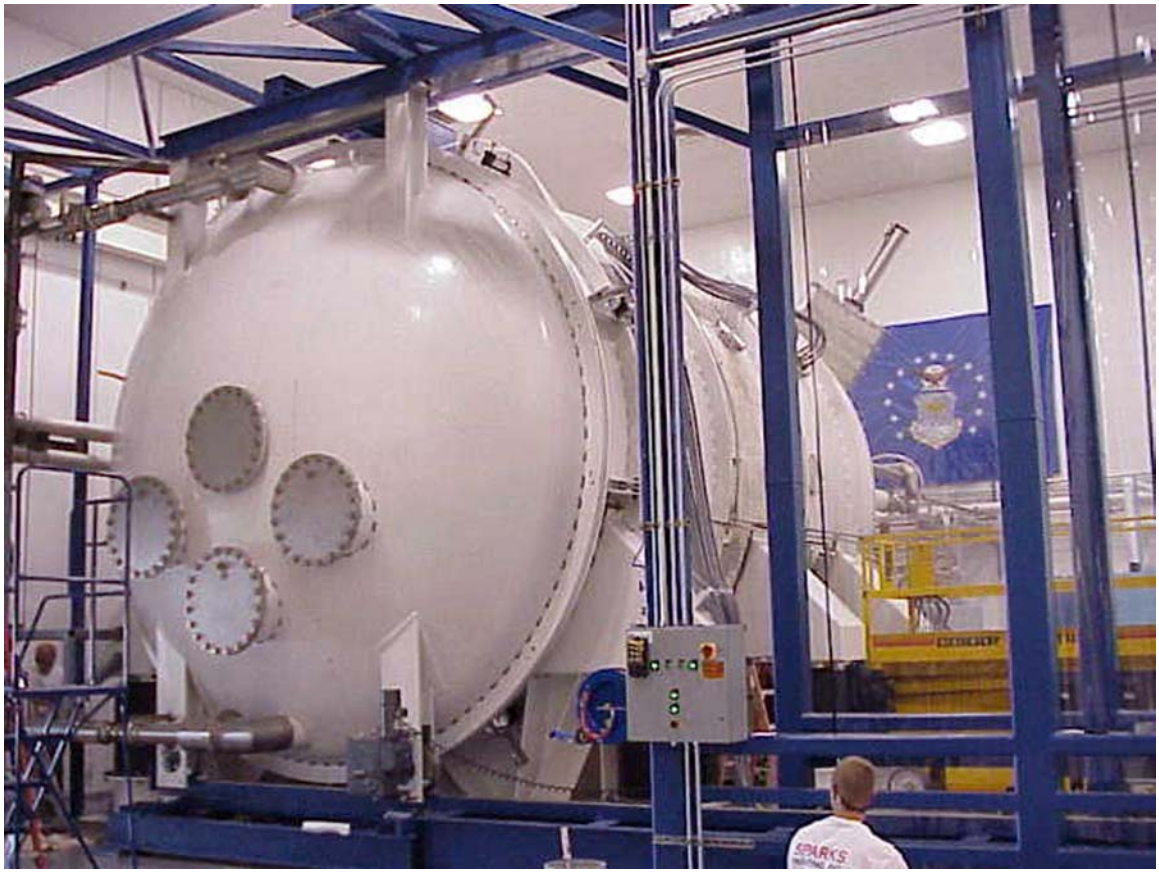
Vibration Isolation for Vacuum Chamber Applications

When performing testing of large spacecraft or hardware that will be launched into orbit, it is necessary to conduct testing in a space-simulated environment. To achieve this, a vacuum chamber or thermal vacuum chamber is used, which creates an environment to simulate the pressure and thermal effects of launch or space travel.

Additionally, it is necessary to decouple the spacecraft/payload from the chamber using vibration isolators to attenuate environmental vibration from the testing. In some cases where feasible, the entire chamber with payload is decoupled from the test facility.

In the cases where the chamber and payload are isolated together, the isolation system is installed to support and lift the chamber externally, or the chamber may be anchored to ground and a dynamically rigid platform or structure is isolated beneath it. The platform then connects to the chamber using feedthroughs or support points, which penetrate the chamber using vacuum compatible seals. The payload/object under test inside the chamber is supported on these feedthroughs, providing vibration isolation for the payload.

