

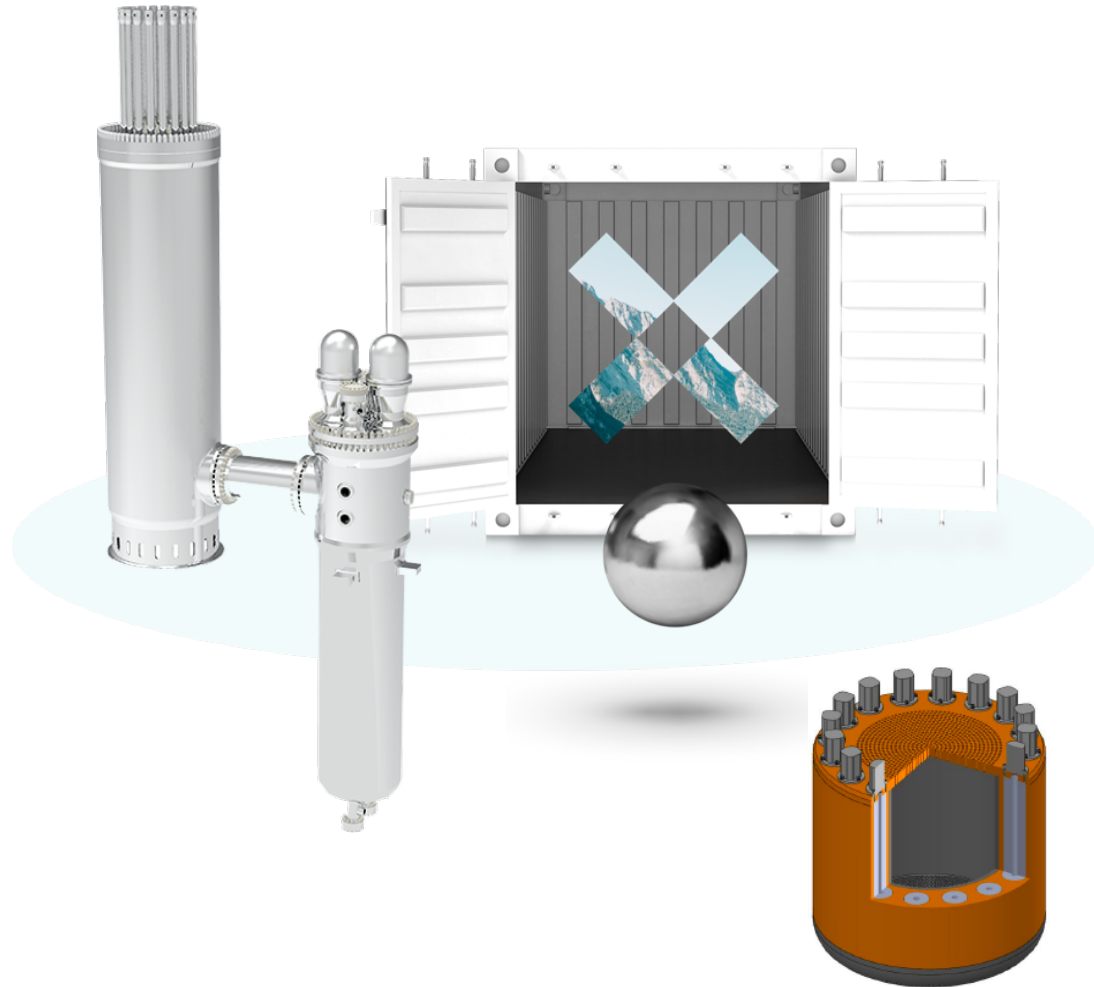


Nuclear Data Accuracy Needs for Mobile Reactors

Presented to: Organization for Economic Cooperation and Development (OECD), Nuclear Energy Agency (NEA), Nuclear Science Committee (NSC), Working Party on International Nuclear Data Evaluation Co-operation (WPEC) Subgroup 46 on the Efficient and Effective Use of Integral Experiments for Nuclear Data Validation Meeting on Target Accuracy Requirements (TARs)

***Dr. Bradley T. Rearden
Director of Engineering, Xe-Mobile***

April 14, 2021



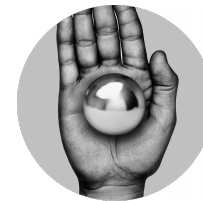
Reactor: Xe-100

We are focused on Gen-IV High-Temperature Gas-cooled Reactors (HTGR) as the technology of choice, with advantages in sustainability, economics, reliability and safety. We have completed conceptual design and entering the Basic Design Phase of design development.



