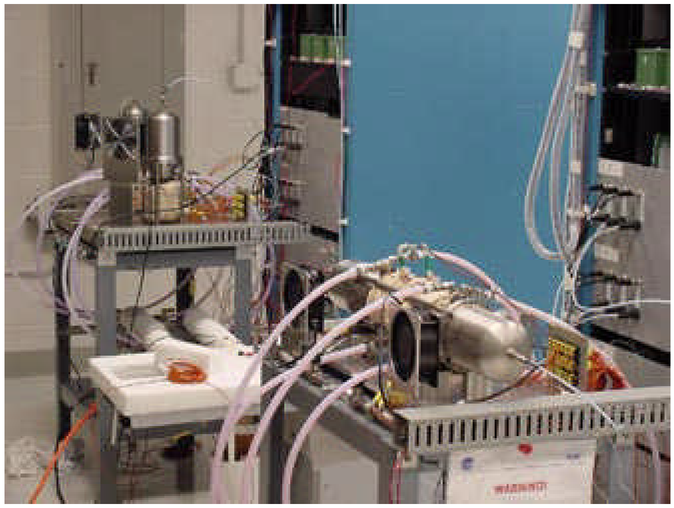
Stirling Research Laboratory Providing Independent Performance Verification of Convertors for a Stirling Radioisotope Generator

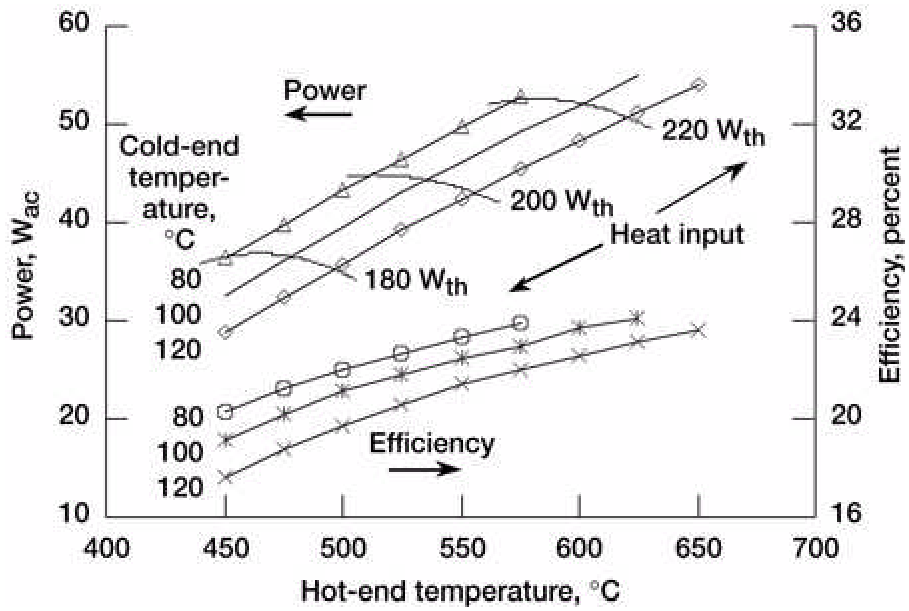
The Department of Energy (DOE), Germantown, Maryland, Stirling Technology Company (STC), Kennewick, Washington, and NASA Glenn Research Center are developing a free-piston Stirling convertor for a high-efficiency Stirling Radioisotope Generator for NASA Space Science missions. This generator is being developed for multimission use, including providing electric power for unmanned Mars rovers and for deep space missions. STC is developing the 55-W Technology Demonstration Convertor (TDC) under contract to DOE. Glenn is conducting an in-house technology project to assist in developing the convertor for readiness for space qualification and mission implementation. As part of this effort, a Stirling Research Laboratory was established to test the TDC's and related technologies. A key task is providing an independent verification and validation of the TDC performance.

Four TDC's are now being tested at Glenn. Acceptance testing has been completed for all convertors, and in general, performance agreed well with that achieved by STC prior to the delivery of the convertors. Performance mapping has also been completed on two of the convertors over a range of hot-end temperatures (450 to 650 °C), cold-end temperatures (80 to 120 °C), and piston amplitudes (5.2 to 6.2 mm). These test data are available online at http://www.grc.nasa.gov/WWW/tmsb/. The TDC's can be tested in either a horizontal orientation with dual-opposed convertors or in a vertical orientation with a single convertor. Synchronized dual-opposed pairs are used for dynamically balanced operation that results in very low levels of vibration. The Stirling Research Laboratory also supports launch environment testing of the TDC's in Glenn's Structural Dynamics Laboratory and electromagnetic interference and electromagnetic compatibility characterization and reduction efforts. In addition, the TDC's will be used for long-term endurance testing, and preparations are underway for unattended operation.



Stirling Technology Demonstration Convertors being tested at Glenn in both dual-opposed and single convertor modes of operation.
Photograph of four 55-W Stirling Technology Demonstration Convertors being tested at Glenn's Stirling research laboratory. These convertors can be tested in either a horizontal orientation with dual-opposed convertors or in a vertical orientation with a single convertor. Synchronized dual-opposed pairs are used for dynamically balanced operation that results in very low levels of vibration.

A competitive procurement by DOE for the Stirling Radioisotope Generator system integration contractor is nearing completion. Following announcement of the selected contractor, Glenn will continue to provide critical support for the overall DOE project as the work moves into system development. Other key efforts underway at Glenn are a life assessment of the TDC heater head, including creep testing of the Inconel 718 hot-end material and accelerated life testing of prototypical heater heads, long-term aging characterization of NdFeB permanent magnets used in the linear alternator, finite element analyses of the linear alternator in particular to determine the demagnetization margin of the permanent magnets, evaluation of the TDC organic materials used in the piston bearing coatings and linear alternator insulations and adhesives, support for DOE reliability assessments, and development of a multidimensional Stirling computational fluid dynamics performance code.



Full-stroke performance map for the Stirling Technology Demonstration Convertor.
Long description Performance mapping has been completed on a pair of dual-opposed technology demonstration convertors over a range of hot-end temperatures (450 to 650 °C), cold-end temperatures (80 to 120 °C), and piston amplitudes (5.2 to 6.2 mm). The performance map shown gives power output and efficiency at full stroke for one of the convertors as a function of hot-end temperature, cold-end temperature, and heat input.

Find out more about this research from Glenn's Thermo-Mechanical Systems Branch. http://www.grc.nasa.gov/WWW/tmsb/

References

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2. Thieme, L.G.; Schreiber, J.G.; and Mason, L.S.: Stirling Technology Development at NASA GRC. NASA/TM-2001-211315, 2002. (To be published in Space Technology and Applications International Forum (STAIF-2002), 2002.)

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Programs/Projects: Stirling Radioisotope Generator, Mars rover, Outer Planets
Special recognition: Space Technology and Applications International Forum (STAIF) 2000 Outstanding Paper Award for paper entitled "Technology Development for a Stirling

Radioisotope Power System"