

INTEGRATED REVIEW SERVICE FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT, DECOMMISSIONING AND REMEDIATION (ARTEMIS)

MISSION TO ESTONIA

TALLINN, ESTONIA

24 March to 1 April 2019

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY
DEPARTMENT OF NUCLEAR ENERGY





**REPORT OF THE
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TO
ESTONIA**

Mission dates: *24 March to 1 April 2019*
Location: *Tallinn, Estonia*
Organized by: *IAEA*

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IAEA-2019

The number of recommendations, suggestions and good practices is in no way a measure of the status of the national infrastructure for nuclear and radiation safety. Comparisons of such numbers between ARTEMIS reports from different countries should not be attempted.

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EXECUTIVE SUMMARY

On 29 September 2017, the Resident Representative of Estonia to the International Atomic Energy Agency invited the IAEA to conduct an Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) Mission in the volume that is correspondent to the national context, together with the Integrated Regulatory Review Service (IRRS) Follow-up Mission during the 1st quarter of 2019 in Tallinn, Estonia, in order to fulfil the obligation for peer review on all EU Member States in Article 14.3 of the European Council Directive 2011/70/EURATOM of 19 July 2011, establishing a Community Framework for the Responsible and Safe Management of Spent Fuel and Radioactive Waste. Later it was agreed to divide the ARTEMIS and the follow-up IRRS Missions. The ARTEMIS Mission took place from March 25 to April 1, 2019 in Tallinn in the premises of the Ministry of Environment.

The purpose of the ARTEMIS review mission was to provide an independent international evaluation of the National Programme for Radioactive Waste Management in Estonia (hereinafter referred to as the National Programme), requested in line with the obligations of the Waste Directive. The ARTEMIS review assessed, as requested by the Waste Directive, the overall programme for the management of all types of radioactive waste in Estonia against the relevant IAEA Safety Standards and proven international practice and experiences.

The team comprised four senior international experts in the field of radioactive waste management and decommissioning from the United Kingdom of Great Britain and Northern Ireland, the Swiss Confederation, the Portuguese Republic and Hungary as well as three IAEA staff members.

The method of work included review of all documentation submitted by National Counterpart for the considered scope of the review, including clarifications presented in presentations and discussions during the mission, with a focus on the National Programme, as well as the results of self-assessment, based on the provided questionnaire. Observations and interviews during the technical visit to Paldiski site demonstrated adequacy of the information presented an advance reference material and during the mission to the real situation in waste management.

Advance reference material included: Radiation Act, the National Programme for Radioactive Waste Management, Draft National Radiation Safety Development Plan 2018-2027, -5th Estonian National Report as referred to in Article 32 of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Report of the Integrated Regulatory Review Service (IRRS) Mission to Estonia (full list of the documentation is presented in the Section III).

During the mission representatives held discussions with the Ministry of Environment, Environmental Board, Environment Inspectorate, and the state-owned Radioactive Waste Management Organisation A.L.A.R.A. the following additional documentation was presented to address the experts' questions:

- Preliminary Studies for the Decommissioning of the Reactor Compartments of the Former Paldiski Military Nuclear Site and for the Establishment of a Radioactive Waste Repository. Task 4 Interim Report. Determining the Possibilities of the Disposal of Radioactive Waste;
- Preliminary Studies for the Decommissioning of the Reactor Compartments of the Former Paldiski Military Nuclear Site and for the Establishment of a Radioactive Waste Repository. Task 5 Interim Report. Radioactive Waste Management Cost and Planning.

The ARTEMIS team acknowledged the particular challenges associated with the significant legacy waste inventory in Estonia as the country does not have any nuclear reactors. They commended the strong commitment of the Representatives of the Ministry of the Environment and ALARA to ensure safe

management of radioactive waste. They also were particularly encouraged by the very open and constructive manner in which the counterparts engaged throughout.

The ARTEMIS team concluded that many aspects relevant to the safe management of radioactive waste in Estonia are in place. However, they noted some important omissions which should be addressed. They made a number of recommendations and suggestions, of which the most significant were to ensure that:

- all responsible governmental bodies take an active role to ensure effective delivery of their responsibilities in the area of radioactive waste management;
- the National Programme addresses safe management of radioactive waste up to the time of closure of the disposal facilities and any necessary post-closure activities;
- the selection of the proposed disposal concepts is underpinned by appropriate safety cases supported by safety assessments, including consideration of long-term safety after the facilities have been closed;
- preliminary WAC for all planned disposal concepts are established as soon as possible;
- the necessary human technical and financial resources to deliver all aspects of the National Programme are provided.

The ARTEMIS team considers that by adequately implementing the outcomes of the present review Estonia will be in a good position to meet high standards of safety for radioactive waste management in the country.

In this regard, the ARTEMIS team suggests that a follow-up mission in around 3 years from now could bring value to Estonia's efforts to improve its waste management.

I. INTRODUCTION

At the invitation of Estonian authorities, the International Atomic Energy Agency organized an ARTEMIS review of the Estonian arrangements for Spent Fuel and Radioactive Waste Management. The objective of the ARTEMIS Peer Review Service is to provide independent expert opinion and advice on radioactive waste, decommissioning and remediation, based upon the IAEA safety standards and technical guidance, as well as international good practice. Estonia requested this review to fulfil its obligations for peer review under Article 14.3 of the Council Directive 2011/70/Euratom of 19 July 2011 establishing a *Community Framework for the Responsible and Safe Management of Spent Fuel and Radioactive Waste* (“Waste Directive”).

The review was performed by a team of four senior international experts in the field of radioactive waste management and decommissioning, from multiple IAEA Member States, with IAEA staff providing coordination and administrative support. Subsequent to a preparatory meeting in September 2018, and the receipt and review of Advanced Reference Material in the beginning of 2019, in March 2019 the ARTEMIS peer review team evaluated the overall Estonian programme for the management of all types of radioactive waste, including aspects of decommissioning.

Estonia has no commercial power reactors or research reactors. There is a former nuclear submarine training centre at the Paldiski site with two defueled reactors. These facilities are in long-term safe storage and decommissioning is scheduled from 2040. There are no spent fuels, because they were returned back to Russia in 1995. The former RADON-type disposal facility in Tammiku, has been already cleaned up and is undergoing final site clearance in anticipation of release in 2022. All the waste from Tammiku has already been retrieved and transported to the Paldiski site, where it is held in a licensed low/intermediate level waste store, awaiting final disposal.

Estonia’s current waste generation is small and arises from institutional practice only (all together is less than 1 m³ annually). Thus, the choice of economic management methods is relatively limited.

II. OBJECTIVE AND SCOPE

The ARTEMIS review provided an independent international evaluation of the Radioactive Waste and Spent Fuel Management Programme of Estonia, requested in line with the obligations of the *Waste Directive*.

The ARTEMIS review, organized by the Department of Nuclear Safety and Security and the Department of Nuclear Energy of the IAEA, was performed against the relevant IAEA Safety Standards and proven international practice and experiences with the combined expertise of the international peer review team selected by the IAEA. It assessed, as requested by the *Waste Directive*, the overall programme for the management of all types of radioactive waste in Estonia.

The ARTEMIS review service is designed to avoid overlapping with the IRRS review service. In this regard, outcomes of the IRRS mission and its recent follow-up have been considered and, as appropriate, taken into account, as part of implementation of ARTEMIS review service. Therefore, the ARTEMIS peer review has focused on implementation of the National Programme and aspects of legal and regulatory framework in relation to its implementation.

III. BASIS FOR THE REVIEW

A) PREPARATORY WORK AND IAEA REVIEW TEAM

At the request of the Government of Estonia, a preparatory meeting for the ARTEMIS Review mission, was conducted from 6 to 7 September 2018 jointly with a preparatory meeting for the follow-up IRRS mission. The preparatory meeting was carried out by the appointed Team Leader Ms Cherry Tweed (in a mode of teleconference), the IAEA Team representative Mr Andrey Guskov and senior management and staff of the Ministry of the Environment, Radiation Safety Department (RSD) of the Environment Board (EB) and relevant stakeholders from the National Counterparts, including Mr Ilmar Puskar and Ms Reelika Runnel in person.

The ARTEMIS mission preparatory team had discussions regarding:

- dates of the ARTEMIS mission;
- scope and modules to be included in the ARTEMIS missions;
- the Terms of Reference for the ARTEMIS review of the Estonian programme to fulfil obligations from article 14(3) of the Waste Directive;
- Advanced Reference Material (ARM) to be uploaded by the EB to the dedicated web platform of the mission; and
- logistics and relevant detailed arrangements for organization and conduct of the ARTEMIS review mission.

A preliminary meeting of the ARTEMIS team was held at IAEA headquarters in Vienna in January 2019. The purpose of the meeting was to familiarize the team members with the ARTEMIS guidelines, review of the ARM and to assign particular review tasks to specific team members.

Estonia provided IAEA with the Advance Reference Material (ARM) for the review in January 2019, consisting of:

- The completed ARTEMIS self-assessment;
- National Programme for Radioactive Waste Management document provided to the EC in 2015 and an updated draft National Programme provided to the EC in October 2018;
- the 6th Country report to the Joint Convention;
- National report on the implementation of the Council Directive 2011/70/Euratom to EC 2018;
- Extracts from the draft National Radiation Safety Development Plan (NRSDP) and the Radiation Act.

