Nuclear and Emerging Technologies for Space, American Nuclear Society Topical Meeting
Richland, WA, February 25 – February 28, 2019, available online at http://anstd.ans.org/

Development of Robust and Reliable Experiments to Qualify Nuclear Thermal Propulsion Engine Fuels and Components

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Abstract. Nuclear thermal propulsion (NTP) technology offers a more efficient power source for interplanetary space travel than conventional chemical rockets due to the reduced weight and higher specific impulse of the NTP engine. However, the propulsion system derives its power from nuclear fission and operates under extreme conditions. During operation, hydrogen, the NTP working fluid, is constantly injected into the reactor at near-cryogenic temperatures and heated to temperatures in excess of 2,800 K. As such, reactor components such as fuel, structural components, and instrumentation must be demonstrated to properly operate in these normal, yet extreme, conditions. Early NTP developments such as the ROVER/NERVA program, built and ground-tested prototypic reactors to demonstrate and qualify these essential components. However, this approach is unfeasible and cost prohibitive today. Therefore, novel, subscale testing formats must be developed to rapidly and economically qualify and/or down select NTP core component materials. Researchers at the Oak Ridge National Laboratory have designed an out-of-pile testing apparatus that can bring specimens to prototypic NTP conditions. This apparatus is also designed to be converted to a flexible in-pile irradiation experiment for use in testing such subscale components. This paper discusses design and fabrication methodologies for the testing apparatus, current capabilities of the out-of-pile testing configuration, modifications required for in-pile testing, and results from preliminary testing experiments.

Keywords: nuclear thermal propulsion, qualification, irradiation experiments