An example of an isolation system, which supports the entire vacuum chamber and test payload, is show below. This vacuum chamber is 16.5' in diameter and over 25' long. The total supported weight is 127,000 lbs with test payload.

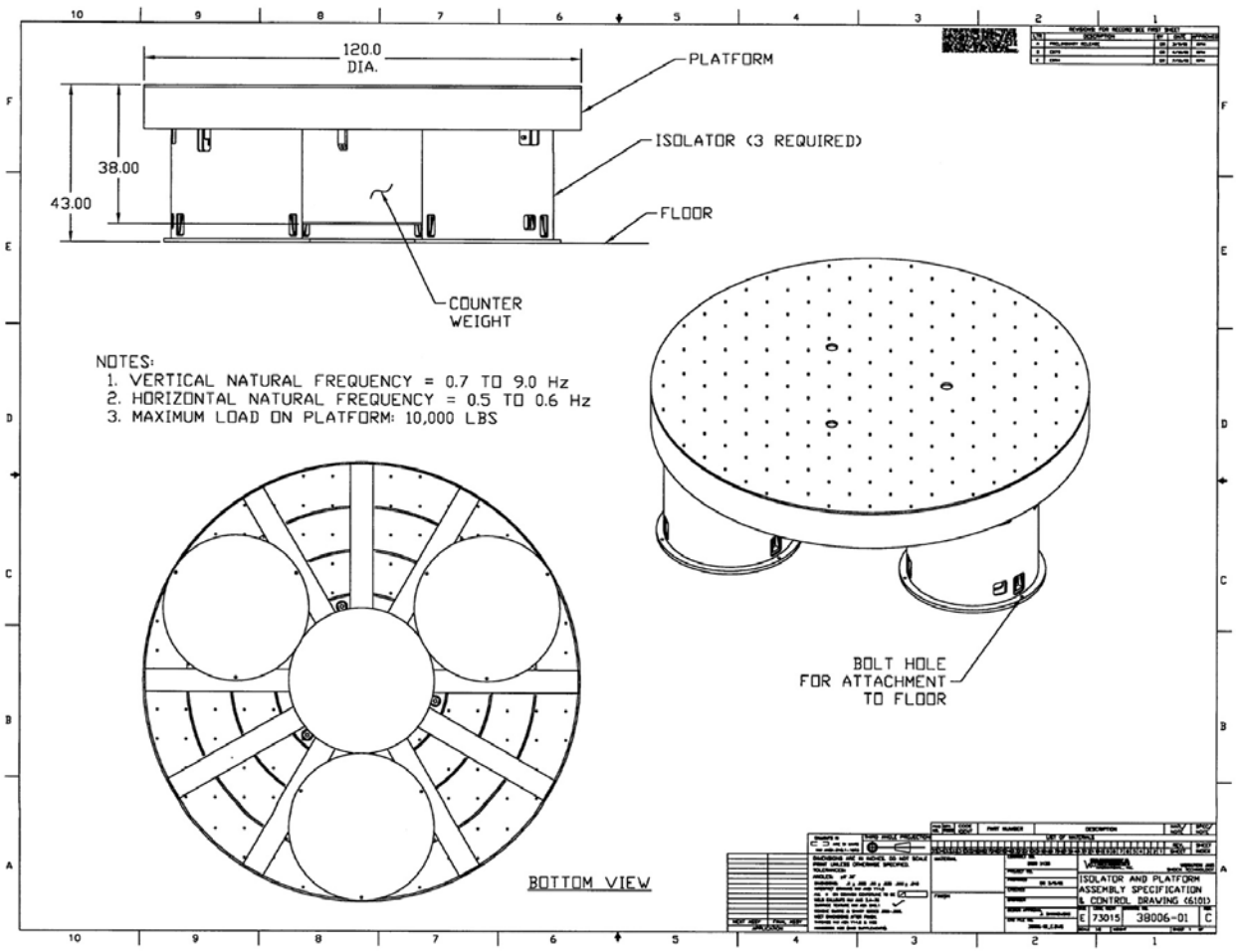


The chamber is supported and isolated using six pneumatic isolators (PAL 255-36P). Each isolator can support a maximum weight of 25,500 lbs and is designed to meet Zone 4 seismic inputs. In the event of seismic activity (earthquake), the isolators will continue to isolate the chamber with payload so that they will not be damaged. A seismic analysis and restraints were required as part of this program.

