

Status and Trends of Spent Fuel Management from Power Reactors and Related IAEA Activities

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TM on Operating Experience and Lessons Learned on Managing Non-Standard Legacy Power and Research Reactor Spent Fuels, Vienna 18-21 February 2025





Content

The IAEA at Glance

Global Status and Trends in the Back End of the Nuclear Fuel Cycle

IAEA's Activities in Support of Spent Fuel Management

- Scientific/Technical Events

- Publications

- Coordinated Research Projects

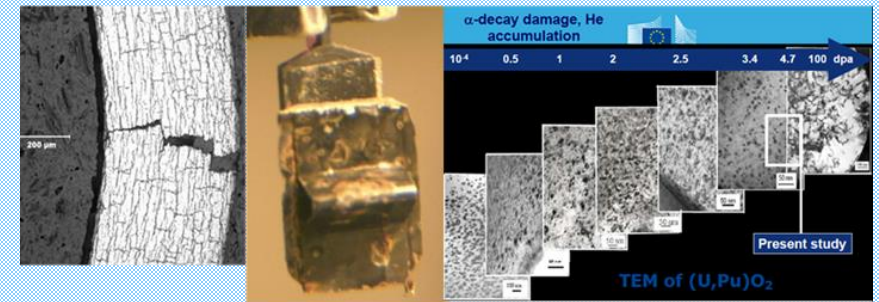
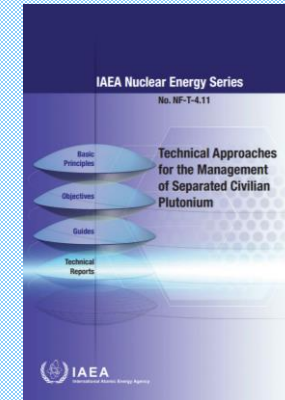
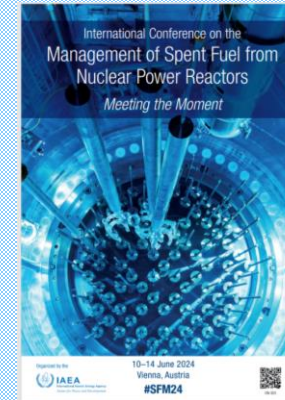
- Review Missions

- e-Tools

IAEA's Role and Activities

- Established in 1957, as an autonomous organization within the United Nations system, the IAEA actively supports its 180* Member States to (*inter alia*) improve their capabilities for **the safe and effective management of spent nuclear fuel** from the current and future reactor's fleet (e.g. GenIV, SMRs, AMRs, etc)
- Through:
 - Organizing international **conferences** and **workshops**
 - Publishing **technical documents** and **reports**
 - Coordinating international **research activities** (CRPs)
 - Providing **review missions/advisory services**
 - Managing specific **databases** and **e-tools**

* as of 15 November 2024



IAEA's Governance and Advisory Boards



- Biennial programmes (ex: 2024-2025) taking into consideration Member States' recommendations & requests expressed through the yearly adopted resolutions, during the General Conferences

*"Calls upon the Secretariat and Member States in a position to do so **to investigate new reactor and fuel cycle technologies** with improved utilization of natural resources, and proliferation resistance, **including technologies for the recycling of spent fuel** and its use in advanced reactors under appropriate controls and for the long-term disposition of remaining waste materials, taking into account economic, safety, and security factors"*

*"Recommends that the Secretariat continue to explore, in consultation with interested Member States, **innovative nuclear technologies, including alternative fuel cycles, associated back-end management capabilities**, innovative nuclear energy systems and fusion power plants, with a view to strengthening and fostering infrastructure, safety, security, science, technology, engineering, and capacity building via the use of experimental facilities and material testing reactors, to facilitate licensing, construction, and operation of these technologies"*

- **Standing Advisory Groups (SAGs)**

Standing Advisory Group on Nuclear Energy (**SAGNE**): a group of international experts advising (yearly) the Director General on nuclear power, fuel cycle and nuclear science issues

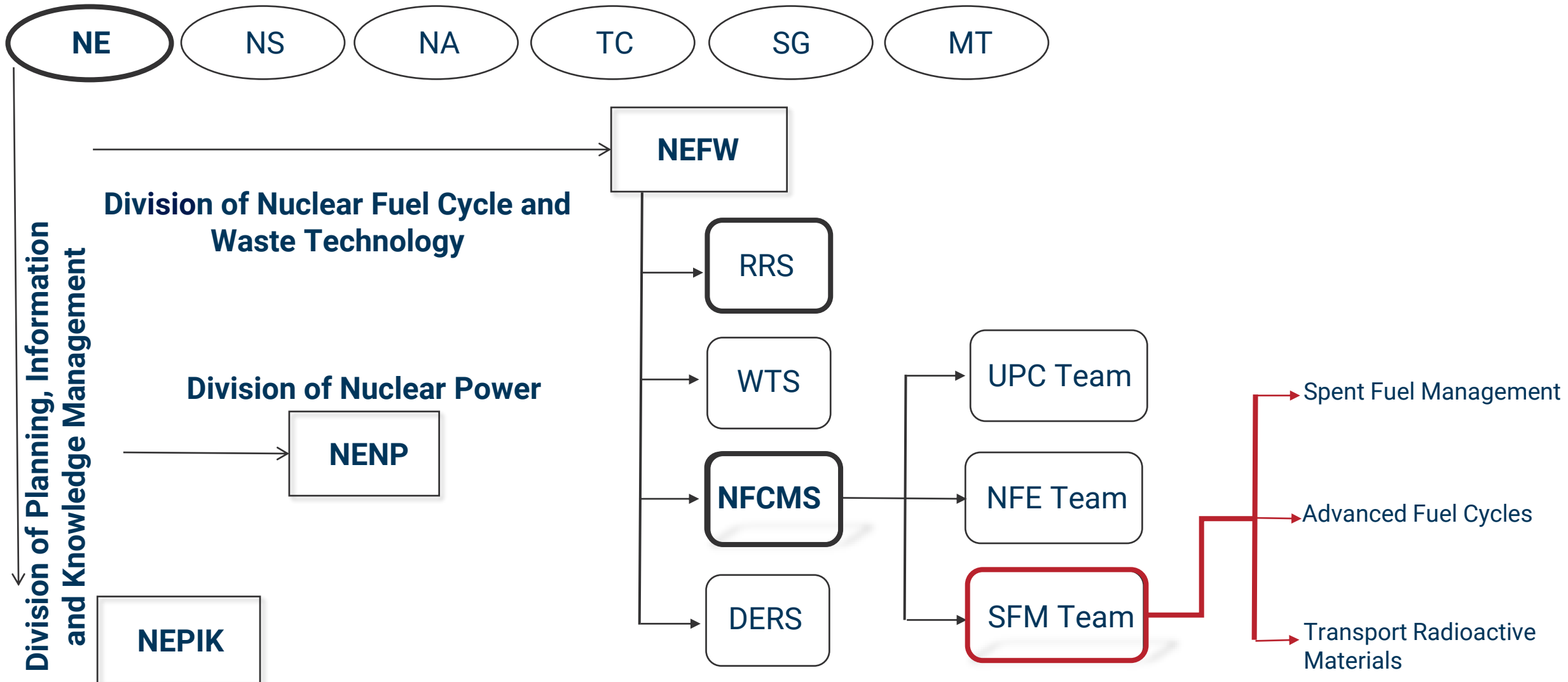
- **Technical Working Groups (TWGs)**

Groups of international experts advising (yearly) the DDG-NE on the orientation and implementation of NE programmatic activities (ex: **TWG on Nuclear Fuel Cycle Options and Spent Fuel Management (TWG-NFCO)**)



IAEA's Organization

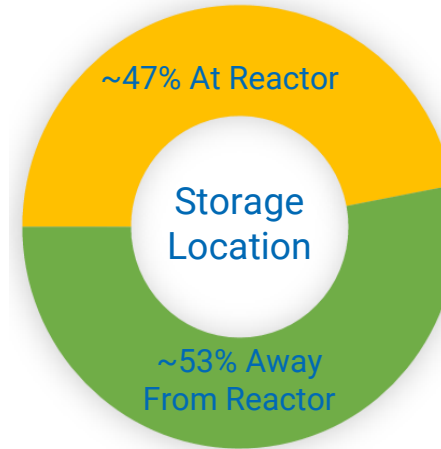
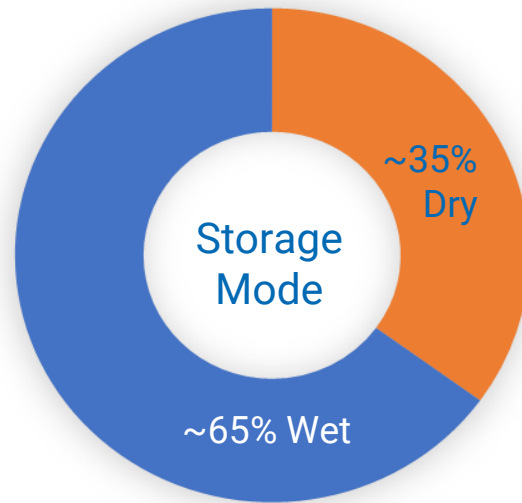
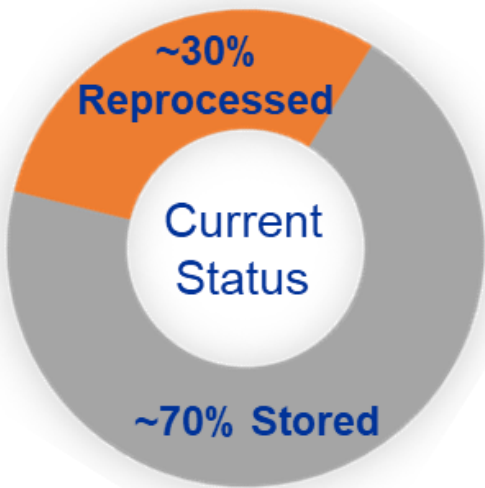
Department of Nuclear Energy



