

Cooperation Between NRC and JAEA on Nuclear Safety Research

Raymond Furstenau, Director
Office of Nuclear Regulatory Research



Agenda

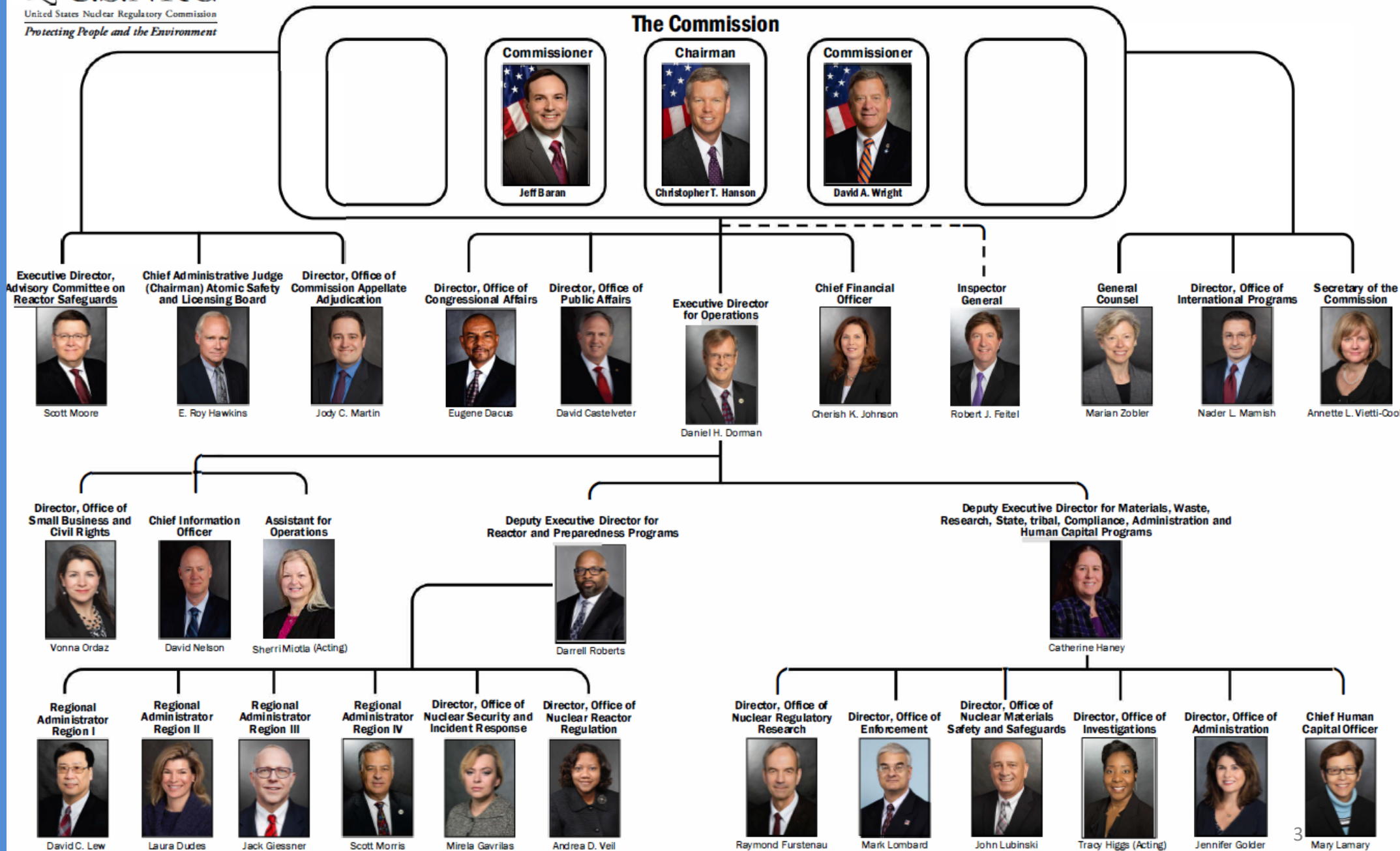
- NRC overview
- Current collaboration
- NRC research on advanced nuclear technologies
- Future collaboration





