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Baseline Strategic Research Agenda
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Abstract

This report describes the first phase of the development of a Strategic Research Agenda (SRA) for the Pre-disposal of Radioactive Waste, written during the first year of the EU project "Pre-disposal management of radioactive waste" (PREDIS). This initial stage has focussed on the consolidation of the existing published SRAs of major European and worldwide stakeholder groups (where available) and describes the scientific and technical domains and sub-domains and needs of common interest in Pre-disposal. This fulfils the PREDIS project milestone M2.3.

Further phases of the SRA document will be developed, with the final SRA (planned for 2024) being based on the needs of PREDIS as identified throughout the duration of the PREDIS project through consultation with the project partners and stakeholders.

There are many stakeholders with an interest in the predisposal waste management subject either through direct involvement or at the interfaces; several documents have been published which consider predisposal activities. Key themes from these published documents have been consolidated into this baseline SRA for the subsequent development of the PREDIS SRA. The SRA structure was developed from IAEA guidance and in line with the structure used for the JOPRAD/EURAD SRAs.

The list of existing SRA or other strategic outputs from previous and current projects or organisations was developed through consultation with the PREDIS partners. The exercise to review these SRAs and identify pertinent sections was also undertaken by the PREDIS partner organisations, with reviewers assigned to identified sources according to their knowledge and experience, and in the main reviewing the documents they had identified. Each document review was carefully recorded in a purpose-built audit trail template where the reasoning behind each identified section could be captured or, conversely, if no pertinent text was identified this could be recorded to show that the document had been reviewed but discounted as not relevant to PREDIS.

A broad review of the extracted text highlighted a significant amount of duplication of topics across the different source SRAs. The next step therefore was to rationalise the text to eliminate this duplication. The text was reviewed carefully and a number of common themes topics were identified that could be assigned to keywords based on the PREDIS SRA sections. It was then possible to use the assigned keywords to sort the text into groups of common topics, with the next step then being to remove duplication through the development of a single section of discussion for each topic, ensuring links are made to original SRA through references.

A workshop was held with the PREDIS partner organisations that had undertaken the initial SRA reviews to present the findings and obtain buy-in for the proposed structure and identified priority themes. The outcome of this workshop was a positive acceptance of the structure and themes, and it was recognised that the topics and themes identified from the review of existing SRAs were largely in line with those identified in a similar exercise undertaken for the gap analysis task 2.6. This provided good confidence that both the SRA and gap analysis were focusing on the appropriate topics.

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HISTORY OF CHANGES

Date	Version	Author	Comments
18.6.2021	0.6	Wareing, Fowler, Banford	Initial draft for comment
09.7.2021	0.7	Wareing, Fowler, Banford	Account for review comments (Holt, Bruggeman)
14.07.2021	1 (Draft)	Wareing, Fowler, Banford	First issue (Draft 1) for review
20/08/2021	1	Wareing, Fowler, Banford	First full issue following review comments from PREDIS WP Leaders and Coordinator

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1 Introduction

This report describes the first phase of the development of a Strategic Research Agenda (SRA) for the Pre-disposal of Radioactive Waste, written during the first year of the EU project "Pre-disposal management of radioactive waste" (PREDIS). This initial stage has focussed on the consolidation of the existing published SRAs of major European and worldwide stakeholder groups (where available) and describes the scientific and technical domains and sub-domains and needs of common interest in Pre-disposal. This fulfils the PREDIS project milestone M2.3 Draft SRA for consultation (M9).

Further phases of the SRA document will be developed, with the final SRA (planned for 2024) being based on the needs of PREDIS as identified throughout the duration of the PREDIS project through consultation with the project partners and stakeholders.

2 Background

The PREDIS project is the outcome of the EURATOM NFRP-2019-2020-10 RIA call "Developing pre-disposal activities identified in the scope of the European Joint Programme in Radioactive Waste Management" (September 2019). The project started on 1st September 2020 and has a four-year duration. The consortium includes 47 partners from 18 Member States.

Figure 1 shows the PREDIS project in the context of two other major European Projects, namely **SHARE** (https://share-h2020.eu/) which addresses issues of decommissioning nuclear facilities and **EURAD** (https://www.ejp-eurad.eu/) which addresses radioactive waste management & disposal issues. It should be noted that both SHARE and EURAD touch on predisposal waste management topics and indeed collaboration with these projects is a key element of the PREDIS programme.

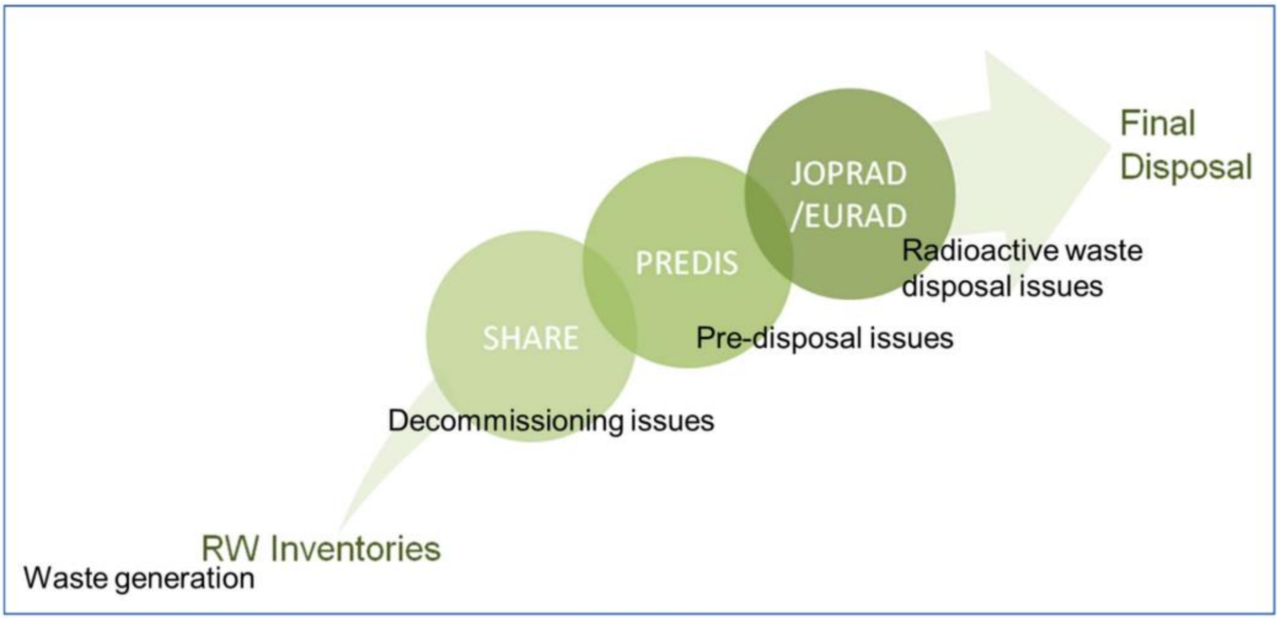

Figure 1 PREDIS project interfaces with upstream and downstream domains

The PREDIS project develops and increases the Technological Readiness Level (TRL) of treatment and conditioning methodologies for (low and intermediate level) wastes for which no adequate or industrially mature solutions are currently available, including metallic materials, liquid organic waste and solid organic waste. The PREDIS project also develops innovations in cemented waste handling and pre-disposal storage by testing and evaluation. The technical Work Packages align with priorities formulated within the Roadmap Theme 2 of EURAD and with those identified by the project's industrial End Users Group (EUG). PREDIS will produce tools guiding decision-making on the added value of the developed technologies and their impact on the design, safety and economics of waste management and disposal.

