U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Nuclear Energy University Programs (NEUP) Fiscal Year (FY) 2017 Annual Planning Webinar

Mission Supporting Transformative Research Reactor Concepts RD&D (MS-RC1)

Office of Advanced Reactor Technologies

August 2016

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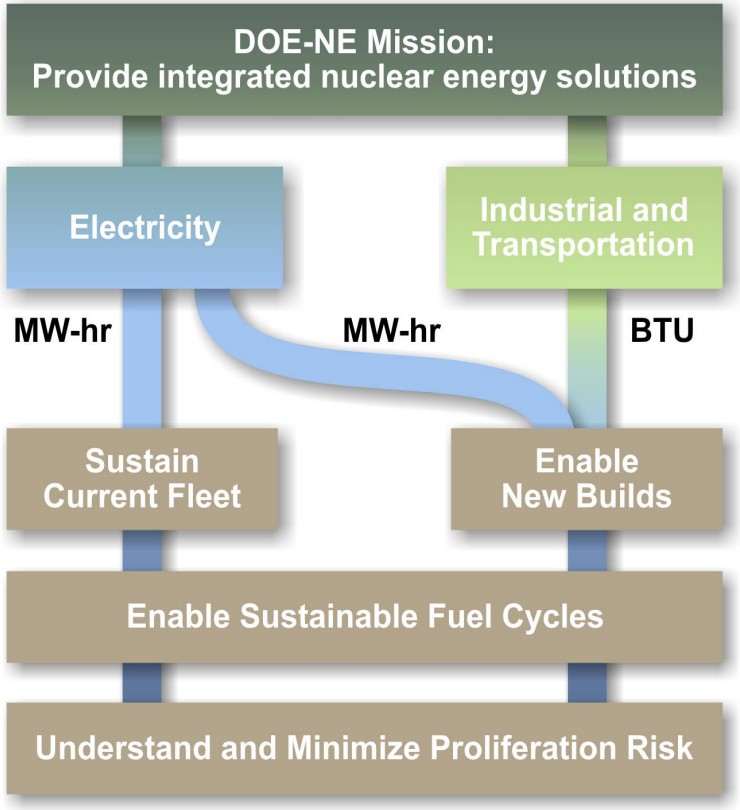
Office of Nuclear Energy Roadmap R&D Objectives

- **Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors**
- **Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals**
- **Develop sustainable nuclear fuel cycles**
- **Develop capabilities to reduce the risks of nuclear proliferation and terrorism**



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Office of Nuclear Reactor Technologies

- **Mission: Keep current fleet operating safely and develop new nuclear technologies for deployment**
  - Promote technologies that have greatest promise to enable new nuclear power
  - Conduct R&D to maintain safe operation of existing fleet
  - Honor commitments to other Federal agencies, International partners and universities
  - Maintain unique capabilities and facilities to support future USG policy decisions and industry needs
  - Explore new high-risk, high-reward technologies
- **NE- 7 consists of three Offices:**
  - NE-72: Light Water Reactor Technologies – Tom Miller (Acting)
  - NE-74: Advanced Reactor Technologies (ART) – Tom O'Connor
  - NE-75: Space and Defense Power Systems – Alice Caponiti
- **Research activities are designed to address technical, cost, safety, and security issues associated with various reactor concepts**

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Reactor Concepts Portfolio

Office of Science and Technology Innovation
NE-4

Office of Fuel Cycle Technologies
NE-5

Deputy Assistant Secretary for Nuclear Reactor Technologies NE-7

Light Water Reactor Technologies

- LWRS
- SMR LTS

Advanced Reactor Technologies

- Fast Reactor Technologies
- High Temperature Reactor Technologies
- Advanced Reactor Generic Technologies
- Advanced Reactor Licensing Framework
- Advanced Reactor System Studies

