DANISH HEALTH AUTHORITY

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COUNCIL DIRECTIVE 2011/70/EURATOM FOR THE RESPONSIBLE AND SAFE MANAGEMENT OF SPENT FUEL AND RADIOACTIVE WASTE

Second report from Denmark

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Introduction

The bulk of radioactive waste in Denmark originates from the decommissioning of the former research reactors and supporting facilities at the Risø peninsula close to Roskilde, where all nuclear facilities in Denmark are located. Minimal amounts of experimentally irradiated spent fuel of power reactor type and fuel from one former research reactor is stored under safe and secure conditions at the Risø site by the operator of the nuclear facilities under decommissioning in Denmark, Danish Decommissioning. Radioactive waste stored at the facilities of Danish Decommissioning complies with the criteria for classification as Low Level Waste and Intermediate Level Waste (IAEA, GSG-1, 2009). Nuclear energy is not part of the Danish energy mix, and the annual production of radioactive waste from users of radioactive substances in research, industry and the medical sector in Denmark is managed by Danish Decommissioning. NORM waste originating from the oil and gas-extractive industries resulting from maintenance and routine operations is managed and stored by the responsible licensees at their sites.

Danish Decommissioning is the operator responsible for decommissioning of the former research reactors and supporting facilities at Risø. Danish Decommissioning is also responsible for the safe and secure management of spent fuel and radioactive waste arising from the decommissioning activities as well as radioactive waste originating in the research, industrial and the medical sectors in Denmark. Danish Decommissioning refers to the Ministry of Higher Education and Science, which is the entity responsible for the implementation of the national programme for safe management of spent fuel and radioactive waste stored at Danish Decommissionings facilities.

The Danish Health Authority regulates all use of radioactive substances, including management of radioactive waste, in Denmark. For the regulatory oversight of the nuclear installations at Risø, The Danish Health Authority and the Nuclear Division of the Danish Emergency Management Agency constitute the Nuclear Regulatory Authorities, which refer to the Minister of Health.

The policy and practice for management of radioactive waste and spent fuel was up to 2015 governed by the parliamentary resolution B48/ 2003, which in May 2018 was replaced by parliamentary resolution B90/2018 specifying long term storage for up to 50 years of all radioactive waste and spent fuel followed by geological disposal no later the 2073. Further information on these events is summarized below.

The report was compiled by the Danish Health Authority for the Ministry of Health. The report is structured with reference to the guidelines prepared by ENSREG Working Group 2 on Member States reporting on Article 14.1 of Council Directive 2011/70/Euratom (2018). The information presented includes contributions from The Ministry of Higher Education and Science and Danish Decommissioning (DD).

Recent developments

1.1. New national policy and programme:

The policy and programme for management of radioactive waste and spent fuel was up to 2015 governed by the parliamentary resolution B48/ 2003, by which the Danish parliament adopted a decision to decommission the nuclear facilities at Risø, and at the same time initiate the work to establish a repository for all Danish radioactive waste.

In 2015, the plan to establish a Danish repository was by political agreement supplemented with two additional lines of effort; a survey of the basis for, and implications of, establishing a long term storage solution prior to disposal, and an effort to explore the options for an international solution for all of the Danish radioactive waste.

Pending the outcomes of this work, all efforts to further develop and realise the plans regarding disposal pursuant of parliamentary resolution B48 were suspended.

In May 2018, the Danish parliament adopted resolution B90/2018 on a long-term solution for Denmark's radioactive waste, specifying long term storage for up to 50 years of all radioactive waste and spent fuel followed by geological disposal no later the 2073. The full wording of parliamentary resolution B90/2018 on a long-term solution for Denmark's radioactive waste is available (in Danish) on the website of the Danish parliament (https://www.ft.dk/samling/20171/beslutningsforslag/B90/som_vedtaget.htm), and in English at the website of the Ministry of Higher Education and Science (https://ufm.dk/en/newsroom/issues/radio-active-waste/english-material/english_translation_of_danish_parliament_resolution_b90.pdf). As a result of the adoption of parliamentary resolution B90/2018, a new national policy and associated programme for the responsible and safe management of spent fuel and radioactive waste is to be established in compliance with Council Directive 2011/70/Euratom. The policy and programme is currently under development.

1.2. Implications of adoption of parliamentary resolution B90/2018

The decision to suspend all efforts to further develop and realise the elements of the national programme regarding disposal as specified by parliamentary resolution B48/2003, meant that in the period from 2015 to 2018, only activities related to decommissioning and operational management of radioactive waste as well as maintenance of the nuclear facilities have been carried out. Consequently, the present reporting is focussed on operational progress in the areas of decommissioning and waste management, supplemented with information on status and progress regarding further development of the national policy and programme where available.

