PREDIS

2.1.1 DI Inventory

Domain Insight with EURAD Roadmap

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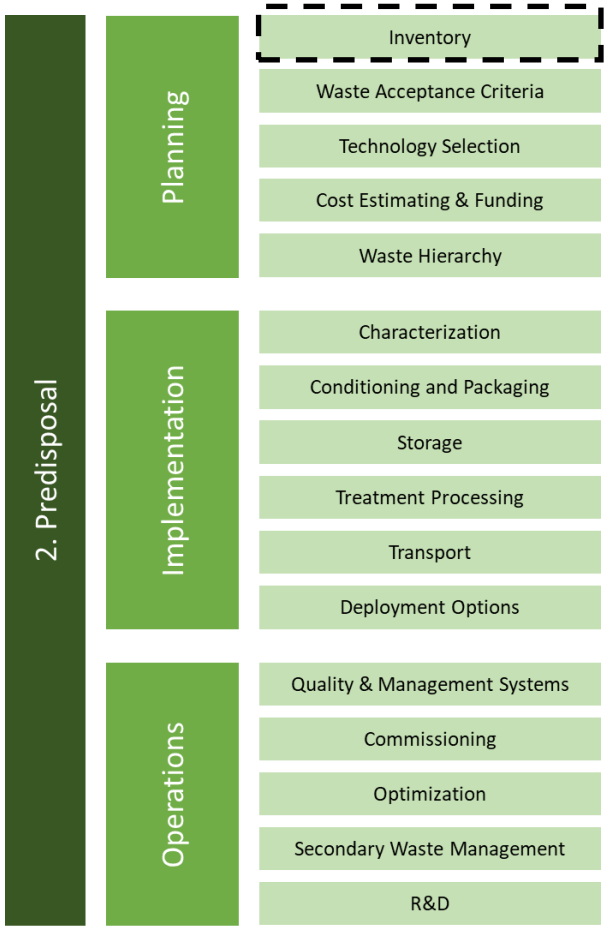
Introduction to DI 2.1.1

This Domain Insight has been produced to provide key information and references for the following:

- Waste Producers/Owners who are accountable for the safe management (storage, treatment and eventual disposal) of the waste
- Government Departments and Agencies who develop policies and strategies for managing waste and who regulate nuclear operations
- Supply chain organisations who process waste and need data to support the planning, operation and performance of their facilities
- Waste planners who are responsible for ensuring that waste management facilities meet local and national needs
- Researchers and academics who are developing innovative technologies and processes for managing radioactive waste
- Members of the public who would like to understand more about radioactive waste



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Typical overall goals and activities in the domain (Based on EURAD Roadmap GBS)

- Domain Goal - Evaluate waste inventory from generators and existing storage, accounting for future waste generation and evolution (Inventory)
- Domain Activities –
- Phase 1: Planning and Programme Initiation
- Phase 2: Program Implementation
- Phases 3–4: Program Operation/Optimisation and Closure

- Producing inventory information necessary to address the requirements at each Phase

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International Legislation

- IAEA (2016). Government, Legal and Regulatory Framework for Safety; SSR-2/2 (Rev. 1).
- EC (1999). European Commission Recommendation on a Classification System for Solid Radioactive Waste, SEC(1999) 1302 final.
- EC (2011). Seventh Situation Report Radioactive Waste and Spent Fuel Management in the European Union SEC(2011) 1007 final.
- ENSREG (2014). Final Guidelines for MS Reports to the Waste Directive, HLG, p(2014-27)_137
- EU Council Directive 2011/70/EURATOM. Establishing a Community Framework for the responsible and safe management of spent fuel and radioactive waste.
- IAEA (2012). Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management: Guidelines Regarding the Form and Structure of National Reports. INFCIRC/604/Rev.2.
- IAEA (2010). Guidance on Translation of Member State Waste Classes for Purposes of Reporting Waste Inventories to the Net-Enabled Waste Management DataBase, unpublished.

