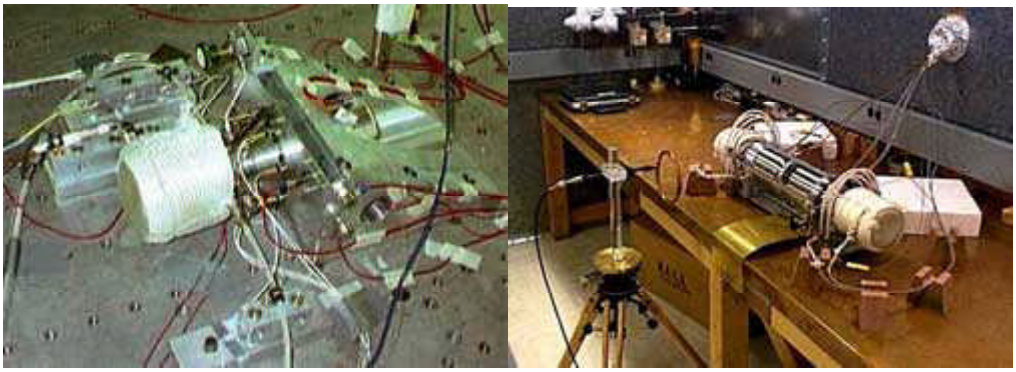
Assessment of Stirling Technology Has Provided Critical Data Leading Toward Flight Readiness of the Stirling Converter



Left: Launch environment testing of Stirling converter. Right: Stirling converter EMI/EMC characterization.

The NASA Glenn Research Center is supporting the development of a Stirling converter with the Department of Energy (DOE, Germantown, Maryland) for an advanced Stirling Radioisotope Power System (SRPS) to provide spacecraft onboard electric power for NASA space science missions. A key technology assessment completed by Glenn and DOE has led to the SRPS being identified as a high-efficiency power source for such deep space missions as the Europa Orbiter and the Solar Probe. In addition, the Stirling system is now being considered for unmanned Mars rovers, especially where mission profiles may exclude the use of photovoltaic power systems, such as exploration at high Martian latitudes or for missions of long duration.

The SRPS efficiency of over 20 percent will reduce the required amount of radioisotope by more than a factor of 3 in comparison to current radioisotope thermoelectric generators. This significantly reduces radioisotope cost, radiological inventory, and system cost, and it provides efficient use of scarce radioisotope resources.

In support of this technology assessment, Glenn conducted a series of independent evaluations and tests to determine the technology readiness of a 55-We Stirling converter developed by Stirling Technology Company (Kennewick, Washington) and DOE. Key areas evaluated by Glenn included

1. Radiation tolerance of materials
2. Random vibration testing of the Stirling converter in Glenn's Structural Dynamics Lab to simulate operation in the launch environment
3. Electromagnetic interference and compatibility (EMI/EMC) of the converter operating in Glenn's EMI lab

4. Independent failure modes, effects, and criticality analysis, and life and reliability assessment

5. SRPS cost estimate

The data from these evaluations were presented to NASA Headquarters and the Jet Propulsion Laboratory mission office by a joint industry/Government team consisting of DOE, Glenn, and Lockheed Martin Astronautics. This team concluded that there are no technical reasons that would rule out using the Stirling converter for deep space missions.

As a direct result of the successful testing at Glenn, the DOE/Stirling Technology Company 55-We Stirling converter has been baselined for the SRPS. Glenn is now continuing an in-house project to assist in developing the Stirling converter for readiness for space qualification and mission implementation. As part of this effort, the Stirling converter will be further char-acterized under launch environment random vibration testing, methods to reduce converter EMI will be developed, and an independent performance verification will be completed. Converter life assessment and permanent magnet aging characterization tasks are also underway. Substitute organic materials for the linear alternator and piston bearing coatings for use in a high-radiation environment have been identified and have now been incorporated in Stirling converters built by Stirling Technology Company for Glenn. Electromagnetic and thermal finite element analyses for the alternator are also being conducted.

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

References

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Programs/Projects: Stirling Radioisotope Power System, Outer Planets/Solar Probe Project, Mars Rover