

Management of Spent Fuel, Radioactive Waste and Decommissioning in SMRs or Advanced Reactor Technologies

7-10 November 2022

Ottawa, Canada

PROGRAMME

Background

As many countries are exploring ways to achieve their commitments to achieving net zero emissions by 2050, they are focusing their attention on the ongoing development of small modular reactors (SMRs) and Generation IV reactor technologies as an option to address the effects of climate change and meet future energy demands. To ensure these new technologies are viable to supplement existing energy sources, the management, storage, transport and disposal of the radioactive waste needs to be closely examined at the early design stage. This topic is at the centre of the nuclear and radioactive waste management field and has been considered with increased attention during the past several months at various international community events, including those hosted by the Nuclear Energy Agency (NEA).

The workshop will convene participants from various fields of expertise in the areas of radioactive waste management, decommissioning, nuclear science and development, transportation, community outreach, as well as young professionals. The goal of the workshop is to devise a guideline document that will serve implementers in understanding the key issues in decommissioning and waste management of new reactors from the design perspective, aiding in the licensing process and in future decommissioning and waste management activities.

Objectives

- To better understand how radioactive waste management and decommissioning should be considered as part of a more comprehensive preparation for the deployment of these reactors right from the design stage.
- To understand unique features of SMR waste and the key questions that need to be answered to ensure a clear path to final disposal.
- To review current challenges in decommissioning and provide lessons learnt.
- To better integrate educational institutions and engage with interested communities early in the processes.
- To better understand how the current regulatory framework should be considered in the early development of SMR and advanced reactor technologies.

General information

Conference venue

Sessions and cocktail reception

Lord Elgin Hotel

100 Elgin Street

ON, K1P 5K8

Ottawa Canada

Telephone +1(613)235-3333

Registration

Registration will take place in the Foyer of the Lord Elgin Hotel on Monday morning from 8:30-17:00.

Programme overview

Monday, 7 November 2022

Session 1. Understanding the functioning of major SMRs/advanced reactor technologies and fuel cycles

1.1. Overview of mature SMR/advanced reactor technologies and associated fuel type

This session will focus on understanding the functioning of major SMRs/advanced reactor technologies, with the main differences expected in the function of the technologies and mode of operation (e.g. fuel type) compared with contemporary designs.

1.2. Key attributes of SMRs/advanced fuel type, and design considerations and implications for decommissioning and radioactive waste management

This session will explore the key questions designers need to consider when developing a new fuel that has not been evaluated by waste acceptance criteria. For example: are deep geological repositories capable of taking this kind of waste? Should that be considered now? What challenges/issues may arise that are different compared to traditional reactor oxide fuels during transportation, management and disposal of spent fuel or by-products of spent fuel treatment (recycling/conditioning)?

1.3. Panel discussion on key takeaways and recommendations

This panel invites the previous presenters to develop one slide with key takeaways/recommendations and proceed with to a panel discussion, during which the floor will be opened for questions from the audience will be invited.

Session 2. Storage and transportation of spent fuel and radioactive waste in SMRs/advanced reactor designs

2.1. Overview of work activities on fuel storage and transportation

This session will highlight the challenges associated with fuel storage and transportation and their potential applicability to new fuel types (e.g. dual cask, criticality issues and environmental concerns).

2.2. Technical and economic feasibility of reprocessing radioactive waste, as well as storage and transport of reprocessed fuel based on reactor type (closed-loop fuel cycle)

This session will address the feasibility of reprocessing fuel from new designs, noting the different types of reprocessing techniques, including associated waste generation and economic feasibility.

2.3. Panel discussion on key takeaways and recommendations

This panel invites the previous presenters to develop one slide with key takeaways/recommendations and to proceed to a panel discussion, during which questions from the audience will be invited.

Session 3. Radioactive waste and decommissioning in SMRs/advanced reactor technologies

3.1. Licensing and regulatory requirements of spent fuel and waste management for SMRs/advanced reactor technologies

This session will explore how regulators have prepared and identified potential regulatory process changes, resulting from future deployment of SMRs and advanced reactors that may need to be considered to properly manage waste and decommissioning activities in the future. The possibility of regulatory harmonisation will also be examined.

3.2. Operational and design optimisation related to decommissioning and radioactive waste management for SMRs/advanced reactor technologies

This session will evaluate whether implementers are ready to integrate waste generated from SMRs/advanced reactors into their disposal strategy. Furthermore, it will explore whether feedback from current practices in waste management and decommissioning can help optimise the design of SMRs/advanced reactors to minimise the flow of waste and facilitate the efficient decommissioning of future reactors.

