DANISH HEALTH AUTHORITY
Radiation Protection

2020

Joint convention on the safety of spent fuel management and on the safety of radioactive waste management

NATIONAL REPORT FROM THE UNITY OF THE REALM

DENMARK

GREENLAND

7TH REVIEW MEETING

Health for all

Joint convention on the safety of spent fuel management and on the safety of radioactive waste management

National report from the Unity of the Realm, Denmark, Greenland
7TH Review meeting

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Introduction

The present report consists of the combined reporting from Danmark (Denmark) and Kalaallit Nunaat (Greenland) under the obligations to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste.

Rigsfællesskabet (the Kingdom of Denmark) encompasses Danmark, Kalaallit Nunaat and Førøyar (Faroe Islands), and is collectively termed The Unity of the Realm. Due to their special status - nationally, historically and geographically - the Faroe Islands and Greenland both enjoy autonomous authority within the fields of responsibility taken over, which results in an extensive type of self-government.

The Self-Government arrangements transfer legislative and executive powers and responsibilities within specific defined fields from the Danish political authorities to the Faroese Home Rule authorities and to the Greenlandic Self-Government authorities. The arrangements likewise provide for the Faroese and Greenlandic governments to assume the field of administration of justice, which has been assumed in several underlying administrative areas, while Denmark will remain constitutionally responsible for foreign, defence and security policy matters.

The Faroese and Greenlandic authorities administer the tasks taken over from the state of Denmark, enact legislation in these specific fields and have the economic responsibility for solving these tasks. The state of Denmark provides an annual grant to the Faroese and the Greenlandic authorities.

More in-depth descriptions of the rights and responsibilities of the Greenland Self-Government are available at the Danish Prime Minister's office[1] and the Government of Greenland (Naalakkersuisut)[2], respectively.

The Kingdom of Denmark signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 29 September 1997, the day it opened for signature. The Convention was accepted 3 September 1999 by letter from the Ministry of Foreign Affairs to the International Atomic Energy Agency (IAEA).

On 15 December 2016, the Kingdom of Denmark withdrew its territorial declaration with regard to Greenland made upon acceptance of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

[1] The Greenland Self-Government Arrangement
[2] Politics in Greenland

Given the extensive powers of Self-Government arrangements for Greenland, which include independent legislative competences in the fields of radiation protection and radioactive waste management, Greenland is thus under obligation to report independently to the Convention on the application of widely recognized principles and tools for high-quality safety management of radioactive waste.

As the regulatory infrastructure and the operational measures to ensure safe management of radioactive waste in Greenland differ from corresponding Danish arrangements, the present report contains separate contributions from Denmark and Greenland, respectively.

The Convention does not apply to the autonomous territory of the Faroe Islands.

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Section A. Introduction

The present report is the Danish National Report for the Seventh Review Meeting to the Convention. The meeting takes place from 24 May to 04 June, 2021 at IAEA headquarters, Vienna. As described in the Guidelines regarding the Form and Structure of National Reports, (INFCIRC/604 rev. 3, 18 December 2014) duplication within the reporting, including repetition of former reports, should be avoided. At the same time it is stated that the report should be a stand-alone report. Consequently, the present report includes summarised presentations of previous developments and focusses on what is considered highlights and new developments since the National Report from the Sixth Review Meeting. Readers wishing a more detailed description of the Danish practices and understanding of the development before 2018 will find the former reports as well as the questions and answers submitted via the homepage for the Joint Convention.

The main developments since the Sixth Review Meeting centre around the adoption of a new policy for achieving a final national management solution for radioactive waste in Denmark and the continued progress in decommissioning activities. In this respect, work has progressed in relation to 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, 4) decommissioning of the Waste Management Plant. Below, the current status is briefly summarised.

New policy for long term management

Since the spring 2018 meeting, a Parliamentary Resolution B90 (2018) for a Long-Term Solution for Denmark’s Radioactive Waste was adopted. Hereby, the Government has established a national policy with provisions for the safe management and disposal of the combined amount of radioactive waste arising from institutional use as well as from decommissioning of the Danish nuclear facilities.

Parliamentary Resolution B90 specifies the end goals for management and disposal of these waste streams, and defines the responsibilities of Danish Decommissioning as waste management organization in the framework of B90. The resolution aims to implement a long-term solution for Denmark's radioactive waste with a view to continued safe storage until the waste is placed in a disposal facility. Parliamentary Resolution B90 also allows for the – in parallel – continued exploration of the possibilities for an international solution for the most radioactive part of the waste, the so-called “special waste”. The special waste will, at the latest at the point in time where a planning act for a geological disposal facility is passed, be included in the inventory to be disposed of in Denmark, should an international solution not have been found for this minor amount of waste.

Decommissioning

The Danish nuclear facilities are all located on the Risø peninsula (Risoe site) to the North of Roskilde. Decommissioning has been in progress since 2003, when responsibility for operation and decommissioning of the nuclear facilities, as well as continued waste management at the Waste Management Plant was transferred to Danish Decommissioning (DD). DR 1 (Danish Reactor 1) is fully decommissioned and released from regulatory control. As of 2008, DR 2 (Danish Reactor 2) is also fully decommissioned, but the reactor building has not been released from regulatory control, as it serves as a handling and storage hall for decommissioning works associated with the Hot Cell Facility and of DR 3. With respect to DR 3, decommissioning has progressed to the point where only the structural component of the biological shield remains to be removed before decommissioning of the reactor hall can commence. In the Hot Cell Facility, the initial remote cleaning of all 6 cell units is complete, and each cell is now ready for secondary robotic cleaning. As for the Fuel Fabrication Facility, decommissioning works were completed early 2014, but a slight contamination in the basement during final radiological survey was discovered and now awaits decontamination. Once decontamination of the concrete floor is complete, the final decommissioning report can be submitted to the Nuclear Regulatory Authorities[1]. In May 2019 the Nuclear Regulatory Authorities approved the decommissioning plan for the Waste Management Plant. The preparatory work for the decommissioning of the Waste Management Plant is ongoing.

The present report considers the challenges mentioned in the Rapporteur's Report for Denmark at the 2018 meeting:

- Public acceptance regarding the long-term storage facility at the Risoe site, Denmark
- Adjustment of Denmark's waste management infrastructure and design of all relevant aspects of the strategy to accommodate policy on long-term storage and disposal by latest 2073.

These challenges are mainly addressed in Section H.2

The report is prepared by the Danish Health Authority, Radiation Protection under the Ministry of Health, with contributions from Danish Decommissioning, the Nuclear Division of the Danish Emergency Management Agency, and the Danish Agency for Higher Education under the Ministry of Higher Education and Science. The report demonstrates that Denmark meets all obligations of the Convention.

An overview matrix is presented in the Annex of this report in Section L.2.

[1] The Danish Health Authority and the Danish Emergency Management Agency jointly constitute the Nuclear Regulatory Authorities (details on the national framework are given in Section E).

Section B. Policies and Practices

The policy and practice for radioactive waste management is to collect, characterize, manage and store all Danish radioactive waste under safe and secure conditions in dedicated storage facilities under responsibility of Danish Decommissioning (DD) as described in the following subsections of Section B. The purpose of storage is ultimately to facilitate safe management of Denmark´s radioactive waste until disposal solution for all waste types has been achieved.

The availability of adequate financial resources for these processes is assured also in the future, inasmuch as Danish Decommissioning is government property under the administration of the Ministry of Higher Education and Science. Thus the financial capacity to maintain and, if necessary, improve the safety of facilities for spent fuel and radioactive waste management in accordance with the regulatory requirements is ensured.

B.1. Policy and strategy for spent fuel and waste management

B.1.1. National policy for safe management of spent fuel and radioactive waste

The Government has made provisions for the safe decommissioning of the nuclear facilities at the Risoe site, the safe management and disposal of radioactive waste, and the safe management of spent fuel by the adoption of Parliamentary Resolution B48 (2003) and Parliamentary Resolution B90 (2018).

Decommissioning

The Danish Parliament adopted Parliamentary Resolution B48 on the decommissioning of nuclear facilities at Risø Research Center on March 13, 2003. Herein, the Danish Parliament announces its agreement that the Government will promote the decommissioning of the nuclear facilities at Risoe Research Center under the independent undertaking DD, in order to release the areas for unrestricted use within a timeframe of up to 20 years. Pursuant to the resolution, the Danish Parliament also gave consent that the government, at the time of the dismantling (decommissioning), was to start preparing a basis for decision for a Danish disposal facility for low- and medium-level waste.

Inventory

The national inventory of radioactive waste comprises LLW and ILW (IAEA, GSG-1) as detailed in Section D. The inventory comprises a small amount of so-called “special waste”, primarily consisting of 233 kg (HM) of experimentally irradiated spent fuel segments, which underwent physio-chemical and metallurgical examinations in the years 1968-1990 and has a combined inventory of approximately 533 TBq out of which about 35 TBq is long-lived alfa-emitting nuclides. Heat generation is insignificant and provisions

for cooling are not required. In the combined inventory of radioactive waste, the alfa emitting nuclides in the special waste constitutes approximately 90 % of the long-lived waste, while the remainder of the activity in the special waste comprises about 40 % of short-lived activity in the overall inventory.

Total estimated volumes of waste to be disposed of, once decommissioning is completed, is estimated in the range of 5-10.000 m^3 (conditioned form).

Disposal

The Danish Parliament adopted Parliamentary Resolution B90 on a long-term solution for Denmark's radioactive waste on May 15, 2018. Parliamentary Resolution B90 aims to implement a long-term solution for Denmark's radioactive waste with a view to continued safe storage until the waste is placed in a disposal facility. Parliamentary Resolution B90 enables the short-term upgrade of the DD's existing storage facilities at the Risoe Peninsula through the construction of a new storage facility. Parliamentary Resolution B90 facilitates - in the medium term – geological studies at depths of up to 500 meters in order to identify possible sites for a deep geological disposal facility in Denmark. After this, a location of the disposal facility can be recommended based on a number of analyses of geological, physical and socio-economic and safety conditions. In the long term, Parliamentary Resolution B90 will enable the establishment of a deep geological disposal facility for commissioning by 2073 at the latest.

Parliamentary Resolution B90 also allows for the – in parallel – continued exploration of the possibilities for an international solution for the most radioactive part of the waste, the so-called "special waste". The special waste will, at the latest at the point in time where a planning act for a geological disposal facility is passed, be included in the inventory to be disposed of in Denmark, should an international solution not have been found for this amount of waste.

According to Parliamentary Resolution B90, a geological disposal solution could also be considered for NORM waste, which is currently stored by the waste owner under safe and secure conditions in dedicated storage facilities until a disposal option is decided upon.

Parliamentary Resolution B90 includes provisions for financing of decommissioning and establishment of a deep geological disposal facility for commissioning by 2073. Funding is provided through dedication of financial reserves in The Finance Act for these activities.

Through B90, the remit of activities for DD has been expanded in order to enable DD to actively engage in relevant activities, including research, necessary to implement the decisions adopted in Parliamentary Resolution B90.

B.1.2. National strategy for safe management of spent fuel and radioactive waste

A national strategy (programme) was established in response to Parliamentary Resolution B48, and an update of this strategy to match the specific interim and end targets of Parliamentary Resolution B90 is in progress. The updated strategy will be established according to the relevant parts of the body of IAEA standards as well as in accordance with the articles of Council Directive 2011/70/EURATOM, and is foreseen to enter into force by January 2021.

B.2. Management policies and practices of spent fuel and radioactive waste at Risoe site

There are currently no operational nor closed disposal facilities in Denmark. The Danish policy for safe management of spent fuel and radioactive waste generated from the operation and decommissioning of the Danish nuclear facilities at the Risoe site and institutional waste generated in industry, research and medical use, is established in Parliamentary Resolution B90 adopted in 2018. The policy covers all radioactive waste generated from institutional use and decommissioning of the nuclear facilities at the Risoe site, and states that long-term safe management is to be achieved through storage of waste for a period of up to 50 years, before disposal of all waste in a geological disposal facility. Pursuant of Parliamentary Resolution B90, development of the geological disposal facility has commenced in 2018. Parliamentary Resolution B90, chapter 4, expresses the safety objectives underpinning the resolution as a whole.

For decommissioning of the nuclear facilities and the Risoe site, the Nuclear Regulatory Authorities have issued Operational Limits and Conditions (BfDA) for the operational and decommissioning activities undertaken by the state owned operator of the nuclear cacilities, Danish Decommissioning (DD). The BfDA mirrors the provisions in Executive Orders 669/2019 and 670/2019 through regulatory requirements (licence conditions) adapted to the specificities of the work performed by DD.

DD is the main generator and responsible manager of radioactive waste in Denmark, and DD also has responsibility for pre-disposal management, incl. storage of spent fuel (“special waste”) and radioactive waste from the operation and decommissioning of the nuclear facilities as well as other institutional radioactive waste generated in Denmark. The generalised framework for management of radioactive waste is illustrated in Figure 1.

Licensees may discharge radioactive waste (liquid and gaseous) if this is otherwise suited for discharge, according to the provisions in Executive Order 670/2019. Alternatively radioactive waste may be transferred for further processing, which may lead to discharge, for instance by incineration, or treatment with the aim to reduce volume or with a view to re-cycle or re-use. Radioactive waste not suited for discharge, must be transferred either for further processing or to DD. DD, within it remit of activities works towards reducing the amounts of radioactive waste to be disposed of. Both licensees and

DD may release material from regulatory control, including waste, from regulatory control, if upon decay, the criteria for release of material from regulatory control are satisfied. Licensees may store radioactive waste for up to 1 year with a view to release material from regulatory control, whereas DD may store waste up until the point in time, where a national disposal facility is available.

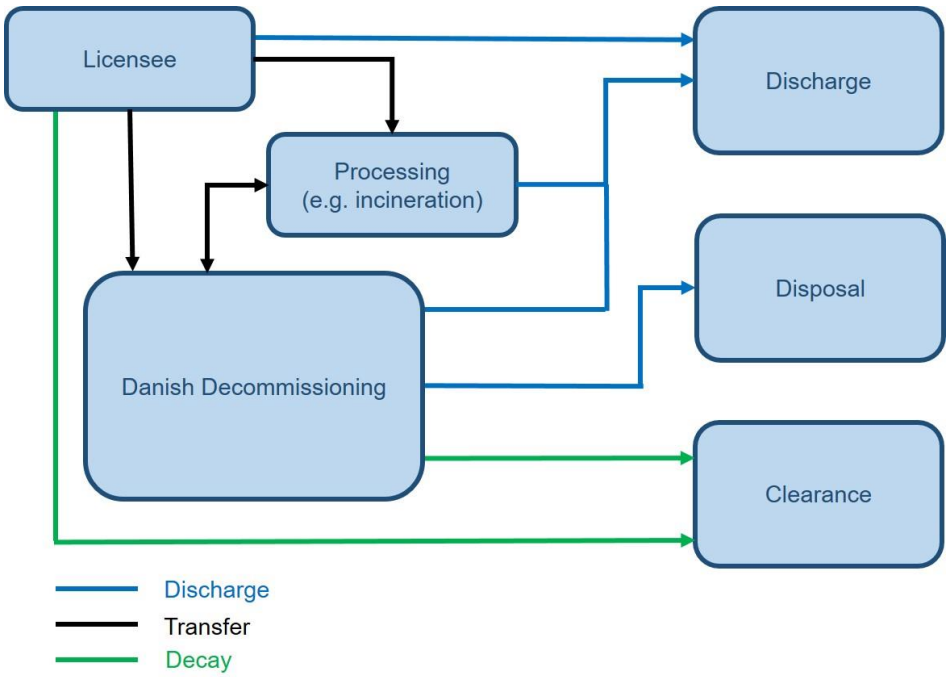

Figure 1: Generalised framework for management of radioactive waste in Denmark.

Radioactive waste produced as a result of activities in oil and gas industries, as a by-product of geothermal heat generation, at water treatment plants etc. are subject to the same regulatory regime as specified above. Radioactive waste from these activities is stored at facilities operated by the waste-generators, awaiting development of a final management solution for these types of radioactive waste.

Section C. Scope of Application

Article 3

As Contracting Party to the Joint Convention, Denmark has declared that:

- Reprocessing is not part of the spent fuel management.
- Waste that contains only naturally occurring radioactive materials is not radioactive waste for the purpose of the Convention.
- Spent fuel or radioactive waste within military or defence programmes is not spent fuel or radioactive waste for the purpose of the Convention.

However, waste that contains only naturally occurring radioactive materials (NORM-waste) as well as radioactive waste from the Danish military or defence programmes, is managed identically to the radioactive waste described in this report, as this kind of waste in Denmark is also covered by the legislative and regulatory system portrayed in Section E.

Section D. Inventories and Lists

Article 32, Paragraph 2

D.1. Spent fuel management facilities

The amount of “special waste” in terms of volume and mass remains unchanged, as there are no spent fuel management facilities located in Denmark, and no processing abroad has been pursued. The present situation is described below.

Danish Decommissioning (DD) facilitates the storage, surveillance and security of the spent fuel at the Risoe site. Special precautions for heat dissipation are not necessary for these materials. Table 1 below shows details and actual amounts of special waste stored at Danish Decommissioning.

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	28.4 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	533 TBq fission products 35 TBq Actinides

Table 1: Specification of the source of spent fuel as well as the material composition and quantities with regard to mass/volume and activity as of January 2020.

The mass and the material composition of the spent fuel remains unchanged since the last reporting. Thus, the nuclide composition is overall the same with a small adjustment in the activity due to the nuclear decay; the fission products, ^{137}Cs and ^{90}Sr, and the actinides, ^{239}Pu and ^{240}Pu, almost exclusively account for the current activity of the Danish Reactor 1 (DR 1) spent fuel.

Similar to the DR 1 spent fuel, the amount of experimentally produced and irradiated segments of spent fuel of power reactor type remains the same. Accordingly, the calculated activities are decay corrected to the datum of 01-01-2020 using the safeguard

records and burnup scaling factors. The most notable fission products are ^{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.

D.2. Radioactive waste management facilities

An overview of nuclear facilities and associated buildings at the Risoe site is given in Figure 2. Building numbers and their respective names are listed in Table 2.

As a consequence of the planned decommissioning activities at the Waste Management Plant, the waste water evaporator installed in 2016 was relocated in 2019 to building 217, adjacent to the Danish Reactor 3 (DR 3).

Following inspection and approval by the Nuclear Regulatory Authorities ultimo 2005, the Radiological Characterization Laboratory (or A-lab) for sampling and characterisation of radiological materials from the nuclear facilities, buildings, and surroundings was commissioned. Since, the laboratory has been through several external audits of quality assurance according to DS/EN ISO 9001: 2015, and last audit was in 2019. As an example of the work being carried out at the laboratory it can be mentioned, that all filled drums intended for storage in the Low Level Waste Storage are characterized at the Radiological Characterization Laboratory using Ge-detectors prior to storage.

The Clearance Laboratory (F-lab) for decommissioning waste upholds an independent accreditation (ISO/IEC 17025:2005), granted by DANAK in 2007, and confirmed during the latest audit in 2019. The Clearance Laboratory handles clearance tasks with no restrictions on the amount or type of decommissioning waste.

Since the publication of the last national report, approximately 101.5 tons of material passed the clearance test and subsequently has been released from the regulatory control of DD. This number does not include materials released in 2020, as the materials released in the period 2020 to 2023 will be reported in the subsequent National Report.

