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

MISSION

TO

IRELAND

WEXFORD, IRELAND

18-21 October 2021

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY
DEPARTMENT OF NUCLEAR ENERGY

IAEA

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

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REPORT OF THE

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

TO

IRELAND

Mission *18-21 October 2021*
Location: *Wexford, Ireland*
Organized *IAEA*

ARTEMIS REVIEW TEAM	
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IAEA-2021

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

At the request of Department of the Environment, Climate and Communications, on behalf of the Government of Ireland, the International Atomic Energy Agency organized an Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) peer review mission. The objective of the ARTEMIS Peer Review Service is to provide independent expert opinion and advice on radioactive waste and spent nuclear fuel management, decommissioning and remediation, based upon the IAEA safety standards and technical guidance, as well as international good practice. Ireland requested this IAEA review to fulfil its obligations 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 three senior international experts in the field of management of radioactive waste and disused radioactive sources, three from IAEA Member States, with IAEA staff providing coordination and administrative support. A preparatory meeting was convened in February 2021 and the receipt and review of Advanced Reference Material was carried out in July 2021. Subsequent to this, in October 2021 the ARTEMIS Review Team evaluated the overall Irish framework for the management of all types of radioactive waste including disused sealed radioactive sources.

Considering the very small amount of radioactive waste and disused radioactive sources to manage in the country, Ireland has established a specific national programme as follows:

- storage for decay of short-lived radioactive materials and subsequent clearance,
- the storage of legacy disused sealed radioactive sources (DSRS) at licensee sites until a practical arrangement with a third-party country is established to manage the DSRS,
- the direct transfer of Sealed Radioactive Sources (SRS), upon becoming disused, in line with the return agreements as per the licensing of the SRS,

The authorities in Ireland are committed to finalise by 2022 the terms of an agreement for management of any future legacy sources or radioactive waste associated with future activities in Ireland with a third-party country.

The ARTEMIS team was impressed by the pragmatic approach that was adopted by the Ireland authorities to reduce by 99 % the inventory of disused radioactive sources in the Country and to maintain efforts in the near future for the small remaining amount and by the systematic implementation of the fundamental pay-polluter principle as a key driver for establishing take-back agreements under the responsibilities of the licensees.

However, the ARTEMIS team made the following two recommendations with the view to improve the safe management of radioactive waste in Ireland.

- The Department of the Environment, Climate and Communications should continue to explore options to provide a long term solution for the management of radioactive waste and disused radioactive sources.
- The Environmental Protection Agency should include in the national inventory existing and anticipated radioactive waste streams.

In addition, the ARTEMIS team provided the Ireland authorities with the following five suggestions:

- The Department of the Environment, Climate and Communication should consider revising the national programme to reflect the interfaces between the national plan for the

radiological and nuclear emergency exposure situations and the management of radioactive waste;
- The Department of the Environment, Climate and Communication should consider assigning clear responsibilities and establishing mechanisms for the management of legacy sources;
- The Environmental Protection Agency should consider developing guidance on essential provisions for a reliable take-back agreement with a supplier, as well as the licensee's financial provisions, in order to prevent a lack of management pathway;
- The Environmental Protection Agency should consider developing guidance for risk assessment of activities related to the management of radioactive waste;
- The Department of the Environment, Climate and Communication should consider strengthening existing arrangements for the provision of the education and training required for building and maintaining the competence of all persons and organizations with responsibilities relating to the management of radioactive waste and disused sources.

In summary, the ARTEMIS Team considers that Ireland has established a good basis for the safe and responsible management of radioactive waste and disused radioactive sources upon which further improvements can be considered.

The ARTEMIS Team is of the collective opinion that Ireland is in a good position to continue meeting high standards of safety for radioactive waste and disused radioactive sources management in the country.

I. INTRODUCTION

On 17th January 2019, the Department of the Environment, Climate and Communications (hereinafter the Counterpart), on behalf of the Government of Ireland (hereinafter Ireland), requested the International Atomic Energy Agency (hereinafter the IAEA) to organize and carry out, in the third quarter of 2021, an Integrated Review Service for Radioactive Waste and Spent Fuel, Decommissioning and Remediation (ARTEMIS), as required 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 (hereinafter the EU *Waste Directive*).

The review was performed by a team of three senior international experts in the field of radioactive waste and management of disused radioactive sources, from three IAEA Member States, with IAEA staff providing coordination and administrative support. A preparatory meeting was convened in February 2021 and the receipt and review of Advanced Reference Material was carried out in July 2021. Subsequent to this in October 2021, the ARTEMIS Review Team evaluated the overall Irish framework for the management of all types of radioactive waste including disused sealed radioactive sources.

II. OBJECTIVE AND SCOPE

The ARTEMIS review provided an independent international peer evaluation of Ireland's Radioactive Waste Management Strategy against the relevant obligations under the EU *Waste Directive*.

The ARTEMIS review, organized by the Department of Nuclear Safety and Security and the Department of Nuclear Energy of the IAEA, 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.

The ARTEMIS review assessed the overall strategy for the management of all types of radioactive waste in Ireland in line with the requirements of the EU *Waste Directive*.

The ARTEMIS review addressed the national framework and the national programme for safe and sustainable radioactive waste management in Ireland. The review focused on the domains of (a) national policy, framework and strategy; (b) predisposal management of radioactive waste, including the management of disused sealed radioactive sources (DSRS); and (c) disposal of radioactive waste, where relevant.

III. BASIS FOR THE REVIEW

A) PREPARATORY WORK AND IAEA REVIEW TEAM

At the request of the Government of Ireland, an on-line preparatory meeting for the ARTEMIS Review mission, was conducted on the 23rd February 2021. The preparatory meeting was carried out by the appointed Team Leader Mr Patrice François, the IAEA coordinator Mr Zhiwen Fan and the deputy coordinator Mr William Stewart, and the team of National Counterparts led by Mr Paul Shortt from the Department of the Environment, Climate and Communications, with participation of representatives of the Environmental Protection Agency (EPA).

The ARTEMIS mission preparatory team had discussions regarding:

- the Terms of Reference for the ARTEMIS review of the Irish strategy to fulfil obligations from article 14(3) of the EU *Waste Directive*; and
- the relevant detailed aspects for organization and conduct of the review.

IAEA staff presented the ARTEMIS principles, process and methodology. This was followed by a discussion on the work plan for the implementation of the ARTEMIS review in Ireland in October 2021.

Mr Paul Shortt was appointed as the National Counterpart for the ARTEMIS mission and designated IAEA point of contact.

Ireland provided IAEA with the Advance Reference Material (ARM) for the review before the 15th July 2021

B) REFERENCES FOR THE REVIEW

The articles of the EU *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 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 E.

C) CONDUCT OF THE REVIEW

The initial Review Team meeting took place virtually on Thursday, 14th October 2021, directed by the ARTEMIS Team Leader Mr Patrice François, the ARTEMIS Team Coordinator Mr Zhiwen Fan and the Deputy Team Coordinator, Mr William Stewart.

Mr. Colman Hickey was present at the initial Review Team meeting, in accordance with the ARTEMIS guidelines, and presented logistical arrangements planned for the mission.

The ARTEMIS entrance meeting was held on Monday, 18th October 2021, with the participation of the the Department of the Environment, Climate and Communications, the Environmental Protection Agency, senior management and staff. Opening remarks were made by Mr Niall Mcloughlin, Principal of Air Quality, Noise, Environmental Radiation Protection and International Climate Division; Mr Tom Ryan , Director of the Office of Environmental Enforcement, EPA, and Mr Patrice François, ARTEMIS Team Leader. Mr David Pollard, the EPA Programme Manager with responsibility for radiation regulation gave an overview of the Irish context.

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

The ARTEMIS Review Team performed its review according to the mission programme given in Appendix B.

The ARTEMIS Exit Meeting was held on Thursday, 21 October 2021. Opening remarks were made by Mr David Pollard, Progamme Manager, EPA. A presentation of the results of the Review Mission was given by the ARTEMIS Team Leader Mr Patrice François. Closing remarks were made on behalf of the IAEA by Mr Peter Johnston, Director of the Division of Radiation, Transport and Waste Safety, Department of Nuclear Safety and Security. Closing remarks were made on the behalf of the EPA by Laura Burke, Director General and by Mr Niall McLoughlin, Principal on behalf of the Department of the Environment, Climate and Communications.

An IAEA press release was issued.

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

1.1. NATIONAL POLICY

Irish position

The Irish Government adopted a national policy on radioactive waste management for Ireland in late 2010 on foot of a governmental decision. The policy incorporated European Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. In 2015 Ireland published the first national programme, which includes both policy and strategy. In 2018 the original programme was revised to reflect developments since 2015 including recommendations from the 2015 International Atomic Energy Agency International Regulatory Review Service (IRRS) Mission and the transposition of Council Directive 2013/59/Euratom of 5 December 2013 (the Basic Safety Standards Directive). Finally, a new version of the programme was published in May 2021. Implementation of radioactive waste policy is overseen by the Department of the Environment, Climate and Communications (DECC).

