballed in 1974, immediately after its last tests were completed. Plum Brook reopened in the 1980s, but neither B–1 nor B–3 were ever restored. Both were demolished in 2010.

Half of the Centaur Standard Shroud is lifted into the 210-foot-tall B–3 test stand. Unlatch tests verified that the shroud would jettison in a cold space environment, structural load tests determined the structural integrity of the shroud in a cold environment, and insulation tests led to a redesign of the insulation system.



An engineer studies the setup of the NERVA Kiwi-B nuclear engine in B–3. The engine's reactor was unfueled for all the NERVA tests, but the propellant feed system was tested using liquid hydrogen and liquid nitrogen. The test area began at the 74-foot level and extended to the crane bottom at 176 feet.

Researchers monitor the B–3 test stand remotely from the B–3 control room in the B Control and Data Building. The building originally contained just the B–1 control room, but it was expanded in the early 1960s to incorporate control rooms for B–3 and other new facilities.

A 200,000-gallon liquid-hydrogen dewar was used to supply the B–3 test stand. When B–3 began operating in 1965, the 37-foot-diameter, 26,800-cubic-foot tank was the largest known liquid-hydrogen tank in the world. It was twice as large as the tank used for the NERVA tests at Los Alamos, New Mexico.

PS-002143-0810