During the mission additional documentation was presented to address the experts' questions:

- Preliminary Studies for the Decommissioning of the Reactor Compartments of the Former Paldiski Military Nuclear Site and for the Establishment of a Radioactive Waste Repository. Task 4 Interim Report. Determining the Possibilities of the Disposal of Radioactive Waste;
- Preliminary Studies for the Decommissioning of the Reactor Compartments of the Former Paldiski Military Nuclear Site and for the Establishment of a Radioactive Waste Repository. Task 5 Interim Report. Radioactive Waste Management Cost and Planning.

B) REFERENCES FOR THE REVIEW

The articles of the *Waste Directive*, the draft guidelines for the ARTEMIS review service and the responses to the self-assessment questionnaire were used as the basis for the review together with the ARM listed above and materials presented during the mission and associated discussions. The complete list of IAEA publications used as the basis for this review is provided in Appendix D.

C) CONDUCT OF THE REVIEW

The initial review team meeting took place on Sunday, 24 March 2019 in Tallinn, directed by the ARTEMIS Team Leader Ms Cherry Tweed and the ARTEMIS Team Coordinator Mr Andrey Guskov. The Deputy Team Coordinator, Mr Jiri Faltejsek supported his respective leads.

The ARTEMIS entrance meeting was held on Monday, 25 March 2019, with the participation of senior management and staff of the Ministry of the Environment, Environmental Board and A.L.A.R.A. (Estonian state-owned radioactive waste management agency). Opening remarks were made by Mr Harry Liiv, Deputy Secretary General of the Ministry of the Environment and Ms Cherry Tweed, ARTEMIS Team Leader. Ms Reelika Runnel gave an overview of the Estonian context.

During the ARTEMIS mission, a review was conducted for all review topics within the agreed scope with the objective of providing Estonian authorities with recommendations and suggestions for improvement and, where appropriate, identifying good practices.

The review team performed its review according to the mission programme given in Appendix B.

The ARTEMIS exit meeting was held on Monday, 1 April 2019. Opening remarks were presented by Mr Meelis Münt, Secretary General of the Ministry of the Environment, and were followed by the presentation of the results of the mission by the ARTEMIS Team Leader Ms Cherry Tweed. Closing remarks were made by Mr Peter Johnston, Director of the Division of Radiation, Transport and Waste Safety, IAEA Department of Nuclear Safety and Security.

An IAEA press release was issued.

1. NATIONAL POLICY AND FRAMEWORK FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT

1.1. NATIONAL POLICY

Estonian position

The Estonian national policy for the management of radioactive waste is set out in:

- Radiation Act;
- National Radiation Safety Development Plan (hereinafter NRS DP);
- Estonian National Programme for Radioactive Waste Management (hereinafter National Programme).

The principles of the Policy are that radioactive waste generated in Estonia has to be managed and disposed locally in Estonia, and radioactive waste should not be transported from other countries to Estonia for disposal.

The main goal of the national policy is to reduce the risks associated with radioactive waste and its management. One of most important policy aims for achieving this goal is reducing the amount of waste generated, ensuring that the amount of waste to be managed and stored is as small as possible. The generated waste must be carefully managed and stored.

According to national policy, the producer of radioactive waste is responsible for the management of such waste. In case of historical waste, i.e. inherited waste from the former Soviet Union, or if it is not possible to identify its ownership, the state is responsible for the management of such waste. Although the management of such waste should be ensured by the state, if possible, funds from the EU Structural Funds are sought in addition to the state budget funds.

Sealed radiation sources are neither manufactured nor recycled in Estonia. The policy states that contracts for the supply of these sources must include arrangements for their return, reuse or recycling. If it is not possible to return them to the manufacturer, they will be stored in Paldiski site, where they are managed by A.L.A.R.A. Ltd, which is under the administration of the Ministry of Economic Affairs and Communications.

For the management of NORM residues, the basic aim is to avoid the formation of NORM-waste by finding ways for clearance of NORM residues through recycling and reuse. Estonia has no plans to build a storage or disposal facility for NORM waste.

A decision was taken by the Government in April 2016 to build a disposal facility for radioactive waste into Estonia.

Decommissioning of the reactor compartments of the Paldiski nuclear site of the former military area is scheduled to commence in 2040. Since it is not possible to store waste of this volume and activity in the existing storage facility in Paldiski, a disposal facility should be established for this purpose by 2040, at the latest.

ARTEMIS observation

The National Policy is documented in the National Programme, which in turn is one of the annexes (sectoral sub-plans) of the NRS DP (its other annex is the National Radon Action Plan). The NRS DP is

updated every 10 years, Therefore, the National Programme is regularly reviewed (at least once in ten years).

This NRSDP is approved by the Minister of the Environment by an order, but other ministries, authorities, and the public also have rights to shape it. This also means that the National Policy and the National Programme is approved only at ministerial level, not governmental, or parliamentary, which may concur with not so strong a commitment from the state towards waste management issues.

The recent update of the National Programme, to reflect the results of the preliminary studies on the decommissioning of the reactor compartments and on the disposal facility completed in 2015, was particularly reasonable. The updated National Programme (including the Policy) remains one of the Annexes of the 2018-2027 NRSDP. For the NRSDP and its both two annexes (National Programme and National Radon Action Plan) a Strategic Environmental Impact Assessment is being carried out. These documents are therefore in draft.

The review team noted that storage of waste at a waste producer's site is limited in law to a maximum of 5 years and considered that this is a good safety approach.

1.2. LEGAL, REGULATORY AND ORGANISATIONAL FRAMEWORK (PARTLY REFERRING TO IRRS)

Estonian position

The Radiation Act, together with its sub-acts (regulations) provides basic safety requirements for the protection of people and the environment against the adverse impact of ionizing radiation, the rights and obligations of persons in using radiation, the requirements for radiation practices, the organisation of state supervision over compliance and the liability for failure to comply with the requirements provided in the Radiation Act. Radioactive waste management in particular is regulated in the framework of the Radiation Act.

The First Radiation Act was adopted in 1997. A new law was passed in 2016 and the most recent amendments entered into force in June 2018. Some further amendments are planned to improve the consistency and applicability of the legislation.

The Radiation Act is supported by a NRSDP which is a ten-year programme for development and enhancement of radiation and nuclear safety in Estonia. The first NRSDP was adopted in 2008 and covered the period until the end of 2017. It was approved by the Government. The current plan covers the period 2018-2027. The new NRSDP is a draft which still requires approval by the Minister of Environment. It is currently in the phase of Strategic Environmental Impact Assessment procedure and formal approval is expected in Summer 2019. There are Action Plans for NRSDP implementation for the next 4 year period.

The objectives of the NRSDP are to minimise radioactive waste; improve emergency preparedness; optimise the use of radiation in medicine; reduce risks from natural radiation sources and to raise awareness amongst the Estonian public of radiation-related issues.

The responsibilities for radiation safety are allocated amongst a number of governmental departments as illustrated in Figure 1.

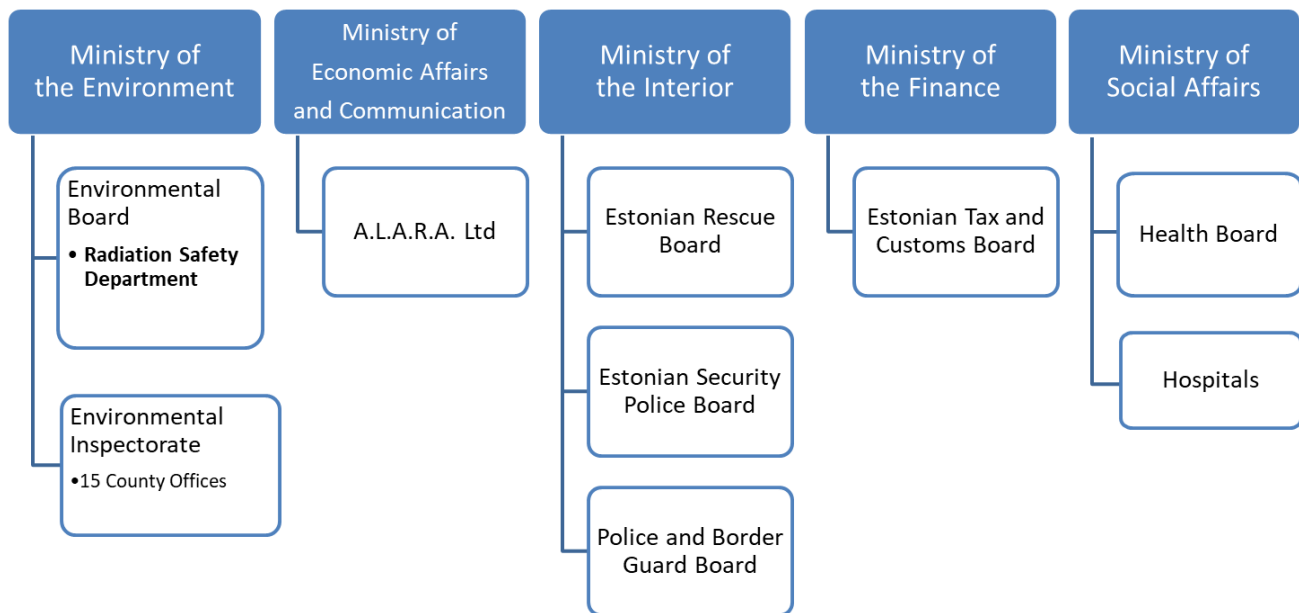


Figure 1: Radiation safety infrastructure

The activities related to safety under the responsibility of the Ministry of the Environment are delivered through the Environmental Inspectorate and the Environmental Board. The Ministry of the Environment develops radiation safety policies and legislative drafting. The Environmental Board reviews the applications of radiation practice licences and qualified radiation expert licences, provides services ensuring radiation safety and advises the Environmental Inspectorate, which carries out monitoring and coordinates and controls the use of the environment and natural resources by executing the state's coercive measures in the cases determined by law.

