

BRIEFING ON ADVANCED REACTOR PREPAREDNESS THROUGH REGULATORY ENGAGEMENT AND RESEARCH COOPERATION



April 13, 2021

▶ Opening Remarks

Margaret Doane

Executive Director for Operations





"The research and guidance development we're preparing right now will ensure safe and secure licensing of advanced reactor fuel cycles in the near future."

Andrew Barto, NMSS

OUR PEOPLE OUR GREATEST ASSEST

"Extensive stakeholder outreach enables openness and transparency in considering broad perspectives from various advanced reactor stakeholders."

Jordan Hoellman, NRR



"RES is actively building technical review capabilities to support advanced reactors when applicants are ready."

Kimberly Webber, RES

"NSIR stands ready to support the deployment of advanced reactors with forward-thinking policy and guidance needs on emergency planning and security."

Steven Vitto, NSIR



AGENDA

01.

02.

03.

04.

05.

**Advanced Reactor
Program Overview**

Robert Taylor
Deputy Director for
New Reactors, NRR

**Advanced Reactor
Research**

Raymond Furstenau
Director, RES

**Advanced
Materials**

Raj Iyengar
Chief, Component
Integrity Branch, RES

**Advanced Reactor
Fuels**

Marilyn Diaz
Chemical Engineer,
NMSS

**Advanced Reactor
Licensing**

Michelle Hayes
Chief, Advanced Reactor
Technical Branch, NRR

Advanced Reactor Program Overview

Robert Taylor

Deputy Director for New Reactors
Office of Nuclear Reactor
Regulation



The NRC is strategically transforming and modernizing to prepare for safe deployment of

ADVANCED REACTORS

Stakeholder
Engagement



Transforming
Our Workforce



Strategic
Policymaking



Modernizing
Our Tools



Supporting
Innovation



Flexible
Review Strategies



NRC is Preparing for an Increase in Advanced Nuclear Technology Licensing

EVOLVING LANDSCAPE

Research and Test Reactors

Molten Salt Reactors

Small Modular Reactors

High-Temperature Gas-Cooled Reactors

Liquid Metal Cooled Fast Reactors

13+

Current and potential applications by 2027

6+

Potential operating licenses by 2027

- 10** Entities actively engaged in pre-application activities
- 17** Topical reports and white paper reviews completed for 7 vendors
- 20** Topical reports and white papers under evaluation from 8 vendors



LICENSING ACTIVITIES

Executing the Vision



Knowledge, Skills,
and Capability



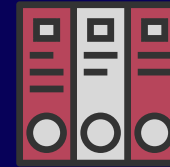
Flexible Review
Processes



Computer Codes
& Review Tools



Policy and
Technical Issues



Consensus Codes
and Standards



Communications

Fostering Partnerships

Sharing experience and knowledge to enhance our regulatory processes and decision-making



