*Significance of Developments in RTG Technology**

Essentials of the Technology. An RTG basically consists of a radioisotopic heat source and a thermoelectric converter that transforms thermal energy into electrical energy through two conductors, made of different metals, which are at different temperatures at their point of juncture. The heat results from the radioactive decay of plutonium-238, a radioisotope which has a half-life of 87.8 years. Plutonium-238 fueled all RTGs that flew on U.S. space missions. The principal decay process of this radioisotope is by emission of alpha particles, which are easily absorbed in the heat source to produce heat and require no special shielding.

Design Type and Trends. The RTG's flown since 1961 can be grouped into six basic design concepts—SNAP-3, SNAP-9A, SNAP-19, SNAP-27, TRANSIT-RTG, MHW-RTG. The general trend was to improve generator performance, efficiency, and specific power (electric power per kg of weight).

Basic Improvements. Power requirements for missions rose from a few watts electric to the 292 W(e) required in the forthcoming Galileo mission. Conversion efficiency rose slightly but specific power improved greatly as lighter weight converter materials (Beryllum or aluminum) reduced mass, even as fuel loadings increased and high-temperature thermoelectric power-conversion materials were introduced.

Snap-3(B). Each generator in the SNAP-3(B) RTG, which was the first to fly, was designed to provide an initial power output of 2.7 W(e). Heat source was approximately 52.5 W(t) of encapsulated plutonium-238 metal. Design life was five years. The power-conversion subsystem consisted of 27 spring-loaded, series-connected pairs of PbTe 2N/2P thermoelectric elements operating at a hot-juncture temperature of about 783 K and a cold-juncture temperature of about 366 K. This subsystem had a power-conversion efficiency of 5 to 6 percent and specific power of 1.29.

SNAP 9A. RTGs were adopted for the DOD Transit 5BN-1 and 5BN-2 satellites because RTGs are inherently radiation-resistant, while solar cells on earlier Transits were adversely affected by the 1962 high-altitude nuclear explosion. Each SNAP-9A was designed to provide 25 W(e) at a nominal 6V for five years in space after one year of storage on Earth. Thermal inventory of approximately 525 W(t) was supplied by Pu-238 metal encapsulated in a heat

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*Abstracted from Bennett et al, 1983 paper (op. cit.) and *Enhancing Technology Leadership: Space . . .* (op. cit.), by the same authors.

W(e) = Watts electric

W(t) = Watts thermal

K = Kelvin