ANALYSIS OF ARTEMIS PEER REVIEWS TO EUROPEAN UNION MEMBER STATES

2023

Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation

with funding from the European Commission
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I. Executive Summary

This report provides an analysis of the IAEA integrated peer review service missions for radioactive waste and spent fuel management, decommissioning and remediation programmes (ARTEMIS) conducted in 2023. During this period, the Agency conducted ten ARTEMIS missions, of which nine addressed entire national systems for radioactive waste and spent fuel management, for all the recognized waste stream and activities.

In this report, the trends and issues highlighted during the nine ARTEMIS missions which had the same scope are disseminated to IAEA and Member States with the objective of improving the management of radioactive waste and spent fuel.

The findings raised during ARTEMIS missions are analysed according to their status, as defined by ARTEMIS Guidelines:

- **Recommendations**: These are raised “when aspects relative to the IAEA Safety Requirements and additional supporting documents agreed as a basis for review such as International Conventions, Codes of Conduct are missing, incomplete or inadequately implemented.”

- **Suggestions**: These “identify opportunities for improvement not directly related to inadequate conformance with IAEA Safety Requirements, but which should be shared with the host country.”

- **Good practices**: These are “identified in recognition of an outstanding arrangement, programme or performance superior to those generally observed elsewhere.”

As stipulated in the ARTEMIS Guidelines, the findings of ARTEMIS missions are based on IAEA Safety Standards and supporting international documents, such as IAEA Nuclear Energy Series or other international documents complementing the safety standards.

This report provides a two-step analysis:

- the distribution of findings between the categories of Recommendations, Suggestions and Good Practices, and their technical content by topic, in order to draw conclusions concerning the range and trends of the mission findings.

- a quantitative analysis of the basis used for findings in the ARTEMIS missions to indicate the role and importance of the IAEA Safety Requirements and other documents in the ARTEMIS review process in general and in the various specific ARTEMIS topics.

Among the seven topics covered by ARTEMIS missions covering the entire national system for radioactive waste and spent fuel management, the topics which resulted in the most findings are:

- Policy and framework
- Strategy

Recommendations were systematically raised in relation to the national policy concerning coverage of all waste types and timely and effective implementation. The analysis also highlighted that the significance of gaps in the availability of regulations varied depending on the regulatory approach.
Specific emphasis was also given to the need for adequate financial provision and the development and maintenance of expertise.

The following documents were referred to most often as the basis for ARTEMIS recommendations and suggestions:

- GSR Part 1; Governmental, Legal and Regulatory Framework for Safety (68 occurrences)
- GSR Part 5; Predisposal Management of Radioactive Waste (68 occurrences)
- SSR-5; Disposal of radioactive waste (56 occurrences)

For good practices, the documents used as reference are:

- GSR Part 5; Predisposal Management of Radioactive Waste (4 occurrences)
- GSR Part 6; Decommissioning of facilities (4 occurrences)
- Safety guides (3 occurrences)
- GSR Part 1; Governmental, Legal and Regulatory Framework for Safety (2 occurrences)
- SF-1; IAEA Safety Fundamentals (2 occurrences)

The IAEA safety requirements referred to most frequently in findings were:

- GSR Part 1 Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel (28 occurrences)
- SSR-5 Requirement 1; Government responsibilities (22 occurrences)
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management (20 occurrences)
- GSR Part 1 Requirement 1; National policy and strategy for safety (10 occurrences)
- SSR-5 Requirement 2; Responsibilities of the regulatory body (10 occurrences)
- GSR Part 5 Requirement 1; Legal and regulatory framework (9 occurrences)
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management (9 occurrences)

For Good Practices, no specific safety principles and IAEA safety requirements were referred to more frequently than others. The following principles and requirements were referred to twice or once:

- SF-1 Principle 7; Protection of present and future generations (two occurrences)
- GSR Part 1 Requirement 1; National policy and strategy for safety (one occurrence)
- GSR Part 1 Requirement 11; Competence for safety (one occurrence)
- GSR Part 5 Requirement 1; Legal and regulatory framework (one occurrence)
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management (one occurrence)
- GSR Part 5 Requirement 6; Interdependences (one occurrence)
- GSR Part 5 Requirement 8; Radioactive waste generation and control (one occurrence)
- GSR Part 6 Requirement 6; Responsibilities of the licensee for decommissioning (one occurrence)
- GSR Part 6 Requirement 9; Financing of decommissioning (one occurrence)
- GSR Part 6 Requirement 14; Radioactive waste management in decommissioning (one occurrence)
- GSG-15; Remediation Strategy and Process for Areas Affected by Past Activities or Events
- WS-G-6.1; Storage of Radioactive Waste (one occurrence)
- SSG-47; Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities (one occurrence)
II. Introduction

II.1. Development of the ARTEMIS Service

The Agency developed the IAEA Radioactive Waste Management Integrated Review Service (ARTEMIS) under its Regular Budget Programme for 2014-15 under Project 3.4.1 on “Radioactive Waste and Spent Fuel Management.”

Based on several decades of experience in conducting peer reviews in the field of radioactive waste and spent fuel management, the service was structured to cover both technical and regulatory aspects of radioactive waste and spent fuel management. The aim was to provide an integrated approach with sufficient flexibility to adapt the scope of the review and the requests and needs of Member States.

Thus, the ARTEMIS service developed by the Department of Nuclear Safety and Security and the Department of Nuclear Energy covers all aspects of radioactive waste and spent fuel management from the national legislative, regulatory and organizational framework to national policy and programme, including predisposal and disposal activities, decommissioning and remediation.

The first ARTEMIS Peer Reviews were conducted in 2017.

The ARTEMIS service is designed to allow its application to a variety of needs arising in Member States, ranging from high-level national aspects to focused, technically oriented and specific reviews. It may cover the entire national arrangements or target specific implementation aspects, with an emphasis on technology, or on safety, or both. The service may be requested for existing or planned national/institutional frameworks, systems, activities and facilities.

As such, ARTEMIS Peer Reviews may vary according to the needs of the requesting IAEA Member State. The service can support any organization involved in the management of radioactive waste and spent nuclear fuel.

ARTEMIS findings are based on IAEA Safety Standards and supporting international documents, such as the IAEA Nuclear Energy Series.

The flexibility of ARTEMIS Peer Reviews is based on a graded approach to ensure that the review (size of team, duration, etc.) corresponds to the size and scope of the national context, or the stage of development of the activity or facility being reviewed. The structure of ARTEMIS Peer Reviews, based on peer review domains (Figure 1), strengthens this flexible approach.
The Agency conducts ARTEMIS peer reviews on a global basis. However, the domain of national policy, framework and strategy facilitates the implementation of the Council Directive 2011/70/Euratom on establishing a Community Framework for the responsible and safe management of spent fuel and radioactive waste.

The Council Directive 2011/70/Euratom (Waste Directive) places obligations on EU Member States for periodic international peer reviews of their national framework, competent regulatory authority and/or national programme. Also, Member States shall periodically, at least every 10 years, arrange for self-assessments of their national framework, competent regulatory authority, national programme and its implementation.

II.2. Scope and objectives
The ARTEMIS Peer Reviews undertaken to date varied considerably in terms of size, scope and complexity. Between 2017 and 2020, 11 ARTEMIS missions have been conducted within IAEA Member States. Two missions focused on decommissioning programmes, one focused on pre-disposal management while eight missions covered the entire national system for radioactive waste and spent fuel management, for all the recognized waste streams, facilities and activities. A first analysis report presented a comparison of ARTEMIS mission limited to the same type of scope and thus addressed only the eight ARTEMIS missions which covered the entire national system for radioactive waste and spent fuel management. The first report is publicly available on the ARTEMIS GNSSN platform.
The second report follows the same approach and covers ten initial ARTEMIS mission and one follow-up mission conducted between 2021 and 2022. The second report is publicly available on the ARTEMIS GNSSN platform.

In line with this approach, the third report analyses the nine ARTEMIS missions undertaken in 2023 which covered the entire national system for radioactive waste and spent fuel management.

The objectives of this report are to:

1. Analyse the ARTEMIS missions which covered the entire national system for radioactive waste and spent fuel management. These were conducted in EU Member States in 2023 on the basis of the scope of the Council Directive 2011/70/Euratom.

2. Support transparency and the dissemination of information to Member States.

3. Contribute to the continuing development of the ARTEMIS service and improved management of radioactive waste management, decommissioning and remediation (RWMDR) against the Safety Standards in Member States hosting ARTEMIS missions.

4. Support the implementation of EU-IAEA cooperation in the field of nuclear safety, specifically, integrated regulatory review services in the EU.

II.3. Missions analysed
The analysis addresses nine ARTEMIS Peer Reviews implemented in EU Member States in 2023: nine ARTEMIS initial missions. These missions covered the entire national system for radioactive waste and spent fuel management and were conducted under the scope of the Council Directive 2011/70/Euratom. Figure 2 below indicates the locations of the ARTEMIS Peer Review conducted in each year, and the number of experts involved as peer reviewers for each mission. Some 52 peer reviewers took part in these missions.

<table>
<thead>
<tr>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slovakia (6)</td>
</tr>
<tr>
<td>Sweden (8)</td>
</tr>
<tr>
<td>Portugal (4)</td>
</tr>
<tr>
<td>Croatia (5)</td>
</tr>
<tr>
<td>Greece (4)</td>
</tr>
<tr>
<td>Italy (6)</td>
</tr>
<tr>
<td>Czech Republic (6)</td>
</tr>
<tr>
<td>The Netherlands (6)</td>
</tr>
<tr>
<td>Belgium (7)</td>
</tr>
</tbody>
</table>

Figure 2: Number of Peer Reviewers taking part in each ARTEMIS Peer Review
II.4. Method of analysis
The analysis reported here was conducted in two consecutive steps.

Firstly, after a general overview of the numbers and distribution of mission findings (Recommendations, Suggestions and Good Practices) during ARTEMIS initial missions, the technical content of the findings has been analysed by topic in order to draw conclusions on the range and trends of the mission findings. The areas of improvements most frequently identified during ARTEMIS initial missions are highlighted (Chapter IV).

Secondly, a quantitative analysis of the IAEA Safety Requirements referred to in the ARTEMIS missions has been conducted. This analysis reveals the role and importance of the IAEA Safety Requirements in the ARTEMIS review process in general and in the specific ARTEMIS Topics (Chapter V).

II.5 General references to IAEA Safety Standards
The ARTEMIS Peer Review Service provides independent expert opinion and advice on radioactive waste and spent nuclear fuel management, management of residues arising from uranium production, environmental remediation and decommissioning, based upon the IAEA safety standards and technical guidance, as well as international good practice.

The specific objective is to review the existing national arrangements against applicable IAEA safety standards and international good practice, forming a point of reference for how the requirements are met. Thus, the Recommendations, Suggestions and Good Practices identified during a mission are based on IAEA Safety Standards (safety principles and safety requirements) and technical guidance that are clearly documented in the mission report.

The following chapter provides an analysis of the references used as the basis for Recommendations, Suggestions and Good Practices during the nine ARTEMIS Peer Reviews conducted in European Member States in 2023. These covered the entire national systems for radioactive waste and spent fuel management and were conducted under the scope of the Council Directive 2011/70/Euratom.

When the same Requirement is used more than once as a basis for the same Recommendation or the same Suggestion, it is counted as a single reference.

Example: In Table 1 below, GSR Part 5 Requirement 2 is used twice as a reference for a suggestion. It is counted as one single reference.

If two Requirements serve as the basis for one single recommendation or suggestion, then they count as two References to the safety standards.

Example: In Table 1 below, GSR Part 1 Requirement 1 and GSR Part 5 Requirement 2 are used as references for the same suggestion so they will be counted as two references.

When a Requirement is used as a basis for a recommendation and a suggestion as well, or for two recommendations, it counts as two separate references to the safety standards.

Example: In Table 2 below, GSR Part 3 Requirement 31 is used as references for two suggestions (S5 and S6) and is counted as two references.
### Table 1

**RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES**

**Observation:** The Government’s intent to ensure long term safety through setting out the preferred options for radioactive waste and spent fuel management and reflect national priorities as the basis for decisions is presented in multiple documents at various hierarchical levels and various ministerial areas.

<table>
<thead>
<tr>
<th></th>
<th>BASIS: GSR Part 1 Requirement 1 para. 2.3 states that “National policy and strategy for safety shall express a long term commitment to safety. The national policy shall be promulgated as a statement of the government’s intent.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>GSR Part 5 Requirement 2 states that</strong> “To ensure the effective management and control of radioactive waste, the government shall ensure that a national policy and a strategy for radioactive waste management are established. [...] The national policy and strategy shall form the basis for decision making with respect to the management of radioactive waste.”</td>
</tr>
<tr>
<td>2</td>
<td><strong>GSR Part 5 Requirement 2 para 3.5 states that</strong> “The national policy on radioactive waste management has to set out the preferred options for radioactive waste management. It has to reflect national priorities [...]”</td>
</tr>
<tr>
<td>3</td>
<td><strong>Suggestion:</strong> The Government should consider to enhance its statement of intent regarding the safety of SF and RAW management, through compilation of all elements of the policy on RAW and SF management in a single statement, to provide a position on the preferred options and endpoints as a clear basis for establishing a National Strategy for the management of SF and RAW.</td>
</tr>
</tbody>
</table>

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### Table 2

**RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES**

**Observation:** The level of detail provided in the inventory for NHGW is limited to numbers and volumes of conditioned waste packages and weights of unconditioned waste (inorganic, organic and miscellaneous waste); there is no information on quantities and volumes, conditioning factors/processes or conditioning assumptions and characteristics for waste streams.

