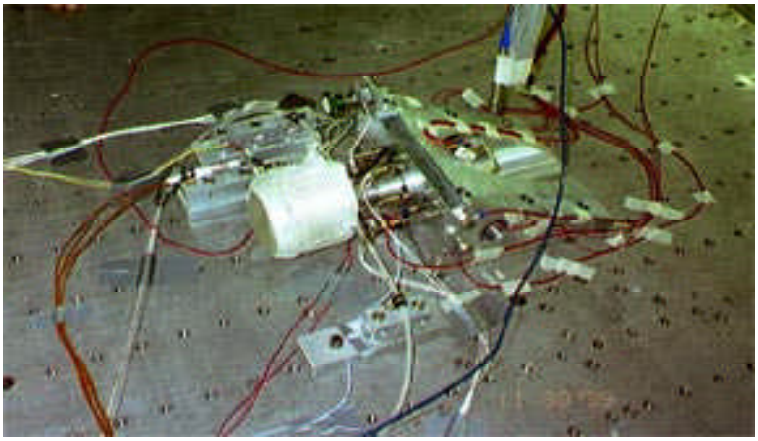
Vibration Test Demonstrated Dynamic Capability of an Operating Stirling Convertor

The NASA Glenn Research Center and the U.S. Department of Energy are currently developing a high-efficiency, long-life, free piston Stirling convertor for use as an advanced spacecraft power system for future NASA missions. As part of this development, a Stirling Technology Demonstrator Converter (TDC), developed by Stirling Technology Company for the Department of Energy, was vibration tested at Glenn's Structural Dynamics Laboratory in November and December 1999. This testing demonstrated that the Stirling TDC is able to withstand the harsh random vibration (20 to 2000 Hz) seen during a typical spacecraft launch and to survive with no structural damage or functional power performance degradation, thereby enabling its use in future spacecraft power systems.

Glenn and Stirling personnel conducted tests on a single 55 We TDC. The purpose was to characterize the TDC's structural response to vibration and to determine if the TDC could survive the vibration criteria established by the Jet Propulsion Laboratory for launch environments. The TDC was operated at full-stroke and full power conditions during the vibration testing.

It was tested in two orientations, with the direction of vibration parallel and perpendicular to the TDC's moving components (displacer and piston). The TDC successfully passed a series of sine and random vibration tests. The most severe test was a 12.3grms random vibration test (peak vibration level of 0.2 g^2/Hz from 50 to 250 Hz) with test durations of 3 min per axis. The random vibration test levels were chosen to simulate, with margin, the maximum anticipated launch vibration conditions.



Vibration testing of the Stirling Technology Demonstrator Converter.

As a result of this very successful vibration testing and successful evaluations in other key technical readiness areas, the Stirling power system is now considered to be a viable

technology for future application for NASA spacecraft missions. Possible usage of the Stirling power system would be to supply onboard electric spacecraft power for future NASA deep-space missions, performing as an attractive alternative to Radioisotope Thermoelectric Generators. Use of the Stirling technology is also being considered as the electric power source for future Mars rovers, whose mission profiles may exclude the use of photovoltaic power systems (such as exploring at high Martian latitudes or for missions of lengthy durations). Glenn's Thermo-Mechanical Systems Branch provides Stirling technology expertise under a Space Act Agreement with the Department of Energy. Additional vibration testing, by Glenn's Structural Systems Dynamics Branch, is planned to continue to demonstrate the Stirling power system's vibration capability as its technology and flight system designs progress.

Find out more about this research from Glenn's Structural Dynamics Laboratory (http://facilities.grc.nasa.gov/sdl/index.html) and Thermo-Mechanical Systems Branch (http://www.grc.nasa.gov/WWW/tmsb/).

Bibliography

1. Hughes, William O.; McNelis, Mark E.; and Goodnight, Thomas W.: Vibration Testing of an Operating Stirling Convertor. NASA/TM--2000-210526, 2000. http://gltrs.grc.nasa.gov

2. Goodnight, Thomas W.; Hughes, William O.; and McNelis, Mark E.: Dynamic Capability of an Operating Stirling Convertor. AIAA Paper 2000-2839, 2000. NASA/TM--2000-210527. http://gltrs.grc.nasa.gov

3. Thieme, Lanny G.; and Schreiber, Jeffrey G.: NASA GRC Technology Development Project for a Stirling Radioisotope Power System. AIAA Paper 2000-2480, 2000. NASA/TM--2000-210246. http://gltrs.grc.nasa.gov

Glenn authors and contacts: William O. Hughes, 216-433-2597, William.O.Hughes@grc.nasa.gov; Thomas W. Goodnight, 216-433-2381, Thomas.W.Goodnight@grc.nasa.gov; and Mark E. McNelis, 216-433-8395, Mark.E.McNelis@grc.nasa.gov
Author: William O. Hughes
Headquarters program office: OSS (MPDD), Flight Program Division
Programs/Projects: Power and On-Board Propulsion/Stirling Engine Technology