Reactor: Xe-Mobile

To address the need for ground, sea and air transportable small power production. We've completed the preliminary design of this nuclear fission-based power generation system, with potential applications to DOD, civilian government, remote community, and critical infrastructure applications.



Fuel: TRISO-X

Our reactors use tri-structural isotropic (TRISO), ceramic-coated particle fuel, developed and improved over 60 years of R&D and commercial production. We manufacture our own proprietary version (TRISO-X) to ensure commercial supply quantities and quality control.



Space Applications

NASA, DOE, and DOD are exploring our reactor and fuel technologies for nuclear thermal propulsion, nuclear electric propulsion, and fission power for lunar and Mars surface continuous electricity delivery.



X-energy: Success Building On Success

AR ENERGY About Us REACTOR TECHNOLOGIES INITIATIVES INFORM

Office of Nuclear Energy

U.S. Department of Energy Announces \$160 Million in First Awards under Advanced Reactor Demonstration Program

OCTOBER 13, 2020

Home » U.S. Department of Energy Announces \$160 Million in First Awards under Advanced Reactor Demonstration Program

WASHINGTON, D.C. – The U.S. Department of Energy (DOE) today announced it has selected two U.S.-based teams to receive \$160 million in initial funding under the new [Advanced Reactor Demonstration Program](#) (ARDP). ARDP, announced in May, is designed to help domestic private industry demonstrate advanced nuclear reactors in the United States.

DOE is awarding TerraPower LLC (Bellevue, WA) and X-energy (Rockville, MD) \$80 million each in initial funding to build two advanced nuclear reactors that can be operational within seven years. The awards are cost-shared partnerships with industry that will deliver two first-of-a-kind advanced reactors to be licensed for commercial operations. The Department will invest a total of \$3.2 billion over seven years, subject to the availability of future appropriations, with our industry partners providing matching funds.

X-energy to work with Ontario Power Generation to advance clean energy technology in Canada



NEWS PROVIDED BY
[X-energy](#) →
Oct 06, 2020, 15:38 ET

TORONTO, Oct. 6, 2020 /PRNewswire/ -- X-energy is pleased to announce that it has been selected to advance the engineering and design work of the Xe-100

IMMEDIATE RELEASE

Strategic Capabilities Office Selects Two Mobile Microreactor Concepts to Proceed to Final Design

MARCH 22, 2021



The Department of Defense (DOD) exercised contract options for two teams— led by BWXT Advanced Technologies, LLC, Lynchburg, Virginia; and X-energy, LLC, Greenbelt, Maryland—to proceed with development of a final design for a transportable advanced nuclear microreactor prototype. The two teams were selected from a preliminary design competition, and will each continue development independently under a Strategic Capabilities Office (SCO) initiative called Project Pele.

After a final design review in early 2022 and completion of environmental analysis under the National Environmental Policy Act, one of the two companies may be selected to build and demonstrate a prototype. This selection follows an April 2019 request for solutions through which three companies were awarded competitively other transaction agreements for prototyping to develop preliminary designs.



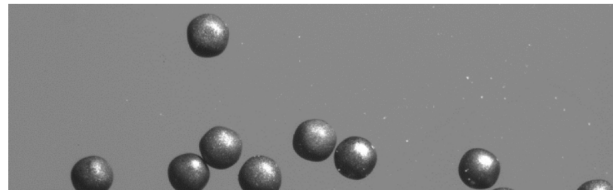
Energy & Environment | New Nuclear | Regulation & Safety | Nuclear Policies | Corporate | [Uranium & Fuel](#) | [Nuclear Power](#)

X-energy and NFI team up to supply HTGR fuel

30 June 2020



US company X-energy has announced it is to be the exclusive counterparty to supply fuel to Japan's high-temperature gas-cooled reactor under a teaming arrangement with Nuclear Fuel Industries (NFI) of Japan.