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International Legislation

- IAEA (1997), “Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management”, INFCIRC/546
- IAEA (2009) Predisposal Management of Radioactive Waste. General Safety Requirements No. GSR Part 5.
- IAEA (2019). Predisposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education; Specific Safety Guide SSG-45
- the European Union Directives

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Planning and Program Initiation

- In the early phases of program initiation, it is necessary to consider the full ‘life cycle’ of the processes that may require the management of wastes or nuclear materials. A conceptual understanding can be developed that allows the Features, Events and Processes (FEPs) of the programme to be identified and the necessary related inventory data determined.
- The aggregated data for safety assessments within the planning and initiation stage will
  - Demonstrate that the program is likely to operate safely with inventories that can be managed using existing, or potentially anticipated, waste management controls.
  - Ensure that all wastes and materials have identified disposition routes and that the generation of problematic wastes is unlikely.
  - Help to identify gaps, or stress points, where data may not robustly substantiate the safety claims. Such gaps or failures to substantiate may require further attention before the next phase of Program Implementation can commence.
  - Identify the SNM, SNF, and the types (LLW, ILW and HLW) and volumes of radioactive wastes anticipated to be generated during operations and decommissioning activities.
  - Integrate with Characterisation (Characterisation DI) strategy and Waste Hierarchy (WMH DI), to ensure optimisation is fully considered and demonstrated.

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Program Implementation

- The situation of implementation today considering new insights
- The planning and initiation program may have identified the expected wastes and their associated inventories but the demonstration of the accuracy of these estimates arrives at the program implementation stage.
- Optimisation and sustainability are key processes and periodic consideration of the materials used in the facility should be tested against their end of life fate.
- Systems should be designed and implemented to set up adequate sampling and monitoring regimes (location, frequency and analytical parameters) to
  - Demonstrate the system is behaving as expected
  - The inventory being generated is as expected and builds confidence in predicted future arisings
  - Opportunities to optimise and apply the waste hierarchy can be identified and realised
  - Faults and failure mechanisms in such systems should be considered and mitigated (add to note loss of ~~power to loss of disposition route and reassessment of Acceptance Criteria~~)

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Program Operation and Closure

- The situation of operation and closure today considering new insights
- compliance with waste hierarchy and safety precautions towards public and environment,
- documentation of the physical properties of the radioactive material and processing conditions,
- safety and operational performance of the processing facilities and equipment,
- accurate operating procedures applicable to expected waste arisings and non-standard operations,
- accurate characterisation and classification of materials recovered for reuse,
- accurate markings and labelling imposed on wasteforms and packages,
- verifying the recovered materials or wasteform packages are safe for use:
- Recovered materials comply with specifications for reuse,
- wasteforms/packages meet Waste Acceptance Criteria for interim stores or disposal sites.

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Critical issues, information, data or knowledge in the domain of Inventory

- Member States may use different radioactive waste classification schemes and some form of translation may be appropriate to apply to your case.
- Member States use different units (volume, mass, etc.) for unconditioned waste. Conversion from mass to volume without detailed knowledge of radioactive waste treatment/conditioning methods used can result in significant uncertainty.
- Member States report differently volumes of unconditioned radioactive waste – some report actual volumes in storage, while others report estimated volumes after conditioning to be placed in disposal.
- The confidence level to which a derived inventory has been developed may be challenging to demonstrate to satisfaction of peer review
- Security and Safeguards should be of prime consideration and inventory data management should demonstrate the Safeguarding of Special Nuclear Material and support to non-proliferation activities.

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Future advances

- The PREDIS Strategic Research Agenda has shown that inventory development falls into the categories of **Strategic Studies** and **Knowledge Management**. Knowledge Management and the provision of the right information at the time it is most needed is a key component of the inventory lifecycle.
- The inventories developed may be aggregated and assessed in facility, site or national studies. Methods to understand the uncertainty associated with these inventories assists such studies.
- The use of statistics, tied with characterisation within inventory assessment also has important benefit of being able to demonstrate the degree of confidence in the derived inventory.
- PRE-DISposal management of Radioactive Waste (PREDIS), Milestone 2.4, Strategic Research Agenda; Version 2. May 2023.
- Knowledge and records management is a legacy for future generations. Preserving the information and anticipating the future needs (to be completed).

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Future optimisation challenges and innovations

- Known challenges
  - To identify opportunities for optimisation
  - To demonstrate sustainability
  - To build confidence in the inventory data for robust decision making
- Needed innovations
  - Suitable programmes to train subject matter experts in inventory development
  - Technology to aid the detection and modelling and key inventory parameters
  - Assessment of novel materials

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Past RD&D projects on Inventory

- Processes are often well developed for the reporting and management of Higher Activity Wastes (HAW) and Low Activity Wastes. These processes are routinely assessed for their adequacy and changed as and when it is appropriate to do so. The most fundamental changes are focussed on the disposition routes available and relate to the safety cases of operating and subsequently closing these disposition routes. The bulk of the inventory information demands are to demonstrate that the RW satisfies the acceptance criteria of these disposition routes.