Space and Defense Power Systems

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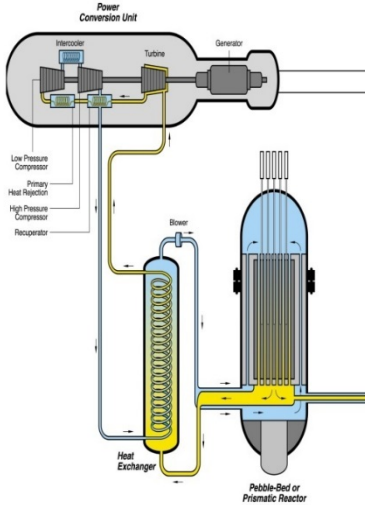
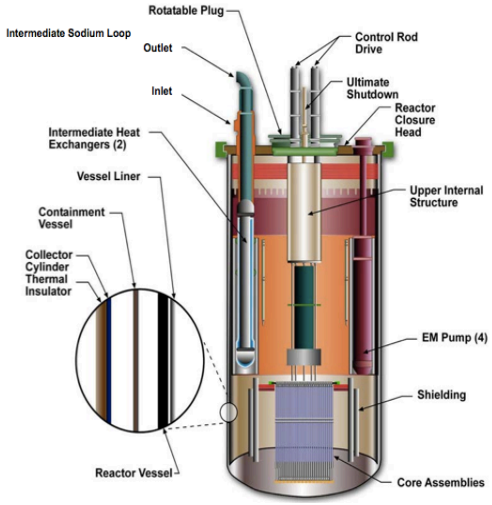
ART Focus Areas

- **Fast Reactor Technologies**
  - For actinide management and electricity production
  - Current focus on sodium coolant
- **High Temperature Reactor Technologies**
  - For electricity and process heat production
  - Current focus on gas- and liquid salt-cooled systems
- **Advanced Reactor Generic Technologies**
  - Common design needs for advanced materials, energy conversion, decay heat removal systems and modeling methods
- **Advanced Reactor Regulatory Framework**
  - Development of licensing requirements for advanced reactors
- **Advanced Reactor System Studies**
  - Analyses of capital, operations and fuel costs for advanced reactor types





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ART Research Questions

Working to address several high level questions to advanced reactor development and deployment:

- How can we improve **affordability** of nuclear power?
- How can we improve **inherent safety** of advanced nuclear reactors?
- How can we improve **proliferation resistance** of advanced reactors?
- How can we address nuclear waste through **advanced fuel cycle** options?
- How can we expand into **non-traditional nuclear energy markets**?
- How can we **increase performance and efficiency** through new materials, advanced systems or components?

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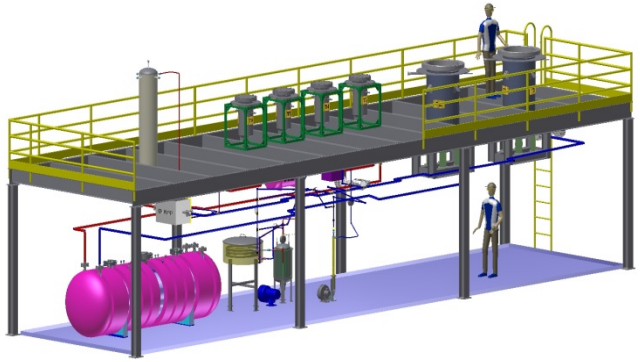
Fast Reactor Technologies

- **Concept Development and Technology Maturation**
  - Assessments to guide innovative R&D
  - Conduct of small-scale sodium fast reactor component testing at Materials Engineering Testing Laboratory (METL)



- **Advanced Materials**
  - Intermediate term testing of two candidate alloys currently in progress
- **Advanced Energy Conversion Interface System**
  - Sodium to Supercritical CO_2 Interaction loop at ANL
- **Safety and Risk Reduction**
  - Licensing aspects
  - Capital Cost Risk Reduction (International Collaborations and Industry Partnerships)
- **Ultrasonic Viewing Technology**
  - Key for under-sodium inspection

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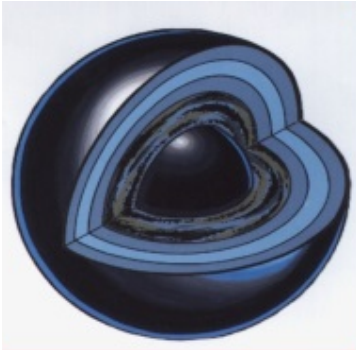
High Temp Reactor Technologies
High Temp Gas Reactor (HTGR)