3.3. Operational feedback on management and disposal of existing waste streams and how some of these concepts can be applied to future endeavours, such as SMRs/advanced reactors

This session will highlight lessons learnt from radioactive waste disposal projects as well as dismantling and decommissioning activities. The aim is to share information with designers and utilities to minimise overall radioactive waste volumes expected from SMRs and advanced reactor technologies, and to manage fuel damaged during operation.

Wednesday, 9 November 2022

3.4. Panel discussion on key takeaways and recommendations

This panel invites the previous presenters to develop one slide with key takeaways/recommendations and proceed to a panel discussion, during which questions from the audience will be invited.

Session 4. Key considerations for communities, Indigenous peoples and stakeholder involvement

4.1. Indigenous community/tribal nation perspectives on the potential deployment of SMRs and advanced reactor technologies

4.2. Good practices in stakeholder engagement and dialogue, including the intergenerational aspects of SMRs/advanced reactors

4.3. Panel discussion on key takeaways and recommendations

This panel invites the previous presenters to develop one slide with key takeaways/recommendations and proceed to a panel discussion, during which questions from the audience will be invited.

Session 5. Summary and closing remarks

Thursday, 10 November 2022

Site Visit to Canada's National Nuclear Laboratory

Canadian Nuclear Laboratories (CNL) is Canada's premier nuclear science and technology organisation, and a world leader in developing nuclear technology for peaceful and innovative applications. Using its unique expertise, CNL works to restore and protect the environment, advance clean energy technology, and facilitate medical breakthroughs that continue to improve the health of people around the world.

Workshop agenda

Day I – Monday 7 November 2022

08:30 **Registration** (Closes at 17:00)

09:00 **Opening with Elder Thomas Louttit**

Opening session

Workshop Chair, **James McKinney**, Chief Strategist, Integrated Waste Management, UK Nuclear Decommissioning Authority (NDA)

Welcome address and introductory remarks

John Hannaford, Deputy Minister, Natural Resources Canada

William D. Magwood, IV, Director-General, OECD Nuclear Energy Agency (NEA)

Keynote speech

Rumina Velshi, President and Chief Executive Officer, Canadian Nuclear Safety Commission (CNSC)

Sam Brinton, Deputy Assistant Secretary for Spent Fuel and Waste Disposition, Office of Nuclear Energy, U.S. Department of Energy (DOE)

Laurie Swami, President and CEO of the Nuclear Waste Management Organization (NWMO)

Łukasz Młynarkiewicz, President, Poland's National Atomic Energy Agency (PAA)

Daniel H. Dorman, Executive Director for Operations, US Nuclear Regulatory Commission (NRC)

Patrick Landais, High Commissioner for the French Alternative Energies and Atomic Energy Commission (CEA)

10:45 **Session 1. Understanding the functioning of major SMR/advanced reactor technologies and fuel cycles**

1.1. Overview of mature SMRs/advanced reactor technologies and associated fuel type

Presenter

Massimiliano Fratoni, University of California, Berkeley

11:05 **Coffee break** (15 Min)

11:20 **1.2. Key attributes of SMRs/advanced fuel types and design consideration and implications for decommissioning and radioactive waste management**

Chair

Massimiliano Fratoni, University of California, Berkeley

Presenters

Bret van den Akker, Director of Fuel Cycle Innovation, Ultra Safe Nuclear Corporation – *Ultra Safe Nuclear Corporation Back End Strategy*

Eric Williams, Vice President of Engineering, TerraPower – *Sodium Advanced Reactor Fuel Cycle Management*

David Le Blanc, President, CTO, Terrestrial Energy

Paul Thompson, Senior Strategic Advisor, New Brunswick Power Plant (NBP) – *Fuel Cycle considerations for Gen IV reactors being developed in New Brunswick Canada*

Fausto Franceschini, Consulting Engineer, Westinghouse Mangiarotti – *Westinghouse Lead Fast Reactor - Design and Waste Management Overview*

Riccardo Chebac, PhD candidate, Politecnico di Milano – *Design considerations for waste minimisation and decommissioning optimisation*

13:20 **Lunch break (1.5hr)**

14:50 **1.3 Panel discussion on key takeaways and recommendations**

Chair

Massimiliano Fratoni, University of California, Berkeley

Panellists

Bret van den Akker, Director of Fuel Cycle Innovation, Ultra Safe Nuclear Corporation