Radioactive waste is generated in the course of radiation activities, which are regulated by a radiation practice licence. The Radiation Act requires the holder of a radiation practice licence to deliver the waste to a storage facility within five years of its generation. This requirement does not apply to NORM, since the procedure for NORM residue and waste management is assessed and decided by the Environmental Board on a case-by-case basis.

The self-assessment recorded that, in summer 2018, the decision was adopted in the Ministry of the Environment, to merge Environmental Board and Environmental Inspectorate with effect from January 2019. One of main drivers for the merger was to enhance capability in environmental safety, including radiation safety. However, this merger has not yet taken place. In the meeting, the counterparts reported that the necessary parliamentary vote was not passed and that any possibility of a merger is now delayed until Autumn 2019 at the earliest.

Radioactive waste management activities are administrated by the Ministry of Economic Affairs and Communications. However, the siting process for the disposal facilities is being initiated by the Ministry of the Environment. There is a plan to establish a project team with representatives from a number of different ministries. The proposal for the site selection will be prepared by this ministerial advisory committee. The Government will make the final decision.

There are no specific requirements for the siting of disposal facilities. They will be assessed under the standard arrangements for infrastructures. These measures include a requirement for Environmental Impact Assessment, which will include consideration of matters related to long-term safety.

The Radioactive waste management organisation A.L.A.R.A Ltd. was established in 1995. It is a state-owned company under the responsibility of the Ministry of Economic Affairs and Communication. A.L.A.R.A. Ltd. administrates the Paldiski and Tammiku sites and manages decommissioning activities and operates the interim storage facility at the Paldiski site.

ARTEMIS observation

The legal framework for the safe management of radioactive waste in Estonia is generally established. Most elements are in place. The Estonian counterparts described clear plans that are in place to improve clarity and operability of the regulations and the review team is, therefore, confident that these matters are in hand.

The implementer A.L.A.R.A. Ltd. is under the responsibility of the Ministry of Economic Affairs and Communication. The regulatory body is under the Ministry of the Environment. This provides the necessary separation between implementer and regulator which is fundamental to effective control of safety. To recognize the national liability and ensure the timely funding for the planned activities, the Ministry of Finance needs to have a central role.

Representatives from the Ministry of the Environment and its implementing bodies, the Environmental Board and the Environmental Inspectorate, and representatives from A.L.A.R.A. Ltd., participated in the

review. Based on the information received from the counterparts, the other responsible organizations have not been actively involved in the planning for radioactive waste management.

The current legislation does not clearly specify all aspects of radioactive waste management from generation to disposal. There is no defined process for site selection for disposal facilities. The development of relevant procedures and guidelines would facilitate the process of ensuring radiation safety and safe management of radioactive waste.

The overall role of the Ministry of the Environment in siting is unclear. The national waste management organization would usually deal with the licence application associated with the implementation of site selection and siting as the licensee but does not have sufficient expertise and number of staff. It is not clear who will be the real implementer in this process.

The ARTEMIS team is concerned that siting appears to be being initiated by the Ministry of the Environment. It considers that this may compromise the independence of licensing later in the process.

Although an Environmental Impact Assessment will be carried out for this phase of siting, this is not considered sufficient to support assessment of long-term nuclear safety. The review team noted that neither responsibilities nor the requirements for authorizing the site selection, design, siting, construction, operation, closure and institutional control of a final disposal site have been developed and set down.

According to the information provided there has not been a comprehensive review concerning the legal framework, consolidating the missing parts and those that should be amended.

The current regulatory framework is not sufficient for licensing disposal. A comprehensive modification and further development are needed.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: <i>Whilst the responsibilities are clearly laid down in the Radiation Act, the team did not see any evidence of active coordination and leadership between the responsible Ministries. Responsibilities within the scope of the ARTEMIS mission are allocated to the Ministry of the Environment, the Ministry of Economic Affairs and Communications and the Ministry of the Finance. Delivery appeared to be exclusively by the Ministry of the Environment. The team did not observe any active involvement from the other ministries. In addition, approval of the NRSDP has been recently devolved to the Minister of the Environment whilst previously it required Government approval. Even so, the current NRSDP (2018 – 2027) remains in draft form.</i>	
(1)	BASIS: GSR Part 1 (Rev. 1) Requirement 7 states that “.... Where several authorities have responsibilities for safety within the regulatory framework for safety, the government shall make provision for the effective coordination of their regulatory functions, to avoid any omissions or undue duplication and to avoid conflicting requirements being placed on authorized parties....”
R1	Recommendation: The Government should ensure that all responsible governmental bodies take an active role to ensure effective delivery of their responsibilities in the area of radioactive waste management.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *There is no clear system for licensing of disposal facilities (siting, construction, operation, closure and post-closure).*

(1)

BASIS: SSR 5 Requirement 1 states that “The government is required to establish and maintain an appropriate governmental, legal and regulatory framework for safety within which responsibilities shall be clearly allocated for disposal facilities for radioactive waste to be sited, designed, constructed, operated and closed. This shall include: confirmation at a national level of the need for disposal facilities of different types; specification of the steps in development and licensing of facilities of different types; and clear allocation of responsibilities, securing of financial and other resources, and provision of independent regulatory functions relating to a planned disposal facility”

R2

Recommendation: The Government should improve their licensing procedures to address specific aspects of radioactive waste disposal.

1.3. TRANSPARENCY

Estonian position

The Estonian Government seeks to deliver all its activities in an open and transparent manner. It has set out general requirements for good practice in public engagement on matters of government policy. Further obligations with respect to transparency on matters concerning safety and to informing the public are required by the Ministry of the Environment. There are also arrangements to protect sensitive information.

Key documents relevant to radiation safety are reviewed by the public relations department and are accompanied by media releases. For example, the basic safety standards legislation release was accompanied by a dedicated press release. The documents are made available on the departmental website. Licence applications listed in the Radiation Act's § 71, which includes all applications concerning the management of radioactive waste are made publicly available. The issuers of these licences disclose the information to the extent which does not contain any information treated as information with limited access as well as business secrets, provided this is reasonable and the information is understandable. The Ministry of the Environment also makes public any exchange of information with interested parties e.g. response to queries from members of the public.

The Ministry of the Environment has prepared some public information and guidance leaflet on topics such as what a member of the public should do if they come across a radiation source.

The Ministry of the Environment also holds an annual seminar on a topics of interest concerning radiation matters. The public get an opportunity to listen to a presentation and to ask questions. Generally, the public interest is not huge, and attendance is typically 30 – 40 people.

The Ministry of the Environment was approached by officials from a municipality who had an interest in hosting a disposal facility and preliminary discussions have taken place. No wider communication on siting is currently planned. A communication strategy for siting has not yet been developed.

ARTEMIS observation

In general, the arrangements for openness and transparency for matters in radioactive waste management are considered good. However, communication on the siting process has not taken place yet. The team understands that the Ministry of the Environment is planning to consult with the leaders of the municipalities of the three possible locations identified in the preliminary studies in 2015.

The national policy should clearly indicate the obligation of providing the public with information about proposed plans for radioactive waste management, consulting the concerned parties and members of the public to aid in making related informed consented decisions in due time.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *Although general examples of public involvement were presented, there has been no public involvement in the siting of disposal facilities.*

(1)	<p>BASIS: SSR 5 Requirement 1, para 3.7 (d) states that “Matters that have to be considered include:</p> <p>(a)...</p> <p>(d) Defining the overall process for the development, operation and closure of disposal facilities, including the legal and regulatory requirements (e.g. licence conditions) at each step, and the processes for decision making and the involvement of interested parties;</p> <p>...”</p>
S1	<p>Suggestion: The Government should consider establishing a Communication strategy concerning disposal (siting, construction, operation, closure and post-closure) and set out how and when the public will be engaged.</p>

2. NATIONAL STRATEGY FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT

2.1. SCOPE

Estonian position

The National Programme (2018 version) describes the Estonian National Strategy for radioactive waste management up to 2050. There is no spent fuel in Estonia.

The radioactive waste to be managed in Estonia consists of three distinctly different parts:

- a. Existing institutional and decommissioning waste in an interim storage facility and control area at the Paldiski site;
- b. Institutional waste from ongoing practices and findings (orphan sources) ($< 1 \text{ m}^3/\text{a}$);
- c. Decommissioning waste from the two submarine reactors currently under safe storage conditions at the Paldiski site. These reactors are currently sealed in concrete and housed in buildings at the Paldiski site. This waste will only be produced during the dismantling operations which are planned to take place between 2040 and 2050.

According to the Estonian policy it is the declared aim to reduce as much as possible future arisings of radioactive waste and to minimize the need for disposal by:

- Applying justification considerations before licensing practices which might produce radioactive waste;
- Applying decontamination and decay storage to already-produced radioactive waste with subsequent release from institutional control;
- Licensing the use of sealed sources only with specific license conditions on return to producer after use (preferred option) and financial guarantee to cover anticipated costs of future waste management at A.L.A.R.A. Ltd.

Two disposal facilities are envisaged:

1. A near-surface facility for short-lived L/ILW, based on a concept similar to that already in use at Centre de L'Aube or El Cabril;
2. A silo-type facility at a depth of 30-50 metres for long-lived L/ILW based on a concept similar to the SFR facility in Sweden. The geological environment envisaged for this silo facility is a non-clay sedimentary rock, which may therefore support some advective groundwater movement.

The planning assumption is that both facilities will be at the same location.

