

An Overview and Status of NASA's Radioisotope Power Conversion Technology NRA

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NASA's Advanced Radioisotope Power Systems (RPS) development program is developing next generation radioisotope power conversion technologies that will enable future missions that have requirements that can not be met by either photovoltaic systems or by current Radioisotope Power System (RPS) technology. The Advanced Power Conversion Research and Technology project of the Advanced RPS development program is funding research and technology activities through the NASA Research Announcement (NRA) 02-OSS-01, "Research Opportunities in Space Science 2002" entitled "Radioisotope Power Conversion Technology" (RPCT), 13 August 2002. The objective of the RPCT NRA is to advance the development of radioisotope power conversion technologies to provide significant improvements over the state-of-practice General Purpose Heat Source/Radioisotope Thermoelectric Generator by providing significantly higher efficiency to reduce the number of radioisotope fuel modules, and increase specific power (watts/kilogram). Other Advanced RPS goals include safety, long-life, reliability, scalability, multi-mission capability, resistance to radiation, and minimal interference with the scientific payload. These advances would enable a factor of 2 to 4 decrease in the amount of fuel required to generate electrical power. The RPCT NRA selected advanced RPS power conversion technology research and development proposals in the following three areas: innovative RPS power conversion research, RPS power conversion technology development in a nominal 100W_e scale; and, milliwatt/multi-watt RPS (mWRPS) power conversion research. Ten RPCT NRA contracts were awarded in 2003 in the areas of Brayton, Stirling, thermoelectric (TE), and thermophotovoltaic (TPV) power conversion technologies. This paper will provide an overview of the RPCT NRA, and a brief summary of accomplishments over the first 18 months but focusing on advancements made over the last 6 months.

I. Introduction

Radioisotope fueled power systems have a long history of successful National Aeronautics and Space Administration (NASA) space flight missions. Radioisotope Power Systems (RPS) are capable of producing electricity for decades under the harsh conditions of deep space. An RPS converts the heat generated from the natural decay of radioisotope material into useful electrical power. They are most attractive in deep space applications where the solar flux is too low, or for extended planetary applications such as that on Mars where the day/night cycle, settling of dust, and long-life requirements limit the usefulness of photovoltaics.¹

NASA has used RPS reliably in space exploration for more than 35 years. The current state-of-practice RPS used on NASA missions is the Radioisotope Thermoelectric Generator (RTG), which incorporates DOE's General Purpose Heat Source (GPHS) modules. The GPHS-RTG, which uses Silicon-Germanium thermoelectric (TE) power conversion, was utilized on NASA missions Galileo, Ulysses, and Cassini. While the GPHS-RTG is a proven, reliable design, it has a relatively low power conversion efficiency of about 7%, a Beginning-of-Mission (BOM) system specific power of about 5 W/kg, and is limited to vacuum environment applications only.²

Current RPS development efforts, which include the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) and the Stirling Radioisotope Generator (SRG), are aimed at re-establishing the production of an RPS since the last of the already produced RTGs will be utilized on nearer term missions. The MMRTG and SRG efforts

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