To deliver these aims the PREDIS project has 7 work packages as illustrated in Figure 2. The technical work packages (WP4-7) focus on developing solutions (methods, processes, technologies and demonstrators) for future treatment and conditioning of waste across a number of Member States, making significant advances in TRL during the course of the PREDIS project. The WPs address issues associated with metallic (WP4), organic liquids (WP5), organic solids (WP6) and cemented wastes (WP7). These subjects were identified during the proposal phase as described in the Gap Analysis report [1].

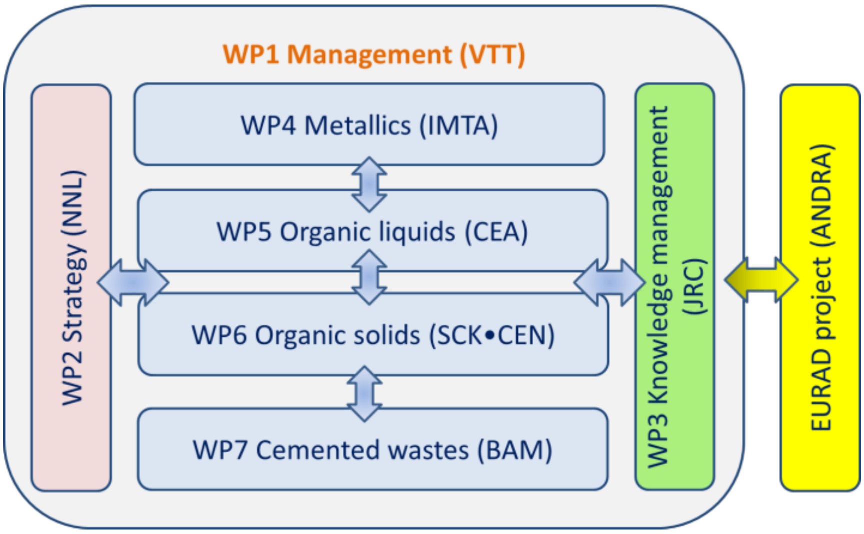

Figure 2 PREDIS Project Work Packages

Work Package 2, (Strategy), aims to enhance the strategic implementation of the PREDIS project and focus future predisposal collaborative programmes through extensive engagement of stakeholders across member states and international bodies.

Within WP2, **Task 2.2 of PREDIS is the development of an SRA specific to the needs of predisposal activities**. The intention is to build on available existing research agendas developed by European and worldwide nuclear waste management organisations, forums and governing bodies, identifying topics and themes pertinent to PREDIS which can then be consolidated into a standalone document for engagement and discussion with the wider PREDIS project and user community.

This work will lead to the publication of the PREDIS Predisposal Strategic Research Agenda in Month 44 of the project.

3 Development of the PREDIS SRA – The Plan

The development of the SRA comprises of 3 phases (Figure 3), which are detailed below by PREDIS project year.

Figure 3 Schedule for the development of the PREDIS Strategic Research Agenda (PREDIS Task 2.2)

Year 1 - focuses on the consolidation of existing SRAs.

- Many stakeholder groups have already declared their interest in the predisposal waste management subject either because they are directly involved, or are operating at the interfaces; consequently, many of these groups have already published documents (in many cases SRAs) which consider predisposal activities (e.g. Nugenia, EURAD etc.). Some initial work was undertaken in 2019, when originally preparing the PREDIS project proposal, to review existing SRAs to consider what has already been flagged as important needs. This has assisted in developing a focused list of topics and SRA documents for review.
- Key themes from these published documents will be consolidated into the baseline for the subsequent development of the PREDIS SRA.
- **This document is the first iteration of this baseline.**

Years 2 and 3 – focuses on the development of the PREDIS SRA through stakeholder engagement

- PREDIS aims to produce an informative long term, future focussed SRA based on a holistic lifecycle philosophy, of both relevance and use to the Commission and different stakeholders. The PREDIS SRA should complement the updated EURAD SRA and, ideally, contains the same structure and types of information.
- Engagement with the relevant stakeholder communities is key to achieving this aim and build a comprehensive Predisposal SRA.
- It should be noted that there are many stakeholders and interfaces involved in Predisposal as illustrated in Figure 4. Key interfaces are with:
    - the legacy waste owners, nuclear operators, and decommissioners, who are the inputs to the predisposal waste management operations,
    - waste treatment and waste management organisations (WMOs), who strive to treat the waste (predisposal) and develop new treatment technologies, implementing the waste management hierarchy,
- Mixed methods will be used to facilitate this engagement, including for example stakeholder workshops, surveys, facilitated discussions, engagement with other relevant projects (e.g. SHARE, EURAD) and relevant stakeholder organisations (e.g. SNETP, IAEA, NEA etc.).
- Inclusion of the output from the PREDIS Gap Analysis Task 2.6 Deliverable D2.2 [1] and the relevant predisposal elements of the SHARE SRA to be published in PREDIS Year 2.

Year 4 – focuses on peer reviewing, finalising and publishing the PREDIS SRA

- Compilation of the elements of the PREDIS SRA document ready for publication.
- Peer review of the SRA document will be undertaken.
- Final version of the SRA will be published, (Month 44) and subsequent dissemination activities implemented.

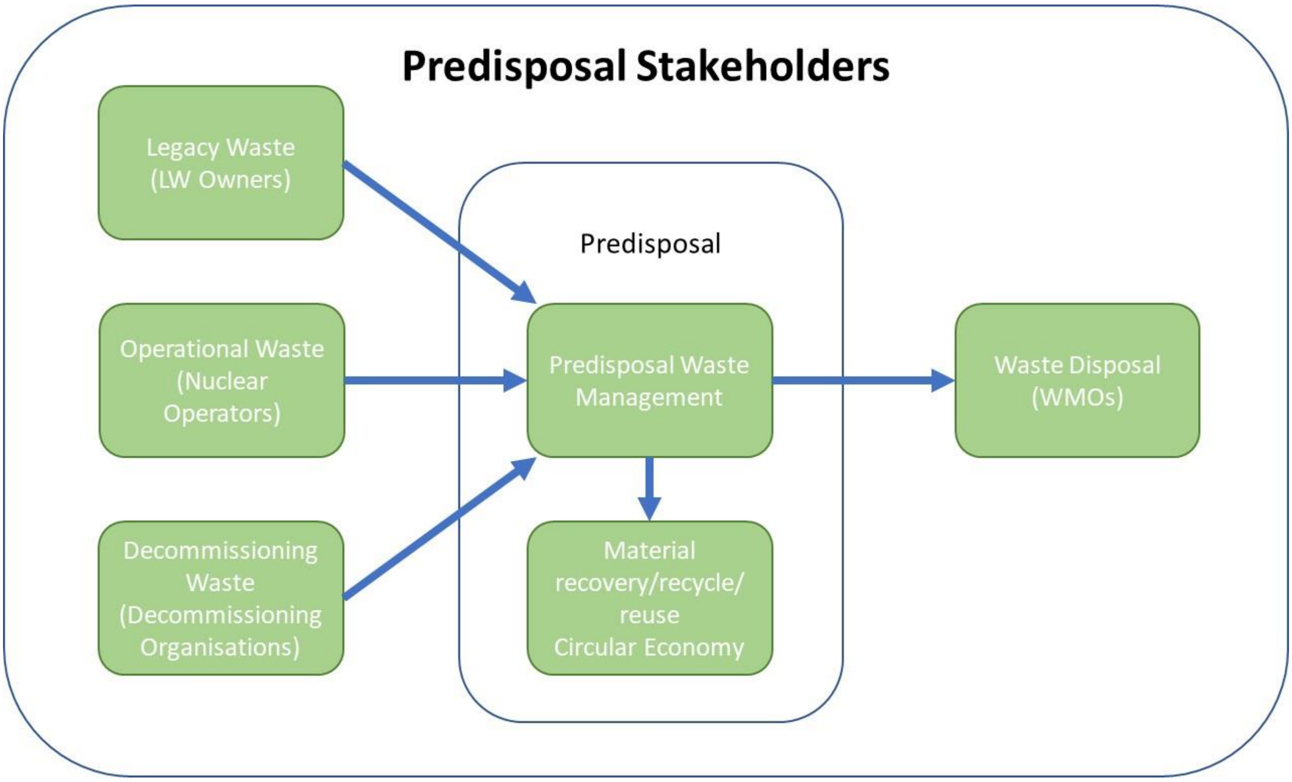

Figure 4 Predisposal Stakeholder and 'waste management interfaces'