Moving Forward: 2021 and Beyond

Making **SAFE** Use of Nuclear Technology **POSSIBLE**

Advanced Reactor Research

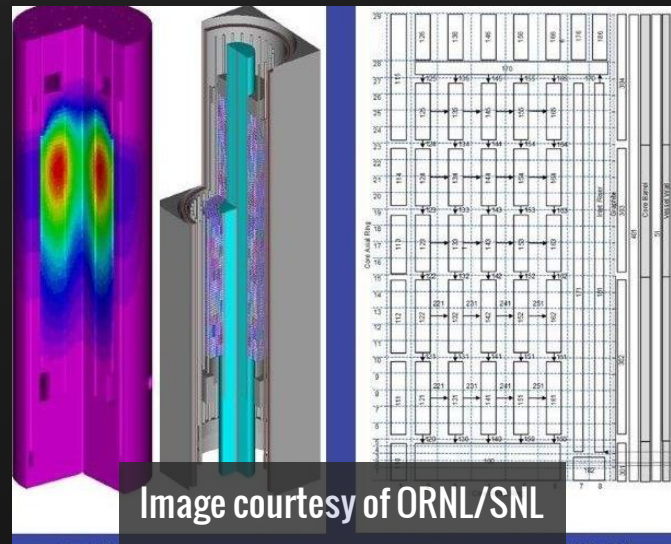
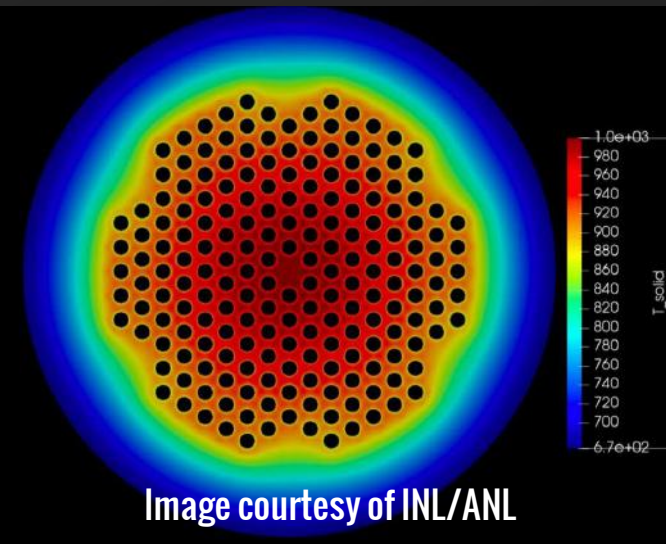
Raymond Furstenau

Director

Office of Nuclear Regulatory
Research



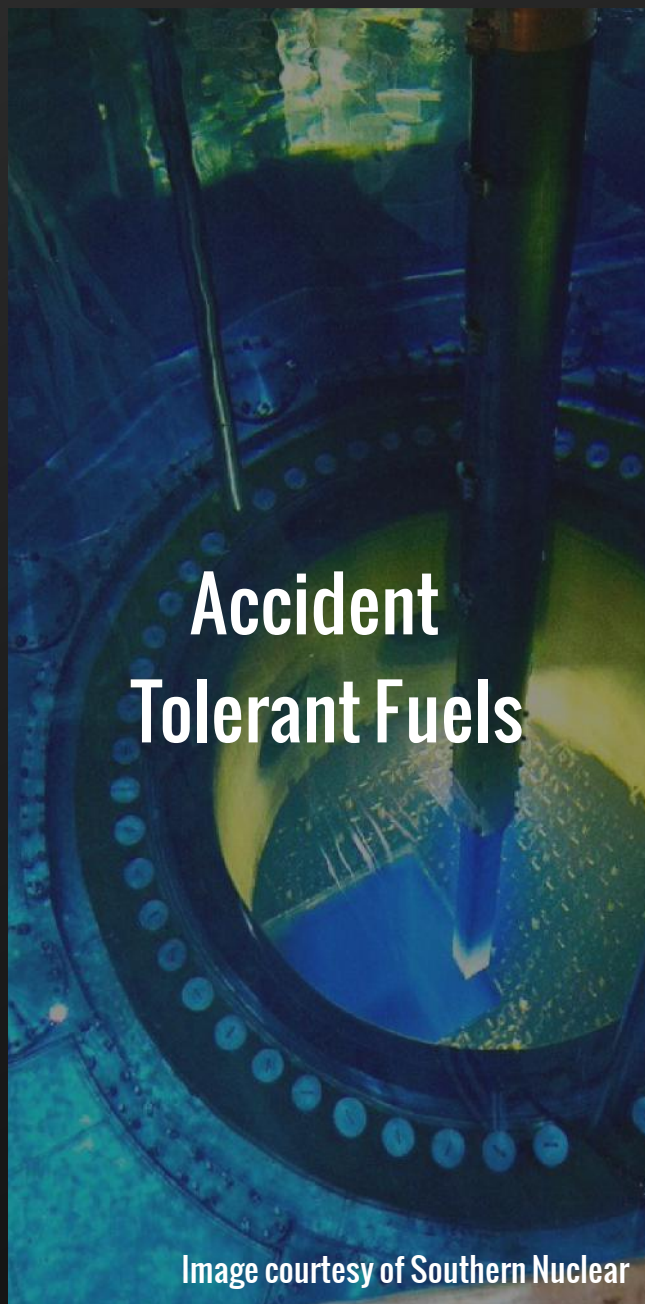
Research to Support Advanced Reactor Licensing Readiness