<table>
<thead>
<tr>
<th></th>
<th>BASIS: GSR Part 3 Requirement 31, para. 3.131 (e) states that “Registrants and licensees, in cooperation with suppliers, as appropriate: Shall maintain an inventory of all radioactive waste that is generated, stored, transferred or disposed of;”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Suggestion:</strong> To improve transparency on how waste streams are being managed, BMU should consider including additional information and description on NHGW in future revisions of the radioactive waste inventory report.</td>
</tr>
<tr>
<td>S5</td>
<td><strong>Suggestion:</strong> BMU should consider making greater use of the radioactive waste inventory to monitor changes in the inventory over time and demonstrate waste minimization.</td>
</tr>
</tbody>
</table>
III. Distribution and analysis of findings in ARTEMIS missions by Peer Review topic

III.1. General overview of the distribution of Recommendations and Suggestions of ARTEMIS Peer Review Topics

ARTEMIS missions which covered entire national systems for radioactive waste and spent fuel management addressed seven topics. Figure 3 below lists each topic and the number of references classified as Recommendations, Suggestions and Good Practices for the nine ARTEMIS Peer Reviews in the scope of this report.

The topics which raised the most findings are:
- Policy and framework
- Strategy

The topic of Inventory and Cost estimates resulted in the lowest number of findings. Good practices were identified in Strategy, Concepts, and Capacity building.

![Findings per topics](image-url)

**Figure 3: Number of references to findings per ARTEMIS Peer Review topics**

The following chapter analyses the findings made by the ARTEMIS reviewers for each topic in order to identify general trends. For ease of reference, a short summary is provided for each finding (Recommendation, Suggestion and Good Practice) analysed. However, these shorter versions of the findings do not replace the findings as recorded in official reports which are all publicly available using the following link: [Peer Review and Advisory Services Calendar | IAEA](https://www.iaea.org).
III.2. Topic 1: Policy and framework
This topic covers national policy, governmental, legal and regulatory framework, as well as responsibilities for radioactive waste and spent fuel management, decommissioning and remediation. Each sub-topic is analysed separately.

III.2.1. Topic 1.1: National policy
Findings concerning national policy were identified in seven of the nine ARTEMIS Peer Reviews in the scope of the analysis, with a total of fourteen Recommendations and two Suggestions raised during the missions. Figure 4 shows the findings raised on the basis of the IAEA principles, requirements and guides.

**Slovakia Recommendation:** Progress of the geological disposal is delayed due to lack of Government decision on undertaking further work in this regard. The Government should expedite the decision for the undertaking of further work on geological disposal.
- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- SSR-5 Requirement 1; Government responsibilities

**Slovakia Recommendation:** The National Programme for Management of Spent Nuclear Fuel and Radioactive Waste in Slovakia is required to be updated every six years but finalisation of the latest draft of the National Programme has been delayed with the last formal approval having been granted in 2015. The National Nuclear Fund should establish documented procedures for the timely and regular updating of the National Programme for spent fuel and radioactive waste management.
- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- SSR-5 Requirement 1; Government responsibilities
**Slovakia Recommendation:** Transparency is listed as a key principle in the draft National Programme, but it was observed that little evidence of proactive engagement with interested parties, including the general public, on radioactive waste management, especially around the siting of disposal facilities. The Government should establish a programme of proactive involvement of interested parties, including the public, regarding radioactive waste and spent fuel management, particularly in the siting of a geological disposal facility and its planned evolution.

**Sweden Recommendation:** The policy of relying upon generators of spent fuel and radioactive waste to provide for their safe management themselves, or by agreement with other generators, is effective in the case of the nuclear power plant operators. However, in the case of those responsible for other radioactive wastes, such as non-nuclear users of radiation or finders of orphan sources, the policy is effective only for radioactive waste or sources that can technically and economically be treated by Cyclife Sweden AB for disposal by the Swedish Nuclear Fuel and Waste Management Company (SKB). For wastes for which this is not the case, there is no management route available currently. The Government should supplement its policy and strategy so that responsibilities and resources are allocated to ensure safe and sustainable management of all non-nuclear radioactive waste.

**Portugal Recommendation:** Although elements of general policies and commitment to safe radioactive waste management are embedded in the regulatory framework, there is no comprehensive national policy. The Government should further develop a comprehensive national policy that sets out the preferred options for radioactive waste management.

**Portugal Recommendation:** Notwithstanding that provisions in the law include statements of the government’s intent, and the principle of avoiding undue burdens on future generations, they do not address the implementation of a disposal facility. There is currently no definitive commitment to dispose of all radioactive waste (existing and future) in the long term. The Government should make a commitment to radioactive waste disposal as a safe long-term solution for the management of all radioactive waste to avoid undue burden on future generations.

**Portugal Suggestion:** Despite significant amounts of NORM arising from past and present activities and facilities being identified as potentially requiring management as radioactive waste, there is no policy or elements thereof, regarding its management as such. The Government should consider including provisions in the national policy regarding the management of NORM as radioactive waste.
- SSG-60; Management of Residues Containing Naturally Occurring Radioactive Material from Uranium Production and Other Activities, Responsibilities of the government

**Croatia No findings:** Comprehensive arrangements are in place for the national policy. The guidelines, principles and goals defined in the National Strategy document have been defined in accordance with a number of underlying policy objectives and policy-related legal provisions.

**Greece Recommendation:** All radioactive waste generators with a legitimate interest in the national programme are not involved to the same extent in its development and implementation. The Government should assess the means of involving all radioactive waste generators in development and implementation of the national programme.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 1 (Rev. 1) Requirement 4, para. 2.7.

**Greece Recommendation:** Some radioactive waste streams such as radioactive waste arising from decommissioning of cyclotron facilities and radioactive waste management facilities are not addressed in the national programme. The Government should ensure that waste streams such as radioactive waste arising from decommissioning of cyclotron facilities and radioactive waste management facilities that are not currently included are addressed in the national programme.

- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management
- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel

**Italy Recommendation:** The National Programme (2019), which is the most recent approved programme, does not describe plans for the development of a geological disposal. The revised National Programme (2023) is not yet formally approved. The Government should approve without undue delays the 2023 National Programme, that includes geological disposal as a destination for spent fuel and high-level radioactive waste.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management
- SF-1 (Rev. 1) Principle 7; Protection of present and future generations

**Czech Republic No findings:** The scope and basic principles of the national policy are comprehensive and in line with IAEA fundamental safety principles and international practice, including the requirements for the periodic review and updating of the policy.

**Netherlands Recommendation:** The National Programme for the Management of Radioactive Waste and Spent Fuel does not specify in detail the steps for planning, development and decision making for long term waste management including disposal. The next revision of the National Programme, currently under revision, is intended to include a roadmap for disposal that encompasses these components. The Government should enhance the National Policy and Strategy to further specify the steps in planning, development and authorization of disposal facilities and clearly allocate responsibilities.
Netherlands Suggestion: The National Programme sets the framework for research in the Netherlands, however now it does not include a formalized structure to coordinate research and development. The Government should consider enhancing its National Policy and Strategy to formalize the roles and responsibilities for research and development in relation to decommissioning and waste management, including disposal.

Netherlands Recommendation: The regulatory framework stipulates requirements for decommissioning, however, the National Programme does not establish the decommissioning aspects, such as decommissioning strategies (e.g., immediate and/or deferred dismantling) and end-states, that may impact waste management. The Government should include in the National Policy decommissioning aspects that may impact waste management, such as decommissioning strategies (immediate and/or deferred dismantling) and end states.

Belgium Recommendation: The Belgian government has not established clear policies for all spent fuel management options or geological disposal development. Consequently, the public organization responsible for managing radioactive waste lacks clear premises for the development of a repository for category B&C radioactive waste, and the site selection process has not been initiated. The Government should formulate a well-defined policy decision regarding spent fuel management options, specifically addressing the choice between reprocessing and direct disposal.

Belgium Recommendation: Policy or policies should encompass all nuclear power plants and research reactors. During policy making, the Government should establish, without undue delay, a comprehensive geological disposal policy for the management of ILW and HLW waste including all the necessary milestones and initiate as soon as possible the site selection process.
Belgium Recommendation: The waste landfills and contamination at the former radium product manufacturing site in Olen are identified as an existing exposure situation. The public organization responsible for managing radioactive waste is preparing a policy proposal for the disposal of the radioactive waste resulting from remediation of the site. An effective remediation can only proceed once government policy is established. The Government should establish a policy for management of radium-bearing waste in a timely manner to enable the effective remediation of the existing exposure situation.

ANALYSIS OF FINDINGS

The findings concerning national policy address four main trends.

1. Delayed Decision-Making and Approval:

The delay in governmental decisions and approvals is a recurring issue across a number of countries. Examples are shown where delays in progressing geological disposal programmes due to government decisions being delayed or deferred. Similarly, delay/deferment of updating national policy and/or strategy is resulting in delayed development of disposal facilities.

2. Importance of Geological Disposal:

The need for geological disposal facilities to be available for high level waste is emphasized in several recommendations to various countries. The need for a comprehensive consideration of geological disposal in national policy is stressed as an essential aspect of managing spent fuel and high level waste and several governments are urged to approve national programmes that include geological disposal as a destination for these types of waste.

3. Disposal of all waste types

Several recommendations highlight the importance of addressing all radioactive waste types and streams. This includes managing waste from all decommissioning activities, radioactive waste from non-nuclear applications as well as considering the management of waste containing naturally occurring radionuclides.
4. Involvement of Stakeholders and Transparency:

Transparency and stakeholder involvement are highlighted in various recommendations. It is recommended to establishing programmes for proactive involvement of all interested parties, including the public, in radioactive waste and spent fuel management. Also, it is recommended to involve all organisations that generate radioactive waste in the development and implementation of the national policy.

5. Comprehensive National Policy:

The need to have in place a comprehensive national policy for radioactive waste management has been stressed to several countries. It was recommended that such policies should be comprehensive covering all waste types and all organisations generating and managing radioactive waste from generation to disposal.

In summary, the recommendations collectively underscore the importance of timely, transparent decision-making involving all stakeholders. The importance of comprehensive national policies addressing the management of all radioactive waste streams, with a specific emphasis on geological disposal as a long-term solution for the management of high level waste has been stressed. These common themes suggest a shared concern for comprehensive, effective and sustainable radioactive waste management practices across different countries.

III.2.2. Topic 1.2: Legal, regulatory and organisational framework

Findings on legal, regulatory and organisational framework were identified in six of the nine ARTEMIS Peer Reviews in the scope of the analysis. A total of eight recommendations and six suggestions were made on legal, regulatory and organisational framework aspects by the experts during the missions. Figure 5 below shows the IAEA principles, requirements and guides used as the basis for these findings.

![Figure 5: References for Findings used by experts for the Legal, regulatory and organisational framework ARTEMIS topic](image-url)
REVIEW OF FINDINGS

**Slovakia Recommendation:** The responsibilities of the various regulators are described in their respective laws and decrees; however, there is a lack of clarity on how these regulators work together in the field of spent fuel management, radioactive waste management, decommissioning and environmental remediation. The Government should establish formal arrangements for the effective coordination of regulatory functions in cases where multiple regulatory organizations have responsibilities for spent fuel management, radioactive waste management, decommissioning and environmental remediation.

- GSR Part 1 (Rev. 1) Requirement 7; Coordination of different authorities with responsibilities for safety within the regulatory framework for safety

**Sweden No findings:** Sweden has a comprehensive legal, regulatory and organizational framework for the safe management of spent fuel and radioactive waste. Interfaces between different legislation and different regulators (e.g. for radioactive waste that is also hazardous waste) appear generally to be well defined and managed effectively.

**Portugal Suggestion:** The allocation of responsibilities, as well as the coordination between the two main branches of the Regulatory Body, seem well established in practice. However, the approval of a formal memorandum of understanding (MoU) between the two branches is still pending. With the introduction, in January 2023, of supervisory roles of other government entities, it is suggested to be even more important to ensure coordination between all parties.

- GSR Part 1 (Rev. 1) Requirement 7, para. 2.18.; Coordination of different authorities with responsibilities for safety within the regulatory framework for safety
- GSR Part 1 (Rev. 1) Requirement 7, para. 2.19; Coordination of different authorities with responsibilities for safety within the regulatory framework for safety

**Portugal Suggestion:** On the completion of the preliminary feasibility studies regarding the long-term management options for radioactive waste including disposal, it is assumed that the government will develop a strategic approach according to which an existing or a new actor/entity not belonging to the Regulatory Body will take on the responsibility for implementation of the disposal facility including the siting process to maintain regulatory independence in the future. The Government should consider strengthening the regulatory body’s independence by establishing a waste management organization or similar entity not belonging to the Regulatory Body to ensure functional separation of responsibility for regulatory oversight of safety from co-ordination, financial oversight, and implementation of the National Programme for radioactive waste management, including the development of disposal solutions.

