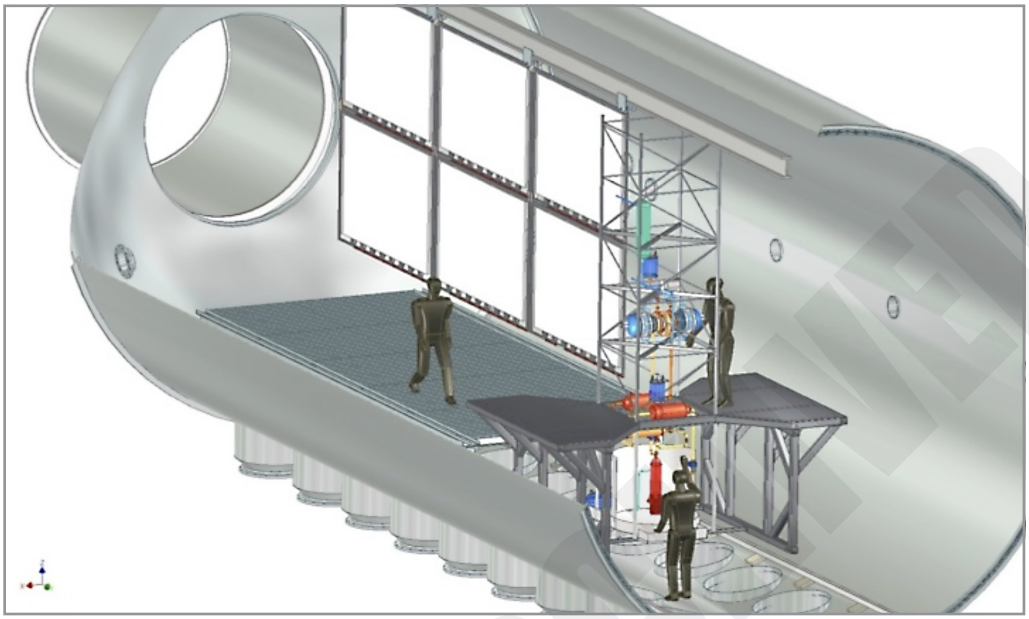
National Aeronautics and
Space Administration

The Fission System Gateway to Abundant Power for Exploration

Nuclear Systems Project: Demonstrating That Fission Power System Technology Is Available To Provide Safe, Abundant, and Reliable Power for Human Missions to Space



Nonnuclear system test at NASA Glenn Research Center.

game changing development

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. In order to meet the large power needs for some future NASA missions, solar or radioisotope power systems may be impractical.

Fission power from nuclear reactors could provide abundant energy anywhere that humans or our robotic science probes might go. Fission, the splitting of the nucleus of an atom (commonly uranium), 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 (FPSs) 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 the great potential of fission power for space exploration, NASA Space Technology's Game Changing Development (GCD) program is funding the Nuclear Systems Project—an effort led by NASA 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 laboratory hardware that functions like a space FPS. The technology demonstration unit (TDU) has three major subsystems: an electrically heated reactor simulator, a power conversion unit (PCU), and a heat rejection loop. Working together, these elements comprise a laboratory version of a space FPS that can be fully exercised in a simulated space environment.

Accomplishing the Goal

Decades-long experience with terrestrial nuclear power and prior space fission power projects forms the basis for development of the reactor simulator, which reproduces the heat from a nuclear reactor using electrical heaters. The PCU consists of a pair of Stirling engines that convert heat into electrical energy using a reciprocating piston and linear alternator. Waste heat from the Stirling engines is rejected by a water cooling system that serves in place of the thermal radiators which reject waste heat in space. The Nuclear Systems Project includes development of all of the TDU subsystems by the end of 2013, and assembly and testing in 2014.

Space Exploration Uses for Fission Power

NASA has been asked to take an affordable and flexible approach as it plans for humans to journey into the solar system. Mars, an important goal on this path, has a 25-hour day, similar to Earth. Mars is about 1.5 times farther from the Sun than Earth is, so at the top of its atmosphere, Mars receives only about 40 percent of the Sun's energy. At Mars' surface, conditions are even worse: the Mars atmosphere dims the light from the Sun, and periodic planetwide dust storms can block up to 99 percent of the sunlight for months at a time. For these reasons, from the early 1960s to today, mission planners have called for fission power to support human bases or outposts on Mars.

Characteristics of fission power that make it so beneficial for the surface of Mars also apply to other space missions. Nuclear fission systems could power nuclear electric propulsion vehicles to transport heavy cargo efficiently to more distant planets and offer the potential for shorter crewed trip times to Mars and beyond. In addition, FPSs could be scaled down to provide a few kilowatts of power for robotic space probes headed to investigate the mysteries hiding in the darkness of deep space.

The Game Changing Development (GCD) program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

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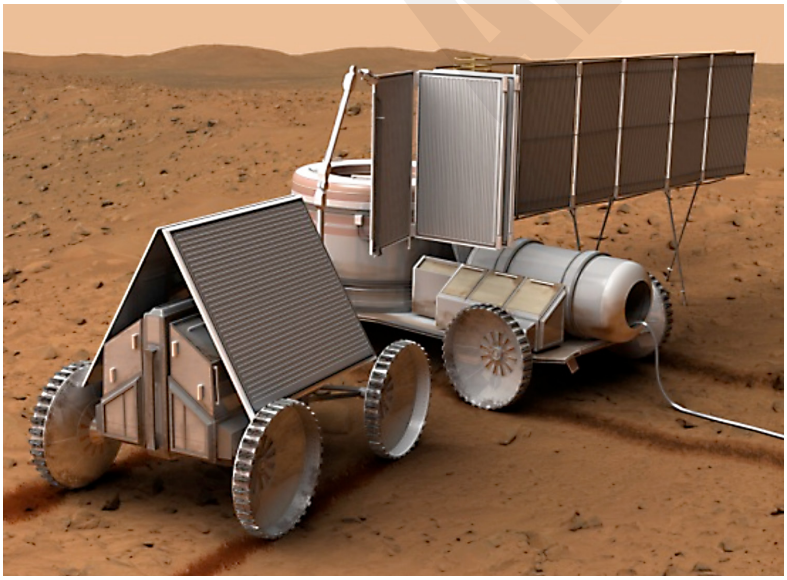

Mars fission power system concept.

Nuclear electric power system concept.

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