1.3. Adoption of new legislation implementing Council Directive 2013/59/Euratom in Denmark.

On February 6, 2018 a complete revision of Danish legislation in the area of radiation protection was finalized through the adoption of 1 new law and 3 new orders, replacing 2 acts and in excess of 15 orders. The full texts of the law and pursuant orders are available (in Danish) through links on the website of the Danish Health Authority: (https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/lovgivning). The new law and orders were adopted in compliance with Council Directive 2013/59/Euratom as reported to the European Commission. Regulatory guidance on all relevant subject matters is currently under development.

1.4. IAEA review missions to Denmark in 2020

Denmark has invited the IAEA to conduct full scope IRRS and ARTEMIS missions in the spring of 2020 in accordance with the requirements in Council Directives 2009/71/Euratom, article 9.3 regarding national framework and authorities for nuclear safety and 2011/70/Euratom, article 14.3 regarding the national framework, competent regulatory authority and national programme.

2. Scope and Inventory

Article 2, Article 12.1 (c), Article 14.2 (b)

Article 2 – Scope

1. This Directive shall apply to all stages of:
   (a) spent fuel management when the spent fuel results from civilian activities;
   (b) radioactive waste management, from generation to disposal, when the radioactive waste results from civilian activities.
2. This Directive shall not apply to:
   (a) waste from extractive industries which may be radioactive and which falls within the scope of Directive 2006/21/EC;
   (b) authorised releases.
3. Article 4(4) of this Directive shall not apply to:
   (a) repatriation of disused sealed sources to a supplier or manufacturer;
   (b) shipment of spent fuel of research reactors to a country where research reactor fuels are supplied or manufactured, taking into account applicable international agreements;
   (c) the waste and spent fuel of the existing Krško nuclear power plant, when it concerns shipments between Slovenia and Croatia.
4. This Directive shall not affect the right of a Member State or an undertaking in that Member State to return radioactive waste after processing to its country of origin where:
   (a) the radioactive waste is to be shipped to that Member State or undertaking for processing; or
   (b) other material is to be shipped to that Member State or undertaking with the purpose of recovering the radioactive waste.

   This Directive shall not affect the right of a Member State or an undertaking in that Member State to which spent fuel is to be shipped for treatment or reprocessing to return to its country of origin radioactive waste recovered from the treatment or reprocessing operation, or an agreed equivalent.

Article 12 – Contents of national programmes

1. The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:

(…)

   (c) an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;

Article 14 – Reporting

(…)

2. On the basis of the Member States' reports, the Commission shall submit to the European Parliament and the Council the following:

(…)

   (b) an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects.

2.1. Radioactive waste in Denmark

In accordance with Danish law, radioactive materials, including NORM (Naturally Occuring Radioactive Materials) without any foreseen use are to be considered as radioactive waste.

Radioactive waste in Denmark is presently stored either by Danish Decommissioning or at the site of licensees in the oil and gas industry (the latter only host NORM waste).

Classification of radioactive waste in Denmark is based on the IAEA Classification of 2009 (IAEA Safety Guide “Classification of Radioactive Waste”, GSG-1, 2009). The use of the category “Very Low Level Waste” (VLLW) may only take place after specific approval by the Regulatory Authorities.

2.2. Waste generating activities

The bulk of radioactive waste in Denmark originates from the decommissioning of the former research reactors and supporting facilities at Risø, where all nuclear installations in Denmark are located. Minor quantities of radioactive waste are delivered to Danish Decommissioning from users of radioactive materials in Denmark, i.e. hospitals, industries etc. Furthermore, routine maintenance and operational activities in the oil and gas industry result in an annual production of NORM waste which is stored at the sites of the licensees.

The expected total inventory of radioactive waste intended for final disposal as a result of decommissioining of the nuclear facilities at Risø was estimated in 2008 to 5000 – 10.000 m^3, depending on the final choice for long term management of NORM waste stored at Danish Decommissiong (see below). Management and disposal options for NORM waste originating from the oil and gas industry were not included in this estimate.

2.2.1. Decommissioning

The decommissioning of the Danish Reactor 1 (DR 1) and Danish Reactor 2(DR 2) was successfully completed in 2005 and in 2008, respectively. The building and nearby surroundings of the DR 1 reactor were released from regulatory control in 2006, while the reactor building of DR 2 still is in use as a handling and storage facility for large and/or heavy objects as well as other waste objects from the on-going decommissioning projects at the Risø site. The main developments regarding decommissioning of the remaining nuclear facilities and Risø are summarized below, and detailed information on individual decommissioning projects are provided in the national report from the Kingdom of Denmark to the 6th review meeting under the joint convention on the safety of spent fuel management and on the safety of radioactive waste management, available through the website of the Danish Health Authority: (https://www.sst.dk/~/media/509CCB144EC5489592F7345F998C92C1.ashx).