The national programme reflects the country's status: no nuclear facilities, no defence research reactors, no civilian research reactors and no spent fuel or reprocessing facilities. Transboundary movement of radioactive waste consists of the repatriation of disused sealed sources to suppliers or manufacturers in other Member States. No formal waste classification process is in place. However, for inventory management purposes disused and orphan sources are categorised in terms of 'half-life bands' and IAEA source categorization system.

Ireland has adopted a "cradle to grave" management principle for all radioactive sources. The principle is implemented through a revised authorization system and a legislative requirement for take-back arrangements to be in place with the original overseas supplier or manufacturer of the sources (Regulation 69 of the Ionising Radiation Regulations 2019). The authorisation system is based on graded approach. Unless justified, the practice of replacement of radioactive sources by non-radioactive alternatives is required. In implementing this policy, Ireland follows also the principles of minimisation of the generation of radioactive waste in any form and avoidance of the importation of radioactive waste in any form.

The following activities have also been adopted to implement the Irish policy on radioactive waste:

- Inventory Reduction Programme: In the past number of years the Government has facilitated a programme to reduce the amount of disused radioactive sources in Ireland. This has seen a reduction from approximately 3,000 disused sources in 2011 to 26 sources in October 2021. This, coupled with the requirement for undertakings to have "take-back arrangements" for sources has meant that the amount of radioactive waste in Ireland is negligible and consists of legacy sources only. Nonetheless, efforts are ongoing at reducing still further the amount of waste and on managing this kind of waste appropriately prior to disposal.
- Enhanced enforcement: Environmental Protection Agency (EPA), as the regulatory authority responsible for the safe management of radioactive waste and disused sources, has been granted enhanced powers under the Ionising Radiation Regulations 2019 framework to enforce compliance with legislative and licensing requirements for the safe management of waste and disused sources. It is expected that these powers will

result in a further and ongoing reduction in the number of disused sources being stored in medium or long term.

- National Radioactive Waste Storage Facility: Based on the small number of disused sources currently in Ireland and the enforcement of policies to ensure that the number of disused sources trends towards zero, it has been determined that a National Radioactive Waste Storage Facility is no longer a requirement for the time being.
- Operational Protocol: Ireland has in place an Operational Protocol for the recovery and management of legacy sources. This protocol was reviewed as part of the 2015 IRRS Mission to Ireland and found to be fit for purpose. It is currently under review.
- Financial Provision for Waste Management: DECC has put in place a Radioactive Waste Management Fund to address any waste management requirements such as the recovery of orphan sources where the holder has not been identified or the storage of legacy sources when the owner has an inability to pay. This fund has been set out in legislation in Regulation 77 of the Ionising Radiation Regulations 2019.

ARTEMIS observation

The main principles of National Policy are documented in the National Programme. These principles are compatible with other existing policies and strategies in the country, for example the policy and strategy and radiation protection and the policy and strategy on preparedness and response in case of a nuclear or radiological emergency. The outline of the process implemented in the country for the development of a policy is as follows: The lead organization usually starts the drafting of the text and the interested parties may be consulted. When the draft is in its final shape it is forwarded to the Ministry and then to the Government for the final approval. When there are cross cutting issues all the relevant authorities are consulted and informed before sending the draft to the Government to be approved. There is a process in place for stakeholders' involvement through official procedure.

The National Programme for radioactive waste is revised and updated on a five year basis. DECC is the lead organization in its development. DECC consults with EPA in all issues related to radiation protection as well as in the case of radioactive waste management. DECC is also responsible for the implementation of the strategy, while EPA is responsible for operational issues.

The current National Programme reflects the success of the Inventory Reduction Programme from approximately 3,000 disused sources in 2011 to 26 sources in 2021 which fall within IAEA categorization 4 or 5.

During the ARTEMIS discussions it was underlined that the decision not to commission a National Radioactive Waste Storage Facility is based on the success on the Reduction Programme and the "take back" agreements required for the authorized parties who use sealed radioactive sources. However, Ireland has recognized that these options do not solve the problem of legacy sources and, as a result, Ireland is working on establishing an agreement with a third country for the management of existing legacy DSRS. The process has already started and is expected to be finalized in 2022.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *In the updated National Programme dated May 2021, the decision has been taken not to develop a centralized storage facility at this time. In this context, the ARTEMIS Team has been informed that negotiations with another country are ongoing to establish an agreement for the management of existing legacy DSRS. This management option provides a potential solution for the removal of a number of legacy DSRS from Ireland to a third country and may provide a long term management solution.*	
(1)	**BASIS: SF-1 Principle 7, para 3.29 states that** *"Radioactive waste must be managed in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management. The generation of radioactive waste must be kept to the minimum practicable level by means of appropriate design measures and procedures, such as the recycling and reuse of material."*
R1	**Recommendation: DECC should continue to explore options to provide a long term solution for the management of radioactive waste and DSRS.**

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

Irish position

Ireland is a member of the European Union, and, therefore, its regulatory framework in respect to radioactive waste and the protection of workers and the public from the hazards associated with ionising radiation is based on the relevant EU Directives and Regulations.

The legislative framework governing the nuclear and radiation protection sectors is the Radiological Protection Act 1991, as amended. Ionising Radiation Regulations 2019 (S.I. No. 30 of 2019) which was made under Section 30 of the Radiological Protection Act of 1991, gives legal effect in Ireland for the EU Council Directive 2013/59/Euratom, which lays down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation. According to Ionising Radiation Regulations 2019 all activities involving radioactive sources, save those which meet the criteria for exemption, require an authorisation from EPA. In addition, the control of high activity sealed radioactive sources and orphan sources is exercised by EPA.

Responsibility for nuclear safety policy is vested in the Minister for DECC. Within DECC, there is a dedicated Air Quality, Noise and Environmental Radiation Protection Division, whose responsibilities include: Policy development and advice to Government in relation to nuclear matters; Transposition into national legislation of relevant EU and other international instruments; Representation at meetings of the EU, IAEA and other international organisations.

ARTEMIS observation

The overall governmental responsibilities and the regulatory framework have been established. More specifically, the Radiological Protection Act, 1991 Ionising Radiation Regulations 2019 apply to practices related to all stages of radioactive waste management from generation to disposal, when the radioactive waste results from civilian activities. Licensing is required for

the siting, design, construction, commissioning, operation, decommissioning and closure of a radioactive waste management facility or the exportation for disposal of radioactive waste from Ireland to another Member State or third country.

Ionising Radiation Regulations 2019 provide for the responsibilities of EPA as well as for the authorized parties regarding the safe management of radioactive waste including the seeking of advice from a qualified expert (Radiation Protection Adviser, RPA). The ARTEMIS Team was informed that although there is provision in the general legislative framework that the prime responsibility rests with the authorized party, EPA and DECC have made efforts in formalizing and communicating this aspect to the authorized parties. The fact that the RPA is responsible to sign the risk assessment report underlines only the advice offered to the owners and not discharging them from their responsibilities.

2. NATIONAL STRATEGY FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT

2.1. SCOPE

Irish position

The implementation of the national strategy is included in the National Programme. Categorisation of radioactive materials and radioactive waste in Ireland is based on a pragmatic approach consistent with the relatively simple needs of the country. The waste categorisation scheme under the current categories applicable in Ireland includes disused sealed sources in storage/custody and unsealed radioactive material arising mainly from medical applications.

In Ireland, sealed and unsealed sources are used in public and private sectors of the economy. In the public sector, the main users are medical and educational establishments. The uses of sealed sources in the private sector includes also density/level gauges, as check sources and in medical devices. Authorized users of disused sources are required to verify their holdings at specific periods which are set out in their authorization process and to report any changes to the EPA. Sealed sources, whether in use or not, must be leak tested not less than once every two years or as recommended by the manufacturers and reported to the EPA.

The decommissioning phase of the cyclotron will be a phased process involving removal, recycling and disposal of the cyclotron by the licence holder followed by decommissioning of the concrete plinth beneath the cyclotron. Similarly, it is envisaged that all components of the industrial sterilization facilities will be monitored for activation products, and if active, these products will remain on-site under licence until decay below relevant exemption or clearance levels, and will then be disposed as conventional waste.

While recognizing that there remains the potential for orphan source to arise in the future, according to Ireland, long-term waste storage would be a disproportionate use of resources relative to the actual problem.

In the national programme it is mentioned that members of the National Crime Prevention Unit undertake security audits of facilities holding High Activity Sealed Sources (HASS) in addition to facilities holding large numbers of radioactive sources. Good practical working relationships are also in place with the An Garda Síochána (Irish Police) and with other bodies, such as Health and Safety Authority, the Health Services Executive.