- SSR-5 Requirement 1; Government responsibilities
- GSR Part 1 (Rev. 1) Requirement 4; Independence of the regulatory body

**Croatia Recommendation:** The Strategy document was established about 10 years ago as a comprehensive summary of national policy. Since then, there have been significant changes about legislation, planning scenarios and the responsibilities of different organizations. Neither the Strategy
document nor the National Programme (last formally amended as recently as December 2022) provide a consistent, up-to-date picture of the national framework for radioactive waste management or the milestones and assumptions associated with different goals. The Ministry of the Interior should initiate without delay a revision of the Strategy and National Programme to provide clarity and consistency for planning, communication and decision making, including on the roles of the relevant organizations, planning assumptions and programme milestones.

- **GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management**

**Croatia Recommendation:** The two storage facilities that ceased to receive wastes are not subject to regulatory authorization according to the current legislation. Independent regulatory verification of the contents of the storage facilities and the conditions of the waste they hold is not therefore undertaken. The Ministry of the Interior should ensure that the two storage facilities are required to comply with safety requirements, including clear allocation of ownership of waste and sources, and responsibilities for safety and monitoring of the facilities.

- **GSR Part 1 Requirement 23; Authorization of facilities and activities by the regulatory body**
- **GSR Part 5 Requirement 11; Storage of radioactive waste**
- **GSR Part 5 Requirement 3; Responsibilities of the regulatory body**
- **GSG-16; Leadership, Management and Culture for Safety in Radioactive Waste Management**

**Croatia Recommendation:** The Ministry of the Interior should undertake inspections of all facilities that store sources and waste, including the two storage facilities that ceased to receive wastes.

- **GSR Part 1 Requirement 23; Authorization of facilities and activities by the regulatory body**
- **GSR Part 5 Requirement 11; Storage of radioactive waste**
- **GSR Part 5 Requirement 3; Responsibilities of the regulatory body**
- **GSG-16; Leadership, Management and Culture for Safety in Radioactive Waste Management**

**Croatia Recommendation:** Croatia plans a renewed national strategic environmental assessment process leading to the selection in 2038 of a site for the near surface disposal facility. Appendix 9 of the Ordinance (88/2022) on the management of radioactive waste and disused sources refers to siting criteria that are acknowledged by the Counterpart as being insufficient for the planned national site selection process. The Ministry of the Interior should update site selection criteria for the near surface disposal facility.

- **SSR-5 Requirement 2; Responsibilities of regulatory body**

**Greece Recommendation:** The Regulatory Body decides on a case-by-case basis whether radioactive materials containing naturally occurring radionuclides are to be controlled as radioactive waste. However, specific criteria for decision making have not been documented. The Regulatory Body should specify criteria for radioactive materials containing naturally occurring radionuclides to be controlled as radioactive waste.

- **GSR Part 5 Requirement 3; Responsibilities of the regulatory body**

**Italy Recommendation:** According to the provisions of legal framework, the closure of the near surface disposal facility is subject to prior authorization. Currently there are no provisions in the legal
framework to request update of the Safety Report and to be presented together with the application for the closure the near surface disposal facility. The Government should ensure that the process for authorization of closure of the near surface disposal facility requires update of the safety report as part of the application.

- GSR Part 1 (Rev. 1) Requirement 24; Demonstration of safety for the authorization of facilities and activities
- SSR-5 Requirement 2; Responsibilities of the regulatory body

Italy Suggestion: Guidance on procedures to demonstrate compliance of the material with the established clearance levels or site release is not yet developed. Such a guidance, detailing procedures of release of installations, sites and materials from regulatory control is currently under development by ISIN. The Regulatory Body should consider completing the development and issuance of guidance without undue delay, detailing procedures for release of installations, sites, and materials from regulatory control.

- GSR Part 5 Requirement 3; Responsibilities of the regulatory body
- GSR Part 6 Requirement 5; Responsibilities of the regulatory body for decommissioning
- WS-G-5.1; Release of Sites from Regulatory Control on Termination of Practices; Regulatory and legal framework

Italy Suggestion: Additional progress is required in the development of arrangements to validate compliance with waste acceptance criteria upon receipt of waste for emplacement in the repository. A robust quality assurance and quality control programs are necessary to ensure wastes that continue to be generated during repository development will meet the forecast waste acceptance criteria. The Government should consider ensuring a formal waste certification programme between waste generators and repository operator is developed.

- GSR Part 5 Requirement 7; Management systems
- GSR Part 5 Requirement 12; Radioactive waste acceptance criteria
- SSR-5 Requirement 20; Waste acceptance in a disposal facility

Italy Suggestion: The Government should consider reviewing existing legislative constraints around what locations can be considered for siting of the National Repository with the potential to relax where they do not impact safety and to avoid preventing consideration of local communities that may be supportive.

- SSR-5 Requirement 1; Government responsibilities

Czech Republic Suggestion: A comprehensive legal, regulatory and organisational framework is established, and applied. However, the Government should consider undertaking a review of the decommissioning and radioactive waste implications of potential additional and new types of nuclear facilities. which could be included in a future State Energy Policy.

- GRS Part 5 Requirement 2; National policy and strategy on radioactive waste management
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management
Netherlands No findings: The Government established a regulatory framework for nuclear and radiation safety, and have an established system of stakeholder and public participation in regulatory processes. Some areas for improvement to enhance safety have been identified during a previous IRRS peer review, including that the regulatory body should further develop regulations and guides to be consistent with current IAEA safety standards, as well as, the Government should establish regulatory requirements well before a deep geological repository is established.

Belgium Recommendation: The regulatory body has prepared safety requirements and a licensing scheme specifically tailored to disposal facilities, and a proposal for Royal Decrees has been submitted for Government approval. These provisions are important for the later steps in the operation of the Dessel near surface disposal facility and critical for the development of the radium-bearing waste disposal facility and the deep geological disposal facility. The Government should complete the process of establishing safety requirements and a licensing scheme specific to disposal facilities.

- GSR Part 1 (Rev. 1) Requirement 2; Establishment of a framework for safety

ANALYSIS OF FINDINGS

The findings concerning legal, regulatory, and organisational aspects address two main trends.

1. Coordination enhancement and clarification of regulatory responsibilities:

One recurring concern is the need for enhanced coordination and clarity of responsibilities among regulatory bodies or between the different entities within the national regulatory body involved in regulatory control of spent fuel management, radioactive waste management, decommissioning, and environmental remediation. The importance of formal arrangements, memoranda of understanding (MoUs), or revisions to national strategies to ensure effective collaboration to avoid regulatory gaps, overlaps or incoherence in these critical areas was emphasized. When developed by the regulatory body, any newly proposed legislations or requirements should, if necessary be approved by the Government without unnecessary delay.

2. Independence of regulatory function

The need for regulatory independence was emphasised especially avoiding instances where regulatory bodies are directly involved in the management or disposal of radioactive waste.

2. Completeness and comprehensiveness of legal and regulatory frameworks for radioactive waste management:

The importance of all facilities where radioactive waste is generated, managed, stored or disposed being subject to an appropriate level of regulatory control was emphasised. Governments were encouraged to consider undertaking a review of the legal framework for decommissioning and radioactive waste implications of potential additional and new types of nuclear facilities.

3. Shortcomings in legal, regulatory and organisational frameworks

A number of findings pointed out shortcomings in legislation, regulatory requirements and guidance. Of particular concern were site selection processes, clearance of material, site release, maintenance
of safety cases, establishment and compliance with waste acceptance criteria, development of
disposal facilities and regulatory control over waste containing naturally occurring radionuclides.
III.3. Topic 2: National strategy for radioactive waste and spent fuel management

Findings on National strategy have been raised in each of the nine ARTEMIS Peer Reviews in the scope of the analysis. A total of fifteen recommendations, ten suggestions and one good practice were raised on National strategy by the experts during the missions. Figure 6 below provides the IAEA principles, requirements and guides used as the basis for these findings.

![Figure 6: References for Findings used by experts under National Strategy ARTEMIS topic](image)

**REVIEW OF FINDINGS**

**Slovakia Recommendation:** The organisation in charge of the plan for implementation of geological disposal developed in 2020 but not yet approved, has not updated the plan. The opportunity should be taken to update the plan with interim targets and timelines in support of the National Programme milestones.

- GSR Part 2 Requirement 4; Goals, strategies, plans and objectives

**Sweden Recommendation:** The existing strategy relying upon generators of spent fuel and radioactive waste to provide for their safe management themselves, or by agreement with other generators, is effective in the case of the nuclear power plant operators. However, in the case of those responsible for other radioactive wastes, such as non-nuclear users of radiation or finders of orphan sources, the strategy is effective only for radioactive waste or disused sealed radioactive sources that can technically and economically be treated by Cyclife Sweden AB to make them suitable for disposal by SKB. For waste for which this is not the case, there is no management route available at this time. Under these conditions, some orphan sources have to stay with the finder until a solution is found. This can potentially raise safety issues. The Government should ensure that safe management routes are made available for all radioactive waste, including disused sealed radioactive sources as some orphan sources must stay with the finder until a solution is found.
Swedish Suggestion: The National Plan presents the policies for managing radioactive waste and spent fuel in Sweden. It is compiled by the Regulatory Body and regularly updated but it is not used as an instrument to support and monitor implementation of Sweden’s national policies for all types of radioactive waste and for spent fuel. Sweden lacks such an instrument. The Government should consider using the National Plan as a strategic planning component to support and monitor implementation of the national policies for all types of radioactive waste and for spent fuel.

Portuguese Recommendation: Elements of the national strategy for radioactive waste management are currently embedded in the regulatory framework, including the National Programme, established in 2017 and updated and published in 2022. Nevertheless, a comprehensive strategy for the safe management of waste, particularly disposal, has not yet been established in Portugal. The Government should establish a comprehensive strategy for safe radioactive waste management, particularly disposal.

Portuguese Recommendation: Notwithstanding provisions in the National Programme regarding the PRR interim storage facility, there are other facilities in Portugal that will require decommissioning. Therefore, a clear strategy for decommissioning and associated radioactive waste management is required. The Government should include specific provisions in the national strategy for radioactive waste management to deal with the waste associated with the decommissioning of all facilities.

Portuguese Suggestion: The licensees should consider selecting a decommissioning strategy for all facilities consistent with the national radioactive waste management strategy.

Portuguese Recommendation: The Portuguese Environment Agency should establish safety requirements for decommissioning activities including requirements for management of the resulting radioactive waste and associated regulations and guides before the submission of the decommissioning plans by the licensees.
Portugal Suggestion: The current legal framework and National Programme consider that near surface disposal is the final solution for management of radioactive waste. Considering the current classification system established in the National Programme, the ILW currently stored at PRR and future ILW is not suitable for near surface disposal. The Government should consider solving the potential contradiction between the current classification of waste and the disposal solution confirmed in the National Programme.

- GSR Part 5 Requirement 9; Characterisation and classification at various steps

Portugal Suggestion: Portugal has significant quantities of NORM coming from past activities and they are mostly at the site where they were produced. Although the legislative framework exists, in practice significant quantities of NORM have not yet been classified. This poses uncertainties in the definition of a national strategy for the management of radioactive waste for its storage and disposal. The Government should consider including suitable provisions in the national strategy to align it with a future national policy decision on the management of NORM as radioactive waste.

- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management
- SSG-60, Management of Residues Containing Naturally Occurring Radioactive Material from Uranium Production and Other Activities; Responsibilities of the government

Croatia Recommendation: The achievement of milestones within the National Programme has been repeatedly delayed. A process for mitigation of programme risk is especially important for those milestones that lie on the critical path to achieving defined goals. The Ministry of the Interior, in consultation with the Fund and other relevant Governmental Bodies, should enhance arrangements for the planning, monitoring and delivery of the National Programme, including measures for identifying, reporting, and mitigating programme risks, and for taking corrective actions as appropriate.

- GSR Part 2 Requirement 4; Goals, strategies, plans and objectives
- GSG-16; Leadership, Management and Culture for Safety in Radioactive Waste Management

Croatia Suggestion: The absence of centralized arrangements for the storage of institutional radioactive waste within Croatia could have implications for safety and security in relation to the management of disused sources and contaminated scrap materials. A centralized storage facility for such waste is planned as part of the Radioactive Waste Management Centre, but even under ambitious assumptions regarding its establishment, the facility may not be available to accept waste for several years. The Government should consider urgently providing arrangements for the safe and secure centralized storage of institutional waste in Croatia.

- GSR Part 5 Requirement 11; Storage of radioactive waste
- SSG-45; Predisposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education

Croatia Suggestion: It is planned to transport Croatia’s share of waste generated at the Krško NPP after 2023 directly to the planned near surface disposal facility in Croatia. There are risks associated with this strategy since processes for site selection and safety case development for disposal facilities
are more complicated than those for storage. The Fund should consider identifying back-up strategies for waste storage in case the disposal facility is not ready to accept the waste at the point when Croatia is obliged to accept it from the Krško NPP.