- Code Development Plans
- Reference Plant Models

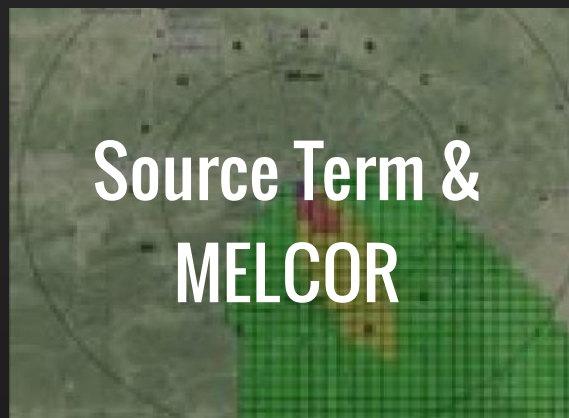
- Technical Basis and Consensus Standards
- Technical Expertise





**Accident
Tolerant Fuels**

Image courtesy of Southern Nuclear



**Source Term &
MELCOR**



**National Reactor
Innovation Center**

Image courtesy of NRIC

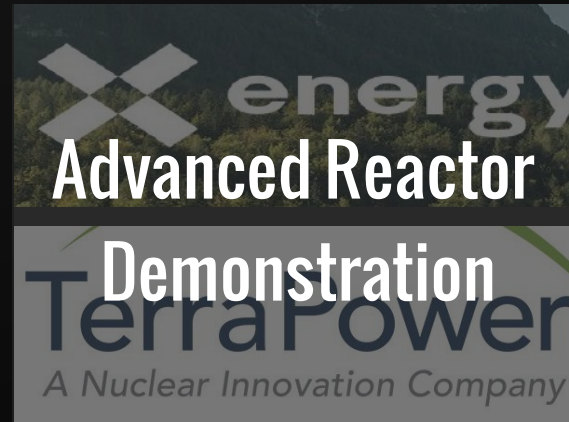