ARTEMIS observation

Following the “polluter pays” principle, the disposal of radioactive waste is borne by the authorized party. Regarding the orphan sources a specific fund has been established on a statutory basis in the Ionising Radiation Regulations 2019. The profiled expenditure is based on historic data and is considered adequate to meet anticipated spend on the safe management and disposal of orphan sources. For the management of legacy sources (disused sources kept at the undertaking’s sites) the fund can be used if the undertaking has an inability to pay. Regarding the activation material coming from the cyclotron there is an agreement in place with the manufacture company to take back any waste generated from decommissioning.

For the potential waste generated from a radiological or nuclear emergency there are provisions in Regulation 56 of Ionising Radiation Regulation 2019 where the Minister shall develop a strategy for contaminated areas and existing exposure situations, aimed at minimising the

lasting exposures. However, there is no provision in the national programme for these kinds of waste streams.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The ARTEMIS Team was informed that the national emergency plan includes provisions for the management of waste arising from an emergency situation and identifies the bodies involved. In the national programme, there is no provision for the management of such radioactive waste.*	
(1)	**BASIS: GSR Part 5 Requirement 8 states that** *"All radioactive waste shall be identified and controlled. Radioactive waste arisings shall be kept to the minimum practicable."*
(2)	**BASIS: GSR Part 7 Requirement 3, para 5.84 states that** "*The national policy and strategy for radioactive waste management shall apply for radioactive waste generated in a nuclear or radiological emergency, with account taken of paras 5.85 to 5.88."*
S1	**Suggestion: DECC should consider revising the national programme to reflect the interfaces between the national plan for the radiological and nuclear emergency exposure situations and the management of radioactive waste.**

2.2. MILESTONES AND TIMEFRAMES

Irish position

Key performance indicators (KPIs) are set out in the National Programme and include the following:

- Accurate and up-to-date inventory of disused sources maintained on an ongoing basis;
- Waste management arrangements in place periodically reviewed to ensure continuing appropriateness;
- Number of orphan sources detected annually;
- Adequate funding provided by Government to deal with orphan sources that arise;
- Results of EPA inspections of licensees against waste management criteria.

The National Programme does not include any milestones and timeframes related to the above list of KPIs. However, Ireland has set a measurable goal to have almost no DSRS by the year 2023.

ARTEMIS observation

KPIs have been set by Ireland with no relevant specific timeframes and milestones. During the discussions it was pointed out there are no suitable metrics in the specific case of Ireland to demonstrate the progress made in the area of radioactive waste. The ARTEMIS Team was informed that priority is currently given to an establishment of an agreement with a third country to manage the legacy sources. However, other mechanisms are also in place such as the

take back agreements and the governmental funding mechanism and the review of the operational protocol.

2.3. PROGRESS INDICATORS

Irish position

The bulk of disused sources have been removed from the country for disposal or recycling. It is expected that through a combination of coordinated actions such as legislative requirements and enhanced regulatory enforcement the number will trend towards zero in the coming years (see Table 1).

Table 1 The evolution of disused sources in the Inventory Reduction Programme

Year	No. of Disused Sources
2011	3,300
2018	16
2021	37
2023	~0

EPA will continue, through formal inspection activities, to enhance the active engagement with all holders of radioactive sources to ensure that an accurate inventory of disused sources is maintained on an ongoing basis, and that these disused sources are properly stored.

ARTEMIS observation

There are no milestones and timeframes related to KPIs. However, the ARTEMIS Team was informed about the inventory reduction programme which significantly reduced the number of DSRS to 26 at time of Mission.

Furthermore, the ARTEMIS Team was informed of a scoping exercise by DECC to examine the viability of commissioning a National Waste Storage Facility. Due to the success of the source inventory reduction programme DECC requested that the EPA review case made in the 2010 Enviros Report. This review lead to a recommendation not to proceed with the National Waste Storage Facility at this time.

3. INVENTORY OF SPENT FUEL AND RADIOACTIVE WASTE

Irish position

Ireland currently has no high or medium-level radioactive waste on its territory. There is no processing, storage and radioactive waste conditioning for the purpose of disposal in Ireland, as well as no radioactive waste disposal facilities.

Ireland has disused sealed sources in storage/custody; and unsealed radioactive material arising from medical applications that are managed by decay in storage. In practice, radioactive waste in unsealed form arises from the use of radionuclides mainly in hospitals and in a few educational and research establishments. The unsealed sources are either imported from the relevant overseas suppliers or in the case of short-lived sources are generated on the main hospital sites e.g. technetium generators.

Sources of radioactive waste in Ireland consist of:

a) Liquid Radioactive Waste Disposal: In general, authorised liquid discharges from the medical sector are via the foul sewer system to waste water treatment plants and then discharge into the sea.

b) Cyclotron Waste: Activated materials from a PET trace cyclotron, such as disused target foils, used post-irradiated O-16 and O-18, auxiliary cyclotron components, post-irradiated separation and purification columns and possibly some contaminated water from sonic baths used in target maintenance, are allowed to be stored until they decay below the relevant exemption levels and then are treated as conventional waste.

c) Legacy Disused Sealed Radioactive Sources: The sources that are classified as disused and held in custody mainly arise from acquisitions made prior to the introduction of take-back agreements into normal regulatory practice.

d) Lightning Preventors Incorporating Radium: A programme has been undertaken to review historic records to identify unlicensed lightning preventors containing radium-226. They are no longer considered to provide any benefit over conventional lightning conductors and the EPA does not allow their importation.

e) Tc-99 Generator Cores: Generator cores that produce Tc-99 are returned to the supplier.

f) I-125 Sources: There is a procedure in place for the return of I-125 seeds for use in brachytherapy to suppliers. On occasion issues can arise with the return of individual seeds, in these instances they are stored to decay.

g) Industrial Sterilisation Facilities: Ireland currently has two licensed operational panoramic wet storage gamma irradiators (IAEA Category IV) and two licensed E-Beam irradiators operating at 10 MeV, one of which has capability to operate at 12 MeV. There is no radioactive waste associated with the operation or the decommissioning of panoramic wet storage gamma irradiators. It is envisaged that, during the decommissioning of the E-Beam irradiators, all components will be monitored for activation products, and, if active, these products will remain on-site under licence until decay below relevant exemption or clearance levels, and will then be disposed as conventional waste.

h) High Activity Sealed Sources (HASS): There are approximately 1,500 sealed sources held under licence as HASS in Ireland. The majority of these are used in the irradiation cells of two sterilisation plants. The majority of the remaining sources are held by industrial radiography companies, universities, and hospitals and by a manufacturer of radioactive gauges. All legacy

HASS sources previously reported have been disposed of abroad as part of the source reduction program me in line with Government policy.

The outstanding legacy disused sources currently comprising the national inventory are legacy disused or orphan sources of Categories 4 and 5 according to IAEA's categorization scheme (Safety Guide RS-G-1.9). All institutional waste from research and medical purposes in Ireland is short lived and kept at the licensees' premises until is decayed down to clearance levels and released to the environment as exempt waste. In this context, Ireland does not consider that is deemed of value to apply a waste classification system beyond this stage. The team was informed that the national inventory does not consider natural sources of radiation (NORM) and materials handled and disposed of by NORM industries, such as diffuse sources arising from extractive industries, oil and gas, peat burning and bauxite and cement production.

The inventory includes information detailing the radionuclide type, activity, physical form, number of sources, manufacturer/supplier, source serial number, the licensed practice it was used for and location.

For the past decade the Government has facilitated the implementation of the "Source Inventory Reduction Programme" to reduce the amount of disused radioactive sources in Ireland. Some of the highlights of the programme include removing abroad all high activity high energy gamma sources of Categories 1 and 2, 2.5 tonnes of uranium metal in the form of rods, 1,066 educational legacy disused sources and an estimated 9 kg of thorium and uranium components (unsealed) from schools, 1,980 Ra-226 sources used in various medical applications, and all known but three lightning preventors from buildings.

A detailed licensing system facilities and activities using sealed sources is in place since 1977, allowing a detailed pattern of the locations and life histories of sources and tracking those that are still in use and those that are disused. Using the licence records, the EPA is able to give a breakdown of the total inventory of sources that are disused and in safe storage under the relevant licence conditions and their locations. There is no time restriction for the licensees in keeping those disused sources in their premises. The EPA manages its regulatory activities through the "Licensing and Enforcement Management Application" (LEMA), which operates as an information management system. All EPA licensees use the EPA's Environmental Data Exchange Network (EDEN) on-line web portal. Undertakings licenced to hold or use radioactive sources are required to keep an inventory of all radioactive sources and waste products, including the locations and quantities of sealed and unsealed radioactive sources and radiation generators, and of the dates and method of transfer or recycling or disposal. Licensees are required to inform the EPA through the EDEN portal of any changes in the inventory of radioactive waste for which they are responsible, and to have their licence amended accordingly.