Spent Fuel Current Global Inventory

~ 417 NPPs* in 31 countries discharging ~ 10 000 tHM per year

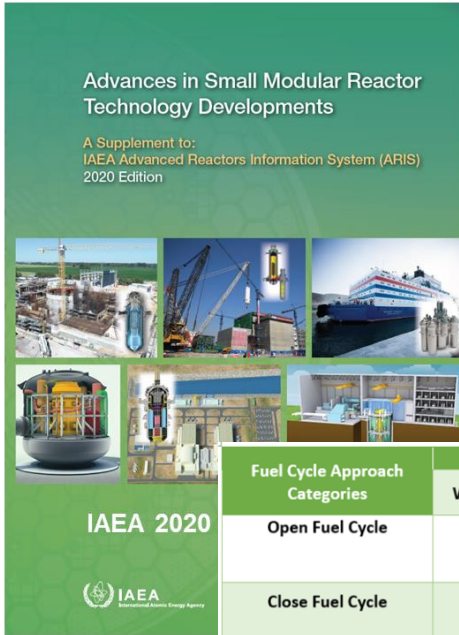
Global Inventory by the end 2024, ~ **430 000 tHM**



(* Feb. 2025, see PRIS database: <https://pris.iaea.org/pris/>)

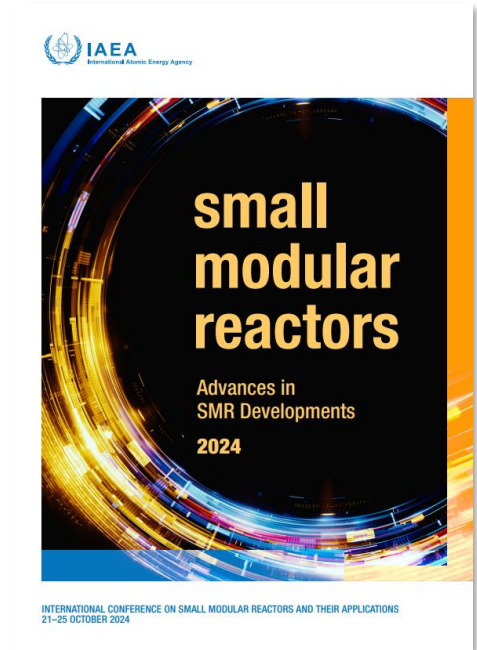
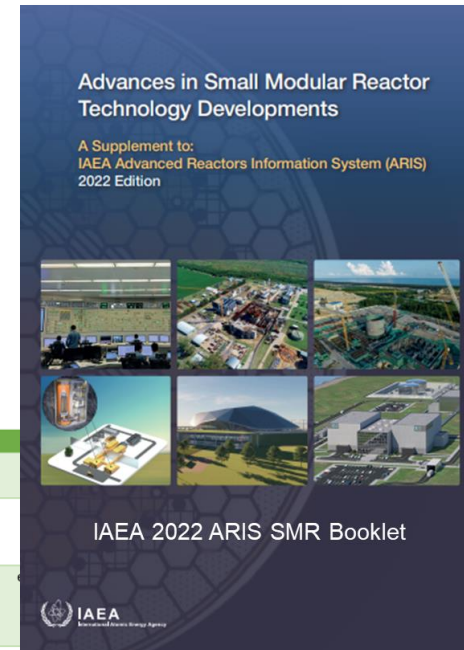
- Global Inventory of spent fuel at the end 2023: ~ **430 ktHM**, among which ~ **301 ktHM are in Storage**
 - 47% at Reactor, 53% Away from Reactor (**33% Wet Storage / 67% Dry Storage**)
- Selection of storage technology depends on many factors: Fuel, Economics, Stakeholders' preference

IAEA-ARIS SMR Booklet 2020/2022/2024 Editions



2020 Edition: For the first time a special coverage on fuel cycle approaches and waste management by technology was included

Insightful annexes with various charts and tables



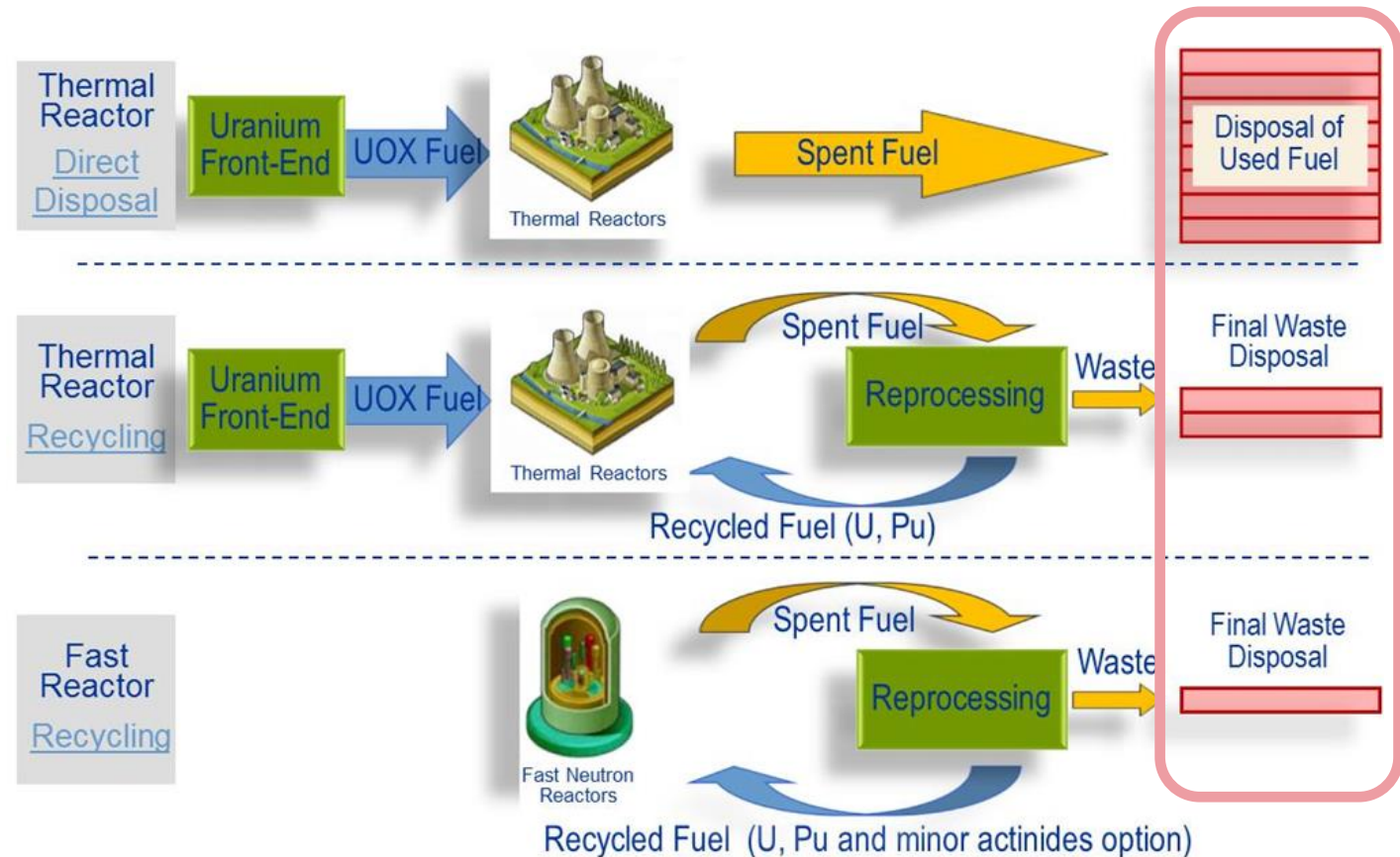
Fuel Cycle Approach Categories	SMR designs by type of coolants and technology characteristics				
	Water-cooled Reactors	HTGRs	Liquid-metal cooled and Fast Reactors	Molten Salt Reactors	
Open Fuel Cycle	CAREM, ACP100, SMART, NuScale, CANDU-SMR	HTR-PM, GTHTR300, PBMR, GT-MHR, Xe-100, SC-HTGR	EM ²	Integral MSR, SmTMSR-400	
Close Fuel Cycle	SHELF		BREST-300-OD, 4S, SVBR-100	FUJI, LFTR, CA Waste Burner (later generation), and MCSFR	
Longer Refuelling Cycle > 24 months	SMART, HAPPY200, ABV-6M, RITM-200, SHELF	HTR-PM (online refuelling), GTHTR300	MicroURANUS, W-LFR, SEALER and EM ²	CA Waste Burner	
Enrichment < 5%	CAREM, NuScale, VBER, NUWARD and ACPRS0S			Integral SMR Stable Salt Reactor	MoveLuX
5% ≤ Enrichment ≤ 15%		HTR-PM, PBMR, GTHTR300	BREST-300-OD, 4S, EM ² , ARC100, Superstar	ThorCon	Energy Well
Enrichment > 15%	KLT-40S, RITM, SHELF, ABV-6M	MHR-T, MHR-100, GT-MHR, SC-HTGR, Xe-100,	SVBR, SEALER, LFR-TL-X, W-LFR	ThorCon	eVinci®, Aurora, MMR
Spent Fuel Processing and Conditioning			BREST-300-OF, 4S, SVBR	SmTMSR-400	
Use of Thorium-cycle and/or Plutonium Disposition		HTMR-100, GTHTR300, GT-MHR, SC-HTGR, and possibly for all	LFR-AS-200, Superstar	FUJI, LFTR, Integral MSR, CA Waste Burner, ThorCon, Moltex SSR and SmTMSR-400	
Use of Spent Fuel as Fuel		GTHTR300	BREST-300-OD	Moltex SSR and CA Waste Burner	

Very limited experience worldwide on the management of SNF from SMR technologies



Nuclear Fuel Cycle Options

- For Nuclear power to be sustainable, the nuclear fuel cycle must remain **economically viable and competitive** through the optimization of the use of fissile materials in reactor cores or the **recycling of valuable materials**
- This results in different fuel **cycle options**, some already implemented and others may be deployed in the future
- Potential future synergies between LWR-SMRs and AMRs will bring new spectrum of Nuclear Fuel Cycle Options



Each Type of Reactor has an Associated Nuclear Fuel Cycle

Spent Fuel Management Strategies Worldwide

Today mainly countries with large nuclear power programmes recycle spent fuel: France, the Russian Federation, Japan, India and China.