Eric Williams, Vice President of Engineering, TerraPower

David Le Blanc, President, CTO, Terrestrial Energy

Paul Thompson, Senior Strategic Advisor, New Brunswick Power Plant (NBP)

Fausto Franceschini, Consulting Engineer, Westinghouse Mangiarotti

Riccardo Chebac, PhD candidate, Politecnico di Milano

15:45 **Coffee break (15 Min)**

16:00 **Session 2. Storage and transportation of spent fuel and radioactive waste in SMRs/advanced reactor designs**

2.1 Overview of work activities on fuel storage and transportation

Chair

Joe Faldowski, Chief Operations Officer, Orano Federal Services

Presenters

James McKinney, Chief Strategist, Integrated Waste Management, NDA – *Overview of the NEA’s Ad Hoc group work on waste & fuel extended storage and transportation*

Amparo Gonzalez Espartero, Technical Lead, Spent Fuel Management, Division of Nuclear Fuel Cycle and Waste Technology, Department of Energy, International Atomic Energy Agency (IAEA) – *IAEA ongoing activities on addressing the backend of the fuel cycles for SMRs (tentative)*

Martin Porter, Secretary General, World Nuclear Transport Institute (*virtual*)

Rod McCullum, Senior Director, Used Fuel and Decommissioning, Nuclear Energy Institute – *Opportunities to optimise recycled used fuel management in the United States*

Robert Howard, National Technical Director, Integrated Waste Management, Pacific Northwest National Laboratory (PNNL) – *Advanced Non-Light Water Reactors: Integrated Waste Management System Considerations and Challenges*

17:40 **End of first day remarks**

Workshop Chair, **James McKinney**, Chief Strategist, Integrated Waste Management, NDA

17:45-20:00 **Cocktail reception**

Day II – Tuesday 8 November 2022

09:00

Day II welcome

Workshop Chair, **James McKinney**, Chief Strategist, Integrated Waste Management, NDA

Keynote address

Alastair MacDonald, Vice-President, Decommissioning & Waste Management, Atomic Energy of Canada Limited (AECL)

09:15

Session 2. Understanding the functioning of major SMR/advanced reactor technologies and fuel cycles

Continued

2.2. Technical and economic feasibility of reprocessing radioactive waste, as well as storage and transport of reprocessed fuel based on reactor type (closed-loop fuel cycle)

Chair

Joe Faldowski, Chief Operations Officer, Orano Federal Services

Presenters

Robin Taylor, Senior Fellow, UK National Nuclear Laboratory Limited – *The NEA Expert Group in Fuel Recycling & Waste Technology & options for future fuels recycling*

Kenneth Marsden, National Technical Director for the Material Recovery and Waste Form Development Campaign, Idaho National Laboratory (INL) – *Recycling considerations for Small Modular Reactors*

Bertrand Morel, R&D Manager, Orano – *Reprocessing fuel from new SMR: Orano's perspective with a focus on molten salt fuels*

Stuart T. Arm, Senior Technical Advisor, PNNL – *Strategies for Processing TRISO Nuclear Fuel*

Chris Deir, Director, Strategy & Acquisitions, Ontario Power Generation

Victoria Hisko, Kinectris Chapter, North American Young Generation in Nuclear

11:15

Coffee break (15 Min)

11:30

2.3. Panel discussion on key takeaways and recommendations

Chair

Joe Faldowski, Chief Operations Officer, Orano Federal Services

Panellists

James McKinney, Chief Strategist, Integrated Waste Management, NDA

Amparo Gonzalez Espartero, Technical Lead, Spent Fuel Management, Division of Nuclear Fuel Cycle and Waste Technology, Department of Energy, IAEA

Martin Porter, Secretary General, World Nuclear Transport Institute (virtual)

Rod McCullum, Senior Director, Used Fuel and Decommissioning, Nuclear Energy Institute (NEI)

Robert Howard, National Technical Director, Integrated Waste Management, PNNL

Robin Taylor, Senior Fellow, UK National Nuclear Laboratory Limited

Kenneth Marsden, National Technical Director for the Material Recovery and Waste Form Development Campaign, INL

Bertrand Morel, R&D Manager, Orano

Stuart T. Arm, Senior Technical Advisor, PNNL

Chris Deir, Director, Strategy & Acquisitions, Ontario Power Generation

Victoria Hisko, Kinectris Chapter, North American Young Generation in Nuclear

12:25

Lunch break (1.5hr)