4 Methodology

The first activity was to establish a baseline SRA document from which to develop the PREDIS-specific SRA over the duration of the project. The starting point was to undertake a review of existing SRAs, strategic roadmap documentation and or Research Needs documents from a range of sources and identify the sections relevant to PREDIS activities. These would then be extracted and placed into the draft PREDIS SRA structure for further analysis and development. The SRA structure was developed from IAEA guidance and in line with the structure used for the JOPRAD/EURAD SRAs. It is noted that whilst this structure has been utilised for the initial existing SRA assessment, it may evolve in future iterations of the PREDIS SRA report in line with new IAEA guidance.

The list of existing SRA or other strategic outputs from previous and current projects or organisations was developed through consultation with the PREDIS partners. Table 1 shows the list of identified source documents, with weblinks where available, and provides a brief description for each of these. The exercise to review these SRAs and identify pertinent sections was also undertaken by the PREDIS partner organisations, with reviewers assigned to identified sources according to their knowledge and experience, and in the main reviewing the documents they had identified. Table 1 also shows a short summary of the outcome of the review. The partner organisations involved in the SRA review work included BAM, CEA, ENRESA, NNL, SCK CEN, SOGIN and VTT.

Table 1 - Summary of outcome of reviews

Area	Aims of the SRA/Outputs	Summary of Outcome
H2020 CHANCE	To address the characterisation of conditioned radioactive waste by means of non-destructive analytical techniques and methodologies, encompassing both physicochemical and radiological characterisation. https://www.chance-h2020.eu/public-deliverables	Reviewed and sections identified
H2020 Micado	To propose a cost-effective solution for non-destructing characterisation of nuclear waste, implementing a digitisation process that could become a referenced standard facilitating and harmonising the methodology used for the in-field Waste Management and Dismantling & Decommissioning operations. https://www.micado-project.eu/publications/	Reviewed and sections identified
H2020 Metrodecom	To provide nuclear site operators with measurement techniques that can be used to measure radioactivity for planning decommissioning, for segregating and checking waste materials during demolition, and for monitoring the condition of waste packages in radioactive waste repositories. http://www.decommissioning-emrp.eu/?page_id=1388	Reviewed and sections identified
H2020 Pleiades	To provide a new digitally enhanced methodology for improving current D&D operations, defining good practices for digitalisation and facilitating higher standardisation required for international application. https://pleiades-platform.eu/results/	Reviewed and sections identified
IAEA IDN	IAEA International Decommissioning Network. The mission is to raise skills and expertise levels to facilitate safe decommissioning of nuclear facilities through collaboration, training and sharing of knowledge and information.	Predisposal topics addressed in IPN
NEA RWMC	RWMC systematically identifies its activities by focusing on three main aspects of radioactive waste management: 1) environmental; 2) economic; and 3) societal. These aspects are considered in the context of three frameworks: legislative, organisational and regulatory.	Too general to identify appropriate PREDIS sections

NEA CDLM	The Committee on Decommissioning of Nuclear Installations and Legacy Management provides a forum for experts, authorities, operators, service providers, research institutes and other relevant stakeholders to exchange experience and information on decommissioning and dismantling of nuclear facilities and development of practical guidance on regulating and managing legacy waste, sites and releases of legacy sites.	No document identified for review
WNA	To promote a wider understanding of nuclear energy among key international influencers by producing authoritative information, developing common industry positions, and contributing to the energy debate. Within WNA, the Waste Management and Decommissioning Working Group monitors trends in waste management strategies on both the international and local level, and seeks to establish a consensus for a more effective system of nuclear waste management and decommissioning. https://world-nuclear.org/getmedia/e81d115f-70c2-4c47-b208-242acc799121/methodology-to-manage-material-and-waste-report.pdf.aspx	Reviewed and sections identified
SNETP	An R&D platform to support and promote the safe, reliable and efficient operation of Generation II, II and IV civil nuclear systems. The international membership base of the platform includes industrial actors, research and development organisations, academia, technical and safety organisations, SMEs as well as non-governmental bodies. https://snetp.eu/wp-content/uploads/2020/06/Strategic-Research-Agenda-May-2009.pdf	Reviewed and sections identified
Nugenia - Global Vision	Hosted within SNETP and dedicated to the research and development of nuclear fission technologies, with a focus on Gen II & III nuclear plants. The NUGENIA Global Vision Document provides a detailed description of the technical and scientific content of the technical areas while addressing the main inherent R&D objectives, recalling their general scope and state of the art and outlining the main R&D challenges in the medium and long term. https://snetp.eu/wp-content/uploads/2020/10/Global-vision-document-ves-1-april-2015-aa.pdf	Reviewed and sections identified
Nugenia Technical Area 5B V. 2014	A NUGENIA sub-area is focused firstly on safe the management of nuclear plant operational waste and decommissioning "waste", and secondly the decommissioning/dismantling step in the nuclear plant lifetime. The aim is to minimise the arising waste through good design and operational practices, and to develop new technical solutions through focussed R&D on waste management and decommissioning.	Reviewed and sections identified
IGD-TP	The IGD-TP Vision 2040 SRA considers the next steps that must be taken to achieve the industrialisation of radioactive waste disposal in Europe by 2040; its scope covers RD&D supporting progress towards achieving final geological disposal, as well as RD&D relating to pre-disposal issues such as waste acceptance criteria, waste characterisation and waste treatment in support of disposability. https://igdtp.eu/document/2020_igd-tp_strategic-research-agenda/	Reviewed and sections identified