The anticipated date for first waste emplacement in both facilities is 2040. This date coincides with the end of the planned design life for the sarcophaguses which are currently protecting the reactor compartments. Final emplacement of the last waste packages from the reactor decommissioning project and from waste currently in storage is scheduled for 2050.

Until such time as the disposal facility is available, the projected future small arisings of institutional waste can readily be accommodated in existing interim storage facilities at the Paldiski site.

The National Programme includes a detailed table (Table 6) of all planned strategic waste management activities indicating the expected result, responsibilities, timeframe, expected costs and foreseen source of financing.

Currently NORM-waste has not contributed in any significant way to the waste volume to be disposed of in the future disposal facility. There is a certain potential for changes to this situation and there are three activities defined in section 3 of Table 6 of the National Programme related to “*Prevention of NORM residues and waste generation and safe management*”.

As a result of the preliminary studies, three potential locations for the disposal facility were proposed and the specific need for the detailed environmental, radiological, and other studies required for the establishment of the disposal facility and for the decommissioning of the reactor compartments was determined.

ARTEMIS observation

The National Programme elaborates activities until 2050. This is the planned date of completion of the decommissioning of the defueled reactor compartments at the Paldiski site. However, it is clear that waste management activities must continue beyond this date. The disposal facilities will need to be closed and arrangements put in place on any required ongoing monitoring and control.

Concerning the site selection and licensing process for the disposal facility and associated safety and other criteria the Estonian counterparts explained that the siting decision will be a Government decision based on the positive outcome of an environmental impact analysis which would include all short and long-term aspects of radiation safety. Currently the legal procedures for licensing radiation practices have no specific regulations for design and construction of larger installations nor specific requirements for disposal facilities (such as requirements for long-term safety assessments). This finding is substantiated by the last two sentences of the National Programme: “*The establishment of a disposal facility should be preceded by a comprehensive modification of legislation, since the current legal framework is not sufficient for the establishment of a disposal facility. In addition to the Radiation Act and the regulations issued based on this, the legislation concerning the construction design and establishment should also be amended in order to lay down the requirements for the establishment of a disposal facility.*”

Concerning the problem of NORM-residues becoming radioactive waste the Government seems to have addressed previously identified shortcomings. Industrial activities with the potential of producing NORM residues/waste need a license on the basis of environmental legislation. Analysis of the radiological consequences of the proposed activity will be integrated in the licensing process. Foreseen licensing conditions according to the National Programme are:

- 1) avoid any production of residues above general clearance levels;
- 2) allow for specifically authorised conventional disposal route, provided application of de minimis concept can be ensured by a specific radiation protection analysis;
- 3) financial guarantee for the future waste management expenses similar to the licensing of sealed sources.

2.2. MILESTONES AND TIMEFRAMES

Estonian position

The Estonian answers to the related questions of the ARM refer again to Table 6 of the National Programme. The end of design lifetime of the safe enclosure provision for the two reactor compartments at the Paldiski site is 2040. Hence it is a necessity to start the dismantling operations by 2040 and by this time the repository should be operable and ready to accept the conditioned waste from the decommissioning activities

ARTEMIS observation

The quality, comprehensiveness and degree of detail of Table 6 seem to be adequate for a general planning tool. However, there are a number of shortcomings in the current plan.

First, the timeline appears to have been established in a process of calculating backwards from the end of design lifetime of the safe enclosure provision for the two reactor compartments at the Paldiski site. Compared to the first version of the National Programme (2015 version) it can be seen that some activities e.g. establishing the methods and techniques for characterisation of “free form waste” packages are delayed. In the case where major activities would be delayed in the future, a situation could arise when the integrity of the safe enclosure would be compromised due to ageing and the repository would not yet be ready to accept waste packages. This is an inherent problem of such backwards calculation which does not provide any buffer for unexpected delays.

More importantly this pure listing and timing of the isolated waste management activities in Table 6 does not show and reflect the many interdependencies between many of the activities. Just one of several examples: The most important contributors to the source term of the repository are certain parts of the reactor decommissioning waste. The detailed characterization of these wastes can only be done after opening the reactor compartments which is only foreseen around 2040. Without this information the preparation of the disposal safety case, which is a necessary document for the construction license, is not possible. Such application should be submitted –according to Table 6, activity 1.7- by the year 2027.

Concerning the duration of planned activities, the team noted that there seems to be an underestimation of the additional managerial efforts needed for preparation, contracting and control of outsourced activities.

Also, the time allowed for some activities appears unrealistic given the available resources. For example, the site characterization is scheduled to be completed by 2025. However, a detailed plan has not yet been developed and essential contractor support has yet to be secured.

2.3. PROGRESS INDICATORS

Estonian position

A selected list of the individual and detailed activities of Table 6 have been selected as “performance indicators” in Chapter 8.8 of the National Programme. During the presentation the Estonian counterparts explained that, based on the list of waste management activities, a short-term action plan is elaborated

with a horizon of 4 years which forms the basis for regular bi-annual implementation progress reporting to the Minister of Environment. The ARTEMIS team was informed that, as the National Programme is a draft it has no formal status and progress reporting is informal.

ARTEMIS observation

Progress indicators are useful but by themselves only help in detecting the foreseen progress of a project or its delay. Even more important is, that such knowledge should initiate automatically corrective actions which should be considered in any organisational management system (“management of deviations”). The team did not see any evidence that this was taking place. As the National Programme has no formal status, there is no process for assessing the consequences of any delays on the realisation of the programme and/or initiating any corrective actions.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: The National Programme provides a detailed list of the technical activities to be completed up to 2050. However, there are several significant omissions:

- *There is no consideration of the closure of the disposal facility nor any ongoing activities in the post-closure phase;*
- *The interdependencies and sequencing between the individual tasks are not identified;*
- *The plan does not account for the full list of administrative and managerial tasks such as procurement of contractors.*

The time scales for some of the tasks seem unrealistic, given the available resource, for example the completion of site investigations by 2025.

(1)	BASIS: SSR 5, Requirement 11 states that <i>“Disposal facilities for radioactive waste shall be developed, operated and closed in a series of steps. Each of these steps shall be supported, as necessary, by iterative evaluations of the site, of the options for design, construction, operation and management, and of the performance and safety of the disposal system. ...”</i>
(2)	BASIS: GSR Part 5, Requirement 6 states that <i>“Interdependences among all steps in the predisposal management of radioactive waste, as well as the impact of the anticipated disposal option, shall be appropriately taken into account.”</i>
R3	Recommendation: The Government should update and enhance the National Programme to include the comprehensive list of activities and their interdependencies up to the time of final closure of the facility and any necessary post-closure activities.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *The team noted that a number of planned activities had been delayed. As the National Programme has no formal status, progress reporting is informal and there is no process for assessing the consequences of such delays on the realisation of the programme and/or initiating any corrective actions.*

(1)	BASIS: GSR Part 5, Requirement 6 states that “ <i>Management systems shall be applied for all steps and elements of the predisposal management of radioactive waste.</i> ”
(2)	BASIS: SSR 5 Requirement 11, para 4.2 states that “ <i>A step by step approach to the development of a disposal facility for radioactive waste refers to the steps that are imposed by the regulatory body and by political decision making processes (see para. 1.18). This approach is taken to provide an opportunity to ensure the quality of the technical programme and the associated decision making. For the operator, it provides a framework in which sufficient confidence in the technical feasibility and safety of the disposal facility can be built at each step in its development.</i> ”
R4	Recommendation: The Government should formalise the national approach and put in place a comprehensive management system, involving all responsible ministries for the implementation of the National Programme which shall amongst others include processes for decision making and corrective actions in case of deviations.

3. INVENTORY OF SPENT FUEL AND RADIOACTIVE WASTE

Estonian position

In Estonia there is no spent fuel.

The total amount of existing radioactive waste in Estonia is about 1130 m³ (as of August 2018).

The waste to be managed as part of the National Programme is classified into three main types:

1. Low and intermediate activity short-lived waste (more than 90 %);
2. Low and intermediate activity long-lived waste (few %);
3. NORM waste (scrap metal) (few %).

There is no defined class of very low level waste. Exemption and clearance levels are defined in the Radiation Act.

Although there are documented inventory data as well, several further assumptions are made regarding the isotopes and activity levels contained in the stored waste, because only a part of the waste has been already characterized.

Regarding the existing unspecified waste in Paldiski site there is an ongoing programme using gamma spectrometric measurements to characterize gamma active nuclides of this waste in order to create a more precise inventory of the waste. This work is scheduled to be completed during the next 2-3 years. Other properties of the waste the inventory are obtained where possible by consulting historical documentation, if they are available.

The inventory does not contain most of the NORM waste and the waste coming from the decommissioning of the reactor compartments at the former nuclear site of Paldiski. The amount of the decommissioning waste is estimated to be about 1000 m³ by 2040, when the beginning of the decommissioning activities is scheduled.

The estimation of the future waste arisings is made taking into account the information in the Environmental Decisions Information system which includes the registers of radioactive sources currently in use and planned decommissioning activities. It is considered that waste streams from the radiation practices will be consistent also in the future (less than 1 m³ annually) and significant changes are not foreseen.

Concerning sealed radioactive sources, a holder of a radiation practice licence has the obligation to keep records of every radiation source and radioactive waste for which the holder is responsible and submit the report of the inventory to the Environmental Board in an annual basis.

A national record of sealed sources is held by the Environmental Board and any changes must be notified to them. In cases where the sealed radioactive source is delivered to the Paldiski site, the verification of the properties of the source is done also by the register maintained by the Environmental Board.