- **Fuel Qualification**
  - Ongoing work to establish licensing basis for coated particle fuel (TRISO) and commercial fabrication capability
  - Accident testing performed at 1600°C, 1700°C and 1800°C with no failures



- **Passive Decay Heat Removal Modeling**
  - Natural Convection Shutdown Heat Removal Test Facility (NSTF) at ANL evaluates ex-vessel passive decay heat removal system performance
  - High Temperature Test Facility (HTTF) at Oregon State University will verify and validate thermal fluids modeling programs from fuel to pressure vessel wall

- **Materials**
  - High temperature materials
  - Graphite

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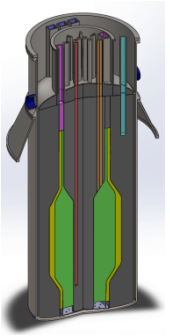
High Temp Reactor Technologies
Fluoride High Temp Reactor (FHR)



- **FHR R&D primarily funded through Integrated Research Projects (IRPs)**
  - Two Recent IRPs awarded in 2014 to investigate key technology and design challenges associated with FHRs
    - Team from Massachusetts Institute of Technology, University of California, Berkeley, and the University of Wisconsin on materials, neutronics, and tritium management
    - Team from Georgia Institute of Technology on licensing and technology challenges
- **International Collaboration**
  - Collaborations with China on their FHR test reactor activities
  - Collaborations with Czech Republic to support their test program with salts provided by DOE in 2013

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Mission Supporting Reactor Concepts Work Scope Description (MS-RC1)

REACTOR CONCEPTS RD&D (MS-RC1) (FEDERAL POC – CARL SINK, TECHNICAL POC – PHIL SHARPE)

Development of new reactor concepts that may offer the potential for *revolutionary improvements to reactor performance and/or safety* is sought. Such advanced reactor concepts could include:

- **Incorporation of advanced systems or components into existing concepts (e.g. Generation-IV systems)**
- **Inclusion of innovative design alternatives (e.g., new fuel type, nano-engineered coolants, etc.)**
- **Designs employing radically different technology options (e.g., advanced coolants, fuel, or operational regimes).**
- **Reactors with unique capabilities to address operational missions other than the delivery of base load electric power, such as desalination or mobile reactors**

The scope of the proposed project should include an assessment of the concept's technical viability, a detailed technology gap analysis, and a comprehensive technology development roadmap that identifies research needed on key feasibility issues.

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Recent MS-RC1 Awards

FY16

- Experimental and Modeling Investigation of Overcooling Transients that include Freezing, in Fluoride-Salt Cooled High-Temperature Reactors (FHRs)

FY15

- Enhanced Performance Fast Reactors with Engineered Passive Safety System

FY14

- Feasibility assessment of an innovative compact reactor concept that integrates power production, power conversion and electricity generation in a single unit

FY13

- Feasibility study of breed and burn pebble-bed metal cooled reactor offering a significant increase in the uranium ore utilization versus contemporary light water reactors without need for fuel reprocessing and recycling.
- Tritium mitigation and control systems for FHRs.

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FY 2017 MS-RC1 Summary

- **A variety of reactor technologies are being pursued in the current DOE-NE R&D portfolio**
  - High temperature gas-cooled and sodium-cooled reactors
  - Liquid salt reactors via FY 2011 IRP and FY 2014 IRP
  - Different technologies reviewed by Technical Review Panel http://www.energy.gov/sites/prod/files/2014/12/f19/Advance%20Reactor%20Concepts%20Technical%20Review%20Panel%20Public%20Report.pdf

- **MS-RC1 scope includes**
  - Major innovations to advanced reactors concepts
    - Advanced systems or components
    - New fuel types or engineered coolants
  - Radically different (new) technology options
    - Innovative operating regimes
    - Unique capabilities other than base-load electric production

Questions?