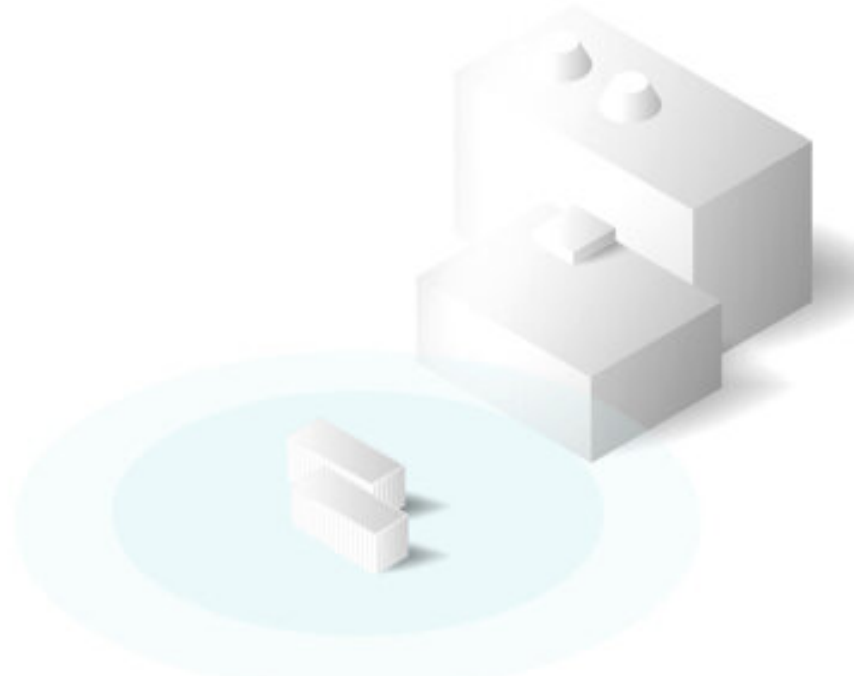
X-energy's Novel Applications of Microreactors



Defense & forward bases

As the US Military prepares for “near-peer” adversaries of the future, highly portable power with a high energy density will be a game-changing technology.

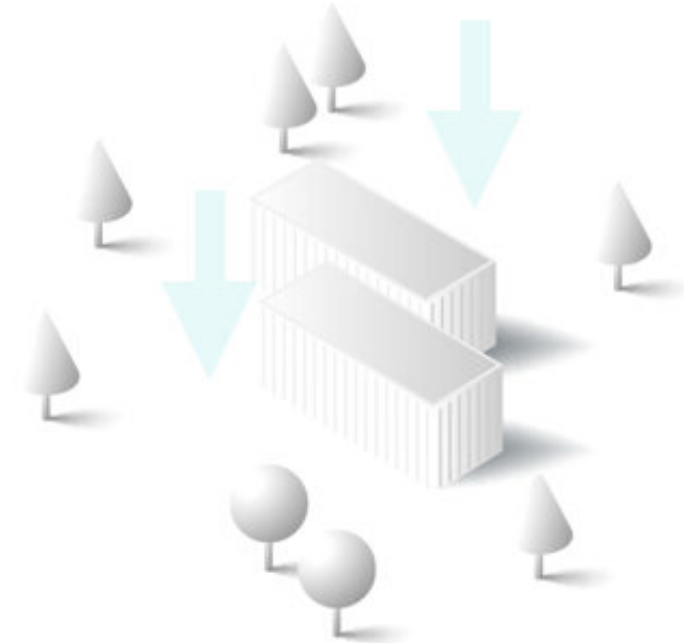
Highly Portable Power



Disaster Relief

The ability to transport flexible electricity solutions that do not require fueling for months or years provides critical infrastructure to get railroads, water purification facilities, and hospitals powered again – within one week.