Inventories of radioactive waste subject to the Convention are given in Table 3 for conditioned waste and in Table 4 for unconditioned waste, respectively. Secondary waste received over the last three years is presented in Table 5, which includes secondary waste (waste with a non-decommissioning origin generated at the Risoe site) as well as unconditioned waste received from external producers.

The volume of waste stored at the Low Level Waste Storage remains essentially unchanged compared to previous years (Table 3).

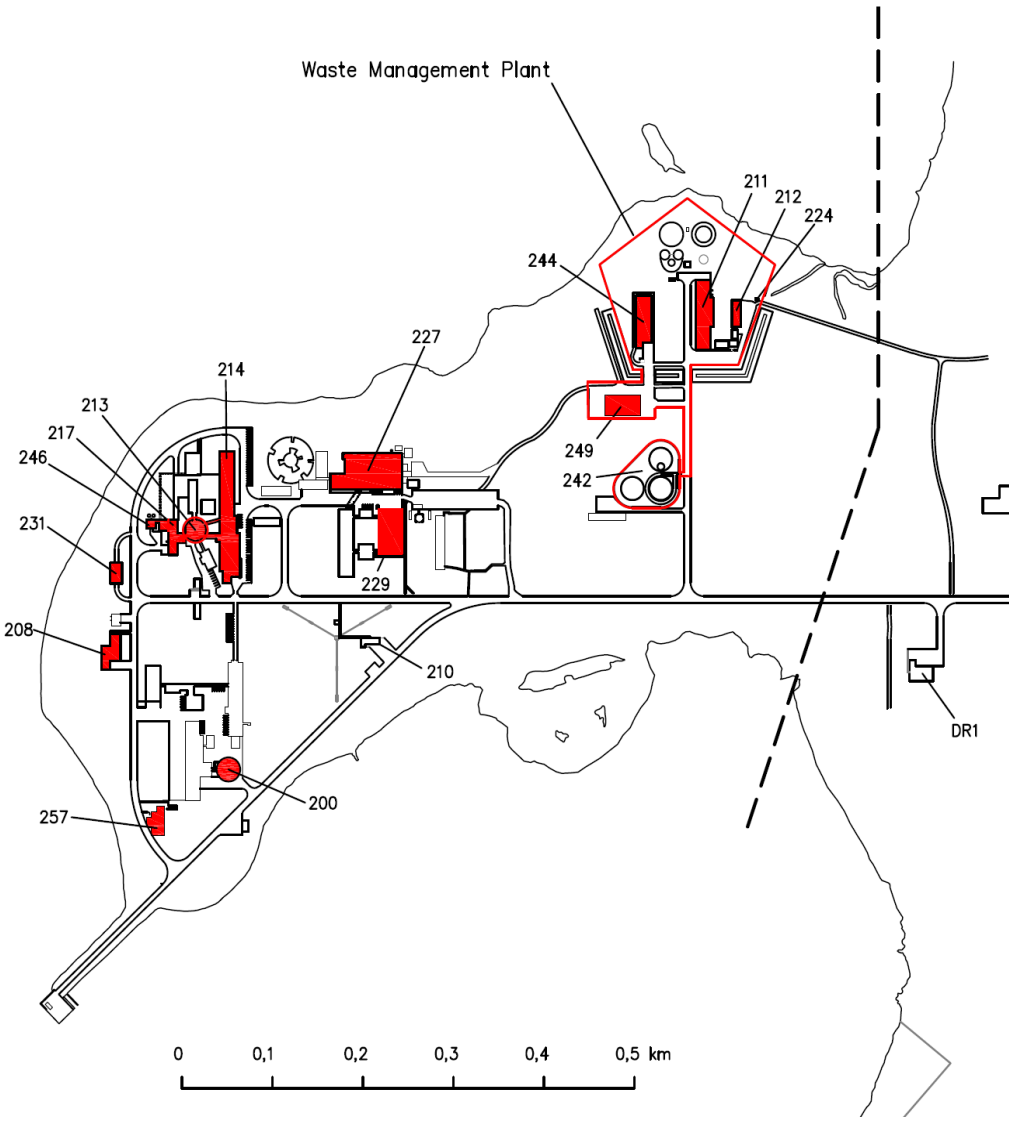

Figure 2: A map of the Risoe Peninsula/Risoe site. The objects marked red resemble the building managed by DD. Each red building has a number attached, which corresponds to the building number in Table 2.

Building number	Danish designation	English designation
200	H-hallen (DR 2, reaktorhal)	DR 2 Reactor Containment Hall
208	Aktivt Laboratorium (A-lab)	Radiological Characterization Laboratory
211	Behandlingsstationen	Waste Management Plant (main building)
212	Tromlelager	Drum Storage (including drum press)
213	DR 3, reaktorhal	DR 3, Reactor Containment Hall
214	Kontorbygning og DR 3 AH-hal	Office building and DR 3 Active Handling Hall
217	DR 3, driftsbygning Inddampningsanlæg	DR 3 (auxiliary building) Radioactive water treatment
224	Lager for radioaktive væsker	Storage of Radioactive Liquids
227	Hot Cell	Hot Cell Facility
229	Teknologihallen	Fuel Fabrication Facility
231	Centralvejslager	Centralvej Storage
242	Tailingsbassiner og malmbunker	Tailings pools and ore heap
244	Lager for Lavaktivt Affald	Low Level Waste Storage
246	Bygning der rummer tanke til aktivt spildevand	Building including tanks for radioactive waste water
249	Mellemlager og Bufferlager	Intermediate Storage
257	Frigivelseslaboratorium (F-lab)	Clearance Laboratory

Table 2: List of buildings managed by DD. The location of each building on the Risoe Peninsula is shown in Figure 2.

In 2019, a repackaging of 350 drums with a total volume of just under 100 m^3 from the Low Level Waste Storage was concluded. The drums were repackaged to larger steel-containers and stored in the Intermediate Storage. The lowering of the volume at the Low Level Waste Storage did not cause a noteworthy decrease in activity.

The Sixth National Report declared that the Intermediate Storage contained an activity of 112 TBq and a mass of 808 tons. The values have since then increased significantly. The increase in activity is largely due to the addition of graphite from the former reactor DR 3, where in particular ^{3}H and ^{152}Eu account for the main portion of the activity. A large quantity of experimental rigs previously used in DR 3 has also been added. The increase in mass is a result of the addition of drums from the Low Level Waste Storage and concrete used as radiation shielding for the added rigs. Furthermore, a campaign of drying and repackaging around 100 drums contributed to the increase in mass.

Storage facility	Mass (tons)	Activity (TBq)
Low Level Waste Storage	~1,100	6

Table 3: Inventory of conditioned radioactive waste stored at Danish Decommissioning, classified as low and intermediate level waste (LLW & ILW) as of January 2020.

Storage facility	Mass (tons)	Activity (TBq)
Drum Storage and Centralvej Storage	~130	424
Taillings pools and ore heap	4,800	0.1
Intermediate Storage	1,605	234

Table 4: Inventory of unconditioned radioactive waste stored at Danish Decommissioning as of January 2020, classified as low and intermediate level waste (LLW and ILW).

Year	2017	2018	2019
Secondary waste from the Risoe site	5.0 tons	2.2 tons	36.0 tons
Secondary waste from external waste producers	5.3 tons	10.0 tons	2.5 tons

Table 5: Unconditioned secondary waste generated from the decommissioning project and received from external sources.

Since the last national report volume reduction through incineration was carried out in 2015 at Studsvik Nuclear AB, a second round of volume reduction was performed in 2019 – this time under the name of Cyclife Sweden AB.

The incineration campaign was able to reduce 5584 kg of combustible radioactive waste by approximately 90%. The total activity of this waste was determined to be 39.9 MBq before the incineration. The resulting waste fraction from combustion containing the activity has since been returned to DD.

The contract with Cyclife Sweden AB still stands and once the mass of combustible radioactive waste reaches above a certain point, DD will undertake a new incineration campaign.

Secondary waste generated during the decommissioning activities at the Risoe site by DD consists of used consumables (lab coats, gloves, etc.). Decommissioning waste consists of dismantled parts, building components, etc. from the dismantling and demolition of the nuclear facilities. Quantities of secondary waste received from external waste producers (i.e. hospitals, industries etc.) generally vary between 2 and 10 tons per year. In 2018, DD received 6.6 tons of ionization smoke detectors, which account for the notable fluctuation of received secondary waste. The large spike of secondary waste from the Risoe site in 2019 stems in part from 28 tons of equipment and radiation shielding, which were used in relation to the decommissioning of DR 3.

D.3. Nuclear facilities under decommissioning

The decommissioning work at the Risoe site is progressing, and in the following a status is given for the completed decommissioning work and for the ongoing decommissioning work at the Risoe site. The emphasis is on the decommissioning of the Hot Cell Facility, Danish Reactor 3 (DR 3), Fuel Fabrication Plant, and the facilities of the Waste Management Plant.

An overview of the decommissioning status of each nuclear facility at the Risoe site is given in Table 6. Details on completed and ongoing decommissioning activities at the Hot Cell Facility, DR 3, the Fuel Fabrication Plant, and the Waste Management Plant are presented in the following subsections.

Nuclear facility	Type	Taken out of operation	Decommissioning status
Danish Reactor 1 (DR 1)	Small homogeneous 2 kW reactor mainly used for educational purposes	2001	Fully decommissioned and the building was released from regulatory control in 2006.
Danish Reactor 2 (DR 2)	5 MW research reactor of the open pool type	1975	The reactor is fully decommissioned, but the Reactor Containment Hall is in used for storage and handling of waste objects.
Danish Reactor 3 (DR 3)	10 MW heavy water research reactor of the PLUTO type	2000	The decommissioning of DR 3 has progressed and only the structural component of the biological shield remains to be removed before decommissioning of the reactor hall can commence.
Hot Cell Facility	Facility for post irradiation investigations of nuclear fuel	1989	Initial remote cleaning of all 6 cells is complete, and each cell is ready for secondary robotic cleaning.
Fuel Fabrication Plant	Fuel Fabrication Plant for DR 2 and DR 3	2002	Decommissioning were completed early 2014, but slight contamination in the basement was discovered during final radiological survey and awaits decontamination.
Waste Management Plant	Radioactive waste management facilities	2019	In May 2019, the Nuclear Regulatory Authorities approved the decommissioning plan. The preparatory work and initial decommissioning of building 211 is ongoing.

Table 6: Nuclear facilities decommissioned or under decommissioning at the Risoe site.

D.3.1. Danish Reactor 1 and Danish Reactor 2

The decommissioning of the Danish Reactor 1 (DR 1) and the 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 Risoe site.

In 2019 DD designed and established a new ventilated enclosed decommissioning facility in the reactor building of DR 2 to be used for handling (e.g. facilitating various techniques such as the use of plasma cutting, angle grinding, flame cutting, nibbling, sawing etc.) and packing of lager contaminated objects. The facility was approved by the regulatory authorities and put into operation in July 2019.

Details on the decommissioning of DR 1 and DR 2 reactors are given in the Third National Report.

D.3.2. Danish Reactor 3

The Danish Reactor 3 (DR 3) was put into operation in 1960 and permanently shut down in 2000. The final plan for decommissioning of DR 3 was approved by the Nuclear Regulatory Authorities in late 2011. The decommissioning of DR 3 is divided into a number of phases, which are summarized in the following subsections.

Phase 1

The dismantling and removal of the peripheral systems (cooling systems, experimental set-ups, and electrical systems) was fully completed at the end of 2011.

Phase 1 included clearing of the three decks in the reactor building:

- The top deck was cleared by the end of 2009
- The 1st floor was cleared by the end of 2010
- The basement was cleared by the end of 2011

Phase 2

Phase 2 included the dismantling of the primary cooling system in the heavy water plant room, which was completed at the end of 2012. The decommissioning report was finally approved by the Nuclear Regulatory Authorities in February 2017.

Phase 3

Phase 3 was initiated in 2012 and included the removal and dismantling of the internal reactor parts:

- Top Shield Plug (TSP) – completed in May 2014
- Top Shield Ring (TSR) – completed in October 2014
- Reactor Aluminum Tank (RAT) - completed in 2017
- Graphite reflector – completed by the end of 2018
- Cast layer of led – completed by mid-2019

Details on the removal of the Top Shield Plug (TSP) and Top Shield Ring (TSR) were presented in the Fifth National Report from Denmark to the Convention.

As part of Phase 3 a temporary Packing Hut and Manipulator Box was installed on top of the Movable Top Shield (MTS) to facilitate remote robotic dismantling and removal of the

internals of the reactor. The unit was mounted with a single hydraulic unit. The whole unit was operated from a control room in the basement of the reactor hall.

The decommissioning work of phase 3 was completed by mid-2019.

Phase 4

Phase 4 began in 2019 and covers the demolishing of the external reactor parts and the reactor block:

- Boral plates – ongoing
- Inner and outer steel tank – ongoing
- Lead shielding – ongoing
- Concrete – ongoing

Progress since last national report

The internal parts of DR 3 consists of the Reactor Aluminium Tank (RAT), the Graphite reflector and the cast layer of lead.

Remote cutting of the Reactor Aluminium Tank (RAT)

After some initial problems with the Helium gas for the plasma cutter, a mix of Helium and Nitrogen was found efficient and the cutting proceeded well. By mid- 2017 around 80% of the RAT was cut and put into three DD type 2 containers with extra shielding.

The next step was to remove the liner tubes going from the RAT through the biological shield to the outside, making it possible to remove the big aluminium piece seen on the right in Figure 4 (there are four in total). Then the grid plate was cut and put into a special shielded container with an extra 100 mm of steel to keep the dose rate on the outside of the container below 2 mSv/h.

By the end of 2017, the entire Reactor Aluminium Tank (RAT) was cut up (Figure 4). In total the RAT filled six DD Type 2 steel containers; five of these had an additional shielding of 30 mm steel built-in.

In general, the cutting went well. All the chosen tools and equipment worked without any major problems.

Figure 3: Inside the reactor, grid plate and experimental tubes

Figure 4: RAT has been cut up and taken out. Next step is vacuuming.

Emptying the storage facilities – Experimental rigs

The saw developed by DD for cutting up the old experiments in storage was completed and tested by early 2017 (Figure 5).

After many tests, the best blade for the saw turned out to be the type with diamonds. The width of the cutting segments was the key for the positive tests.

Figure 5: View of saw for cutting old experiments. The front shielding is not shown.

Built-to-order containers were made by the company Bladt (Aalborg, Denmark) including 11 special designed containers for the Coarse Control Arms (CCA). They have around 20 cm of steel for shielding and are made out of an axel for a ship's propeller. Furthermore a special designed container for the cut Flux Scan Absorbers (FSA) were delivered. These were put into the centre of the Jumbo container, which holds the doughnut shaped Top Shield Ring (TSR). This in order to minimise the amount of free space in the container.

The Flux Scan Absorbers (FSA) were cut into 10 cm pieces with the hydraulic cutter in the spent fuel pond. They were then transferred into a stainless steel basket. This was then put into the TSR shielded centre container.

This centre container was - with assistance from Mammoet - put into the Jumbo container containing the TSR and four corner containers, and the last fuel element plugs were put into four ¼ moon containers and also put into the centre of the TSR container as shown in the picture below.

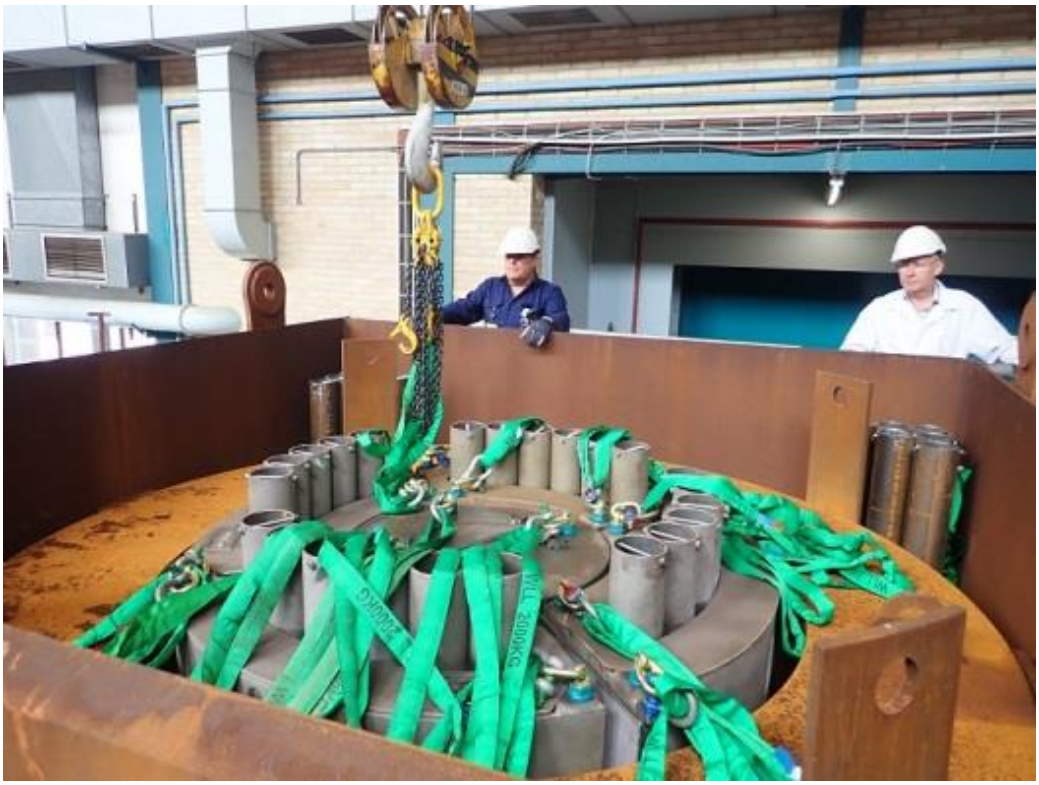

Figure 6: The centre of TSR is filled with the centre container surrounded by the four ¼ moon containers.

Mammoet then transported the full TSR container back into the Intermediate Storage.

The Zr-rigs were cut in the spent fuel pool to alleviate potential problems with self-combustion (Figure 7). The cut pieces were put into a basket, and then transferred to a DD Type 2 steel container.

In the same container, the FS-rigs were stored after being cut. In order to meet the requirement for a dose rate on the outside of the container of less than 2 mSv/h. The design for a new container for the rigs was finally defined and used. Four drums (previously used for storing heavy water) were reused and placed in a standard DD type 2 steel container and back-filled with concrete (Figure 8).

In 2019 all the 4” rigs in the external storage Block have been removed, cut and packed. A large amount of the 7” rigs have also been handled. These rigs have been placed in DD type 2 steel containers with extra concreted shielding inside.

Figure 7: Cut Zr-rigs

Figure 8: Four steel drums placed in a standard DD type 2 steel container back-filled with concrete

Removal of paint by CO_2 ice blasting

During the summer of 2017, a sub-contractor was hired to remove the paint from the four sides of the biological shield. Because the inner most paint layer had an exceptional good adhesion to the metal, it was necessary to use a small amount of granite as an add-on the CO_2 ice. Following ablation, all four sides were ready for the cutting of the biological shield.

