U.S.NRC United States Nuclear Regulatory Commission *Protecting People and the Environment*

U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

EPRI CNWRA®

2024 Workshop on

STORAGE AND TRANSPORTATION OF TRISO AND METAL SPENT NUCLEAR FUELS

Program Schedule

December 3-5, 2024

The Nuclear Regulatory Commission (NRC) is holding the 2024 Workshop on Storage and Transportation of TRISO and Metal Spent Nuclear Fuels as a virtual event on December 3rd to 5th, 2024. The workshop is being held in coordination with the DOE Office of Nuclear Energy and EPRI, with assistance from the Center for Nuclear Waste Regulatory Analyses.

The workshop will be focused on research on technical and regulatory considerations for new fuels spent fuel management.

A meeting link will be sent to registered attendees and presenters approximately one week before the event.

AGENDA

Tues, Dec. 3rd, 10:00 AM to 5:00 PM

Time	Topic	Speaker
10:00 – 11:20 am	Intro & Plenary Session	NRC, DOE, EPRI
11:20 – 11:30 am	Q&A	Public
11:30 – 12:30	TRISO SNF Structural Integrity	NRC, DOE, EPRI, and Industry
12:30 – 1:30 pm	Lunch Break	
1:30 – 2:20 pm	TRISO SNF Materials Performance Part 1	NRC, DOE, EPRI, and Industry
2:20 – 3:00 pm	TRISO SNF Materials Performance Part 2	NRC, DOE, EPRI, and Industry
3:20 – 3:20 pm	Break	
3:20 – 4:45 pm	TRISO SNF Nuclear Physics / Neutronics	NRC, DOE, EPRI, and Industry
4:45 – 5:00 pm	Q&A	Public

Wed, Dec. 4th, 10:00 AM to 5:00 PM

Time	Topic	Speaker
10:00 – 11:00 am	TRISO SNF Materials Performance Part 3	NRC, DOE, EPRI, and Industry
11:00 – 12:30	Metal SNF Nuclear Physics / Neutronics	NRC, DOE, EPRI, and Industry
12:30 – 1:30 pm	Lunch Break	
1:30 – 4:40 pm	Metal SNF Materials Performance and Structural Integrity (with one break)	NRC, DOE, EPRI, and Industry
4:30 – 5:00 pm	Q&A	Public

Thurs, Dec. 5th, 10:00 AM to 4:30 PM

Time	Topic	Speaker
10:00 – 12:30	Additional Topics Part 1: Experience and Projections	NRC, DOE, EPRI, and Industry
12:30 – 1:30	Lunch Break	
1:30 – 3:00 pm	Additional Topics Part 2: Regulations, Guidance, Crosscutting Topics	NRC, DOE, EPRI, and Industry
3:00 – 3:30 pm	Break	
3:30 – 4:00 pm	Q&A	Public
4:00 – 4:30 pm	Closing Remarks	NRC

Session 1: Plenary Session – Tuesday, Dec 3, 10:00 AM to 11:30 AM Eastern Standard Time
Public Meeting Statement: Andrea Johnson
Moderator: Raj Iyengar
Scribes: Ashley Smith, Patrick LaPlante

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Kathy Brock	*U.S. Nuclear Regulatory Commission*	Opening Remarks	5	N/A
Cinthya Roman	*U.S. Nuclear Regulatory Commission*	NRC Vision	15	
Paul Murray	*U.S. Department of Energy*	DOE Vision	15	
Craig Stover	*Electric Power Research Institute*	EPRI Perspective	15	
Gordon Petersen	*Idaho National Laboratory*	TRISO Spent Nuclear Fuel PIRT – Storage and Transportation	15	
Jason Piotter	*U.S. Nuclear Regulatory Commission*	Advancing the Vision of NextGen Fuels	15	
		Q&A	10	

Session 2: TRISO SNF Structural Integrity – Tuesday, Dec 3, 11:30 AM to 12:30 PM Eastern Standard Time.
Subtopics: *Matrix Fracture, Non-fuel Block Fracture, TRISO Particle Layer Fracture*
Moderator: Tom Boyce
Scribes: Joseph Bass, Curtis Lurvey, Hector Mendoza

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
John Stempien	*Idaho National Laboratory*	Matrix Structural Integrity – desirable and undesirable features of matrix materials for TRISO-based fuels	5	5
Eddie Lopez Honorato	*Oak Ridge National Laboratory*	Implications of new coated particle fuels with new architectures for an expanded service envelope	5	5
Tanner Mauseth	*Idaho National Laboratory*	Fracture Behavior Considerations for the TRISO Particle Matrix	5	5
Wen Jiang	*North Carolina State University*	Modeling of TRISO and Matrix Fracture	5	5
John Stempien	*Idaho National Laboratory*	TRISO Particle Fracture – importance of strong matrix and careful handling	5	5
		Open Discussion	10	

Additional Discussion Participants: Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Benjamin Spencer (Idaho National Laboratory), and Public Attendees.