Main progress in decommissioning since 2015 fall within the following areas:

1) Decommissioning of Danish Reactor 3 (DR 3),

2) Decommissioning of the Hot Cell Facility,

3) Decommissioning and clearance measurement of the Fuel Fabrication Facility

Below, the current status is briefly summarised.

With respect to DR 3, decommissioning work is progressing as planned. A Packing Hut and Manipulator Box unit for remote handling of waste items has been installed on the top of the reactor, and the dismantling of the internal reactor parts and demolition of the reactor block are well under way. The preparatory work for the decommissioning of the Hot Cell Facility is completed, including rebuilding of the ventilation system, removal of the shutter blocks used to separate the hotcell units, and their housings. The development of remote handling equipment for sandblasting and vacuum cleaning of the hot cells has been completed and the equipment tested. The initial decontamination of the individual hot cells commenced in August 2017, and full scale blasting operations are in progress. As for the Fuel Fabrication Facility, clearance measurements following the completion of the decommissioning work, showed low levels of uranium contamination of a concrete floor below a set of drainpipes in a crawlspace. Pending the decision on the management of the contaminated concrete floor, the final decommissioning report can be submitted to the Nuclear Regulatory Authorities.

Remaining facilities to be decommissioned include the Waste Management Plant and associated storage facilities. These operations will commence in the coming years, in coordination with the process of establishing a new, long term storage facility as specified in parliamentary resolution B90/2018. Following completion of the decommissioning tasks, the process leading to release from regulatory control of land areas (green field) can be initiated.

2.2.2. Radioactive waste from institutional users and NORM waste from oil and gas industries.

Institutional users of radioactive materials in Denmark (i.e. hospitals, industries, research institutions etc.) deliver 2 to 6 tons of predominantly LLW and disused sealed sources per year to Danish Decommissioning. NORM waste originating from the oil and gas industry is stored at licensee sites. The combined amount is approximately 450 tons. The estimated annual production of NORM waste from the oil and gas industry is in the order of 50-100 tons per year.

2.3. Inventory

2.3.1. Spent Fuel

There are no spent fuel management facilities in Denmark. Minor amounts of spent fuel are stored, under safe and secure conditions at the storage facilities for radioactive waste at Danish Decommissioning. Special precautions for heat dissipation are not necessary for these materials. Based on these properties, activity concentrations in the spent fuel, and for communicative purposes, the spent fuel has been designated as ILW.

The activity of fission products in the spent fuel from Danish Reactor 1 (DR 1) was in the first report from Denmark listed as 50 GBq and is now given as 30 GBq. The discrepancy between activities stems from the lack of decay correction for the dataset reported previously. The activity of spent fuel from DR 1 reported here includes the fission product isotopes ^{137}Cs and ^{90}Sr and actinides ^{239}Pu and ^{240}Pu with correction for decay from 2001 when the activities were determined by measurement until January 2017. The activity of experimentally produced and irradiated spent fuel of power reactor type was calculated using Safeguard records and burnup scaling factors with decay correction to 2017. Fission product isotopes include ^{137}Cs, ^{90}Sr, ^{151}Eu and ^{154}Eu and actinide isotopes include: ^{235}U, ^{236}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, and ^{241}Am. The calculation of actinides has been updated to take into account the transformation of ^{241}Pu to ^{241}Am. The change in calculation is responsible for the minor increase in actinide activity, compared to previous reportings – the amount of material is unchanged.

An inventory of the stored spent fuel is given in Table 1 (data as of May 2017).

Spent fuel	Storage facility	Material	Mass/ Volume	Activity
Spent fuel from DR 1	DR 3 building complex	Solution of 20% enriched uranyl sulphate in light water	4.9 kg U 15.8 l	30 GBq fission products 0,4 GBq actinides
Experimentally produced and irradiated spent fuel of power reactor type	The Centralvej Storage	Uranium oxide pellets mostly in zircalloy tube	233 kg U	574 TBq fission products 35 TBq actinides

Table 1. Spent fuel in storage

2.3.2. Radioactive waste stored at Danish Decommissioning

Inventories of radioactive waste are given in Table 2 with reference to storage facility, volume or mass and activity stored.

Storage facility	Volume (m^3) / Mass (tons)	Activity (TBq)
Low Level Waste Storage	~1,200 m^3	6
Drum Storage and Centralvej Storage	~130 t	473
Taillings pools and ore heap	4,800 t	0.1
Intermediate Storage	808 t	112

Table 3. Inventory of radioactive waste stored at Danish Decommissioning as of January 2017, classified as low and intermediate level waste (LLW and ILW).