13:55

Session 3 Radioactive waste and decommissioning in SMRs/advanced reactor technologies

3.1. Licensing and regulatory requirements of spent fuel and waste management for SMRs/advanced reactor technologies

Chair

Ramzi Jammal, Executive Vice-President and Chief Regulatory Operations Officer, CNSC

Presenters

Łukasz Młynarkiewicz, President, PAA

Nancy Greencorn, Director, Wastes and Decommissioning Division, CNSC

Shana Helton, Director, Division of Fuel Management, US NRC – *US Regulatory Perspectives*

Seung-Young Jeong, Executive Director of Office of Radiation Safety (KINS) – *Licensing and Regulatory for SMR/AR in the Republic of Korea*

Ville Koskinen, Senior Inspector, Radiation and Nuclear Safety Authority Finland (STUK) – *SMR waste management in Finland (virtual)*

15:35

Coffee break (15 Min)

15:50

3.2. Operational and design optimisation related to decommissioning and radioactive waste management for SMRs/advanced reactor technologies

Chair

William Boyle, Director, Office of Spent Fuel & Waste Science and Technology, Office of Nuclear Energy, US DoE

Presenters

Prakash Narayanan, Chief Technical Officer, Orano TN Americas – *Backend optimisation considerations for advanced fuels/advanced reactors*

Gordon Petersen, Spent Fuel Analyst, INL – *Comparing Legacy Waste Management to Advanced Reactor Waste Management*

Anne Saturnin, Senior Expert, CEA – *SMR/AMR: what impact on radioactive waste? Principles and analysis methodology proposal*

Megan Harkema, PhD candidate in environmental engineering, Vanderbilt University – *Lessons Learnt from Decades-Long Surveillance and Maintenance of the Molten Salt Reactor Experiment (MSRE)*

Roundtable discussion on waste implications from the deployment of SMRs/advanced reactor technologies

William F. Smith, Senior Vice President, Operations & Engineering, Terrestrial Energy

Lindsay M. Krall, Former MacArthur postdoctoral fellow, Former Center for International Security and Cooperation, Stanford University

Virginie Wasselin, Head, waste management strategy department, Andra

Prakash Narayanan, Chief Technical Officer, Orano TN Americas

Gordon Petersen, Spent Fuel Analyst, IINL

Gursimer Sandhu, Environmental Remediation Management Mission, CNL

18:20-

End of second day remarks

18:25

Workshop Chair, **James Mckinney**, Chief Strategist, Integrated Waste Management, NDA

Day III – Wednesday 9 November 2022

09:00 Day III welcome

Workshop Chair, **James McKinney**, Chief Strategist, Integrated Waste Management, NDA

09:05 Session 3 Radioactive waste and decommissioning in SMRs/ *Continued* advanced reactor technologies

3.3. Operational feedback on management and disposal of existing waste streams and how some of these concepts can be applied to future endeavours, such as SMRs/advanced reactors

Chair

William Boyle, Director, Office of Spent Fuel & Waste Science and Technology, Office of Nuclear Energy, US DoE

Presenters

Rebecca Tadesse, Head of Division of Radioactive Waste Management and Decommissioning, NEA – *NEA’s overview of lessons learnt from current reactor decommissioning and dismantling*

Shaun Robarts, Waste Management Director, Nuclear Waste Services – *Managing challenging waste and lessons for advanced reactors – a UK Perspective*

Virginie Wasselin, Head, waste management strategy department, Andra – *Feedback from waste management in France*

Ursula Carvajal, Spent Nuclear Fuel Analyst, Idaho National Laboratory – *Considerations for the Management of Spent Nuclear Fuel from Advanced Reactors*

Jim McKenna, Director Strategic Materials, AECL – *Canada’s Repatriation Programme: Lessons learnt from the transportation campaign*

Paula Keto, Senior Scientist, VTT – *Applicability of Current Finnish Disposal Methods for Spent Fuel from Small Modular Nuclear Reactors*

11:05 Coffee break (15 Min)

11:20

3.4. Panel discussion on key takeaways and recommendations

Chair

William Boyle, Director, Office of Spent Fuel & Waste Science and Technology, Office of Nuclear Energy, US DoE

Panellists

Rebecca Tadesse, Head of Division of Radioactive Waste Management and Decommissioning, NEA