H2020 Theramin	To provide improved safe long-term storage and disposal of ILW and LLW suitable for thermal processing. Work carried out within the project aimed to identify radioactive wastes that could benefit from thermal treatment, which treatment technologies were under development in participating countries, and how these could be combined to deliver a wide range of benefits. http://www.theramin-h2020.eu/downloads/THERAMIN%20D5_4%20Project%20Synthesis%20Report.pdf	Reviewed and sections identified
H2020 Mind	A multidisciplinary project with the goal of addressing key microbiology technical issues that must be tackled to support the implementation of planned waste disposal across the EU. The project addresses the influence of microbial processes on organic wasteforms and their behaviour and on the technical and long-term performance of repository components. https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwi4i9uWnNbxAhWbRUEAHWcsAF0QFnoECAUQAA&url=https%3A%2F%2Fec.europa.eu%2Fresearch%2Fparticipants%2Fdocuments%2FdownloadPublic%3FdocumentIds%3D080166e5c7a215bd%26appId%3DPPGMS&usg=AOvVaw31lMpoG58-oQIXvgAelJ-N	Reviewed and sections identified
EURAD-SCIENCE	The first international network of research entities established to unite the work of national research organisations on radioactive waste management from cradle to grave, and to drive scientific excellence in the field over the next decades. The EURADSCIENCE network links research-oriented organisations to EURAD, the 1st European Joint Programme on geological disposal of radioactive waste.	No document identified for review
EC EURATOM	Facilitate the establishment of a nuclear-energy industry on a European rather than a national scale. Other aims of the community were to coordinate research in atomic energy, encourage the construction of nuclear-power installations, establish safety and health regulations, encourage the free flow of information and the free movement of personnel, and establish a common market for trade in nuclear equipment and materials	No document identified for review
H2020 EURAD	Describes the scientific and technical domains and sub-domains and knowledge management needs of common interest between EURAD participant organisations. Developed in a stage-wise manner and taking over entirely the scope developed within the EC JOPRAD Project enhanced with a small number of additional needs identified by ongoing EC projects. The SRA scope is structured by scientific themes broadly relating to infrastructure and resources, fundamental science, engineering & technology, and applied science and integration. https://www.ejp-eurad.eu/sites/default/files/2020-01/2._eurad_sra.pdf	Referred to JOPRAD as it has same structure and content as EURAD but with a greater level of technical detail.

H2020 JOPRAD	To prepare a proposal for the setting up of a "Joint Programming on Radioactive Waste Disposal" to bring together at the European level those aspects of R&D activities implemented within national research programmes where synergy from Joint Programming is identified. The aspects of R&D activities brought together concern geological disposal of spent fuel and other high activity long lived radioactive waste, including waste management aspects linked with their disposal and accompanying key activities (Education and Training, as well as Knowledge Management). http://www.joprad.eu/fileadmin/Documents/JOPRAD_Deliverables/JOPRAD_D4.3_JOPRAD_meeting_on_Programme_Document_report_v1.pdf	Reviewed and sections identified
ERDO	Multinational working group to study the feasibility of implementing a shared geological repository in Europe. http://www.erdo-wg.com/documents/ERDO%20Strategy%20Document.pdf	Reviewed but no appropriate sections identified
EDRAM	An association of well-established organisations from eleven countries with responsibility for management of radioactive wastes in their respective countries. Two meetings are held every year to discuss the progress of work worldwide and the most recent developments in the different member countries, to support national efforts towards site selection and implementation of long-term disposal strategies and to promote a common understanding of waste management issues and the internationally recognised principles which apply thereto.	No SRA document available. Referred to work cited in IGD-TP Vision
WENRA	The Association of Regulators of Western Europe is an association of agencies or regulatory agencies in the field of nuclear countries of Western Europe with the intention of acting as a European network of chief regulators of EU countries with nuclear power plants to improve nuclear safety. http://www.wenra.eu/sites/default/files/publications/2019_wenra_strategy_2019-2023_final.pdf	Reviewed but no appropriate sections identified
EUR organisation	To develop common specifications for new designs to be proposed by Vendors in Europe and its promotion of harmonisation in requirements across Europe and worldwide. The EUR Organisation brings together thirteen Utilities which represent the major European electricity producers. The purpose is to present a clear, complete statement of utility expectations for Generation III NPPs. https://www.europeanutilityrequirements.eu/Portals/0/Documents/Courses/2014/EUR%20roadmap%202019-2021%20-%20Executive%20summary%20fin.pdf	Reviewed and sections identified

ENEF	A platform for a broad discussion about the opportunities and risks of nuclear energy, linked to the energy challenges faced by the EU and its Member States and in particular to the role of nuclear energy within the strategic framework for the energy union. ENEF gathers all relevant stakeholders in the nuclear field: governments of EU countries, European institutions including the European Parliament and the European Economic and Social Committee, representatives of the nuclear industry and regulators, electricity consumers, and civil society. https://ec.europa.eu/info/sites/default/files/enef2019conclusions_0.pdf	Reviewed but no appropriate sections identified
SITEX Network	Sustainable network for Independent Technical Expertise on radioactive waste management. To enhance and foster cooperation at the international level to achieve a high-quality expertise function in the field of safety of radioactive waste management. https://igdtp.eu/wp-content/uploads/2019/09/SITEX-II-D1.1_SRA_final.pdf	Reviewed and sections identified
IAEA - NEFW	This Section supports Member States to identify and apply safe, prompt and cost-effective solutions to manage all forms of radioactive waste resulting from the nuclear fuel cycle and nuclear applications	Projects reviewed but no publicly-available documentation identified
IAEA - IPN	A forum for the sharing of practical experience and international developments on radioactive waste management activities before disposal.	
IAEA - CRP T13017	Coordinated Research project under topic "Spent fuel management options". Covers management of wastes containing long-lived alpha emitters: Characterisation, processing and storage.	
IAEA Disponet	To enhance efficiency in sharing international experiences to ensure the application of safe and sustainable solutions in the disposal of low and intermediate level waste.	
IAEA - Labonet	International Network of Laboratories for Nuclear Waste Characterisation. Purpose is to increase efficiency in sharing international expertise on characterisation of low and intermediate level wastes.	

Each document review was carefully recorded in a purpose-built audit trail template (APPENDIX 1) where the reasoning behind each identified section could be captured or, conversely, if no pertinent text was identified this could be recorded to show that the document had been reviewed but discounted as not relevant to PREDIS.

Following extraction, the relevant SRA paragraphs were consolidated into a single draft PREDIS SRA document. Table 2 shows how the sections extracted from the various reviewed SRAs have been mapped to the appropriate sections in the PREDIS SRA. It can be seen that whilst some SRA documents, such as EURAD/JOPRAD, have content in most or all areas, others cover only one or two sections. The broad coverage of EURAD (through JOPRAD) is to be expected as it covers all the areas of waste management & disposal, and has also been used as the basis for the PREDIS structure. Importantly, Table 2 illustrates that relevant paragraphs have been identified in at least one existing SRA document for all of the PREDIS sections.

Table 2 – Mapping of SRAs to PREDIS areas

Areas	Nugenia Global Vision [2]	Nugenia Technical Area 5B [3]	IGD-TP-Vision 2040 [4]	MIND [5]	SNETP [6]	THERAMIN [7]	JOPRAD [8]	EUR [9]	SITEX II ToR [10]	SITEX II SRA [11]	WNA [12]
Methodology for identifying the SRA							X				
Predisposal Management - Waste generation	X	X	X	X	X		X			X	X
Predisposal Management - Processing		X	X		X	X	X			X	X
Predisposal Management - Storage & Transport	X	X	X		X		X		X		
Disposability Management - Disposability Assessment		X	X	X		X	X			X	
Disposability Management - WAC						X	X				
Way forward - Knowledge Management		X	X			X	X			X	
Way forward - Stakeholder Engagement							X	X			

A broad review of the extracted text highlighted a significant amount of duplication of topics across the different source SRAs. The next step therefore was to rationalise the text to eliminate this duplication. The text was reviewed carefully and a number of common themes topics were identified that could be assigned to keywords based on the PREDIS SRA sections, as shown in Table 3. In future iterations of this SRA, it is intended that these keywords will be refined to align with the WP3 Glossary of predisposal keywords.