Be powered again – within one week



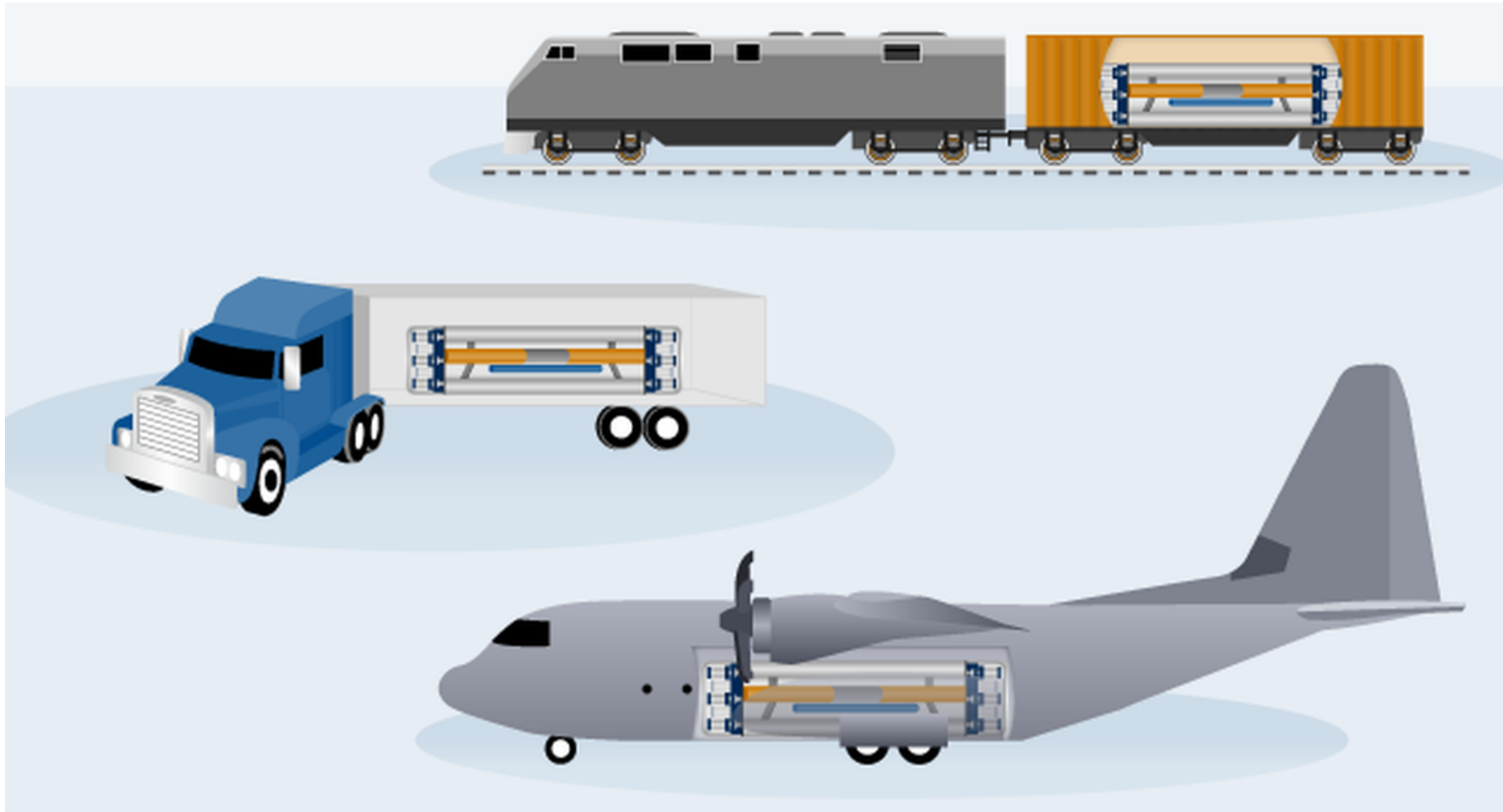
Remote Communities

Arid, Island and Alaskan/Canadian communities often use government-subsidized petroleum fuel deliveries to maintain their power. If their deliveries are disrupted, the impact can be significant.

Maintain Power



Portable Microreactors will be in close contact with people before, during, and after operation