The main portion of the activity in the Intermediate Storage is placed in two specially shielded containers enclosing the top shield of the reactor tank from the former reactor DR 3 and a number of fuel element plugs. The decrease of total activity in the Intermediate Storage relative to activities reported previously is due to decay of short lived activity in these components (dominated by ^{60}Co). Together, the two containers contain 110 TBq as of January 2017.

Danish Decommissioning also stores a combined amount of 4800 tons of uranium ore and tailings with a total activity of 0,1 TBq.

2.4. NORM waste stored at licensee sites

NORM waste originating from the oil and gas industry is stored at licensee sites associated with the main operational hub of the offshore industry at Esbjerg in the western part of Denmark, and constitute a combined volume of approximately 450 tons. The estimated annual growth of NORM waste from the oil and gas industry is 50-100 tons per year.

3. General principles and policies

Article 4 – General principles

1. Member States shall establish and maintain national policies on spent fuel and radioactive waste management. Without prejudice to Article 2(3), each Member State shall have ultimate responsibility for management of the spent fuel and radioactive waste generated in it.
2. Where radioactive waste or spent fuel is shipped for processing or reprocessing to a Member State or a third country, the ultimate responsibility for the safe and responsible disposal of those materials, including any waste as a by-product, shall remain with the Member State or third country from which the radioactive material was shipped.
3. National policies shall be based on all of the following principles:
   - (a) the generation of radioactive waste shall be kept to the minimum which is reasonably practicable, both in terms of activity and volume, by means of appropriate design measures and of operating and decommissioning practices, including the recycling and reuse of materials;
   - (b) the interdependencies between all steps in spent fuel and radioactive waste generation and management shall be taken into account;
   - (c) spent fuel and radioactive waste shall be safely managed, including in the long term with passive safety features;
   - (d) implementation of measures shall follow a graded approach;
   - (e) the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials;
   - (f) an evidence-based and documented decision-making process shall be applied with regard to all stages of the management of spent fuel and radioactive waste.
4. Radioactive waste shall be disposed of in the Member State in which it was generated, unless at the time of shipment an agreement, taking into account the criteria established by the Commission in accordance with Article 16(2) of Directive 2006/117/Euratom, has entered into force between the Member State concerned and another Member State or a third country to use a disposal facility in one of them.

Prior to a shipment to a third country, the exporting Member State shall inform the Commission of the content of any such agreement and take reasonable measures to be assured that:

- (a) the country of destination has concluded an agreement with the Community covering spent fuel and radioactive waste management or is a party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management ('the Joint Convention');
- (b) the country of destination has radioactive waste management and disposal programmes with objectives representing a high level of safety equivalent to those established by this Directive; and
- (c) the disposal facility in the country of destination is authorised for the radioactive waste to be shipped, is operating prior to the shipment, and is managed in accordance with the requirements set down in the radioactive waste management and disposal programme of that country of destination.

3.1. National policy and programme during the reporting period.

The decision to suspend all efforts to further develop and realise the plans regarding disposal as specified by parliamentary resolution B48/2003 meant that in the period from

2015 to 2018, only activities related to decommissioning and operational management of radioactive waste as well as maintenance of the nuclear facilities were carried out. No further development in the programme described previously has therefore taken place. Further details regarding the Danish National policy and programme for safe and responsible management of spent fuel and radioactive waste in Denmark as reported in 2015 is available through the following link: http://sundhedsstyrelsen.dk/da/udgivelser/2015/~/media/C5F0AAE525294F6B9947859DC3D2A2A4.ashx

3.2. Adoption of new policy and development of new national programme

In May 2018 the Danish parliament adopted resolution B90/2018 on a long-term solution for Denmark's radioactive waste, specifying long term storage for up to 50 years of all radioactive waste and spent fuel followed by geological disposal no later the 2073. The new policy assures continued safe and secure management of radioactive waste and spent fuel in Denmark, while observing the principles of, *inter alia*, responsibility of the state, waste minimization, the interdependencies of waste generation and management, long term emphasis on safety through application of passive safety features, as well as the polluter-pays principle. The main decisions adopted through B90/2018 are:

- Construction of a new storage facility at the nuclear facilities at Risø in the period 2018-2023
- Continued storage of spent fuel and radioactive waste at Danish Decommissioning until no later than 2073
- Extension of Danish Decommissioning's brief to include contributions to the long-term solution
- Localization, construction and commissioning of a geological repository by 2073 at the latest
- Continued exploration of international solutions regarding spent fuel and technological collaboration

In compliance with Council Directive 2011/70/Euratom, a national programme setting out how the new policy will be implemented is currently under development and the policy and associated programme will be communicated to the European Commission once completed.

The adopted policy B90/2018 also provides for the possibility to expand the mandate to include NORM waste originating from the oil and gas industry in the framework of a comprehensive national policy and associated programme.