After the removal of the paint from the facades of the biological shielding, a test was made of the dust and air in the reactor hall. The test showed a value of lead in the dust

above health and safety limits. Following a four weeks cleaning period of the entire reactor building, tests verified the removal of lead from both the dust and air.

Remote removal of the Graphite reflector
After cutting up the Reactor Aluminium Tank (RAT), the next task in dismantling the reactor internals was to take out the 685 graphite blocks. This task was started in January 2018.

The Graphite reflector consists of 13 layers, 11 in the cylindrical part and two in the bottom part. It was necessary to break the first block in each layer to make it possible to lift out the rest of the blocks.

During the first work, four different tools were developed for the job: a pneumatic chisel, a pneumatic drill, a handsaw and a pneumatic vacuum lifter (Figure 9 and Figure 10). With the drill, it was possible to perforate the first graphite block in each layer.

The hydraulic cutter was then used to break parts of the first block, where one of the 4VGR experimental tubes had passed through the block.

The last of the graphite blocks was removed in the later part of 2018 (Figure 11). The last layer was some more challenging that the previous. The leakage that initially shut down the reactor had caused some corrosion of the boral layer. This had fused into the graphite and caused it to stick to it. The photo in Figure 11 shows the corrosion as the white areas close to the wall.

Removal of the cast layer of lead
Work then continued with the lead that had been put between the graphite and the boral layer (Figure 13).

Due to differences in the pouring of the lead over time, some layers had not fused the together, so it was possible to pull them off as sheets. These were then put into the DD type 2 steel containers after being folded to take up as little space as possible (Figure 14).

Mid-2019 the last part of lead was removed and packed. Afterwards the equipment for the dismantling of the internals was removed, this include the dismantling of the temporary Packing Hut and Manipulator Box (Figure 15).

The Externals
The external reactor parts includes: Boral plates, Inner and outer steel tank, lead shielding and the biological shield. The reactor block is made of Baryte concrete and a layer of shot concrete around the core zone.

The preparatory work for cutting of the reactor block was carried out during the second half of 2019 and in the beginning of 2020 the first cut was made (Figure 16).

Figure 9: Drill in use

Figure 10: Vacuum lifter in use.

Figure 11: Last graphite block

Figure 12: House cleaning

Figure 13: Lead sheets being peeled off

Figure 14: Lead sheets in the DD type 2 steel container

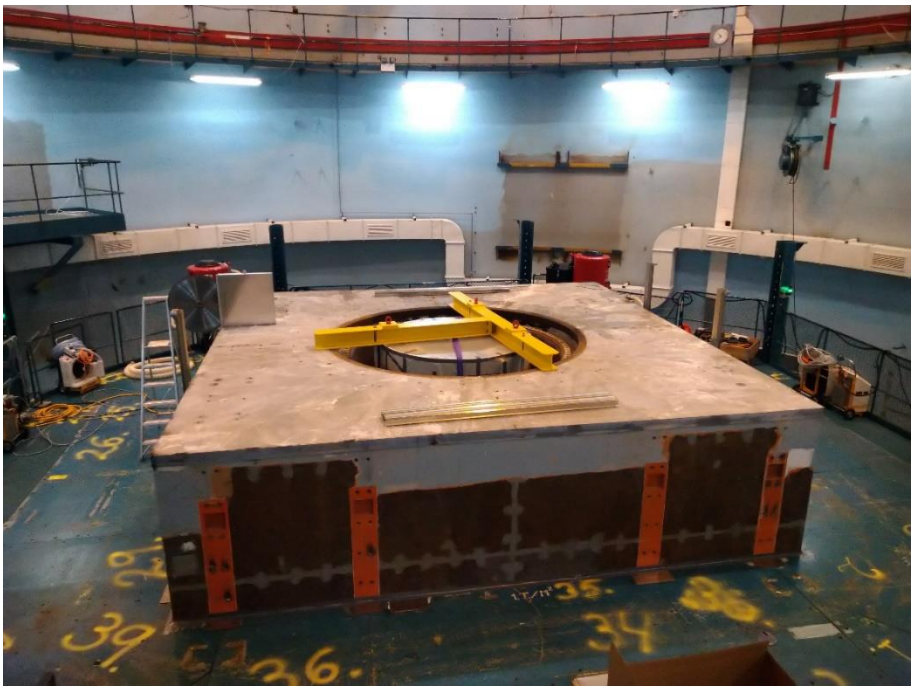

Figure 15: The deck around the biological shielding has been lowered.

Figure 16: The saw was mounted and ready to make the first cut.

D.3.3. Hot Cell Facility

The Hot Cell Facility was in active use in the years from 1964 to 1989. The facility consists of 6 interconnected concrete hot cells, each equipped with master-slave manipulators and lead glass windows. Each cell could be isolated from the next by means of a steel door. Each cell could individually be accessed from the back through a set of airtight seal-doors enclosing a concrete plug mounted on a rail system to facilitate plug removal.

The Hot Cell Facility was used for post-irradiation examination of fuel irradiated in the DR 3 reactor, the Halden reactor in Norway, and other European reactors. Examination of power reactor fuel, including plutonium enriched fuel, from several foreign reactors has also been carried out at the Hot Cell Facility. Various kinds of non-destructive and destructive physical and chemical examinations have been performed at the facility. In addition, various radiotherapy sources – mainly Co-60 sources - were produced.

As a result of the cutting and destructive testing of irradiated fuel and other irradiated materials, dust containing fission and activation products have been released within the cells. Hence, Sr-90 and Cs-137 as well as a number of transuranic α-emitters were still present in the cells as dust settled on workbenches and other surfaces. Also, hot spots on workbenches and floors occur due to the work with Co-60 radiotherapy sources, where a number of Co pellets were dropped, and not retrieved.

The originally chosen method for decontamination of the cell-interiors by sandblasting underwent re-evaluation and by 2012, an updated approach requiring rebuilding of the ventilation system in the cells was chosen.

- The rebuilding of the ventilation system was completed in the spring of 2016.
- The shutters and shutter housing and shutter of each Hot Cells were removed in 2016.
- The mechanical arms for media blasting and vacuum cleaning of the Hot Cell interiors were successfully developed and put into production.
- The sub-decommissioning plan (project description) of the cleaning of the Hot Cell Facility was approved by the Nuclear Regulatory Authorities.
- The initial cleaning of the interiors of the Hot Cells by remote controlled media blasting was initiated in the summer of 2017.

Progress since last national report

Since the last report, final testing of the equipment for remote controlled blasting showed that the equipment was working and ready for use. In the following a summary is given of how the equipment was used.

Blast cleaning

The remote blasting of the interiors of the Hot Cells has been done with the remote controlled mechanical arms through existing plugholes in the fronts of the cells (Figure 17 and Figure 18).

A mock-up of one of the Hot Cells in scale 1:1 was constructed to test and verify the function of the blasting equipment (Figure 19 and Figure 20)

The testing in the mock-up showed that it was possible to cover most of the floor with the mechanical arm and extract almost all material from the cells (Figure 19, Figure 20 and Figure 21). In areas where the arm cannot reach, it is possible to mobilize the blasting material using the blasting equipment on low airflow, hereby moving the blasting material to an area where it is reachable.

As the testing was successful, the equipment was approved for “real” use.

The last part of the remote blasting campaign was to remove as much of the hot spots as possible, and this was done in January, 2019 (Figure 23, Figure 24 and Figure 25). The results are presented in Table 7.

The cleaning started on July 27th, 2017 in Hot Cell no. 6 and by the end of 2018, the blast cleaning of all the cells was almost finished (Figure 22), except for a few hot spots.

The final effect of the remote blasting ended up being around 85%, calculated from the amount of GBq Cs-137 extracted (171,2 GBq extracted compared to expected remaining amount of 28,5 GBq).

The remaining activity is assumed to be primarily the remaning hot spots and hard to reach areas, mainly the upper third of the cells.

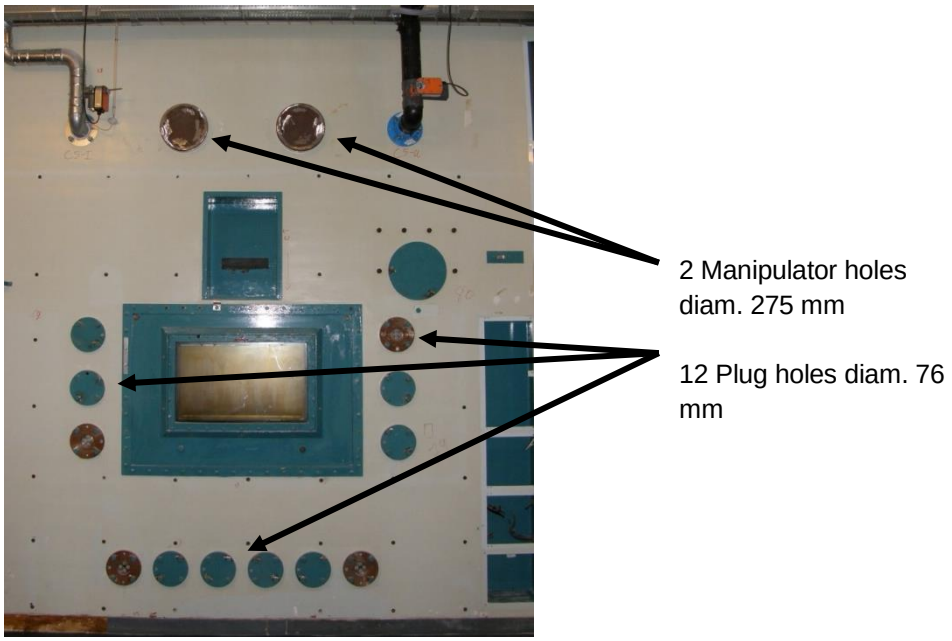

Figure 17: Front of one of the Hot Cells

Figure 18: Mechanical arm for blasting

Figure 19: Operator testing the mock-up of a Hot Cell

Figure 20: Inside of a mock-up of a Hot Cell

Figure 21: Remote blasting test within a mock-up of a Hot Cell

Hot Cell no.	Celle 1	Celle 2	Celle 3	Celle 4	Celle 5	Celle 6
Initial average dose mSv/h	2,1	1,7	1,9	0,1	0,5	0,1
Initial hot spots mSv/h	15 23 6	8	7,5 3	-	1,4	0,3
Final average dose mSv/h	0,17	0,25	0,27	0,04	0,25	0,03
Final hot spots mSv/h	0,7 0,5	0,8	0,6	-	1,4	0,3

Table 7: Doses before and after the remote blast campaign

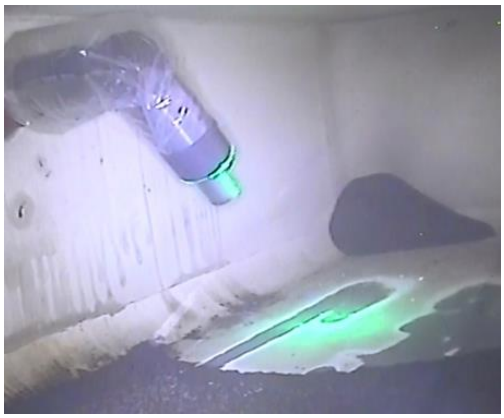

Figure 22: Sandblasting in one of the Hot Cells

Figure 23: Sandblasting a table in Hot Cell no. 6

Figure 24: Remote vacuum cleaning in one of the Hot Cells

Blasting material

Initially it was decided to use corundum as blasting material in size medium (0.5-1 mm. However, this proved to produce so much dust, that it only was possible to work for 2-5 minutes, before the dust in the air reduced visibility to a degree, where it was impossible to work. Therefore more tests were done with steel grit as blasting material and this proved to be a better solution (Figure 25).

Corundum
+ Very effective
+ Decent radiation shielding
- Poor visibility during blasting
- Dust in filters
- High wear on equipment

Steel grit+
+ Good visibility during blasting
+ No need for air purification
+ Excellent radiation shielding
+ Less filter changes
- Cost +30%
- Maybe not as effective, but close
- Heavier drums

Figure 25: Different blasting materials

Preparations for further decommissioning

Airlocks

- The original material airlock for the entire cell range was cleared and re-modelled to being the main personal airlock entrance.
- On the back of the Hot Cell range, the outer “alpha” doors (Figure 26) were removed and a 12t shielding plug was removed from Hot Cell no. 5. The big and heavy outer “alpha” doors were exchanged to lighter conventional doors as part of the new airlock outside Hot Cells no. 4, 5 and 6.

Figure 26: Outer “alpha” doors being removed from the back of the cells.

Figure 27: The robot with the first now obsolete remote controlled platform

Equipment

- The remote controlled platform for the robot, which was under development is completed (Figure 27). It´s capable of positioning the robot in the cell, so it´s possible for the robot to reach all necessary surfaces.
- The robot itself is mounted on the remote controlled platform.
- Personnel have been trained to use the robot and have been testing it in a 1:1 mock-up of a cell.
- While testing the robot/platform some weaknesses in the design of the platform became apparent and it was necessary to rethink the concept. The new concept is

under development and when finished will be tested further. The new concept is expected to be based on a more flexible wagon-like construction, which can also be used to transport equipment out of the cells.

Decontamination of the shutter openings

- In 2016 the shutters used to separate the upper part of the cells were removed. That leaves five openings, which are about 3 meters by 0.4 meters and 1 meter deep in the ceiling of the cells. This opening needs to be decontaminated from the top of the cells.
- One part of the equipment needed for this task is a lid that works as a new confinement, while working with the blast cleaning of the openings. The lid has been developed and constructed.
- The preparations and testing of the method and equipment began in late 2019 and will continue in 2020 and then the work can begin.

”Green Field” – Hot Cells

The original decommissioning plan for the Hot Cell Facility was to decommission the Hot Cells Facility, preserve building and release the facility from regulatory control, hence to *Green Field*.

To evaluate whether or not this is a realistic goal, a study was made in 2019. The study showed that especially due to the imbedded pipes and cables (Figure 28), there is too considerable a risk that this will not be possible or be very time consuming.

Because of the result of the study, the decision of not to preserve the facility has been made. This means that the entire cell range will be dismantled totally and an attempt to free release as much concrete as possible will be made.

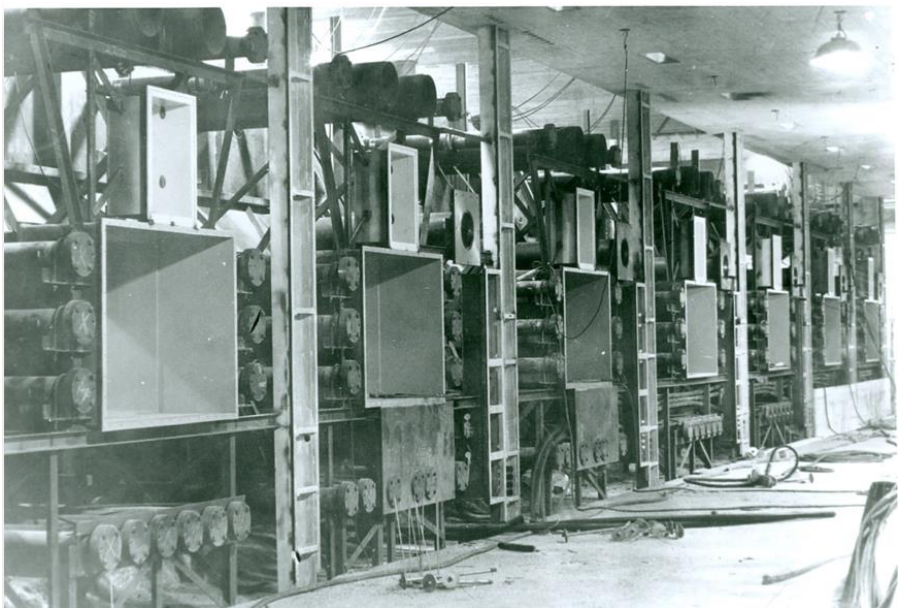

Figure 28: Picture from the construction of the cells in the 1960´s showing some of the now imbedded cables and tubes.

D.3.4. The Fuel Fabrication Plant

From the 1960s until the year of 2002, the Fuel Fabrication Plant was used for the production of uranium fuel elements for DR 2 and DR 3 research reactors. Production led to potential contamination by non-irradiated uranium powder settled with dust and deposited on equipment surfaces. The initial steps in decommissioning were presented in the Fifth National Report, where decommissioning activities comprised dismantling and cleaning the production equipment as well as clearance measurements, based on initial radiological classification of the rooms in the facility. An overview of these activities as well as further findings and decommissioning works was presented in the Sixth National Report, however a short summary is given in the following.

Based on a historical study of the operations carried out at the Fuel Fabrication Plant and radiological measurements, each area (laboratory or room) within the building was in general found to hold the predicted level of contamination as mapped out in Figure 29 and Figure 30.

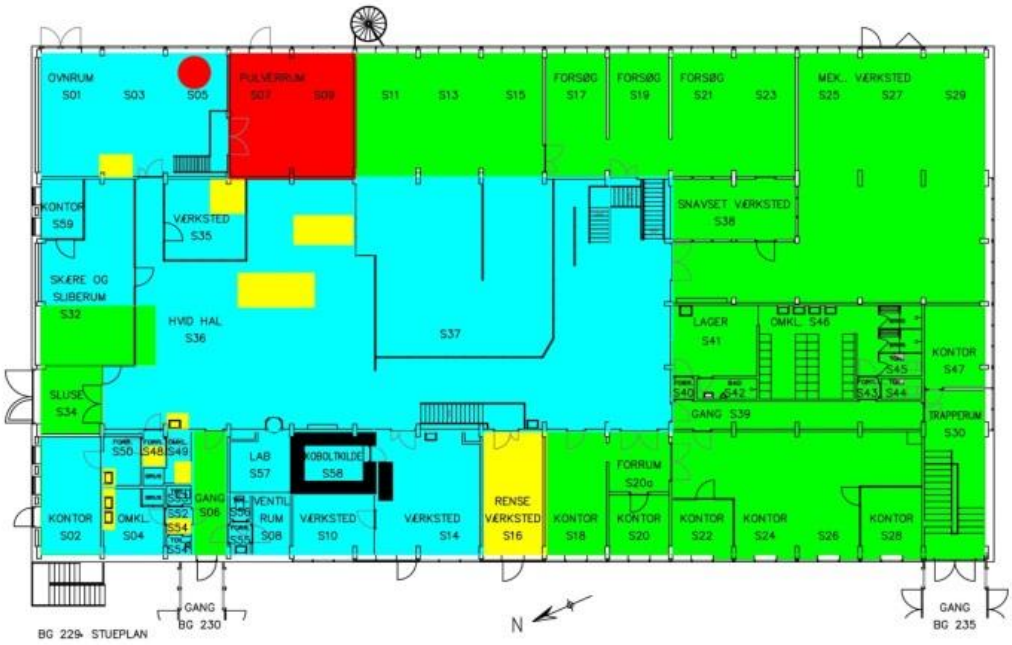

Figure 29: Classification by colours of the ground level before the start of decommissioning.