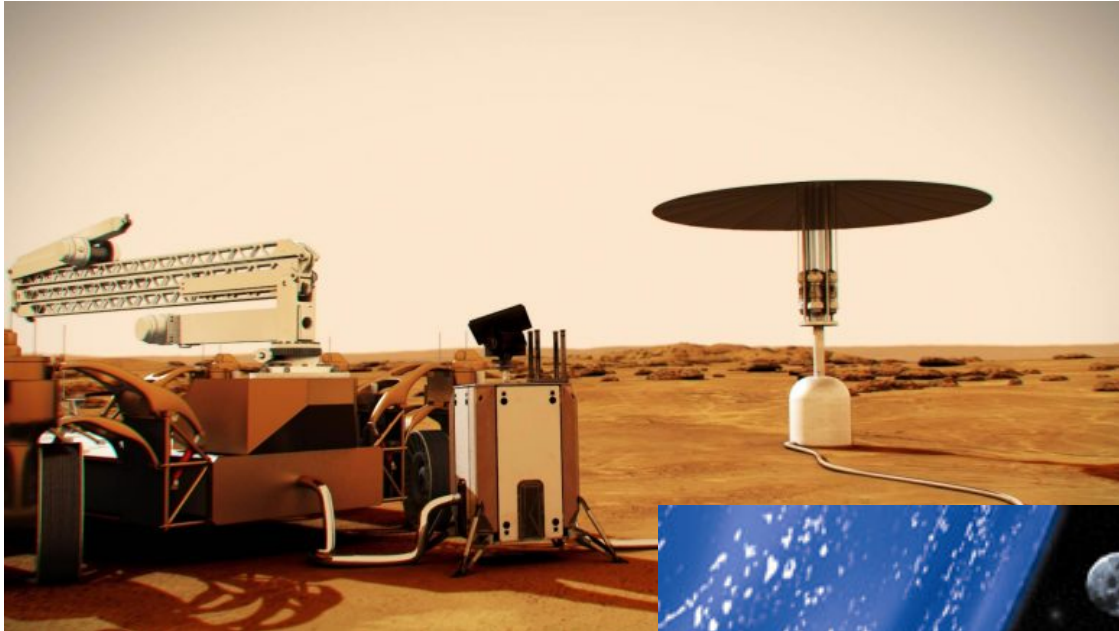
Source: GAO. | GAO-20-380SP

These concepts from the Government Accountability Office show potential ideas for transport and deployment. (U.S. Government Accountability Office)