Each isolator has a vertical natural frequency of 0.9 Hz – 1.0 Hz and a horizontal natural frequency of 0.6 – 0.7 Hz using tuned pendulums. The isolators are self-leveling using servo valves to maintain the chamber's position, and since the chamber is installed in a Class 1000 cleanroom, the servo valves and gas connections are plumbed to exhaust outside the room to prevent contamination.

In cases where the size of the chamber, or the existing chamber, does not allow for "external" isolators, the test payload must be isolated inside the chamber. To achieve this, a vacuum compatible isolation system is used. When isolators are used inside a vacuum chamber, they must meet strict material specifications to limit outgassing and be constructed to meet particulate and molecular cleanliness requirements as well. Additionally, in thermo-vacuum applications, the isolators may be required to operate in temperature extremes where heater blankets are necessary to keep the isolators at an operable temperature.

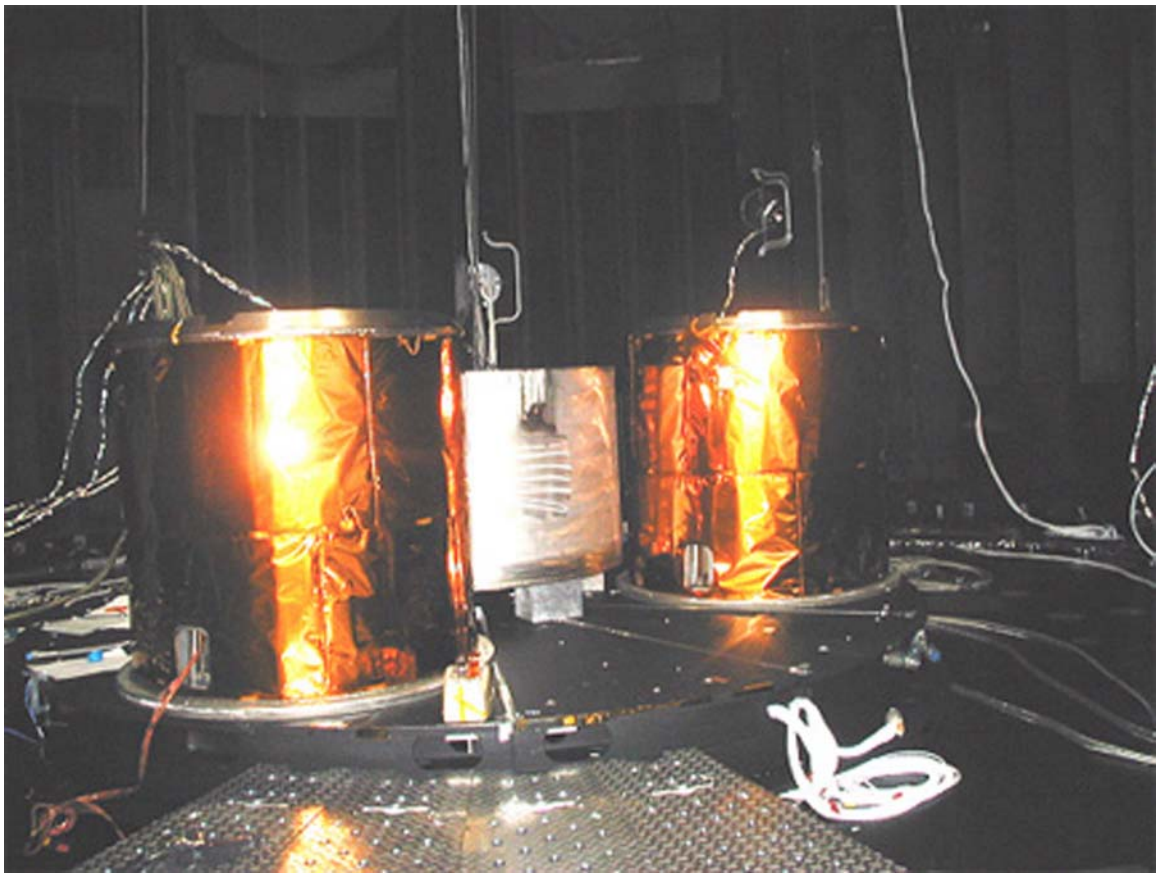
A few examples of vacuum compatible isolation systems are shown on the following pages.