- Red – Contaminated. Areas and/or objects must be decontaminated or removed and the area must undergo a clearance process.
- Yellow – Probably contaminated. Flooring must be removed and the areas and/or object must undergo clearance process.
- Blue – Not contaminated - Individual floor reassuring measurements must be conducted
- Green – Not contaminated - no reassurance measurements are necessary / Greenfield

Figure 30: Classification by colours of the first floor level before the start of decommissioning

- Red – Contaminated. Areas and/or objects must be decontaminated or removed and the area must undergo a clearance process.
- Green – Not contaminated - no reassurance measurements are necessary / Greenfield

Decommissioning status of the contaminated areas of the Fuel Fabrication Plant

- **The degreasing workshop** (S16, marked in yellow in Figure 29) is cleared for unrestricted use (spring of 2014).
- The contaminated **vacuum oven** (indicated by a red circle in Figure 29) is removed and has been handled as radioactive waste.
- **The powder room** (designated “pulverrum” on the ground floor in Figure 29) is decontaminated and clearance measurements have been carried out.
- The entire pipe work of the **drain system** was dismantled.
- Three **ventilation systems** above the powder room were removed.

By the end of February 2015, the decommissioning plan for the Fuel Fabrication Plant was completed and the final decommissioning report was being compiled. Unexpectedly, conformational clearance measurements of the gutters below the drainpipes in a crawlspace below floor level revealed the presence of uranium contamination on the concrete floor. The uranium contamination appears as dark spots on the concrete floor of the crawlspace, where leakage has occurred due to corrosion of the gutter (Figure 31). Further characterization was revealed penetration of uranium to a depth of approximately 6 cm over an area of 1 x 21 m^2.

Due to the space limits of the crawlspace (Figure 31), a study was carried out to find a possible method for removing the upper 6 cm of the concrete floor. The method chosen was milling. A purpose built milling tool was developed (Figure 32 and Figure 33) by rebuilding a tool previously used for other tasks at the Fuel Fabrication Plant and at DR 3.

Once installed in the crawlspace, the milling tool can be operated by remote control and will not require an operator to be present in the crawl space during milling operations.

Figure 31: Crawlspace with uranium contamination in the floor

Figure 33: The closely spaced saw blades forming a milling tool capable of milling a 10 cm broad groove in the concrete

Figure 32: The milling tool in action

Development since last report

The planned work, milling of 6 cm of concrete from the basement floor, has not yet been carried out, in the anticipation that the floor might be releasable without further actions under the provisions of the new radiation protection act from 2018.

However, in September 2018 the Nuclear Regulatory Authorities rejected the application for the release of the contaminated basement floor.

Hence, the top 6 cm of the basement floor is to be removed. The task is difficult, both technically and with regard to work-environment safety due to the limited space. In addition it will be very expensive to carry out while the building is still in use.

Therefore, it has been decided to postpone the work, until other current users of the building has vacated the building (planned to take place by the end of 2021). The plan is to initiate and complete the work in the year of 2022. On that time is possible it will be possible to access the concrete floor of the crawlspace from above by removing the overlying floor structure, hereby providing easier access to the contaminated floor but also improving the working conditions.

Upon request from the Danish Nuclear Regulatory Authorities, the final decommissioning report will be split into two reports: A final decommissioning report and a clearance report. The two reports are almost finalized, only awaiting the completion of the final decommission work planned to take place in 2022.

D.3.5. Waste Management Plant

The last of the six decommissioning projects, the Waste Management Plant, was initiated in 2018.

Background

The Waste Management Plant refers to multiple buildings with various waste management facilities. The following buildings and facilities are part of the Waste Management Plant:

- Building no. 200, DR 2 Reactor Containment Hall including waste handling and packing facility
- Building no. 208, Radiological Characterization Laboratory and isotope laboratories
- Building no. 211, the main building of the old Waste Management Plant including the old radioactive waste treatment and bituminisation facility, old active laundry, old isotope laboratory.
- Building no. 212, Drum Storage and reception centre for external radioactive waste including the handling box and evaporation drum facilities
- Building no. 217, DR 3 auxiliary building including the new facilities for distillation of active waste water, storage tanks for active waste water, active laundry, and decontamination cabinet.
- Building no. 224, Storage of Radioactive Liquids
- Building no. 231 Centralvej Storage
- Building no. 242, Tailings pools and ore heap
- Building no. 244, Low Level Waste Storage
- Building no. 249, Intermediate Storage including a Buffer Storage
- Building no. 246, Building containing tanks containing radioactive waste water

- Building no. 249, Clearance Laboratory
- The conventional Water Treatment Plant

The first building to undergo decommissioning is the main building of the Waste Management Plant (Building no. 211) which contains facilities such as the old active waste water treatment (distillations) and bituminisation facility, the old active laundry, a sewing room, active laboratories and a workshop. In addition, the building holds non-active facilities such as offices, bathrooms, and changing facilities.

The main building, which was built in 1958 is an elongated, flat one-story building split lengthways by a corridor. There is a tall factory hall in the center of the building. The factory hall contains a number of concrete cells that contains parts of the old active waste water treatment and the bituminisation facility.

Compared to the other projects of decommissioning of research facilities at the Risoe site as listed in Table 6, the Waste Management Plant is unique, as it has been and is still being used for waste management and storage of radioactive waste generated from the decommissioning activities at the Risoe site, as well as for receiving and management of secondary radioactive waste from external waste producers (i.e. hospitals, industrial users etc.).

This means that some waste management and storage activities are to be continued both during and after the decommissioning of the main building of the Waste Management Plant.

In March 2018, a group was set up to prepare the decommissioning plan for the Waste Management Plant (project description). Before submitting the decommissioning plan to the Nuclear Regulatory Authorities for approval it was reviewed by DD's international expert panel. The external review took place on the 13th and 14th of November 2018.

The reviewed decommissioning plan was submitted to the Nuclear Regulatory Authorities for approval on 14th of December 2018. On 14th of May 2019, DD received a formal approval of the decommissioning plan from the authorities.

In the decommissioning plan, it was recognized that a certain parts of Building no. 211 were defined as areas for which more detailed sub-decommissioning plans, are to be developed. These sub-decommissioning plans are also to be submitted for approval to the Nuclear Regulatory Authorities before the decommissioning may be initiated.

Other parts of Building no. 211 is not considered to be contaminated (non-active), however this is to be documented by radiological contamination surveys to ensure that there are no existing contaminations.

Figure 34: Non-active office area prepared for contamination survey

Figure 35: The laundry, including the active laundry area to be prepared for contamination survey

Prior to carrying out the radiological contamination surveys it is necessary to remove all equipment (Figure 34 and Figure 35). It is also necessary to remove non-original flooring, in order to ensure the exposure of the original flooring and possible historic contaminations, which may has been covered by new flooring materials in the past. This task are initiated in the “non-contaminated areas”.

As part of the preparatory work for the decommissioning of the Waste Management Plant and the continued safe management of radioactive waste, the following facilities have been relocated to other buildings managed by DD:

- Isotope Laboratory facilities
- Active waste water facility including the distillation unit and active tanks
- The laundry, including the active laundry

A storage room in Building No. 217 was converted to house the laundry facilities. Within the room a separate enclosure was made for the active laundry (Figure 36).

The distillation unit and the associated tanks for distillated water were placed in another room in Building No. 217 (Figure 37). Space for the tanks was created by inserting a steel deck above the distillation unit (Figure 38).

The Isotope Laboratory was moved to Building No. 208, which the building of the Active Laboratory. In 2019 prior to the move, some reconstruction were done to accommodate the Isotope Laboratory. The laboratory was finally moved in June 2020.

These tasks has been finally carried out during July and August 2020.

Parallel with the preparatory work for decommissioning mentioned the sub-decommissioning plans are being developed and is still under development.

Figure 36: The laundry facilities, including the active laundry in is new location in Building No. 217.

Figure 37: New location of the distillation unit in Building No. 217 with the associated tanks placed above on an inserted steel deck.

Figure 38: New steel deck above the distillation unit for the associated tank in Building 217.

D.4. International expertise and decommissioning

Representatives from Danish Health Authority, Radiation Protection have participated in or contributed to:

- The Waste Safety Standards Committee (WASSC) IAEA
- The Radiation Safety Standards Committee (RASSC) IAEA
- Transport Safety Standards Committee (TRANSSC) IAEA
- ENSREG Working Group 2 on Waste Management and Decommissioning
- Facility Decommissioning training course provide by Argonne National Laboratory
- Workshop on Current and Emerging Methods for Optimising Safety and Efficiency in Nuclear Decommissioning organised by IFE on behalf of the OECD Halden Reactor Project and in collaboration with the IAEA and the NEA.
- International Conference on the Safety of Radioactive Waste Management organized by IAEA
- International Project on Decommissioning Risk management (DRiMa) organized by IAEA
- Challenges to the Regulators in siting and licensing the construction and operation of radioactive waste repositories – a meeting organized by The OECD-NEA RWMC Regulators' Forum (RWMC-RF)
- The 7th International Conference on Clays in Natural and engineered Barrieres for Radioactive Waste Confinement organised by Nagra in cooperation with ANDRA, COVRA, KORAD, NUMO, NWMO, ONDRAF/NIRAS, POSIVA, PURAM, RWM, SKB, SURAO, and Swisstopo.
- IAEA Network of Environmental Management and Remediation (ENVIRONET)
- The International Harmonization and Safety Demonstration Project for Predisposal Radioactive Waste Management (ECLiPSE project) organized by IAEA
- International Project on Decommissioning of Small Medical, Industrial and Research Facilities (MIRDEC project) organized by IAEA
- Integrated Regulatory Review Service (IRRS) – an IRRS mission to Denmark was planned in 2020, but has been postponed to April 2021 due to COVID-19 pandemic. Several staff members have participate in training courses and a staff member has participated as observer during an IRRS mission.
- Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) – Denmark is planning for an ARTEMIS mission in 2022. Staff from the Danish Health Authority, Radiation Protection participated in ARTEMIS missions.

Representatives from Danish Decommissioning have participated in or contributed to:

- Decommissioning training course provided by Argonne National Laboratory, US
- Decommissioning of nuclear installations provided by SCK CEN Academy in Belgium
- MARSSIM training course provide by Argonne National Laboratory

- Workshop on Current and Emerging Methods for Optimising Safety and Efficiency in Nuclear Decommissioning organised by IFE on behalf of the OECD Halden Reactor Project and in collaboration with the IAEA and the NEA.
- Technical Advisory Group (TAG) which is a part of a joint project between NEA and OECD
- The International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD)
- ERDO working group a project managed by the national waste agency of the Netherlands, COVRA and the Arius Association.
- International Training Course on the Physical Protection of Nuclear Material and Nuclear Facilities in collaboration with the IAEA and Sandia National Laboratory, NM, US
- Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS). Staff from the Danish Decommissioning participated in an ARTEMIS mission as observer.

Section E. Legislative and Regulatory System

Article 18. Implementing measures
Article 19. Legislative and regulatory framework

Since the submission of the Sixth National Report, the Danish radiation protection legislation was changed by the unanimous adoption by the Danish Parliament of the Radiation Protection Act. The new Act contains provisions implementing provisions of Council Directive 2013/59/EUROATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation.

The regulations for radiation safety are hence based on Act no. 23 of 15 January 2018 on Ionising Radiation and Radiation Protection (the Radiation Protection Act) and comprised in the executive orders issued by the Danish Health Authorities:

- Executive Order no. 669 of 1 July 2019 on Ionising Radiation and Radiation Protection,
- Executive Order no. 670 of 1 July 2019 on Use of Radioactive Substances,
- Executive Order no. 671 of 1 July 2019 on Use of Radiation Generators,
- Executive Order no. 672 of 1 July 2019 on Transboundary Shipments of Radioactive Waste and Spent Nuclear Fuel and
- Executive Order no. 993 of 5 December 2001 on Transport of Radioactive material
- Executive Order no. 10 of 5 January 2018 on Medical Examinations Pertaining to Potential Occupational Exposure to Ionising Radiation issued by the Danish Working Environment Authority.

The legislative and regulatory requirements relevant solely for the nuclear installations, which are still in place, are:

- Act no. 170 of 16 May 1962 on Nuclear Installations (The Nuclear Installations Act) and the underlying
- Act no. 244 of 12 Maj 1976 on Safety and Environmental Conditions at Nuclear Facilities, etc. (The Nuclear Safety Act)
- Executive Order no. 278 of 27 June 1963 on Protective Measures against Accidents at Nuclear Facilities, etc.
- Executive Order no. 1762 of 27 December 2016 on Security Measures for Nuclear Material and Nuclear Facilities and Drafting of Security Plans
- Circular no. 9450 of 9.July 2020 on the regulatory control exercised by the nuclear regulatory authorities regarding the nuclear safety of nuclear installations, etc.

- Circular no 9654 of 18. September 2020 on tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science concerning responsible and safe management of radioactive waste.

In addition, the Nuclear Regulatory Authorities have established Operational Limits and conditions (BfDA) for operation and decommissioning of the nuclear facilities at the Risoe site, detailing specific provisions in accordance with the provisions of the Nuclear Installations Act, applicable to the decommissioning and operational activities of DD.

A complete list of relevant Acts, Orders etc. in force is given in Section L.

Article 20. Regulatory body

National framework

The national framework comprises three organizations:

1. The Danish Health Authority under the Ministry of Health,
2. the Danish Emergency Management Agency under the Ministry of Defense, and
3. the Danish Agency for Higher Education and Science under the Ministry of Higher Education and Science.

In accordance with The Nuclear Installations Act (with later repeals and amendments), the regulatory oversight with the nuclear facilities at Risoe, lies with the Nuclear Regulatory Authorities. The Danish Health Authority and the Danish Emergency Management Agency jointly constitute the Nuclear Regulatory Authorities. The two authorities jointly carry out regulatory activities in accordance with their respective areas of authority, i.e. technical nuclear safety and radiation protection. In practical terms, activities conducted in relation to decommissioning and waste management fall under the jurisdiction of The Radiation Protection Act, as they concern radiation protection and safety. Hence, all inspectional, licensing and other regulatory activities are conducted with reference to this act and pursuant executive orders.

The Nuclear Regulatory Authorities are empowered by The Nuclear Installations Act to issue Operational Limits and Conditions for nuclear facilities, to gain direct access at any time to all nuclear facilities, buildings etc. for inspection purposes and to withdraw licenses and suspend operations in cases where nuclear safety or security cannot be demonstrated. Further, it is the responsibility for the Nuclear Regulatory Authorities to initiate legal action, should a breach of the regulations occur.

The Danish Agency for Higher Education and Science has the formal responsibility for institutions under the Ministry of Higher Education and Science, including Danish Decommissioning, which is responsible for operation (care and maintenance) and decommissioning of the existing nuclear installations in Denmark. All Danish nuclear facilities are thus owned, operated and decommissioned by government institutions.

Funding

There are legislative provisions for the funding of the regulatory authorities. The Finance Act, fee and revenue provide funding as detailed below. Apart from the broad specifications in the annual Finance Act there are no detailed provisions to ensure that the regulatory authorities is assured relevant competences and resources corresponding to the obligations given to the regulatory body by law.

The Finance Act is the state budget setting the framework for the financial dispositions of ministries and authorities. It is a central and decisive element in the practical execution of fiscal policy in Denmark. According to the Constitution, no expenses may be incurred without the authority of an appropriation Act adopted by the Parliament. The state budget forms the basis for the state's activities in a financial year. It is passed as a financial act by the Parliament, which has the appropriation authority and exercises control over the use of the appropriations.

The Constitution actually provides for two additional types of appropriation acts, besides The Finance Act: 1) Temporary appropriation acts (which are proposed if, exceptionally, the draft budget bill is not expected to be finalized before the beginning of the financial year) and 2) Supplementary appropriation acts, which contains changes to appropriations after the adoption of The Finance Act.
The 2019 Finance Act e.g. declares the appropriation for:

- the activities of the Danish Health Authority (page 79, § 16)
- the activities of the Danish Emergency Management Agency (page 56, § 12)
- the Danish Agency for Institutions and Educational Grants[2] (page 104, § 19).

Development since last report

The Danish Health Authority, Radiation Protection thus has a budget determined by the annual negotiation of The Finance Act as well as by fee and revenue-covered business. The budget is stable over years and on this background, The Danish Health Authority, Radiation Protection has a number of qualified and competent staff members, which Danish Health Authority find sufficient. The total number of employees, including three students, is presently 40 – corresponding to a total number of effective man-years of about 35, when part-time positions is taken into account.

Since the last National Report, the Danish Health Authority, Radiation Protection has filled vacancies and formed several new positions.

[2] In 2020, Danish Agency for Institutions and Educational Grants changed its name to Danish Agency for Higher Education and Science following a re-organisation of the Ministry of Higher Education and Science.

Section F. Other General Safety Provisions

F.1. Responsibility of the licence holder

Article 21. Responsibility of the licence holder

The only Danish waste management facility subject to the convention is located at the Risoe site and is licensed to and operated by Danish Decommissioning (DD). DD is collaboratively hosted by the Danish Technical University at Risoe (DTU Risø Campus). The property owner is the Danish Building & Property Agency owned by the Danish state.

The prime responsibility for the safety of a nuclear installation resides with the licence holder. The Nuclear Regulatory Authorities have issued Operational Limits and Conditions for Danish Decommissioning, detailing how the nuclear installations at the Risoe site may be safely operated and decommissioned. As the decommissioning of the nuclear facilities at the Risoe peninsula is ongoing, the Operational Limits and Conditions are progressively updated. The latest update to the Operational Limits and Conditions was performed in 2020. In analogy to the Operational Limits and Conditions for Danish Decommissioning, similar conditions have been issued for DTU Risø Campus, addressing the role and obligations of the institution hosting the nuclear facilities at the Risoe peninsula.

Public versions of the Operational Limits and Conditions are available on the websites of the Danish Health Authority.

Article 22. Human and financial resources

The responsibility for operation and decommissioning of the nuclear facilities, as well as continued waste management at the Waste Management Plant was transferred to DD from the Risoe National Laboratory in 2003. The staff originally assigned to the decommissioning and for operating the Waste Management Plant was reassigned to DD assuring qualified and adequate human resources needed for safety related activities during the decommissioning and the operating lifetime of the Waste Management Plant.

The Operational Limits and Conditions for Danish Decommissioning states that every employee at any level in the organisation shall maintain adequate training and instruction necessary to comply with the requirements of the position, in full accordance with the safety provisions prescribed by the Nuclear Regulatory Authorities. As DD is subject to minor, but continuous staff adjustments and replacements, training courses, seminars, and more extensive classes are therefore undertaken in order to ensure both an

adequate level of qualification as well as transfer of relevant experience from skilled members of the staff.

For DD, the availability of adequate financial resources is also assured, inasmuch as the organization is subordinate to the Ministry of Higher Education and Science. Thus, the financial provisions to support the safety of facilities for radioactive waste management are in place.

Article 23. Quality assurance

Danish Decommissioning was certified according to ISO 9001 in June 2004. Since then, the quality assurance system for the entire process of decommissioning, including all radioactive waste management has been based on this standard. The system is inspected biannually by Danish Standards (DS) and every third year a complete audit of all certified functions is conducted. All audit reports are available to the Nuclear Regulatory Authorities. DD regularly conducts internal audits as required by the standard. Since 2015, DD has implemented the requirements regarding IT security according to ISO 27001.