ARTEMIS observation

Approximately 5,000 disused sources were reported to exist in the country in 2010. This included 2,656 sources, which decayed to below the clearance levels within 5 years, and 1,767 sources with a half-life greater than 10 years. The consistent implementation of the country's Inventory Reduction Programme established in 2012 resulted in the reduction of the national inventory from approximately 3,000 disused sources in 2011 to 37 sources in 2021, representing a 99% reduction in total number of these sources. The review team acknowledges that this has been recognised as an area of "Good Performance" under the Joint Convention's review cycle in 2018.

The team was informed that disused sources are listed on EPA licences with the indication "custody only" to reflect their status. Such sources are subject to additional regulatory requirements to ensure their safe and secure management. The team was also informed that Ireland considers there is minimal risk these disused sources could become orphaned in the short to medium term and that efforts are ongoing at reducing still further the amount of disused sources and to trend this number towards zero by 2023.

The review team was informed that currently Ireland has in its national inventory 33 disused sources held under regulatory control. These sources are kept by 11 licensees, 7 of them are in the state sector, and these are active users of radiological practices. Eight sources are orphan sources (i.e. they were never under regulatory control), from which 4 were seized from members of the public by the EPA, and are currently held at EPA's premises pending a final management solution. The team acknowledges that Ireland recognizes that keeping these sources indefinitely in EPA authorised sites cannot be considered as an appropriate management solution.

Of the 4 remaining sources, three are lightning preventors with Ra-226 in place on buildings (two are on churches and one is on a disused factory). The review team was informed that the owners of the Ra-226 lightning preventers have so far been unable to finance their removal from their current locations and their shipment abroad for recycling/reuse. To date, while it is under consideration, it has not been deemed appropriate to trigger the Operational Protocol, as routes for disposal for these sources have not yet been identified.

The remaining one source is a World War II aeroplane Ra-226 dial compass, with estimated activity of 21.7 kBq, and was detected by a portal radiation monitoring system at an incinerator in 2020. This source is currently being held at an authorized temporary secure storage at that waste to energy facility and discussions are ongoing to find an appropriate solution.

The review team noted that the national inventory does not consider any predictions on anticipated waste, for example of waste to be generated during the decommissioning.

In addition to the above, there are small numbers of Am-241 sources from smoke detectors, Ni-63 from sources from electron capture devices and chemical compounds containing natural decay series radioisotope taken from laboratories etc., which are held under licence. These are typically stockpiled until commercially viable quantities are available for export to recovery facilities. The numbers of these sources are subject to regular change and are not reported/included in the national inventory. The review team was informed that currently Ni-63 sources fall under registration, and the intention is that these sources will be exempted in near future.

Although the radiological risk posed by the sources mentioned above cannot be considered significant, the situation with the 3 lightning preventors and the radium compass, as no satisfactory arrangement has been found, remains outstanding and, certainly, requires resolution as soon as possible. The team believes that options for removal and of the disposal of these devices need to continue to be explored, as there have been cases reported in the past where such devices went missing during roofing work and were never recovered. Despite the extensive exercise by EPA to identify the locations of lightening preventors on other buildings, it is still possible that some further sources may be identified on buildings, as well as be detected in incinerators, metal recycling facilities, ports and airports, that will require appropriate management solutions. The review team also shares the country's concern that it becomes much more difficult to find reuse, recycling or disposal routes for orphan sources in future, by means of export for disposal abroad, especially for radionuclides Ra-226, Cs-137 and Sr-90, when considering those cases that there is no agreement in force at the time of shipment between Ireland and the receiving State. Moreover, the significant costs involved in the shipment of such sources abroad cannot be neglected. Given all the above, the review team addressed recommendation 1 (R1)

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The national inventory is currently comprised of a number of legacy sources (disused or orphan). Anticipated radioactive waste, for example, waste that could be generated during decommissioning and dismantling of facilities, is not considered.* *In addition, authorization has been granted to a licensee to collect disused sources whose numbers are subject to regular changes, for example Am-241 sources from smoke detectors, Ni-63 from sources from electron capture devices. These disused sources are not included in the national inventory.*	
(1)	**BASIS: GSR Part 1 (rev. 1), Requirement 35, para 4.63 states that** *"The regulatory body shall make provision for establishing and maintaining the following main registers and inventories: ...* *— Inventories of radioactive waste and of spent fuel."*
(2)	**BASIS: GSR Part 5 Requirement 2, para. 3.5 states that** *"The national policy on radioactive waste management has to ... be based on knowledge of the waste to be managed (e.g. knowledge of the inventory and of waste streams) now and in the future."*
(3)	**BASIS: SSG-45, para. 3.18 states that** *"In order to facilitate the establishment of a national policy and strategy, the government should establish a national inventory of radioactive waste (both current waste and anticipated waste, including waste generated during the decommissioning and dismantling of facilities) and should update it at regular intervals…."*
(4)	**BASIS: SSG-45, para. 3.18 states that** *"... the government should establish a national inventory of radioactive waste ... and should update it at regular intervals…."*
R2	**Recommendation: The EPA should include in the national inventory existing and anticipated radioactive waste streams.**

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

Irish position

- **Management of orphan sources**

In the frame of the national radioactive waste management policy, Ireland has in place an Operational Protocol for the recovery and management of orphan radioactive sources. This protocol outlines the arrangements to manage the safe interim storage of an orphan radioactive source or of a source identified for seizure, pending its ultimate disposal. Orphan radioactive sources meeting the following criteria will be considered for interim management under the terms of this Operational Protocol:

- Presence of a demonstrable risk to public safety if the source is not moved;
- Inability of current holder to arrange safe disposal;
- Failure to identify the original owner;
- Immediate export route unavailable.

This Operational Protocol was strengthened in IRR19 and Regulation 77 which provides that the Minister shall make financial provisions for the recovery and disposal of orphan sources. Regulation 77 about the recovery and disposal of orphan sources requires that the intervention costs associated with the recovery, management, control and disposal of orphan sources shall, in the first instance, be borne by the person in possession of the source, if identified. The Minister shall make reasonable provisions for funds for the recovery and disposal of orphan sources where a responsible person cannot be identified. Such a source will not remain in the temporary storage location for any longer than 18 months. The transfer and/or disposal of the source will be managed within that timeframe – this would be considered a priority activity. A non-exhaustive list of organisations who could be requested, on a case by case basis is provided in this Operational Protocol (Departments of Ministries, EPA, Health Service Executive, Customs, etc.). These organizations could play an advisory and/or supporting role in the implementation of the protocol, including, where applicable, through the provision of temporary storage by agreement under the terms of the protocol.

This Protocol was reviewed as part of the 2015 IRRS Mission to Ireland and found to be fit for purpose. This Protocol will be reviewed periodically to ensure that it remains effective.

According to Ireland's National Waste Programme, the number of such sources is very low and the EPA has dealt with them on a case-by-case basis and their disposal has been funded by the state through the Radioactive Waste Management Fund. There are currently 37 legacy (disused or orphan) sources in Ireland. They are illustrated by sector (industrial, educational, state etc), and categorised by half-life > 10 years). Thirty-four are disused sealed sources (held under regulatory control). The remaining three sources are lightning preventers in place on buildings.

In the majority of past orphan source cases, EPA has ended up holding the source at its laboratory pending export. In the review of the 2010 SKM Enviros report[1], it is indicated that "*this approach is clearly not sustainable going forward*." This report concludes that "*Ireland does not have adequate medium to long term arrangements for dealing with orphan sources and that national arrangements need to be made for the management and ultimate disposal of orphan sources where they arise*." It is recommended that the Protocol "*arrangement need to*

[1] Page 12, Review of 2010 SKM Enviros Business Case for a National Radioactive Waste Store - May 2021.

clearly assignment of responsibility for temporary management and storage to a competent party".

- **Take back agreement for disused radioactive sources**

In accordance with the Polluter Pays Principle, Ireland's National Waste Programme indicates that the recycling of disused sources recycling is facilitated through take back arrangements with suppliers of sources. This policy is enshrined in legislation in Regulation 17(1) of the Ionising Radiation Regulations 2019. In the frame of the national Inventory Reduction Programme and the requirement of take-back agreements, the amount of radioactive waste in Ireland is negligible and consists of legacy sources only. It is indicated that licensees are required, as a prerequisite to licence issue, to have an agreement with the source supplier or manufacturer to take back sources ("take back agreement") when they become disused. The EPA looks for written evidence from the supplier or manufacturer that the source will be accepted back when no longer required before issuing a licence."