Some countries have not yet made a final decision. Most spent fuel is in interim storage.



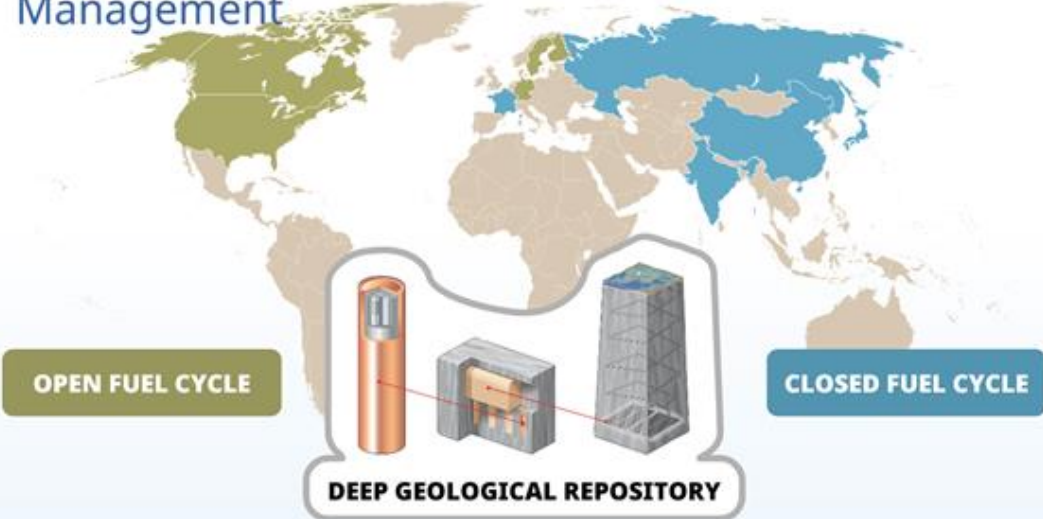
Several other countries have opted for direct disposal: Finland, Sweden, Canada, Germany



The Netherlands reprocess SNF from Borssele NPP abroad and stores High Level Waste at HABOG facility



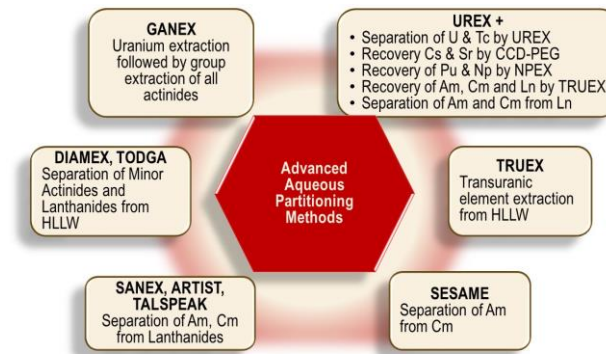
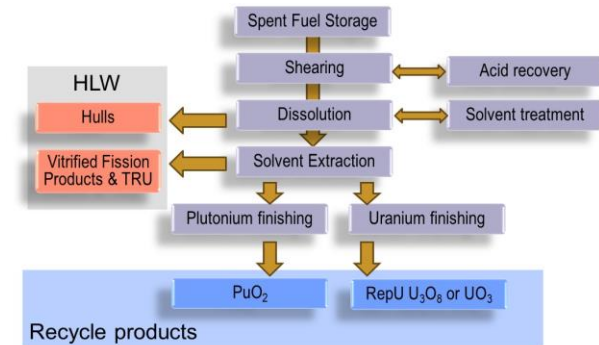
Strategic Options for Spent Nuclear Fuel Management



Spent Fuel Recycling through Reprocessing

- Reuse of **Reprocessed Pu as MOX in Light Water Reactors**
 - More than **40 years** of experience worldwide (44 LWRs have used MOX fuel at industrial scale since 1986)
 - Loading cores partially with MOX (25-50%) and the remainder with UOX fuel
 - Recent reactor designs can accommodate 100% MOX cores
 - Demonstrating Multiple Recycling in LWRs contributes to transitioning to Fast Reactors
- Reuse of **Rep-Pu as MOX in Fast Reactors**: implemented in Russia in BN-800
- Reuse of **Rep-U as Enriched Reprocessed U (ERU)** in Thermal Reactors (PWRs, VVERs, RBMKs, AGRs, PHWRs)
 - More than **30 years** of experience worldwide (TRs can accommodate 100% Rep-U cores)
- For decades, advanced (hydro/pyrometallurgical) processes have been researched worldwide for **Minor Actinides recycling**

PUREX Process



- Recycling Spent Fuel is a **mature technology** (Pu recycling in LWRs saves up to 25% of natural uranium resources)
- Reference options exist worldwide (PUREX)
- Reprocessing capacities exist in **France, Russia, India, Japan and China**

Current Challenges in Spent Fuel Management

- **Spent Nuclear Fuel Storage**

- Planned SNF storage durations are increasing:
 - In 1980s 20-50 years
 - In 1990s up to 100 years
 - In 2000s 100+ years
- License renewal of storage systems
 - Confirming on-going SNF behaviour & integrity
 - Maintenance and inspection of SSCs
 - Ageing management (beyond design basis for most)

- **SNF transportability** after long storage durations and orphan sites

- **Spent Nuclear Fuel recycling**

- Implementation of multi-recycling in LWRs at industrial scale
- Demonstration and scaling-up of multi-recycling through Advanced Fuel Cycles for innovative reactors

- Accommodation of SNF from **Small and Modular Reactors**

- Successful implementation of **Deep Geological Repositories**



IAEA's Activities in Support of Spent Fuel Management

Publications

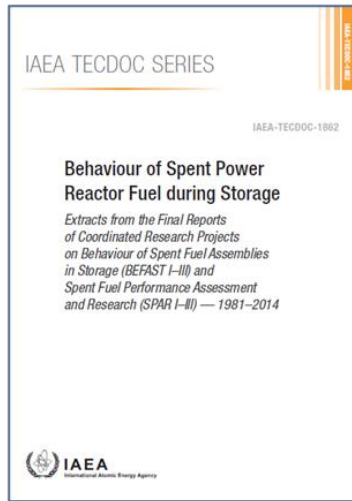
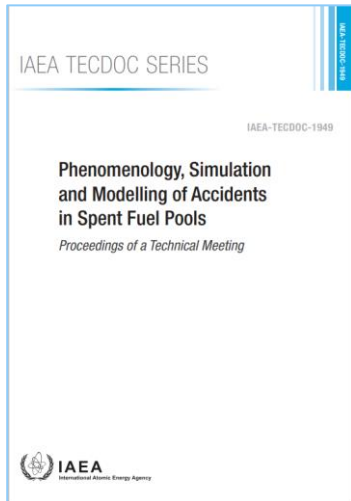
Scientific/Technical Events

Coordinated Research Projects

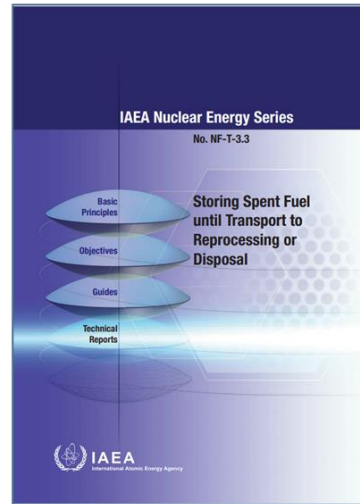
Review Missions

e-Tools

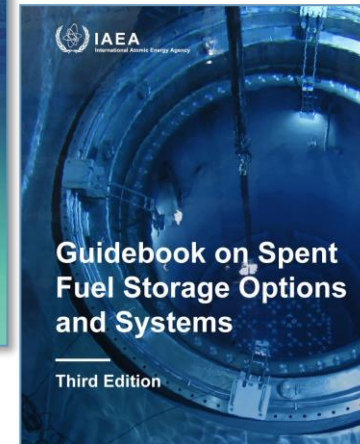
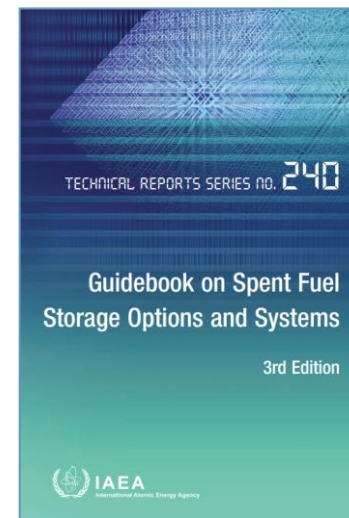
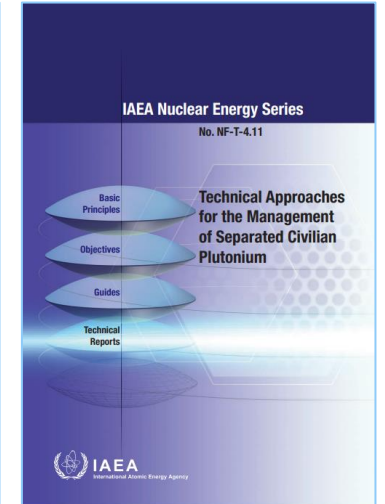
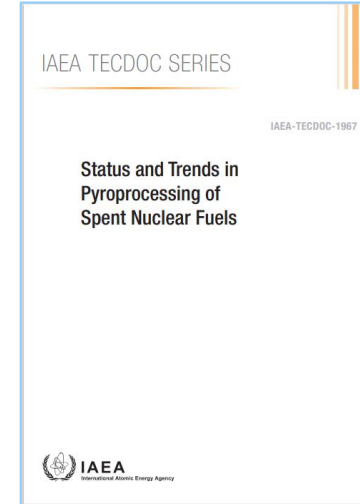
IAEA Publications on Spent Fuel Management



Translated in Arabic, Chinese & Russian



Translated in Arabic, Chinese and Russian



INTERACTIVE Available ON-LINE

AFR Wet Storage (~ 52,800 tHM)

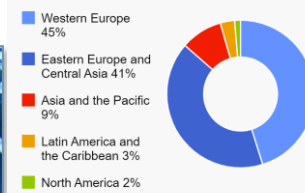


FIG. 8. Regional Distribution of Away from Reactor Inventory in wet storage.