Shaun Robarts, Waste Management Director, Nuclear Waste Services

Ursula Carvajal, Spent Nuclear Fuel Analyst, INL

Jim McKenna, Director Strategic Materials, AECL

Paula Keto, Senior Scientist, VTT

Virginie Wasselin, Head, waste management strategy department, Andra

Lukasz Młynarkiewicz, President, PAA

Nancy Greencorn, Director, Wastes and Decommissioning Division, CNSC

Shana Helton, Director, Division of Fuel Management, US NRC

Seung-Young Jeong, Executive Director of Office of Radiation Safety (KINS)

Ville Koskinen, Senior Inspector, STUK (virtual)

12:15

Lunch Break (1.5hr)

13:45

Session 4 Key considerations for communities, Indigenous peoples and stakeholder involvement

4.1. Indigenous community/tribal nation perspectives on the potential deployment of SMRs and advanced reactor technologies

Chair

Emily Whetung-MacInnes, Chief Emeritus, Curve Lake First Nation

Presenters

Jessica Perritt, Director of Indigenous Innovation, Turtle Island Institute – *Reconciliation: Leaning into the richness of Indigenous knowledge systems*

Emily Whetung-MacInnes, Chief Emeritus, Curve Lake First Nation

Talia Martin, Director of Energy for the Shoshone Bannock Tribe in Idaho (*video*)

Rebekah Wilson, Reconciliation Coordinator, Nuclear Waste Management Organisation – *Creating space for meaningful engagement with Indigenous communities*

15:10 **4.2. Good practices in stakeholder engagement and dialogue, including the intergenerational aspects of SMRs/advanced reactors**

Chair

Julie Mecke, Senior Policy Advisor Radioactive Waste, National Resources Canada (NRCan)

Presenters

Candice Jackson, Deputy Director, Nuclear Energy Division, NRCan – *SMR Action Plan Pan-Canadian Engagement*

Eric McGoey, Director, Engagement and Communications, Global First Power – *Mutual Benefits: Contemporary Indigenous Engagement*

Joe Gaboury, Director, NWMO

Duane Bratt, Professor, Department of Economics, Justice, and Policy Studies, Mount Royal University – *SMRs and public engagement*

16:35 **Coffee break (15 Min)**

16:50 **4.3. Panel discussion on key takeaways and recommendations**

Chair

Betsy Forinash, Deputy Assistant Secretary for Waste and Materials Management, Office of Policy and Regulatory Affairs, US DoE, Office of Environmental Management

Panellists

Jessica Perritt, Director of Indigenous Innovation, Turtle Island Institute

Emily Whetung-MacInnes, Chief Emeritus, Curve Lake First Nation

Rebekah Wilson, Reconciliation Coordinator, NWMO

Candice Jackson, Deputy Director, Nuclear Energy Division, NRCan
Eric McGoey, Director, Engagement and Communications, Global First Power

Joe Gaboury, Director, NWMO

Duane Bratt, Professor, Department of Economics, Justice, and Policy Studies, Mount Royal University

17:45 **Session 5. Summary and closing remarks**

Workshop Chair, **James McKinney**, Chief Strategist, Integrated Waste Management, NDA

17:55 **Closing address**

Joe McBearty, President and Chief Executive Officer, CNL

Closing with **Elder Thomas Louttit**

Day IV – Thursday 10 November 2022

Site visit to Chalk River

06:45 **Meet in the lobby of Lord Elgin Hotel**

07:00-09:00 **Travel from Ottawa to Chalk River**

09:00 **Entrance process at Minwamon Building**

09:45 **Coffee break (15 Min)**

10:00 **Group 1**

Tour of Decommissioning of National Research Experimental Reactor (NRX)

Group 2

Tour of Waste Management Storage Areas (HLW/ILW) and Display of Transportation Flasks

12:00 **Lunch & presentations**

- Overview of CNL and Environmental Remediation Management (ERM)
- CNL Facilities Decommissioning Program
 - Regulatory Approach
 - Reactor Decommissioning
- CNL Integrated Waste Strategy
 - Waste Storage – current and planned
 - Waste Disposal – Near Surface Disposal Facility (NSDF)
 - Consolidation of Waste
- CNL R&D Work on SMR Waste

13:30 **Group 1**

Tour of Waste Management Storage Areas (HLW/ILW) and Display of Transportation Flasks

Group 2

Tour of Decommissioning of National Research Experimental Reactor (NRX)

15:30 **Break (1.5hr)**

15:45 **Departure process at Minwamon Building**

16:00-18:00 **Travel from Chalk River to Ottawa**



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