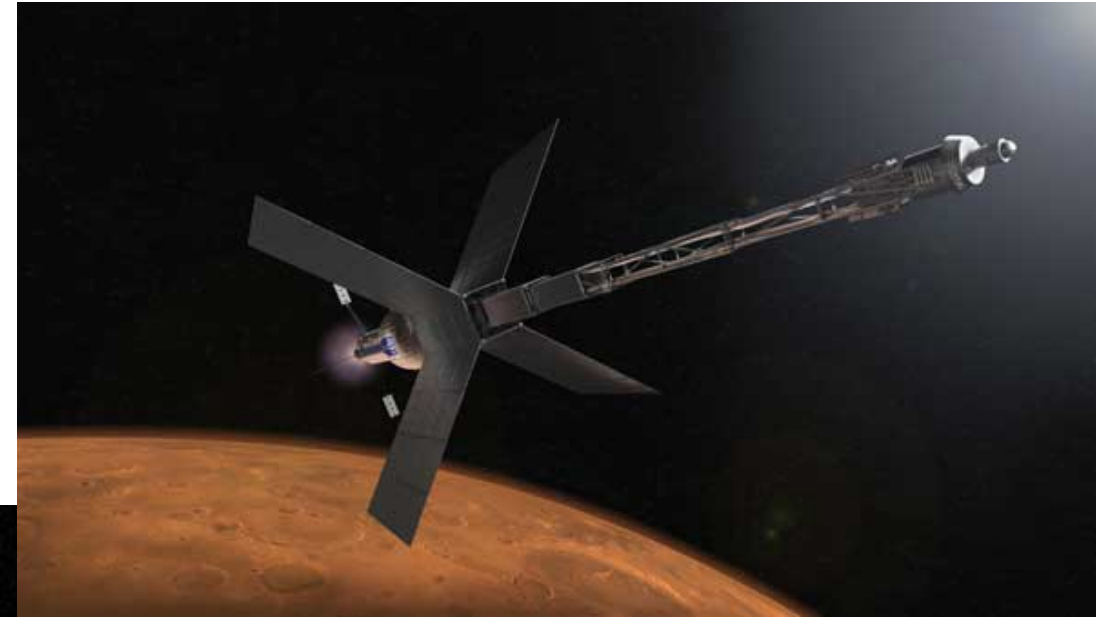


Emerging Opportunities in Space Nuclear Applications

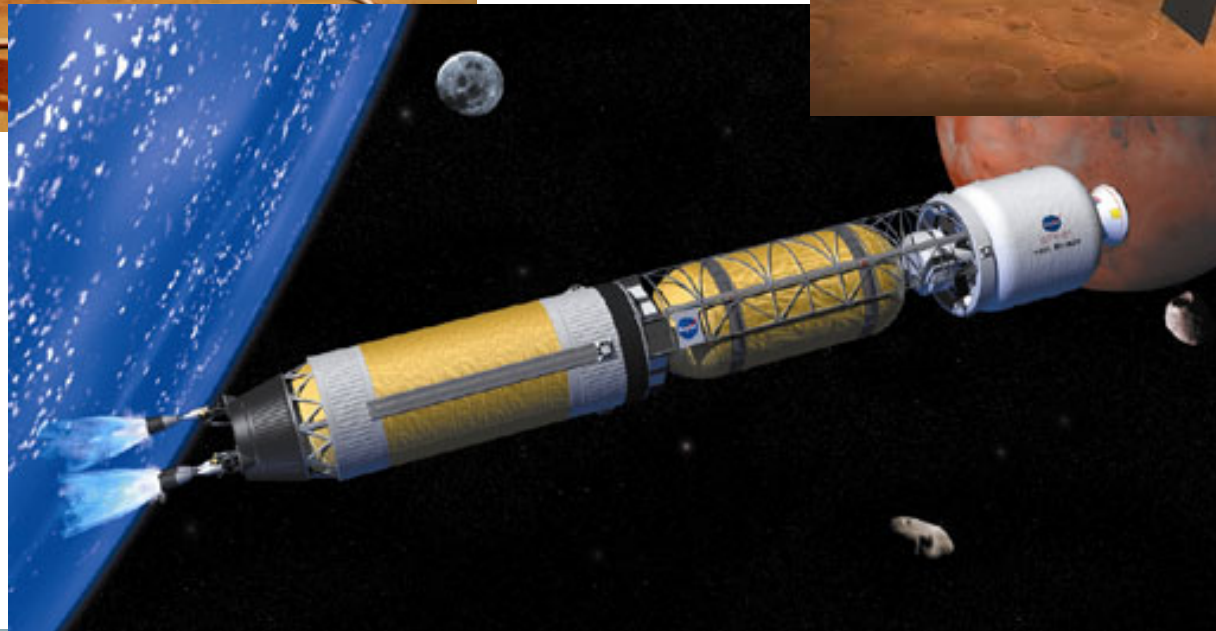
Fission Surface Power System



Nuclear Electric Propulsion



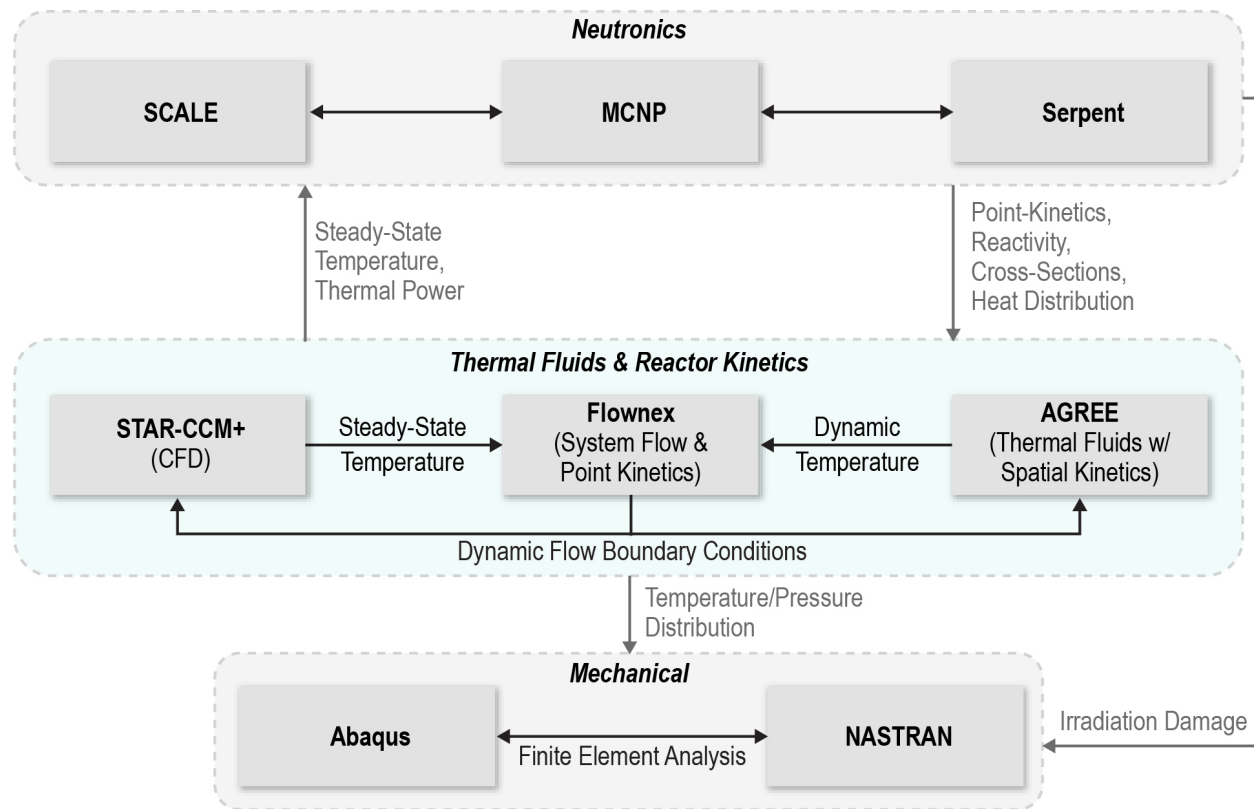
Nuclear Thermal Propulsion



Images: NASA



Nuclear data provide a foundation for performance and safety analysis



Analysis	Tool/Model	Analysis Type	Outcome
Core neutronics	SCALE/ KENO/ORIGEN	Steady-state Monte Carlo neutron transport and transmutation	Power Profiles, Core life, Burnable poison design, Temperature and control element reactivity
Cross section generation	Serpent	Steady-state Monte Carlo neutron transport	Generated few-group cross sections for AGREE-Xe and verified reactivity results from SCALE and MCNP
Photon/Neutron Transport	MCNP	Steady-state Monte Carlo neutron and photon transport	Ex-core heating rates
Reactor Thermo-fluid Analysis	StarCCM+	High fidelity heat conduction and thermo-fluid dynamic behavior	Spatially resolved temperatures and coolant flow rates
Coupled neutronic-thermal fluid analysis	AGREE-Xe	Steady-state and time-dependent neutron diffusion/heat conduction/ subchannel fluid behavior	Peak and average temperatures of structures during transient scenarios
Plant Dynamics	Flownex	Steady-state and time-dependent analysis of plant-wide behavior	Plant/Reactor response to perturbations and fault conditions. Startup, shutdown, and critical power maneuvers
Shielding	SCALE/ MAVRIC/ ORIGEN	Steady-state neutron and gamma transport, activation, decay	Ex-vessel dose and activation rates
Structural Dynamics	NASTRAN	Dynamic Finite Element Analysis	Static-equivalent accelerations to be used for stress analysis, Load Isolation System evaluation
Mechanical and thermal stress	Abaqus	Steady-state Finite Element Analysis	FEA-calculated stresses, to be compared against material allowables to determine if the parts meet design requirements



Concerns with changes in ENDF/V-III.0 without consideration for reactor applications