Table 3 – Keywords assigned to SRA common topics

SRA Section	Keyword	Description
Waste generation	Planning	Waste management strategy, waste hierarchy, waste routes, technology selection
	Inventory	Sources and quantities of waste generated and in existing storage, future waste generation
	Classification	Characteristics of wastes in order to sort, classify and identify waste types
Processing	Treatment	Pre-treatment and treatment to minimise waste quantities and volumes
	Conditioning	Stabilise waste by conditioning
	Packaging	Containers and packaging for future transport, storage and disposal
Storage & Transport	Storage	Safe storage of wastes/packages including decay storage, interim storage and long-term storage
	Transport	Transport of wastes between facilities at different stages of pre-disposal management
Disposability Management	Disposability	Suitability of wasteform for disposal, behaviour within a disposal environment, implications for treatment, conditioning and
WAC	WAC	Parameters and metrics for waste acceptance
Cross-cutting	Characterisation	Characterisation of wastes throughout the lifetime of wastes/packages
	Optimisation	Optimisation of the different phases of pre-disposal management
	Quality & Management	Quality and management systems, records management and monitoring required throughout the lifetime of the wastes/packages

The PREDIS SRA text was then reviewed again with reference to the keywords in Table 3 with up to four keywords assigned to each paragraph depending on relevance. It was then possible to use the assigned keywords to sort the text into groups of common topics, with the next step then being to remove duplication through the development of a single section of discussion for each topic, ensuring links are made to original SRA through references.

Following development of the PREDIS SRA structure and the list of topics and themes for consideration within the SRA, a workshop was held with the PREDIS partner organisations that had undertaken the initial SRA reviews to present the findings and obtain buy-in for the proposed structure and identified priority themes. The outcome of this workshop was a positive acceptance of the structure and themes, and it was recognised that the topics and themes identified from the review of existing SRAs were largely in line with those identified in a similar exercise undertaken for the Gap Analysis task 2.6 [1]. This provided good confidence that both the SRA and gap analysis were focusing on the appropriate topics.

The following sections of this document focus on the technical topics identified in the SRA review and provide a baseline position from which the subsequent PREDIS SRA will be developed.

5 PREDIS Strategic Research Agenda

This SRA spans a wide range of phases from waste generation through to preparing for final disposal. The SRA is structured into two main sections:

- Predisposal Management (Section 5.1) – waste generation, processing, and storage and transport
- Disposability Management (Section 5.2) – pre-disposal activities that influence the understanding and/or management of wastes during long-term disposal (disposability assessment and waste acceptance criteria)

5.1 Predisposal Management

This section of the SRA covers:

- Waste generation (Section 5.1.1)
- Processing (Section 5.1.2)
- Storage and transport (Section 5.1.3)

It covers areas relating to the planning and implementation phases of predisposal management to support hazard reduction, reduce volumes for storage and disposal, and help reduce costs.

5.1.1 Waste generation

For the purpose of this SRA, waste generation issues relate to both (a) planning stages, involving development of a waste management strategy and application of the waste hierarchy to minimise waste volumes, and (b) understanding the nature of the wastes produced, through identifying the sources, types of waste, quantities and characteristics. This area interfaces with facility design, operational and decommissioning issues that impact on the quantities and types of waste produced.

Issues relating to waste generation are discussed under the three keyword areas of:

- Planning (Section 5.1.1.1)
- Inventory (Section 5.1.1.2)
- Classification (Section 5.1.1.3)

5.1.1.1 Planning

Development of a waste management strategy is highlighted within several SRAs [3], [6], [8], [12]. A strategy needs to cover the full lifecycle from design and construction, through to operation and decommissioning phases [12], [3]. The need for a waste management strategy at the early design stages for advanced reactors [6], [8] is also highlighted. It is clear that early planning presents an opportunity to minimise waste generation and implement processes to optimise waste treatment and packing in containers for disposal. Effective planning and strategy development should also mitigate the need for future re-conditioning of waste packages and limit disposal of mixed wastes, which could be sorted for treatment, free release, re-use or recycle [12].

A waste management strategy needs to apply the waste hierarchy and employ methods for selecting technologies for dismantling and retrieval, sorting, segregation, decontamination, volume reduction, conditioning, wasteforms and containers, interim storage, reduction of secondary wastes and measurement [12], [3]. For example, planning of the dismantling of plant during decommissioning and the choice of cutting technique used can be optimised to minimise the amount of waste requiring disposal [3].

Particular areas within existing SRAs relating to planning aspects of waste generation are:

- Developing waste management strategies to account for different waste types and the waste routes available [12], [8].

- Understanding the characteristics and quantities of wastes from Gen IV reactors. While these reactors should produce less radioactive wastes than current reactors, the wastes will have different properties and challenges compared with current wastes [8]. A specific example is the use of lead coolant in

Advanced Lead Fast Reactors, which requires a waste management strategy to be developed for used lead [6]. Early identification of challenges can be fed back to the reactor design to be addressed.

- The need for waste tracking strategies, including improved software and hardware (e.g. barcodes or RFID tags) to support this [3].
- Developing cost-effective technologies for radiological characterisation and segregation of wastes, for countries with small amounts of raw historical radioactive waste [8].

5.1.1.2 Inventory

Several themes relating to waste inventories are identified within existing SRAs. These include:

- Improve understanding of the different existing waste inventories that may require bespoke R&D, in particular legacy and problematic wastes and small inventories (e.g. research reactor fuels).
- Improve understanding of the different types of wastes and inventories that could be generated in the future as a result of using new, advanced fuel types and fuel cycles.
- Improve understanding of the chemotoxic / chemical characteristics and inventory of wastes to understand the implications for processing, storage and disposability.
- Develop methods for quantifying the inventory of difficult-to-measure radionuclides and those that are important to transport, operation and post-closure repository safety cases (e.g. long-lived radionuclides).
- Identify good practice in the assessment, recording and management of inventory data (calculation, non-destructive analysis, destructive analysis, remote and in-situ technologies).
- Use of effective characterisation and knowledge of waste inventories to support development of the waste management strategy, including plant characterisation and associated analysis and visualisation tools.

5.1.1.2.1 Understanding existing waste inventories including legacy, problematic wastes and small inventories

There is a need to gain a better understanding of certain waste inventories that exist, which are currently either not well characterised or are known to pose issues for current treatment and conditioning technologies and disposal routes (legacy and problematic wastes). A better understanding of the characteristics of these wastes and how they will behave in a disposal environment is required to support the development of options for treatment and disposal and to understand if bespoke solutions requiring specific R&D is required. Particular wastes highlighted in existing SRAs include graphite wastes, mixed wastes, organic wastes, tritiated wastes [3], and small inventories of fuel from research reactors [4].

JOPRAD [8] also identifies the need for quantification of the fissile content of spent fuels to gain an improved understanding of the characteristics and behaviour of spent fuel, in order to understand the implications for storage and disposal in terms of safety and security.

5.1.1.2.2 Understanding of future wastes and inventories from advanced fuels and fuel cycles

Development of Gen IV fast reactors provides the opportunity for significant reductions in wastes [6]. However, there is a need to develop an improved understanding of future wastes and inventories that will arise from the use of advanced fuels, reactors and fuel cycles, due to the different characteristics of the fuels and wastes compared with those currently produced. Particular areas highlighted in existing SRAs include:

- Understanding inert matrix fuels (IMF) and dispersion fuels, in terms of their properties, stability as a wasteform and suitability for disposal [2]

- Minor actinide (Np, Am, Cm) bearing fuels for use in Light Water Reactors and Gen IV fast reactors [2], where a particular issue is the quantity of helium generated that may be problematic for long term storage and disposal.