The Clearance Laboratory (F-lab) for decommissioning waste upholds an independent accreditation (ISO/IEC 17025) of the lab, granted by the Danish Accreditation Fund (DANAK) in 2007, and confirmed during the latest audit in 2016. The present accreditation was validated in 2020. The Clearance Laboratory handles clearance tasks with no restrictions on the amount or type of decommissioning waste.

A computerized Waste Documentation System with bar code identification ensures documentation of inventories and enables real-time spatial tracking of any characterised waste item. In addition, extensive use of colour-coded waste categories, waste containers and waste routes, has successfully minimized the number of waste handlings as well as waste destination errors.

Article 24. Operational radiation protection

In accordance with the Nuclear Installations Act (1962), Danish Decommissioning is subject to Operational Limits and Conditions, which set out regulations covering all aspects of decommissioning, including administrative structure, project planning and management, detailed operation planning, quality assurance, characterization of radioisotope inventory, operational radiation protection, safety assessment, environmental impact assessment and documentation.

The general principles for operational radiation protection in relation to decommissioning are similar to those applied during operation of the facilities. The operational radiation protection program must comply with the regulations given in Operational Limits and Conditions for Danish Decommissioning.

With respect to personnel at the contractor level, it is the responsibility of DD to ensure that all relevant personnel are instructed to the necessary level, in order to accomplish the assignments properly in terms of health physics and radiological safety.

F.2. Discharge

Releases of radioactive materials from the Waste Management Plant at the Risoe site are primarily liquid and originate in the radioactive wastewater distillation plant from which the purified liquids are transferred to the inactive waste water system and in turn into Roskilde Fjord.

Since the reactors were taken out of operation, the release of tritium to Roskilde Fjord has been reduced by one to two orders of magnitude and now displays a declining trend below 100 GBq per year. As facilities containing tritium have been progressively decommissioned, the remaining tritium inventory is low and discharges are similarly expected to remain so.

The evolution of discharge to Roskilde Fjord over time is illustrated in Figure 39 and Figure 40.

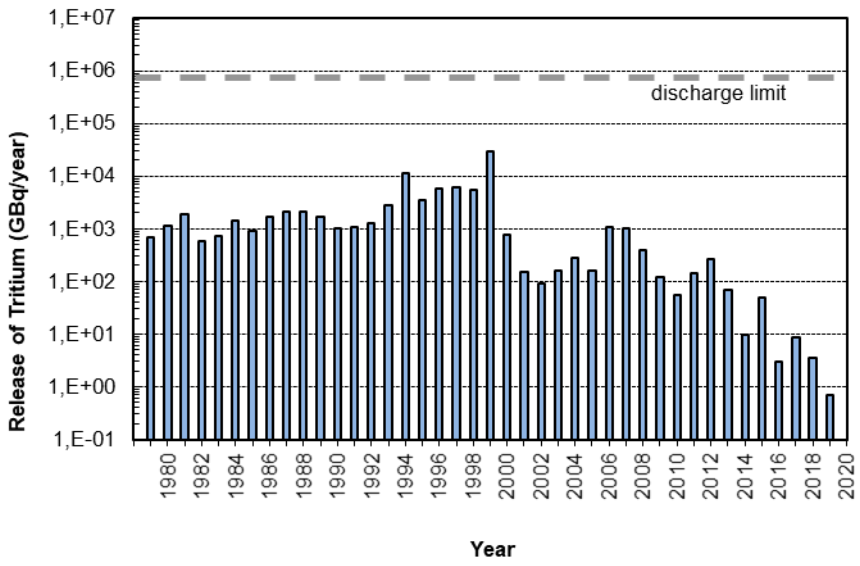

Figure 39: Annual release of tritium into Roskilde Fjord from the Waste Management Plant

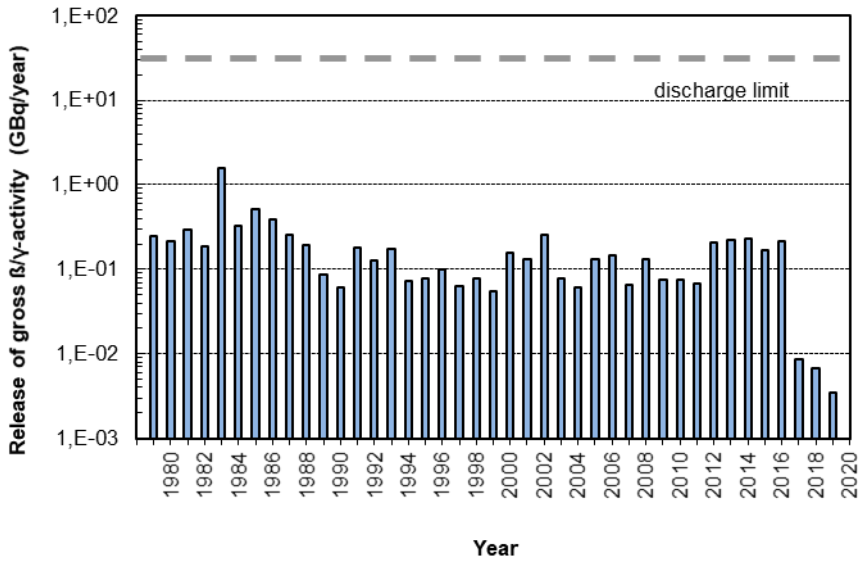

Figure 40: Annual release of gross ß/γ-activity into Roskilde Fjord from the Waste Management Plant.

Article 25. Emergency preparedness

Regarding off-site emergency preparedness Danish Emergency Management Agency is responsible for drawing up the national nuclear contingency plan. The nuclear contingency plan concerns coordination and cooperation between the authorities responsible for maintaining and continuing the functions of society in the event of a nuclear accident that may affect Danish or Greenlandic territory or Danish/Greenlandic interests abroad. An authority's specific contingency responsibility depends on the authority's normal tasks; according to the principle of sector responsibility any authority responsible for a given task on a daily basis must also perform this task in the event of, for example, a nuclear accident. The nuclear contingency plan aims to provide an overview of the responsibilities of the sector responsible authorities as well as their capacities and resources. The nuclear contingency plan can also be implemented in case of radiological accidents. The national nuclear contingency plan must according to law be revised at least every four years. The current nuclear contingency plan entered into force in 2018.

Regarding on-site emergency preparedness any operator of nuclear facilities etc. is obliged to draw up a contingency plan. This plan is part of the conditions that the respective supervisory authorities must approve and supervise. This thus applies to the current storage facility for radioactive waste as well as for the former research reactors currently under decommissioning.

F.3. Decommissioning

Article 26. Decommissioning

F.3.1. Doses from the decommissioning of DR 1 and DR 2

The decommissioning of DR 1 was finalised in late 2005. A final account of accumulated doses from the decommissioning of DR 1 was given in the final decommissioning report for DR 1 and referred in the Third National Report. In summary, DD personnel received a total collective dose slightly above 1 person-mSv and no doses were recorded for the external contractors who carried out the concrete demolition.

Decommissioning of DR 2 was finalised during spring 2008. An account of doses and surveillance techniques from this undertaking was reported in the final decommissioning report for DR 2 submitted to the Nuclear Regulatory Authorities in 2009. Staff from DD received a collective dose 1.6 person-mSv. Staff from the external contractors who carried out the demolition of concrete received a collective dose of 3.2 person-mSv.

F.3.2. Doses from the decommissioning of DR 3, Hot Cells, Fuel Fabrication Facility and work at the Waste Management Plant

Workers at DD are involved in multiple projects and hence accumulate doses from working in more than one facility. Individual doses are monitored for each sub-project in the decommissioning process. The sum of read-outs from personal dosimeters for work associated with decommissioning and waste treatment in the years 2017-2019 was less than 16,5 person-mSv, with a maximum individual dose of 1.5 mSv.

Section G. Safety of Spent Fuel Management

As a consequence of the decision taken by the Danish Parliament in 1985 to not include nuclear power in the Danish energy supply, there are no plans for siting, designing, constructing or operating spent fuel management facilities or for systematic disposal of spent fuel. Spent fuel from the research reactors DR 2 and DR 3 has been transferred to the USA according to an agreement with the US Department of Energy.

The only exemption from this is the spent fuel from the research reactor DR 1 and about 233 kg of experimentally irradiated fuel of power reactor type remaining from post-irradiation investigations conducted in the former Hot Cell Facility. This material is stored under safe and secure conditions awaiting a decision on the final management, either in the context of an international solution or by disposal in a national disposal facility. The radionuclide inventory occurs with activity concentrations of less than 10^4 TBq/m^3 and heat production from the waste in its originally designed waste packages is less than 1 kW/m^3. Storage of this material thus requires no special precautions regarding heat dissipation. The storage does not give rise to any discharges of radioactive materials to the environment and hence no exposure of the public.

Denmark has since the Sixth Review Meeting continued the search for an international solution regarding the spent fuel from the research reactor DR 1 and 233 kg of experimentally irradiated spent fuel. Until now, this effort has proven unsuccessful. If an international solution cannot be found, the spent fuel will be included in the long term management solution for radioactive waste in Denmark. Therefore, in the planning for a potential intermediate storage solution as well as a final geological repository, the spent fuel from the research reactor DR 1 and the 233 kg of experimentally irradiated spent fuel is considered part of the waste to be stored or disposed of; see Section H for further details on long term management solutions for radioactive waste in Denmark.

Section H. Safety of Radioactive Waste Management

At Danish Decommissioning, all radioactive waste related to the decommissioning activities as well as all other radioactive waste produced in Denmark is stored under safe and secure conditions in one of the following storage facilities: the Low Level Waste Storage, the Centralvej Storage, the Drum Storage, the Intermediate Storage, the Storage of Radioactive Liquids or the Tailings Pools and the Ore Heap.

Waste storage facilities are inspected by the Nuclear Regulatory Authorities on a routine basis with a maximum interval of 6 to 12 months. Furthermore, Danish Decommissioning conducts internal reviews to verify compliance with Operational Limits and Conditions and all other operational instructions at the waste storage facilities.

H.1.1. Radiation protection - policy

In accordance with the overall objectives in 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 and with a policy to follow the principles outlined in IAEA Fundamental Safety Principles, ICRP and other relevant international organisations, the foundations for all work related to long term management of radioactive waste are directed toward ensuring:

Protection of humans and the environment

Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for humans and the environment.

Protection beyond national borders

Radioactive waste shall be managed in such a way as to assure that possible effects on human health and the environment beyond national borders will be taken into account.

Protection of future generations
Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today. Likewise, radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.

The legal framework
Radioactive waste shall be managed within an appropriate national legal framework including clear allocation of responsibilities and provision for independent regulatory functions.

From these principles, quantitative criteria for the protection of humans and the environment have been derived in the form of dose constraints.

For any type of facility (including a disposal facility) operating as part of a long-term management solution for radioactive waste in Denmark, a dose constraint of 0.1 mSv/y applies. After closure, a disposal facility is subject to a dose constraint set at 0.01 mSv per year with regard to the expected development of the repository at all relevant times.

H.2. Developments since the Sixth National Report

The political decision-making process towards a long-term solution for radioactive waste management in Denmark was continued in 2017-2018, following the presentation of a summary report of a cross-ministerial working group in April 2017 (kindly refer to the Sixth National Report, pp. 42-43, for a summary of the working group report).

The political process was based on the following criteria that followed from the cross-ministerial working group's report:

1. A long-term solution for radioactive waste management must be based on basic principles of radiation protection and physical protection, including protection of human beings and the natural environment, protection outside of national borders, and protection of future generations. Health effects deriving from the long-term solution must not exceed current accept criteria. The long-term solution must provide security from unauthorised intrusion on the basis of risk analyses from all relevant national authorities.
2. A long-term solution must meet the international obligations that Denmark has accepted regarding radioactive waste management.
3. A long-term solution, regardless of content, must meet the requirements of Council Directive 2011/70/EURATOM to produce a reasonable and sufficient resource allocation over time. The financial obligations tied to the long-term solution must be met by the present generation to avoid passing on any undue burden to future generations.
4. A long-term solution must be based on the inclusion and facilitation of stakeholder involvement to the largest possible degree during siting, construction and operation phases of the long-term solution.

H.2.1. Political negotiations 2017-2018

In September 2017, the Danish Government called for political negotiations of a long-term solution based on the following proposal:

1. The storage facility on the Risoe site should be upgraded with the aim of extending operations at the site for a period of 30-50 years after 2023. The facility should be moved to a higher elevation on the Risoe peninsula to preclude the risk of flood resulting from climate change. The upgrade should allow for improved ventilation to control corrosion of storage units. Finally, the upgrade should provide more storage space for the waste volume resulting from the remaining decommissioning projects on the Risoe site.
2. The possibility of concluding an agreement with another EU Member State or third country regarding disposal of the experimentally irradiated spent fuel fraction included in Denmark's waste inventory should continue to be explored.
3. Further geological studies should be carried out to establish potential sites for a deep geological disposal facility to undergo further surveying.
4. The preparations for a deep geological disposal facility should take place on the basis of a dialogue with relevant stakeholders in municipality administrations and local communities.

The political negotiations were concluded in May 2018 with the unanimous adoption by Danish Parliament of Parliamentary Resolution B90 of 15 May 2018.

H.2.2. Parliamentary Resolution B90/2018

Parliamentary Resolution B90 stipulates the national policy for management and disposal of spent research fuel and radioactive waste.

The policy is summarised in the following statement of the proposal for resolution:*The Danish Parliament notifies of its consent for the Government to implement a solution for Denmark's radioactive waste with the objective of upgrading the Danish Decommissioning storage facilities at the Risø peninsula and to prepare the localisation and implementation of a deep geological final repository to be in operation by 2073 at the latest* (Parliamentary Resolution B90, p.1)

The national policy consists of the following action points:

1. Upgrade of the storage facility at the Risoe site with the aim of:
   - providing sufficient storage space for the radioactive waste emerging from the decommissioning activities and radioactive waste from external waste producers (i.e. hospitals, industries etc.) until the implementation of a disposal facility
   - securing the facilities against being affected by a flood tide situation in Roskilde Fiord
   - improving the storage conditions to sustain climate control of the facility as well as longer term waste management
   - retaining specialist competences and delivery of knowledge at a sufficient level, until the waste is finally placed in a disposal facility.

2. Expansion of the scope of Danish Decommissioning's objectives and activities with the aim of:
   - securing Danish Decommissioning's contribution to the conceptualisation and development of the long-term solution, including preparation of a disposal facility
   - supporting Danish Decommissioning's organisation to secure that a sufficient level of both theoretical and practical knowledge is available for the development and implementation of the long-term solution
   - establishing the necessary financial authority for Danish Decommissioning to be able to defray expenses for activities that form part of the long-term solution
3. Geological surveys to depths of 500 metres with the aim of:
   - providing clarity on the possibilities of finding geologically suitable locations for a disposal facility at a greater depth than that previously posited in the prefeasibility studies for a disposal facility
   - demonstrating and charting a geological formation with low permeability, of a sufficient thickness (more than 100 metres), and which has a horizontal continuous expanse (several kilometres) across the whole survey area
   - demonstrating a geological formation as mineralogically homogenous and uniform as possible
   - demonstrating a geological formation of long-term geological stability
4. Preparations for a disposal facility, including:
   - proactive dialogue with local authorities and stakeholders in areas with potentially suitable locations for a disposal facility
   - revision and expansion of the existing conceptualisation of a disposal facility in the pre-feasibility studies
   - further waste characterisation and development of waste acceptance criteria
5. Establishment of a disposal facility no later than 2073, including:
   - final decision on the concept of the disposal facility based on the consideration of different types of disposal facilities
   - siting of the disposal facility on the basis of continuing stakeholder involvement and studies of technical, environmental and socio-economic consequences for the host community
   - planning, approval and execution of the disposal facility
   - operational license

Finally, the Parliamentary Resolution includes further exploration of the feasibility of concluding an agreement with another EU Member State or third country regarding disposal of the experimentally irradiated spent fuel fraction included in Denmark's waste inventory. The task is delegated to the Ministry of Foreign Affairs, which has not yet been able to report any progress in the matter for the period covered by this report.

The realisation of the goals in the national policy will be elaborated further in a strategy (programme) for implementing the policy as required under the articles of Council Directive 2011/70/EURATOM. The updated strategy will be established according to the relevant parts of the body of IAEA standards as well as in accordance with the articles of

Council Directive 2011/70/EURATOM, and is foreseen to enter into force by January 2021.

H.2.3. Construction of an upgraded long-term storage facility

Following the adoption of the Parliamentary Resolution B90, Danish Decommissioning has initiated the process of upgrading storage facilities on the Risoe site. The project is still in the planning stage. It is estimated that the project will enter the construction phase in 2022.

H.2.4. Interaction with stakeholders

Interaction with stakeholders through the National Contact Forum has been maintained in the period covered by this report. Following the adoption of Parliamentary Resolution B90, meetings in the forum have been held with reduced frequency as per the wish of participants. Agendas, presentations and minutes from the meetings (in Danish only) are available on the website of the Ministry of Higher Education and Science.

Following the initiation of the upgrade of storage facilities at Risoe site, a local contact forum has been established for stakeholders in Roskilde Municipality, the host municipality of Danish Decommissioning. Contact Forum Roskilde held its first meeting in January 2019. Meeting frequency is four meetings annually. The following stakeholder groups are represented in the forum:

- Members of Roskilde City Council (4 members)
- Roskilde Municipality Administration (4 members, together representing the Department of Environment and the Department for Planning and Development)
- Veddelev Citizens' Association (3 members)
- NOAH Friends of the Earth Denmark (1 member)
- Greenpeace Denmark (1 member)
- Concerned Citizens' Group for the Responsible Management of Denmark's Radioactive Waste (1 member)
- Danish Decommissioning (3 members)
- Geological Survey of Denmark and Greenland (1 member)
- Danish Health Authority, Radiation Protection (2 members)
- Danish Emergency Management Agency, Nuclear Division (2 members)
- Technical University Denmark (DTU) (1 member)
- Aarhus University (1 member)
- Danish Building and Property Agency (1 member)
- Ministry of Higher Education and Science (1 member)

The Panel of Independent Experts, mentioned in the report for the 6th Review Meeting, is continuing its service as a neutral provider of independent and scientifically vetted information to the public on radioactive waste management issues. 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 International Experts' Group formed by Danish Decommissioning in 2016 is also continuing counselling in technical matters. The group consists of four members from the Netherlands, Sweden (two members) and Norway, all representing national organisations of radioactive waste management.

H.2.5. Preparatory geological surveys for the siting of a radioactive waste repository

Geological Survey of Denmark and Greenland has initiated desk studies and modelling exercises, which will be reported in the beginning of 2021. The conclusions of the report will form the basis of stakeholder involvement prior to the siting of survey locations.

Section I. Transboundary Movement

Article 27. Transboundary movement

The European Council has adopted Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel. Denmark implemented this directive in Order no. 672 of 1. of July 2019 on Transboundary Shipments of Radioactive Waste and Spent Fuel. The directive and the Order cover all shipments of radioactive waste and spent fuel, whether it is intended for disposal or for reprocessing.

Since the last Review Meeting, the Danish Health Authority, Radiation Protection has received and approved 96 applications according to Council Directive 2006/117/Euratom concerning the supervision and control of shipments of radioactive waste and spent fuel. Eighty seven applications were related to transit through Denmark, six related to transports from Sweden to Denmark, and three related to transportations from Denmark to Sweden.

