Space and Defense Infrastructure

The U.S. Department of Energy's Office of Nuclear Energy

Radioisotope power systems are used in space exploration and national security missions.

The Department of Energy (DOE) and its predecessors have provided radioisotope power systems that have safely enabled deep space exploration and national security missions for nearly five decades.

Radioisotope power systems (RPSs) convert the heat from the decay of the radioactive isotope plutonium-238 (Pu-238) into electricity. Pu-238 is a type of plutonium that is not used for nuclear weapons. RPSs are capable of producing either heat or electricity for decades under the harsh conditions encountered in deep space. They have proven safe, reliable, and maintenance-free in missions to study Jupiter, Saturn, Mars, and Pluto.

DOE maintains the infrastructure to develop, manufacture, test, and deliver RPSs for space exploration and national security missions. In addition to providing Radioisotope Thermoelectric Generators (RTGs), DOE also provides Radioisotope Heater Units (RHUs) and develops advanced RPSs.

Galileo

Cassini

New Horizons

Photos courtesy of NASA

Radioisotope Thermoelectric Generators (RTGs) — The RTG systems are ideal for applications where solar panels cannot supply adequate power, such as for spacecraft surveying planets far from the sun. RTGs have been used on many National Aeronautics and Space Administration (NASA) missions, including the following.

Galileo mission to Jupiter

Launched in 1989, the RTG-powered Galileo mission revealed intense volcanic activity on Jupiter's moon, Io. It was the first spacecraft to fly past an asteroid, and the first to discover a moon of an asteroid.

Cassini mission orbiting Saturn

In July 2004, the Cassini mission entered the orbit of Saturn. Launched in October 1997, the Cassini spacecraft uses three DOE-supplied RTGs and is the largest spacecraft ever launched to explore the outer planets. It is successfully returning data and sending images of Saturn and its surrounding moons, using a broad range of scientific instruments. This mission requires RTGs because of the long distance from the sun, which makes the use of solar arrays impractical.

New Horizons mission to Pluto

The New Horizons spacecraft was launched on January 19, 2006. The fastest spacecraft to ever leave Earth, New Horizons has already returned images and scientific data from Jupiter and will continue its journey of three billion miles to study Pluto and its moon, Charon, in 2015. It may also go on to study one or more objects in the vast Kuiper Belt, the largest structure in our planetary system. DOE supplied the RTG that provides electrical power and heat to the spacecraft and its science instruments.

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Program Budget

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($ in Millions)

	FY 2010 Actual	FY 2011 Request
	$42.0	$47.0

Radioisotope Heater Units (RHUs) — RHUs use the heat generated by Pu-238 to keep a spacecraft's instruments within their designed operating temperatures.

In June and July 2003, NASA launched the Mars Exploration Rovers, Spirit and Opportunity, to explore evidence of water on Mars. Each rover has eight RHUs to keep the rover instruments warm during the cold Martian nights. The rovers landed at separate sites on Mars in January 2004 on a planned 90-day mission and are still operational nearly six years later. NASA has also identified several new missions potentially requiring RHUs.

ADVANCED RPSs

Two new RPSs are under development:

Multi-Mission Radioisotope Thermoelectric Generator (MMRTG)

The MMRTG is being developed for operation in planetary atmospheres as well as in the vacuum of space. The first use of an MMRTG will be for the Mars Science Laboratory (MSL), planned for launch in 2011. The MSL will collect Martian soil samples and rock cores, and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past.

Advanced Stirling Radioisotope Generator (ASRG)

The ASRG is currently being developed as a high-efficiency RPS technology to support future space missions on the Martian surface or in the vacuum of space. This system uses a Stirling converter, which has moving parts to mechanically convert heat to electricity. This power conversion system, if successfully deployed, will reduce the amount of Pu-238 needed per mission and weight of each RPS.

