Radioisotope Thermoelectric Generators for Deep Space Science Missions
Overview of Plutonium Fuel

GPHSs

Pellets, clads, fuel capsules
## RTGs for NASA – Reference RTGs

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
<th>Descriptions</th>
<th>Power/GPHS</th>
<th>Th, °C</th>
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</thead>
<tbody>
<tr>
<td><strong>GPHS-RTG</strong></td>
<td>General-Purpose Heat Source RTG</td>
<td>This RTG was designed to operate in vacuum only. It was flown on PNH, Cassini, and other missions. Not a modular system.</td>
<td>290/18</td>
<td>1000</td>
</tr>
<tr>
<td><strong>MMRTG</strong></td>
<td>Multi-Mission RTG</td>
<td>Operates in vacuum and atmosphere. Flown on the Curiosity rover. Not a modular system.</td>
<td>110/8</td>
<td>530</td>
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</table>

**GPHS RTG**

**MMRTG**
RTG Primer

• Converts heat produced from the decay of plutonium into quiet DC power.

• The DOE has produced a variety of RTGs that have been designed and flown over the last 5 decades by NASA.

• Only the MMRTG can be procured today.

• No moving parts

• An MMRTG weighs approximately 45 kg and produces 110W at launch.

• Operates in vacuum and planetary atmospheres.

• Thermal output is ~1880Wth, BOL.

• Estimate ~90 Welec at Europa (7 yrs. after BOL)

RTG – Radioisotope Thermoelectric Generator
RTG Heat Distribution
Thermal Loops to Move Heat

Coolant Tube Inlet/Outlet
Primary - 316L SS Omnisafe VCR fitting
Secondary – Aluminum AN fitting

Coolant Tubes (Al 6063)
0.375 inch Primary Tube
0.250 inch Secondary Tube
Planetary Protection

• Self-sterilizing in large part in room temperature air
  – Only coldest edges on fins are not self-sterilizing
  – These can be easily cleaned

• Housing temperature will drop below freezing within 60 years on an icy moon or ocean world such as Europa
  – RTGs will not provide a permanent heat source for life on icy moons or other bodies