**Cooperating with the
Department of Energy**



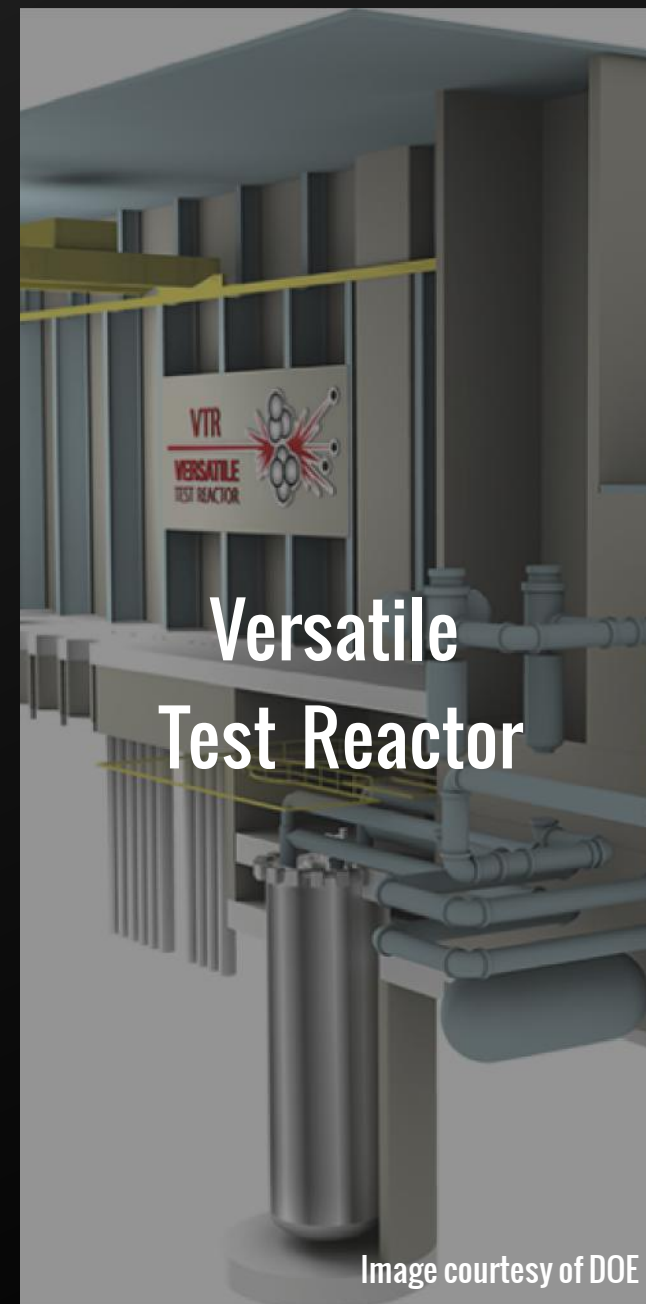
**Modeling and
Simulation Tools**

Image courtesy of INL



**Advanced Reactor
Demonstration**

A Nuclear Innovation Company



**Versatile
Test Reactor**

Image courtesy of DOE

Regulatory Research Innovation

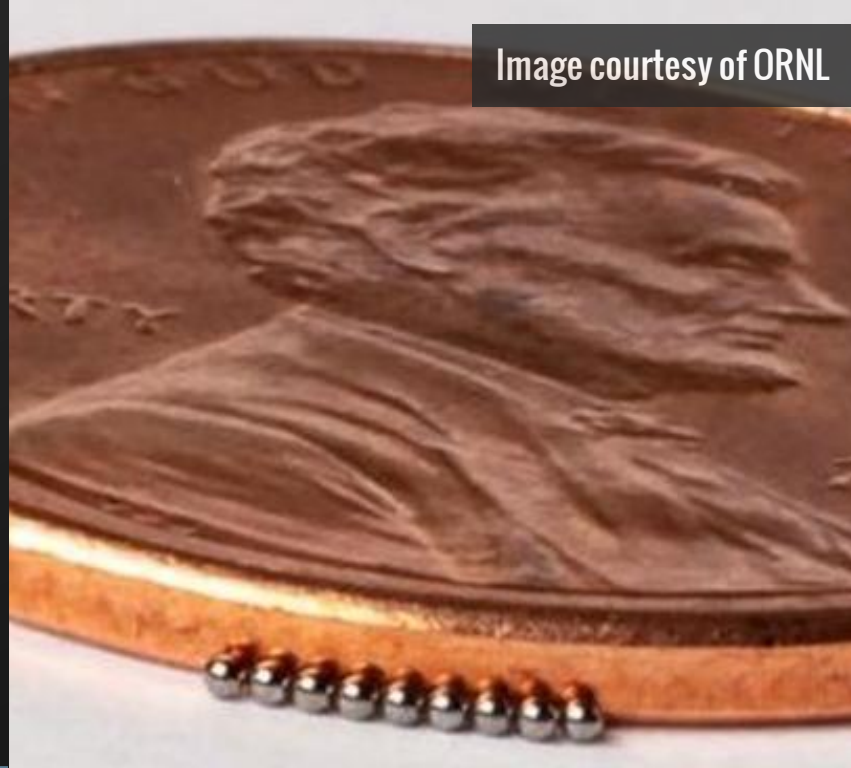