Section J. Disused Sealed Sources

Article 28

The regulatory framework given by the Radiation Protection Act (Act 23/2018) and the underlying Executive Order No. 670/2019 is in agreement with IAEA's Code of Conduct on the safety and security of radioactive sources (2004) and the supplementary guidance documents to the Code of Conduct, namely the:

- Guidance on the import and export of radioactive sources from 2005 and
- Guidance on the management of disused radioactive sources from 2018.

Denmark co-signed the Code of Conduct in 2004 as well as the supplementary guidance documents, respectively in 2005 and 2019.

The possession, use and disposal of disused sealed sources is regulated through Executive Order no. 670/2019 on Use of Radioactive Substances, § 5. This order (§ 23) states that once a sealed source is taken out of use, it must be returned to the producer or alternatively turned over to an undertaking that is licensed to manage the source, or to store or dispose of it as radioactive waste (i.e. Danish Decommissioning). In accordance with § 14 of the same order, the Danish Health Authority, Radiation Protection shall be duly notified in order to keep records and registries up to date.

Disused sealed sources are on rare occasions detected by means of portal monitoring systems typically installed at major scrap yards. In guides distributed to scrap dealers. the Danish Health Authority, Radiation Protection thus recommend installation of monitoring systems, offering also specific instructions on how to manage disused sealed sources and radioactive substances found in metal scrap. In accordance with Executive Order 669/2019, § 92, the Danish Health Authority, Radiation Protection must be notified immediately in such cases.

At the administrative level, a national data integration interface enables daily combination of data from the Danish Health Authority radiation source database, data from the Danish Civil Registration System (CPR), and data from the Danish Central Business Register (CVR) to facilitate a proactive and timely intervention by the Danish Health Authority, Radiation Protection in case of bankruptcy, or discontinuation for other reasons, of undertakings possessing radioactive sources.

Pursuant to Circular no. 15105 of 22 December 1975 on the 24/7 Expert Service at the Danish Health Authority, Radiation Protection maintains a 24/7 expert service to be reached 24/7 all year. The expert on duty is able to provide contact to relevant medical assistance; provide instructions on safety precautions to limit an accident; provide

assistance with decontamination, regaining control of sources, and to make on-site radiological measurements for the estimation of dose and contamination level. The expert also has access to the customer relationship management database system (CRM) in order to obtain information on source type, activity, location, responsible undertaking etc. registered with the Danish Health Authority, Radiation Protection.

Household ionizing smoke detectors containing Am-241 are collected at the local scrap yards as they are being replaced by photoelectric smoke detectors in households etc. Danish Health Authority, Radiation Protection has instructed local scrap yards to collect these with the Waste from Electrical and Electronic Equipment (WEEE). The WEEE is subsequently collected by licenced recycling companies, which holds the responsibility of separating ionizing smoke detectors and deliver them to the Waste Management Facility the Danish Decommissioning. Industrial ionizing smoke detectors are either delivered directly to the Waste Management Facility or returned to the manufacturer through the importing company.

Section K. General Efforts to Improve Safety

K.1. International co-operation

Participation in international co-operation regarding the safety of spent fuel and radioactive waste management is essential to a small country without a nuclear power programme such as Denmark. Denmark participates with its limited resources in a suite of international groups in order to follow and take part in the evolution of the safety of nuclear fuel and radioactive waste management.

In the IAEA context, Denmark has contributed to the development of the IAEA Safety Standards by representation in two Committees (RASSC, WASSC) since 2005 and in the Transport Safety Standards Committee (TRANSSC) since 2015.

In the European Union, Denmark is actively engaged in the Euratom Article 31 Group of Experts. Since 2007, Denmark has been represented in the European Nuclear Safety Regulators Group (ENSREG), and is further actively involved in ENSREG Working Group 1 on nuclear safety and ENSREG Working Group 2 on waste management and decommissioning.

K.2. International peer review

The Danish government has invited the International Atomic Energy Agency to conduct a combined Integrated Regulatory Review Service (IRRS) and ARTEMIS mission in Denmark. The combined mission was planned to take place in 2020, however due to the COVID-19 pandemic the missions postponed, respectively the IRRS to April 2021 and ARTEMIS to 2022.

The IRRS mission will serve as part of the Danish compliance with the requirement in Article 8e.1 in Council Directive 2009/71/Euratom as amended by Council Directive 2014/87/Euratom to perform international peer review of the national framework and competent regulatory authorities in the field of nuclear safety.

The Danish obligations through Article 14.3 in Council Directive 2011/70/Euratom, are further satisfied through the conduct of an ARTEMIS review of the Danish national framework, competent regulatory authority and/or national programme in the area of safe management of spent fuel and radioactive waste.

Section L. Annexes

L.1. Danish Legislation – Spent Fuel and Radioactive Waste

The Danish legislation listed below is in force per October 2020. The legislation is available in English at the web site of the Danish Health Authority, Radiation Protection.

Acts:

- Act no. 23 of 15 January 2018, on Ionising Radiation and Radiation Protection (The Radiation Protection Act)
- Act no. 244 of 12 Maj 1976 on Safety and Environmental Conditions at Nuclear Facilities, etc. (The Nuclear Safety Act)
- Act no. 170 of 16 May 1962, on Nuclear Installations (The Nuclear Installations Act)
- Consolidation Act no. 993 of 9 September 2014 on compensation for nuclear accidents and incidents
- The Finance Act, 2019, § 16.11.11 including text annotation 2
- Consolidation Act no. 903 of 26 August 2019 on Health (The Health Act)
- Consolidation Act no. 1225 of 25 October 2018 on Environmental Impact Assessment of Plans and Programs and of Specific Projects (EIA) (The EIA Act)

Parliamentary Resolutions:

- Parliamentary Resolution B103, 1985 on Energy Planning without Nuclear Energy
- Parliamentary Resolution B48, 2003 on the Decommissioning of the Nuclear Facilities at Research Station, Risø
- Parliamentary Resolution B90, 2018 on a Long-Term Solution for Denmark's Radioactive Waste

Executive Orders:

- Executive Order no. 669 of 1 July 2019 on Ionising Radiation and Radiation Protection
- Executive Order no. 670 of 1 July 2019 on Use of Radioactive Substances
- Executive Order no. 671 of 1 July 2019 on Use of Radiation Generators
- Executive Order no. 672 of 1 July 2019 on Transboundary Shipments of Radioactive Waste and Spent Nuclear Fuel
- Executive Order no. 278 of 27 June 1963 on Protective Measures against Accidents at Nuclear Facilities, ect. - as changed according to Executive Order no. 502 of 10 January 1974
- Executive Order no. 1111 of 7 November 2019 on Fees for Danish Health Authority Inspection and Guidance (in Danish)
- Executive Order no. 1762 of 27 December 2016 on Security Measures for Nuclear Material and Nuclear Facilities and Drafting of Security Plans
- Executive Order no. 315 of 27 June 1972 on the Peaceful Control of Nuclear Materials

- Executive Order no. 993 of 5 December 2001 on Transport of Radioactive Material

Circulars:

- Circular no. 15105 of 22 December 1975 on the 24/7 Expert Service at the Danish Health Authority, Radiation Protection
- Circular no. 3151 of 26 November 1964 on the Cooperation between the Danish Health Authority and the WEA
- Circular no. 9450 of 9.July 2020 on the regulatory control exercised by the nuclear regulatory authorities regarding the nuclear safety of nuclear installations, etc.
- Circular no 9654 of 18. September 2020 on tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science concerning responsible and safe management of radioactive waste.

Operation Limits and Conditions:

Operational Limits and Conditions issued by the Nuclear Regulatory Authorities (the Nuclear Division under the Danish Emergency Management Agency and the Danish Health Authority, Radiation Protection):

- Operational Limits and Conditions for Danish Decommissioning
- Operational Limits and Conditions for DTU Risø Campus

In order to comply with the current situation at the Risoe site the Nuclear Regulatory Authorities continuously update these documents. Public versions of the Operational Limits and Conditions are available on the websites of the Nuclear Regulatory Authorities and Danish Decommissioning.

National policy and programme:

- Council directive 2011/70/Euratom for the responsible and safe management of spent fuel and radioactive waste (Second report from Denmark)

As a result of the adoption of Parliamentary Resolution B90, a new national policy for radioactive waste management was established and the associated strategy (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 strategy is foreseen to enter into force in January 2021.

L.2. Denmark – Overview matrix

Type of Liability	Long-term management policy	Funding of liabilities	Current practice/facilities	Planned facilities
Spent fuel	According to Parliamentary Resolution B90, an international solution remains an option until planning act for disposal facility is passed. Following this, disposal will take place in Denmark.	The Danish state carries the financial liability of an ultimate management solution.	Spent fuel from DR 1 and the experimentally produced and irradiated spent fuel is stored under safe and secure conditions by Danish Decommissioning (DD).	Long-term storage facility followed by a geological disposal facility, if efforts to find international solution proves unsuccessful.
Nuclear fuel cycle wastes	Not applicable	Not applicable	Not applicable	Not applicable
Application Wastes	Intermediate storage until disposal in 2073 at the latest.	Waste producers pay a management fee upon delivery of waste to DD. The Danish State carries the financial liability of disposal.	DD receives, handles and stores application wastes produced by hospitals, industry and research intuitions in Denmark.	Disposal according to specific implementation of long-term management goal of Parliamentary Resolution B90.
Decommissioning	Following Parliamentary Resolution B48, Denmark has adopted a policy of immediate dismantling and decommissioning.	DD is funded under the administration of the Ministry of Higher Education and Science.	DD performs all decommissioning tasks at the nuclear facilities at Risoe.	Decommissioning in progress must be completed no later than 2023 according to Parliamentary Resolution B48.
Disused sealed sources	Return to the manufacturer or management by DD	Return to the manufacturer is at the cost of the licensee DD carries other costs.	DD stores disused sealed sources, which cannot be returned to the manufacturer.	Disposal according to specific implementation of long-term management goal of Parliamentary Resolution B90.

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JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT

NATIONAL REPORT FROM GREENLAND

7TH REVIEW MEETING, 2021

Contents

Section A. Introduction

The Kingdom of Denmark includes the islands of Greenland and the Faroe Islands. These territories are linked within the 'Commonwealth of the Realm', where both island territories enjoy autonomous authority in most domestic affairs, while Denmark remains constitutionally responsible for foreign, defence and security policies. This division of responsibility is important to fully appreciate the following.

Denmark signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 29 September 1997, the day it opened for signature, and the Convention was accepted 3 September 1999 by letter from the Foreign Ministry to the International Atomic Energy Agency (IAEA). Upon signature, the Kingdom of Denmark announced a territorial declaration with regard to Greenland, stating that the Convention does not apply for the autonomous territories Greenland and the Faroe Islands. This territorial declaration could be withdrawn at any given time.

In 1985 the Danish Parliament made the decision that Denmark would not use nuclear energy.

In 2010, pursuant to the newly adopted Act on Greenland Self-Government (Act no. 473 of 12 June 2009), Greenland was granted autonomous authority over natural resources within the territory. Additionally, by decision of the Greenland Self-Government in October 2013, extraction of naturally occurring radioactive materials (NORM) in Greenland was accepted. Lastly, in August 2015 by decision of the Greenland Self-Government the reservation to this Convention was revoked. On 15 December 2016, the Kingdom of Denmark withdrew its territorial declaration with regard to Greenland made upon acceptance of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Waste that contains only NORM is not radioactive waste for the purpose of the Convention. The decision to accept possible future extraction of NORM in Greenland has put some focus on Greenlandic management systems within the mineral resource administration regarding radioactive waste and waste facilities in general. Because waste arising as part of the nuclear fuel cycle is considered radioactive waste for the purpose of the Convention, a description of the plans for the NORM waste management has been added to this report as a subsection to each chapter.

The present Report is the second Report from the Government of Greenland prepared for the 7th Review Meeting to the Convention, 2021, IAEA in Vienna. The Danish Center for Environment and Energy (DCE), Department of Bioscience, Aarhus University have prepared the draft. The Environmental Agency for Mineral Resource Activities (EAMRA), the Ministry of Health, the National Board of Health, the Ministry of Mineral Resources including the Mineral Licence and Safety Authority (MLSA), the Ministry of Foreign Affairs and Energy and The Ministry of Science and Environment have contributed to the report. The report has been finalized by the National Board of Health.

The report is made in accordance with the Guidelines regarding the Form and Structure of National Reports (INFCIRC/604/Rev. 3) adopted by the Contracting Parties under Article 29 of the Convention at the Preparatory Meeting at IAEA 10 to 12 December 2001 and modified at the Second Review Meeting of the Contracting Parties held from 15 to 24 May 2006, the Fourth Review Meeting of Contracting Parties held from 14 to 23 May 2012 and the Second Extraordinary Meeting of the Contracting Parties held from 12 to 13 May 2014.

As described in the Guidelines regarding the Form and Structure of National Reports (INFCIRC/604/Rev.3, 18 December 2014), duplication within the reporting should be avoided, including duplication from the recent report. Nevertheless, at the same time, the report should be a stand-alone report. In this report, Greenland decided to focus on what is considered highlights and new developments since the National Report from the 6th Review Meeting. However, as considered necessary for a stand-alone report the present situation will be stated briefly under each paragraph, even if there has been no development since the last meeting. Detailed description of the Greenland practices and the development before 2018, the previous report, and the questions and answers can be found via the homepage for the Joint Convention[1].

In the 2018 review meeting the following challenges were identified;

1. Further development of regulatory infrastructure for safe management of radioactive waste in Greenland

2. Build up the appropriate technical expertise in Greenland

In order to address these challenges Greenland has initiated work in the following areas:

1. Establishing a well-defined regulatory infrastructure for radioactive waste management in Greenland with clear allocation of mandate and responsibilities and provisions to ensure necessary expertise.

2. Drafting executive orders and implementation provisions for radiation protection.

3. Drafting guidelines for the Safe Management of Radioactive Waste generated from the mineral and hydrocarbons industries in Greenland.

4. Development and implementation of a system for the registration of radioactive sources, including radioactive waste.

5. Development of a system for management of radioactive waste generated from the industrial and educational sectors.

6. Development of a tracking system for sealed sources.

7. Procedures for dealing with an orphan source.

8. Emergency preparedness exercise.

Below, the current status is briefly summarized.

1. The National Board of Health was in January 2020 appointed as the Greenlandic authority on radiation protection in close cooperation with the Ministry of Health, All initiatives are now coordinated by the National Board of Health.

   The necessary staff to start the processes have now been employed. A plan and priority of initiatives has been developed. Initially, advanced technical expertise is expected to be hired outside Greenland. General advice is obtained from the Danish radiation protection agency under the Danish Health Authority.

2. The Ministry of Health is drafting the executive order: ''Self-Government Executive Order on dose limits for ionizing radiation'' under the Radiation Protection Act. The executive order sets threshold values for annual dose limits for occupational and members of the public from use and exposure to ionizing radiation. The executive order is still under development. It is expected that the executive order will enter into force at the end of 2021.

   The Danish Working Environment Authority (WEA) is drafting a new executive order regarding ionizing radiation and the working environment in Greenland. The executive order is prepared in collaboration with the Greenland Self-Government. The scope of the order will include occupational health and safety issues associated with exposure to ionizing radiation. Requirements of the order, which may have a direct effect on health and safety (such as adherence to dose limits), will apply to both employees and self-employed. On a more general note, the provisions will stipulate requirements, such as avoiding unnecessary exposure to radiation, drafting a workplace assessment, and prohibiting employment of persons under 18 years of age in work with ionizing radiation. Dose limits will be set to ensure human health and safety. Methods of evaluation and calculation of radiation exposure will be based on international approved standards and on the system applied in Denmark.

   Work with ionizing radiation must only be carried out by trained personnel. To ensure minimum risk of exposure, health examinations must be carried out regularly. Occupational monitoring will be required. The executive order is under development. It is expected that the executive order will enter into force at the end of 2021.

3. DCE has prepared recommendations for guidelines for the Safe Management of Radioactive Waste generated from the mineral and hydrocarbons industries in Greenland for EAMRA. The recommendations for guidelines provide safety requirements and guidance to ensure the safe management of waste containing naturally occurring radioactive materials (NORM) and technologically enhanced naturally occurring radioactive material (TENORM) generated from the mineral and hydrocarbons industries in Greenland. The recommendations for guidelines include requirements for all phases of the waste facility, such as site selection, site assessment, site design and preparation, construction, operation, closure, site release from licensing, and long-term stewardship. The recommendations for guidelines supplement the Mineral Resources Act and Guidelines for preparing an Environmental Impact Assessment (EIA) report for mineral exploitation in Greenland. These recommendations for guidelines are based on the most recent international standards and recommendations by the International Commission on Radiological Protection (ICRP), (Council Directive 2013/59/EURATOM, Council Directive 2011/70/EURATOM), and the International Atomic Energy Agency (IAEA). So far, independent senior experts from Canada and EAMRA have reviewed the recommendations for guidelines. Relevant experts in Greenland will further review the recommendations for guidelines before the expected publishing at the end of 2021.

4. A system for online registration of radioactive waste has been developed and is expected to be implemented during 2021. In the meantime, The National Board of Health has begun registration of ionizing sources in Greenland. Preliminary records show that there are very few sealed sources (sources incorporated in measuring instruments) from educational, and industries falling out of the Mineral Resource Act.

5. As mentioned under point 1, The Ministry of Health is drafting the order 'Self-Government Executive Order on dose limits for ionizing radiation''. This order also includes provisions for the safe management of radioactive waste generated from industries falling out of the Mineral Resource Act and educational system. Based on assessments, the National Board of Health in Greenland plans to store radioactive waste such as sealed sources (e.g., Am-241 sources taken out of the smoke detectors, sources incorporated in measuring instruments) in a storage facility. It should be underlined that the volume/quantity, the

number of waste types, and the activity of the stored waste are very low. Additional assessments will be performed before a decision for the need of a permanent disposal facility or implementation of alternative solutions, including options for export to Denmark under a Danish-Greenlandic agreement, can be made.

6. Industries falling out of the Mineral Resource Act and educational system are using sealed sources (sources incorporated in measuring instruments). Additional sealed sources in Greenland are Am-241 sources in smoke detectors.

7. The Ministry of Health is working in close collaboration with Arctic region experts to develop and implement procedures for dealing with an orphan source.

8. In collaboration with the Danish Emergency Management Agency (DEMA), the Greenlandic relevant authorities held a nuclear emergency preparedness exercise in December 2019 in Nuuk, Greenland. The outcome of the exercise was incorporated in the Greenlandic emergency preparedness plan.

In the 2018 review meeting the following suggestion was made:

1. The Unity of the Realm Denmark Greenland should consider inviting IRRS and ARTEMIS missions to Greenland

The National Board of Health have clarified how the suggestion can be implemented in practice. The National Board of Health will in cooperation with the Ministry of Health start a process ending up in a review of the status regulatory functions and statutory duties related to radiation protection in Greenland, including recommendations for implementing improvements as deemed necessary.

Section B. Policies and Practices

Article 32, paragraph 1

This section addresses article 32 (Reporting) (1) of the Joint Convention and provides information on Greenland's policies and practices for radioactive waste management.

In 1985 the Danish Parliament made the decision that Denmark would not use nuclear energy, which also includes Greenland.