ARTEMIS observation

The ARTEMIS team considered that the measures in place for managing waste arisings from currently-licensed activities are adequate.

The ARTEMIS team noted that the inventory currently being stored at Paldiski contains a number of uncertainties because most of the waste has not yet been characterised. The other main uncertainties are the assumptions necessary for future arising waste from the decommissioning activities.

The draft National Programme contains a number of discrepancies which the counterparts were not able to resolve during the meeting. Therefore, for the ARTEMIS team it still remains unclear that during the reporting of both the existing and the future decommissioning waste, what prerequisites were applied; whether the estimated volume of the waste was based on the conditioned, unconditioned, packaged or the calculated “as disposed” form. In the reference materials several inconsistent amounts were mentioned concerning, for example, the total volume of the existing waste.

The team commended the ongoing programme of gamma spectroscopic measurements. However, available information about the heavily measurable isotopes (α, β emitters), the chemical, organic content and the other physical properties of the waste is very limited. The team noted that work is to be initiated to try to optimize the strategy for waste characterization to ensure that enough relevant safety information is available.

For the design of the currently planned final disposal solution, particularly in the case of long-lived ILW-LL (silo type facility), one of the most important inputs should be the inventory with sufficient detail. For this reason, the ARTEMIS team emphasized the importance of the determination of the relevant attributes and requirements including the information in the inventory following the waste characterization process.

The team considered that the statement by the counterpart: “Conditioned waste volume was transferred directly to final disposal volume as waste package should be suitable for final disposal (container has acceptance for Sweden SFR disposal facility)” did not provide sufficient confidence with respect to their disposability in Estonia. There have to be some preliminary considerations regarding these waste packages in line with the WAC of the future disposal site concerning the container itself and the waste in it.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *There are still some uncertainties in inventory that might have influence on establishing the safety case for disposal. The ongoing characterization is restricted to gamma measurements only. Characterization of other important properties is only planned.*

There is no consistent approach to the recording of the future waste arisings in the National Programme.

(1)

BASIS: GSR Part 5 Requirement 9 states that “At various steps in the predisposal management of radioactive waste, the radioactive waste shall be characterized and classified in accordance with requirements established or approved by the regulatory body.

4.10. Radioactive waste has to be characterized in terms of its physical, mechanical, chemical, radiological and biological properties. ...

4.11. The characterization serves to provide information relevant to process control and assurance that the waste or waste package will meet the acceptance criteria for processing, storage, transport and disposal of the waste. The relevant characteristics of the waste have to be recorded to facilitate its further management.”

S2

Suggestion: The Implementer should consider the following activities in order that the technical solution may be planned with the fullest knowledge possible of the inventory:

- bringing forward its planned activities on waste characterization;
- establishing a consistent approach to the estimation of the future waste arisings;
- identifying and compiling any available information on the non-radiological properties of the waste;
- ensuring that the inventory for disposal fully reflects any remaining uncertainties in waste volumes and properties.

4. CONCEPTS, PLANS AND TECHNICAL SOLUTIONS FOR SPENT FUEL AND RADIOACTIVE WASTE MANAGEMENT

Estonian position

Based on the national strategy the National Programme describes foreseen technical solutions for each of the 3 waste sources (legacy waste in storage, currently produced institutional waste and future decommissioning waste from the Paldiski reactors): specific management steps for storage, processing and disposal.

Storage

For already existing waste in storage a characterisation programme has been started which is based on γ -spectroscopy. About 40 % of the uncharacterised waste has been measured. For most of the waste continued storage is foreseen until availability of the disposal facility.

For waste from current practices acceptance criteria for the storage facility have been established in the Regulation of the Minister of the Environment, No. 34 of 4 October 2016 “The Classification of Radioactive Waste, the Requirements for Registration, Management and Transfer of Radioactive Waste and the Acceptance Criteria for Radioactive Waste”

The expected waste from the decommissioning of the two reactor compartments is currently under safe storage conditions in the same building as the interim storage at the Paldiski site. It will remain there until the decommissioning activities start.

All radioactive waste is and will be stored at the Paldiski site. A potential additional 600 tonnes of waste from NORM activities is currently stored at Sillamäe with the producing company. Whether this material has to be disposed of as radioactive waste will depend on pending licensing activities for that facility. The currently preferred options are further use or conditional release.

Conditioning

For all waste streams feasible processing technologies are identified in Table 7 of the National Programme. In many cases even alternative techniques are given.

Disposal

Based on a feasibility study of 2014-2015 the proposed disposal solution consists of a near-surface repository with a capacity of 2160 m³ of LL-short-lived waste and a silo-type underground repository for 960 m³ at a tentative depth of 30-50 m at the same site. The facility is scheduled to be licensed in 2027 with an operational start-up in 2040. Operations are foreseen at least until 2050 when the decommissioning of the two reactor compartments is planned to be complete. There are no plans for ongoing operation nor for closure. Major tasks and milestones are listed in table 6 of the National Programme.

According to current legislation, the Ministry of Economic Affairs and Communication is responsible for the organizing waste management. A.L.A.R.A. Ltd. has been appointed as the implementing organization. The team was informed that this arrangement is for a 7-year-period. Currently A.L.A.R.A. Ltd. with a total staff of 10 is operating the existing storage facility including the reactor compartments, accepting the ongoing waste production and carrying out the characterisation campaign. Any significant work is planned to be sub-contracted. The associated budget is provided on a yearly basis.

ARTEMIS observation

The technical solutions provided for conditioning the different waste streams seem to be adequately selected and appropriate to the given problems to be solved.

The established storage solution in the same building where also the two reactor compartments are located seems to be adequate and effective. It is -however- questionable whether the characterisation campaign should only rely on γ -measurements while even in the National Programme it is indicated that there is a need to develop a system for identification of β - and α -emitters (activity 2.1). According to the National Programme such system shall only be installed in the period 2022-2030. It is not clear why all characterisation activities are not being coordinated in such a way that waste handling steps are minimized.

The disposal feasibility study consists of an international survey and a proposal for the best disposal solution including a vote to site the facility at Paldiski (in preference to 5 other discussed sites in Estonia). It states however, that the data basis on the sites as well as on the waste characteristics is too weak to support either the final site selection or a specific facility design, especially for the silo type part of the facility. The study report in chapter 6.7 explicitly formulates 4 recommendations:

- 1. Improvement of waste characterization system. Good knowledge of waste inventory is a key component in preparation of a disposal facility Safety Case. In order to simplify the waste characterization process and to increase accuracy of radioactivity measurements it is recommended to characterize raw waste (before cementation). Most of long-lived radionuclides in the activated structures of reactors are beta emitters. Therefore, methods for measurement of beta and alpha radionuclides in raw waste have to be introduced;*
- 2. Upgrading of the waste conditioning facility. Due to expected increase of work load, waste cementation techniques have to be improved and renewed;*
- 3. Development of a strategy and siting criteria for siting of the disposal facility. Siting criteria would be an important tool during the EIA;*
- 4. Optimization of the waste management system and improvement of waste management effectiveness. World wide experience in waste disposal and interdependencies between different waste management phases are to be considered.*

In the course of this ARTEMIS mission, more than 3 years after this study has been issued, the mission team has found 3 of the 4 recommendations to be still not adequately addressed:

- study recommendation 1 on waste characterisation;
- study recommendation 3 on development of siting criteria;
- study recommendation 4 on interdependencies and holistic approach to waste management.

While activities which would address all these recommendations are all part of the National Programme little progress has been achieved and some of them are already delayed. Since providing all necessary input information for establishing the disposal facility safety case is crucial for the success of the whole project, any further delay will most likely lead to delays in the operational start of the disposal facility. Going ahead in the project without this information will certainly increase the risk of a project failure i.e. in designing a repository which –in the end- might not be suitable for all waste streams to be disposed of or for which the safety analysis report will be insufficient.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *The selected disposal options and particularly the proposed disposal silo at the depth of 30 - 50 meters have been selected based mainly on consideration of similar facilities overseas and have not been evaluated for the suitability for the specific waste inventory and expected range of geological environments in Estonia.*

(1)

BASIS: SSR 5 Requirement 14, para. 4.24 states that “Justification concerns explaining the basis for the choices that have been made and the arguments for and against the decisions, especially those decisions concerning the main arguments for safety. ... Justification and traceability both require a well-documented record of the decisions made and the assumptions made in the development and operation of a disposal facility, ...”

R5

Recommendation: The Implementer should evaluate the suitability of the proposed disposal concepts to provide safe disposal of the total expected waste inventory in the geological environments at potential site(s).

5. SAFETY CASE AND SAFETY ASSESSMENT OF RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT ACTIVITIES AND FACILITIES

Estonian position

In Estonia a safety assessment is required as part of the documentation to be submitted in a licence application. Detailed requirements for this assessment are set out in the Radiation Act, 2016.

The requirements include an assessment of the impact of the proposed activity to the environment and of the dose to the public and to workers. Requirements for long-term safety include consideration of matters such as radionuclide migration in water, uptake of radionuclides in food, migration in air, consequences of inhalation and deposition.

With respect to current operations at the Paldiski site, the first assessment was started in 1999. It considered a number of options for the defueled reactors, including entombment in position and dismantling for disposal. The conclusion at that time was the facility should be finally dismantled but as Estonia had no facilities and the inventory contains many radionuclides with half-lives of 5 years or less, a delay of 50 years was recommended to allow for in-situ decay.

Between 2005 and 2007, an EC-funded PHARE project re-evaluated safety under a number of potential scenarios and suggested improvements to the facilities at the site to improve confidence in safety over a 50-year timeframe. There was some improvement to the building housing the sarcophaguses and a monitoring system was installed – covering air, soil and water. This upgrade was funded by the EC.