Image courtesy of ORNL

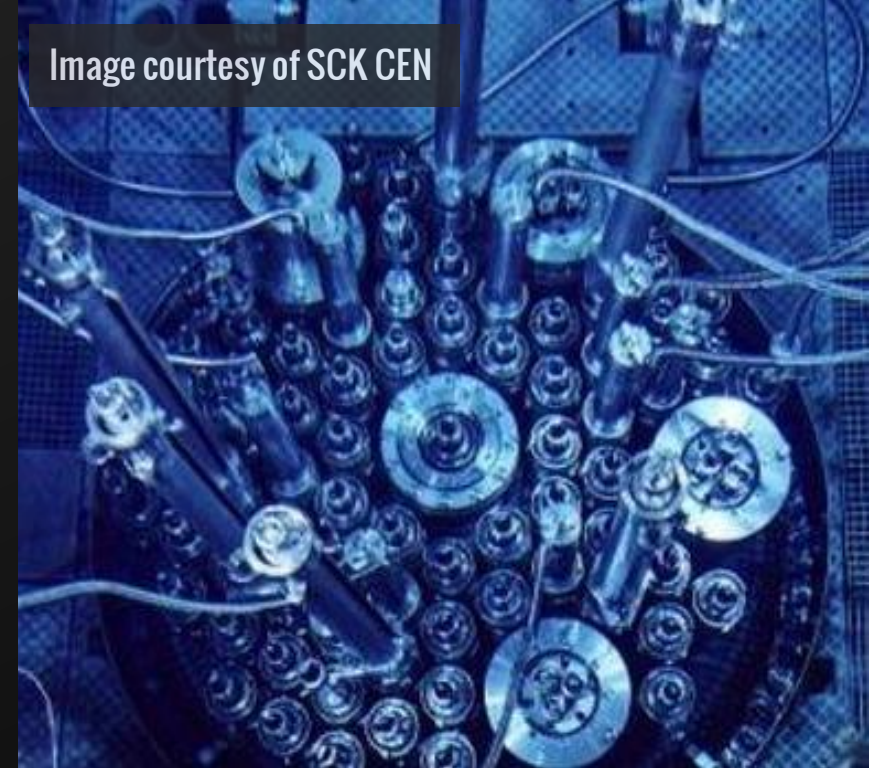


Image courtesy of SCK CEN



Accelerated Fuel Qualification



International Collaboration



University Programs

Advanced Reactor Materials

Raj Iyengar

Chief, Component Integrity Branch
Division of Engineering
Office of Nuclear Regulatory
Research