Regulatory policy and practices on managing radioactive waste

Industry, medical and educational sectors

Management of radioactive waste from industry, the medical, and educational sectors is regulated in the Radiation Protection Act. The purpose of the Act is to ensure that the public, and the environment are not unnecessarily subjected to the risks of radiation exposure.

The Radiation Protection Act sets the framework from which an executive order is under development and will enter into force at the end of 2021. The executive order will resemble corresponding Danish legislation and align with international IAEA standards and EU-directives.

The disposal of radioactive waste generated from the industry, medical and educational sectors is to be registered or subjected to a licence issued by The National Board of Health and The Ministry of Health.

NORM waste

Waste may be generated in the future from the mineral industry that contains NORM. At present, no NORM waste is generated from the mineral industry.

There have been exploration activities at Kvanefjeld in South Greenland since 1955. Pilot plant operations conducted by the licensee in November 2012 produced approximately 4.2 tonnes of tailings (NORM waste).

NORM waste is regulated according to Greenland Parliament Act no. 7 of 7 December 2009 on mineral resources and mineral resource activities with later amendments (Mineral Resources Act). Recommendations for guidelines for the safe management of radioactive waste generated from the mineral and hydrocarbons industries in Greenland are under development and expected to be published at the end of 2021.

Waste owners are responsible for funding, managing and operating waste management facilities including disposal and decommissioning in accordance with the "polluter pays" principle of the Mineral Resources Act.

The licensing system comprises licences specific to the prospecting phase, the exploration phase and terms of an exploitation licence pursuant to section 16 of the Mineral Resources Act followed by approvals of exploitation – and abandonment plans under section 19 and 43 of the Mineral Resources Act. Furthermore, terms are set in the final approvals to carry out activities issued under section 86 of the Mineral Resources Act. It is not until final approvals have been issued, pursuant to section 86, that activities may commence.

Classification of radioactive waste in Greenland

The IAEA (GSG -1 2009) system for classification of radioactive waste is to be implemented in Greenland.

Waste from the medical sector

The Greenland Health Care System does not use nuclear medicine. No radioactive waste has been/is generated from the medical sector in Greenland.

Waste from the industry sector

The National Board of Health and The Ministry of Health, under the Radiation Protection Act, regulate radioactive waste generated in the industry sector not covered by the Mineral Resource Act. A system for registration and storage of radioactive waste (e.g. sealed sources incorporated in measurement instruments used in educational and industry, Am-241 from smoke detectors) is under development. Further assessments are needed before a final decision can be made for a disposal facility.

Waste from the educational sector

The National Board of Health and The Ministry of Health under the Radiation Protection Act, regulate storage of radioactive waste generated in the educational sector.

A system for the registration and storage of radioactive waste generated in the educational sector is under development. Further assessments are needed before a final decision can be made for a disposal facility.

Furthermore, The Working Environment Act applies to employees working with science education facilities and laboratories.

NORM waste

Mineral and mill tailings may be generated in the future from the mineral industry in Greenland. The mineralized waste rock and mill tailings will be classified and managed according to IAEA GSG-1 (2009).

Section C. Scope of Application

Article 3

The Greenland Self-Government has in relation to this Convention:

(a) Not declared reprocessing to be part of spent fuel management, pursuant to Article 3(1);
(b) Not declared any spent fuel or radioactive waste within military or defence programmes as spent fuel or radioactive waste for the purpose of the Convention, pursuant to Article 3(3).

Greenland has no spent fuel or reprocessing activities neither radioactive waste generated from military or defence programs, although please see Section H, article 12.

NORM waste arising as a result of activities within the nuclear fuel cycle is considered radioactive waste for the purpose of the convention.

Section D. Inventories and Lists

Article 32, paragraph 2

Spent fuel management facilities and inventory

There are no spent fuel management facilities in Greenland subject to the Convention and no spent fuel has been declared in Greenland so far.

Radioactive waste management facilities and inventory

There are no radioactive waste management facilities in Greenland subject to the Convention.

Nuclear facilities under decommissioning

There have never been any nuclear facilities in Greenland subject to the Convention. Thus, no nuclear facilities are under decommissioning.

Section E. Legislative and Regulatory System

Article 18. Implementing measures

Article 19. Legislative and regulatory framework

Article 20. Regulatory body

Greenland has taken full measures within the scope of autonomy to establish a safe and comprehensive management system for radioactive waste.

The legislative and regulatory system for radioactive waste management is mainly governed by Greenlandic legislation, although Danish legislative and regulatory instruments are still applicable in Greenland. The area of responsibility of occupational health and safety is not a responsibility taken over by Greenland at present state. Occupational health and safety in Greenland is under the responsibility of the Danish WEA.

Legislation regulating the management of radioactive waste comprises of the following:

Legislation passed by the Greenland Parliament:

- The Greenland Parliament Act no. 33 of 9 December 2015 on Ionizing Radiation and Radiation Protection (the Radiation Protection Act).

Legislation passed by the Danish Parliament, which is also applicable in Greenland:

- The Greenland Working Environment Act No. 295 of 4 June 1986 with later amendments provided for in section 3 of Act No. 193 of 26 March 1991 and Act No. 321 of 18 May 2005.
- The Danish Act for Greenland on the Control of Peaceful Uses of Nuclear Material (No 621 of 8 June 2016)
- Danish Act No. 616 of 8 June 2016 on the Control of Export of Dual-Use Items in Greenland
- The Danish Emergency Management Act in Force for Greenland
- Danish Acts on Sea Transportation and executive orders regarding the transportation of hazardous materials
- The Danish Air Navigation Act and executive orders regarding the transportation of hazardous materials

A list of Acts and Guidelines in force per 1 January 2017 can be found in annex B.

The Radiation Protection Act regulates the use of and exposure to radiation for the public in general. The Ministry of Health is responsible for the Radiation Protection Act. The Ministry of Health is drafting an executive order aligned with international IAEA standards and EU-directives for best practices. The executive order by The Ministry of Health is expected to enter into force at the end of 2021.

The Greenland Working Environment Act regulates the health and safety of employees including use and exposure to radiation during work. This includes the health and safety of employees working onshore with mineral resource activities, in the medical sector, in the industry sector and the education sector. The working environment legislation rests with The Danish Ministry of Employment and the underlying authority, The Danish Working Environment Authority (WEA). The WEA is drafting a new executive order regarding ionizing radiation and working environment in Greenland.

The physical protection of nuclear materials and nuclear facilities is regulated in accordance with Danish Act under the responsibility of The Danish Ministry of Foreign Affairs. The Emergency Management Act is partly in force in Greenland and regulates the physical protection of nuclear materials and nuclear facilities in case of emergencies and catastrophes in relation to mineral resource activities involving nuclear materials. The Danish Emergency Management Agency (DEMA) under The Ministry of Defence is the supervisory authority. The IAEA Convention on the Physical Protection of Nuclear Material and Nuclear Facilities is in force in Greenland. The Convention on Nuclear Safety (CNS) and Amendment to the Convention on Physical Protection of Nuclear Material (Amendment to CPPNM) apply to Greenland.

Regulatory system and licensing of radioactive waste management

According to the Radiation Protection Act, any possession, production, packaging, import, storage and/or disposal of radioactive materials is subject to registration or authorization by a license issued by The National Board of Health and The Ministry of Health, except when exempted from regulatory requirements.

System of prohibition for the operation of radioactive waste facilities without a license

The possession, production, packaging, importation, storage and/or disposal of radioactive waste without an issued license or a registration from The National Board of Health and The Ministry of Health can be sanctioned with a fine under the provisions of the Greenland Criminal Code.

NORM regulatory system and licensing of radioactive waste management

The Mineral Resources Act regulates exploitation of mineral resources. The Mineral Resources Act regulates safety, health, the environment, resource exploitation and social sustainability in relation to mineral resource activities. Under the Mineral Resources Act, the management of NORM waste produced from the mineral industry is regulated throughout the entire life cycle – from site preparation, construction, and operation to decommissioning and site abandonment. Each phase of the lifecycle requires specific approvals.

Applicants for an exploitation licence are required to submit an environmental impact assessment (EIA), a social impact assessment (SIA) and feasibility studies including documentation that the company is able to provide sufficient financial guarantees. The EIA and SIA are generally required if any proposed activity is likely to have a significant environmental or social impact. The authorities and independent scientific advisors review all submissions. International third party consultants are used as appropriate. Following EIA and SIA approval a detailed environmental monitoring plan (EMP), a radiation management plan (RMP), a radioactive waste management plan (RWMP) and closure plan (decommissioning and rehabilitation) have to be prepared.

The assessments and decisions by the Mineral Resource authority regarding environmental issues are based on considerations from one or more scientific and independent environmental institutions. EAMRA obtains counsel from the DCE and the Greenland Institute of Natural Resources (GINR). This is set out in accordance with article 9 of the Act on Greenland Self-Government of 2009 and the cooperation agreement of December 2019 between The Ministry of Science and Environment and the Danish Minister of Education and Research covering years 2020-2024. The role of DCE and GINR is set out in an agreement of December 2019 regarding the joint environmental advice of DCE and GINR to EAMRA 2020-2024. Independent third party consultants may be included on a case-by-case basis.

There are public pre-consultations of 35 days and consultations of 8 weeks including public meetings throughout EIA/SIA development. The Mineral Resources Act stipulates that a positive decision shall be made on an EIA and SIA for all projects with a significant impact on the environment or society, in order for the Greenland Self-Government to proceed with a licensing decision.

System of prohibition for the operation of NORM waste facilities without a licence

Regulation of radioactive waste facilities is the responsibility of the Ministry of Mineral Resources regarding exploitation of NORM under the Mineral Resources Act.

According to the Mineral Resources Act exploitation of NORM may be performed only under a license granted by the Greenland Self-Government. Clearance and exemption threshold values recommended to apply to Greenland are set out in the document ‘’DCE recommendations for: Guidelines for the Safe Management of Radioactive Waste generated from the mineral and hydrocarbons industries in Greenland’’ under review and expected to be published at the end of 2021.

Article 20. Regulatory body

See section B and E of this report. The Greenland legislative and regulatory system described above implements all obligations under Article 18 (Implementing measures), Article 19 (Legislative and regulatory framework) and Article 20 (Regulatory body) of the Convention.

Section F. Other General Safety Provisions

Article 21. Responsibility of the licence holder

Industry, medical and educational sectors
The Ministry of Health is drafting an executive order detailing responsibilities for registrants and licensee. The provisions will align with corresponding Danish legislation, as well as international standards for best practices.

NORM responsibility of the licence holder

Greenland applies the “polluter pays” principle. Greenland Self-Government under the Mineral Resources Act requires waste owners to be financially responsible for the management of their radioactive waste. Greenland Self-Government has set in place mechanisms to ensure that this financial responsibility does not fall to the Greenlandic public. The Greenland Self-Government requires a bank guarantee, cash deposit, insurance or other measures deemed satisfactory before mining and milling operations can commence.

In Greenland, the licensee of NORM waste facilities are responsible for providing qualified staff and financial resources to enable appropriate controls, decommissioning, and monitoring of waste facilities to effect compliance with the Mineral Resources Act and specific guidelines. According to the Mineral Resources Act it is the responsibility of the licensee to provide adequate financial resources to support the safe management of the radioactive waste facility while the mine is in operation, under closure, and for the long-term stewardship.

NORM Compliance enforcement

Environmental liability is set out in section 14 of the Mineral Resources Act. Furthermore, liability terms are set in the exploitation licence pursuant to the Mineral Resources Act article 16, 63-72, 84, 86, 92 and 96-97. In case of non-compliance with regards to health, safety, security or environmental matters orders can be issued until the situation is corrected and compliance achieved. Activities under the licence can be restricted or terminated for a period until the corrective measures requested are taken. Ultimately, the punishment for violations of this Act and/or provisions can be penalties, termination of the licence as well as other sanctions according to the criminal acts of Greenland (cf. MRA Section 96). In Greenland before any industrial activity starts, financial assurances are in place to ensure funds are available to safely shut down, maintain, decommission, rehabilitate and for the long-term stewardship the site. In case of the termination of licence, the site's responsibility is transferred to the Relevant Greenland Authority or an appointed independent institution. According to the Mineral Resources Act the license holders are subjugated inspections by the authorities. Injunctions can be issued due to safety concerns or other non-compliance with the Mineral Resources Act and other applicable legislation in Greenland such as the Radiation Protection Act.

NORM Regulatory reporting

Licensees are required to submit operating reports according to licence conditions.

Article 22. Human and financial resources

Industry, medical and educational sectors

To ensure that The Ministry of Health is supported by relevant professional expertise in radiation protection, the Ministry of Health is supported in ad-hoc matters of radiation protection and safety by the Danish Health Authority, Radiation Protection (SIS). It should be noted, that the Danish Health Authority has no jurisdiction in matters of radiation protection in Greenland.

The Danish WEA is drafting a new executive order regarding ionizing radiation and working environment in Greenland. This is prepared in collaboration with the Greenland Self-Government. The scope of the order will include occupational health and safety issues associated with exposure to ionizing radiation.

NORM Regulatory agencies

The Ministry of Mineral Resources is responsible for the Mineral Resources Act. The MLSA and the EAMRA are administrative authorities pursuant to the Mineral Resources Act.

The staff of the Mineral Resource Authorities which include the EAMRA, the MLSA, the Ministry of Mineral Resources, and the Ministry of Foreign Affairs and Energy regularly undergo various training programs specifically targeted at Mineral Resource Administration. The staff is also trained according to the Anti-Corruption Policy of the Ministry of Mineral Resources and its subordinate institutions of March 2015.

Section 9 of the Act on Greenland Self-Government (Act no. 473 of 12 June 2009) obligates the Danish Government, against payment, to ensure adequate consulting and other assistance relating to environmental management of the mineral resource sector. Based on section 9, agreements have been made with the DCE under the Danish Ministry of Science, Technology and Innovation and the GINR and they are long-time advisors to the Greenland authorities on environmental issues within mineral activities.

International research projects, training courses, seminars, conferences, IAEA related meetings, workshops, international collaborations with scientists, independent regulatory bodies and consultants especially from Arctic region and visits to operational uranium mine sites and closed facilities are undertaken by the DCE and GINR staff to ensure an adequate level of qualification and transfer of relevant experience from skilled members of the staff.

NORM Licence holders

Under the Mineral Resources Act and the Radiation Protection Act, the NORM licensees must ensure that all workers, employees, contractors and sub-contractors are trained and competent to perform the work they are employed for.

Article 23. Quality assurance

Industry, medical and educational sectors
The National of Health oversees any use, possession etc. licensed or registered by The Board pursuant to the Radiation Protection Act, as mentioned above in section E.

NORM quality assurance

The licensees must prepare and implement a management system. The management system shall comply with the requirements set out in ISO 14001 or equivalent standards.

The licensees must submit their overall management system programs to the MLSA and EAMRA accordingly before starting the planned activity. After a licence is granted, the licensee must demonstrate the effectiveness of the management system. The Greenland Self-Government monitors compliance of the licensee through regular site visits and monitoring programs.

Article 24. Operational radiation protection

The Ministry of Health is drafting an executive order that regulate dose constraints and limits for the exposure to radioactivity in medical, educational and industry sectors and for the public. Constraints and limits will resemble corresponding Danish legislation and international standards and practices. It is expected that the executive order will enter into force at the end of 2021.

NORM Keeping radiation exposures and doses ALARA

For further NORM activities, Operational Limits and Conditions will be formulated based on the dose constraint of 0.3 mSv/y.

NORM Authorized discharge limits

Authorized discharge limits are established with reference to a dose limit for members of the public of 1 mSv/y considering a dose constraint of 0.3 mSv/y.

NORM Preventing unplanned releases

Several measures to prevent the risk of unplanned releases of radioactive materials from NORM waste facilities into the surrounding environment are developed before the start-up of planned activity and implemented by the licensee under license terms.

Article 25. Emergency preparedness

Industry, medical and educational sectors

Anyone in possession of any type source of radioactive material has to inform The National Board of Health of any accidents or incidents that may result in unintentional radiation, theft of, or any other loss of radioactive materials. The National Board of Health is to maintain an emergency response team, from which assistance can be obtained in situations of incidents involving radiation emergencies.

International arrangements

Following international response conventions apply to Greenland:

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1986) – This international assistance agreement, which was developed under the auspices of the IAEA, promotes cooperation between signatories and facilitates prompt assistance in the event of a nuclear accident or radiological emergency. Its purpose is to minimize the consequences of such an accident; practical steps include taking measures to protect life, property and the environment. The agreement sets out how assistance is requested, provided, directed, controlled and terminated.

Convention on Nuclear Safety (1994) - This international convention, which was developed under the auspices of the IAEA, aim to legally commit participating States' operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which States would subscribe. The obligations of the Parties cover for instance, siting, design, construction, operation, the availability of adequate financial and human resources, the assessment and verification of safety, quality assurance and emergency preparedness.

Should a nuclear or a radiological accident occur near Greenland territory, the Danish Emergency Management Authority may accord assistance. The Danish Emergency Management Authority has a revised nationwide nuclear emergency preparedness plan, which entered into force in 2014. The overall emergency response is under private sector liability, which entails that each sector/licensee is responsible for preventing accidents and likewise establishing a sound emergency management plan for accidents and other incidents.

NORM Emergency preparedness

In Greenland, onsite and offsite radiological emergency preparedness and response for mineral resource activities is a responsibility carried by the licensee with administrative oversight by the Ministry of Mineral Resources, the MLSA and EAMRA. The response activities involve and require different stakeholders, and therefore coordination must occur among all levels of government and the licensee to assure an effective and efficient response to a radiological emergency.

An application for mineral resources activities covered by the Mineral Resources Act must, as part of the application include an Emergency Response and Preparedness Plan for all aspects of proposed activities.

Article 26. Decommissioning

Industry, medical and educational sectors

There are no nuclear facilities under the scope of the Radiation Protection Act.

NORM decommissioning

The licensee has to prepare an initial decommissioning and rehabilitation plan and submit it to the appropriate authorities for review and approval. The licensee should progressively update the initial decommissioning and rehabilitation plan throughout the life of the facility.

The licensee has to prepare and submit a final closure plan and supporting documents for review and approval by the regulatory body, in accordance with national regulations, in order to obtain an authorization to conduct closure activities.

To provide the necessary confidence that the resources will be available to maintain radiation and environmental protection during the decommissioning, to secure the funds needed for decommissioning including premature decommissioning, long term monitoring and to protect against the contingency of a private company ceasing to exist, the Greenland Self-Government require appropriate financial guarantees such as bank guarantees, cash deposits or other means deemed appropriate before mining and milling operations can commence.

Section G. Safety of Spent Fuel Management

Article 4. General safety requirements
Article 5. Existing facilities
Article 6. Siting of proposed facilities

NORM facilities

This subsection provides a list of potential future waste facilities from mining and milling of radioactive minerals in Greenland (Table D 1). An application for an exploitation license for a project, which contains uranium and thorium as bi-products, is currently being processed. For the purpose of this report, the project is named “Kvanefjeld.”