Global Inventory Distribution in Dry Storage Systems (~ 105,900 tHM)

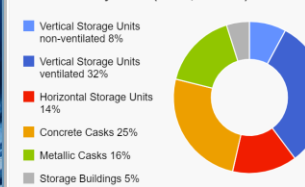


FIG. 13. Distribution of the global dry inventory.

<https://www.iaea.org/publications>

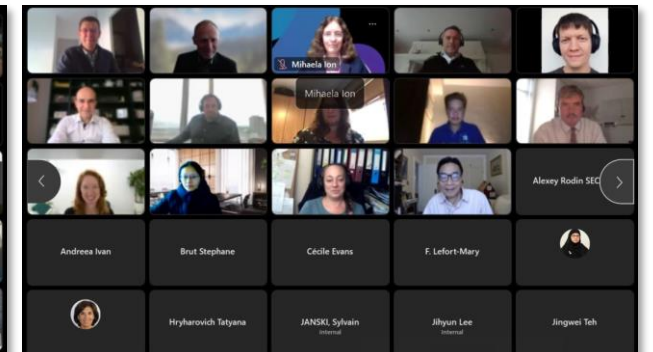
- TECDOCs
- NE Series publications
- Interactive Books with pictograms, animations and downloadable pictures and charts



Technical Meeting on Backend of the Fuel Cycle Considerations for SMRs, 20-23 September 2022

107 Participating Experts
from **32** Member States &
3 International Organizations

~ 40 Presentations and Extended
Abstracts



RESULTS of the IAEA Technical Meeting on Backend of the Fuel Cycle Considerations for SMRs

Summary of Presentations and Discussions during the Technical Sessions on

- IAEA Activities
 - SMR Developments and Associated Nuclear Fuel Cycle Options, Fuel Designs, Safety, Security, Safeguards, Economics, Transportation
- International Organization's Activities and Perspectives
 - EC/JRC, OECD/NEA and ERDO
- Member States' Activities and Perspectives
- Three Breakout Sessions (Storage, Reprocessing&Recycling, Transportation, Disposal)
 - LWR type
 - **HTGR type**
 - AMRs (LMFRs and MSRs) type
- General Discussion
- Conclusions and Future Areas of Work

IAEA TECDOC SERIES

IAEA-TECDOC-2040

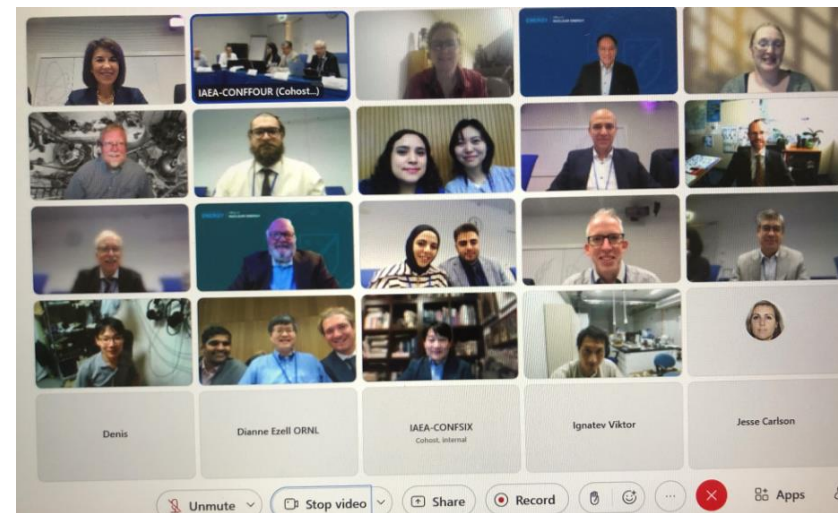
Considerations for the
Back End of the Fuel Cycle
of Small Modular Reactors

Proceedings of a Technical Meeting

IAEA-TECDOC-2040
Published in Dec 2023

International Workshop on the Chemistry of Fuel Cycles for Molten Salt Reactor Technologies, 2-6 Oct. 2023, in cooperation with the OECD/NEA

- Global attendance from national laboratories and SMR developers
 - 44 participants including 4 SMR developers
- Follow-up activities: to develop
 - a **Taxonomy** of nuclear fuel cycle options for MSRs
 - a **Terminology** associated to nuclear fuel cycle options for MSRs, to help when communicating on concepts





IAEA


International Conference on Spent Fuel Management: *Meeting the Moment*

10-14 June 2024


- In cooperation with OECD/NEA, WNA, EC, WNTI
- **300** in person participants from **58** countries and **6** Int Org
 - 86 women and 214 men present
 - About 220 participants online
- **77** oral presentations, **4** panels, **2** side events, **13** E-posters, **21** posters
- **Proceedings** in progress (publication: early 2025)



International Conference on the
Management of Spent Fuel from
Nuclear Power Reactors
Meeting the Moment

Organized by the
 IAEA
International Atomic Energy Agency
Atoms for Peace and Development

10–14 June 2024
Vienna, Austria
#SFM24



Ch-323

Special Attention Given to Young Generation




11 Young Generation Winners were selected based on the outstanding quality of their papers, the diversity of topical areas as well as the geographical distribution Egypt, Ethiopia, France, Mexico, Nigeria, Poland, Russia, Sweden, UK and USA

In recognition of their work, each winner was granted to attend the Conference in person, invited to deliver an oral presentation and to co-chair a technical session and they received a certificate signed by the IAEA DG-Grossi

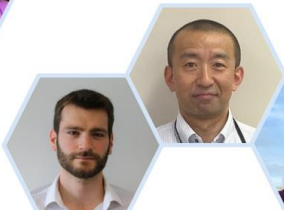
#SFM24 Panel Discussions

Panel on National Programmes (I)


Sama Bilbao Y Leon
World Nuclear Association (WNA)
Moderator




Takuji Fukuda
Nuclear Regulation Authority
Japan




Hong-June Park
Institute for Korea Spent
Nuclear Fuel
Korea




John Lubinski
Nuclear Regulatory
Commission (NRC)
United States of America




Thibault Manneville
French General Directorate
for Energy and Climate
France



Theo Klomberg
Ministry of Infrastructure
and Water Management
Netherlands



Tellervo Juurmaa
Nuclear Decommissioning Authority
United Kingdom



Panel on National Programmes (II)

Hans Wanner
Hans Wanner Consulting
Moderator



Umesh Dani
Bhabha Atomic Research Centre
(BARC)
India



Bartosz Sosnik
Polskie Elektryczne Jądrowe
Poland



Nos Balint
Public Limited Company for
Radioactive Waste Management
(PURAM)
Hungary



Muhammad Shoaib
Pakistan Atomic Energy
Commission (PAEC)
Pakistan



Panel on Stakeholders Involvement

Irena CHATZIS
IAEA
Moderator



Matti Kojo
Lappeenranta-Lahti University of
Technology (LUT)
Finland



Jan Boelen
Centrale Organisatie Voor
Radioactief Afval (COVRA)
Netherlands



Tim Vietor
Nationale Gesellschaft für die
Lagerung radioaktiver Abfälle (NAGRA)
Switzerland



Lisa Frizzell
Nuclear Waste Management
Organization (NWMO)
Canada



Rachel Zirovnik
Association Nationale des Comités et
Commissions Locales d'Information (ANCLLI)
France



María Pérez Fernández
Empresa Nacional de Residuos
Radiactivos, S.A. (ENRESA)
Spain



Panel on Innovation and Integration

Laura McManniman
EPRI, USA
Moderator



Luis Iglesias Perez
Joint Research Centre -
European Commission (JRC-EC)



Edward Petit de Mange
OKLO
United States of America



Arthur Situm
University of Regina
Canada



Cecile Evans
World Nuclear Association
(WNA)



