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Space Technology
Game Changing Development

The Fission System Gateway to Abundant Power for Exploration

The Nuclear Systems Kilopower Project: demonstrating that nuclear fission technology is available to provide safe, abundant, and reliable power for human missions to space

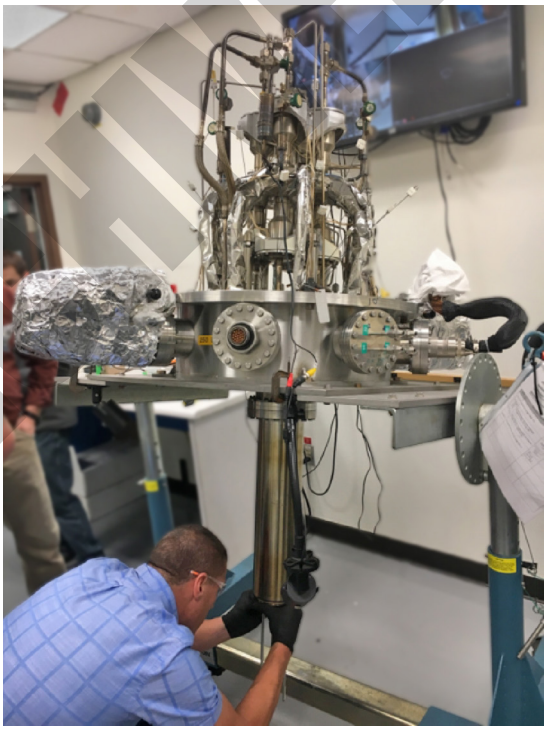
Why Nuclear Fission?

Until it is taken away from us by storms or grid problems, abundant electrical power is so available that we take it for granted; just plug into any outlet. The solar system, however, provides no such easy access to electric power. Currently, power is usually generated in space by solar arrays that convert the Sun's energy into electricity or by radioisotope power systems that convert the heat from naturally decaying plutonium-238 into electricity. Solar or radioisotope power systems may be impractical for future NASA missions to places where sunlight is dim or unavailable, and where more than a few hundreds of watts of power are needed.

Fission power from nuclear reactors could provide abundant energy anywhere that humans or our robotic science probes might go. Fission, the splitting of an atom's nucleus, releases a great amount of heat energy: 1 pound of uranium fuel can produce as much energy as about 3 million pounds of burnable coal. With such a high energy density, fission power systems present an ideal solution for space missions that require large amounts of power, especially where sunlight is limited or not available.

Technology Demonstration Goal

Because of fission power's great potential for space exploration, the NASA Space Technology Mission Directorate's Game Changing Development (GCD) Program is funding the Kilopower project, an effort led by NASA's Glenn Research Center to demonstrate space fission power systems technology. Building on prior work by a joint NASA and Department of Energy team, the project's main goal is to assemble and test an experimental prototype of a space fission power system. In 2012, Los Alamos National Laboratory and NASA Glenn demonstrated how an innovative, small-scale heat pipe-cooled fission reactor could provide



Kilopower experiment assembly at NASA's Glenn Research Center.

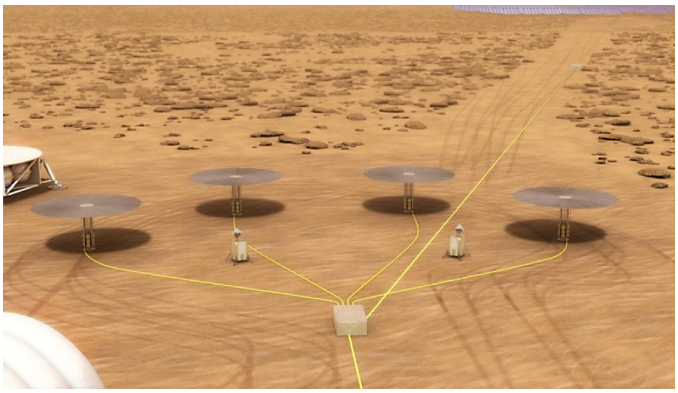
electrical power using Stirling power conversion. This proof of physics demonstration provided the basis for the Kilopower project, the goal of which is to demonstrate the readiness of a monolithic-core heat-pipe reactor power system for use in NASA's exploration missions.

Accomplishing the Goal

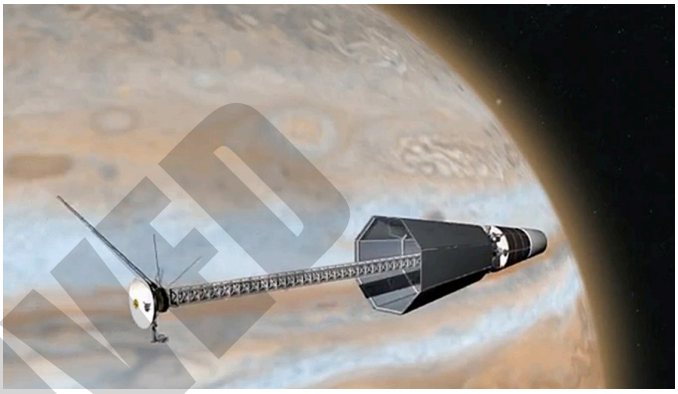
The NS Kilopower project is a partnership between NASA and the Department of Energy's National Nuclear Security Administration (NNSA). Together, NASA and NNSA have designed and developed a 1-kWe reactor prototype with technology that is relevant for systems up to 10 kWe. It consists of a highly enriched uranium core built by NNSA, heat pipes provided by Advanced Cooling Technologies through a NASA Small Business Innovation Research contract, and Stirling generators provided by Sunpower, Inc. The core is a solid block of a uranium alloy, and heat pipes are clamped around the core to transfer heat to Stirling power conversion units to generate electrical power. Much smaller than terrestrial nuclear plants, Kilopower systems are small enough to be demonstrated here on Earth in existing facilities at the Nevada National Security Site.

Space Exploration Uses for Fission Power

The Kilopower project was initiated because NASA mission planning includes exploration of places in the solar system—such as deep space beyond Jupiter's orbit and the surfaces of Earth's moon and Mars—where power generation from sunlight is difficult and power from radioisotope systems is limited by the fuel supply. For human exploration, multiple 10-kWe Kilopower systems could provide the 40 kWe initially estimated to be needed by NASA's preliminary concepts for a human outpost, with the ability to add power as the outpost grows. For robotic exploration, 1-kWe Kilopower units enable abundant, reliable power for science and communications, and the potential to field deep space missions based on science return while conserving the limited supply of radioisotope fuel for its best opportunities. Characteristics of fission power that make it so beneficial for Mars outposts and deep space robotics also apply to other space missions. Nuclear fission systems could be scaled up to power nuclear electric propulsion vehicles to efficiently transport heavy cargo beyond Mars, and they could potentially shorten crewed trip times to Mars and other distant planets.



Mars fission power system concept.



Space fission power system concept.

Game Changing Development Program

The Game Changing Development (GCD) program is part of NASA's Space Technology Mission Directorate. The GCD program aims to advance exploratory concepts and deliver technology solutions that enable new capabilities or radically alter current approaches.

For more information about GCD, please visit http://gameon.nasa.gov

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