Lunch Break – Tuesday, Dec 3, 12:30 PM to 1:30 PM Eastern Standard Time

Session 3: TRISO SNF Materials Performance Part 1 – Tuesday, Dec 3, 1:30 PM to 2:20 PM Eastern Standard Time
Subtopics: *SiC Corrosion, PyC Creep and SIC Fracture*
Moderator: Tom Boyce
Scribes: Ashley Smith, Joseph Bass

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Tanner Mauseth	*Idaho National Laboratory*	Micro-Tensile Properties of Irradiated AGR-2 TRISO Fuel Pyrolytic Carbon (PyC) and Silicon Carbide (SiC) Coatings	5	5
Haiming Wen	*Missouri University of Science and Technology*	Oxidation Behavior of the SiC Coating of TRISO Fuel Particles in Air	5	5
John Stempien	*Idaho National Laboratory*	PyC Creep and SiC Fracture – out-of-pile PyC creep should be zero as should SiC fracture	5	5
Wen Jiang	*North Carolina State University*	Time-Dependent Weibull Failure Analysis of TRISO Fuel	5	5
		Open Discussion	10	

Additional Discussion Participants: Benjamin Spencer (Idaho National Laboratory), Steven Muller (U.S. Nuclear Regulatory Commission), Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Jeffery Powers (BWX Technologies, Inc.), Eddie Lopez Honorato (Oak Ridge National Laboratory, and Public Attendees.

Session 4: TRISO SNF Materials Performance Part 2 – Tuesday, Dec 3, 2:20 PM to 3:00 PM Eastern Standard Time
Subtopics: *Particle, Block, and Matrix Oxidation*
Moderator: Wendy Reed
Scribes: Aditya Savara, Patrick LaPlante

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Rebecca E. Smith	*Idaho National Laboratory*	Safety Considerations for Irradiated Graphite	5	5
Lu Cai	*Idaho National Laboratory*	Determining the Oxidation Behavior of Matrix Graphite	5	5
J. David Arregui-Mena	*Oak Ridge National Laboratory*	Oxidation of graphitic components under accident conditions	5	5
		Open Discussion	10	

Additional Discussion Participants: Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Benjamin Spencer (Idaho National Laboratory), Joseph Bass (U.S. Nuclear Regulatory Commission), Jeffery Powers (BWX Technologies, Inc.), Eddie Lopez Honorato (Oak Ridge National Laboratory), and Public Attendees.

Break – Tuesday, Dec 3, 3:00 PM to 3:20 PM Eastern Standard Time

Session 5: TRISO SNF Nuclear Physics / Neutronics – Tuesday, Dec 3, 3:20 PM to 4:45 PM Eastern Standard Time
Subtopics: *Decay Heat, Neutron Multiplication and Criticality, Shielding and Radiation Protection*
Moderator: Hossein Esmaili
Scribes: Trey Hathaway, Ellie Cohn

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Andrew Bielen	*U.S. Nuclear Regulatory Commission*	NRC's simulation capabilities supporting criticality, reactor physics, decay heat, and shielding for TRISO-particle fueled non-LWRs	20	5
Laura Price	*Sandia National Laboratories*	TRISO and Metal Spent Nuclear Fuels Decay Heat	5	5
Gordon Petersen	*Idaho National Laboratory*	Modeling Capabilities for TRISO and Metallic SNF	5	5
Andrew Barto	*U.S. Nuclear Regulatory Commission*	Licensing Experience with TRISO Spent Fuel – A Historical Perspective: Fort St. Vrain Independent Spent Fuel Storage Installation (ISFSI)	10	5
		Open Discussion	25	

Additional Discussion Participants: Taek K. Kim (Argonne National Laboratory), Pavlo Ivanusa (Pacific Northwest National Laboratory), Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Justin Clarity (Pacific Northwest National Laboratory), Jeffery Powers (BWX Technologies, Inc.), Sven Bader (Orano Federal Services LLC), Steven Nesbit (LMNT Consulting), Eddie Lopez Honorato (Oak Ridge National Laboratory), and Public Attendees.

Q & A – Tuesday, Dec 3, 4:45 PM to 5:00 PM Eastern Standard Time
Moderator: Hossein Esmaili
Scribes: Trey Hathaway, Ellie Cohn

Public attendees may participate in session discussions, as well as dedicated Q&A periods.