Paul Gauthé
HEXANA
France



Bruno Merk
University of Liverpool
United Kingdom



Scientific Conference Programme from 8:30h to 18:30h

Monday, 10 June		Tuesday, 11 June		Wednesday, 12 June		Thursday, 13 June		Friday, 14 June			
09:00-10:30	Opening Session R. M. Gross, Director General International Atomic Energy Agency (IAEA) W. O. Magwood, Director General OECD Nuclear Energy Agency (OECD/NEA) S. Shibayama, Director General World Nuclear Association (WNA) U. Engelmann, Director for Nuclear Safety and Security Joint Research Centre - European Commission (JRC-EC) P. Buchen, Managing Director of Shipping Nuclear Transport Solutions (NTS), Board Member World Nuclear Transport Institute (WNTI) J.A. Gago, Conference Chairman, Spain	08:30-09:30	Poster Session 6 ADV IDW76 Characterization of the Swiss SNF Radionuclide Inventory for DGR Planning, E. Vassopoulou, SW IDW99 Computational Spent Fuel Characterization at VTT Finland, S. Hakkinen, FIN IDW127 EURAD - Spent Fuel Characterization - Report from a Recently Finished European Project, E. Vassopoulou, SW IDW132 Overview of Decay Heat Measurements at Ozb Facility: Description of Decay Heat Measurements from 2003-2021 Under EPB-SAB Collaboration, H. Akauri, USA IDW144 New Calorimeter Concept for the Measurement of Decay Heat from Spent Fuel Assemblies: A Gaseous NPP Project, S. Caruso, SW	09:00-10:30	Poster Session 4 REC IDW6 New Dual-Purpose Casks for Spent Fuel of Foreign WWER NPPs and High Level Waste from Spent Fuel Reprocessing, M.F. Balci, ARS IDW33 Modifications of the Interim Spent Fuel Dry Storage Facility for the Storage of Fresh Fuel, A. Smolys, LT IDW108 Performance Enhancement of the NHHOMS EDS Dry Storage System and the TN EAGLE Transportation Cask for Used Fuel Management, P. Marayanan, USA IDW77 Complementary Facility for Cask Recovery at EFSL, F. Lantjo, SPN IDW52 Spent Nuclear Fuel Management for Holtec International's SMR-300, R. Moran, SPN	08:30-10:30	Poster Session 5 DIS Panel on Innovation and Integration C. Evans, World Nuclear Association (WNA) (IDW50) I. Iglesias Alvarez, Joint Research Centre - European Commission (JRC-EC) F. Gauthé, HEXANA, FRA E. Petit de Mange, OKLO, USA (IDW91) B. Merik, University of Liverpool, UK (IDW103) A. Sibani, University of Regina, CAN	08:30-10:10	Poster Session 7 INT IDW45 About Spent Nuclear Fuel in Argentina: Should We Worry?, L. Gonzalez, ARG IDW55 The Value of an Integrated View on Spent Nuclear Fuel and Radioactive Waste Management Strategies Reducing Financial Risks to Stakeholders, L. Van der Duyn, BEL IDW74 ROWA: A Holistic Approach to the Optimization of Deep Geological Disposal of High Level Waste, E. Vassopoulou, SW IDW112 Advances in Developing a LWR Multirecycling System, C. Evans, FRA IDW116 Study of Scenarios for Spent Fuel Management in Mexico, J.L. François, MEX	08:30-10:10	Poster Session 7 INT IDW114 Preparing Safe and Efficient Loading and Transport Operations of Spent Nuclear Fuel, Y. Solignac, FRA IDW20 Experience and Perspectives of SNF Transportation in Russia: Organization of Shipments, Safety Requirements and Justification, Emergency Response, New Tasks, V.N. Ershov, RUS IDW110 Spent Nuclear Fuel Management at KKM Nuclear Power Plant: Spent Nuclear Fuel Storage Away from the Plant, F. Holmgren, SW IDW32 Transportation of Spent Nuclear Fuel Conducted in Poland - Lessons Learned, L. Bak, POL IDW141 Packaging Safety, Security, and Safeguards (3S) for Nuclear Fuel Cycle Materials in Storage, Transportation, and Disposal, Y. Liu, USA
10:30-11:00	Coffee/Tea Break	10:30-11:00	Coffee/Tea Break	10:30-11:00	Coffee/Tea Break	10:30-11:00	Coffee/Tea Break	10:30-11:00	Coffee/Tea Break		
11:00-12:15	P1 Panel on National Strategies for Spent Fuel Management (I) T. Manville, French General Directorate for Energy and Climate, FRA T. Fukuda, Nuclear Regulation Authority, JPN T. Klumberg, Ministry of Infrastructure and Water Management, NET R. Soćka, Państwowe Elektroenergetyczne, POL H. J. Park, Institute for Korea Spent Nuclear Fuel, ROK T. Juurva, Nuclear Decommissioning Authority, UK (IDW61) J. Lubinski, Nuclear Regulatory Commission, USA	11:00-12:40	Side Event 1: "The French Fuel Cycle: An Integrated System for a Sustainable Low-Carbon Energy", sponsored by France 12:50-13:50	Panel on Navigating Stakeholders Engagement L. Frizzen, Nuclear Waste Management Organization (NAMO), CAN M. Kato, Lappeenranta-Lahti University of Technology (LUT), FIN (IDW75) R. Zivovik, Association Nationale des Comités et Commissions Locales d'Information (ANCLLI), FRA J. Boelen, Centrale Organisatie voor Radioactief Afval (COVRA), NET M. Pérez Fernández, Empresa Nacional de Residuos Radiactivos, S.A (ENRESA), SPA T. Westor, Nationale Gesellschaft für die Lagerung radioaktiver Abfälle (NAGRA), SWI	11:00-12:40	Panel on Innovation and Integration C. Evans, World Nuclear Association (WNA) (IDW50) I. Iglesias Alvarez, Joint Research Centre - European Commission (JRC-EC) F. Gauthé, HEXANA, FRA E. Petit de Mange, OKLO, USA (IDW91) B. Merik, University of Liverpool, UK (IDW103) A. Sibani, University of Regina, CAN	11:00-12:15	Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS	11:00-12:40	Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS	
13:15-14:45	Lunch Break	12:40-14:00	Lunch Break	12:40-14:00	Lunch Break	13:00-14:20	Lunch Break	13:00-14:20	Lunch Break		
14:45-16:00	P2 Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS	14:00-15:40	Poster Session 2.1 STO IDW106 Solvent Extraction Experiments for Uranium, Plutonium, and Neptunium Co-Recovery with Dissolver Solutions Derived from Irradiated Nuclear Fuels, M. Nakahara, JPN IDW43 Recycling of PWR Spent Fuel in a Fast Reactor, C.-B. Lee, ROK IDW112 MOX and UOX Fuel Recycling in Pressurized Water Reactors, G. Vlast, FRA IDW7 Fundamental Approaches to HTR SNF Reprocessing Technology Development, E.D. Filimonova, RUS IDW9 Technological Approaches to Spent Accident-Tolerant Nuclear Fuel Processing, J.N. Podonov, RUS IDW61 Outlines for Building the Future of French Recycling Facilities, M. Vincenz, FRA IDW131 The ASOF Project - Advanced Separation for the Optimal Management of Spent Fuel, K. Lemmens, BEL IDW3 Sustainable Fuel Cycle as Basis for Successful Development of Nuclear Power Programmes for Embarking Countries, T.A. Aleksandrov, RUS	14:00-16:00	Poster Session 2.2 STO IDW120 CIBED, Readiness of the French DGR Project at the Construction Licence Examination Stage, M. Maréchal, FRA IDW80 Recent Progress within the United Kingdom R&D Programme for the Geological Disposal of High Heat Generating Wastes, J.J. Dunford, UK IDW124 Challenges in Collecting and Preserving Sufficient Spent Nuclear Fuel Information Before the Fuel is Placed in the Final Repository, F. Johansson, SWE IDW111 Cost Estimations for Disposal of Radioactive Waste in Switzerland: An Established Framework Takes the Next Step, M. Grogono, SWI IDW71 Adaptation of Current Final Disposal Strategy and Methods in Finland for Spent Fuel from SMRs, P. Kato, FIN IDW63 Spent Nuclear Fuel and the ConfinAR Geo Project, L. Klotz, ARG	14:20-15:40	Panel on Innovation and Integration C. Evans, World Nuclear Association (WNA) (IDW50) I. Iglesias Alvarez, Joint Research Centre - European Commission (JRC-EC) F. Gauthé, HEXANA, FRA E. Petit de Mange, OKLO, USA (IDW91) B. Merik, University of Liverpool, UK (IDW103) A. Sibani, University of Regina, CAN	14:45-16:00	Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS	14:45-16:00	Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS
16:00-16:30	Break	15:40-16:00	Break	16:00-16:30	Break	15:40-16:10	Break	15:40-16:10	Break		
16:30-18:30	ADV Poster Session 1 NAT IDW26 Characterization of Spent Fuel for Selected Small Modular Reactors and Implications for the Back End Fuel Cycle, X. Wang, CAN IDW68 A Tool to Estimate Isotopic Evolution for Actinides Transmutation Dedicated to Fast Molten Salt Reactors: A Comparative Study of Evolving In-core Key Parameters for the Preliminary Design of a Fast Molten Salt Reactor (F-MSR), P.-E. Dufour, FRA IDW51 Assessing the Potential for Molten-Salt Reactor (MSR) Technology as EU's Sustainable Nuclear Energy Futures, L. Van der Duyn, BEL IDW37 The French R&D Collaborative Project ISAC on Fast MSR Dedicated to Actinides Transmutation, M.-S. Chevraud, FRA IDW142 NRC Research Activities in Spent Fuel Storage and Management of Advanced Fuels for Advanced Reactors, T. Boyce, USA IDW21 The Implementation of SMR and the Back End Issue of the Fuel Cycle in Ukraine, B.P. Zhabenko, UKR	16:00-17:20	Poster Session 2.1 STO IDW106 Solvent Extraction Experiments for Uranium, Plutonium, and Neptunium Co-Recovery with Dissolver Solutions Derived from Irradiated Nuclear Fuels, M. Nakahara, JPN IDW43 Recycling of PWR Spent Fuel in a Fast Reactor, C.-B. Lee, ROK IDW112 MOX and UOX Fuel Recycling in Pressurized Water Reactors, G. Vlast, FRA IDW7 Fundamental Approaches to HTR SNF Reprocessing Technology Development, E.D. Filimonova, RUS IDW9 Technological Approaches to Spent Accident-Tolerant Nuclear Fuel Processing, J.N. Podonov, RUS IDW61 Outlines for Building the Future of French Recycling Facilities, M. Vincenz, FRA IDW131 The ASOF Project - Advanced Separation for the Optimal Management of Spent Fuel, K. Lemmens, BEL IDW3 Sustainable Fuel Cycle as Basis for Successful Development of Nuclear Power Programmes for Embarking Countries, T.A. Aleksandrov, RUS	16:30-18:30	Poster Session 2.2 STO IDW120 CIBED, Readiness of the French DGR Project at the Construction Licence Examination Stage, M. Maréchal, FRA IDW80 Recent Progress within the United Kingdom R&D Programme for the Geological Disposal of High Heat Generating Wastes, J.J. Dunford, UK IDW124 Challenges in Collecting and Preserving Sufficient Spent Nuclear Fuel Information Before the Fuel is Placed in the Final Repository, F. Johansson, SWE IDW111 Cost Estimations for Disposal of Radioactive Waste in Switzerland: An Established Framework Takes the Next Step, M. Grogono, SWI IDW71 Adaptation of Current Final Disposal Strategy and Methods in Finland for Spent Fuel from SMRs, P. Kato, FIN IDW63 Spent Nuclear Fuel and the ConfinAR Geo Project, L. Klotz, ARG	16:10-17:50	Panel on Innovation and Integration C. Evans, World Nuclear Association (WNA) (IDW50) I. Iglesias Alvarez, Joint Research Centre - European Commission (JRC-EC) F. Gauthé, HEXANA, FRA E. Petit de Mange, OKLO, USA (IDW91) B. Merik, University of Liverpool, UK (IDW103) A. Sibani, University of Regina, CAN	16:30-18:30	Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS	16:30-18:30	Panel on National Strategies for Spent Fuel Management (II) R. Kise, Public Limited Company for Radioactive Waste Management (PURAM), HUN U. Dan, Bhabha Atomic Research Centre (BARC), IND M. Shoaib, Pakistan Atomic Energy Commission (PAEC), PAK (IDW19) A.I. Chivchev, ROSATOM, RUS
18:30-20:00	Official Reception										