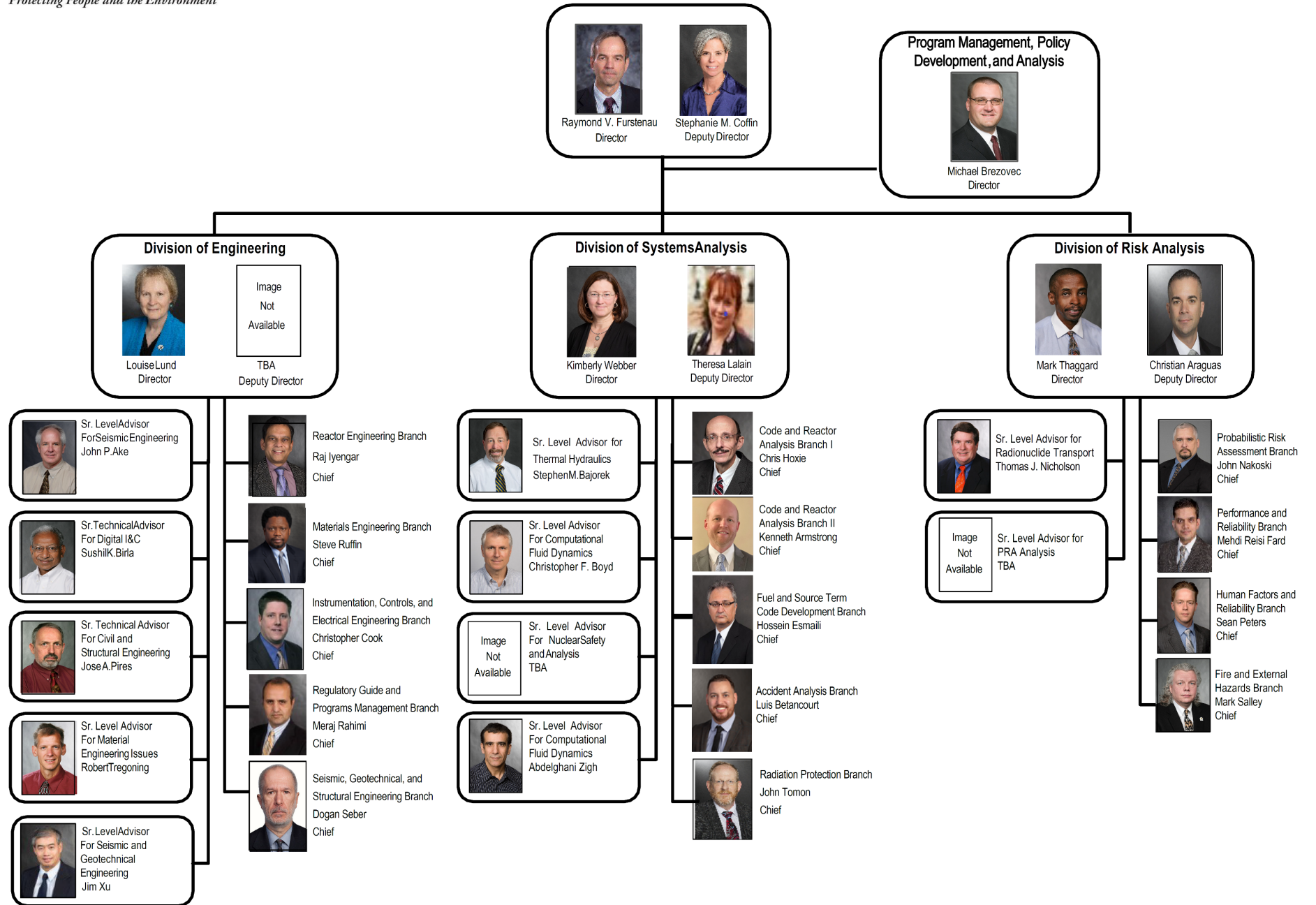
U.S. Nuclear Regulatory Commission

The Commission





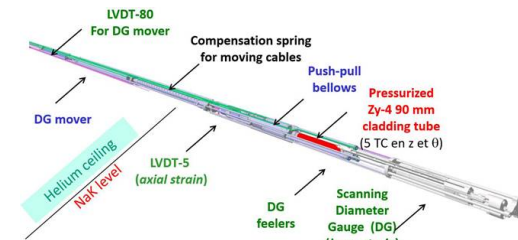
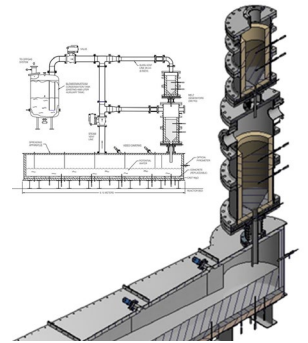
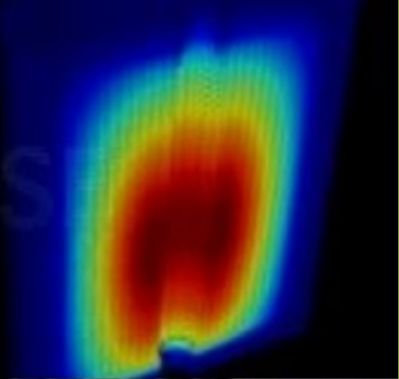
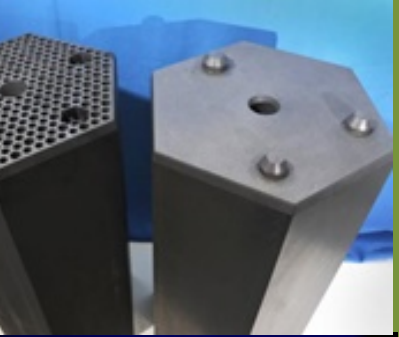
Office of Nuclear Regulatory Research



NRC/JAEA Collaboration

OECD/NEA projects

- TCOFF: Thermodynamic Characterization Of Fuel Debris and Fission Products
- PreADES: Preparatory Study on Analysis of Fuel Debris
- ARC-F: Analysis of Information from Reactor Buildings and Containment Vessels of Fukushima Daiichi Nuclear Power Station
- FIDES: Framework for Irradiation Experiments
- ROSAU: Reduction of Severe Accident Uncertainties
- ESTER: Experiments on Source Term for delayed Releases



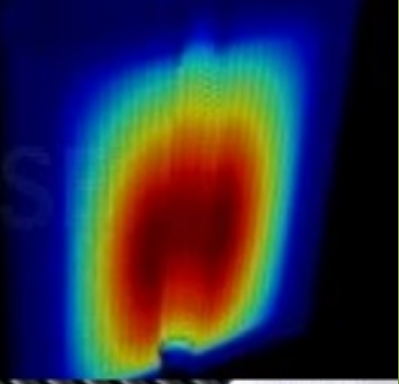
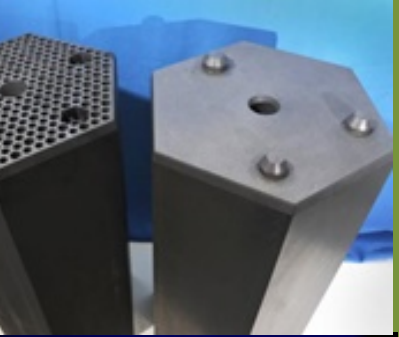
Additional Collaborations / Areas of Interest

JAEA Bilateral

- High temperature materials
- Reliability and integrity management
- Materials surveillance programs

Areas of Common Interest

- MUSA (EU H2020): Management and Uncertainties of Severe Accidents
- DENOPI (IRSN): Fuel coolability during a loss of coolant accident in spent fuel pool



Technical Meetings & Workshops

Severe Accidents

- Cooperative Severe Accident Research Program (CSARP)
- MELCOR Code Assessment Program (MCAP)
- Asian MELCOR User Group (AMUG)
- European MELCOR User Group (EMUG)

Thermal-hydraulics and Reactor Kinetics

- Code Application and Maintenance Program (CAMP)

Fukushima Forensics

- NRC staff and contractors participate in international workshops and working groups
- Forensics information and severe accident research w

2021 (November 28-30) U.S. DOE Fukushima Forensics Expert Panel Meetings with participation from JAEA (as well as NRA-J and TEPCO)

 **U.S. NRC**
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

CSARP/MCAP Meeting
June 7-11, 2021
Virtual Meeting (Microsoft Teams)
(Limited Attendance)
Final Agenda (June 11, 2021)

