Non-Nuclear Testing for NASA Fission Power System Technologies

Why Nuclear Fission Power Systems?

- Safe, abundant, cost effective power
- Potential for fast, efficient transportation throughout the solar system

Nuclear Thermal Propulsion (NTP)

- Nuclear thermal propulsion systems will enable human exploration of the inner solar system
  - Higher specific impulse than traditional chemical rockets
  - Shorter trip times
  - Reduced propellant mass
  - Increased payload

Fission Power Systems (FPS)

- Provide power anytime, anywhere for harsh environments where sunlight is limited
  - Conditions that are anticipated for future human missions beyond low earth orbit

Marshall Space Flight Center (MSFC) Early Flight Fission Test Facility (EFF-TF) for non-nuclear testing

- Established in 1998, the MSFC EFF-TF is designed to enable affordable development of space fission systems
  - Is the only operating facility in the U.S. capable of performing highly realistic thermal hydraulic, heat transfer, structural, safety, and integrated system testing of space nuclear systems using non-nuclear (electrical) heat sources
  - Applicable to both surface and in-space fission systems

Role of Non - Nuclear Testing

Non-nuclear testing is a system and component development strategy that dramatically lowers the cost and time needed to develop a nuclear system. Heat is provided using electrical power (resistance or induction heating) in such a way that the balance of plant can't tell the difference between the nuclear heat and the simulator.

NTP Non-Nuclear Testing

- Dedicated Fuel Materials and Processing Laboratory

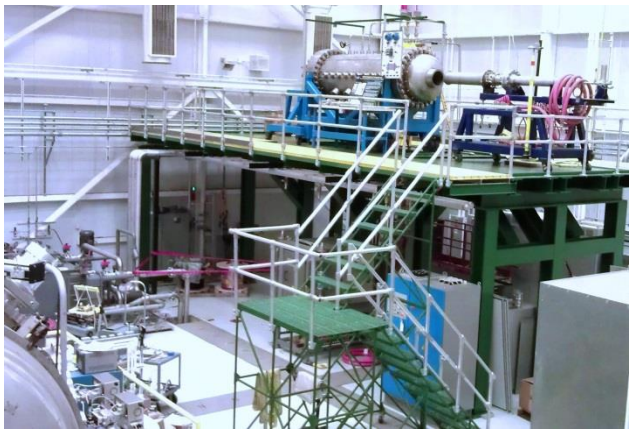
- Powder metallurgy processes
- Coated fuel particles
- Low cost fabrication of prototypes

MSFC is working with other NASA centers and the Department of Energy to optimize advanced manufacturing processes to develop and test a NTP fuel material.

Fission Power Systems Non-Nuclear Testing

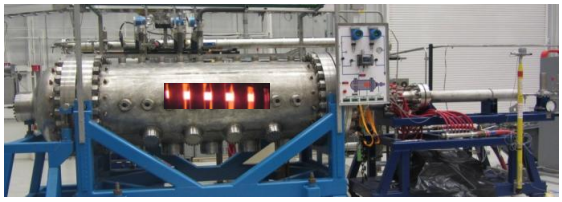
➢ Fuel Materials Testing

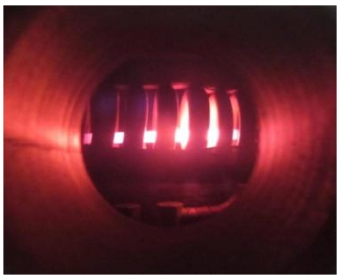
- NTP systems typically use hydrogen for propellant that is heated directly by nuclear fuel



Nuclear Thermal Rocket Element Environmental Simulator (NTREES) MSFC

- NTREES is designed and constructed to achieve test conditions that evaluate material samples which are characteristic of nuclear thermal rocket fuel elements
- Uses hot hydrogen testing capabilities to screen potential fuel materials





Checkout testing in NTREES

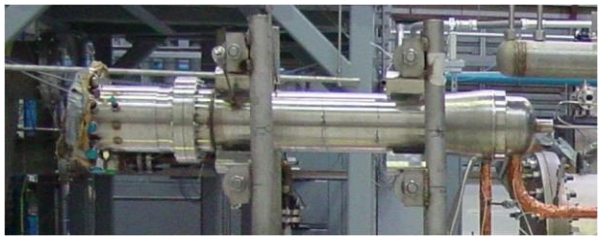
Space nuclear propulsion is a 'game changing' technology for space exploration. NTP has been identified as a critical technology need by most of the independent reviews conducted over the last fifty years for NASA human exploration to Mars and beyond, including as recently as 2011 by the National Research Council and 2013 by the NASA Technology Executive Council (NTEC).

➢ Fission Power Reactor Simulators

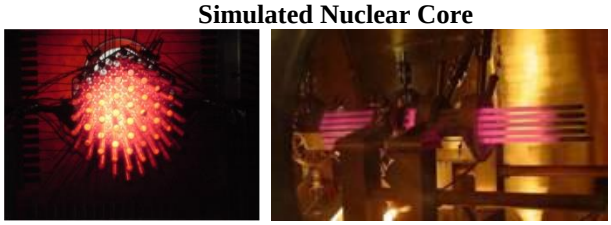
- Thermal simulators use resistance heated graphite elements that mimic operating conditions of nuclear fuel rods
- Simulators are tailored to realistic power profiles

Thermal simulators

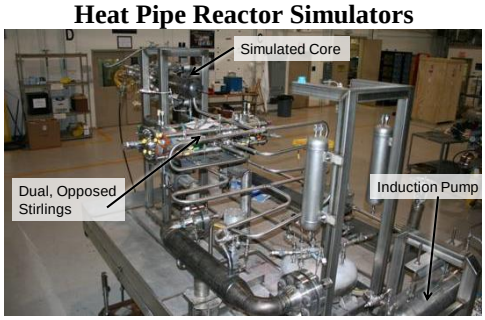
- Matches the reactor core design
- Uses carefully tailored fuel rod thermal simulators
- Simulates reactor behavior



Simulated Nuclear Core



Heat Pipe Reactor Simulators



Liquid metal reactor simulator

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