The review of the 2010 SKM Enviros report indicates that "*while the requirement to provide evidence of financial provision is enshrined in IRR19 for High Activity Sealed Sources, this is not the case for other sources. While in reality, the EPA has found that undertakings do put takeback agreements in place for all sources, its ability to enforce this requirement is uncertain*."

- **National Radioactive Waste Storage Facility**

Ireland's National Waste Programme indicates that Ireland previously signalled an intention to consider the commissioning of a National Radioactive Waste Storage Facility based on the Enviros Consultants Report of 2010. In 2021, DECC requested that the EPA review the Enviros Report and associated recommendations in light of existing radioactive waste requirements, the success of the inventory reduction programmes and expected requirements to adequately deal with radioactive waste. This review concluded that "*While recognising that there remains the potential for orphan sources to arise in the future, a long-term waste store of the scale and nature envisaged in the SKM Enviros 2010 report would now be a disproportionate use of resources relative to the actual problem*." It has been determined that a National Radioactive Waste Storage Facility is no longer a requirement.

Factors involved in reaching this conclusion included:

- There has been a very significant reduction in the overall number of sources for storage.
- The Enviros estimate made allowance for specific high activity high energy gamma sources. These sources are no longer in the national legacy source inventory.
- The remaining legacy sources all fall into the lower risk end of the IAEA source classification system (categories 4 & 5). The higher risk sources identified by Enviros have all been disposed of at this stage.
- The rate of new disused/orphan sources arising is very much lower than was anticipated at that time

In the review of the 2010 SKM Enviros report, it is considered that the potential for orphan source incidents remains. It is indicated that "*based on the figures over the last three decades for Irish orphan sources incidents, it is estimated that there is potential for the discovery of approximately 50-100 orphan sources over the next 50 years*".

Materials generated by the routine operation of the 16.5 MeV self-shielded PET trace Cyclotron are managed by decay (until relevant clearance levels are reached). It is anticipated that the operational phase of the Cyclotron will continue for at least 20 years. Regarding waste to be

generated by the decommissioning of the cyclotron, the facility will be left unused for a period of 1 year to allow for the decay of the short-lived activation products. Cyclotron components that are not activated will be recycled and disposed of as normal, conventional waste materials. Materials still active after the 1 year time period will be securely stored until decay below relevant exemption levels and will then be disposed as conventional waste. Once the cyclotron has been decommissioned, the concrete plinth directly beneath the cyclotron will be removed. It is estimated that a maximum of 1 m3 of concrete may be activated. Activated concrete will be securely stored until decay below the relevant exemption levels and will then be disposed as conventional waste.

ARTEMIS observation

Regarding the Operational Protocol, the Artemis team observes that the Review of the 2010 SKM Enviros report mentioned that the Operational Protocol is implemented on a case-by-case basis for the recovery of orphan sources and that this approach has proved to be problematic as the protocol does not assign responsibility for temporary storage to any organisation. The ARTEMIS team was informed that the Operational Protocol is currently under review and will be applicable in the future for emergency management as a service level agreement. In addition, the ARTEMIS team has been informed that there is a contingency fund which can be implemented for the recovery of legacy radioactive sources. This fund can be used when evidence is provided to DECC that the holder of legacy sources is not able to pay for their management. As a result, existing legacy sources, such as lighting preventers and Ra 226 compass, are temporarily stored or kept locally pending a solution.

Regarding the "take-back agreement", the ARTEMIS team observes this agreement is one of the pillars of the management of disused sealed radioactive sources in the Country. Nevertheless, there is no description of what could be the format and the content of such agreement and it seems that guidance for the operators/licensees on establishing such agreements does not exist. It should be clarified how "take-back agreements" address the following elements for returning a DSRS to a supplier:

- the commitment by supplier to take back the DSRS within a specified time period;
- the arrangements for transport and associated conditioning of the DSRS in connection with its return;
- The initial estimation, periodic revision, if needed, and allocation of the costs of return between the operator and the supplier.

Regarding the national centralized waste storage facility, based on the existing inventory of disused radioactive sources, the forecast amount of orphan radioactive sources expected to be discovered in the future, the amount of radioactive materials and waste which may arise from the decommissioning of the Cyclotron, and the requirement of "take back agreements", the ARTEMIS teams observes that this option is considered by Ireland to be not currently justified. The ARTEMIS team has been informed that the number of existing disused radioactive sources has been reduced from 37 to 26. In addition, the team has been informed that an agreement with a third country is under negotiation to provide a solution for the management of remaining existing legacy disused sources and should be established in 2022. Nevertheless, it has been recognized that if some legacy disused sources are not managed under this agreement these sources will remain under licensee responsibility for long term management. The ARTEMIS team has been informed that the decision regarding the need for the development of a national waste storage facility is based on prevailing circumstances and could be reconsidered in the

future according to need. The ARTEMIS team considers that this issue is addressed by the terms of the Recommendation n°1 (R1) of the present report.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The ARTEMIS team was informed that the Operational Protocol is currently under review and will be applicable for emergency situations as a service level agreement. Recovery of orphan or legacy sources are part of this protocol if there is a safety concern. In addition, there is a contingency fund in place but is only applicable when evidence is provided to DECC that owner of legacy sources is not able to pay for their management. As a result, legacy sources, such as lighting preventers and Ra 226 compass, are temporarily stored or kept locally pending a solution.*	
(1)	**BASIS: GSR Part 5 Requirement 1, para. 3.4 (X) states that** *"Matters that have to be considered by the government include:* *Setting clearly defined legal, technical and financial responsibilities for organizations involved in predisposal radioactive waste management activities;"*
(2)	**BASIS: IAEA Guidance on the Management of Disused Radioactive Sources states that** *"VII National Policy And Strategy For The Management Of Disused Sources* *(11) Each State should establish a national policy and strategy for the management of disused sources that reflects the State's long-term commitment to their safe and secure management. The policy and strategy together should:* *c - Identify responsibilities and arrangements, including funding, for the management of a disused source in cases where such arrangements were not made prior to acquisition of the radioactive source, or in cases where prior arrangements can no longer be implemented."*
S2	**Suggestion: DECC should consider assigning clear responsibilities and establishing mechanisms for the management of legacy sources.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *"Take-back agreements" are required for all sealed sources. However, there is no guidance on how a licensee should establish a "take-back agreement" with a supplier or what the key provisions of such an agreement would be.*	
(1)	**BASIS: GSR Part 5 Requirement 1, para. 3.8 states that** *"To facilitate compliance with regulatory requirements, the regulatory body has to do the following:* *Provide necessary guidance on the interpretation of national standards and regulatory requirements that takes into consideration the complexity of the operations and the magnitude of the hazards associated with the facility and operations;* *Document the procedures that operators are expected to follow in the licensing process;* *Document the procedures that apply to the mechanisms for compliance verification and enforcement;"*
S3	**Suggestion: The EPA should consider developing guidance on essential provisions for a reliable take-back agreement with a supplier, as well as the licensee's financial provisions, in order to prevent a lack of management pathway.**

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

Irish position

Regulation 17 of IRR19 "*Radioactive Waste Licences*" requires applicants for a licence of a radioactive waste management facility or a practice involving radioactive waste management to carry out a safety assessment covering the development and operation of the practice and the development, operation and decommissioning of the facility or closure of the disposal facility as well as the post-closure phase of the disposal facility. The extent of the safety assessment shall be commensurate with the complexity of the operation and the magnitude of the hazards associated with the radioactive waste, and the facility or practice.

The Risk Assessment must take account of the nature and magnitude of the risks of exposure to radiation for staff and members of the public from normal operations (expected exposures) as well as from reasonably foreseeable incidents and accidents (potential exposures). The EPA has developed a Risk Assessment framework which comprises two distinct stages:

- The Design Stage,
- The Operational Stage.

The EPA will not authorise a licensed practice without a valid Risk Assessment. All undertakings must complete a Risk Assessment before commencing a practice and it must be acceptable to the EPA (see Regulation 31 of IRR19).

The Risk Assessment must be reviewed periodically and immediately if circumstances arise whereby the Risk Assessment is no longer appropriate, for example changes to working conditions, source inventory etc. The frequency of periodic review will depend on the nature of the practice and shall be determined by the undertaking, in consultation with their RPA.

It is specified under the Regulation 31 that the undertaking shall make an assessment in consultation with an approved Radiation Protection Adviser (RPA) who has appropriate radiation protection experience relevant to the practice being assessed. The risk assessments and in general the applications for authorizations from the undertakings to the regulatory body have to be signed by RPA's hired by the undertakings to assist them in radiation protection matters. The RPA is an individual or a body, having the knowledge, training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, which meets such criteria of competence as may from time to time be specified in writing by EPA. Consultations with a RPA is addressed under the Regulation 33 of IRR19. The advice of the RPA covers arrangements for radioactive waste management (Regulations 33, item (2) – (i)). Safety Assessment for a radioactive waste management facility under Regulation 17 is separate to the Risk Assessment for a practice under Regulation 31.