In this case, three pneumatic isolators support a dynamically rigid platform on which spacecraft will be attached. The isolators and platform are installed inside a large vacuum chamber.

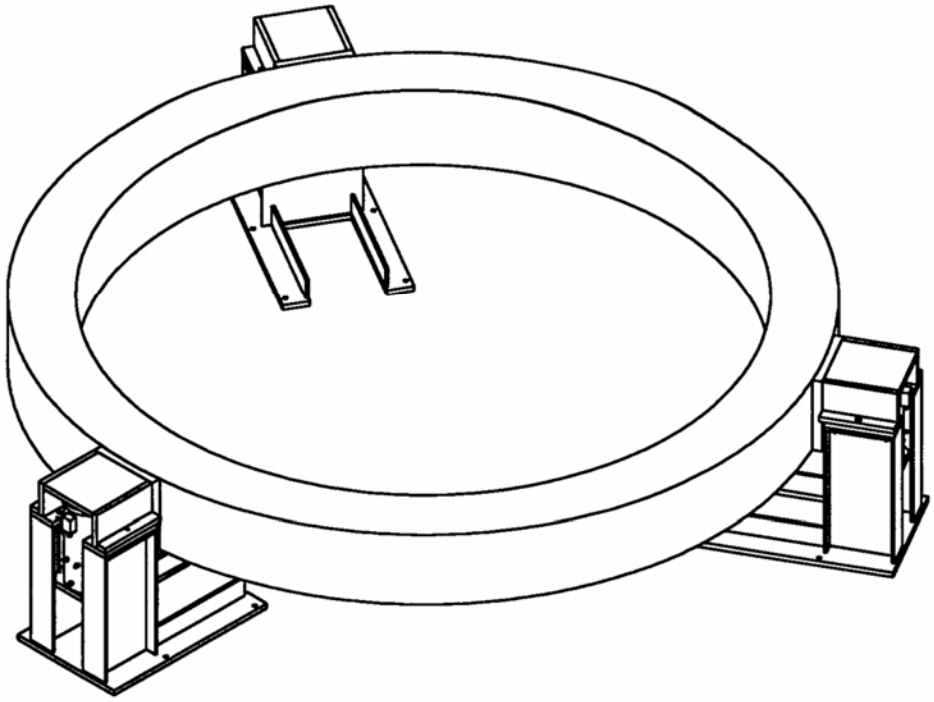
Each isolator (shown at left) is capable of supporting 13,300 lbs and has a vertical natural frequency of 1.0 Hz and a horizontal natural frequency of 0.45 Hz. The pneumatic isolators are made of vacuum compatible materials and can operate in a 1 x 10^{-6} Torr environment. All gas connections are pumped outside the chamber under vacuum.

The three-isolator system (below) must also operate in an extreme temperature environment (-180°C to 100°C). Heater blankets and thermo couples are attached to the isolators to maintain a constant operating temperature.



For this program, three vacuum compatible isolators are used to support and isolate a structural ring which will in turn support a test payload. The isolation system has a 17,000 lb capacity and natural frequency of 1.3 Hz vertical and 1.0 Hz horizontal.

The isolators are designed to operate in a $1x10^{-6}$ Torr environment using low outgassing materials.



In the unique application shown below, the isolators are attached to a frame, which rolls on rails into the vacuum chamber. The test payload is attached to a second frame, which rests on the rail frame below it.

When activated, the isolation system lifts the upper frame (with payload) off the lower frame decoupling the test hardware from the chamber.

Each pneumatic isolator includes tubing and fittings, which do not outgas or leak when under vacuum. The isolation system has a vertical natural frequency of 1.0 Hz and a horizontal natural frequency of 0.6 Hz.