Nuclear Data Performance Assessment for Advanced Reactors

ORNL/TM-2018/1033

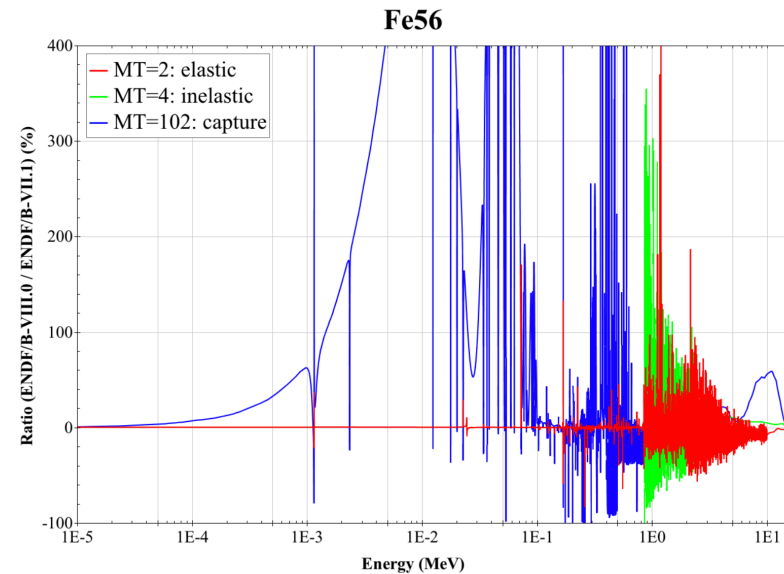
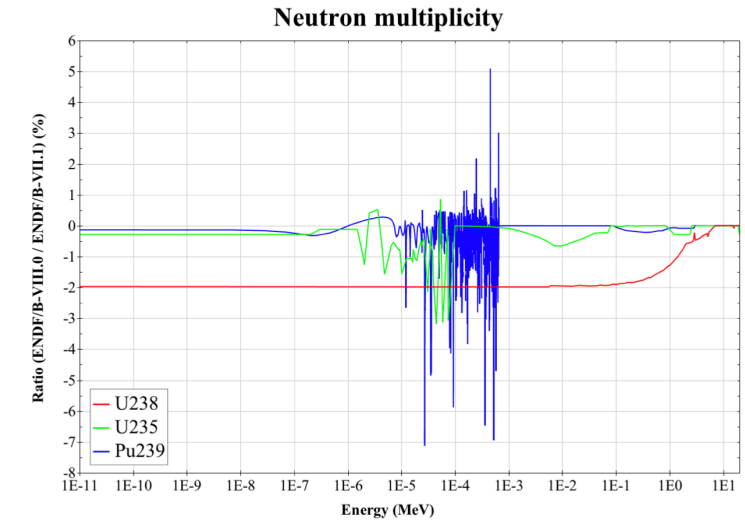
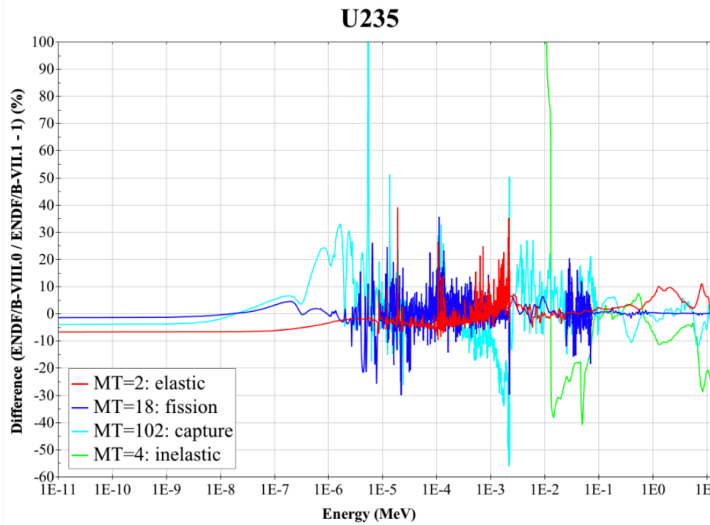


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March 2019

Approved for public release.
Distribution is unlimited.

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY





Needs for Validated Nuclear Data

- **Accurate reaction rates for every nuclide, not just integrated k_{eff}**
 - Power distribution
 - Reactivity control and shutdown margin
 - Doppler feedback
- **Fission product inventories, with accurate data for individual and cumulative yields**
 - Power and lifetime
 - Reactor kinetics
 - Xenon transients
 - Decay heat source terms for inherent safety confirmation
 - Radionuclide source terms for AOO, DBE, and BDBE analysis
 - Volatile radionuclide source terms for lift-off and plate analysis
- **Secondary radiation generation and deposition**
 - Prompt neutrons and gammas from fission
 - Gamma emissions from fission product decay
 - Neutron capture and gamma emission data
 - Material activation and decay
 - Neutron and gamma attenuation
 - Energy deposition in all materials
- **Thermal scattering law data**
 - Improved graphite data that could be used outside of ENDF/B-VIII.0
 - Advanced moderators/reflectors are needed for small HA-LEU cores
 - NTP systems approach 3000 K for fuel and structural materials with H₂ as internal propellant
- **Irradiation damage assessment is needed for wide range of materials**
 - Damage cross sections are not available in ENDF libraries