Regarding license conditions, an example of the safety and security section of licence conditions in relation to storage of authorized items has been presented in the frame of the ARM materials. The license conditions illustrate among others some of the provisions that are expected to be considered, such as:

- Fire safety provisions
- Movement of authorised items taken out of use

ARTEMIS observation

EPA has developed a Risk Assessment Framework with the aim to support the implementation of a new practice by a licensee. This risk assessment framework addresses radiation protection aspects, including controls of access, to assess the impact to the workers and the public, taking into account foreseeable incidents and accidents making the distinction between the design stage and the operational stage. The team observes that this risk assessment framework should address all the lifecycle steps of a practice in particular regarding the safe management of potential radioactive waste arising from any practice or activity of a licensee. It has been recognized that Risk Assessment is not specific to radioactive waste management but it can be used. The ARTEMIS team has been informed that EPA is currently in the process of developing a guidance for authorized parties.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The risk assessment framework developed by the EPA comprises design and operational stages. This risk assessment does not address all steps of the authorized facility life cycle that could give rise to radioactive waste. The team has been informed that EPA is in the process of developing a guidance for authorized parties.*	
(1)	**BASIS: GSR Part 4 Requirement 2 states that** *"Scope of the safety assessment* *A safety assessment shall be carried out for all applications of technology that give rise to radiation risks; that is, for all types of facilities and activities."*
(2)	**BASIS: GSR Part 4 Requirement 3 states that** *"Responsibility for the safety assessment:* *The responsibility for carrying out the safety assessment shall rest with the responsible legal person; that is, the person or organization responsible for the facility or activity;* *4.2 The responsibility for carrying out the safety assessment shall rest with the responsible legal person; that is, the person or organization responsible for the facility or activity — generally, the person or organization authorized (licensed or registered) to operate the facility or to conduct the activity."*
(3)	**BASIS: IAEA GSG-3 states that "***The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste* *1.16. Waste may arise from:* *The commissioning, operation and decommissioning of nuclear facilities;* *The use of radionuclides in medicine, industry, agriculture, research and education;* *The processing of materials that contain radionuclides of natural origin;* *The remediation of contaminated areas."*
S4	**Suggestion: The EPA should consider developing guidance for risk assessment of activities related to the management of radioactive waste.**

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

Irish position

The funding of liabilities from the implementation of the national programme is given in Table 1 of the National Programme. The "polluter pays" principle remains one of the fundamental principles of the national policy for the management of radioactive waste and disused radioactive sources. The costs for the management of radioactive waste, at first instance, is borne by the undertaking responsible for generating the waste.

It is indicated in the National Programme that DECC has put in place a Radioactive Waste Management Fund for the disposal of orphan sources. The profiled expenditure is based on historic data and empirical calculations, and is considered adequate to meet anticipated costs associated with the safe management of orphan sources. This fund has been established on a statutory basis in the Ionising Radiation Regulations 2019. The amount of 50k euro is indicated in Table 4 of the National Programme, according which such financial provisions are established until 2023.

The EPA's radiation regulatory functions are funded separately through an annual government vote.

ARTEMIS observation

The ARTEMIS team has been informed that, based on the polluter-pays principle, the take back agreements for the recovery of disused sources, for which financial provisions have to be addressed by the undertakings, and the agreement with a third country for the recovery of legacy sources that is under negotiation by DECC, are commercial agreements. It has also been indicated that the activated components arising from the future decommissioning of the Cyclotron are also subject to a commercial take back agreement under the responsibility of the licensee.

The ARTEMIS team was also informed that the Radioactive Waste Management Fund will be maintained after 2023. In addition, it has been indicated that the provisions of this Contingency Fund will be increased up to 60k euro per year. The implementation of this Fund will remain flexible to take into account any possible situations arising in the country regarding the management of radioactive waste and legacy disused radioactive sources. In addition, the ARTEMIS team was informed that the financial provisions can be increased as necessary depending on the need.

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

Irish position

Regulatory body

a) Human resource development and strategic priorities

EPA's Human Resource Development Strategy for the years 2017-2021 identifies four strategic goals, of which Goal 2 relates to the development of people and organisational resources. The strategic priorities identified under Goal 2 include inter alia actions to develop an integrated view of workforce planning and resource management and a succession management plan that addresses critical posts foreseen to become vacant.

The Office of Environmental Enforcement (OEE) of EPA is responsible for providing staff and resources to enable the radiation protection regulation (RPR) and radioactive waste regulation to carry out its functions. The Programme Manager is responsible for reviewing the staff complement within the RPR and reports on the sufficiency of current human resources annually. Where deficiencies are identified, the Programme Manager makes recommendations to the Director of the OEE to increase the staff complement where necessary. The RPR currently have 11 staff with a significant range of experience and qualifications in science and business.

The on-going EPA's financial, human resource, and research and development requirements are ensured through the standard annual budgeting process and workforce planning processes exercised between the Department of the Environment, Climate and Communications and agencies under its aegis. Where additional resources are required outside of this annual process, these are pursued on a case-by-case basis.

b) Development of skills and expertise

EPA is required to make arrangements, as appropriate, for the education and training of its staff, as well as research and development activities to cover the needs of the national programme for radioactive waste management, in order to obtain, maintain and to further develop necessary expertise and skills. The ISO 17020 standard, under which the RPR holds an accreditation as an inspection body, requires that the competence requirements for all personnel involved in inspection activities, including requirements for education, training, technical knowledge, skills and experience, must be defined and documented.

Most of staff recruited to RPR come directly from universities. All new inspectors must undergo a comprehensive training programme, regardless of their previous experience or where they might have worked. An individual training plan is developed for all new inspectors that takes account of any previous experience or expertise in relation to sources of ionising radiation. The training programme includes training on areas of required technical knowledge and expertise and on "soft" skills to allow them gain the required competencies to work effectively as regulators. Generally, new inspectors are assigned a mentor from the most experienced staff in RPR and complete an induction period, where the trainee observes inspections and reviews the relevant literature, followed by a supervised working period, with experienced inspectors accompanying them on inspections and monitoring them for satisfactory performance. Finally, the inspector undergoes a documented competence assessment on the basis of skills, underpinning technical knowledge and demonstrated capability through the process of inspection witnessing.

OEE operates a Performance Management Development System (PMDS), which measures the contribution of all staff members to the successful delivery of the strategic plan and the associated goals. This ensures that the work of all staff is strategically aligned to the overarching aims of the

organisation. Moreover, the use of PMDS allows the identification of staff training and development needs, which are met throughout the year by conducting in-house and external training programmes. An annual Learning and Development Plan is aligned to support the achievement of EPA goals, whilst also supporting team and individual development needs. In addition, OEE undergoes a periodic "Workforce Planning", which comprises mapping of resources and required competencies for the organization against new and on-going work requirements.

Training takes place in various forms, including self-study, postgraduate studies, internal training courses, workshops and international conferences. While inspectors are trained to cover all disciplines, individual inspectors also have their own specific areas of interest/expertise, for example radioactive waste, transport, medical applications etc. Records of monitoring, education, training, technical knowledge, skills, experience and authorisation are maintained for each member of RPR's personnel.

c) Accessing external expertise

EPA is assisted by an Advisory Committee, which convenes several times a year to discuss issues of concern and offer advice to the Board. There is also a specific Radiological Protection Advisory Committee (RPAC), which was established to advise EPA in carrying out its functions on matters concerning ionising radiation. RPAC members come from organisations covering a broad range of fields relevant to the radiological protection functions of the EPA and also includes experts from France and the United Kingdom, who offer an independent perspective to the discussions.

RPR also avails of support from other organisations for technical or other expert professional advice or services. Some of the ways in which this support is obtained include engaging external consultants under contract, e.g. to assist with the development of new or revised regulatory requirements or to provide legal advice; requesting peer reviews; participating in national and international fora and in bilateral arrangements; and cooperating with national stakeholders.

Requirements on undertakings

Current regulations pose responsibilities to the undertakings for the provision of education, training and information in radiation protection, including the safe management of disused sources and radioactive waste. The undertakings are also required to set out a training policy in consultation with an appropriate qualified expert, i.e., a Radiation Protection Advisor (RPA). Based on this training policy, a training programme that sets out the content and frequency of training is implemented for each type of worker. In particular for holders of high activity sealed sources, a specific condition outlining training in the field of the safe and secure management of sources, including when they become disused, is attached to relevant EPA licenses. The undertaking should provide refresher education and training at appropriate intervals, but at least every 3-5 years, or whenever there is a significant change from a radiation protection point of view. The undertakings are required to document all training, education or information provided to their workers and maintain appropriate records. These records should include details on the date(s) of the training, the names of those who attended, who provided the training and the topics covered, and must be accessible throughout regulatory inspections. Training records are also communicated to the EPA at regular intervals.