Technical Reports

Molten Salt Compatibility
Advanced Materials
Graphite



Computational Tools

Creep-Fatigue of Metals
Graphite Aging

(a)
Image courtesy of Noel N. Nemeth



Codes and Standards Assessments

ASME Section III,
Division 5



Workshops

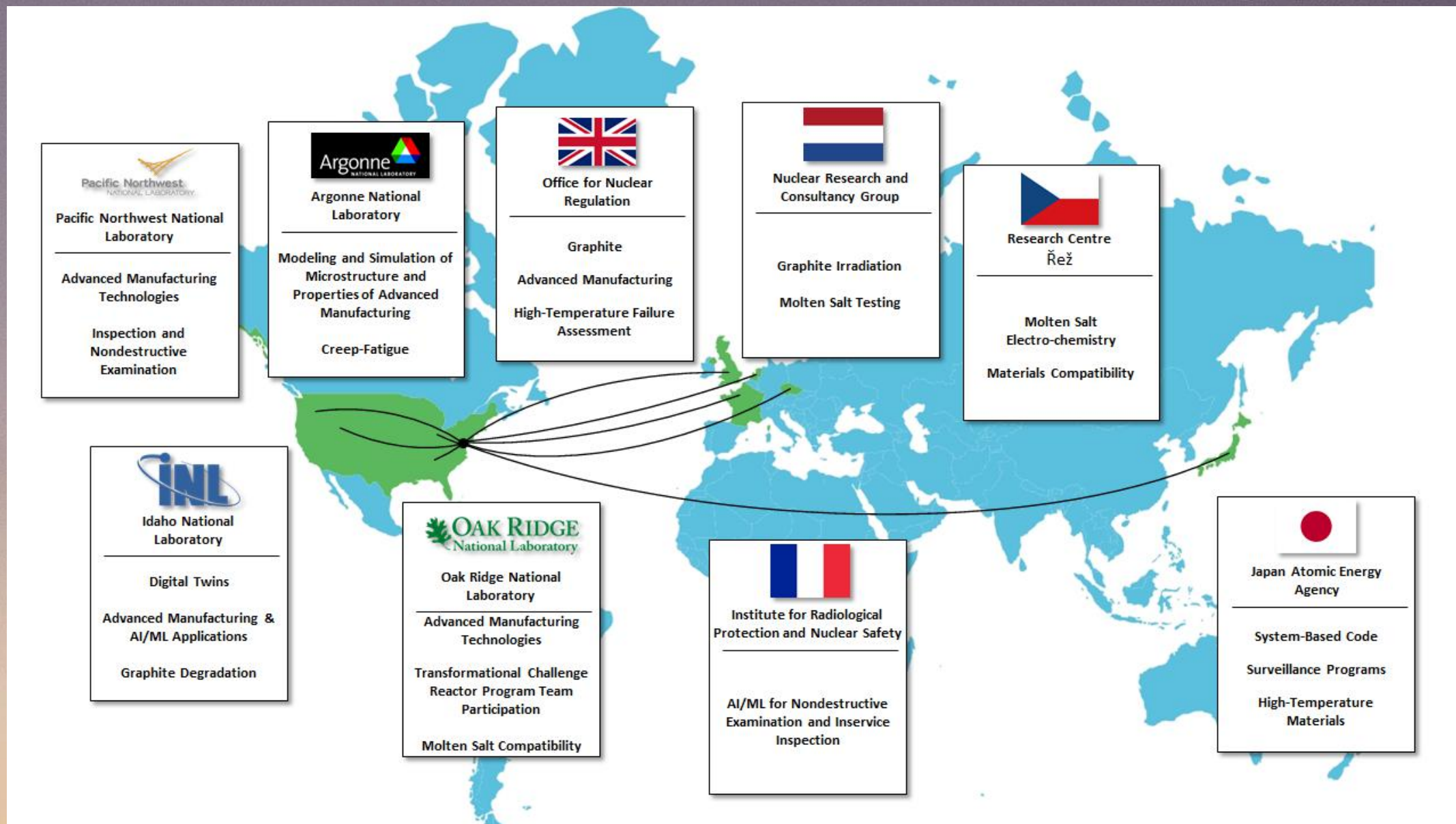
Advanced
Reactor
Materials and
Component
Integrity

AMT for
Nuclear
Applications

Advanced Materials

- Enhancing staff readiness for review of materials and components
- Proactively assessing technical issues and regulatory impacts
- Making significant progress with early successes

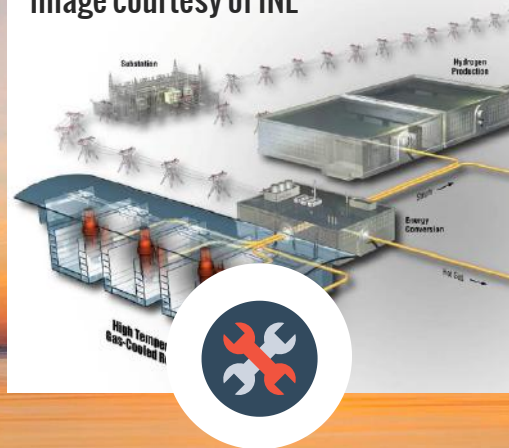
Leveraging Research Activities



Where Are We Heading?



