Nimbus III -- In early 1968, two SNAP 19 RTG's (Martin-Marietta Company) were launched to supplement solar power on the Nimbus III weather satellite. Due to a guidance malfunction, the entire missile was destroyed. The fuel capsule was later recovered from the ocean floor off Santa Barbara, California, and found to be in excellent condition.

In April 1969, two more SNAP 19 RTG's were launched aboard a second Nimbus III satellite. Initial power from these RTG's was approximately 28 watts each. These RTG's utilized 90 lead telluride (3M Company) thermocouples wired in a series parallel network and MIN-K (Johns Manville) thermal insulation. Hot junction temperatures were approximately 538° C and an argon cover gas was used to suppress the expected high rate of hot junction erosion (sublimation). The fuel capsule contained a thermal inventory of approximately 630 watts derived from the decay of plutonium dioxide microspheres contained in a super alloy case. The RTG outer case was sealed (Vitron seal) via a bolted flange. Combined power from the two RTG's was approximately 47 watts at the end of one year and decayed to approximately 30 watts at the end of two. This unusually high rate of degradation (although design requirements were met) is generally attributed to oxidation attack of the thermoelectric metallurgical bonds and hot junction sublimation due to gas leakage.

Pioneer 10 and 11 -- Hostile environments such as are encountered by deep space probes and the day-night temperature excursions found on the lunar surface are the forte of the RTG's. The Pioneer 10 mission to Jupiter was launched in March 1972 with four SNAP 19 RTG's providing the sole source of power. Successful Jupiter encounter occured in December 1973 and the space probe is now programmed to leave the solar system--the first (and of course, the first RTG) to do so. Figure 5 shows performance of RTG's on Pioneer 10 and 11.

The SNAP 19 Pioneer RTG was produced by Teledyne Energy Systems (TES). The 90 thermoelectric elements are the 3M Company's lead telluride (N leg) and the TES TAGS 85 alloy. This is a change from the Nimbus version of this RTG and partially accounts for the power-out increase. Hot junction design operating temperatures are approximately 516° C. The design incorporates a degaussing loop for magnetic suppression and the series parallel network has been modified to two couples in parallel vice 3 for the Nimbus version. The heat source contains a nominal 645 thermal watts and is a spin-off from the Transit Heat Source design. The thermopile case was sealed by welding. The Pioneer 11 shot to Jupiter was launched in April 1973 with Jupiter encounter (within 27,000 miles--three times closer than Pioneer 10) occurring in December 1974. The Atlas Centaur launch vehicle was used for both missions. Four SNAP 19 RTG's again provided the sole source of electric power. Following Jupiter encounter, this space probe was reprogrammed for a Saturn flyby which is expected to occur in mid 1979. Both spacecraft continue to transmit data relative to space conditions beyond Jupiter.