Radiation Protection Advisers

A formal competence-based system has been established for the recognition for RPAs. Persons wishing to get approval to act as RPAs must be able to demonstrate to the RPA Assessment Committee's satisfaction that they have, inter alia, training, knowledge and experience on radiation protection and qualifications in a physical science. This is demonstrated through the documentation of any training courses and scientific meetings attended over the previous 3-5 years, which are relevant to their work in radiation protection.

In order to demonstrate a commitment to a structured skill and knowledge development approach, applicants should also provide examination results and evidence of Continuous Professional Development (CPD) or hours accumulated from attending conferences or seminars, experiential learning, on-the-job training, short courses, obtaining formal qualifications etc. relevant to a specific area of radiation protection. For approval renewals, applicants should demonstrate that they have maintained their knowledge and competence since the previous approval was granted.

ARTEMIS observation

Ireland' national policy and strategy (national programme) provides for the obligation of licensees to educate and train their employees, but it does not include any particular provisions on capacity building and expertise, training and skills development associated with the management of radioactive waste.

The current arrangements in place to obtain, maintain and further develop the necessary expertise and skills to cover the needs of the national programme mainly address the needs of the regulatory body, which in turn poses capacity building requirements on the undertakings (licensees). There are no specific actions taken by Government with regard to competency building beyond providing adequate funding and legislative authority to the regulatory body. The Government also funds to a large extent the third level institutions, which provide training in certain related disciplines. Such training arrangements are made as the need arises and are done locally by the interested party or regulated sector, without any central coordination.

When EPA authorises a facility, appropriate assurance with regard to professional training is primarily assessed during the inspection process. For example, for a non-destructive testing facility, proof of relevant qualifications, training and experience of radiographers is sought and such issues are routinely discussed and checked during inspections. The review team was informed that EPA is currently developing a guidance for undertakings which includes education and training requirements, including requirements relating to the management of radioactive waste and disused radioactive sources.

Training courses are organised by the regulated sectors themselves. The review team was informed that, the general practice, is to look abroad and particularly to the UK, on private initiative, for training opportunities. The practice for building competence for certain professionals is done on a case-by-case basis and as part of the licensing and authorisation process.

Ensuring the availability of sufficient radiation protection professionals appears to be a challenge both for the competent authority and for the regulated community. RPAs have an important role in terms of advising the undertakings within the areas of their competence on the management of radioactive materials. The current register of RPAs is considered as well populated according to the needs present in the country. As concerns waste management, the basic syllabus for Category I (competence in medicine) RPAs includes (i) principles of management and disposal; (ii) legislation governing disposal; (iii) critical group concept and dose calculation for critical group; and (iv) control and monitoring of releases. For Category II (Industrial & Educational Practices and Work Activities) RPAs, there are in place more detailed requirements that include demonstration of basic underpinning knowledge and practical competencies, at three graded levels: general awareness, basic understanding and detailed understanding.

The team noted that, although the national regulations require that EPA should make arrangements, as appropriate, for the education and training of its staff, as well as research and development activities to cover the needs of the national programme for radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills, Ireland has not identified

any emerging needs to be fulfilled as concerns the management of radioactive waste and disused sources. Such needs may exist in other fields, such as medical applications (proton therapy).

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *DECC has implemented legislative requirements covering both the regulator and undertakings with regard to training, education and competency on the management of radioactive waste and disused radioactive sources. Although the Government funds to a large extent the third level institutions which provide training in certain related disciplines, there is no central coordination, and training arrangements are made as the need arises and are done locally by the interested party or the regulated sector. In addition, where education and training programmes in the country prove insufficient, the general practice has been for professionals to look abroad and particularly to the UK for training opportunities on their own initiative.*	
(1)	**BASIS: GSR Part 1 (rev. 1), Requirement 11 states that** *"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."* **BASIS: GSR Part 1 (rev. 1), Requirement 11, para 2.36 states that** *"The government: … (c) Shall make provision for adequate arrangements for increasing, maintaining and regularly verifying the technical competence of persons working for authorized parties".* **BASIS: GSR Part 1 (rev. 1), Requirement 11, para 2.37, states that** *"In cases where the training programmes available in the State are insufficient, arrangements for training shall be made with other States or with international organizations."*
(2)	**BASIS: GSR Part 3, Requirement 2, para. 2.22 states that** *"The government shall ensure that arrangements are in place for the provision of the education and training services required for building and maintaining the competence of persons and organizations that have responsibilities relating to protection and safety."*
(3)	**BASIS: SSG-44, para. 4.233 states that** *"The government, through the designated body, should ensure that the education and training activities are coordinated, should start as soon as possible developing a systematic approach, and should consider establishing a national strategy for education and training."*
(4)	**BASIS: SSG-44, para 4.202 states that** *"In terms of implementing the national policy for radioactive waste management, the government should consider the following: …* *— Ensuring that the necessary scientific and technical expertise remains available to the operator and is available for the support of independent regulatory functions and other review functions at the national level."*
S5	**Suggestion: DECC should consider strengthening existing arrangements for the provision of the education and training required for building and maintaining the competence of all persons and organizations with responsibilities relating to the management of radioactive waste and disused sources.**

APPENDIX A: TERMS OF REFERENCE

1. Introduction

On 17 January 2019, the Department of Communications, Climate Action and Environment (hereinafter the Counterpart), on behalf of the Government of Ireland (hereinafter Ireland), requested the International Atomic Energy Agency (hereinafter the IAEA) to organize and carry out, in the third quarter of 2021, an Integrated Review Service for Radioactive Waste and Spent Fuel, Decommissioning and Remediation (ARTEMIS), as required 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 (hereinafter the EU Waste Directive).

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

2. Objective

The ARTEMIS review (also referred to as the "mission") will provide an independent, international evaluation of Irish radioactive waste management programme, considering the elements required by Article 14(3) of the EU Waste Directive.

The review will assist Ireland in further improving its national framework on the management of radioactive waste.

3. Scope

The ARTEMIS review will address the national framework and the national programme for The ARTEMIS review will address the national framework and the national programme for safe and sustainable radioactive waste management in Ireland.

The review will focus on the following domains (as described in the ARTEMIS Guidelines document): (a) national policy, framework and strategy; (b) predisposal management of radioactive waste, including the management of disused sealed radioactive sources (DSRS); and (c) disposal of radioactive waste, where relevant.

The following domains are out of scope of the review: (a) decommissioning of facilities; (b) spent fuel management; and (c) remediation of sites contaminated by radioactive materials.

Management of naturally occurring radioactive material and management of residues from mining and milling are also out of scope of this review.

Results from the 2015 IRRS mission to Ireland will be taken into account, where relevant and appropriate to avoid unnecessary duplication.

4. Basis for the review

The ARTEMIS review will be based on the relevant IAEA safety standards and proven international practice and experience, following the guidelines of the ARTEMIS review service. The review will take into consideration the requirements laid by the EU Waste Directive. A

graded approach will be implemented by the review team in order to take into account the specificities in Ireland.

5. Reference material

Reference material should include a set of documents, reports, data, and other supporting materials relevant to and depending straight on the scope of the review as specified in Section 3. The list of reference material is provided in Annex 1, which is subject to update and should be finalized by 15 July 2021.

Reference material for the purpose of the ARTEMIS review will be submitted to the ARTEMIS mission webpage on the Global Nuclear Safety and Security Network (GNSSN) of the IAEA.

6. Modus operandi

The working language of the mission will be English.

The ARTEMIS review mission will be conducted from 18 to 22 October 2021 in Dublin, Ireland. The provisional review mission schedule is provided in **Annex 2**.

The timeline for the key steps of the review process is provided below:

- Self-assessment questionnaire: February 2021 made available to Ireland by IAEA
- Preparatory Meeting: 23 February 2021, WebEx meeting
- Notification by IAEA to the Counterparts on the team composition: by 1 May 2021
- Submission of documents: by 15 July 2021 (including the self-assessment report)
- Submission of questions based on the preliminary analysis of the reference material and the self-assessment report by the review team to the Counterpart: by 30 September 2021

The Liaison Officer of the Counterpart is Mr Paul Shortt.

The organizations to be involved in the review are:

- Department of Environment, Climate and Communications
- Environmental Protection Agency

7. International peer review team

The IAEA will convene a team of international experts to perform the ARTEMIS review according to the ARTEMIS Guidelines and these Terms of Reference. The team will consist of:

- Three qualified and recognized international experts from government authorities, regulatory bodies, waste management organizations, and/or technical support organizations with experience in the safe management of radioactive waste and DSRS;
- Two IAEA staff to coordinate the mission. The Coordinator of the ARTEMIS review is Mr Zhiwen Fan from the Waste and Environmental Safety Section of the Department of Nuclear Safety and Security of IAEA. The Deputy Coordinator is Mr William Stewart from the Waste Technology Section of the Department of Nuclear Energy of IAEA;
- One IAEA staff for administrative support.