4. National framework

Article 5 – National framework

1. Member States shall establish and maintain a national legislative, regulatory and organisational framework ('national framework') for spent fuel and radioactive waste management that allocates responsibility and provides for coordination between relevant competent bodies. The national framework shall provide for all of the following:
   - (a) a national programme for the implementation of spent fuel and radioactive waste management policy;
   - (b) national arrangements for the safety of spent fuel and radioactive waste management. The determination of how those arrangements are to be adopted and through which instrument they are to be applied rests within the competence of the Member States;
   - (c) a system of licensing of spent fuel and radioactive waste management activities, facilities or both, including the prohibition of spent fuel or radioactive waste management activities, of the operation of a spent fuel or radioactive waste management facility without a licence or both and, if appropriate, prescribing conditions for further management of the activity, facility or both;
   - (d) a system of appropriate control, a management system, regulatory inspections, documentation and reporting obligations for radioactive waste and spent fuel management activities, facilities or both, including appropriate measures for the post- closure periods of disposal facilities;
   - (e) enforcement actions, including the suspension of activities and the modification, expiration or revocation of a licence together with requirements, if appropriate, for alternative solutions that lead to improved safety;
   - (f) the allocation of responsibility to the bodies involved in the different steps of spent fuel and radioactive waste management; in particular, the national framework shall give primary responsibility for the spent fuel and radioactive waste to their generators or, under specific circumstances, to a licence holder to whom this responsibility has been entrusted by competent bodies;
   - (g) national requirements for public information and participation;
   - (h) the financing scheme(s) for spent fuel and radioactive waste management in accordance with Article 9.
2. Member States shall ensure that the national framework is improved where appropriate, taking into account operating experience, insights gained from the decision- making process referred to in Article 4(3)(f), and the development of relevant technology and research.

4.1. National framework during the reporting period

The legislative, regulatory and organizational framework for safe and management of radioactive waste in Denmark as reported in section 2.2 of the first national report, (https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/~/media/A4C87DD15ECC4A34BAB4FC15B2BB3774.ashx) have remained unchanged in the period from the last reporting and until February 2018, where the revised of Danish legislation on radiation protection entered into force.

4.2. Adoption of new legislation and parliamentary resolution B90/2018

Following the adoption of the new legislative provisions for compliance with Council Directive 2013/59/Euratom, notification to the European Commission on compliance with Council Directive 2011/70/Euratom in the framework of the new legislative structure is underway. Provisions to ensure continued compliance with Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel are likewise in place.

The components of the national legislative, regulatory and organizational framework will be updated as appropriate, taking both changes in legislative basis as well as provisions detailed in parliamentary resolution B90/2018 into consideration, and will be communicated as part of the notification of the adopted policy and associated programme.

5. Competent regulatory authority

Article 6 – Competent regulatory authority

1. Each Member State shall establish and maintain a competent regulatory authority in the field of safety of spent fuel and radioactive waste management.
2. Member States shall ensure that the competent regulatory authority is functionally separate from any other body or organisation concerned with the promotion or utilisation of nuclear energy or radioactive material, including electricity production and radioisotope applications, or with the management of spent fuel and radioactive waste, in order to ensure effective independence from undue influence on its regulatory function.
3. Member States shall ensure that the competent regulatory authority is given the legal powers and human and financial resources necessary to fulfil its obligations in connection with the national framework as described in Article 5(1)(b), (c), (d) and (e).

5.1. Situation during the reporting period

As stated in the first national report from Denmark, The Danish Health Authority (formerly the National Institute of Radiation Protection under the Danish Health and Medicines Authority) regulates all use of radioactive substances, including management of radioactive waste, in Denmark. For the regulatory oversight of the nuclear installations at Risø, The Danish Health Authority and the Nuclear Division of the Danish Emergency Management Agency constitute the Nuclear Regulatory Authorities, which refer to the Minister of Health. Regulatory activities were conducted with reference to the legal framework reported in the first national report from Denmark, and from 6 February 2018, with reference to the revised legislation listed in Appendix 2.

The regulatory authorities are functionally separated from the organisations or bodies responsible for management of radioactive waste in Denmark through allocation of the responsibility for facilitating and realizing the political decisions in parliamentary resolution B48/2003 and later B90/2018 to the Ministry of Higher Education and Science.

5.2. Changes following adoption of parliamentary resolution B90/2018

The components of the national legislative, regulatory and organizational framework will be updated as appropriate, and will be communicated as part of the notification of the adopted policy and associated programme.

5.2.1. Financial provisions

In parallel to the financial provisions reserved for the operational aspects of parliamentary resolution B90/2018, efforts to ensure corresponding and sufficient financial resources necessary for the regulatory authority to fulfil its obligations are underway. The outcome

of this process will be communicated as part of the notification of the adopted policy and associated programme.

