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Atomic Power In Space

A History

March 1987

U.S. Department of Energy
Assistant Secretary for Nuclear Energy
Deputy Assistant Secretary for Reactor Systems
Development and Technology
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Washington, DC
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FOREWORD

On December 8, 1953 President Dwight D. Eisenhower, in his famous "Atoms-for-Peace" address, proposed that the United Nations establish an international agency which would promote the peaceful uses of atomic energy. The President's purpose was to take a small step toward adapting the atom "to the arts of peace." Within a few years his small step had grown into a number of peaceful atomic activities, among them an International Atomic Energy Agency, bilateral agreements for cooperation in peaceful atomic development, research reactors built in foreign countries, two international peaceful uses conferences, the creation of special schools with curriculums centered on nuclear technology, and the expanded use of radioisotopes in medicine, agriculture, and industry. One such peaceful use developed late in the decade was the "world's first atomic battery." Unveiled for the first time in President Eisenhower's office on January 16, 1959, the "atomic battery" was a radioisotope thermoelectric generator, a special device which converted the heat created by the natural decay of a radioactive isotope directly into useable electric power. The President was gratified to learn that the generator, developed under the aegis of the Atomic Energy Commission's Space Nuclear Auxiliary Power program, could provide sufficient power to run the instruments aboard a satellite.

Characterized as a part of "Atoms-for-Peace" programs, radioisotope thermoelectric generators did not provide power for satellites until after the nation had entered the space age. The U.S. Navy launched the first radioisotope thermoelectric generator-powered satellite on June 29, 1961, a month after President John F. Kennedy committed America to put a man on the moon. The power unit, called a SNAP 3A device, supplied electricity for instruments on a Navy navigational satellite. Despite extensive safety tests which the Atomic Energy Commission performed on the device, the Kennedy Administration had some qualms about launching the SNAP 3A device, resulting in a last-minute approval and some extraordinary effort to get the device to the launch pad on time.

Although a small, self-contained unit might seem an obvious power source for a satellite, radioisotope thermoelectric generators actually powered only a few of the many satellites the United States placed into earth orbit. Altogether they provided electric power for six Navy navigational satellites, two Nimbus meteorological satellites, and two communications satellites. Solar panels provided a more suitable power source for most earth satellites.

The race to the moon and the requirements of space exploration, however, created more varied and challenging uses for radioisotope thermoelectric generator power units than did satellite missions. Because they were relatively rugged, light weight, and compact, contained no moving parts and did not depend on the sun for power, the National Aeronautics and Space Administration decided that radioisotope thermoelectric generators should power instrument packages and probes which must survive severe environments with little or no sunlight. Radioisotope thermoelectric generators therefore were developed to supply electricity to instrument packages left on the moon during the long lunar night. Astronauts deployed five Apollo Lunar Surface Experimental Packages on the moon between November 1969 and December 1972. Not only did the radioisotope thermoelectric generators survive the lunar night but they also continued to supply power until shut down on command from the earth years later.

The ability to supply power in severe, sunless environments also prompted the National Aeronautics and Space Administration to select radioisotope thermoelectric generator units to power the Viking unmanned Mars lander and the Pioneer and Voyager space probes to Jupiter, Saturn, and beyond. The Viking lander sent back the first pictures taken from the surface of another planet, correcting many misconceptions about the red planet. Although Mars was considered a prime candidate for supporting some form of life, Viking found no evidence of it on Mars. Surviving the Jovian radiation belts, the Pioneer and Voyager spacecraft provided a wealth of data about Jupiter, Saturn, and their moons, surprising scientists with unexpected discoveries. Overnight our conception of these worlds changed from planetary systems frozen in cold storage for eons to dynamic systems with swirling clouds of gases, tempestuous storms, ever-changing rings, and moons with active volcanoes and one with an atmosphere of methane.