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

The Team Leader of the review team will be Mr Patrice Francois from IRSN, France. The IAEA will inform the Counterpart on the composition of the proposed review team, as scheduled under Section 6 on modus operandi.

The review mission may include up to two observers, including the possibility of one observer from the European Commission. The Counterpart will be notified of any proposed observers. The presence of any observer must be agreed with the Counterpart not later than 1 September 2021.

8. Reporting

The findings of the ARTEMIS review, conclusions, recommendations, suggestions and, if applicable, good practices will be documented in a review report. The report shall reflect the collective views of the review team members and not necessarily individual of the team member, neither those of their respective organization or Member State or the IAEA.

Prior to its finalization, the draft report will be delivered to the Counterpart for fact-checking.

9. Funding of the ARTEMIS review

The cost estimate for the ARTEMIS review covers both preparatory meeting and the review mission, and includes travel costs, per diem of the peer review team (external experts and the IAEA staff) in line with the IAEA Financial Regulations and Rules.

The review will be funded by the Government of Ireland, through the budget of the Counterpart. The cost of the ARTEMIS review is estimated to the amount of 16,000 EUR, to be paid to the IAEA as voluntary contribution before the start of the mission. Ireland is aware that the review cost includes 7% programme support costs.

If the actual cost of the ARTEMIS review exceeds the estimated voluntary contribution, Ireland agrees to cover such additional cost to the IAEA. Similarly, if the actual cost is less than the estimated voluntary contribution, any excess will be refunded to Ireland through the Counterpart.

These Terms of Reference were agreed on 23 February 2021 between the IAEA and the Department of Environment, Climate and Communications, on behalf of the Government of Ireland, during the preparatory meeting held on-line 23 February 2021.

Annex 1: List of reference material

1. Responses to the ARTEMIS Self-assessment Questionnaire
2. Laws, regulations and regulatory guidelines (including waste classification, concept of clearance, radiation sources categorization)
3. Responsibilities between DECC and EPA regarding policy, strategy, funding and Human resources
4. JC national report for the 6th review meeting and (if possible) the JC report for the 7th review meeting
5. Questions/answers about the JC Report for the 6th review process
6. IRRS mission report and an up to date action plan
7. EC report under the EC Directive 2011 dated 2018 (last update if any) including the national report and the national program
8. The Code of Conduct report for Safety and Security of Radiation Sources
9. Expert's reports on the implementation of policy and strategy (2010 Enviros Report)
10. EPA review of the Enviros Report
11. Update of national inventory of RAW and disused radiation sources
12. Feedback from recovery and repatriation actions of former DSRS since 2010
13. Financing aspects for disused radiation source and waste management
14. License conditions for storage of DSRS at the existing licensees sites
15. Any additional information that might be relevant

APPENDIX B: MISSION PROGRAMME

Time	Sun, 17 October	Mon, 18 October Meeting room in EPA Johnstown Castle, Wexford, Y35 W821	Tue, 19 October Meeting room at the hotel Oscar Wilde Suite	Wed, 20 October Meeting room at the hotel Oscar Wilde Suite	Thur, 21 October Meeting room in EPA Johnstown Castle, Wexford, Y35 W821	Fri, 22 October
9:00-9:30	Arrival of the ARTEMIS review team members	Opening General presentations	Further discussions	Finalization of Recommendations and Suggestions with the counterparts	Finalizing the draft report Coffee break Finalizing the draft report **Delivery of final draft report Closure** Lunch Departure of the Team Members, if convenient	Departure of the Team Members
9:30-10:00						
10:00-10:30		Coffee break	Coffee break			
10:30-11:30		1. National Policy and Framework	ARTEMIS Team Drafting Recommendations and Suggestions			
11:30-12:30		2. National Programme (strategy)				
12:30-13:30		Lunch	Lunch	Lunch		
13:30-14:00		3. Inventory	ARTEMIS Team Drafting Recommendations and Suggestions	ARTEMIS Team Drafting the report		
14:00-14:30		4. Concepts, Plans and Technical Solutions				
14:30-15:00		5. Safety Case and Safety Assessment				
15:00-15:30		Coffee break	Coffee break			
15:30-17:00		6. Cost Estimates and Financing Discussion	Presentation of Recommendations and Suggestions to the Counterparts and discussion	**16:00** Discussions with the Counterparts on the draft report		
		7. Capacity Building - Expertise, Training, Skills				
17:30		ARTEMIS team meeting at the hotel Drafting of the report	19:00 Official dinner	ARTEMIS team meeting at the hotel Drafting of the report		

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	DECC should continue to explore options to provide a long term solution for the management of radioactive waste and DSRS.
2.	**NATIONAL STRATEGY FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT**	S1	DECC should consider revising the national programme to reflect the interfaces between the national plan for the radiological and nuclear emergency exposure situations and the management of radioactive waste.
3.	**INVENTORY OF SPENT FUEL AND RADIOACTIVE WASTE**	R2	The EPA should include in the national inventory existing and anticipated radioactive waste streams.
4.	**CONCEPTS, PLANS AND TECHNICAL SOLUTIONS FOR SPENT FUEL AND RADIOACTIVE WASTE MANAGEMENT**	S2	DECC should consider assigning clear responsibilities and establishing mechanisms for the management of legacy sources.
		S3	The EPA should consider developing guidance on essential provisions for a reliable take-back agreement with a supplier, as well as the licensee's financial provisions, in order to prevent a lack of management pathway.

Area		R:Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
5.	**SAFETY CASE AND SAFETY ASSESSMENT OF RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT ACTIVITIES AND FACILITIES**	S4	The EPA should consider developing guidance for risk assessment of activities related to the management of radioactive waste.
7.	**CAPACITY BUILDING FOR RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT – EXPERTISE, TRAINING AND SKILLS**	S5	DECC should consider strengthening existing arrangements for the provision of the education and training required for building and maintaining the competence of all persons and organizations with responsibilities relating to the management of radioactive waste and disused sources.

APPENDIX D: LIST OF COUNTERPARTS

Ms Laura Burke, Director General, Environmental Protection Agency

Mr Tom Ryan, Director of Environmental Enforcement, Environmental Protection Agency

Mr Paul Shortt, Assistant Principal, Department of the Environment, Climate and Communications, Liaison Officer

Mr David Pollard, Programme Manager, Radiation and Waste Thematics, Environmental Protection Agency

Ms Collette O'Connor, Manager, Radiation Protection Regulation, Environmental Protection Agency

Ms Noeleen Cunningham, Team Lead Radioactive Waste, Environmental Protection Agency

Mr Niall Mcloughlin, Principal of Air Quality, Noise, Environmental Radiation Protection and International Climate Division

Mr Colman Hickey, Higher Executive Officer, Department of the Environment, Climate and Communications

Ms Elaine Reddy, Clerical Officer, Department of the Environment, Climate and Communications

APPENDIX E: IAEA REFERENCE MATERIAL USED FOR THE REVIEW

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, Vienna (2006).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series 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 (Rev. 1), IAEA Safety Standards Series No. GSR Part 4, IAEA, Vienna (2016).

[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 GSR Part 6, IAEA, Vienna (2014).

[8] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, PREPARATORY COMMISSION FOR THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Disposal of Radioactive Waste, IAEA Safety Standards Series No. SSR Part 5, IAEA, Vienna (2011).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, Establishing the Infrastructure for Radiation Safety, IAEA Safety Standards Series No. SSG 44, IAEA, Vienna (2018).

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education, IAEA Safety Standards Series No. SSG 45, IAEA, Vienna (2019).

[12] INTERNATIONAL ATOMIC ENERGY AGENCY, The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSG-3, Vienna (2012).

[13] INTERNATIONAL ATOMIC ENERGY AGENCY, Radioactive Waste Management Objectives, Nuclear Energy Series, NW-O, Vienna (2011).

[14] INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Management of Disused Radioactive Sources, IAEA/CODEOC/MGT-DRS/2018, Vienna (2018).

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, Policies and Strategies for Radioactive Waste Management, IAEA Nuclear Energy Series No. NW-G-1.1, IAEA, Vienna (2009).

[16] 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).

[17] INTERNATIONAL ATOMIC ENERGY AGENCY, Policy and Strategies for Environmental Remediation, IAEA Nuclear Energy Series No. NW-G-3.1, IAEA, Vienna (2015).

[18] 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).

[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Glossary – Terminology used in Nuclear Safety and Radiological Protection, IAEA, Vienna (2018).

[20] 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).