Session 6: TRISO SNF Materials Performance Part 3 – Wednesday, Dec 4, 10:00 AM to 11:00 AM Eastern Standard Time
Subtopics: *Gas Pressurization (Including from Alpha Decay), Fission Products Leaching, Fission Products Diffusion, SiC Corrosion*
Public Meeting Statement: Andrea Johnson
Moderator: Tekia Govan
Scribes: Ashley Smith, Patrick LaPlante

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
James Corson	*U.S. Nuclear Regulatory Commission*	US NRC Modeling for TRISO Material Performance	10	10
Umapathy R Ganjigatte	*Indian Institute of Technology Delhi, New Delhi, India & Inter University Accelerator Center, New Delhi, India*	Effects of Rare Earth Doping and High-Energy Irradiation in Silicon Carbide for Advanced Nuclear Applications	5	5
		Open Discussion	30	

Additional Discussion Participants: Rebecca E. Smith (Idaho National Laboratory), Lu Cai (Idaho National Laboratory), J. David Arregui-Mena (Oak Ridge National Laboratory), Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Benjamin Spencer (Idaho National Laboratory), Joseph Bass (U.S. Nuclear Regulatory Commission), Jeffery Powers (BWX Technologies, Inc.), Wen Jiang (North Carolina State University), Eddie Lopez Honorato (Oak Ridge National Laboratory), and Public Attendees.

Session 7: Metal SNF Nuclear Physics / Neutronics – Wednesday, Dec 4, 11:00 PM to 12:30 AM Eastern Standard Time
Subtopics: *Decay Heat, Neutron Multiplication and Criticality, Shielding and Radiation Protection*
Moderator: Jason Piotter
Scribes: Trey Hathaway, Ellie Cohn

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Andrew Barto	*U.S. Nuclear Regulatory Commission*	10 CFR Part 71 - Certification of Transportation Packages for Metal Fuel	10	5
Andrew Bielen	*U.S. Nuclear Regulatory Commission*	NRC's simulation capabilities supporting criticality, reactor physics, decay heat, and shielding for metallic fueled non-LWRs	20	5
Gordon Petersen	*Idaho National Laboratory*	Modeling Capabilities for TRISO and Metallic SNF	5	5
Laura Price	*Sandia National Laboratories*	TRISO and Metal Spent Nuclear Fuels Decay Heat	5	5
		Open Discussion	30	

Additional Discussion Participants: Taek K. Kim (Argonne National Laboratory), Justin Clarity (Pacific Northwest National Laboratory), Sven Bader (Orano Federal Services LLC), Steven Nesbit (LMNT Consulting), and Public Attendees.

Lunch Break – Wednesday, Dec 4, 12:30 PM to 1:30 PM Eastern Standard Time

Session 8: Metal SNF Materials Performance and Structural Integrity – Wednesday, Dec 4, 1:30 PM to 4:30 PM Eastern Standard Time
Subtopics: *Corrosion, Reactions with Water and Chemical Treatments, Fission Products Leaching, Fission Products Diffusion, Fission Gas Generation and Release, Cladding Rupture Due to Pressurization, Fuel Swelling, Deformation*
Moderator: Tekia Govan
Scribes: Ashley Smith, Hector Mendoza, Aditya Savara

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
James Corson	*U.S. Nuclear Regulatory Commission*	U.S NRC Modeling Capabilities of Metal Fuel in FAST	10	10
Tiankai Yao	*Idaho National Laboratory*	Fission Product Diffusion	5	5
Tiankai Yao	*Idaho National Laboratory*	Corrosion of Cladding Materials	5	5
Tiankai Yao	*Idaho National Laboratory*	Interactions Between Metallic Fuel and Water	5	5
Walter Williams	*U.S. Nuclear Regulatory Commission*	Fission Product Induced Metal Fuel Swelling	5	5
Walter Williams	*U.S. Nuclear Regulatory Commission*	Assessment on Metal Spent Nuclear Fuel Swelling Effects on Structural Integrity	5	5
		Open Discussion	**20**	
		Break	**20**	**N/A**
Stuart Arm	*Pacific Northwest National Laboratory*	Potential Treatment Options for Sodium-Bonded Metal Fuel	10	15
Steven D. Herrmann	*Idaho National Laboratory*	Removal and Deactivation of Bond Sodium from Fast Reactor Materials	5	5
Jamie Noel	*University of Western Ontario*	Materials interactions leading to enhanced dissolution or protection of fuel in a waste storage	5	5
		Open Discussion	25	

Additional Discussion Participants: Benjamin Spencer (Idaho National Laboratory), Sven Bader Orano (Federal Services LLC), and Public Attendees.