- GSR Part 5 Requirement 6; Interdependences
- GSR Part 5 Requirement 11; Storage of radioactive waste, para. 4.19.

**Greece Recommendation:** A process for the inclusion of interested parties in decision making for the site selection of disposal facilities prior to the issuance of the feasibility license has not yet been developed. The Government should develop a process for inclusion of interested parties in decision making for the site selection of disposal facilities prior to the issuance of the feasibility license.

- SSR-5 Requirement 1; Government responsibilities

**Greece Recommendation:** The Organization for the Interim Storage and Management of Radioactive Materials (OPADRY) which is going to be responsible for predisposal management and disposal of this radioactive waste will not be established until after site selection. The Government should establish OPADRY in a timeframe suitable to carry out the necessary activities for siting, design, and construction of the radioactive waste management facility.

- GSR Part 5 Requirement 4; Responsibilities of the operator
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management

**Greece Recommendation:** The national policy covers all stages of radioactive waste management, including operation, closure, and post-closure phases for the disposal facilities. However, the national programme does not explicitly make provisions for the operation, closure, and post-closure phases. The Government should provide for implementation of the policy in place by including operation, closure and post-closure activities related to disposal facilities in the national programme.

- SSR-5 Requirement 2; National policy and strategy on radioactive waste management
- SSR-5 Requirement 11; Step by step development and evaluation of disposal facilities

**Italy Recommendation:** An integrated R&D programme was not presented. Ongoing and already planned research activities are not clearly linked to the activities defined in the National Programme. It is not clear that all needed R&D activities have been planned. The Government should compile and publish an R&D programme that is clearly linked to the activities defined in the National Programme.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 5 Requirement 3; Responsibilities of the regulatory body
- SSR-5 Requirement 3; Responsibilities of the operator
- SSR-5 Requirement 6; Interdependences

**Italy Recommendation:** Ongoing and already planned research activities are not clearly linked to the activities defined in the National Programme. It is not clear that all needed R&D activities have been planned. The Regulatory Body should implement its own R&D programme to build its expertise to review safety cases for the activities in the National Programme.
- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 5 Requirement 3; Responsibilities of the regulatory body
- SSR-5 Requirement 3; Responsibilities of the operator
- SSR-5 Requirement 6; Interdependences

**Italy Suggestion:** The strategy of being silent on geological disposal while engaging the public on the National Repository may undermine public support for siting of National Repository by leaving questions about geological disposal unanswered when seeking public support for high level storage. The Government should consider developing a comprehensive strategy for proactive involvement of all interested parties, including the public, that encompasses the full scope of the National Programme, to reduce implementation risk for both the National Repository and the geological disposal.

- SSR-5 Requirement 1; Government responsibilities

**Italy Recommendation:** The timelines in the National Programme for the National Repository are too optimistic. The timelines for the geological repository are unlikely to be achieved considering the delayed start in comparison to international experience. To decrease uncertainties possibly having impact to implementation of the geological repository project, the Government should review and revise if needed the schedule for the implementation of the National Programme and confirm that it is realistically achievable.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management

**Italy Suggestion:** The timelines for the geological repository are unlikely to be achieved considering the delayed start in comparison to international experience. In order to decrease uncertainties possibly having impact to implementation of the geological repository project, the initial activities should be started earlier (e.g. issuance of regulatory guidance for geological repository, development of research programme). The Government should consider commencing the preliminary studies of the feasibility of a national geologic repository without undue delay.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management

**Czech Republic Good Practice:** The Government has established mechanisms for ensuring alignment of the strategies and plans developed by organizations involved in the management of radioactive waste and spent fuel with the National Policy, both individually and collectively.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management

**Czech Republic Suggestion:** There are ongoing activities and plans for further development of engagement with potential host communities during selection of the site for the proposed DGR and for the partnership programme between all stakeholders in the various phases of the DGR. There will be a need for additional resources and activities beyond the site selection phase. The Czech Radioactive Waste Repository Authority should consider further enhancing plans and resources for
engagement with interested parties, and, with potential host communities to ensure they are properly engaged beyond the site selection phase of the deep geological repository.

- GSR Part 5 Requirement 1; Legal and regulatory framework
- SSR-5 Requirement 11; Step by step development and evaluation of disposal facilities
- SSG-23; The Safety Case and Safety Assessment for the Disposal of Radioactive Waste

**Czech Republic Recommendation:** The programme for achieving the milestones for the deep geological repository is not sufficiently detailed, including the R&D plan. The Czech Radioactive Waste Repository Authority should update the existing plans and schedules for the development of the deep geological repository, including the R&D plan, considering the Complementary Delegated Act (Taxonomy).

- SSR-5 Requirement 11; Step by step development and evaluation of disposal facilities

**Netherlands Suggestion:** Elements of a national strategy are present in the National Programme. The National Programme provides provisional action points for the long-term timeframe, but it does not detail interim targets and measurable progress indicators to monitor the status of actions and reporting of progress. The Government should consider further developing a national strategy for waste management that sets out the mechanisms for implementing the National Policy, that includes appropriate interim targets, measurable progress indicators and end states.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management

**Belgium Recommendation:** The National Programme does not clearly address the waste streams that are non-conforming, have no clear end points or are waiting for a policy decision. The Government should ensure that waste streams that are non-conforming, have no clear end point or are waiting for a policy decision to be included in the National Programme with their proposed associated management options.

- GSR Part 5 Requirement 8; Radioactive waste generation and control

**Belgium Recommendation:** The further development of the strategy for the management of HLW and ILW is hindered by the ongoing consideration of alternative management options to geologic disposal, such as partitioning/transmutation and deep borehole disposal which are unsuitable for the management of large amounts of HLW and ILW. The Belgian Agency for Radioactive Waste management should focus its main resources on solutions that are technically feasible and internationally acknowledged for the long-term management of HLW and ILW.

- SSR-5 Requirement 4; Importance of safety in the process of development and operation of a disposal facility
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management
ANALYSIS OF FINDINGS

The findings concerning national strategy address three main trends.

1. Strategy and Planning:

The need for clear, updated, and comprehensive strategies is highlighted for several countries. It was found that there is a recurring emphasis on the need to update or establish implementation plans and strategies for waste management in general and particularly for geological disposal, and decommissioning activities. For some countries it was suggested that the national policy, while comprehensive, is not effectively utilized as an instrument to support and monitor the implementing strategy for all radioactive waste types.

2. Safe Management Routes:

The importance of safe management routes being available for all types of radioactive waste, particularly for disused sealed sources and other waste from non-nuclear uses. This concern is voiced in relation to potential safety issues arising from limitations in the strategy for implementing national policies and particularly for disposal.

3. National Strategy Development:

It was suggested to several countries to further develop national strategies for waste management, ensuring the inclusion of appropriate interim targets, measurable progress indicators and end states.

In summary, the recommendations and suggestions collectively underscore the importance of having comprehensive strategies in place to implement all aspects of national policy. Particular emphasis is given to strategic planning, clear management routes, clear safety requirements in place, effective public engagement and timely implementation.

III.4. Topic 3: Inventory of spent fuel and radioactive waste

Findings on Inventory were raised in seven of the nine ARTEMIS Peer Reviews in the scope of the analysis. A total of five recommendations and seven suggestions were raised on Inventory by the experts during the missions. Figure 7 below presents the IAEA principles, requirements and guides used as the basis for these findings.

Figure 7: References for Findings used by experts under Inventory ARTEMIS topic
REVIEW OF FINDINGS

Slovakia Recommendation: Currently there is no comprehensive national database for all radioactive waste and spent nuclear fuel in Slovakia. The Government should plan for the establishment and maintenance of a comprehensive national inventory for radioactive waste and spent nuclear fuel.

- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management, para. 3.5.
- SSG-45; Predisposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education

Sweden Suggestion: The national inventory and records of spent nuclear fuel are very well defined and well maintained by the regulatory body and the waste generators. Information on waste streams associated with non-nuclear radioactive waste and certain other categories of radioactive waste could be further improved to provide a sound basis which will inform the national plan and decision-making for ultimate disposal routes. The Government should consider establishing and maintaining a national database such that records of all radioactive waste and spent fuel are centralized and accurately reflected to inform decision making on storage and disposal routes.

- GSR Part 1 (Rev. 1) Requirement 35; Safety related records
- GSR Part 3 Requirement 3; Responsibilities of the regulatory body
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management

Portugal Suggestion: There are no detailed waste characterization data for the research reactor nor for the storage facility of PRR and no conceptual plans for their decommissioning. Without this information, it will not be possible to plan storage and waste disposal requirements for the future. The licensees should consider developing waste inventory estimates and associated waste characterization data.

- GSR Part 5 Requirement 9; Characterisation and classification at various steps
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management, para. 3.5.

Portugal Suggestion: There are significant quantities of NORM that may be classified as waste in the future, which could impact significantly on existing waste storage capacity and future disposal requirements. A suitable management option is not yet in place but is being developed as part of the National Programme Measure II. Without understanding this issue, it will not be possible to plan storage and waste disposal requirements for the future. The Government should consider establishing a waste inventory, based on characterization data for NORM, on completion of National Programme Measure II.

- GSR Part 5 Requirement 9; Characterisation and classification at various steps
- SSG-60; Management of Residues Containing Naturally Occurring Radioactive Material from Uranium Production and Other Activities, Responsibilities of the government

Portugal Suggestion: Whilst the National Programme contains an assessment of current waste inventories and some elements of future arisings, there is significant uncertainty about this future
inventory. The regulatory body should consider including in the next revision of the National Programme the anticipated future waste inventory data from the ongoing studies for the research reactor and the storage facility decommissioning, NORM management plans and for any other facilities that are not currently included in the national inventory.

- GSR Part 5 Requirement 9; Characterisation and classification at various steps
- GSR Part 1 (Rev. 1) Requirement 35; Safety related records

**Croatia Suggestion:** The national waste classification in Article 4 of Ordinance (88/22) on management of radioactive waste and disused sources is not fully aligned with the waste management routes defined within the National Strategy. The Ministry of the Interior should consider revising the waste classification in Article 4 of the Ordinance on management of radioactive waste and disused sources to provide well-defined boundaries between waste classes and to support mapping between the waste classes and disposal arrangements defined in the National Strategy.

- GSR Part 5 Requirement 9; Characterisation and classification at various steps

**Croatia Recommendation:** Currently only sources in use and DSRS are recorded in RAIS. The Central Registry of Radioactive Waste and Disused Sources is planned, which will also include radioactive waste. Its implementation, as a more appropriate tool than that currently used for managing the national radioactive waste inventory, is necessary to meet inventory reporting requirements. The Ministry of the Interior should complete the Central Registry of Radioactive Waste and Disused Sources and take it into use.

- GSR Part 3 requirement 3; Responsibilities of the regulatory body

**Greece Suggestion:** The national inventory in Greece includes partial information about existing radioactive waste, which has not yet been fully characterized in terms of relevant radiological, physical, mechanical, chemical, and biological properties to support the implementation of the national programme. A comprehensive estimate of future arisings is not fully included. The regulatory body should consider strengthening the national inventory so that it covers all radioactive waste in Greece together with future arisings.

- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management, para. 3.5.
- GSR Part 5 Requirement 9; Characterisation and classification at various steps

**Italy no findings:** The inventory tool was primarily a tool for the regulatory body, and it did not contain all of the supporting data pertaining to each waste package that is needed for disposal. Nonetheless, it is viewed as an effective regulatory tool and should prove to be an efficient path to compiling the national radioactive waste inventory in an automated way.

**Czech Republic no findings:** The national inventory is based on data provided by RW generators, such as NPPs and different institutions; and includes the records of RW and SF in existing storage or disposal facilities. The roles of the main organisations are clearly identified, however establishing a single national inventory database could offer certain advantages over the present arrangements.
**Netherlands Suggestion:** Radioactive waste disposed at landfills is excluded from the national inventory. This has been recognized in the ARTEMIS self-assessment. The Government should consider expanding the national inventory to include radioactive waste to be disposed at landfills.

- GSR Part 1 (Rev. 1) Requirement 35; Safety related records
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management, para. 3.5.

**Netherlands Recommendation:** The regulatory framework does not provide comprehensive regulatory requirements and guidance on the characterization of radioactive waste. The regulatory body should enhance the regulatory framework by establishing regulatory requirements and guidance for the characterization of waste for predisposal and disposal activities.

- GSR Part 5 Requirement 9; Characterisation and classification at various steps

**Belgium Recommendation:** A more effective means for transfer of waste inventory data from the waste producers to the waste management organisation should be established. More timely and better quality information from the reference programmes of waste producers would improve planning, implementation and efficiency of the National Programme. The Government should act upon a proposal from the waste management organisation to revise the legal framework to incorporate additional provisions to allow the definition and the review of the required information for the reference programmes of the waste producers.

- GSR Part 5 Requirement 6; Interdependences

**Belgium Recommendation:** It was noticed that significant quantities of radium-bearing waste from past industrial activities in Belgium are not yet included in the National inventory. The waste management organisation should include in the national inventory a category for radium-bearing waste from past industrial activities to make the radioactive waste inventory complete.