6. License holders

Article 7 – Licence holders

1. Member States shall ensure that the prime responsibility for the safety of spent fuel and radioactive waste management facilities and/or activities rest with the licence holder. That responsibility can not be delegated.
2. Member States shall ensure that the national framework in place require licence holders, under the regulatory control of the competent regulatory authority, to regularly assess, verify and continuously improve, as far as is reasonably achievable, the safety of the radioactive waste and spent fuel management facility or activity in a systematic and verifiable manner. This shall be achieved through an appropriate safety assessment, other arguments and evidence.
3. As part of the licensing of a facility or activity the safety demonstration shall cover the development and operation of an activity and the development, operation and decommissioning of a facility or closure of a disposal facility as well as the post-closure phase of a disposal facility. The extent of the safety demonstration shall be commensurate with the complexity of the operation and the magnitude of the hazards associated with the radioactive waste and spent fuel, and the facility or activity. The licensing process shall contribute to safety in the facility or activity during normal operating conditions, anticipated operational occurrences and design basis accidents. It shall provide the required assurance of safety in the facility or activity. Measures shall be in place to prevent accidents and mitigate the consequences of accidents, including verification of physical barriers and the licence holder's administrative protection procedures that would have to fail before workers and the general public would be significantly affected by ionising radiation. That approach shall identify and reduce uncertainties.
4. Member States shall ensure that the national framework require licence holders to establish and implement integrated management systems, including quality assurance, which give due priority for overall management of spent fuel and radioactive waste to safety and are regularly verified by the competent regulatory authority.
5. Member States shall ensure that the national framework require licence holders to provide for and maintain adequate financial and human resources to fulfil their obligations with respect to the safety of spent fuel and radioactive waste management as laid down in paragraphs 1 to 4.

6.1. Obligations of the license holder

The obligations of licence holders have remained unchanged during the reporting period, and assigns prime responsibility for the safety radioactive waste with the licence holder. As reported in the first national report from Denmark, the Nuclear Regulatory Authorities have issued Operational Limits and Conditions for Danish Decommissioning, detailing how the nuclear installations at Risø may be safely operated and decommissioned. As the decommissioning of the nuclear facilities at the Risø peninsula is ongoing, the Operational Limits and Conditions are progressively updated. Latest version of the Operational Limits and Conditions is from 2018. Public versions of the Operational Limits and Conditions are available on the website of the Danish Health Authority: (https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/nukleare-anlaeg/~/media/E77AAD96E00848F88A90E800BC5463F8.ashx).

The Operational Limits and Conditions set conditions regarding, *inter alia,* maintaining and improving safety of spent fuel and radioactive waste management, documentation for safety, quality assurance and management systems. Further information is provided in the first national report (section 2.2).

6.2. Extension of mandate, tasks and responsibilities for Danish Decommissioning

The adoption of parliamentary resolution B90/2018 extends the tasks of Danish Decommissioning to also include contributions to establishing a long-term solution for radioactive waste. In this capacity, Danish Decommissioning will take active part in processes related to planning, localisation, construction, operation and decommissioning of the planned intermediate storage facility as well as in the development of the disposal solution to be implemented by 2073 at the latest. The full scope of these activities as well as the expanded role and responsibilities of Danish Decommissioning in the national framework will be reported together with notification of national policy and associated programme.

7. Expertise and skills

Article 8 – Expertise and skills

Member States shall ensure that the national framework require all parties to make arrangements for education and training for their staff, as well as research and development activities to cover the needs of the national programme for spent fuel and radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills.

7.1. Arrangements during reporting period

The provisions in force during the reporting period in the national framework regarding requirements for education and training for responsible parties are founded in legislative requirements (ministerial orders and circular letters), which are described in further detail in the first national report from Denmark.

7.2. Changes following adoption of new legislation and parliamentary resolution B90/2018

The revised Danish legislation on radiation protection specifies equivalent requirements for education and training for responsible parties, and the detailed requirements will be reported as part of the national framework during notification of the national policy and associated national programme.

The extended mandate of Danish Decommissioning outlined in B90/2018, recognizes the importance of maintaining a sufficient level of both theoretical and practical knowledge through development and maintenance of Danish competences regarding the processing, safe storage and ultimately disposal of radioactive waste. The role of research and development activities to cover such needs in the national programme will be developed and reported during notification of the national policy and associated national programme.

8. Financial resources

Article 9 – Financial resources

Member States shall ensure that the national framework require that adequate financial resources be available when needed for the implementation of national programmes referred to in Article 11, especially for the management of spent fuel and radioactive waste, taking due account of the responsibility of spent fuel and radioactive waste generators.