Entitling his work *Atomic Power in Space*, Dr. Richard Engler has taken us on satellite launches and to the outer reaches of the Solar System. Characterizing radioisotope thermoelectric generator technology as a "quiet technology," he has aptly pointed out that the generators have been a smaller part of larger shows, albeit a vital part. Although creating a small, "quiet" product, the radioisotope thermoelectric generator programs of first the Atomic Energy Commission, then the Energy Research and Development Administration, and finally the Department of Energy, have nevertheless grown and prospered while the rest of the nuclear space effort has been abolished. Dr. Engler has woven the contrast of prosperity and decline into his story while vividly capturing through oral history the views of radioisotope thermoelectric generator developers and users. Organizational change as well as ever-vigilant attention to safety has also characterized the program and Dr. Engler has discussed these themes in detail. Most thought provoking are the lessons he drew from the program. Regardless of the scale of the radioisotope thermoelectric generator program efforts, the lessons gleaned from such a successful program should be of value to anyone involved in technological development.

PREFACE

"Atomic Power in Space," a history of the Space Isotope Power Program of the United States, covers the period from the program's inception in the mid-1950s through 1982. Written in non-technical language, the history is addressed to both the general public and those more specialized in nuclear and space technologies.

The Space Isotope Power Program has been highly successful and has made major contributions to the overall space program of the United States. It has been part of notable technical triumphs and large-scale organizational endeavors of the space and nuclear age and offers lessons from the program perspective on the problems of modern-day research and development. It is important to document the history now, while key participants can be located to relate their first-hand experiences.

The story is told at a number of levels: developments and achievements at the technical level; major events in the key institutions closely involved in RTG technology, and the larger milieu of the time. A chronology (see Appendix) presents important events in these different lines of action for the period covered by the history. A Bibliography indicates major sources used in developing the different lines contributing to the total story; of course, classified documents were not used.

Illustrations, diagrams, charts, and budgets are shown in Appendices. A table of isotope power systems for space is also appended, as is a chronological listing of launchings and an annotated chart on the different RTGs developed.

Acronyms used frequently in this narrative include:

AEC	Atomic Energy Commission
NASA	National Aeronautics and Space Administration
RTG	Radioisotopic Thermoelectric Generator
SNAP	Systems for Nuclear Auxiliary Power

In the series of SNAP devices developed for space and terrestrial use, odd-numbered SNAPS were RTGs while even-numbered SNAPs were nuclear reactor systems, not isotopic ones.

The following outline of chapter coverage may be helpful in following the chronology of this history and of the program it describes:

Chapter One: Introduction provides an overview of the story, notes how the RTG program reflected a merging of space and nuclear technologies, and identifies major themes.

Chapter Two: The Beginnings covers the 1950s but flashes back from a significant public announcement in early 1959 to trace the beginnings of radioisotope power discovery and development.

Chapter Three: Recognition of Potential describes developments in 1960 and 1961, years of transition from the Eisenhower Presidency to that of Kennedy when the first RTGs were used in space satellites, and notes early safety concerns.

Chapter Four: Golden Days at the AEC covers the years 1962-1965 when a small group of people were intimately involved in the program, a reorganization which created the Space Nuclear Systems Division at the AEC, and the beginning of major growth in the program as it prepared to support APOLLO and other missions of the National Aeronautics and Space Administration (NASA).

Chapter Five: Momentum from the Lunar Race describes the years 1966-1970 when NIMBUS and the first APOLLO launchings occurred, with RTG developments and applications spurred by NASA's major space exploration goals while international and domestic unrest increased.

Chapter Six: A Maturing Program describes developments in the years 1971-1974, the PIONEER and last APOLLO missions, and technical accomplishments before major reorganizations at the AEC.

Chapter Seven: Persistence Amid Change completes the historical narrative by taking the program from 1975 to 1982, describes the VIKING missions and the Lincoln Experimental Satellite (LES) and VOYAGER missions, and covers major organizational changes within the AEC.

Chapter Eight: Lessons and Challenges presents important lessons in the history of a space-age R&D program and future projections for radioisotopic power in space.

Planning & Human Systems, Inc., wishes to thank the many people who participated in developing this history. While not all who contributed their time to this project can be cited here, special thanks go to Bernard Rock and Orrice Murdock of the Office of Special Nuclear Projects, who gave initial impetus to this project, and to Jack Holl and Roger Anders of the History Division of the

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Any errors in fact or interpretation found in this history are the responsibility of Planning & Human Systems, Inc.

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