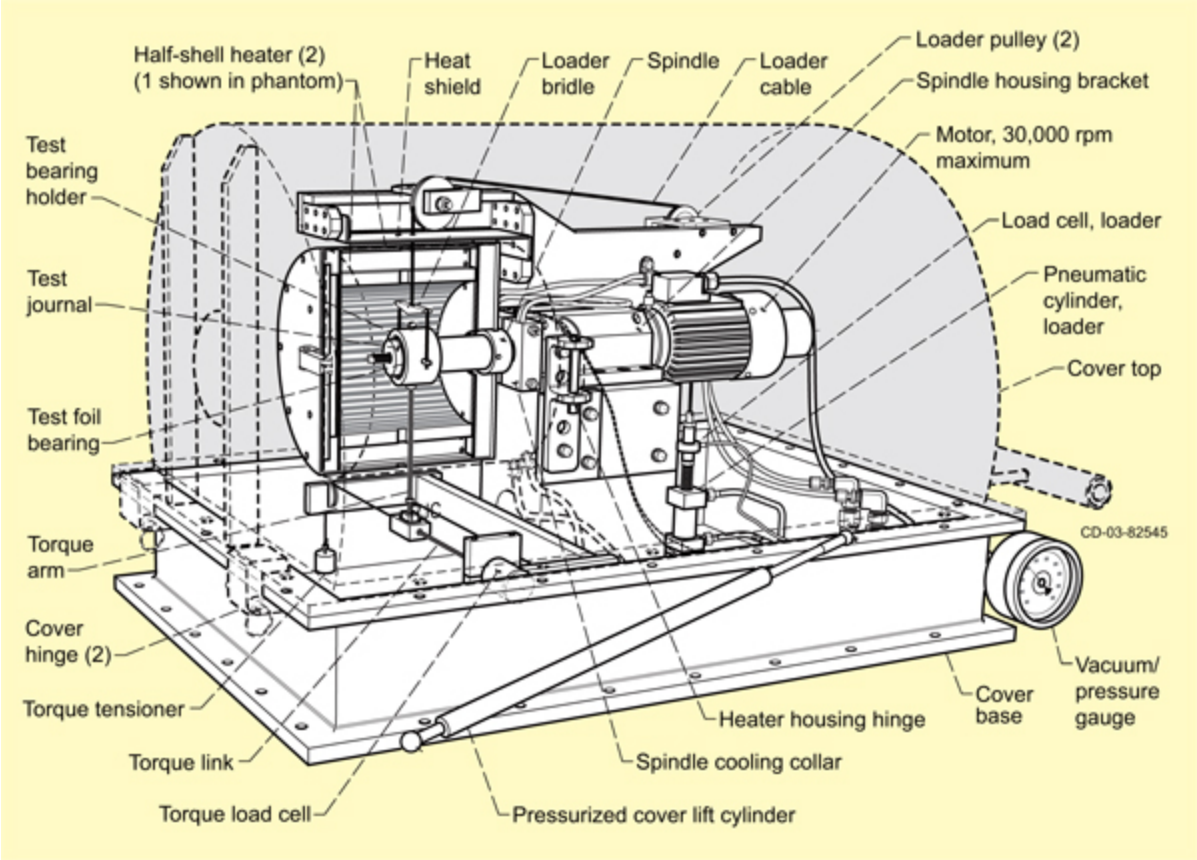
Ambient Pressure Test Rig Developed for Testing Oil-Free Bearings in Alternate Gases and Variable Pressures

The Oil-Free Turbomachinery research team at the NASA Glenn Research Center is conducting research to develop turbomachinery systems that utilize high-speed, high-temperature foil (air) bearings that do not require an oil lubrication system. Such systems combine the most advanced foil bearings from industry with NASA-developed high-temperature solid-lubricant technology. New applications are being pursued, such as Oil-Free turbochargers, auxiliary power units, and turbine propulsion systems for aircraft. An Oil-Free business jet engine, for example, would be simpler, lighter, more reliable, and less costly to purchase and maintain than current engines. Another application is NASA's Prometheus mission, where gas bearings will be required for the closed-cycle turbine-based power-conversion system of a nuclear power generator for deep space.

To support these applications, Glenn's Oil-Free Turbomachinery research team developed the Ambient Pressure Test Rig. Using this facility, researchers can load and heat a bearing and evaluate its performance with reduced air pressure to simulate high-altitude conditions. For the nuclear application, the test chamber can be purged with gases such as helium to study foil gas bearing operation in working fluids other than air.



Ambient pressure Oil-Free bearing test rig illustration.
Long description of figure 1.

During testing, a variable-speed (30,000-rpm maximum) electric motor with an integral precision spindle bearing spins the test journal over which the test foil bearing runs (see the illustration). The test bearing is mounted in a bearing holder that is constrained from turning by a torque arm from which reactionary torque is measured. This is the most important measurement to determine the health and capability of the bearing because the torque from a healthy bearing running on a film of gas is very low, whereas an increase in torque is a sign of sliding frictional contact. Load is applied to the bearing by a bridle (see the inset in the following photograph) that is pulled by a cable that is routed to a pneumatic cylinder that can apply up to 100 lb. The test bearing can be heated up to 650 °C with two ceramic electric heaters in insulated half shells that form an enclosure around the bearing. Multiple sensors register the temperature and other rig health parameters during the test. All are displayed on a programmable logic controller touch-screen controller (top right of the photograph), and some are used to trip alarms or shutdowns. All these components can be sealed in by closing the cover. Air or any alternate gas can be selected, and a vacuum pump can remove most of the gas, down to 0.1 atm, which corresponds to a 53,000-ft altitude, or gas can be added for pressures up to 2.5 atm.

Ambient pressure test rig photograph in NASA Glenn's Engine Research Building.

As a direct result of data collected from this rig, small aircraft turbine engines may be revolutionized by using oil-free bearings that will forever eliminate the complication, weight, and expense of an oil lubrication system. Furthermore, data from alternate gas operation experiments are imperative for developing safe, compact, and efficient nuclear electrical generators vital for NASA to conduct deep-space exploration and have a manned presence on the Moon and Mars, as directed by the President.

Find out more about this research:
Oil-Free Turbomachinery researchers at
http://www.grc.nasa.gov/WWW/Oilfree/team.htm
Oil-Free Turbomachinery Program at http://www.grc.nasa.gov/WWW/Oilfree/
Prometheus at http://exploration.nasa.gov/programs/prometheus/

Glenn contacts: Steven W. Bauman, 216-433-3826, Steven.W.Bauman@nasa.grc; and Dr. Christopher DellaCorte, 216-433-6056, Christopher.DellaCorte-1@nasa.gov, Oil-Free Turbomachinery technical leader
Author: Steven W. Bauman
Headquarters program office: Space Science, Aeronautics Research
Programs/Projects: JIMO, UEET, Project Prometheus