The most recent safety assessment for Paldiski was carried out in 2015 to support the licence renewal. An important conclusion in this report is that confidence in the safety of the current position is assured for more than 20 years.

All the safety cases have been prepared by contractors but there is regular engagement with A.L.A.R.A. Ltd. throughout the process. The safety case has an approval sheet from the contractor which implies a quality management procedure has been followed during its production. A.L.A.R.A. Ltd. ownership of the safety case is presumed when the document is submitted as part of the licence application.

Review of the safety case is carried out by staff in the regulatory authorities. There is no external peer review, but licence application documents are made publicly available (with the exception of any information with limited access or commercial secrets), shared with the local municipality and announced on the Environmental Board's website. The licence application process stipulates a minimum timeframe of 2 weeks for members of the public to comment. However, if questions arise the regulator is required to hold a public hearing.

If everyone is satisfied, licence is issued. The draft licence and the order are also put into public domain.

Internal procedures within the Environmental Board are currently under preparation.

WAC for storage at the Paldiski site have been prepared based on the safety analysis. There are a range of requirements including parameters such as mass of a package, activity content, dose rate at the surface and a number of distances, surface contamination.

There is currently no safety assessment for the planned disposal facilities as these projects are at an early stage of development. A safety assessment will be required to support the licence application, which is currently scheduled for 2027. Some preliminary and generic considerations of safety are included in the feasibility studies carried out in 2015 and these have been used to derive preliminary WAC for the surface

facility. These safety assessments are based on international solutions for similar waste types. There are no WAC for the proposed silo disposal facility.

ARTEMIS observation

A safety case supported by a safety assessment is an important part of safe management of radioactive waste.

The Estonian counterparts have a good understanding of the safety issues relevant to current activities at Paldiski. There is a clear demonstration of regular safety assessments over a period of 20 years. The approach to the assessment of safety includes normal operations and a range of possible scenarios. Detailed consideration of specific scenarios was beyond the scope of the review but the approach of involving a team of experts in identifying potential scenarios was supported. The review team was also encouraged to learn that recommendations from the PHARE safety assessment had been implemented at the site.

The process of review of safety assessments by the Environmental Board and of inviting comments from the public also appears satisfactory. The requirement to update the safety assessment every five years when the licence is renewed is helpful. However, the team noted that the internal procedures concerning such reviews are still under development and suggest that these are completed and formally adopted into the management system as soon as practicable.

The lack of a safety assessment for the planned disposal facilities is a significant weakness. A preliminary safety demonstration is essential to justify the proposed disposal solution. In the absence of such a demonstration, the review team cannot be confident that the proposed solutions will provide for the safe management of Estonia's waste.

A key omission is that there are no detailed specific requirements set down about a safety case for disposal facilities. The counterparts argued that as EIA is specified, matters of long-term safety will also be included. The review team does not have confidence in this position.

The lack of adequate preliminary WAC is also of concern. The supplementary information provides preliminary WAC for a surface facility including limits on specific activities for key radionuclides but there is no supporting safety assessment. There are no preliminary WAC for the proposed silo facility.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *Whilst there is a demonstration of a good understanding of the safety issues relevant to current activities at Paldiski and a clear demonstration of regular safety assessments, for these activities, there is no safety documentation for the planned disposal facilities nor any specific requirements for such documentation to be produced prior to the licence application. As such safety demonstration has not been prepared yet, there is no basis to establish WAC for the silo type disposal facility which, consequently, have not been produced either. Even for the near surface type disposal facility the established WAC only rely on generic considerations based on experience from comparable facilities in other countries.*

(1)	<p>BASIS: SSR 5 Requirement 1, para 3.7 (d) states that “Matters that have to be considered include:</p> <p>(a)...</p> <p>(d) Defining the overall process for the development, operation and closure of disposal facilities, including the legal and regulatory requirements (e.g.licence conditions) at each step, and the processes for decision making and the involvement of interested parties;</p> <p>...”</p>
(2)	<p>BASIS: SSR 5 Requirement 12 states that “A safety case and supporting safety assessment shall be prepared and updated by the operator, as necessary, at each step in the development of a disposal facility, in operation and after closure. ...</p> <p>4.12. A facility specific safety case has to be prepared early in the development of a disposal facility to provide a basis for licensing decisions and to guide activities in research and development, site selection and evaluation and design. ...”</p>
(3)	<p>BASIS: SSR 5 Requirement 3, para 3.14 states that “The operator has to establish technical specifications that are justified by safety assessment, to ensure that the disposal facility is developed in accordance with the safety case. This has to include waste acceptance criteria (see Requirement 20) and other controls and limits to be applied during construction, operation and closure.”</p>
R6	<p>Recommendation: The Government should establish detailed requirements and guidance for safety documentation for disposal facilities which should include the assessment for long-term safety after facility has been closed.</p>
R7	<p>Recommendation: The Implementer should develop a preliminary safety case with supporting safety assessments for all proposed disposal facilities.</p>
R8	<p>Recommendation: On the basis of safety assessment and licence requirements, the Implementer should update the preliminary WAC.</p>

6. COST ESTIMATES AND FINANCING OF RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT

Estonian position

The evaluation of the total waste management costs is described in Table 6 of the Estonian National Programme . There is a list of the activities envisaged, together with an itemised costing, divided into 4 time periods (2018 – 2021, 2022-2030, 2031 to 2040 and 2041 to 2050). These cost estimates have been prepared using a method developed in 2015 with support from a contractor. The major contributors to cost are the decommissioning at Paldiski and the costs of final disposal.

A number of conservatisms are built in to the estimate including staff effort, activity and disposal route. For example, it has been assumed that all waste generated from decommissioning will be ILW and will therefore require silo disposal, the more expensive solution. The staff effort required and therefore labour costs are at a maximum. Grouted waste has been assumed but there may be options for other more sophisticated technologies which would reduce waste volumes. Potential use of these technologies would be dependent on the availability of conditioning equipment for leasing. Purchase is not economic as the waste volumes are so low. It is estimated that the current cost envelope has about 30% contingency.

Although the figures in the National Programme are aggregated over a number of years, supporting spreadsheets were presented at the meeting which show a more detailed consideration and an annualised breakdown for near-term activities. This detailed information is then used to support budget applications.

The budget is recalculated every two years. It was reported in the meeting that the original cost estimate was 90 million euros. As new knowledge is being obtained, the total costs are increasing, and the maximum figure is expected to be exceeded.

Costs related to post-closure were calculated as part of the 2015 study as 800 000€ but are not currently included in the National Programme.

With respect to financing, the vast majority of the costs of waste management are associated with legacy facilities. No fund was established at the time and therefore any monies have to come from the state budget. Applications for budget for waste management activities have to be made to government officials annually. Longer-term commitments are not possible. If the requested funds are not provided, activities must be delayed. Counterparts identified that the delay in planned siting activities over the last three years was due to the lack of funding. A 2018-follow up audit by the National Audit Office of Estonia noted the delays in the programme associated with a lack of timely provision of funding.

Significant monies have been provided from EU structural funds for activities to date and there are ongoing applications for further funds from this source.

For the ongoing management of institutional waste, a fee is levied by A.L.A.R.A. Ltd. to cover the costs of storage and final disposal. This fee is payable in full on waste reception.

ARTEMIS observation

An understanding of the cost of waste management and assurance of the timely availability of adequate funds are essential for the safe management of radioactive waste. The availability of a task-by-task-cost estimate based on a consistent documented methodology is encouraging. The review team has identified a number of potential improvements which would further increase the confidence in the cost of waste management:

- Costs are only estimated for the time period up to 2050.
- Whilst the counterparts informed us that costs associated to post-closure activities have been included in the National Programme, this was not clear to the Artemis review team.
- Current costs are based on a single solution. It does not include possibilities such as time delay which may in turn necessitate refurbishment of sarcophaguses or need to have an alternative solution such as a deeper silo.

With respect to financing, the Estonian position is difficult as it is a country with a small inventory, no nuclear power plants which may generate income and a significant inventory of legacy waste. However, the Government is required to make provision for this management. As delays in the programme associated with a lack of timely provision of funding have already been noted by the National Audit Office, the review team is particularly concerned that no action appears to have been taken.

The use of EU structural funds has been very useful and continued consideration of application to this and other possible funds may be helpful in ensuring timely progress in waste management.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *The current cost assessment is based on an incomplete single scenario.*

(1)	<p>BASIS: SSR 5 Requirement 1, para 3.7 states that “Matters that have to be considered include:</p> <p>(a)...</p> <p>(c) Ensuring the adequacy and security of financial provisions for each disposal facility; ...”</p>
R9	<p>Recommendation: The Government should update their cost assessment to include all stages of waste management including required post-closure activities and to reflect the uncertainties in the programme.</p>

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *The budget is approved for a time period of 3 or 4 years as part of Government spending arrangements. However, there is no evidence of a business plan for the overall implementation of the National Programme this would ensure the availability of sufficient resources in a timely manner for safe management of radioactive waste in the long-term.*

(1)	<p>BASIS: SSR 5 Requirement 1 states that “The government is required to establish and maintain an appropriate governmental, legal and regulatory framework This shall include: ... securing of financial and other resources... relating to a planned disposal facility.”</p>
R10	<p>Recommendation: The Government should ensure that the appropriate mechanisms are in place to ensure the timely availability of adequate funding to deliver the National Programme up to and including any required post-closure activities.</p>

7. CAPACITY BUILDING FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT – EXPERTISE, TRAINING AND SKILLS

Human resources

Estonian position

The Radiation Safety Department of the Environmental Board has a team of 16 people and in the Ministry of the Environment has 2 people responsible for radiation safety policy planning and implementation. A further 15 people work in the Environmental Inspectorate. However, whilst several inspectorate staff have radiation matters amongst their responsibilities, only 1 individual holds qualification in radiation safety.