Image courtesy of INL



Addressing

Technology-specific
and materials-
specific aspects



Collaborating

Acquiring data and
information to aid
staff's independent,
risk-informed
assessments



Assessing

Advanced technologies
impacting uncertainties
and risks

Advanced Reactor Fuels

Marilyn Diaz

Chemical Engineer
Division of Fuel Management
Office of Material Safety and
Safeguards



Making Progress in Licensing Advanced Reactor Fuels and Transportation

- Leveraging operational experience
- Using risk insights to guide our decision making



Images courtesy of DOE and X-Energy



ENSURING REGULATORY PREPAREDNESS

**Providing regulatory
flexibility**

**Addressing technical
complexities associated
with some fuels**

**Ensuring our readiness
by developing a strategy
plan**

**Preparing our
people**


Engaging Our Stakeholders To Leverage Information And Best Practices

A circular image showing a white semi-transparent circle with the text "Nuclear Fuel Industry" overlaid on a background of industrial nuclear fuel rods.

Nuclear Fuel
Industry

A circular image showing a white semi-transparent circle with the text "Members of the Public" overlaid on a background of a group of people in a meeting.

Members of
the Public

A circular image showing the official seal of the United States Department of Energy, which includes an eagle and the text "DEPARTMENT OF ENERGY" and "UNITED STATES OF AMERICA". A white semi-transparent circle with the text "Federal Partners" is overlaid.

Federal
Partners

A circular image showing a white semi-transparent circle with the text "International Community" overlaid on a background of a large, ornate building, likely a government or international organization headquarters.

International
Community

Advanced Reactor Licensing

Michelle Hayes

Chief, Advanced Reactor Technical Branch
Division of Advanced Reactors and Non-power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

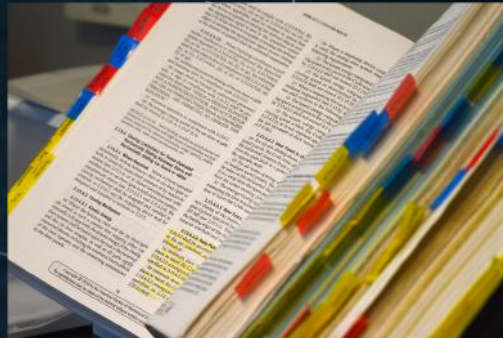


Advanced Reactor Licensing

Use of Research Tools



**Analytical Codes
and Models**



**Consensus Codes
and Standards**



**Advanced
Manufacturing Plan**

Image courtesy of ORNL

International Regulatory Cooperation

Leveraging SMR activities across the globe to enhance safety, security and efficiency in our reviews

Participation in International Communities

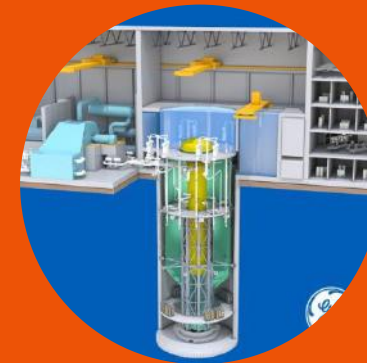


- IAEA - SMR Regulators Forum
- NEA - Working Group on the Safety of Advanced Reactors

NRC's Activities with the Canadian Nuclear Safety Commission



X-energy



GE-H



Terrestrial

- Exploring regulatory similarities and differences
- Collaborating on licensing activities for common vendors