8.1. Financial resources under the framework of parliamentary resolution B48/2003

With reference to the first national report from Denmark, and the national policy and programme for responsible and safe management of spent fuel and radioactive waste (http://sundhedsstyrelsen.dk/da/udgivelser/2015/~/media/C5F0AAE525294F6B9947859DC3D2A2A4.ashx), financial provisions for the conduct of operational and regulatory activities have followed the arrangements provided through parliamentary resolution B48/2003.

8.2. Financial resources under the framework of parliamentary resolution B90/2018

Parliamentary resolution B90/2018 provides the framework for the overall economic conditions related to implementation of the resolution, detailing a total estimated cost of 2271 million Danish kroner, covering costs related to implementing measures associated with B90/2018. As stated in Section 5, efforts to ensure corresponding and sufficient financial resources necessary for the regulatory authority to fulfil its obligations are underway. Further details on financial provisions, mechanisms, costing profiles etc. will be provided together with the notification of the new adopted policy and associated national programme.

9. Transparency

Article 10 – Transparency

1. Member States shall ensure that necessary information on the management of spent fuel and radioactive waste be made available to workers and the general public. This obligation includes ensuring that the competent regulatory authority inform the public in the fields of its competence. Information shall be made available to the public in accordance with national legislation and international obligations, provided that this does not jeopardise other interests such as, inter alia, security, recognized in national legislation or international obligations.
2. Member States shall ensure that the public be given the necessary opportunities to participate effectively in the decision-making process regarding spent fuel and radioactive waste management in accordance with national legislation and international obligations.

9.1. Transparency and public participation

Mechanisms for enhancing transparency in the process of establishing a long term management solution for radioactive waste and spent fuel in Denmark, were adopted by the Ministry of Higher Education and Science, which in the autumn of 2015 carried out a re-organisation of the policy-making process and interaction with stakeholders.

In February 2016, the Ministry of Higher Education and Science created a dedicated landing page on its website to accommodate the need for information on the process towards a long-term solution. The URL of the English version of the landing page is: http://ufm.dk/en/newsroom/issues/radio-active-waste.

Two new bodies were created to accommodate public interest in the process towards a long-term solution for radioactive waste management: a Contact Forum and a Panel of Independent Experts.

The Contact Forum was formed to facilitate regular interaction between key stakeholders in the process such as: concerned citizens' groups, environmental NGOs, representatives of local government agencies, radiation protection and emergency management authorities, Danish Decommissioning, Geological Survey of Denmark and Greenland and the Agency for Institutions and Educational Grants. The Contact Forum consists of 17 members who convene approximately every third month. Minutes of the meetings are made public on the website of the Ministry of Higher Education and Science.

The Panel of Independent Experts was formed to address the need in the public to get access to independent and scientifically vetted information on radioactive waste management. The panel consists of seven scientists from Danish universities, appointed by the Danish Council for Independent Research. The panel members cover the following disciplines: Nuclear Physics/Nuclear Energy, Radioactive Waste Management,

Health Physics/Radiation Protection, Environment Assessment, Environmental Law, Public Governance, and General Ethics. The panel replies to questions raised by the public. Questions are invited every month, with replies to be submitted by the panel in the following month. Questions and answers are posted on the website of the Ministry of Higher Education and Science.

In 2016, Danish Decommissioning formed an International Experts' Group in order to access advice and counselling in technical matters relating to the supplementary studies of a long-term storage solution. The group consists of four members from the Netherlands, Sweden (two members) and Norway, all representing national organisations of radioactive waste management. The group has submitted comments to Danish Decommissioning on the supplementary studies of a long-term storage solution in Denmark.

Efforts for the continued enhancement of transparency during implementation of the decisions in parliamentary resolution B90/2018 will be reported together with the notification of the new adopted policy and associated national programme.

10. Implementation of the national programme

Articles 11 and 12.

Article 11 – National programmes

1. Each Member State shall ensure the implementation of its national programme for the management of spent fuel and radioactive waste ('national programme'), covering all types of spent fuel and radioactive waste under its jurisdiction and all stages of spent fuel and radioactive waste management from generation to disposal.
2. Each Member State shall regularly review and update its national programme, taking into account technical and scientific progress as appropriate as well as recommendations, lessons learned and good practices from peer reviews.

