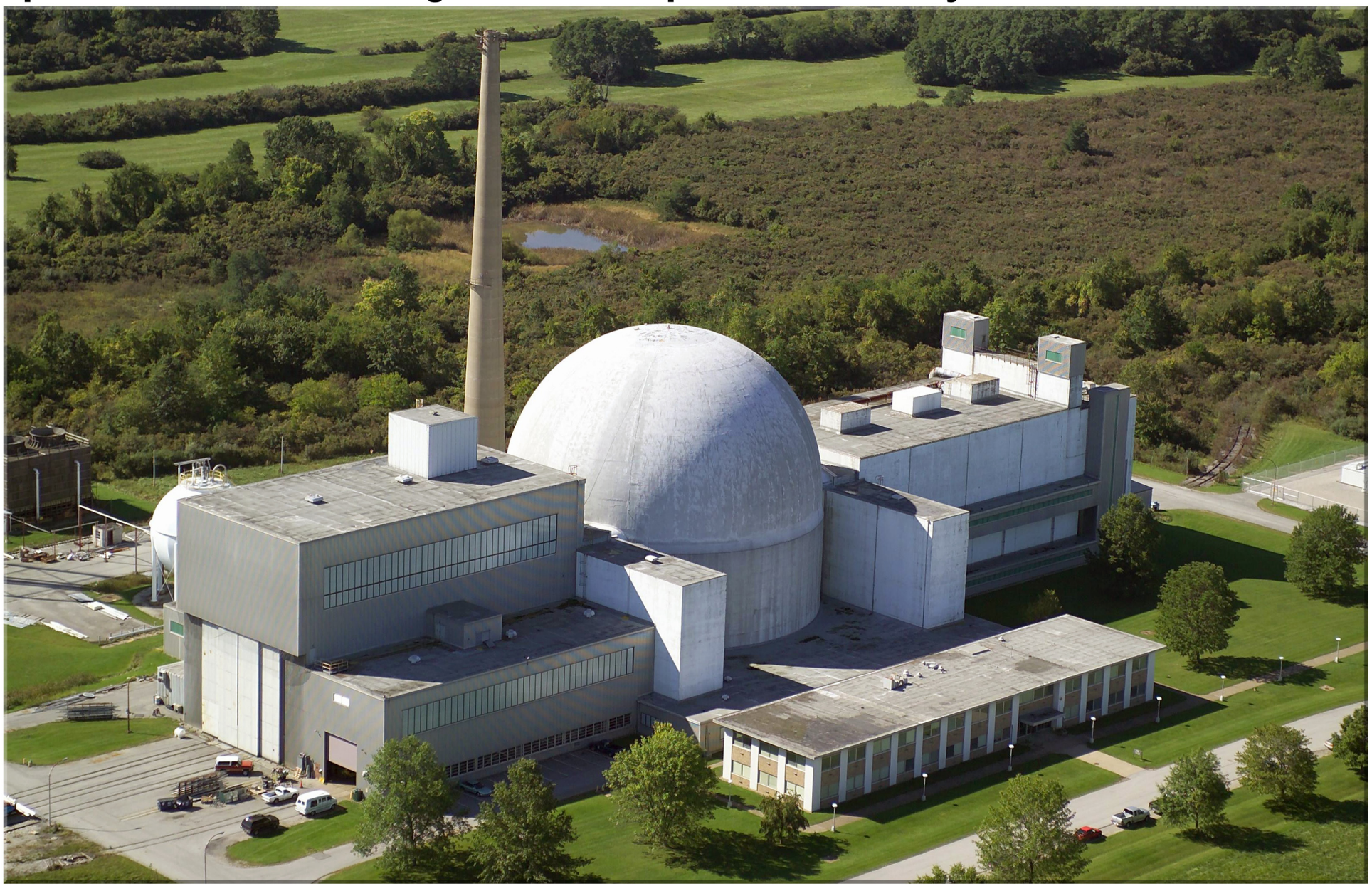
Space Environmental Testing at the NASA Space Power Facility