- GSR Part 5 Background

**ANALYSIS OF FINDINGS**

The findings concerning inventory address one main trend.

1. Establishment and enhancement of national inventories:

A common trend across the observed countries is the incompleteness of national inventories in terms of amounts of waste, inclusion of all waste types and the full characteristics of some waste. Those from past industrial activities and waste containing natural radionuclides are of particular concern. There is a recognition of the importance of establishing and enhancing comprehensive national inventories. The recommendations and suggestions highlight the necessity of accurate and comprehensive inventory data for informed decision-making, planning, and transparency in radioactive waste management.
III.5. Topic 4: Concepts, plans and technical solutions for spent fuel and radioactive waste management

Findings on Concepts, plans and technical solutions were raised during eight of nine ARTEMIS Peer Reviews in the scope of the analysis. A total of five recommendations, seven suggestions and four good practices were raised. Figure 9 below shows the IAEA principles, requirements and guidance used as a basis for these findings.

![Graph showing references for findings in the concept, plans and technical solutions topic]

**Figure 8: References for Findings used by experts under Concept, plans and technical solutions ARTEMIS topic**

**REVIEW OF FINDINGS**

**Slovakia Good Practice:** The application of an immediate dismantling strategy combined with the treatment of all materials arising was outstanding. The integrated approach of all organizations participating in the decommissioning project of V1 reactor effectively supported optimized execution of all technical activities in a timely and cost-effective manner. Furthermore, the openness in sharing their experience can be highly beneficial to several comparable present and future decommissioning projects.

- GSR Part 6 Requirement 7; Integrated management system for decommissioning
- GSR Part 6 Requirement 6; Responsibilities of the licensee for decommissioning
- GSR Part 6 Requirement 14; Radioactive waste management in decommissioning
- SSG-47; Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities
- GSR Part 6 Requirement 9; Financing of decommissioning

**Slovakia Recommendation:** The National Programme for radioactive waste management and spent fuel management recognises the need for research and development to support the implementation of geological disposal. However, there is no evidence of a clearly elaborated plan and resources for the undertaking of the necessary research activities at present. The Government should ensure that a programme is established for the research and development activities to be undertaken in support of the implementation of the geological disposal programme. The research programme should establish...
clear priorities with defined timeframes, responsibilities, and the associated resources for its timely execution.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel

**Sweden Good Practice:** Sweden has designed the KBS-3 for spent nuclear fuel disposal concept of encapsulation and developed it to a mature concept, carried out a successful siting process and interacted with all stakeholders for achieving wide acceptance and a governmental licence for the proposed disposal project.

- SF-1 Principle 7; Protection of present and future generations

**Portugal Recommendation:** Although several existing facilities will require decommissioning, such as Portugal’s RPI, their decommissioning and associated radioactive waste management were not considered when they were licensed for operation. The licensees should develop decommissioning plans for existing facilities including options for radioactive waste management consistent with the National Programme, in accordance with guidance issued by the Regulatory body.

- GSR Part 6 Requirement 8; Selecting a decommissioning strategy
- GSR Part 6 Requirement 10; Planning for decommissioning

**Croatia Recommendation:** The procurement of services for transport, characterisation, storage, and conditioning of D6 drums from the Krško NPP foresees storage for up to five years. The availability of waste acceptance criteria derived from the safety case for the storage facilities at the Čerkezovac site is a necessary input for finalising waste package specifications to guide waste conditioning. The complexity of these arrangements represents a risk for managing interdependencies between waste management steps. The Fund should finalise WAC for the storage facilities at the Čerkezovac site and submit them to the regulator for approval in a timely fashion to allow receipt and safe storage of the waste packages.

- GSR Part 5 Requirement 12; Radioactive waste acceptance criteria
- GSR Part 5 Requirement 6; Interdependences

**Croatia Suggestion:** There are currently no regulations or guidance in place covering the site selection process for a geological disposal facility for spent nuclear fuel and other high-level waste. The Ministry of the Interior, in consultation with other relevant bodies, should consider developing guidance on siting a geological disposal facility.

- GSR Part 1 (Rev. 1) Requirement 32; Regulations and guides

**Greece No findings:** Currently there is no designated national radioactive waste management organization, no national centralised storage facility and no associated predisposal management facilities for radioactive waste in Greece. Current storage conditions for radioactive waste at the interim storage facility and at the research reactor provide limited opportunities for establishing technical solutions for sorting, segregation, characterization and packaging of the radioactive waste.

**Italy Suggestion:** Italy reported that several major projects are being impacted by contracting challenges, many of which are connected to procurement requirements imposed on public agencies.
in Italy, but may not be well suited to the nuclear decommissioning context. The Government should consider review of SOGIN contracting performance for nuclear decommissioning along with legislated contracting constraints for state entities with the intention of exploring opportunities for SOGIN to achieve better project milestone delivery performance while also meeting the state contracting objectives.

- SSR-5 Requirement 25; Management systems
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management

**Czech Republic Suggestion:** The option of transfer of spent fuel from storage into disposal packages at the DGR has been selected to minimise the risk of damage to the disposal packages during transport to the DGR. Consideration of the transfer of damaged spent fuel is underway. There are interdependencies between storage and disposal. There will be similarities between operations for the management of spent fuel at NPPs and the transfer of spent fuel from storage to disposal containers at the DGR. The Radioactive Waste Repository Authority and the NPP operator should consider the interdependencies between storage and disposal of spent fuel in the design of the process for the transfer of spent fuel from storage to disposal packages at the DGR and the transfer of damaged fuel to the DGR for disposal, to gain the benefit of experience in the predisposal management of spent fuel.

- GSR Part 5 Requirement 6; Interdependences

**Czech Republic Recommendation:** In the milestones for the development of the deep geological disposal facility (DGR) there is a lack of clarity on plans for disposal of radioactive waste that is not suitable for disposal in operating disposal facilities, as well as for radioactive waste from additional nuclear power reactor types not considered in current State Energy Policy. The milestones may not be consistent with the Complementary Delegated Act (Taxonomy). The Government should update the milestones for the DGR, in the national policy and strategy, to take account of the Complementary Delegated Act (Taxonomy). This should address all radioactive waste and spent fuel to be disposed of in the DGR, including those from additional nuclear power reactor types not considered in the State Energy Policy.

- SSR-5 Requirement 1; Government responsibilities
- SSR-5 Requirement 3; Responsibilities of the operator
- SSR- 5 Requirement 11; Step by step development and evaluation of disposal facilities

**Czech Republic Recommendation:** In the milestones for the development of the deep geological disposal facility (DGR) there is a lack of clarity on plans for disposal of radioactive waste that is not suitable for disposal in operating disposal facilities, as well as for radioactive waste from additional nuclear power reactor types not considered in current State Energy Policy. The milestones may not be consistent with the Complementary Delegated Act (Taxonomy). The Radioactive Waste Repository Authority should update existing design plans and milestones for the development of the DGR, in addressing all radioactive waste and spent fuel intended for disposal in the DGR, while continuing to apply a graded approach.

- SSR-5 Requirement 1; Government responsibilities
- SSR-5 Requirement 3; Responsibilities of the operator

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- SSR-5 Requirement 11; Step by step development and evaluation of disposal facilities

**Netherlands Suggestion:** While the operator COVRA has a research and development programme on disposal, but it did not encompass research and development activities for predisposal waste management. COVRA should consider enhancing its research and development programme to include predisposal research and development needs derived from the periodic safety review, the safety case and supporting safety assessment, in line with the IAEA Safety Standards.

- SSR-5 Requirement 3; Responsibilities of the operator
- GSG-3; The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste
  o Components of the safety case
  o Evolution of the safety case
  o Maintenance of the safety case and safety assessment

**Netherlands Suggestion:** In a situation whereby spent fuel from the NPP(s) could not be reprocessed under current arrangements, no scenario for the management of spent fuel is established. The Government should consider, in the national policy and strategy, the situation if the reprocessing abroad of spent fuel from the NPP(s) would not be an option.

- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management
- GSR Part 1 Requirement 1; National policy and strategy for safety

**Netherlands Suggestion:** The monitoring of the landfill where radioactive waste has been disposed of, comprises only of non-radiological environmental monitoring. The Government should consider setting requirements for a programme that includes radiological monitoring, in accordance with the graded approach, at the landfill sites authorized to receive designated radioactive material.

- SSR-5 Requirement 21; Monitoring programmes at a disposal facility

**Belgium Good Practice:** Belgium established a policy centralizing the radioactive waste storage facilities at Belgoprocess premises. The provisions of the article 27b of the Royal Decree of 20 July 2001 prevent the accumulation of waste stored by producers. The centralized management of the radioactive waste by Belgoprocess prior to disposal contributes to the minimization of waste and helps to optimize the interdependencies of the different waste management steps.

- GSR Part 5 Requirement 6; Interdependences
- WS-G-6.1; Storage of Radioactive Waste

**Belgium Suggestion:** The decommissioning of the BR-1 reactor will generate graphite waste that is intended to be disposed of in the LLW near surface disposal. This requires specific actions for which the experience gained from international projects could be valuable for the Belgian Nuclear Research Centre (SCK CEN). In this context, SCK CEN should consider extending its international cooperation through the EDF/DP2D Graphite Reactor Decommissioning Demonstrator, as this is a particularly timely opportunity.

- GSR Part 6, Requirement 10; Planning for decommissioning
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management
**Belgium Good Practice:** The proposed approach for remediation of the radium-contaminated Umicore site in Olen is a very effective means for waste minimization.

- SF-1 Principle 7; Protection of present and future generations
- GSR Part 5 Requirement 8; Radioactive waste generation and control
- GSG-15; Remediation Strategy and Process for Areas Affected by Past Activities or Events

**ANALYSIS OF FINDINGS**

The findings concerning concepts, plans and technical solutions address two main trends.

1. **Good practice in waste management processes:**

   Several countries are acknowledged for implementing successful practices in radioactive waste management and decommissioning. Immediate dismantling strategy, combined with effective material treatment is recognized as a good practice. Also, commendation was given for designing an appropriate concept, successfully conducting a siting process, and obtaining wide acceptance, culminating in a governmental license for a geological disposal project. There was also recognition of good management of a facility for waste containing natural radionuclides from an old industrial activity.

2. **Interdependence and supporting research and development**

   Recommendations were made for establishing research and development programmes in support of geological disposal and better linkage between transport, storage and disposal packaging. Also the need was identified to ensure disposal options will be available for all waste types and that assumptions made such as the availability of reprocessing have contingency arrangements. Linking of research and development programmes to safety cases was identified as an important consideration, particularly in the establishment of waste acceptance criteria. Effective project management of decommissioning was emphasised.

3. **Policy Considerations and Environmental Monitoring:**

   Suggestions were made to have radiological environmental monitoring in place for landfill sites where radioactive waste is disposed.

   In summary, the trends indicate a common focus on having in place comprehensive, interlinking waste management processes, addressing challenges through research and development clearly linked to safety arguments set down in safety cases. The recommendations and suggestions also underscore the importance of clear plans, regulatory frameworks, and timely decision-making to ensure the safe and efficient handling of radioactive waste.
III.6. Topic 5: Safety case and safety assessment of radioactive waste and spent fuel management activities and facilities

Findings on the safety case and safety assessment of radioactive waste and spent fuel management activities and facilities were raised for all nine ARTEMIS Peer Reviews in the scope of the analysis. A total of twelve recommendations, and six suggestions were raised during the missions. Figure 9 shows the IAEA principles, requirements and guidance used as the basis for these findings.

REVIEW OF FINDINGS

Slovakia Recommendation: There is no evidence of information on safety to support the early stages for siting process for geological disposal. JAVYS, a.s. should initiate development of an understanding of the features of the geological disposal facility and its host environment that influence safety, to support the siting decision making process.

- SSR-5 Requirement 6; Interdependences

Slovakia Recommendation/Suggestion: There is a need for additional guidance on siting of the geological disposal facility and the development of the geological disposal programme. The regulatory bodies should develop comprehensive guidance for demonstrating compliance with the requirements on siting of the geological disposal facility and subsequent steps in implementation of the geological disposal programme. Also, the regulatory bodies should consider undertaking a detailed review of existing requirements and confirm their applicability to the geological disposal programme.

- GSR Part 1 Requirement 2; Establishment of a framework for safety

Sweden Suggestion: It is not yet clear which Waste Acceptance Criteria (WAC) will be set up for SFL, whether they will allow for all the existing and arising LLW-LL to be accepted by disposal facility for long lived low and intermediate level waste (SFL), and what kind of (re-)conditioning will be required to comply with the WAC. The regulatory body should consider initiating, without further delay, a
forum involving the Nuclear Fuel and Radioactive Waste Management Company and waste owners that fosters development, in a timely manner, of the preliminary conditions, in particular WAC, for the disposal of waste in the SFL. The forum should aim to establish time schedules and milestones for developing such conditions.

