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MORE EFFICIENT, MORE POWERFUL RTGS FOR PLANETARY SCIENCE MISSIONS

Abstract

The Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) is the only type of RTG available for spaceflight and it relies on technology used for the NASA Pioneer and Viking missions of the 1970s. The MMRTG's predecessor, the General-Purpose Heat Source-RTG, went out of production shortly after the turn of the 21st century. The thermoelectric technology in the GPHS-RTG was first flown on the Voyager missions launched in 1977. While manufacturing of GPHS-RTGs could theoretically be brought out of mothballs, many improvements have been made in thermoelectric materials, and these advances warrant a clear-eyed review.

NASA's Radioisotope Power Systems (RPS) Program set the objective for a study to explore what possible options NASA has for a next generation of RTGs. The scope and breadth of the study included many possible destinations within the solar system from the Sun to the Kuiper Belt. The study traded a variety of RTG conceptual designs, and risk rated a variety of thermoelectric materials and couple configurations useful in those concepts. Requirements were defined for the RTG concepts, a variety of thermoelectric materials were evaluated to find the most mature candidates, and performance was estimated for each RTG concept that could use the most mature of these new thermoelectric materials.

The study relied upon mission analyses of mission concepts outlined in the latest Planetary Science Decadal Survey (2011), other more recent mission studies completed throughout the agency, and recent analyses of Ocean Worlds to identify requirements not applied to previous RTGs but might prove valuable to next-generation RTGs. In addition, destinations within the solar system were analyzed against a list of mission concept types including, flybys, orbiters, atmospheric probes, aerial vehicles, landers (static, roving, floating, and submersible), melt probes, and sample return to identify new requirements.

A variety of RTG design concepts with several distinguishing architectural characteristics were formulated. The concepts created were modular (scalable), designed with lower housing temperatures (primarily to be more suitable for for very cold environments), operated only in the vacuum of space, operated in planetary atmospheres, and lastly, a hybrid architecture that could operate in both vacuum and planetary atmospheres.

The RTG concepts with maximal potential utility were identified and documented in the final report, along with a catalog of all the RTG concepts. This presentation will summarize the final report, with an emphasis on RTG concepts that may enable NASA to fly ever-more challenging missions over the next two to three decades.