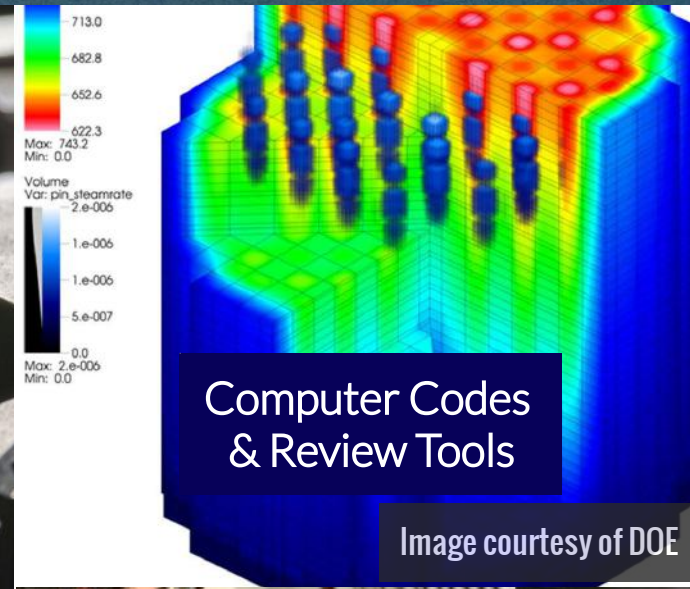
Advanced Reactor Licensing



Knowledge, Skills,
and Capability

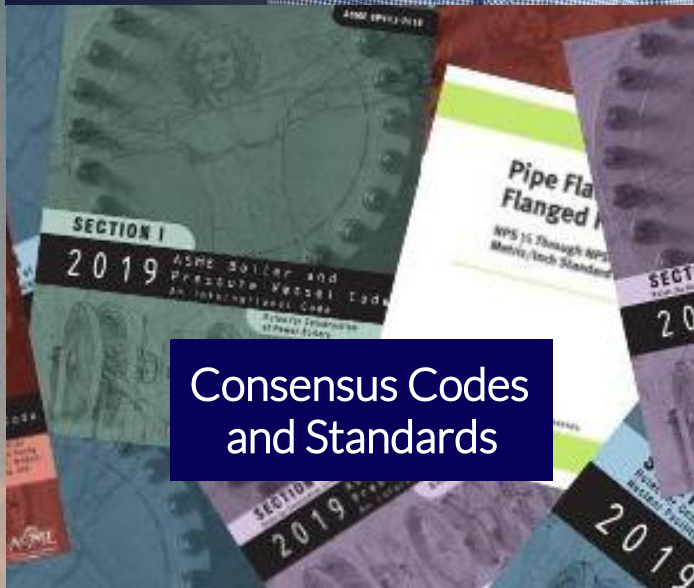


Flexible Review
Processes



Computer Codes
& Review Tools

Image courtesy of DOE



Consensus Codes
and Standards



Policy and
Technical Issues



Communications

Closing Remarks

Margaret Doane

Executive Director for Operations



| Acronyms

- **AMT - advanced manufacturing technologies**
- **ANL - Argonne National Laboratory**
- **ASME - American Society of Mechanical Engineers**
- **DOE - United States Department of Energy**
- **GE-H - GE Hitachi Nuclear Energy**
- **IAEA - International Atomic Energy Agency**
- **INL - Idaho National Laboratory**
- **NEA - Nuclear Energy Agency**
- **NGO - non-governmental organizations**
- **NRC - United States Nuclear Regulatory Commission**
- **NRIC - National Reactor Innovation Center**
- **NRR - Office of Nuclear Reactor Regulation**
- **NMSS - Office of Nuclear Material Safety and Safeguards**
- **NSIR - Office of Nuclear Security and Incident Response**
- **ORNL - Oak Ridge National Laboratory**
- **RES - Office of Nuclear Regulatory Research**
- **SCK CEN - Belgian Nuclear Research Centre**
- **SMR - small modular reactor**
- **SNL - Sandia National Laboratories**
- **Terrestrial - Terrestrial Energy Inc.**
- **X-energy - X-Energy, LLC**