- SSR-5 Requirement 2; Responsibilities of the regulatory body
- SSR-5 Requirement 20; Waste acceptance in a disposal facility
- SSG-14; Geological Disposal Facilities for Radioactive Waste

**Portugal Suggestion:** The National Programme sets out a number of measures to be implemented in the near future in the area of radioactive waste management (preparation of feasibility study for disposal solutions; establishment of WAC’s for storage) and future decommissioning of nuclear installations. Currently, there is not enough regulatory guidance to support safety related decisions on these options. The Regulatory body should consider developing safety requirements and recommendations to support safety related decisions and safety cases that will be required for waste management facilities and activities in the future.

- SSR-5 Requirement 2; Responsibilities of the regulatory body
- GSR Part 5 Requirement 13; Preparation of the safety case and supporting safety assessment

**Croatia Recommendation:** There is a lack of regulatory guidance on how to fulfil the requirements for safety assessments for authorization processes and the application of a graded approach. The Ministry of the Interior should develop guidance stating regulatory expectations for safety assessments to support authorization of radioactive waste storage and disposal facilities.

- GSR Part 1 (Rev. 1) Requirement 24; Demonstration of safety for the authorization of facilities and activities
- GSR Part 5 Requirement 14; Scope of the safety case and supporting safety assessment
- SSR-5 Requirement 2; Responsibilities of the regulatory body

**Croatia Recommendation:** There is no documentation justifying the safety of the two storage facilities that ceased to receive wastes. The Ministry of the Interior should require safety demonstrations to be developed.

- GSR Part 5 Requirement 11; Storage of radioactive waste
- GSR Part 5 Requirement 14; Scope of the safety case and supporting safety assessment

**Croatia Suggestion:** The safety assessment calculations for the RWMC storage facilities at the Čerkezovac site, which are an essential component of the safety case and environmental impact assessment, have just begun. The safety assessment results are required early 2024 to enable time for regulatory review prior to applying for the facility’s location permit expected in 2025. The Fund should consider revising its plans to allow enough time for the development and regulatory review of the safety assessment at the level of detail that is necessary to apply for the RWMC location permit.

- GSR Part 5 Requirement 15; Documentation of the safety case and supporting safety assessment
**Greece Recommendation:** National Centre of Scientific Research "Demokritos" should complete the decommissioning plan and supporting safety assessment without undue delay, including all reactor systems and components taking into consideration the adopted end state for the facility.

- GSR Part 6 Requirement 10; Planning for decommissioning
- GSR Part 6 Requirement 3; Assessment of safety for decommissioning

**Greece Recommendation:** The safety report for the currently operating interim storage of radioactive waste at National Centre of Scientific Research "Demokritos" is not complete. The Centre should update the safety report for the interim storage of radioactive waste.

- GSR Part 5 Requirement 13; Preparation of the safety case and supporting safety assessment

**Greece Recommendation:** While general safety criteria for radioactive waste management and disposal facilities are defined, more specific criteria for undertaking safety assessment as part of a licensing procedure are yet to be adopted. In addition, regulatory requirements and guidance are yet to be developed. The Government should enhance the legal and regulatory framework for safety of radioactive waste management and disposal facilities as planned by specifying the steps in development and licensing of such facilities.

- GSR Part 5 Requirement 1; Legal and regulatory framework
- GSR Part 5 Requirement 3; Responsibilities of the regulatory body
- SSR-5 Requirement 1; Government responsibilities
- SSR-5 Requirement 2; Responsibilities of the regulatory body

**Greece Recommendation:** The Regulatory body should further detail regulatory requirements and provide guidance on the interpretation of the national legislation and regulatory requirements, and on what is expected of the operator in respect of each individual facility.

- GSR Part 5 Requirement 1; Legal and regulatory framework
- GSR Part 5 Requirement 3; Responsibilities of the regulatory body
- SSR-5 Requirement 1; Government responsibilities
- SSR-5 Requirement 2; Responsibilities of the regulatory body

**Italy Suggestion:** The expertise needed is from a small community that is also used by the operators. The Regulatory Body should consider developing a process to ensure availability of experts to support their safety case review who will be independent from the technical experts working with the operators.

- GSR Part 1 (Rev. 1) Requirement 17; Effective independence in the performance of regulatory functions
- SSR-5 Requirement 2; Responsibilities of the regulatory body
- SSR-5 Requirement 14; Documentation of the safety case and safety assessment

**Italy Recommendation:** The law constrains both preparation and review of the repository safety case and safety assessment within strict timelines and the review team considers that the time frames are unreasonable. The driver for such work should be safety and the operator and regulator should be afforded the necessary time to thoroughly prepare and review these documents to the quality
demanded in the Safety Standards. Strict enforcement of these unreasonable time constraints could result in an unintentional compromise in safety and erode public confidence. The Government should take measures to ensure that the time constraints imposed on preparation and review of the safety case and safety assessment for the National Repository will not compromise safety.

- GSR Part 5 Requirement 15; Documentation of the safety case and supporting safety assessment
- SSR-5 Requirement 14; Documentation of the safety case and safety assessment

**Italy Suggestion:** The repository organization is applying overly conservative assumptions in the preliminary safety assessment that may cause unintended consequences to safety by ruling out options that could otherwise prove optimal. The repository operator should consider avoiding unrealistic overly conservative assumptions in the development of the safety assessment of the near surface disposal facility.

- SSR-5 Requirement 2; Responsibilities of the regulatory body
- SSR-5 Requirement 4; Importance of safety in the process of development and operation of a disposal facility
- SSG-29; Near Surface Disposal Facilities for Radioactive Waste

**Czech Republic Recommendation:** When providing the safety case for siting, the Radioactive Waste Repository Authority should update the current safety assessment to include all radioactive waste to be disposed of in the DGR, applying a graded approach.

- GSR Part 1 (Rev. 1) Requirement 26; Graded approach to review and assessment of a facility or an activity
- SSR-5 Requirement 2; Responsibilities of the regulatory body
- SSR-5 Requirement 14; Documentation of the safety case and safety assessment
- SSR-5 Requirement 15; Site characterization for a disposal facility

**Netherlands Recommendation:** Currently, COVRA uses waste specifications for receiving waste at the radioactive waste management facilities based on transport limits, processing, and properties of the storage buildings. However, waste acceptance criteria for waste management facilities should be derived from the facility specific safety case. COVRA should develop waste acceptance criteria for the management of radioactive waste to advance the existing waste specifications. Waste acceptance criteria are to be derived from facility specific safety case and supporting safety assessment, in line with IAEA safety standards.

- GSR Part 5 Requirement 12; Radioactive waste acceptance criteria
- GSR Part 5 Requirement 4; Responsibilities of the operator

**Belgium Recommendation:** Due to the lack of clear policy regarding hampering progress with geological disposal, the waste management organisation should develop the next safety case for geological disposal based on a reference host rock and assess the range of alternative host rocks (in a stylised approach) to support a future site selection process.

- SSR-5 Requirement 3; Responsibilities of the operator
ANALYSIS OF FINDINGS

The findings concerning safety case and safety assessment address four main trends.

1. Geological Disposal and Siting Process:

Recommendations and suggestions are made for countries regarding the need for safety cases to be developed at an early-stage in geological disposal facility siting and development to guide research and to provide a basis for decision making. Also it must be recognized that whilst generic information is relevant initially, site specific information is needed to progress.

2. Waste Acceptance Criteria (WAC):

The importance of establishing Waste Acceptance Criteria (WAC) on the basis of safety arguments in the safety case was emphasized.

3. Regulatory Guidance and timely development for Safety Assessments:

Recommendations were made to several countries highlighting the need for regulatory requirements for safety cases to be developed and used as a basis for all siting, design and operational decision having an impact on safety. A suggestion was made to allow sufficient time for the development and regulatory review of safety cases, stressing the importance of a thorough and timely process. Similarly, it was recommended to complete safety assessments without undue delay. It was also highlighted that the availability of sufficient and independent experts for safety case reviews was essential. It was noted that caution needs to be exercised against undue conservatism in safety assessment.

4. Inclusion of All Radioactive Waste:

Throughout the proposed recommendations, the importance of requiring safety cases for all radioactive waste management facilities and activities was stressed, applying a graded approach where necessary.

Overall, the trend reflects a collective effort across countries to enhance safety practices, regulatory frameworks, and planning processes in the nuclear decommissioning and waste management domain, with a strong emphasis on safety related decisions being justified by supporting safety cases and a graded approach to safety case development.
III.7. Topic 6: Cost estimates and financing of radioactive waste and spent fuel management

Findings on the cost estimates and financing of radioactive waste and spent fuel management topic were raised during seven of the nine ARTEMIS Peer Reviews in the scope of the analysis. A total of four recommendations and six suggestions were raised. Figure 10 below shows the IAEA principles, requirements and guidance used as a basis for these findings.

Figure 10: References for Findings used by experts under Cost estimates and financing ARTEMIS topic.

review of findings

Slovakia No Findings: The generic approach cost calculations seems to be appropriate. Costs are periodically updated based on conceptional decommissioning plans and cost for geological disposal facility considered on the very early stage of the project and as it follows a conservative approach.

Sweden Recommendation: Financial and contractual agreements for the disposal of radioactive waste arising from the operation of the European Spallation Source are not yet finalized. Funds allocated are not sufficient to cover all the future costs associated with handling and final disposal of the legacy waste. For non-nuclear radioactive waste an individual or a recycling facility could become an involuntary holder of radioactive material for which they may lack competence, financial resources, and necessary facilities to manage. The Government should ensure that the responsibilities and
obligations in respect of securing financial provisions allow for the sustainable management of all legacy waste and non-nuclear radioactive waste.

- GSR Part 5 Requirement 1; Legal and regulatory framework
- GSR Part 2 Requirement 2; Demonstration of leadership for safety by managers

Portugal Recommendation: The current information on governmental cost liabilities associated with decommissioning, waste storage and waste disposal are incomplete and not informed by sufficient data and plans. Whilst this is recognised in the National Programme, a comprehensive assessment of the total lifetime liability is required for all stages of all facilities, to enable the Government to discharge its duties with respect to making suitable financial provisions. The Government should update its financial liability estimates for all aspects of radioactive waste management and ensure that long term strategic budgets include sufficient financial provision, particularly for disposal solutions.

- GSR Part 5 Requirement 20; Shutdown and decommissioning of facilities
- SSR-5 Requirement 1; Government responsibilities

Croatia No Findings: Croatia places a very high importance on ensuring that there will be sufficient funds to manage all the radioactive waste it is, and will be, responsible for. Croatia has developed detailed cost estimates for all the activities it expects to be necessary for the safe management of radioactive wastes, from development of facilities through to their decommissioning/closure.

Greece Recommendation: The national programme does not include cost estimates and financial provisions for all stages of all facilities regarding decommissioning, radioactive waste storage and disposal, including post-closure; currently, the national programme does not include detailed cost estimates and financial provisions for the existing interim storage facility and the future radioactive waste storage and disposal facilities regarding their decommissioning and post-closure. The Government should assess the completeness of the costing information used to establish the financial provisions for implementation of the national programme and align cost estimates and funding provisions as appropriate. This applies to the existing interim storage facility and the future radioactive waste storage and disposal facilities regarding their decommissioning and post-closure.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- SSR-5 Requirement 1; Government responsibilities
- GSR Part 6 Requirement 9; Financing of decommissioning
- GSR Part 5 Requirement 1; Legal and regulatory framework

Italy Recommendation: The Government should ensure the improvement of cost estimate associated with all activities in the National Programme with consideration that:

- activities scheduled in the near term have a cost estimate of high enough confidence to support execution.
- the cost estimate for the National Programme includes all foreseeable costs, including those that may result from foreseeable risks and delays.
- a robust cost estimate for the geological repository implementation is developed as the programme for the implementation is better defined.
Italy Suggestion: The Government should consider funding mechanism to ensure adequate funds are available when needed to execute all activities of the National Programme.

Czech Republic Suggestion: The approaches taken to address uncertainty and risk differ between the cost assessments relating to the Nuclear Account and for the Decommissioning Reserves. There is no national requirement to perform a systematic assessment of the full range of uncertainties and risks that may impact on the costs. The Government should consider requiring further development of the methods for cost assessment used by the Radioactive Waste Repository Authority and NPP licensees, to apply a comprehensive, systematic approach to analysing and addressing uncertainty and risk.

Czech Republic Suggestion: The Government should consider the development of less conservative investment frameworks for assets in the Nuclear Account and Decommissioning Reserve accounts, by expanding the range of permissible investment classes, recognizing the need to ensure the continued security of the assets in the funds.

Czech Republic Suggestion: The Government should consider undertaking an in-depth review of the potential impacts on the financing arrangements of an expanded scope and extended duration of nuclear power programme.

Netherlands Suggestion: COVRA has developed a cost-estimate for the potential DGR, however, the existing cost estimate does not include all relevant phases of the disposal project, for example the siting, and post-closure phase. The Government should consider ensuring that all the disposal costs, including siting and post-closure phase, are incorporated in the disposal cost estimate.
- SSR-5 Requirement 1; Government responsibilities, para. 3.7.b.