RPS INFRASTRUCTURE

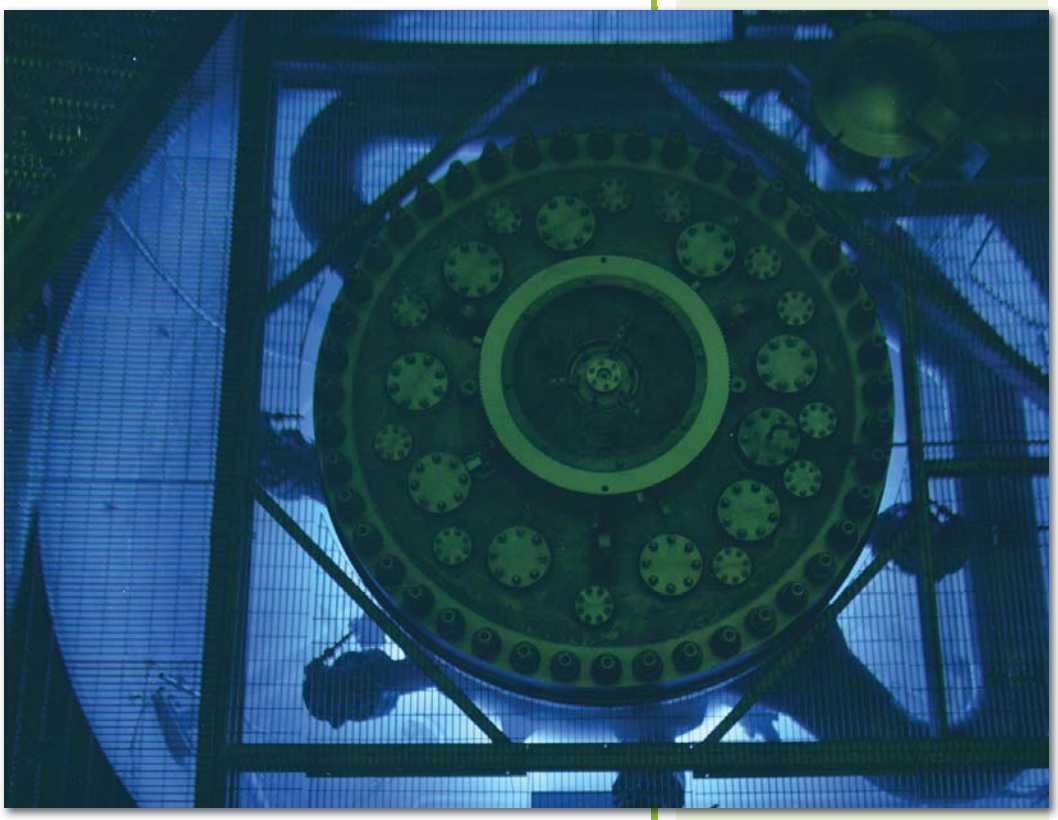
DOE has accomplished this successful mission through highly capable engineers and technicians and specialized facilities at DOE national laboratories. Oak Ridge National Laboratory provides unique materials and hardware. Plutonium-238 is purified and encapsulated at Los Alamos National Laboratory. Idaho National Laboratory assembles the encapsulated fuel into a heat source designed to contain the fuel in potential accident situations and integrates the heat source and power conversion system into the final power system. DOE maintains unique shipping containers and trailers to safely transport components and power systems across the DOE complex and to user agencies. Power system design, development, manufacture and non-nuclear testing are performed by competitively-selected system integration contractors.

DOE also maintains the unique ability to evaluate and characterize the safety of these systems. Sandia National Laboratories has the lead role to develop and maintain the required analytical tools, database and capabilities.

PLANNED PROGRAM ACCOMPLISHMENTS

FY 2010

- Maintain operability of Space and Defense Power Systems-related facilities to enable DOE and Work-for-Others milestones to be achieved.
- Maintain the fully assembled MMRTG flight unit for NASA's Mars Science Laboratory (MSL) in controlled storage ready for launch in 2011.
- Continue development of the Advanced Stirling Radioisotope Generator in support of a potential NASA Discovery mission.
- Continue maintenance and selected upgrades of radioisotope power systems assembly facilities at Los Alamos National Laboratory (LANL) to ensure compliance with systems specifications.
- Fabricate Pu-238 fuel for RPSs to support near-term NASA missions.
- Initiate activities to fabricate RHUs for future NASA missions.
- Complete design of Fission Surface Power System (FSPS) high-power reactor simulator.



The High Flux Isotope Reactor at ORNL has the capability to support the production of Pu-238.

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FY 2011

- Maintain capability at national laboratories.
- Support launch of the MMRTG flight unit for NASA's MSL mission in 2011.
- Continue development of the ASRG in support of a potential NASA Discovery mission.
- Maintain current RPS safety analysis capability and methods as new information becomes available.
- Continue to support development of the NASA Fission Surface Power System project Technology Demonstration Unit experiment at NASA's Glenn Research Center.
- Execute new five-year contract requirements for national security power systems.
- Initiate the Pu-238 production restart project.

NASA's Mars Science Laboratory, a mobile robot shown here in an artist's rendition, will analyze Martian soil samples and rock cores. Photo courtesy of NASA.