Q & A – Wednesday, Dec 4, 4:30 PM to 5:00 PM Eastern Standard Time
Moderator: Jesse Carlson
Scribes: Ashley Smith, Patrick LaPlante, Aditya Savara
Public attendees may participate in session discussions, as well as dedicated Q&A periods.

Session 9: Additional Topics, Part 1 – Thursday, Dec 5, 10:00 AM to 12:30 PM Eastern Standard Time
Subtopics: Experience and Projection
Public Meeting Statement: Andrea Johnson
Moderator: Laurel Bauer
Scribes: Wendy Reed, Andrea Johnson

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Ralf Schneider-Eickhoff , Maik Stuke	*BGZ Gesellschaft für Zwischenlagerung mbH*	Dry Storage of THTR Spent Fuel in Germany	15	10
Bret Leslie	*U.S. Nuclear Waste Technical Review Board*	Management and Disposal of U.S. Department of Energy's TRISO- and Metallic-based Spent Nuclear Fuel and Preliminary Considerations for Waste Resulting from Advanced Nuclear Reactors	15	10
Taek K. Kim	*Argonne National Laboratory*	Projection of TRISO spent nuclear fuels and related issues	10	5
Jesse Sloane[1], Steve Sisley[2]	*[1] Deep Isolation, [2] NAC International*	Management of TRISO spent fuel using a Universal Canister System	15	10
		Open Discussion	60	

Additional Discussion Participants: Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Steven Nesbit (LMNT Consulting), Andrew Barto (U.S. Nuclear Regulatory Commission), Jason Piotter (U.S. Nuclear Regulatory Commission), Paul Cantonwine (Oak Ridge National Laboratory), Sven Bader (Orano Federal Services LLC), Matt Featherston (X-Energy, LLC), Stephen Vaughn (X-Energy, LLC), Prakash Narayanan (ORANO TN), Eddie Lopez Honorato (Oak Ridge National Laboratory), Rod McCullum (Nuclear Energy Institute), Steven Maheras (Pacific Northwest National Laboratory), and Public Attendees.

Session 10: Additional Topics, Part 2 – Thursday, Dec 5, 1:30 PM to 3:00 PM Eastern Standard Time
Subtopics: *Regulations, Guidance, Crosscutting Topics*
Moderator: Jose Cuadrado
Scribes: Ashley Smith, Patrick LaPlante, Andrea Johnson

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Steven Maheras	*Pacific Northwest National Laboratory*	Microreactor Transportation Emergency Planning Challenges	10	10
Travis Chapman	*BWX Technologies, Inc.*	Cross-domain Development of Principal Design Criteria for Transportable Reactors	10	10
Prakash Narayanan	*ORANO TN*	System design and safety analysis associated with storage and transportation	10	10
Rod McCullum	*Nuclear Energy Institute*	Building on Established Knowledge to Inform the Regulatory Framework for TRISO and Metal Spent Nuclear Fuels	10	10
		Open Discussion	10	

Additional Discussion Participants: Blaise Collin (Ultra Safe Nuclear), Jonathan Wright (Ultra Safe Nuclear), Steven Nesbit (LMNT Consulting), Andrew Barto (U.S. Nuclear Regulatory Commission), Jason Piotter (U.S. Nuclear Regulatory Commission), Paul Cantonwine (Oak Ridge National Laboratory), Sven Bader (Orano Federal Services LLC), Matt Featherston (X-Energy, LLC), Stephen Vaughn (X-Energy, LLC), Eddie Lopez Honorato (Oak Ridge National Laboratory), and Public Attendees.

Break – Thursday, Dec 5, 3:00 PM to 3:30 PM Eastern Standard Time

Q & A – Thursday, Dec 5, 3:30 PM to 4:00 PM Eastern Standard Time
Moderator: Jesse Carlson
Scribes: Ashley Smith, Patrick LaPlante, Andrea Johnson
Public attendees may participate in session discussions, as well as dedicated Q&A periods.

Session 11: Closing Session – Thursday, Dec 5, 4:00 PM to 4:30 PM Eastern Standard Time
Subtopics: Closing Remarks

Presenter	Affiliation	Title	Present (minutes)	Discuss (minutes)
Jason Piotter [1], Laura McManniman [2], Jorge Narvaez[3]	*[1] U.S. Nuclear Regulatory Commission* *[2] Electric Power Research Institute* *[3] U.S. Department of Energy*	Closing Remarks	15	15