5.1.1.2.3 Understanding the chemotoxic and chemical (non-radioactive) inventory of wastes

A common theme highlighted within the JOPRAD [8] and IGD-TP [4] is that of improving characterisation and understanding of the chemical components of the waste inventory and associated wasteforms. This reflects an understanding of the importance of chemical species in terms of their chemotoxic properties and influence on the behaviour of radionuclides. Areas identified in existing SRAs for potential research include:

- Understanding the quantities and nature of the chemotoxic components of common decommissioning wastes (low and intermediate level wastes) and their implications for disposability [8]
- Improving data and characterisation methods for chemical species in long-lived ILW [8], [4]
- Understanding the effects of organic materials and species in the wastes and their impact, including complexing agents from degradation of cellulose and PAN (polyacrylonitrile) [4]
- Developing a common, systematic approach to characterising and classifying waste based on physico-chemical properties [4] – see Section 5.1.1.3

A more detailed understanding of the chemical component of wastes will enable the implications for processing, transport, storage and disposal to be identified and assessed.

5.1.1.2.4 Methods for quantifying difficult-to-measure radionuclides and those important to safety cases

Both JOPRAD and IGD-TP [8], [4] identify the need to improve understanding of and develop methods to quantify those species that are dominant in the various safety cases (transport safety case, operational safety case for a repository, post-closure safety case). Some of the important radionuclides are difficult to measure and therefore methods to improve inventory estimates and data quality would be beneficial. IGD-TP [4] highlights approaches that combine a limited number of measurements for samples with modelling of activation, fuel failures and transport of radionuclides.

5.1.1.2.5 Good practice in the assessment, recording and management of inventory data

Identifying good practice in the assessment, recording and management of inventory data is raised in several existing SRAs [12], [4], [8], [11]. This includes use of targeted, fit-for-purpose assays [8], use of radionuclide vectors, characterising wasteforms, addressing uncertainties in radionuclide properties databases [11], remote and in-situ technologies [3], measurement and modelling [4].

5.1.1.2.6 Effective characterisation and tools for analysis and visualisation

Nugenia [2] specifically identifies plant characterisation as an important task which supports planning for decommissioning and feeds into the waste management strategy and therefore pre-disposal management. Aspects for such characterisation include inventory and materials, hazardous substances, spatial distribution within the plant and within materials. Technologies such as laser scanning, and analysis and visualisation tools are required. Development of an approach and tool(s) to provide a comprehensive understanding of the inventory and associated characteristics within a plant would support effective planning and waste management.

5.1.1.3 Classification

Classification relates to the categorisation of waste types based on their properties. Specific issues within existing SRAs that relate to classification are outlined below.

As discussed in Section 5.1.1.2.3, understanding the non-radiological properties and inventory of radioactive waste is important for predisposal management. In addition to this, developing a common system for the classification of wastes based on physico-chemical properties would support better management of these wastes [4].

Another area highlighted in [4] relates to the characterisation and classification of legacy wastes, based on physico-chemical and radiological properties, to help determine suitable approaches for its re-treatment and re-conditioning to meet storage and disposal acceptance criteria.

5.1.2 Processing

Processing of wastes involves its pre-treatment, treatment and conditioning, as well as its packaging prior to storage and/or disposal. This covers treatments to minimise the quantity of wastes for disposal or to change their properties, stabilising the wastes by conditioning them, and packaging the wastes for safe transport, storage and disposal.

Issues relating to processing are discussed under the three keyword areas of:

- Treatment (Section 5.1.2.1)
- Conditioning (Section 5.1.2.2)
- Packaging (Section 5.1.2.3)

5.1.2.1 Treatment

Key themes raised in existing SRA documents relating to pre-treatment and treatment of wastes include:

- Need for a variety of treatment processes
- Understanding best practice in decontamination technologies
- Alternative and novel treatment technologies
- Optimisation of treatment processes
- Knowledge exchange and transfer.

5.1.2.1.1 Need for a variety of treatment processes

A variety of decontamination and treatment processes are needed that provide flexibility and can be adapted to address different quantities and types of materials, different dimensions and characteristics, different waste routes and different regulatory requirements [12], [3]. Different treatment processes are needed to address problematic wastes such as irradiated graphite, organic materials and metallic wastes, e.g. methods to reduce corrosion of reactive metals and generation of hydrogen in disposal environments.

5.1.2.1.2 Understanding best practice in decontamination technologies

Understanding best practice in decontamination technologies is highlighted in [3], covering the different technologies (chemical, mechanical, thermal, other) and their efficiency, avoiding use of large amounts of additives and reducing secondary waste. Applying local decontamination, waste and effluent treatment units is also needed, which requires development of intensified processes for use in modular and mobile plants. Application of remote operations and robotics is also needed. Assay technologies are required to verify the composition of materials that have undergone decontamination, to allow them to be routed for reuse or recycle.

5.1.2.1.3 Develop and evaluate alternative and novel treatment technologies

Alternative and novel treatment technologies need to be developed and evaluated to address the range of wastes that arise from plant operations and from decontamination and decommissioning activities [3], [7].

These technologies could act at ambient temperature or involve thermal treatments and address mixed wastes, organic wastes, ion exchangers, tritiated wastes and graphite wastes [3].

5.1.2.1.4 Optimisation of treatment processes

Optimisation of treatment processes and a reduction in data uncertainties is required to consider throughput, efficiency, secondary waste generation, waste loading, carbon footprint, costs and requirements relating to subsequent conditioning, packaging, transport and disposal [7], [3], [6].

5.1.2.1.5 Knowledge exchange and transfer

Knowledge exchange and transfer is needed between different EC projects and for specific technologies, e.g. thermal, graphite, as well as transfer of knowledge on new treatments to less advanced programmes [8], [11].

5.1.2.2 Conditioning

Existing SRAs identify the need for development of novel conditioning technologies to address a range of problematic wastes (including ion exchange resins, tritiated wastes, wastes containing high levels of I-129, sealed sources, plutonium residues and bitumen sludges) [8]. This includes development of new materials for use as conditioning matrices (e.g. geopolymers) [4] to address safety, technical and economic aspects. The benefit of collaborative R&D and sharing of best practice to support these areas is highlighted [8].

5.1.2.3 Packaging

Areas for future research relating to packaging of wastes, as identified within existing SRAs, are:

- Development of new materials and components for containers [4].
- Optimisation of containers for improvements in safety, handling, costs and robustness applicable to different stages including storage, repository operations and disposal [4].
- Demonstration of container fabrication and operation at full-scale / industrial scale including development of non-destructive techniques for measurements for quality control [4].
- Understanding the long-term performance of container materials, including steel, copper and copper-coated canisters as well as new materials being developed. This requires an improved understanding of corrosion mechanisms other than general corrosion (e.g. pitting corrosion and microbial induced corrosion; effect of irradiation), how these mechanisms are triggered and what impact this has on performance [4].
- Knowledge exchange on good practice for the management of waste packages that have become damaged or degraded prior to disposal. This includes developing criteria to determine whether aged wastes require re-processing and/or re-packaging [8] and how to carry out this re-work.

5.1.3 Storage & Transport

Issues relating to maintaining safety for the transport of radioactive wastes between facilities and for interim and longer-term storage of wastes are discussed in this section.

Two main themes arise within existing project SRAs relating to storage of wastes:

- Monitoring within storage facilities to assess the waste package and wasteform

- Issues relating to the ageing and degradation of wastes, particularly with respect to prolonged or extended periods of storage

5.1.3.1 Monitoring of waste packages within storage facilities

Several SRAs [2], [3], [8], [10] highlight the need for appropriate technologies and techniques for conducting monitoring within storage facilities and their environment. This includes development of a monitoring plan to monitor “control” packages and establishing methods for detecting degradation of stored waste packages as a result of ageing during interim and long-term storage. Monitoring will need to address a range of processes and characteristics including corrosion, temperature, pressure, radiation, container and wasteform integrity and their evolution with time.

