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
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
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
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

Office of Science and Technology Innovation
NE-4

Office of Fuel Cycle Technologies
NE-5
**ART Focus Areas**

**Nuclear Energy**

- **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
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?
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
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
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
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.
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.
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

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?