**Belgium Suggestion:** The Financial parameters used within nuclear management framework for the calculation of nuclear provisions applied by individual actors were not always coherent. The Government should consider enhancing the harmonization and justification of financial parameters to be used by all relevant nuclear actors in the determination of nuclear provisions (time frames, discount rates, inflation rates).

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel, para. 2.33.

**ANALYSIS OF FINDINGS**

The findings concerning cost estimates and financing address three main trends.

1. **Incomplete or Insufficient Financial Information:**
Observation in several countries highlight the incomplete or insufficient nature of financial information and cost estimates in their national programmes. The need for a comprehensive assessment of total lifetime costs and long-term budgetary considerations is emphasized. It was suggested to countries that more detailed and mature cost estimates are necessary. There is recognition of the higher certainty in cost estimates for near-term activities and the inclusion of all foreseeable costs, including those associated with risks, delays, and unexpected events.

2. **Addressing Uncertainty and Risk:**
During the review, it was suggested to several countries that approaches to addressing uncertainty and risk in cost assessments differ between different parts of their programmes. To complement this issue, it is recommended to develop methods for cost assessment that apply a comprehensive and systematic approach to analysing and addressing uncertainty and risk. Also, some suggestions were made, to ensure that disposal cost estimates particularly for geological disposal, incorporate all relevant phases of the disposal project including siting and post-closure phases.

3. **Impact of Programme Expansion and Harmonization on Financing:**
The potential impacts on financing arrangements in the context of an expanded scope and extended duration of a nuclear power programme was illustrated in the observations. This reflects the consideration of how programme expansion may affect financial requirements for waste management and decommissioning and must be taken into consideration. It was also suggested to enhance the harmonization and justification of financial parameters used by all relevant parties in the determination of potential costs. This includes considerations such as time frames, discount rates, and inflation rates.

Overall, the trend indicates a recognition of the critical importance of robust financial planning, detailed cost estimates, and risk management to ensure the successful and sustainable implementation of nuclear decommissioning, waste management, and disposal programmes. The recommendations and suggestions emphasize the need for completeness, transparency, accuracy, and adaptability in financial frameworks to address uncertainties and changing circumstances.
III.8. Topic 7: Capacity building for radioactive waste and spent fuel management – expertise, training and skills

A total of eleven recommendations, eight suggestions and one good practice were raised during eight of the nine ARTEMIS Peer Reviews in the scope of the analysis. Figure 11 shows the IAEA principle, requirements and guidance used as the basis for these findings.

![Figure 11: References for Findings used by experts under the Capacity building ARTEMIS topic.](image-url)

**REVIEW OF FINDINGS**

**Slovakia Recommendation:** JAVYS has been allocated responsibility for the implementation of geological disposal but does not currently have the necessary skilled staff to deliver this mandate. JAVYS should develop and maintain the competence and resources necessary for the implementation of the geological disposal programme.

- GSR Part 2 Requirement 9; Provision of resources

**Slovakia Recommendation:** The regulatory bodies currently do not have all the necessary skills and competencies for regulation of the planned geological disposal programme. The regulatory bodies should develop and implement a plan to establish and maintain the competence and resources necessary for the regulation of the geological disposal programme.

- GSR Part 1 (Rev. 1) Requirement 16; Organizational structure of the regulatory body and allocation of resources

**Slovakia Suggestion:** Resource planning in the National Programme is limited to the period up to 2029 and does not consider the full-time scale of the National Programme. The Government should consider compiling information about the competence and availability of resources necessary for all aspects of the implementation of the National Programme through to the closure of all facilities and to provide a better planning basis for resource needs.

- GSR Part 1 (Rev. 1) Requirement 11; Competence for safety
Sweden Suggestion: The regulatory body has identified the need to increase coordination at the national level to strengthen and sustain the Swedish competence base in nuclear and radiation safety. This is particularly true in the areas of radioactive waste and spent fuel management, which require a wide range of expertise and research. The Government should consider actions to improve national coordination of strategies to strengthen and maintain the competence needed for all parties with responsibilities related to radioactive waste and spent fuel management.

- GSR Part 1 (Rev. 1) Requirement 11; Competence for safety

Portugal Recommendation/Suggestion: Portugal has established the new National Programme where the implementation of some measures have been appointed to the Regulatory body. Considering the current and future activities that the regulatory body will have to deliver according to the National Programme, and the need to compensate for the departure of qualified staff, there may be a requirement for additional staff to ensure statutory obligations. The Regulatory body should develop a resource plan to ensure there are sufficient resources to discharge all its statutory obligations, including suitable provision to compensate for attrition. The Government should consider whether the Regulatory body has sufficient resources to discharge all its statutory obligations, based on planning and assessment of current and future needs.

- GSR Part 1 (Rev. 1) Requirement 3; Establishment of a regulatory body
- GSR Part 1 (Rev. 1) Requirement 18; Staffing and competence of the regulatory body

Croatia Recommendation: The Government should urgently address the human resource needs of the regulatory body in the short term for the environmental impact assessment review and licensing review for the RWMC storage facilities at the Čerkezovac site. The government should also plan to provide sufficient human resources for future phases of the radioactive waste management programme. Planning should be provided for developing and maintaining staff competence through formal training.

- SF-1 Principle 2; Role of government
- GSR Part 1 (Rev. 1) Requirement 3; Establishment of a regulatory body
- GSR Part 1 (Rev. 1) Requirement 18; Staffing and competence of the regulatory body

Croatia Recommendation: The scope of the programme for management of radioactive waste and spent fuel is increasing, with several critical milestones and objectives to be addressed within the next few years. Currently, the Fund has seven technical staff responsible for the safe implementation of the programme and has identified the need to increase its human resources to fulfil its responsibility. The Fund should continuously evaluate the human resource needs in meeting its responsibilities for safe management of radioactive waste and spent fuel, both for the short and long term. The Fund should develop a plan for staff recruitment and retention, and maintenance of competence through training and/or research, development, and demonstration. That plan should be mapped to the needs, objectives, and milestones of the radioactive waste management programme.

- SF-1 Principle 1; Responsibility for safety
- GSR Part 2 Requirement 9; Provision of resources
**Greece Recommendation:** The Government should make provision for the human resource needs for OPADRY, the Organization for the Interim Storage and Management of Radioactive Materials, and ODRA, the new Radioactive Waste Management and Disposal Organization for the selection of a new disposal site, to ensure the implementation of the national programme.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management, para. 3.5.
- SSR-5 Requirement 1; Government responsibilities

**Greece Recommendation:** National Centre of Scientific Research "Demokritos" currently has a limited workforce dedicated to implementation of the national programme. Due to retirements a reduction within 3 to 5 years may have an adverse impact on retention on knowledge and information necessary to perform its responsibilities. The Centre should take measures to ensure retention of knowledge and information and provide human resources with sufficient expertise, training, and skills to implement actions in the national programme.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- GSR Part 2 Requirement 9; Provision of resources
- GSR Part 6 Requirement 7; Integrated management system for decommissioning

**Greece Suggestion:** The Government should consider increasing resources to strengthen the research and development programmes for the implementation of the national programme.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 1 (Rev. 1) Requirement 11; Competence for safety

**Italy Good Practice:** Despite not having an operational nuclear power programme, Italy is having a high degree of success in attracting students to a creative integrated development programme that is supported through collaboration of all the major actors in Italy. Overall, this range of coordinated and collaborative training and development opportunities across all technical areas required to support decommissioning and waste management, as well as new nuclear technologies, indicates a significant investment in the future and is to be commended.

- GSR Part 1 (Rev. 1) Requirement 11; Competence for safety

**Italy Recommendation:** The issue of human resources capacity and competency development is not explicitly addressed in the National Programme. Furthermore, the regulator has not showed a resource profile matched to the scope of the National Programme. The regulatory body should fully identify the regulatory resources needed according to the scope of National Programme and plan for acquiring those resources.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management
- GSR Part 5 Requirement 1; Legal and regulatory framework
**Italy Recommendation:** The Government should ensure that the regulatory body has the necessary resources to execute its duties according to the National Programme.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management
- GSR Part 5 Requirement 1; Legal and regulatory framework

**Italy Suggestion:** The Government should consider including within the National Programme an analysis of the resources and competencies required across all entities/actors.

- GSR Part 1 (Rev. 1) Requirement 1; Government responsibilities
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management
- GSR Part 5 Requirement 1; Legal and regulatory framework

**Czech Republic Recommendation:** There are significant challenges for maintaining, developing, and expanding the workforce needed for the management of radioactive waste and spent fuel and decommissioning. In the absence of an integrated overview, difficulties may arise in predicting future human resource requirements necessary for such programmes. There are also external factors to be considered such as competition between employers and a low level of interest amongst younger people for careers in relevant scientific and engineering fields. The Government should conduct an in-depth analysis of the human resource needs for all entities involved in radioactive waste and spent fuel management and for decommissioning, for the Radioactive Waste Repository Authority and the State Office for Nuclear Safety, and in both the short and long-term. This should consider ongoing and planned activities as well as anticipated developments and make recommendations for ensuring the maintenance and strengthening of the human resource capacity.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 1 (Rev. 1) Requirement 11; Competence for safety
- GSR Part 2 Requirement 9; Provision of resources

**Czech Republic Suggestion:** The Government should consider improving the coordination of information exchange, cooperation and planning of activities in relation to research, development, and training, including international activities, to ensure they are commensurate with the ongoing and future needs for decommissioning, and the management of radioactive waste and spent fuel.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel

**Netherlands No findings:** An interdepartmental working group has assessed the current state of the nuclear knowledge infrastructure in general and proposed a new strategic plan for capacity building. The government, the regulator, and COVRA need to strategically plan for the necessary resources for the current waste management activities as well as the potential nuclear ambitions as well as to participate in international courses on radioactive waste management and decommissioning.

**Belgium Suggestion:** The regulatory body and the waste management organisation individually perform competency surveys for their agencies. However, it may be useful for Belgium to have a strategy for maintaining radioactive waste management competencies on a national level to identify cross-cutting needs in resources or skills and potential means to address them. Therefore, The
Government should consider developing and maintaining a national skills strategy for radioactive waste management.

- GSR Part 3 Requirement 4; Responsibilities for protection and safety

Belgium Recommendation: The waste management organisation currently do not have sufficient staff to address the numerous waste management and disposal issues. The Government should ensure adequate financial and human resources will be available for ONDRAF/NIRAS to fulfil its mission.

- GSR Part 1 (Rev. 1) Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel
- GSR Part 1 (Rev. 1) Requirement 11; Competence for safety

Belgium Suggestion: The waste management organisation appears to be constrained by lack of staff resource and should consider exploring means to increase in-house staff resource in the safety case area, including actively recruiting and developing younger team members.

- GSR Part 2 Requirement 9; Provision of resources
- GSR Part 4 Requirement 5; Preparation for the safety assessment
- SSG-23; The Safety Case and Safety Assessment for the Disposal of Radioactive Waste

ANALYSIS OF FINDINGS

The findings concerning capacity building address four main trends.

1. Competence Development for Implementation:

In general most countries were found to have shortcomings in the availability of expertise and in measures being taken to build capacity. Several countries are recommended or are suggested to urge entities involved in radioactive waste management to develop and maintain the necessary competence and resources for programme implementation. It was suggested that some countries need to increase national coordination to strengthen and sustain competence in nuclear and radiation safety, particularly in the areas of radioactive waste and spent fuel management. For others it was suggested to develop and maintain a national skills strategy for radioactive waste management to address cross-cutting needs.

2. Addressing Staff Attrition and Knowledge Retention:

Several recommendations highlight concerns about staff attrition and the potential adverse impact on knowledge retention. Countries concerned are recommended to put measures in place to ensure retention of knowledge and information, along with the recruitment and training of staff to implement actions in the national programmes.

3. Integrated Approach and International Cooperation:

It was suggested to a few countries to have an integrated and coordinated approach involving all concerned parties in the fields of research, development, and training. Additionally, some countries were recommended to improve the coordination of international activities in these areas to meet ongoing and future needs.
4. Ensuring Adequate Financial and Human Resources:

Several countries are recommended or suggested to ensure adequate financial and human resources for regulatory bodies, waste management organizations, and entities responsible for programme implementation. Recommendations call for in-depth analyses of human resource needs, both in the short and long term, considering ongoing and planned activities, anticipated developments, and external factors.

Overall, the trend indicates a general concern over capacity and a shared recognition of the critical role of human resources and competencies in ensuring the success, safety, and sustainability of radioactive waste management and disposal programmes. The recommendations and suggestions highlight the need for strategic planning, coordination, and international collaboration to address the challenges in this domain.
IV. Occurrences of IAEA Safety Standards and supporting international documents in the ARTEMIS missions’ findings

According to the ARTEMIS guidelines, “the bases for ARTEMIS review service are the IAEA Safety Standards and supporting international documents. In some cases, the review can be supported by other IAEA documents, such as e.g. IAEA Nuclear Energy Series or other international documents in complement to the safety standards”. ARTEMIS guidelines specify that “near the Safety Standards Series and Nuclear Energy Series, the following documents can be included into the review basis:

- For the reviews under obligations of art. 14(3) of the EC 2011/70/EURATOM Directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, the given Directive is included in the basis for the reviews together with the safety standards”.