Nugenia [3] emphasises the need to develop and employ remote monitoring techniques (to reduce human intervention) and non-destructive analysis (to minimise waste generation).

Robust record keeping and information management systems are also important to ensure traceability of stored items and their associated inventory and other characteristics.

5.1.3.2 Management of items under long term storage

Issues relating to the ageing and degradation of stored wastes are raised in several SRAs [2], [3], [8], [10]. This is particularly relevant given examples of storage facilities coming towards the end of their design lifetime and the need to extend storage periods due to the lack of availability of disposal facilities. Areas for which research and knowledge management / transfer are highlighted include:

- Developing predictions to forecast the expected evolution of waste packages and their characteristics
- Surveillance of storage facilitates and monitoring methods to enable the evolution of packages and any degradation to be detected and quantified
- Management of uncertainties brought about due to long term storage and ageing, with implications for ongoing storage and subsequent transport and disposal
- Consequences for safety of the ageing and degradation of waste packages
- Determining criteria to define when re-work and re-packaging of wastes is required and what this re-work should entail, through knowledge transfer on what is good practice in the management of degraded (or damaged) waste packages
- Guidance to support safety case maintenance for storage facilities, including safety assessment periodic review, implications for monitoring and assessment for ageing waste packages and supporting the extension of licensing.

In addition to these two areas, a further area highlighted in [6], [2] is the handling, transport and storage of leaking/compromised fuel assemblies (within spent fuel ponds and in interim wet and dry storage). Handling of fuel and casks after long-term storage can also present a challenge.

5.2 Disposability Management

Disposability management considers how the predisposal management of wastes, in terms of waste types, treatment processes, conditioning and packaging, can influence the performance of a disposal facility once waste packages have been emplaced (disposability assessment). The area also covers the waste acceptance criteria that are needed to specify the parameters and metrics associated with the wasteform / package properties to ensure that operational and post-closure safety are maintained. Issues relating to disposability management are categorised under the two keywords:

- Disposability assessment (Section 5.2.1)

- Waste Acceptance Criteria (Section 5.2.2)

5.2.1 Disposability Assessment

A broad range of topics are raised in existing SRAs relating to disposability, largely reflecting that many projects have (or have had) a focus on waste disposal, including geological disposal of spent fuel and high level wastes. While disposal operations and the long-term performance of a repository are not within the remit of the PREDIS SRA, disposability assessment is relevant to pre-disposal activities. This is because we need to understand the types of parameter that need to be better controlled and characterised during pre-disposal operations in order not to adversely affect the waste's long-term disposal performance. With this focus in mind, the main areas highlighted within existing SRAs for future R&D and knowledge management are:

- Improved data and understanding of organic materials and complexants that affect the release of radionuclides and chemical species
- Improved data on rapid release fractions and improved understanding of dissolution behaviour for UOX and MOX fuels as well as for modern and advanced fuels
- Identifying and addressing knowledge gaps (relating to pre-disposal activities) that can lead to improved understanding of the long-term behaviour and release mechanisms for spent fuel, ILW, and various wasteforms under disposal conditions
- Understanding the long-term behaviour of wasteforms in a disposal environment, so that wasteform performance is assessed according to the proposed disposal environment
- Common approach to disposability assessments and records management to support small inventory member states (linked to pre-disposal planning and decisions)
- Implications for criticality post-closure (linked to waste characteristics)
- Gas generation (linked to waste and package materials)

5.2.1.1 Improved data and understanding relating to organic materials

Organic materials are considered to be problematic with respect to long-term stability and fire hazard (generation of hydrogen and organic gases) [12]. Addressing the disposability of wasteforms containing organic compounds or using organic binders may require an improved understanding of long-term stability of these wasteforms. There is a need to understand the effect of organic materials, especially those with complexing ability (e.g. from degradation of cellulose and polyacrylonitrile), on the release and transport of radionuclides and chemical species [4]. This requires better data on the chemical form of waste materials and on speciation of radionuclides, which in turn requires appropriate characterisation methods. Determining the influence of organic matter in concrete wasteforms on radionuclide release is also highlighted in [11]. Areas for further research relating to organic waste matrix degradation were identified in the MIND project [5] and include investigating impacts of pH in a cementitious repository and microbial degradation of organics, particularly ISA, in complex systems.

In terms of pre-disposal activities, this requires improved data on the chemical form of waste and wasteform materials and their organic content (including complexants), as well as degradation products. This, in turn, requires better characterisation of the waste and wasteform materials.

5.2.1.2 Improved data on rapid release fractions and improved understanding of dissolution behaviour for UOX and MOX and also for modern and advanced fuels.

Significant work has been undertaken in this area for UOX fuel and, to a lesser extent, MOX fuel. However, there are still issues remaining where improved data is required [4], [11], including understanding the differences in behaviour for these fuel types, e.g. the effect of plutonium in MOX fuel on the electrochemistry of the spent fuel matrix and hydrogen effect, and whether different models of dissolution are required for these fuel types. Also, there is a need to extend databases to consider modern and advanced fuels [4] with different properties, e.g. fuels with additives, higher burn-up fuels. It is therefore important to reduce uncertainties in spent fuel properties (composition, impurities, burn-up) that influence behaviour in a repository setting, which requires the development of improved data, methods and guidelines [4].

In terms of pre-disposal activities, this requires improved characterisation and improved data for these different fuel types. In addition, it is important to gain a better understanding of how pre-disposal activities, such as long-term storage of spent fuel, impact instant release fractions.

5.2.1.3 Improved understanding of long-term behaviour and release mechanisms for spent fuel, ILW, various wasteforms under disposal conditions, identifying and addressing knowledge gaps.

There are a number of different areas identified towards improving understanding of the behaviour and release mechanisms of spent fuel and wasteforms. These include:

- Improved data and understanding of the release of fission products from different types of spent fuel [8]
- Improved understanding of the behaviour of spent fuel in waste packages under fire and impact scenarios [8]
- Improved understanding of the source term for a range of existing and future wasteforms [8]
- Identifying the radionuclide release mechanisms and associated kinetics for vitrified waste, metallic wastes, high organic content wastes, graphite and cementitious wasteforms [8], [11]. Reference [4] notes that improved data and understanding of the performance of vitrified HLW is needed to reduce remaining uncertainties, including the role of vapour in dissolution under unsaturated conditions, the impact of radiation and/or the complex chemical environment on cement and corrosion products. The THERAMIN project [7] also highlights the need to better understand the long-term behaviour and chemical durability of thermally treated products. This includes understanding wasteforms for LLW/ILW, which may be more heterogeneous than HLW glass wasteforms, and lead to more complex leaching behaviour.
- Consolidating knowledge of release processes, identifying knowledge gaps and developing further understanding to address these gaps [8].
- Addressing uncertainties associated with the potential impact of neutron activation on the evolution of the radionuclide inventory after its disposal [11].
- Better understanding of the performance of geopolymer wasteforms in terms of their long-term chemical stability (leach performance), product stability, radiolytic performance, gas permeability, resilience to cracking from gas production and fire performance [8], [7].

In terms of relating these areas to pre-disposal activities, there is a need to identify and address knowledge gaps on waste characterisation, treatment, conditioning and storage that can lead to improved understanding of the long-term behaviour and release mechanisms for spent fuel, ILW, and various wasteforms under disposal conditions. This includes better understanding of:

- The degradation mechanisms for different wasteforms (e.g. thermally treated products and geopolymer wasteforms) and their chemical stability and durability. There may be some similarities and differences compared with the mechanisms relevant to long-term storage conditions.
- The mechanisms for release of radionuclides and chemical species for different waste types and wasteforms.