Table D 1. Proposed waste facilities

Future mining operation	Waste structures
Kvanefjeld – exploitation (mining & milling) licence application	Uranium and thorium tailings dams and waste rock piles

Article 7. Design and construction of facilities
Article 8. Assessment of safety of facilities
Article 9. Operation of facilities
Article 10. Disposal of spent fuel

The Greenland Self-Government have not licensed the design, construction and the operation of a nuclear reactor and at the present there are no considerations or plans for taking any kind of nuclear reactors into operation in Greenland. In Greenland, there are no plans for siting, designing, construction and operation of spent fuel facilities or disposal of spent fuel.

Section H. Safety of Radioactive Waste Management

Article 11. General Safety requirements

The radioactive waste as Am-241 sources from smoke detectors, and sealed sources incorporated into the measurement equipment are generated in Greenland.

Industry, medical and educational sectors

The Greenland Self-Government establishes the policy framework for the management of radioactive wastes. A system for the storage of radioactive waste is under preparation according to the Radiation Protection Act. Further assessments will be performed before a decision is made for a waste disposal facility.

NORM

The Mineral Resources Act, the Guidelines for preparation of an Environmental Impact Assessment, and recommendations for guidelines for the safe management of radioactive waste generated from the mineral and hydrocarbons industries in Greenland govern the exploitation of radioactive minerals. These recommendations for guidelines are currently under development and expected to be published at the end of 2021.

The Danish WEA is drafting a new executive order regarding ionizing radiation and working environment in Greenland. The executive order is prepared in collaboration with the Greenland Self-Government. The scope of the order will include occupational health and safety issues associated with exposure to ionizing radiation. It is expected that the executive order will enter into force in Greenland at the end of 2021.

The main objective in the regulation of radioactive waste management facility in Greenland is to ensure that such facilities and their activities do not pose unreasonable risks to the human health, safety, security and the environment.

The licensees in Greenland are required to develop and implement approved plans for radioactive waste management, including the processes by which the generation of radioactive waste is minimized, reused, and recycled.

As stated in Section B and Section F requirements providing for effective protection of human health and the environment are under development as part of the Greenlandic framework legislation and with due regard to internationally endorsed criteria and standards.

Article 12. Existing facilities and past practices

Past activities and existing exposure situations:

In the 1960´s, events and activities related to the American operated facilities at Thule Air Base in Greenland and at Camp Century in the Northwestern part of the Greenland ice sheet, led to the dispersal of radioactivity in the environment. While rooted in different causes, the event at Thule Air Base being an accident, and operations at Camp Century being part of a licensed activity, the present day situation is covered by the same radiation protection principles related to existing exposure situations.

The Kingdom of Denmark is the contracting party to the Convention. Nevertheless, within the Kingdom of Denmark, the legislative and administrative powers relating to radiation protection in Greenland has been taken over by the Greenland Self-Government. However, the events in the 60´s took place prior to the transfer of such powers. In light hereof, the Danish government has since been involved in the relevant clean-up operations, surveying projects, as well as monitoring related to the accident at Thule and the licensed activities at Camp Century.

The accident at Thule Air Base and operations at Camp Century were part of military undertakings, and as such are declared out of scope for the purpose of the Convention. The military control has ceased, and the existing exposure situations is now under regulatory management and responsibility of the Greenland Self-Government.

For the sake of clarity and transparency, events and actions related to the accident at Thule Air Base as well as Camp Century are briefly presented below.

Thule Accident 1968:

In January 1968, an American B-52 bomber carrying four nuclear weapons crashed onto the ice near the Thule Air Base in Northwestern Greenland. Radioactive material (plutonium) from the damaged nuclear weapons was dispersed with the smoke from the burning engine fuel. The majority of the radioactive material landed on the ice surrounding the crash site. Smaller amounts of the radioactive material were carried by the wind over the adjacent landmass to the South.

Following the crash, the USA agreed with the Danish authorities to undertake a thorough cleanup of the ice. Initial characterization of the crash site commenced on the day after the crash. Cleanup operations were initiated immediately hereafter, under the management of the American Strategic Air Command and in collaboration with Danish authorities. Radioactive debris was identified at the crash site, and radioactive contamination was found within an oblong rounded area approximately 500 by 800 meters in size. By September 1968, the last containers with contaminated materials from the crash site were shipped to the USA.

Several surveys of the seafloor beneath the crash site were carried out in the years 1968 to 1991. Scientific sampling and re-evaluation of previous surveys in 2003 showed the presence of particle-associated plutonium on the seafloor at 2-300 m depth below the crash site, and documented that concentrations of plutonium in seawater and marine fauna were low and not posing risks to man.

From 1968 and onwards, Danish experts carried out measurements and collected environmental samples from the land area to the South of the crash site. In 2003, soil samples were collected in the coastal area to the southwest of the Thule Air Base. These samples showed varying plutonium contents as a result of the 1968 plane crash. The findings led to the creation of a collaboration committee between the Greenlandic and Danish health authorities. It was decided to carry out both a health study of the population and further measurements as well as to conduct research on the occurrence of radioactivity in the area in order to assess the risk for people staying in the area. The Danish National Institute of Public Health and The Ministry of Health in Nuuk carried out this comprehensive health study of the population of Avanersuaq (the Thule area) in 2010 and 2011. The study showed no increased illness or mortality associated with the 1968 plane crash.

The research on radioactivity in the Thule area in 2003 was carried out and independently reported by the Radiation Research Division at Risø under the Technical University of Denmark (DTU). The associated assessment of radiation doses for people as a result of terrestrial contamination, and consequently the risk for people staying in the area, was carried out by the then National Institute of Radiation Protection at the then National Board of Health. For assessments concerning the need for special control or protection measures in the Thule area (and the optimization of such measures if necessary), a reference level of 1mSv/y was selected. The final assessment of exposure to representative persons in the Thule area concluded that the total radiation dose was orders of magnitude lower than the reference level, even considering extreme exposure scenarios. Thus, given the foreseen use of land, no recommendations for remedial actions were given. The complete report on this survey and references to earlier studies are available through the following link: https://www.sst.dk/en/publications/2011/~/media/B06E1CBEED9C48028DE403B7B47AD8D6.ashx

Camp Century 1960-1963:

During the years 1960 to 1963, a mobile nuclear reactor was operated on the American base Camp Century, located approximately 10 m below the ice surface of the Greenland ice sheet in Northeastern Greenland. Construction, operation and decommissioning was undertaken in agreement with the Danish government, and was regularly reported on to the Danish authorities by the US military units tasked with the undertaking.

Operational limits and conditions included health physical monitoring as well as environmental monitoring of the subsurface camp areas and sampling of the ice surface and atmosphere above the camp. All solid operational radioactive waste was transported to the USA. Liquid radioactive waste was discharged directly into a dedicated well established within the ice by steam melting, presumably extending to a depth of about 40 m below the camp floor level. The liquid radioactive waste was estimated to consist of fission products such as I-131 and Cs-137 and activated short-lived corrosion products in sub equal proportions. Annual discharge limits for liquid radioactive waste were set at 1.85 GBq. Upper activity concentration limits for discharged liquid radioactive waste were set at 37 MBq/m^3, corresponding to a maximum discharge volume of 50 m^3/y.

Following the decision to terminate operations at Camp Century, decommissioning plans established by the USA and agreed upon by the Danish authorities were effectuated, resulting in the complete removal of the mobile reactor and peripheral systems. All reactor components and dismantled peripheral systems were shipped together with the spent fuel back to the USA. Final clearance surveys documented compliance with agreed clearance and release criteria. The total amount of liquid radioactive waste reported discharged to the ice, contained an activity of 2.7 GBq and was permitted by Danish authorities to remain in the ice upon shutdown of activities at Camp Century. Activities at Camp Century ceased gradually over the following years and final shutdown of operations was in 1967.

In 2016, scientific studies indicated, that the effects of climate change in Greenland may result in melting of the ice sheet to an extent that the remains of the abandoned Camp Century, presently estimated to be buried 30-95 m below the ice sheet surface, may be exposed or carried into the environment by melt water in the next 50-100 years.

The Danish Government has agreed with the Greenland Self-Government to investigate the rate of effects of climate change at Camp Century. Various initiatives regarding further characterization of the remaining types and amounts of waste present at Camp Century were performed. An ice core was extracted in July 2017 from Camp Century and subsequently examined for indications of radioactive contamination from the nuclear reactor's operation during 1960-1964. It is concluded that there is no indication that significant radioactive contamination was released into the air because of the Camp Century reactor operation (DTU, NUTECH, Roskilde, July 2018: (https://knr.gl/files/camp_century_report_20180719.pdf).

Article 13. Siting of proposed facilities Article 14. Design and construction of facilities Article 15. Assessment of safety of facilities

The radioactive waste such as Am-241 in smoke detectors and sealed radioactive sources incorporated in measurement equipment from educational sectors and industry are generated in Greenland. Future possible mining and milling of radioactive minerals will produce wastes containing NORM.

The waste from industry and the educational sectors

A system for the storage of radioactive waste generated in the educational sector and from industry is under development according to the Radiation Protection Act. Further assessments will be performed before a decision is made for the development of a waste disposal facility.

NORM

Currently, there are no approved NORM waste facilities in Greenland. According to the Mineral Resources Act and specific guidelines, prior to siting, construction and commissioning of mill tailings facilities, the applicant shall prepare and submit a draft Environmental Impact Assessment (EIA) together with additional study reports on tailings facilities risk assessment, alternatives for tailings disposal, management practices for the tailings resulted from the project and decommissioning of tailings facilities. Those reports are assessed by engineers, independent consultants and scientists from the Ministry of Mineral Resources, the MLSA, The Ministry of Health, EAMRA, GINR, DCE and independent international third party reviewers.

Public consultation

Public consultation is required as part of the approval process under The Mineral Resources Act sections 87 a – 87 d.

The EAMRA in coordination with The Ministry of Industry, Labour, Trade and Energy under the Greenland Self-Government organized public information and consultations meetings during exploration activities at Kvanefjeld in the licence application process. Those information public meetings where held by independent scientists in various cities in southern and southeastern Greenland and available information from the public meetings can be found at the http://naalakkersuisut.gl/en/Naalakkersuisut/Departments/Erhverv-Arbejdsmarked-og-Handel

The licensee at Kvanefjeld also held public information meetings.

Article 16. Operation of facilities

Industry, medical and educational sectors

At present there are no operating facilities in Greenland. .

NORM Operation of facilities

There are no NORM operating waste facilities in Greenland.

NORM Operational limits and conditions

For further mineral projects involving NORM, discharge limits for controlled release of radionuclides and non-radioactive contaminants to the environment in the form of airborne and liquid effluents will be established, taking into account site-specific data, Greenlandic regulatory framework, and Council Directive 2013/59/EURATOM. The authorities would perform a routine monitoring program of dose, radioactive and non-radioactive contaminants at the mine site and into the environment in order to ensure compliance with the regulatory requirements. The licensee is requested to report incidents relevant to waste management significant to safety.

Article 17. Institutional measures after closure

NORM institutional measures after closure

The authorities conduct inspections and review of closure actions to ensure that they are being carried out in accordance with the authorization for closure and the specific requirements of licences and approvals. The licensee performs environmental monitoring for a number of years after completion of decommissioning and rehabilitation of the site. Terms for such monitoring are established in the licensing process.

Section I. Transboundary Movement

Article 27. Transboundary movement

The Radiation Protection Act regulate import, export, and transport of radioactive materials in Greenland and within Greenlandic waters and is further subject to a license or a registration from The National Board of Health and The Ministry of Health. An application of transboundary movement of radioactive waste has not been received and consequently no license has been issued for a transboundary movement of radioactive waste for the purpose of this Convention.

The Ministry of Health is drafting an executive order to regulate the terms under which the licensing and registration is to be submitted. The executive order is expected to enter into force at the end of 2021.

Internationally, the Danish Maritime Authority has the long-term goal of making the IMO “Guidelines for ships operating in polar waters” and the IMO “Enhanced contingency planning guidance for passenger ships operating in areas remote from SAR facilities” internationally mandatory.

Chapter 7 of the Danish Emergency Management Act (No. 314 of 3 April 2017), ‘*Security of nuclear materials and nuclear facilities’* stipulates an overarching framework for the physical protection of nuclear materials being used, stored and transported. To ensure that these requirements are being met a security plan shall be drafted for any use, storage or transportation of nuclear material, which shall be approved by the Danish Emergency Management Agency.

NORM related transboundary movement

An exploration project started at Kvanefjeld in 1955 and remained at exploration phase until 1983. In 2007, an exploration licence was granted at Kvanefjeld. NORM waste (tailings) generated from exploration activities in 2012 were transported to Perth (Australia) for storage in 2013 (530 kg of sample rocks). In 2015, NORM waste was generated from Kvanefjeld exploration pilot plant in Finland. The NORM waste is currently stored in closed containers at the site. It is the plan of the company to dispose these tailings at the project site if commercial operations commence.

Section J. Disused Sealed Sources

Industry, medical and educational sectors

The Radiation Protection Act regulates Am-241 sources from smoke detectors, and sealed sources used in industry and educational sectors. The Greenland Health Care System does not use sealed sources. A system for the safe storage of radioactive waste has been developed and is implemented in Greenland (see Section B). Additional assessments will be performed before a decision is made for a permanent waste disposal facility.

Section K. General Efforts to Improve Safety

Industry, medical and educational sectors

Greenland is pursuing several initiatives to better manage the radioactive waste produced inside its borders and to ensure the protection of health, safety, security and the environment.

These initiatives include:

- Competence development within environmental and radiation protection issues related to uranium production
- Development of regulatory documents that provide guidance to licensees.

Competence development within NORM

Staff competence development programs within environmental and radiation issues related to the exploitation of radioactive minerals in the Arctic region started in 2014. The development programs include but not to be limited to, a compliance radioecology laboratory unit, workshops related to exploitations of radioactive minerals in the Arctic, uranium mine sites visits, training courses, international collaborations both with independent consultants and regulatory bodies, e.g., the Government of Saskatchewan, Ministry of Environment, Canadian Nuclear Safety Commission (CNSC), Northern Territory Department of Mines and Energy, Southern Australian Environmental Protection Agency, US Environmental Protection Agency.

Regulatory framework initiatives

Standards and requirements for radiation safety matters for exploration and exploitation of radioactive materials in Greenland are under development and expected to enter into force at the end of 2021. In the meantime, Council Directive 2013/59/EURATOM, ICRP recommendations for radiological protection, and IAEA safety fundamentals, general safety requirements, general safety guides and specific requirements and specific safety guides related to uranium mining and milling are considered while developing the Greenlandic standards and requirements for radiation safety.

L. Annexes

Annex A – Inventory of Radioactive wastes

The Ministry of Health has developed a system for the registration of radioactive waste within Greenland.

Inventory of unsealed radioactive waste

Mining and milling site: Currently, the only project where uranium may be produced as a by-product in the future is located at Kvanefjeld in southern Greenland. The licensee of the exploration project has submitted application documents for the exploitation project, which are currently under review. The documents include a draft EIA and SIA, which will be subject to public consultation and government approval pursuant to the Mineral Resources Act section 87 before a decision on the exploitation application can be made.

Inventory of estimated future unconditioned waste at Kvanefjeld site based on the Terms of Reference documents submitted by the applicant: http://naalakkersuisut.gl/en/Hearings/Hearing-Archive/2014/Kuannersuit-forhoering

Proposed tailings sites	Company name or responsible party	Storage	Mass (tons/y)	Mass (tons/37y)
Kvanefjeld	Greenland Minerals and Energy LTD	Concentrator Tailings	3 million tons	111 million tons
		Refinery Tailings		
		Waste rock	3 million tons	111 million tons

Annex B. Greenlandic Regulatory Framework for the management of radioactive waste

Acts:

Greenland Parliament Act no. 7 of 7 December 2009 on mineral resources and mineral resource activities (the Mineral Resources Act which came into force on 1 January 2010) with amendments from Greenland Parliament Act no. 26 of 18 December 2012, Greenland Parliament Act no. 6 of 8 June 2014 and Greenland Parliament Act no. 16 of 3 June 2015.

Greenland Parliament Act no. 33 of 9 December 2015 on Ionizing Radiation and Radiation Protection Act.

Act on maritime safety (Consolidated Act no. 903 of 12 July 2007).

Danish Ministry of Employment Consolidated Act no. 1072 of 7 September 2010 with later amendments (the Working Environment Act).

Danish Act for Greenland no. 621 of 8 June 2016 on the Control of Peaceful Uses of Nuclear Material.

Danish Act No. 616 of 8 June 2016 on the Control of Export of Dual-Use Items in Greenland.

Danish Ministry of Defence Consolidation Act no. 660 of 10 June 2009 (The Emergency Management Act) partly in force in Greenland pursuant to Greenland Parliament Decision of 23 May 2017.

Danish Acts on Sea Transportation and executive orders regarding the transportation of hazardous materials.

The Danish Air Navigation Act and executive orders regarding the transportation of hazardous materials.

Executive Orders:

Order no. 417 of 28 May 2009 on technical regulation on safety of navigation in Greenland waters.

Order no. 170 of 17 March 2003 on ship reporting systems in the waters off Greenland.

Technical Regulation no. 169 of 4 March 2009 on the use of ice search - lights during navigation in Greenland waters.

The following executive orders and recommendations for guidelines are being drafted:

- Self-Government “Executive Order on dose limits for ionizing radiation’’ under the Radiation Protection Act by The Ministry of Health, Greenland, is in proces. Expected to enter in force at the end of 2021.
- Currently the Danish Working Environment Authority is in the process of drafting a new executive order regarding ionizing radiation and working environment in Greenland. This is prepared in collaboration with the Greenland Self-Government.

Guidelines:

Guidelines for preparing an Environmental Impact Assessment (EIA) report for mineral exploitation in Greenland 2015:
https://govmin.gl/images/stories/minerals/Guidelines_for_preparing_an_Environmental_Impa ct_Assessment_EIA_report_for_mineral_exploitation_in.pdf

Guidelines under development:

- The DCE, has prepared for EAMRA the recommendations for guidelines for the Safe Management of Radioactive Waste generated from the mineral and hydrocarbons industries in Greenland. These recommendations will is expected to be published at the end of 2021.

Greenland – Overview matrix

Seventh review meeting of the Joint Convention

Type of Liability	Long-term management policy	Funding of liabilities	Current practice/facilities	Planned facilities
Spent fuel	Not applicable	Not applicable	Not applicable	Not applicable
Nuclear fuel cycle wastes	Not applicable	Not applicable	Not applicable	Not applicable
Application Wastes	The Greenland Self-government can set conditions for any use of radioactive sources, including disposal, according to the Radiation Protection Act	The Greenland Self-Government can levy fees from license holders for waste management according to the Radiation Protection Act	t. No formalized current practices/facilities	. A system for storage of radioactive waste is being developed and implemented according to the Radiation Protection Act. Further assessments will be performed before a decision is made for a waste disposal facility.
Decommissioning	There are no facilities under the scope of the Radiation Protection Act	The Greenland Self-government can levy fees from license holders for aid provided for decommissioning according to the Radiation Protection Act	No formalized current practices/facilities	There are no facilities under the scope of the Radiation Protection Act
Disused sealed sources	The Greenland Self-government can set conditions for any use of radioactive sources, including disposal, according to the Radiation Protection Act	The Greenland Self-government can levy fees from license holders for disposal of radioactive waste	No formalized current practices/facilities	A system for storage of radioactive waste is being developed and implemented according to the Radiation Protection Act.Further assessments will be performed before a decision is made for a waste disposal facility.