A.L.A.R.A. Ltd has a staff of 10, seven engineers and three technicians. A.L.A.R.A. Ltd. hopes to apply for an increased budget with an associated recruitment of an additional expert specifically to support the siting activities.

Forecasts for future needs for the National Programme have been identified up to 2023 and a modest increase is envisaged. National pressures on the total numbers of public sector employees are a constraining factor.

ARTEMIS observation

In terms of available resources, the number of people involved does not seem to be sufficient or even adequate to deliver the specific matters related to radioactive waste management. This staff shortage will become even more acute once siting activities for the disposal of radioactive waste are underway. Whilst there have been some efforts to overcome the shortage of human resources by hiring extra people, these are not considered adequate to address this issue.

Estimation of the personnel skills required to meet national plan objectives, mainly future disposal activities is not considered adequate as the forecasts for future needs go only up to 2023 and therefore do not cover the period of the National Programme.

Training

Estonian position

Training of workers is challenging. The requirements for resources in Estonia are so small that dedicated university courses are not sustainable. In-house training places additional demands on very busy people. International courses such as those of the IAEA are attractive when they are sufficiently tailored to Estonian needs.

ARTEMIS observation

The review team is sympathetic to the challenges facing a small programme in this aspect. However, a suitably qualified and experienced personnel are essential to the safe management of radioactive waste. There must be a core team of qualified personnel in the Government, the implementer and the regulator. This requirement remains even in the case where significant amounts of safety related and technical related work is delivered through contractors. Therefore, a plan to deliver the necessary training is essential.

Research and development

Estonian position

National research funding is provided by the Government in the form of institutional and personal research grants. In both cases, the money is allocated from the national budget through the budget of the Ministry of Education and Research in the framework of an open competition.

R&D activities in the field of radiation safety are included in the national development plan of radiation safety. The research needs of the A.L.A.R.A. Ltd. are identified and budgeted for in the individual tasks. The Estonian counterpart commented that cooperation with universities has proved effective for delivery of these activities.

International cooperation is also desired but has been difficult to achieve in practice.

ARTEMIS observation

The Estonian Counterparts appear to have identified a number of the R&D needs. However, these are currently described in individual documents and a style is not consistent. Therefore, it is difficult to assess the complete needs for the programme and put in place appropriate mechanisms to deliver them.

The establishment of a single R&D plan elaborating the needs of all organizations involved in radioactive waste management is advised.

Increasing involvement in international R&D projects and cooperation with TSOs provides excellent opportunity for delivering these needs in a cost-effective way.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *There is no long-term resourcing plan for the National Programme. Consequently, there are no estimates of the number of people required to deliver the programme nor the skills which these people must have.*

(1)	BASIS: SSR 5 Requirement 1, para 3.7 states that “ <i>Matters that have to be considered include:</i> <i>(a)...</i> <i>(e) Ensuring that the necessary scientific and technical expertise remains available both to the operator and for the support of independent regulatory reviews and other national review functions;...</i> ”
(2)	BASIS: GSR Part 1 (Rev. 1) Requirement 11 states that “ <i>The government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities</i> ”
R11	Recommendation: The Government should develop a national resourcing plan for delivery of the National Programme and ensure it is supported by appropriate training activities to provide the necessary knowledge and skills.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

Observation: *R&D needs are documented as part of individual technical activities within the National Programme. This makes it difficult to obtain a complete picture of the R&D needs for the National Programme and therefore to ensure that necessary human and financial resources will be available as required.*

(1)

BASIS: GSR Part 1 (Rev. 1) Requirement 1, para 2.3 states that “*In the national policy and strategy, account shall be taken of the following: ...*
(e) The provision and framework for research and development”

S3

Suggestion: The Government should compile a single comprehensive list of all the R&D needs for the implementation of the National Programme and establish effective mechanisms for provision of the necessary human and financial resources for the delivery.

APPENDIX A: TERMS OF REFERENCE

ARTEMIS Review of Estonia's Radioactive Waste and Spent Fuel Management Programme

Terms of Reference

1. Introduction

On 29 September 2017, the Resident Representative of Estonia to International Atomic Energy Agency Estonia requested the IAEA to conduct the combined Integrated Regulatory Review Service (IRRS) Follow-up Mission and Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) Mission during the 1st quarter of 2019 in Tallinn, Estonia as required of all EU Member States by Article 14.3 of the European Council Directive 2011/70/EURATOM of 19 July 2011, establishing a Community Framework for the Responsible and Safe Management of Spent Fuel and Radioactive Waste. In subsequent discussion during the preparatory meeting it was agreed to run two separate missions with a short time interval between the two.

2. Objective

The ARTEMIS review will provide an independent, international peer review of Estonia's radioactive waste and spent fuel management programme.

The review, organized in the IAEA by the Department of Nuclear Safety and Security and the Department of Nuclear Energy, will be performed on the basis of the relevant IAEA Safety Standards and proven international practice and experiences, by an international peer review team selected by the IAEA.

3. Scope

The ARTEMIS review will evaluate the Estonian National Programme and national framework for executing the country's obligations for safe and sustainable radioactive waste and spent fuel management.

4. Basis for the review

The ARTEMIS review will be based on the relevant IAEA Safety Standards and proven international practice and experiences, following the guidelines of the ARTEMIS review service.

5. Reference material

The review will cover all documentation submitted by National Counterpart for the considered scope of the review, including materials presented during the mission, with a focus on the National Programme, as well as the results of self-assessment, which should be based on the provided questionnaire.

All documents for the purpose of the ARTEMIS review will have to be submitted in English. When the document(s) need(s) to be translated into English they have to be submitted in Estonian language as soon as possible to facilitate review process and then replaced with the English version.

6. Modus operandi

The working language of the mission will be English.

The National Counterpart Liaison Officer for the review is Mr Ilmar Puskar, Head of Radiation Safety Department, Environmental Board.

- Self-assessment: available to Estonia as of March 2018
- Preparatory Meeting: 6-7 September, Tallinn, Estonia (2 days)
- Reception of English documents: at the latest 2 months before mission (including results of self-assessment)
- Peer review mission: 24 March – 1 April 2019 – nine days
 - Sunday, 24 March: arrival of experts and their meeting
 - Monday to Wednesday, 25 – 27 March: interviews/exchange/discussion with Counterpart(s) on the basis of preliminary analysis and drafting of recommendations and suggestions
 - Thursday, 28 March: drafting of the report - finalization of recommendations and suggestions - delivery of recommendations/suggestions/good practices – fact checking by Counterpart(s)
 - Friday, 29 March: discussions of recommendations and suggestions with the Counterpart(s) - drafting of the report and delivery to the Counterpart(s) (review team)
 - Saturday, 30 March: fact checking of draft report by Counterpart(s) - internal reflection of comments by review team - discussions with the Counterpart(s)
 - Sunday, 31 March: finalization of draft report by review team
 - Monday, 1 April: delivery of final draft report – exit meeting – closure

7. International peer review team

The IAEA will convene an international team of independent experts to perform the ARTEMIS review according to the agreed Terms of Reference. The team will comprise of:

- Four qualified and recognized international experts from government authorities, regulatory bodies, waste management organizations, and technical support organizations with experience in the safe management of radioactive waste and spent fuel;
- Two IAEA staff to coordinate the mission. The IAEA Team Coordinator of the ARTEMIS review, Mr Andrey Guskov of the Waste and Environmental Safety Section is from the Department of Nuclear Safety and Security. The IAEA Team deputy coordinator, Mr Jiri Faltejsek of the Waste Technology Section is from the Department of Nuclear Energy.
- One IAEA staff for administrative support.

A senior member of IAEA staff from the Department of Nuclear Safety and Security will oversee the closure of the review.

The peer review team will be led by a Team Leader from the review team. The Team Leader will be assisted by a Deputy Team Leader, also from the review team. The IAEA will inform the National Counterpart regarding the composition of the proposed review team prior to submission of reference material. The review mission may include the presence of up to two observers, including the possibility of an observer from the EC. The National Counterpart will be notified of any proposed observers; the presence of any observers must be agreed in advance of the mission.

8. Reporting

The findings of the peer review will be documented in a final report that will summarise the proceedings of the review and contain any recommendations, suggestions and good practices. The report will reflect the collective views of the review team members and not necessarily those of their respective organization or Member State or the IAEA.

Prior to its finalization, the ARTEMIS Review Report will be delivered to the National Counterpart for fact-checking.

9. Funding

The cost of the peer review is currently estimated to the amount of EUR. Estonia is aware that the review cost includes 7% programme support costs.

Estonia agrees with these Terms of Reference by accepting necessary arrangements, including release of funds from TC, for holding of the ARTEMIS preparatory meeting on 6-7 September 2018, to the responsible TC budget Officer of the IAEA.

Estonia agrees with these Terms of Reference by accepting necessary arrangements.