Thursday, June 10, 2021

00:00	Welcome	NRC/SNL
Technical Session 7 – Severe Accident Research Programs Virtual Session Chair: SNL/NRC		
00:10	Development of Ex-Vessel Debris formation and Cooling Behavior Analysis System, THERMOS	K. Wataru, S/NRA/R
00:30	Current status of Aerosol Related Research at JAEA in 2021	H. Sun, JAEA
00:50	Status of the OECD Reduction of Severe Accident Uncertainties (ROSAU) Test Program	J. Licht, ANL
01:10	Update on the OECD-NEA Joint Undertaking QUENCH-ATF and Related Activities at KIT	M. Steinbrück, KIT
01:30	Status Report on the DENOPI Project	S. Morin, IRSN
01:50	Applicability and Transfer of Large-LWR Reactor Knowledge & Know-how to iPWR in the view of SA and FPZ Analyses Needs	F. Mascari, ENEA

Current Status of Aerosol related Research at JAEA in 2021

Haomin SUN

Thermohydraulic Safety Research Gr.
Nuclear Safety Research Center
Japan Atomic Energy Agency

CSARP, Jun. 10th, 2021

The experimental systems are developed under the auspices of the Nuclear Regulation Authority (NRA), Japan.



Advanced Fuel Technologies

- Panel of international severe accident experts Phenomena Identification and Ranking Tables (PIRT) that addressed significant phenomenological issues to improve MELCOR
- QUENCH-ATF: Experiments for ATF cladding materials in the QUENCH facility at Karlsruhe Institute of Technology (KIT) – Near term chromium-coated cladding under design basis accident (DBA) and beyond DBA (JAEA Participation)



NUREG/CR-7282
ER/NRC 21-203

Review of Accident Tolerant Fuel Concepts with Implications to Severe Accident Progression and Radiological Releases
NUREG/CR-7282



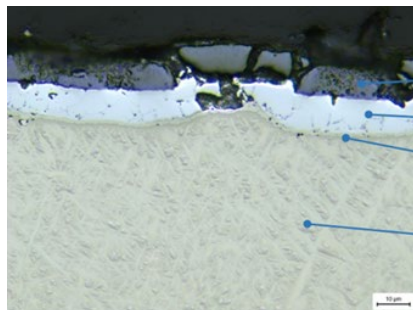
NUREG/CR-7283
ER/NRC 21-204

Phenomena Identification Ranking Tables for Accident Tolerant Fuel Designs Applicable to Severe Accident Conditions

NUREG/CR-7283

Dr. Yu Maruyama (JAEA) served as panel member

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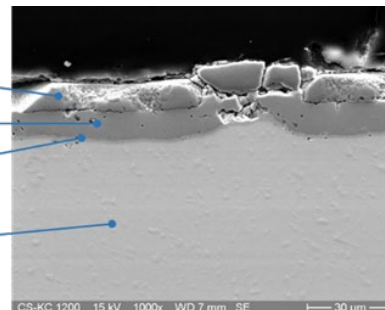