Track titles
1. NAT - National Strategies for Spent Fuel Management
2. STO - Storage of SNF and Vitrified HLW and Subsequent Transportability
3. TRA - Transportation in the Back End of the Fuel Cycle
4. REC - Recycling of Spent Fuel
5. DIS - Disposal of SNF, HLW and Other Waste Forms in Deep Geological Repositories (DGR)
6. ADV - Impacts of Advanced Nuclear Energy Systems on the Back End of the Fuel Cycle
7. INT - Achieving Integrated Spent Fuel Management

Panel titles
P1 - Panel on National Strategies for Spent Fuel Management (I)
P2 - Panel on National Strategies for Spent Fuel Management (II)
P3 - Panel on Navigating Stakeholders Engagement: Sharing Insights and Lessons Learned in Spent Fuel Management Strategy Implementation in Member States
P4 - Panel on Innovation and Integration: Approaches for Managing Spent Fuel from Advanced Reactors (e.g. SMRs, ...)

- 14 Sessions in 7 Tracks
- 77 contributed oral presentations
- 13 E-posters, 21 posters from 29 Member States and 2 international organizations

IAEA Coordinated Research Projects (CRP)

IAEA CRP No T13015 - CORIUM

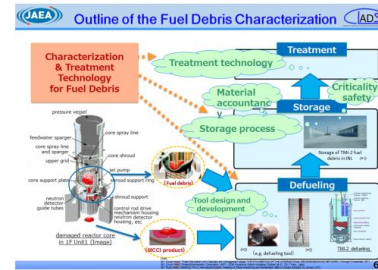
- Management of Severely Damaged Spent Fuel and Corium - IAEA CRP No T13015
- CRP Overall objective is to expand the existing knowledge base and identify optimal approaches for managing severely damaged spent fuel
- Project initiated February 2016

RCM-1 held 13-16 February 2017 in Vienna

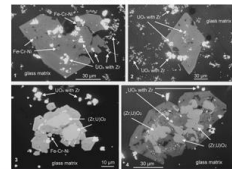
RCM-2 was held 5-9 November 2018 in Tomioka, Japan. Meeting hosted by JAEA at the CLADS Facility

RCM-3 was held 29 August - 2 September 2022 in Vienna (Hybrid)

Final Report (350+ pages) under preparation



Inclusions in black and brown "lava" matrices (from steam discharge corium) SEM-BSE 1.2 - brown 'lava'; 2.4 - black 'lava'



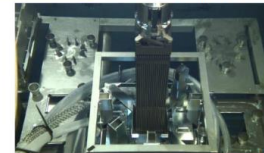
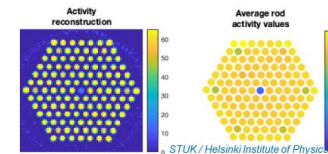
Management of Severely Damaged Spent Fuel and Corium Final report of a coordinated research project

350+ pages

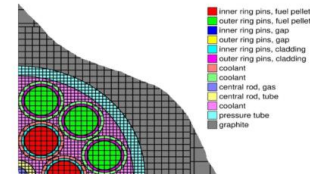
Value of the CRP
Sharing experiences and knowledge TMI, Chernobyl and Fukushima, damaged fuel management strategies

CRP on Spent Fuel Characterization, CRP T13018 (2020-2024)

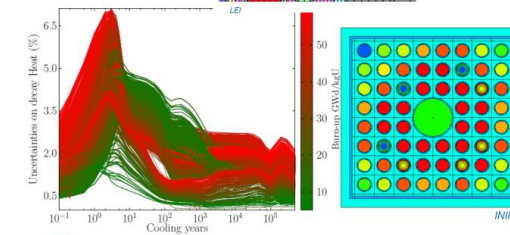
Covering a wide range of power reactor fuels: BWR, PWR, RBMK, WWER, CANDU and AGR fuels



Development and testing of techniques to characterize spent fuel using **non-destructive techniques**.



Destructive testing of spent fuels to enable full characterization and generate data points for future use.



Development, refinement and validation of **modelling techniques** for RBMK and LWR fuels. Includes assessment of biases and uncertainty for important parameters, such as **decay heat**

CRPs on Spent Fuel Behaviour

(40+ years of Operational Experiences and Research Worldwide)

Main Objective

- To sustain and improve the IAEA's Member States **technical knowledge base on the long-term behaviour of power reactor spent fuel** through sharing and disseminating information, reporting topical research carried-out in participating Member States, and by documenting ongoing spent fuel performance
- **Series of Coordinated Research Projects BEFAST and SPAR (1981-2020)**
 - Covering all power reactor fuels: MAGNOX, RBMK, WWER, AGR, BWR, PWR, HWR, PHWR
 - Spent Fuel performance in Wet and Dry storage



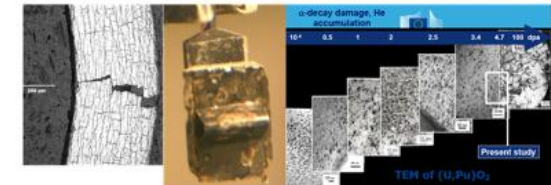
SFERA, CRP T13020 (2021-2025)

Main Objective

- To sustain and improve the IAEA's Member States **technical knowledge base on the long-term behaviour of power reactor spent fuel** through sharing and disseminating information, reporting topical research carried-out in participating Member States, and by documenting ongoing spent fuel performance

Scope limited to fuel

- Fuel material
- Cladding
- Fuel assembly structural components



Looking at both wet & dry storage conditions

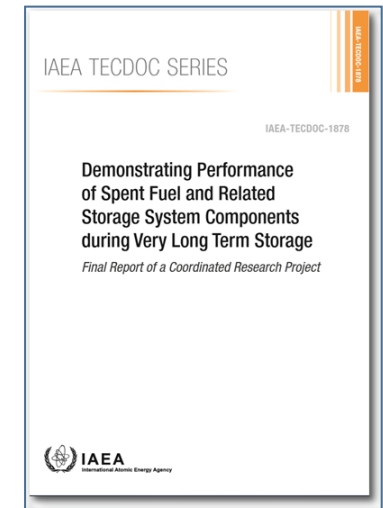
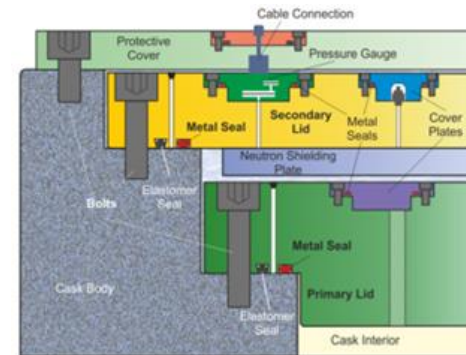
CRPs on SNF Dry Storage Systems Behaviour

- **Demonstrating Performance of Spent Fuel and Related Storage System Components During Very Long Term Storage” (DEMO) CRP T13014 (Closed, 2012-2016)**

Linked to Extended Storage Collaboration Programme (ESCP) International Subcommittee of EPRI

- **Ageing Management Programmes for Dry Storage Systems” (AMP) CRP T21028 (Closed, 2016-2020) (Final Report in Drafting)**

CRP Overall Objective: To develop the technical basis and methodology to enable guidance to be provided to Member States on how to generate an ageing management programme for spent fuel dry storage systems



CRPs on SNF Storage Systems Behaviour

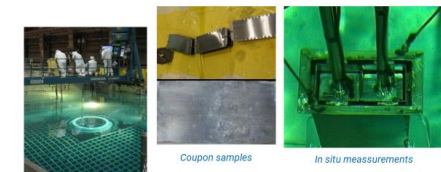
“Performance Assessment of Storage Systems for Extended Durations” (PASSED) T13019 (2022-2026)

Main Objective:

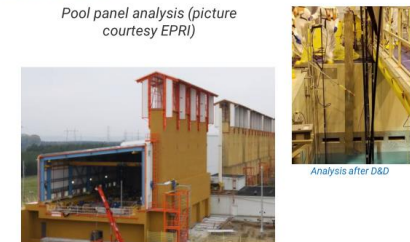
- To sustain and improve IAEA Member States’ technical knowledge base on the **long term behaviour of spent fuel storage systems, inspections possibilities and monitoring technologies**, through the sharing and disseminating of technical information, the reporting on topical researches carried-out and the documentation of on-going storage systems’ performance

Covers wet & dry spent fuel storage systems

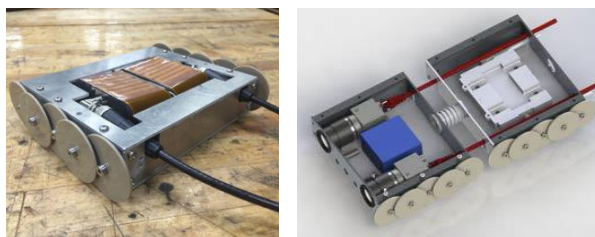
- operational experiences storage system inspections
- new/novel techniques for monitoring
- predictions of spent fuel storage system behaviour over long periods
- documenting the technical basis for spent fuel storage system performance assessment
- predictions of spent fuel storage system behaviour