APPENDIX B: MISSION PROGRAMME

Sunday, 24 March 2019		
<i>Metropol Spa Hotel, Roseni 9, Tallinn</i>		
<i>19:00 – 20:00</i>	Team meeting	<i>ARTEMIS Team</i>
Monday, 25 March 2019		
<i>Meeting room at the Ministry of the Environment, Narva mnt 7a</i>		
<i>09:00 – 10:00</i>	Opening Introduction of ARTEMIS Team and National Counterparts	<i>Mr Harry Liiv Deputy Secretary General of the Ministry of the Environment All participants</i>
	General presentation	<i>Presentation by Ms Reelika Runnel Counsellor, Ministry of the Environment, Ambient Air and Radiation Department</i>
<i>10:00 – 12:00</i>	National Policy and Strategy	<i>Presentation by Ms Reelika Runnel Counsellor, Ministry of the Environment, Ambient Air and Radiation Department Discussions (experts and counterparts)</i>
<i>12:00 – 13:00</i>	<i>LUNCH BREAK</i>	
<i>13:00 – 14:30</i>	National Policy and Strategy (con't)	<i>Discussions (experts and counterparts)</i>
<i>14:45– 16:00</i>	Team meeting	<i>ARTEMIS Team</i>

Tuesday, 26 March 2019

Meeting room at the Ministry of the Environment, Narva mnt 7a

09:00 – 11:00	Inventory Concepts, Plans and Technical Solutions	<i>Presentation by</i> <i>Ms Reelika Runnel</i> <i>Counsellor, Ministry of the</i> <i>Environment, Ambient Air and</i> <i>Radiation Department</i> <i>Discussions (experts and</i> <i>counterparts)</i>
11:00 – 13:00	LUNCH BREAK	
13:00 – 16:00	Site visit	
<i>Meeting room at the Ministry of the Environment, Narva mnt 7a</i>		
16:00– 17:30	Team meeting	<i>ARTEMIS Team</i>

Wednesday, 27 March 2019

Meeting room at the Ministry of the Environment, Narva mnt 7a

09:00 – 12:00	Safety case and safety assessment Cost estimates and financing Capacity building	<i>Presentation by</i> <i>Ms Reelika Runnel</i> <i>Counsellor, Ministry of the</i> <i>Environment, Ambient Air and</i> <i>Radiation Department</i> <i>Discussions (experts and</i> <i>counterparts)</i>
12:00 – 13:00	LUNCH BREAK	
13:00 – 14:00	Team meeting	<i>ARTEMIS Team</i>
from 14:00	Drafting of the report	<i>ARTEMIS Team</i>

Thursday, 28 March 2019

<i>Meeting room at the Metropol Spa Hotel, Roseni 9, Tallinn</i>		
	Drafting of the report and finalization of Recommendations, Suggestions and Good Practices	<i>ARTEMIS Team</i>

Friday, 29 March 2019

<i>Meeting room at the Ministry of the Environment, Narva mnt 7a</i>		
<i>09:00 – 11:00</i>	Presentation and discussions with the Counterparts on draft recommendations, suggestions and good practices	<i>All participants</i>
<i>12:00 – 13:00</i>	LUNCH BREAK	
<i>13:00 – 17:00</i>	Draft report finalization and submission to Estonian Counterparts for fact-checking	<i>ARTEMIS Team</i>
<i>19h00</i>	Social event	<i>All participants</i>

Saturday, 30 March 2019

<i>until 15:00</i>	Fact-checking of the draft report by Estonian Counterparts	Estonian Counterparts
<i>Meeting room at the Metropol Spa Hotel, Roseni 9, Tallinn</i>		
<i>15:00 – 16:00</i>	Internal reflection of comments	<i>ARTEMIS Team</i>
<i>16:00 – 17:00</i>	Discussion with the Counterparts on the draft report	<i>All participants</i>

Sunday, 31 March 2019

<i>Meeting room at the Metropol Spa Hotel, Roseni 9, Tallinn</i>		
	Finalising of the draft report	<i>ARTEMIS Team</i>

Monday, 1 April 2019

<i>Meeting room 32A, Ministry of Ecology, Energy, Sustainable Development and Spatial Planning</i>		
<i>09:00 – 12:00</i>	Presentation of ARTEMIS Outcomes	<i>Ms Cherry Tweed ARTEMIS Team Leader</i>

	<p>Closing remarks on behalf of the National Counterparts</p>	<p><i>Mr Meelis Münt Secretary General of the Ministry of the Environment</i></p>
	<p>Closing remarks on behalf of the IAEA</p>	<p><i>Mr Peter Johnston (Director of Radiation, Transport and Waste Safety Division, IAEA)</i></p>

APPENDIX C: RECOMMENDATIONS AND SUGGESTIONS

Area		R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
1.	NATIONAL POLICY AND FRAMEWORK FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT	R1	The Government should ensure that all responsible governmental bodies take an active role to ensure effective delivery of their responsibilities in the area of radioactive waste management.
		R2	The Government should improve their licensing procedures to address specific aspects of radioactive waste disposal.
		S1	The Government should consider establishing a Communication strategy concerning disposal (siting, construction, operation, closure and post-closure) and set out how and when the public will be engaged.
2.	NATIONAL STRATEGY FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT	R3	The Government should update and enhance the National Programme to include the comprehensive list of activities and their interdependencies up to the time of final closure of the facility and any necessary post-closure activities.
		R4	The Government should formalise the national approach and put in place a comprehensive management system, involving all responsible ministries for the implementation of the National Programme which shall amongst others include processes for decision making and corrective actions in case of deviations.
3.	INVENTORY OF SPENT FUEL AND RADIOACTIVE WASTE	S2	The Implementer should consider the following activities in order that the technical solution may be planned with the fullest knowledge possible of the inventory: - bringing forward its planned activities on waste

Area	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
		<p>characterization;</p> <ul style="list-style-type: none"> - establishing a consistent approach to the estimation of the future waste arisings; - identifying and compiling any available information on the non-radiological properties of the waste; <p>ensuring that the inventory for disposal fully reflects any remaining uncertainties in waste volumes and properties.</p>
<p>4. CONCEPTS, PLANS AND TECHNICAL SOLUTIONS FOR SPENT FUEL AND RADIOACTIVE WASTE MANAGEMENT</p>	<p>R5</p>	<p>The Implementer should evaluate the suitability of the proposed disposal concepts to provide safe disposal of the total expected waste inventory in the geological environments at potential site(s).</p>
<p>5. SAFETY CASE AND SAFETY ASSESSMENT OF RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT ACTIVITIES AND FACILITIES</p>	<p>R6</p>	<p>The Government should establish detailed requirements and guidance for safety documentation for disposal facilities which should include the assessment for long-term safety after facility has been closed.</p>
	<p>R7</p>	<p>The Implementer should develop a preliminary safety case with supporting safety assessments for all proposed disposal facilities.</p>
	<p>R8</p>	<p>On the basis of safety assessment and licence requirements, the Implementer should update the preliminary WAC.</p>
<p>6. COST ESTIMATES AND FINANCING OF RADIOACTIVE WASTE</p>	<p>R9</p>	<p>The Government should update their cost assessment to include all stages of waste management including required post-closure activities and to reflect the uncertainties in the programme.</p>

Area		R:Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	AND SPENT FUEL MANAGEMENT	R10	The Government should ensure that the appropriate mechanisms are in place to ensure the timely availability of adequate funding to deliver the National Programme up to and including any required post-closure activities.
7.	CAPACITY BUILDING FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT – EXPERTISE, TRAINING AND SKILLS	R11	The Government should develop a national resourcing plan for delivery of the National Programme and ensure it is supported by appropriate training activities to provide the necessary knowledge and skills.
		S3	The Government should compile a single comprehensive list of all the R&D needs for the implementation of the National Programme and establish effective mechanisms for provision of the necessary human and financial resources for the delivery.

APPENDIX D: IAEA REFERENCE MATERIAL USED FOR THE REVIEW

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, Safety Fundamentals No. SF-1, Vienna (2006).
- [2] INTERNATIONAL ATOMIC ENERGY AGENCY, Governmental, Legal and Regulatory Framework for Safety, General Safety Requirements No. GSR Part 1 (Rev. 1), Vienna (2016).
- [3] INTERNATIONAL ATOMIC ENERGY AGENCY, Leadership and Management for Safety, General Safety Requirements No. GSR Part 2, IAEA, Vienna (2016).
- [4] INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014).
- [5] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR Part 4, IAEA, Vienna (2009).
- [6] INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSR Part 5, IAEA, Vienna (2009).
- [7] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Facilities, IAEA Safety Standards Series No. GSR Part 6, IAEA, Vienna (2014).
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- [9] INTERNATIONAL ATOMIC ENERGY AGENCY, Disposal of Radioactive Waste, IAEA Safety Standards Series No. SSR 5, IAEA, Vienna (2011).
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- [11] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Energy Basic Principles, Nuclear Energy Series, NE-BP, Vienna (2008).
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- [14] INTERNATIONAL ATOMIC ENERGY AGENCY, Policies and Strategies for Radioactive Waste Management, IAEA Nuclear Energy Series No. NW-G-1.1, IAEA, Vienna (2009).
- [15] INTERNATIONAL ATOMIC ENERGY AGENCY, Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities, IAEA Nuclear Energy Series No. NW-G-2.1, IAEA, Vienna (2012).
- [16] INTERNATIONAL ATOMIC ENERGY AGENCY, Policy and Strategies for Environmental Remediation, IAEA Nuclear Energy Series No. NW-G-3.1, IAEA, Vienna (2015).
- [17] INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, IAEA International Law Series No. 1, IAEA, Vienna (2006).
- [18] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Glossary – Terminology used in Nuclear Safety and Radiological Protection, IAEA, Vienna (2007).
- [19] Official Journal of the European Union No. L 199/48 from 2nd Aug 2011, COUNCIL DIRECTIVE 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, Brussels (2011).