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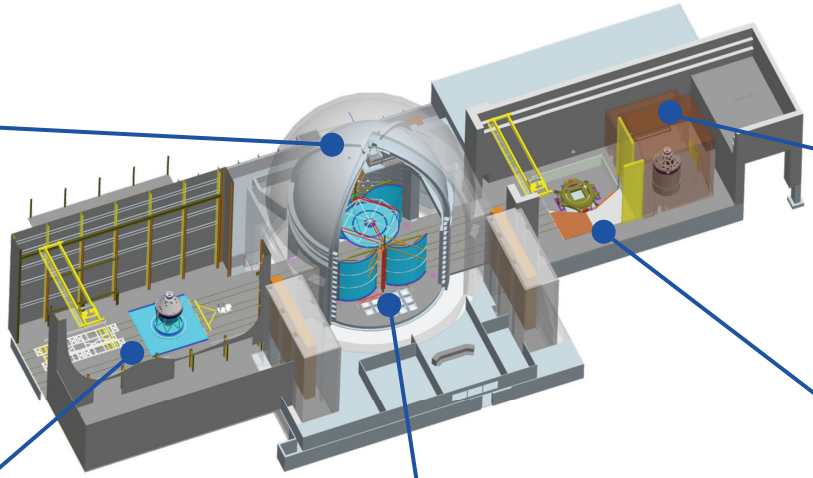
The NASA Glenn Research Center operates the 6,400-acre Plum Brook Station near Sandusky, Ohio. Plum Brook Station is home to the Space Power Facility (SPF), which currently houses the world's largest Space Environment Simulation Chamber (measuring 100 ft in diameter by 122 ft high). Recent facility enhancements have made the SPF home to one of the largest and most powerful reverberant acoustic chambers and the highest capacity mechanical vibration test facility.

Within the vacuum chamber, it is possible to perform development and flight qualification testing of full-scale space-flight systems in vacuum and temperature environments ranging from low Earth orbit to deep space to planetary surface conditions. The chamber's wide-ranging capabilities have been extensively used to test launch vehicle payload fairings; orbital hardware, including International Space Station systems; and planetary landing systems like the Mars Pathfinder and the Mars Exploration rovers' airbag systems. The chamber is positioned between two attached high bays for processing space-flight hardware. A standard-gauge rail system running throughout the facility permits internal transport of hardware between the vacuum chamber and the two high bays.

The Vibroacoustic Highbay, connected to the west side of the vacuum chamber, houses the Reverberant Acoustic Test Facility (RATF) and the Mechanical Vibration Facility (MVF). The vacuum chamber can be configured to perform reverberant-mode electromagnetic interference/electromagnetic compatibility (EMI/EMC) testing in addition to thermal vacuum testing. The SPF serves as a primary, single location for spacecraft environment tests. This "one-stop-shop" capability reduces risk by eliminating the need to transport a vehicle to multiple locations to complete the testing required to qualify it for human space flight.

The vibroacoustic facilities simulate conditions experienced during launch and ascent. Thermal vacuum testing will simulate the extreme temperature environments experienced in orbit. Electromagnetic environmental effects (E^3) testing will ensure that a spacecraft's electrical system operates properly when exposed to expected levels of EMI throughout the entire mission cycle, including prelaunch, ascent, on-orbit, and recovery operations.



Electromagnetic Environmental Effects

E^3 testing can take place in ambient temperature and pressure conditions inside the Space Environment Simulation Chamber. The aluminum chamber provides the radio-frequency shielding necessary to screen out interfering signals from local broadcasters, creating an "electromagnetically quiet" environment for high-sensitivity E^3 testing of spacecraft. At the same time, the chamber walls prevent high-power test signals from leaving the test facility.

Reverberant Acoustic Test Facility

The RATF simulates launch and ascent acoustic environments on a spacecraft. The 101,189-cubic-foot steel-reinforced-concrete chamber has 36 acoustic modulators to produce highly tailored acoustic spectrums on large spacecraft. It is one the most powerful chambers in the world, reaching an empty-chamber overall sound pressure level of 163 dB.

Mechanical Vibration Facility

The MVF exposes the spacecraft to a swept sinusoidal vibration (5 to 150 Hz). An 18-ft-diameter test table is driven by a series of 16 vertically mounted servo-hydraulic actuators and four horizontally mounted actuators to perform testing in three axes without having to reposition the test article.

Space Environment Simulation Chamber

Thermal vacuum testing is performed in the world's largest vacuum chamber. The vacuum chamber is an aluminum-plate vessel inside a concrete enclosure that can sustain a high-vacuum (10^{-6} torr) via roughing, turbomolecular, and cryogenic vacuum pumps. SPF can simulate background space temperatures ranging from –250° to +150 °F with a variable-geometry shroud. Solar heating can be simulated with an infrared heat flux system. The aluminum and concrete doors of the test chamber are 50 by 50 ft and have double o-ring seals to prevent leakage. The chamber floor is designed for distributed loads up to 300 tons, and the chamber has an overhead polar crane with a variable-radius trolley, 20-ton capacity main hoist, and a fixed-radius 10-ton auxiliary hoist.

Assembly Highbay

In the Assembly Highbay, test articles are received and off-loaded from shipping containers and prepared for environmental testing. The facility includes several cranes, a standard-gauge rail track system, and tow tractor to assist in moving test articles to each testing area.

Facility Data Acquisition System

The vibroacoustic facilities include a 1,024-channel digital data acquisition system capable of acquiring data at 256 KB/sec. The system can acquire data from strain gauge, microphone, force, acceleration, and displacement instruments.