However, this type of document was never used as the basis for findings.

Figure 12 shows the number of occurrences of each IAEA Safety Standards and supporting international IAEA document that are referred to as a basis in an ARTEMIS mission finding in the scope of the analysis.

![Figure 12: References to IAEA Documents as basis for findings (Recommendations, Suggestions, Good Practices)](image)

The most referenced documents used as the basis for ARTEMIS recommendations and suggestions are the following safety requirements:
Specific references from IAEA Safety Guides can be used as the basis for ARTEMIS findings, but they are used at a secondary level in comparison with the Safety Requirements. Nine safety guides have been used as references for recommendations and suggestions, with a total of 20 occurrences. For good practices, three safety guides have been used as references, with a total of 3 occurrences.

Of the IAEA Nuclear Energy Series and other IAEA international documents, only one NE Series document, Policies and strategies for radioactive waste management NW-G-1.1, was used as a basis in four recommendations and five suggestions. From other IAEA documents, one document entitled Addressing Uncertainties in Cost Estimates for Decommissioning Nuclear Facilities, NEA No. 7344 prepared jointly by the NEA and IAEA was used as reference only once in a suggestion. They were not used for good practices.

The following figures provide a quantitative analysis of the basis used for findings in the ARTEMIS missions to indicate the role and importance of the IAEA Safety Requirements and other documents in the ARTEMIS review process in general and in the specific ARTEMIS topics.

V.1. References to the 10 Fundamental Safety Principles (SF-1)

Among the fundamental safety objective and ten associated safety principles stated in the IAEA Safety Fundamentals (SF-1), safety principles were referred to 8 times as the basis for recommendations and
suggestions. They were referred to twice for good practices. The most referred safety principles are presented below in descending frequency of occurrence:

- SF-1 Principle 7; Protection of present and future generations (six occurrences)
- SF-1 Principle 2; Role of government (three occurrences)
- SF-1 Principle 1; Responsibility for safety (one occurrence)

V.2. References to GSR Part 1: Governmental, Legal and Regulatory Infrastructure for Safety

GSR Part 1 Requirements were referred to 68 times as the basis for recommendations and suggestions. They were referred to two times for good practices.

The requirement of GSR Part 1 with most references is Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel, with twenty-eight occurrences, followed by Requirement 1; National policy and strategy for safety, with ten occurrences.
V.3. References to GSR Part 2: Leadership and Management for Safety

GSR Part 2 requirements were referred to eight times as the basis for recommendations and suggestions. They were not used for good practices.

The requirement of GSR Part 2 with most references is Requirement 9 (Provision of resources) with five occurrences.

V.4. References to GSR Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

GSR Part 3 requirements were referred to six times as basis for recommendations and suggestions. They were not used for good practices.

The requirement of GSR Part 3 with most references is Requirement 47 (Responsibilities of the government specific to existing exposure situations) with three occurrences.
V.5. References to GSR Part 4: Safety Assessment for Facilities and Activities

GSR Part 4 requirements were referred to one time as the basis for recommendations and suggestions. They were not used for any good practices.

The requirements of GSR Part 4 with most references are Requirement 5 (Preparation for the safety assessment) with one occurrence.


GSR Part 5 requirements were referred to 68 times as the basis for recommendations and suggestions. They were referred to four times for good practices.
The requirement of GSR Part 5 with most references is Requirement 2 (National policy and strategy on radioactive waste management) with 21 occurrences, followed by Requirement 1 (Legal and regulatory framework) with 10 occurrences.

V.7. References to GSR Part 6: Decommissioning of Facilities

GSR Part 6 Requirements were referred to 15 times as the basis for recommendations and suggestions. They were referred to nine times for good practices.

The requirement of GSR Part 6 with most references are Requirement 4 (Responsibilities of the government for decommissioning), 8 (Selecting a decommissioning strategy), 9 (Financing of decommissioning) and 10 (Planning for decommissioning) with three occurrences each.

V.8. References to GSR Part 7: Preparedness and Response for a Nuclear or Radiological Emergency
GSR Part 7 requirements were not referred as basis for recommendation, suggestion or good practice.

V.9. References to SSR-5: Disposal of Radioactive Waste

SSR-5 Requirements were referred to 56 times as the basis for recommendations and suggestions. They were not used for good practices. The requirement of SSR-5 with most references is Requirement 1 (Government responsibilities) with 22 occurrences, followed by Requirement 2 (Responsibilities of the regulatory body) with ten occurrences.

V.10. References to IAEA Safety Guides

Eleven Safety Guides were referred to 20 times as the basis for recommendations and suggestions. They were referred to 3 times for good practices.

The most referenced Safety Guides used as a basis for recommendations and suggestions are:
- GSG-16; Leadership, Management and Culture for Safety in Radioactive Waste Management (four occurrences)
- SSG-47; Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities (four occurrences)
- GSG-3; The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste (three occurrences)
- SSG-60; Management of Residues Containing Naturally Occurring Radioactive Material from Uranium Production and Other Activities (three occurrences)

V.11. References to IAEA Nuclear Energy Series

IAEA Nuclear Energy Series document NW-G-1.1 entitled Policies and Strategies for Radioactive Waste Management was referred to nine times as a basis for recommendations and suggestions. They were not used for good practices.

V.12. References to other IAEA documents

One other IAEA document has been used as reference for one occurrence in a suggestion. The document was not used for recommendations or good practices.
The document used as reference is:

- Addressing Uncertainties in Cost Estimations for Decommissioning Nuclear Facilities, IAEA and OECD Nuclear Energy Agency [NEA No. 7344] (one occurrence)

ANALYSIS

Taking account of all findings (recommendations, suggestions and good practices), the references used most frequently were, in descending order of occurrence, GSR Part 1 Requirement 10, GSR Part 5 Requirement 2 followed by GSR Part 5 Requirement 2.

- GSR Part 1 Requirement 10; Provision for the decommissioning of facilities and the management of radioactive waste and of spent fuel (28 occurrences)
- SSR-5 Requirement 1; Government responsibilities (22 occurrences)
- GSR Part 5 Requirement 2; National policy and strategy on radioactive waste management (21 occurrences)
- GSR Part 1 Requirement 1; National policy and strategy for safety (10 occurrences)
- GSR Part 5 Requirement 1; Legal and regulatory framework (10 occurrences)
- SSR-5 Requirement 2; Responsibilities of the regulatory body (10 occurrences)
- NW-G-1.1; Policies and Strategies for Radioactive Waste Management (9 occurrences)

For good practices, no safety principles and IAEA safety requirements can be clearly identified as the most referenced. The following references were used:

- SF-1 Principle 7; Protection of present and future generations (two occurrences)
- GSR Part 1 Requirement 1; National policy and strategy for safety (one occurrence)
- GSR Part 1 Requirement 11; Competence for safety (one occurrence)
- GSR Part 5 Requirement 6; Interdependences (one occurrence)
- GSR Part 5 Requirement 8; Radioactive waste generation and control (one occurrence)
- GSR Part 6 Requirement 6; Responsibilities of the licensee for decommissioning (one occurrence)
- GSR Part 6 Requirement 9; Financing of decommissioning (one occurrence)
- GSR Part 6 Requirement 14; Radioactive waste management in decommissioning (one occurrence)
- GSG-15; Remediation Strategy and Process for Areas Affected by Past Activities or Events
- WS-G-6.1; Storage of Radioactive Waste (one occurrence)
- SSG-47; Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities (one occurrence)
VI. Conclusions

This report is the third analysis of the IAEA integrated peer review service missions for radioactive waste and spent fuel management, decommissioning and remediation programmes (ARTEMIS). It covers ARTEMIS missions conducted during 2023. During this period, the Agency conducted nine ARTEMIS missions addressing entire national systems for radioactive waste and spent fuel management, for all the recognized waste stream and activities. All nine ARTEMIS missions were initial missions. Each ARTEMIS mission covered seven ARTEMIS topics.

Considering the nine ARTEMIS initial missions conducted in 2023, recommendations and suggestions were raised in each of the seven ARTEMIS topics and two countries received recommendations and/or suggestions in each topic.

While in the first analysis covering ARTEMIS missions conducted from 2017 to 2020, the topic Safety case and safety assessment was the only ARTEMIS topic where no suggestions were identified, in the second and this analysis, all missions raised findings on all topics. The policy and framework topic is the topic which again raised the most findings with 30 recommendations and suggestions. It is followed shortly by the topic national strategy for radioactive waste management which raised a fairly similar number of findings (26). This continues to reinforce the point that ARTEMIS topics as currently defined in the Guidelines and the Self-assessment questionnaire are relevant for ARTEMIS reviews covering the whole national radioactive waste and spent fuel management programme of Member States.

Among ARTEMIS topics covered by the third analysis, frequent findings related to the following themes:

- shortcomings in national plans, particularly delayed decisions on disposal
- incompleteness of national programmes and again the need to provide a cradle-to-grave (i.e. waste generation to disposal) solutions and further develop comprehensive programmes for the management of DSRS, waste containing natural radionuclides and spent fuel
- shortcomings in legislation and regulatory guidance particularly related to site selection, clearance, waste acceptance criteria and development and use of the safety case
- need for mechanisms for monitoring the implementation of national strategies and ensuring completeness of interdependencies between the different steps of the management of radioactive waste
- the adequacy and completeness of financial provisions
- concerns over human resource capacity for both regularity bodies and operator organisations

These themes overlap with those highlighted in the first two analyses. The safe management of DSRS (incompleteness of the national programme, lack of detailed arrangements for the management of DSRS or need to move ahead with the development of disposal facilities) and waste containing natural radionuclides continues to be identified as concerns.

The safety principles and IAEA safety requirements referred to most frequently in recommendations and suggestions were:
Provision for decommissioning and waste and spent fuel management

The significance of GSR Part 1 Requirement 10, on Provision for decommissioning of facilities and the management of radioactive waste and spent fuel, in recommendations and suggestions from ARTEMIS missions reflects the challenges faced by Member States to take reasonable steps in their national policies and programmes to avoid any undue burden on future generations for the management of spent fuel and radioactive waste. These Member States, irrespective of the size of their waste management programme, have also to cope with the expected increase in volumes of radioactive waste arising from the operation and decommissioning of nuclear facilities and activities using radioisotopes in science, industry and medicine. In view of this, Member States do not give the decommissioning and waste management enough priority at the highest political levels in terms of Provision of human and financial resources. A number of the ARTEMIS review findings encourage governments and relevant authorities to demonstrate their active commitment to the safe management of radioactive waste through legislative means as well as provision of resources.

The commitment of resources at a national level is becoming crucial. The human/financial resources necessary for the development, implementation and maintenance of national waste management strategies and programmes have to be made available in a timely fashion to ensure such programmes are safe and effective.

GSR Part 5 Requirement 2 on National policy and strategy on radioactive waste management is the second most frequently referred to requirement in ARTEMIS recommendations and suggestions: “To ensure the effective management and control of radioactive waste, the government shall ensure that a national policy and a strategy for radioactive waste management are established. The policy and strategy shall be appropriate for the nature and the amount of the radioactive waste in the State, shall indicate the regulatory control required, and shall consider relevant societal factors”.

GSR Part 5 Requirement 1 on Legal and regulatory framework the third most frequently referred to requirement in ARTEMIS recommendations and suggestions. It states that “The government shall provide for an appropriate national legal and regulatory framework within which radioactive waste management activities can be planned and safely carried out. This shall include the clear and unequivocal allocation of responsibilities, the securing of financial and other resources, and the provision of independent regulatory functions. Protection shall also be provided beyond national borders as appropriate and necessary for neighbouring States that may be affected.”
Continuity of Responsibility and Comprehensive National Policies:

It is essential for Member States to ensure continuity of responsibility for safe management of radioactive waste and spent fuel and undertake competent decommissioning of facilities at the end of their lifetime, whatever their programme and whatever the management of their waste by one or more operators or whether they have chosen to have their radioactive waste processed in another State. Progress can be made on the comprehensiveness of their policies to ensure they systematically address all types of radioactive waste, including DSRS, and spent fuel and all stages of their management. Thus, the second and third most frequently referred to requirement in ARTEMIS recommendations and suggestions are dealing with the need for comprehensive and well-integrated national policies, national strategies and legal and regulatory frameworks, adapted to the size and characteristics of their national inventory of radioactive waste, based on a graded approach in accordance with national circumstances.

All Member States including those with no nuclear power generation should establish national policies and strategies for the management of their disused sources as stated in the Supplementary Guidance to the Code of Conduct on the Management of Disused Radioactive Sources, including end-of-life management options: recycling and reuse, long-term storage and disposal as well as return to the supplier.

Overall, the findings from the ARTEMIS reviews suggest that the governments, regulatory bodies and operating organizations of the countries examined are taking steps to ensure the safe and responsible management of radioactive waste. However, there is always room for improvement, and the suggestions and recommendations provided can help in enhancing the regulatory framework, and the decommissioning and waste management programmes. It is important to note that the management of radioactive waste is a complex and challenging issue, and continuous efforts are required over periods of decades to ensure that waste and spent fuel are managed safely and responsibly.