- The PREDIS Strategic Research Agenda has shown that inventory development falls into the categories of Strategic Studies and Knowledge Management. Knowledge Management and the provision of the right information at the time it is most needed is a key component of the inventory lifecycle.

- Assessments on the validity of developed inventories have been undertaken for some decades, essentially for as long as radioactive waste has required management. Over the years initiatives and tools have been developed to enable, within a regulated structure, both the inventory development and inventory assessment stages.

- The use of statistics, tied with characterisation within inventory assessment also has important benefit of being able to demonstrate the degree of confidence in the derived inventory.

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Uncertainties

- The generation of an inventory and thus its uncertainty is directly influenced by the approach undertaken, which can include some or all of the following aspects.
  - Modelling
  - Sampling and analysis
  - Similar systems
  - Expert judgement and provenance
  - Interpretation
  - Data management
- Useful references include
  - Eurachem, CITAC, Eurolab, Nordtest and RSC Analytical Methods Committee. (2019). *Measurement uncertainty.* Second Edition.
  - International Atomic Energy Agency. (2009). Determination and Use of Scaling Factors for Waste Characterization in Nuclear Power Plants. IAEA Nuclear Energy Series No. NW-T-1.18.
  - OECD. (2017, November). *Radiological Characterisation from a Waste and Materials End-State Perspective. Practices and Experience.*
  - OECD. (2021, November). *Characterisation Methodology for Unconventional and Legacy Waste. NEA/RWM/R(2020)2.*

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Guidance, training and communities of practice

Guidance
• Spent Fuel and Radioactive Waste Information System (SRIS) | IAEA. IAEA's website provides information on national spent fuel and radioactive waste management programmes, spent fuel and radioactive waste inventories and facilities, as well as relevant laws and regulations, policies, plans and activities.
Training
https://www.iaea.org/services/education-and-training/online-learning/spent-fuel-and-radioactive-waste-management-decommissioning-and-environmental-remediation.
Active communities of practice and networks
• IAEA – themed mission training. – raising the standard across the member states.

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Additional references and future reading

- Benchmarking Analysis of Member States Approaches to Definition of National Inventories Radioactive Waste and Spent Fuel. No. ENER/2018/NUCL/SI2.778797, Final report.
- NEA - OECD Radioactive Waste Management 2017. National Inventories and Management Strategies for Spent Nuclear Fuel and Radioactive Waste: Extended Methodology for the Common Presentation of Data. NEA No.7371.
- SWD(2019) 435 final, COMMISSION STAFF WORKING DOCUMENT: Inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects.
- REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects. {COM(2019) 632 final} - {SWD(2019) 436 final}
- Multifactor Optimisation of Predisposal Management of Radioactive Waste; Proceedings of the NEA Joint Workshop 10-14 February 2020; OECD Conference Centre. NEA/RWM/R(2020)3. June 2021.
- IAEA Nuclear Energy Series No NW-T-1.14 (Rev. 1). Status and trends in Spent Fuel and Radioactive Waste Management. 2022.

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Test Question - 1

- Q1 – Which of the typical inventory development activities below cannot be undertaken during the planning and initiation phase

  - Computer modelling
  - The use of operational experience from an analagous programme
  - Sampling and Characterisation
  - Expert Judgement

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Test Question - 2

- Q4 – Which describes the correct sequence of phases covered in this Domain Insight?
  - Planning and Initiation, Implementation, Operations, Closure
  - Planning and Implementation, Initiation, Operations, Closure
  - Planning and Initiation, Operations, Implementation, Closure
  - Planning, Initiation, Implmentation, Operations, Closure

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Test Question - 3

- Q2 – In which stage should optimisation of the waste inventory be considered?

  - Planning and Initiation
  - Implementation
  - Operations
  - Closure
  - All stages

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Test Questions - 4

- Q3 – Why is a high quality inventory important? Select all that apply

  - The case for implementation may not be adequately made
  - Management and Control of the inventory cannot be adequately demonstrated
  - It isn’t, the work will proceed regardless
  - Wastes will not be accepted by waste treatment and disposal companies
  - All of the other domain insights presented this week become very challenging to accomplish

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Test Question - 5

- Q5 – What do YOU consider to be the main uncertainty to developing an inventory?
  - Demonstarting sufficient confidence in the nature and quantity operational wastes to get past the initiation phase?
  - An understanding of the non-radiological properties present and how they may impact wastes management and disposition?
  - Confidence in classification of each inventory to be generated?
  - Availability of disposition routes for the duration of the programme?
  - Unknown future changes to national policy for radioactive waste and management
  - Other

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