Article 12 – Contents of national programmes

1. The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:
   - (a) the overall objectives of the Member State's national policy in respect of spent fuel and radioactive waste management;
   - (b) the significant milestones and clear timeframes for the achievement of those milestones in light of the over-arching objectives of the national programme;
   - (c) an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;
   - (d) the concepts or plans and technical solutions for spent fuel and radioactive waste management from generation to disposal;
   - (e) the concepts or plans for the post- closure period of a disposal facility's lifetime, including the period during which appropriate controls are retained and the means to be employed to preserve knowledge of that facility in the longer term;
   - (f) the research, development and demonstration activities that are needed in order to implement solutions for the management of spent fuel and radioactive waste;
   - (g) the responsibility for the implementation of the national programme and the key performance indicators to monitor progress towards implementation;
   - (h) n assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time;
   - (i) the financing scheme(s) in force;
   - (j) a transparency policy or process as referred to in Article 10;
   - (k) if any, the agreement(s) concluded with a Member State or a third country on management of spent fuel or radioactive waste, including on the use of disposal facilities.
2. The national programme together with the national policy may be contained in a single document or in a number of documents.

10.1. Policy and programme pursuant of parliamentary decision B48/2003

The policy and programme for management of radioactive waste and spent fuel was up to 2015 governed by the parliamentary resolution B48/ 2003, by which the Danish parliament decided that the decommissioning of the nuclear facilities at Risø should be completed within a timespan of 20 years, and that a Basis for a Decision should be developed for a final repository for low- and intermediate radioactive waste. The Danish National policy and programme for safe and responsible management of spent fuel and radioactive waste in Denmark based on parliamentary resolution B48/ 2003 and reported in 2015 is available through the following link: http://sundhedsstyrelsen.dk/da/udgivelser/2015/~/media/C5F0AAE525294F6B9947859DC3D2A2A4.ashx.

10.2. Development of the programme until 2018.

In 2009, the Parliament examined report R 4 on a Basis for a Decision for a final repository and gave its support for continuing preliminary studies of possible types of repository and studies of possible locations for a final repository in Denmark.
In 2011, preliminary studies for a final repository proposed preliminary safety analyses as well as a description of different types of near-surface and medium-depth repositories of down to 300 metres depth. Studies of possible locations identified six possible locations, which were recommended for further geological studies.
In 2014, an environmental assessment of the planned basis for a final repository was carried out which concluded that it was not possible to identify a location from the six possible locations without carrying out further studies.
In 2015, a Basis for a Decision was taken for an interim storage facility, which concluded that it would be possible to establish a secure interim facility for the radioactive waste, after which it would be placed in a final repository. In the same year, and after exploring possibilities in 23 OECD countries, it was concluded that export of the total amount of waste was not realistic due to the legal, technical, and/or political obstacles for such a solution.
Following this, the political parties decided on 11 March 2015, that further studies of an interim storage solution should be carried out to inform on the safety, economy and operation of an interim facility for 100 years, with a view to comparison with a final repository solution. It was also decided to suspend work on a final repository solution in order to wait for the comparisons arising from further studies of an interim storage solution.
In 2016, results of the new interim facility studies were available in the form of a report on the safety, economy and operation, where the safety and cost level of an interim facility and a final repository were compared. The interim solution studies also included a report on the criteria and process for the localisation of an interim facility.
In 2017, a cross-ministerial working group drafted a report for the Minister of Higher Education and Science on the collective interim storage studies. The working group

determined that both a final repository and an interim storage solution of up to 100 years could be constructed and operated in a satisfactory manner in relation to the protection of man, the environment and the physical facility. The working group pointed out that any decision on a long-term interim solution should be clearly connected with a subsequent planning and implementation of a final repository as the ultimate objective for a long-term solution.
On 19 September 2017, the Government published its proposal for a long-term solution with the aim of adopting a new parliamentary resolution in the case.
On 15 May 2018, the Danish parliament adopted resolution B90/2018 on a long-term solution for Denmark's radioactive waste, specifying long term storage for up to 50 years of all radioactive waste and spent fuel followed by geological disposal no later the 2073.

10.3. Policy and programme pursuant of parliamentary resolution B90/2018

The adoption of parliamentary resolution B90/2018 requires a new national policy and associated programme for the responsible and safe management of spent fuel and radioactive waste to be established in compliance with Council Directive 2011/70/Euratom. The policy and programme is currently under development.

11. Peer reviews and self-assessments

Article 14.3.

Article 14 – Reporting

3. Member States shall periodically, and at least every 10 years, arrange for self-assessments of their national framework, competent regulatory authority, national programme and its implementation, and invite international peer review of their national framework, competent regulatory authority and/or national programme with the aim of ensuring that high safety standards are achieved in the safe management of spent fuel and radioactive waste. The outcomes of any peer review shall be reported to the Commission and the other Member States, and may be made available to the public where there is no conflict with security and proprietary information.

11.1. IRRS and ARTEMIS review missions

Denmark has invited the IAEA to conduct full scope IRRS and ARTEMIS missions in the spring of 2020 in accordance with the requirements in Council Directives 2009/71/Euratom, article 9.3 regarding national framework and authorities for nuclear safety and 2011/70/Euratom, article 14.3 regarding the national framework, competent regulatory authority and national programme.

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