Cr_2O_3

Cr

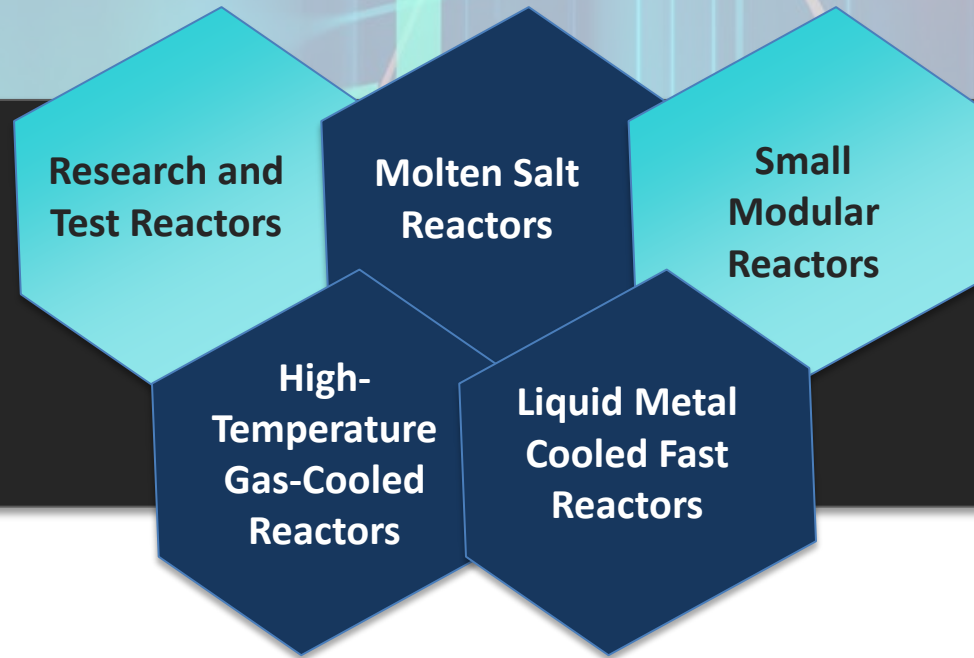
ZrCr_2

Zr



CS-KC 1200 15 kV 1000x WD 7 mm SE 30 μm

Advanced Nuclear Technology Licensing



Pathway to New Regulatory Framework

Evolving Landscape

13+

Current and potential applications by 2027

6+

Potential operating licenses by 2027

“Part 53” Rulemaking

- Nuclear Energy Innovation and Modernization Act (NEIMA) requirement
- Technology-inclusive, risk-informed and performance based regulatory framework
- Builds on decades of experience and lessons learned
- Significant stakeholder engagement

Advanced Nuclear Technology Research

NRC Integrated Action Plan (IAP) Strategy 2: Modernizing our Tools

For More Information

U.S.NRC
January 31, 2020
Approach for Code Development in Support of NRC's Regulatory Oversight of Non-Light Water Reactors

Technical Readiness
Regulatory Readiness
Communication

Introduction
[ML20030A174](#)

U.S.NRC
January 31, 2020
NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 1 - Computer Code Suite for Non-LWR Plant Systems Analysis

Systems & T/H

Volume 1
[ML20030A176](#)

U.S.NRC
January 31, 2020
NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 2 - Fuel Performance Analysis for Non-LWRs

Fuel Analysis

Volume 2
[ML20030A177](#)

U.S.NRC
January 31, 2020
NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 3 - Computer Code Development Plans for Severe Accident Progression, Source Term, and Consequence Analysis

Severe Accidents

Volume 3
[ML20030A178](#)

U.S.NRC
March 31, 2021
NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 4 - Licensing and Siting Dose Assessment Codes

Siting Dose

Volume 4
[ML21085A484](#)

U.S.NRC
March 31, 2021
NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 5 - Radionuclide Characterization, Criticality, Shielding, and Transport in the Nuclear Fuel Cycle

Fuel Cycle

Volume 5
[ML21088A047](#)

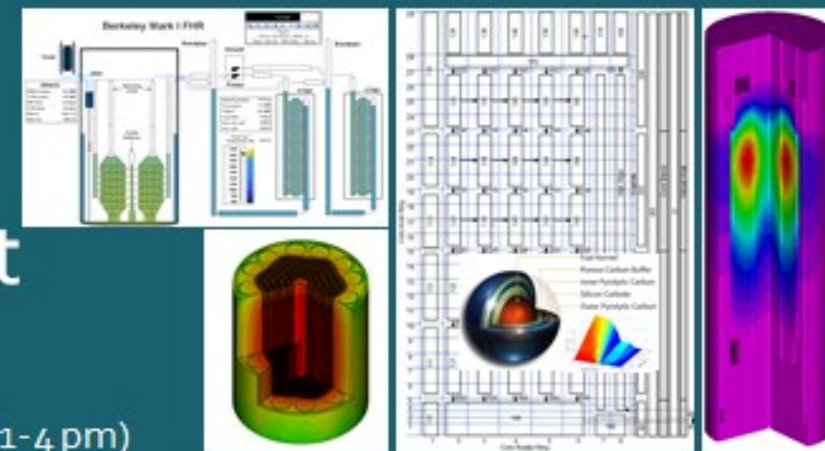


Public Workshop: SCALE/ MELCOR Non-LWR Source Term Demonstration Project

Heat pipe reactor – June 29, 2021 (1-4 pm)

