**NUCLEAR THERMAL PROPULSION DEVELOPMENT EFFORTS WITHIN THE DEPARTMENT OF ENERGY.**

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**Introduction**: The Department of Energy (DOE) Office of Space and Defense Power Systems (NE-75) directs a team of national laboratory personnel in a collaborative effort with the National Aeronautics and Space Administration (NASA) to develop nuclear fuels that could be used in a reactor-powered in-space transportation system for crewed or cargo missions in the 2030 time frame. Extensive fuel development, testing and demonstration was conducted from 1955–1973 under the Rover/NERVA Program. Both graphite and cermet refractory metal alloy fuel types were investigated. Current activities under NASA's Advanced Energy Systems Program include parallel development and evaluation of both graphite and cermet fuel types for comparison and selection of one as a leading fuel candidate to emphasize in the next stage of development. The evaluation activities include lab-scale production line development to make the different fuel types, a collaborative reactor and engine stage modeling effort to compare potential performance of the fuel at the engine stage level, and performance testing of the fuel to validate assumptions made during the modeling process. Potential differences in the fuels include attainable volumetric fissile material loading, maximum operating temperatures, fission product retention, demonstrated capability and engine operation. Engine operation influences engine reactivity, the radiation environments external to the engine and propellant consumption (which influences storage tank volume). Reactor-based engines can provide direct nuclear thermal propulsion only or provide some combination of direct propulsion and electrical power generation. Engines providing electrical power generation will operate for longer periods and reactivity losses due to fissile depletion and fission product absorption will be higher. Engine systems employing fast spectrum reactors show lower sensitivity to fission product buildup than those employing thermal neutron spectrum reactors. Graphite-based thermal neutron engine systems have a larger demonstrated operational heritage. They could potentially be developed sooner than cermet systems, but they may not be as well suited to missions requiring bi-modal operation. So both the timing and nature of a proposed mission can have substantial influence on which fuel type is preferred. The DOE's Nuclear Thermal Propulsion Team is working with NASA to fabricate new fuels, lay the foundation for effective and consistent reactor-based engine evaluation, and to develop affordable paths to fuel, reactor and stage development, testing and qualification. This current effort will establish the anticipated needs for engine development activities that must soon begin in earnest if engines are to be available for missions in the 2030 time frame.

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