5.2.1.4 Understanding the long-term behaviour of wasteforms in a disposal environment.

Several documents identify the need for wasteforms/packages to be assessed against the appropriate disposal environment [3], [7], including backfill type, pH and composition of any groundwater [3]. Examples include understanding the impact of an alkaline environment on glass leaching [11], and integrating repository conditions as part of characterisation tests [7]. Data from assessing the long-term behaviour of wasteforms within a disposal environment should then be fed back into the formulation and treatment processes used for the wasteforms [3]. Therefore, assessment and development of treatment and conditioning processes in the pre-disposal phase should take account of the relevant potential disposal environment(s) and how that may influence the long-term behaviour of the wasteforms.

5.2.1.5 Common approach to disposability assessments and records management to support small inventory member states.

The need to develop simple performance and safety assessments for different small-scale disposal solutions is highlighted in [4]. Systems for managing records on packaged wastes that may not be disposed for long periods of time are also needed. These would support small inventory member states and early stage programmes in making decisions on storage and disposal routes and to support waste packaging and WAC. In terms of pre-disposal activities, this supports the planning, decision-making and records management processes on waste packaging and storage.

5.2.1.6 Implications for criticality post-closure

Although criticality safety analysis is relevant to the post-closure period of a repository, [4] identifies the need for post-closure criticality safety assessment to account for the evolution and degradation of waste packages and wasteforms within a repository. This could lead to possible separation, relocation and accumulation of fissile nuclides, which needs to be addressed in criticality calculations. Understanding the evolution and degradation of waste packages and wasteforms and the stability of fission products in the fuel matrix (requiring appropriate waste and waste package characterisation) is needed so that these scenarios can be assessed in the criticality safety analysis.

5.2.1.7 Gas generation

Issues relating to gas generation due to corrosion of metals and degradation of organic content are raised in several projects [12], [5], [4]. Metallic wastes, waste forms with a water-containing matrix and organic materials can lead to hydrogen generation. Radioactive gases, such as C-14-containing CO_2 can also be produced. Gas generation and migration can affect the engineered barrier system of a repository and host rock properties [5], [4]. Areas for future R&D include:

- Better understanding of microbial processes affecting gas generation in a repository setting [5] (e.g. to understand the conditions in which methanogenesis can prevail and the implications for C-14, to understand microbial corrosion effects, modelling the sulphide/sulphate system as sulphide is a corroding agent of copper)
- Addressing uncertainties in gas generation rates, gas consumption rates and gas transport to reduce conservatisms in gas pressure assessments for repositories [4]

Both of these require appropriate characterisation and understanding of the waste and wasteform materials (pre-disposal activities) in order to determine the potential for gas generation within a disposal setting.

5.2.2 Waste Acceptance Criteria

Areas relating to Waste Acceptance Criteria identified within existing SRAs and project reports are:

- Development of good practice guides for the derivation of WAC, accounting for waste characteristics and uncertainties, the disposal concept, and local site conditions [8]
- Development of WAC for thermally treated products to ensure that characterisation requirements are identified and to enable development of context-specific rather than generic disposability criteria, accounting for specific disposal concepts and disposal environments [7].

6 Socio-economic and legislative considerations

In addition to technical considerations, it is recognised that the different member states have differing political, legislative and socio-economic arrangements, and these need to be taken into account in the development of a strategic research programme. Where Member States have significantly different or challenging socio-economic and/or legislative arrangements that may impact on the ability to implement aspects of the PREDIS SRA, these need to be identified such that mitigating actions can be proposed if necessary.

7 Way forward

This first draft of the PREDIS SRA has examined existing SRA and other related strategy documents published by world-wide nuclear waste management organisations, focus groups and governing bodies, with the intention of identifying the topics of research currently of interest relating to the management of nuclear waste in the pre-disposal phases. This is the starting point for development of the PREDIS SRA. Future issues of this PREDIS SRA document will set out, discuss and further develop the research topics identified within the PREDIS project through ongoing engagement with the PREDIS partner and stakeholder organisations, and through linkage with the EURAD SRA due in 2024. In future iterations this section will therefore set out the proposed way forward for implementation of the PREDIS SRA. The SRA will consider ways to prioritise research topics, accounting for the varying maturity and needs of work programmes. In particular, it will address the issues surrounding long-term management and sharing of PREDIS knowledge and engagement of stakeholders.

7.1 Knowledge Management

This subsection will set out future needs for the management and sharing of knowledge and best practice across the partner organisations and stakeholder groups, linked strongly to the programme and outputs of PREDIS WP3.

7.2 Stakeholder Engagement

Linked to the programme and outputs of PREDIS WP2.1, this subsection will set out needs and expectations for engagement with stakeholders during the development and implementation of the PREDIS strategic research programme.

8 References

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[8] JOPRAD, "Deliverable no 4.2. Programme Document - The Scientific and Technical Basis of a Future Joint Programme on Radioactive Waste Management and Disposal," JOPRAD, May 2018.

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[11] SITEX-II, "Strategic Research Agenda of the Expertise Function in the Field of Geological Disposal of Radioactive Waste," Deliverable no. D1.1, SITEX-II, Sustainable network for Independent Technical EXpertise of radioactive waste disposal - Interactions and Implementation, November 2016.

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APPENDIX 1: AUDIT TEMPLATE USED FOR SRA DOCUMENT REVIEW

PREDIS Strategic Research Agenda – Document review template

Document title	Document reference	Document type	Reviewer name	Reviewer organisation/affiliation	Date reviewed

Document section in initial report	PREDIS topics covered	Countries/States covered	Current or future view	Relevance score (Hi/Med/Lo)	PREDIS SRA section placed	Colour Code	Other comments

Guidance Notes

This template is to be used for the purposes of audit trail in reviewing the Strategic Research Agenda (SRA) documents. The reviewer should identify sections within the allocated SRA document(s) relevant to the PREDIS topic areas, extract these from the document and copy them into the accompanying PREDIS SRA template structure within the most appropriate section. Pasted text should be colour-coded within the PREDIS SRA structure using the highlighter tool to help identify which SRA document it has been extracted from. A separate audit template should be completed for each SRA document reviewed, with a separate entry being made in the audit template for each section extracted and copied. The fields above are to be completed as follows:

Document title: Enter the title of the SRA document being reviewed (e.g. Nugenia Technical Area 5B V. 2014).

Document reference: Enter the reference number of the document.

Document type: Enter the type of document being reviewed, e.g. SRA, roadmap, etc.

Reviewer name: Enter the name of the person reviewing the document.

Reviewer organisation/affiliation: Enter the name of the organisation for the person undertaking the review (e.g. NNL, VTT, etc.)

Date reviewed: Enter the start date of the review.

Document section in initial report: Enter the section number from the document being reviewed for the specific text being extracted.

PREDIS topics covered: Enter a brief summary of topic area covered in the text extracted (e.g. waste characterisation, asset management & care, etc.)

Countries/States covered: Enter the country or countries covered in the text if specific ones are covered. If not then enter N/A.

Current or future view: Enter ‘Current’ if the text reviewed is covering current technologies and/or practices, or ‘Future’ if it is covering future requirements.

Relevance score (Hi/Med/Lo): Enter ‘H’, ‘M’ or ‘L’ dependent on how relevant the text is to PREDIS requirements. This is a subjective assessment based on the opinion of the reviewer.

PREDIS SRA section placed: Enter the section number within the PREDIS SRA document that the text has been placed in.

Colour Code: Using the shading tool, fill in the cell with the colour being used to highlight the text pasted in the PREDIS SRA document to help identify it.

Other comments: Enter any other comments (e.g. further justification for the extracted text being selected).