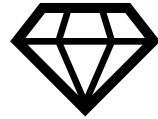
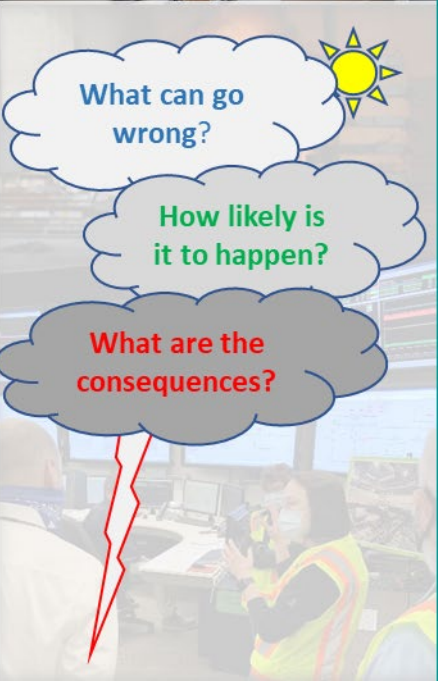
Gas cooled reactor – July 20, 2021 (1-4 pm)

Pebble bed molten-salt-cooled reactor – September 14, 2021 (1-4 pm)



Participated in meeting to discuss restart and experimental results from the final phase of the OECD High Temperature Engineering Test Reactor (HTTR) Loss of Forced Cooling (LOFC) Joint Project.

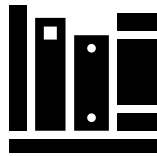
Probabilistic Risk Assessment



**DEVELOPMENT OF RISK MODELS,
TOOLS, AND DATA**



**APPLY RISK TOOLS IN RISK-INFORMED
DECISION-MAKING**



**RIDM AND PRA GUIDANCE
AND STANDARDS**

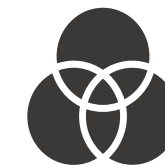


**OPERATIONAL EXPERIENCE, DATA
COLLECTION, AND ANALYTICS**

For More
Information



EVENT AND CONDITION ANALYSIS



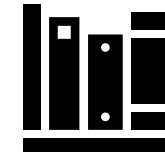
**A FULL-SCOPE MULTI-UNIT SITE
LEVEL 3 PRA**

Engineering and Material Science



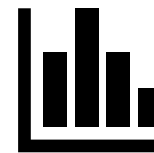
Advanced Reactor Materials and Component Integrity

Identify technical issues impacting safety, and develop methodologies and tools to assess materials degradation and component integrity



Advanced Manufacturing Technologies

Develop technology-specific guidance to prepare the NRC staff for future reviews of advanced manufacturing applications for nuclear power plants



Digital Twins

Develop regulatory infrastructure to enable safe operation of digital twins and potential use of digital twins to enhance regulatory processes



Subsequent License Renewal

- Subsequent license renewal (SLR) is period of extended operation from 60 years to 80 years
- First License Renewal (NUREG-1800/1801 and Interim Staff Guidance)
- Subsequent License Renewal (NUREG-2190/21901 and Interim Staff Guidance)

Currently under review

Plant Name and Units (s)	Application Received
St. Lucie Plant, Units 1 and 2	08/03/2021
Oconee Nuclear Station Units 1, 2, 3	06/07/2021
Point Beach, Units 1 and 2	11/16/2020
North Anna, Units 1 and 2	08/24/2020

For More Information



Completed

- Turkey Point Units 3 & 4 (FL)
- NEW expiration 2052 & 2053
- COMPLETED 12/2019 (ML19191A057)

- Surry Units 1 & 2 (VA)
- NEW expiration 2052 & 2053
- COMPLETED 05/2021 (ML20052F523)

- Peach Bottom Units 2 & 3 (PA)
- NEW expiration 2053 & 2054
- COMPLETED 03/2020 (ML20044D902)

Future Collaborations

- Thermal-hydraulic safety of LWRs (Light Water Reactor), Small Modular Reactors (SMRs) and non-LWRs
- Severe accident and source term research (LWR/SMR/non-LWR)
- Fuel safety (Conventional/ATF/HBU/HALEU)
- Structural integrity assessment and materials degradation
- Criticality safety/accident evaluation
- Use of data science and artificial intelligence
- Cooperation under OECD/NEA framework
- Technical staff exchanges