Pool panel analysis (picture courtesy EPRI)



Enlargement of storage facilities. Courtesy PAKS



Overview about development of inspection technologies



Coordinated Research Project on Challenges, Gaps and Opportunities for Managing Spent Fuel from SMRs

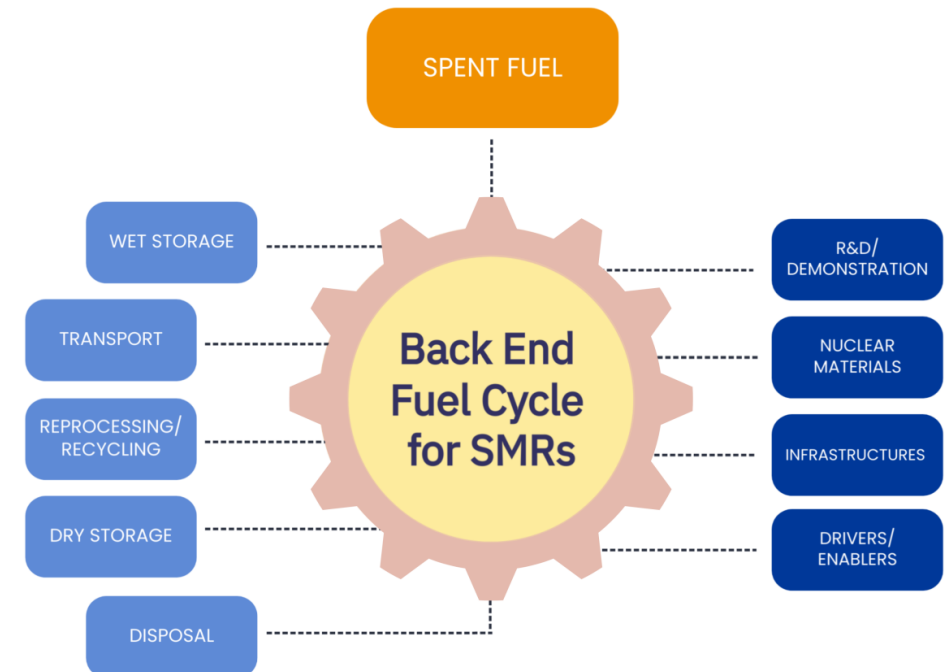
Understanding the implications of the management of new spent fuels is paramount to make informed decisions

MAIN OBJECTIVES and OUTPUTS

Development of **specific roadmaps** for managing spent fuel from the different SMR technologies, identifying **what can be derived, optimized or adapted from existing practices, or what needs to be fully developed**

- **All SMR technologies included:** LWRs (LEU, LEU+, HALEU), HTR (TRISO (prismatic, pebbles)), FRs (Metallic, Oxide, Nitrides, ...), MSR
- To compare various SMR systems, in terms of efforts required to develop and implement an SFM strategy
 - ✓ Nuclear fuel cycle facilities
 - ✓ Technology readiness level
 - ✓ Nuclear materials involved
 - ✓ Infrastructures (e.g., human resources, financing)
 - ✓ R&D / Demonstrations
 - ✓ Enablers/Synergies

SMR-COGS, CRP T13021



First Research Coordination Meeting of SMR-COGS CRP held on 11 to 15 November 2024 in Vienna

STATUS of the Coordinated Research Project SMR-COGS

- **14 Research Contracts** from ARG, ARM, CPR, CZR, EGY, INS, LIT, MEX, POL, ROM(2), UKR(3)
- **18 Research Agreements** from CAN(2), CPR, DEN, EGY, JOR, NOR, SIN, SPA, SWE, TUR, UK(2), USA(5)



- Industry, Operators, Researchers, Regulators, etc.
- Nuclear Energy Programmes:
 - Embarking (Phase 1, 2 and 3), Expanding, Mature and Not Nuclear (DEN and NOR)
- Observers: OECD/NEA, FIN, FRA, NET, RUS

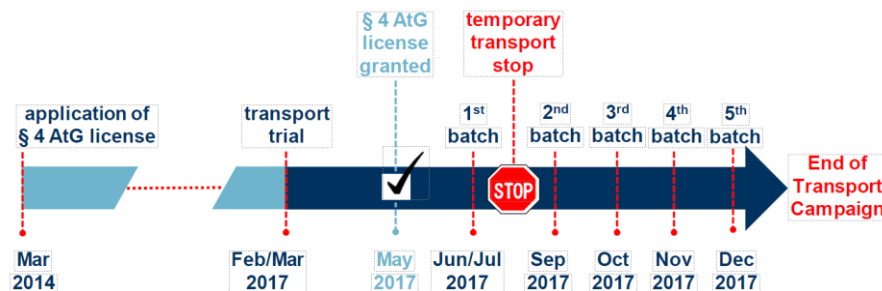
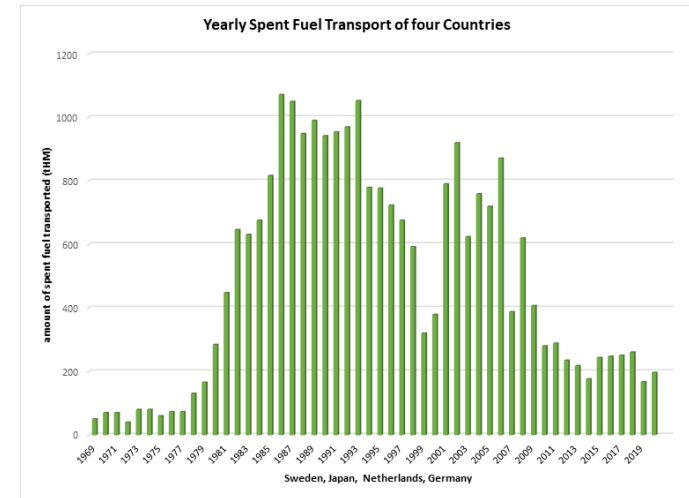
- ❑ Decision to publish **Roadmaps** as soon as they are ready
- ❑ **First one on HTGR spent fuels** foreseen by Dec 2025

45+ participants from 25 countries

Transportation of Spent Fuel

Technical Meeting on Operational Experiences on Spent Fuel and High Level Waste Transportation, 17-21 October 2022

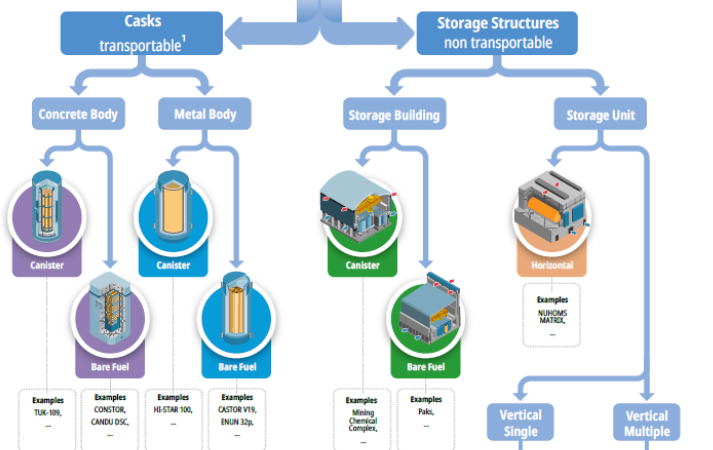
- Spent fuel has been regularly transported for decades
- TM will review draft TECDOC on Operational Experience containing case studies from seven countries
- Will be opportunity to gather and discuss further information
- Tecdoc is under Drafting Process, gathering country cases



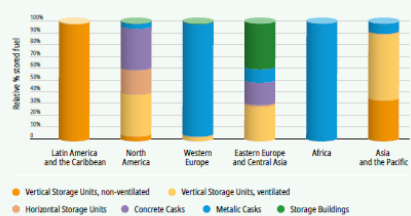
Detailed regulations require long preparation times

IAEA Infographics on Spent Fuel Management

DRY STORAGE TECHNOLOGIES THE CHARACTERISTICS



Spent Fuel Dry Storage Systems by Regions (105,900 tHM)²

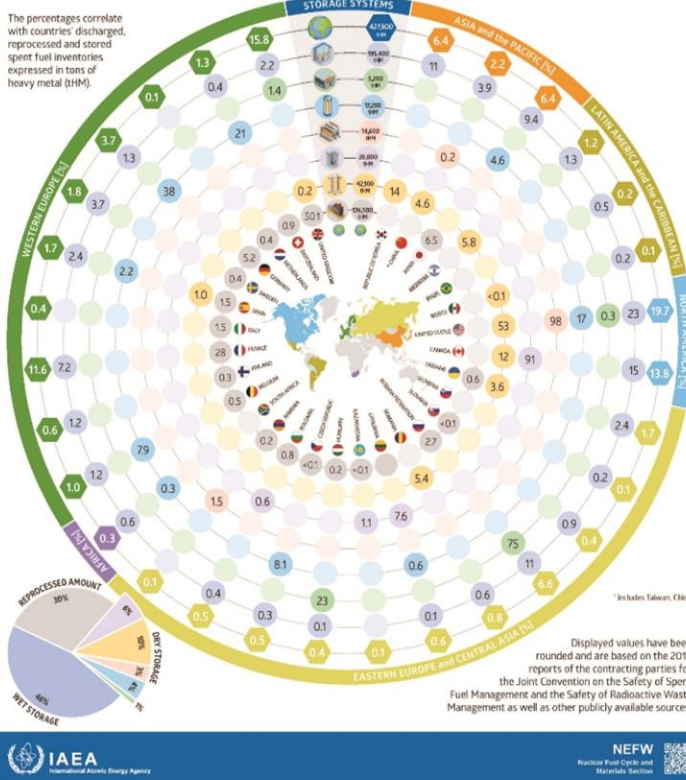


As a wide variety of terms are used for spent fuel dry storage technologies, this infographic classifies them based on the system characteristics.

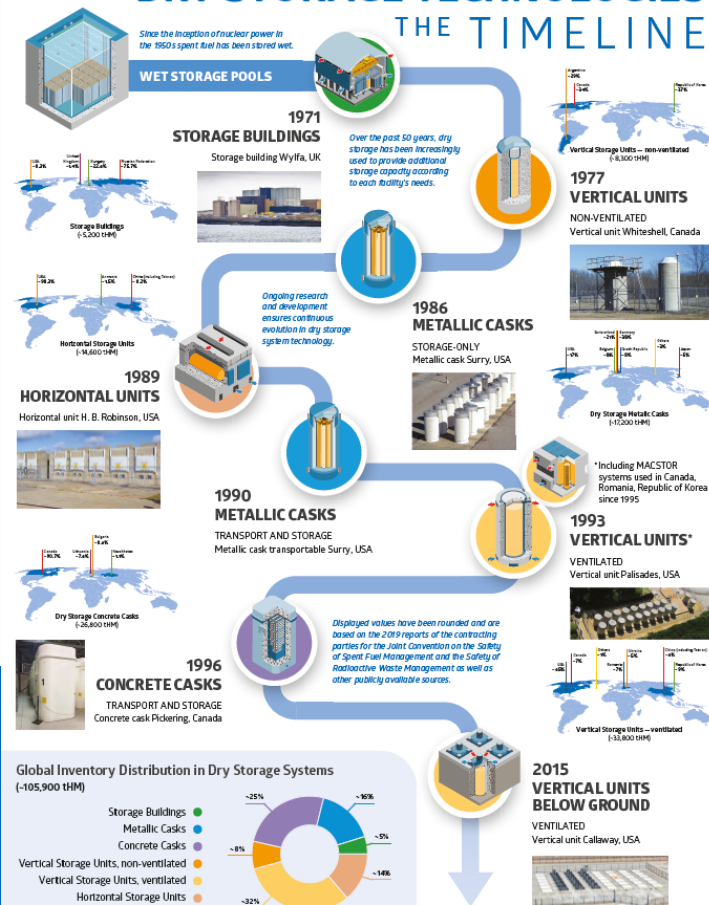
Examples of currently available spent fuel storage systems are given for illustration; these examples are neither an exhaustive list nor an endorsement.

¹ Able to obtain a type B(U) package approval for transportation.
² Displayed values have been rounded and are based on the 2019 reports of the contracting parties for the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management as well as other publicly available sources.

SPENT FUEL MANAGEMENT THE INVENTORY STATUS

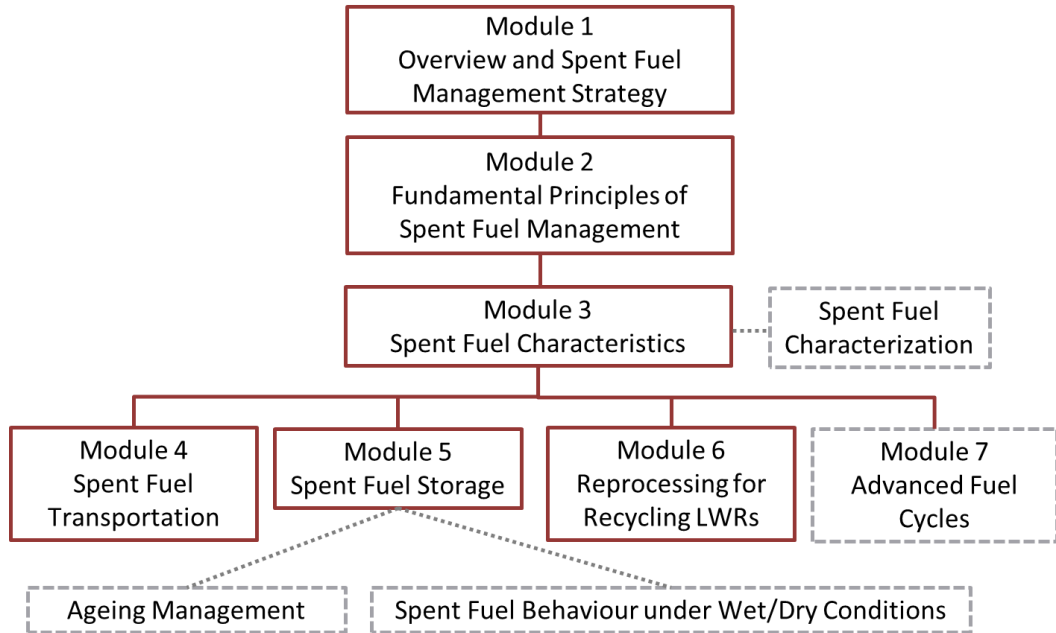


DRY STORAGE TECHNOLOGIES THE TIMELINE



IAEA e-Learnings on Spent Fuel Management

6 Modules (11 Lectures) already available in 



The Nuclear Fuel Cycle

Storage Facility Maintenance Operations

Dry Canister and Cask Storage Systems

- Designed as sealed systems
- Modular dry storage systems
- Dual purpose system requirements
- Burnup credit for increasing density
- Physical barriers for shielding
- Including neutron absorbing materials
- Cylindrical in shape, vertical or horizontal
- Fuel positioned in storage basket
- Decay heat removing
- In building or open area storage

Transport System Operations

- 01 Shipment Planning and Management at the Operations Center
- 02 Assembly and Dispatch from the FPM
- 03 Delivery to Origin Site
- 04 Cask Handling and Loading at Origin Site
- 05 Transporting Loaded Casks to the Destination
- 06 Possession of Transportation Assets from Destination Operations
- 07 Transport, Transportation Assets to FPM
- 08 Reassembly and Preparation for Shipment

Examples of Storage Facility Operations

- Centralised Temporary Storage for SNF in Spain
- The Interim Spent Fuel Storage Facility in Paks, Hungary
- Spent Fuel Storage at Diablo Canyon NPP, USA
- The Central Interim Storage Facility for SNF — CLAB, Sweden
- NUHOMS — Nuclear Horizontal Modular Storage

Coming soon

SF Recycling Options

LWR FR



<https://www.iaea.org/services/education-and-training/online-learning>



IAEA

Up-Coming IAEA Activities on SFM

- Technical Meeting on Operating Experience and Lessons-learned on Managing Non-standard/Exotic Legacy Power and Research Reactor Fuels, 18-21 February 2025, Vienna
- Technical Meeting on the **Behaviour of Spent Fuel and Cladding During Storage and the Performance of Spent Fuel Storage Systems**, 23-27 June 2025, Seoul
- Technical Meeting on the Management of **Spent Fuel from High Temperature Gas Cooled Reactors**, 7-11 July 2025, Vienna
- Joint IAEA-NEA Workshop on the **Taxonomy and Related Terminology of Fuel Cycles for Molten Salt Reactors**, 3 – 7 November 2025, Vienna
- Workshop on the Challenges in Managing **Spent Evolutionary Advanced Technology Fuels**, 10-14 November 2025, Vienna



Spent Fuel Management Network

Welcome to the IAEA International Network on Spent Fuel Management - SFM Net

The spent fuel management (SFM) network is a forum for the sharing of practical experience and international developments on spent fuel management.

Its main objectives are to facilitate the efficient exchange of information, communication and cooperation amongst professionals working in the back-end of the fuel cycle – from its removal from a reactor core to its final disposition (i.e. SNF wet and dry storage, transportation, handling and retrieval, reprocessing and recycling, economics of the back-end of nuclear fuel cycle, damaged SNF management, stakeholder involvement, communication issues, etc.)

The establishment of the SFM Net is aimed at fostering safe, sustainable and efficient spent nuclear fuel management practices across all IAEA Member States.

For further information or questions please contact SFM.Contact-Point@iaea.org.

Featured Publications



Events 2025

- [Technical Meeting on Operating Experience and Lessons Learned on Managing Non-Standard Legacy Spent Fuels from Power and Research Reactor](#) (18 – 21 February 2025) [EV12404678](#)
- [Third Coordination Research Meeting on Spent Fuel Research and Assessment](#) (24 – 28 March 2025) [EV12404557](#)
- [23rd Meeting of the Technical Working Group on Nuclear Fuel Cycle Options and Spent Fuel Management](#) (01 – 04 April 2025) [EV12403024](#)
- [Technical Meeting on the Behaviour of Spent Fuel and Cladding During Storage and the Performance of Spent Fuel Storage Systems](#) (23 – 27 June 2025) [EV12406873](#)
- [Technical Meeting on the Management of Spent Fuel \(Pebble Beds and Prismatic\) from High Temperature Gas Cooled Reactors](#) (7 – 11 July 2025) [EV12404558](#)
- [Joint IAEA-NEA Workshop on the Taxonomy and Related Terminology of Fuel Cycles for Molten Salt Reactors](#) (29 September – 03 October 2025) [EV12404560](#)
- [Workshop on the Challenges in Managing Spent Evolutionary Advanced Technology Fuels](#) (10 – 14 November 2025) [EV12205776](#)
- [Technical Meeting on the Operation and Maintenance of Storage and Transportation Casks](#) (09 – 12 December 2025) [EV12404726](#)

Latest News



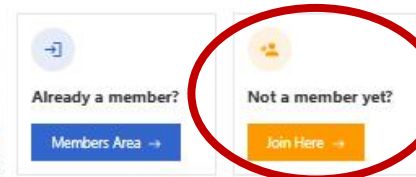
NEW CRP: Challenges, Gaps and Opportunities for Managing Spent Fuel from Small Modular Reactors (T13021)

There are currently more than 80 small modular reactor (SMR) designs under the development globally, spanning a wide range of reactor technologies and fuel...



IAEA's Learning Management System!

With the addition of 3 new modules, the course on Spent Fuel Storage is available on IAEA's Learning Management System! Click here for full course details.



New infographics now available!





Thank You

A.Gonzalez-Espartero@iaea.org