DANISH HEALTH AUTHORITY
Radiation Protection

2024

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

8TH REVIEW MEETING

Health for all

Joint convention on the safety of spent fuel management and
on the safety of radioactive waste management
Denmark
Greenland
8th Review meeting

Danish Health Authority
Islands Brygge 67
2300 Copenhagen S
Denmark

www.sst.dk

ISBN online: 978-87-7014-616-6
Language: English
Version: 01
Versions Date: 16.08.2024
Format: pdf Published by Danish Health Authority

E-mail: sis@sis.dk
Web: www.sis.dk

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 (the 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.

Given the extensive powers of Self-Government arrangements for Greenland, which include independent legislative competences in the fields of radiation protection and

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

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.

DANISH HEALTH AUTHORITY
Radiation Protection

2024

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

NATIONAL REPORT FROM DENMARK
8TH REVIEW MEETING

Health for all

Joint convention on the safety of spent fuel management and
on the safety of radioactive waste management
Denmark
Greenland
8th Review meeting

Danish Health Authority
Islands Brygge 67
2300 Copenhagen S
Denmark

www.sst.dk

ISBN online: 978-87-7014-616-6
Language: English
Version: 01
Versions Date: 16.08.2024
Format: pdf Published by Danish Health Authority

Table of contents

Section A. Introduction

The present report is the Danish National Report for the 8th Review Meeting to the Convention. The meeting takes place from 17 March to 28 March, 2025 at the IAEA headquarters in Vienna. As described in the Guidelines regarding the Form and Structure of National Reports, (INFCIRC/604 rev. 4, 13 January 2023), duplication within the reporting, including repetition of former reports, should be avoided. At the same time, 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 reporting for the 7th Review Meeting. Readers wishing a more detailed description of the development before 2021 are referred to the former reports and questions and answers to these reports available through the website of the Danish Health Authority[1].

The main developments since the 7th Review Meeting relate to the implementation of the strategy for radioactive waste management adopted ultimo 2020 including the progress made in decommissioning of the Danish nuclear facilities at the Risø site.

Implementation of the national strategy for radioactive waste management

The national strategy (hereafter the National Programme[2]) is comprised by 3 technical and 3 socio-economic areas projected over a timescale ranging from the completion of the decommissioning of the nuclear facilities until commissioning of a disposal facility by 2073 at the latest. The timescale is divided into short-term, mid-term and long-term periods, which provides the time frame for the course and completion of the main deliveries defined in the National Programme.

The technical areas are subdivided into “Waste Management”, “Geology & Siting” and “Disposal Solution” – whereas the socio-economic areas are subdivided into “Organisational Framework”, “Stakeholder Engagement” and “Finance and Costing”. The main areas are further divided into a number of variably interdependent deliveries, which take effect in the short term, mid term or long term, or extends over several terms.

Implementation of the National Programme in the reporting period has been focused on the technical areas, notably on the following short-term to mid-term objectives:

- Decommissioning of the nuclear facilities at the Risø site (Waste Management)
- Construction of an upgraded storage facility at the Risø site and associated waste management facilities, including transfer of waste from existing storage facilities at the Risø site to the upgraded storage facility (Waste Management)

[1] Danish Health Authority, national reports from Denmark
[2] National Programme for the Responsible and Safe Management of Radioactive Waste

- Review and identification of potential host geologies for disposal extending to depths of 500 m (Geology and Siting)
- Identifying possible disposal concepts incl. generic feasibility and barrier system studies (Disposal Solution).

Decommissioning

The Danish nuclear facilities are all located on the Risø peninsula (Risø 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.

Danish Reactor 1 (DR 1) and the Fuel Fabrication Facility are fully decommissioned and released from regulatory control. As of 2008, Danish Reactor 2 (DR 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, Danish Reactor 3 (DR 3), and the Waste Management Plant. 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. In May 2019 the Nuclear Regulatory Authorities[3] approved the decommissioning plan for the Waste Management Plant. The preparatory work for the decommissioning of the Waste Management Plant is ongoing.

Challenges and Suggestions

The present report considers the challenges and suggestions mentioned in the Rapporteur's Report for Denmark at the 2021 meeting:

Challenges:

- Public acceptance regarding the long-term storage facility at the Risø site, Denmark
- Public acceptance of a disposal facility
- 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.

Suggestions:

- Further elaboration of appropriate interim targets and end states to enable monitoring of National Programme implementation

[3] 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).

- An implementation plan for the disposal facility is needed to provide the basis of an oversight process
- An overall compliance assurance procedure is needed for monitoring the implementation of the National Programme

The challenges and suggestions are mainly addressed in Section H.2.

The report was 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.

Section B. Policies and Practices

The policy for radioactive waste management is defined in Parliamentary Resolutions and codified in national legislation. Radioactive waste is to be collected, characterized and safely managed until disposal in a dedicated disposal facility. Radioactive waste is categorized with reference to IAEA safety standards for the classification of radioactive waste (IAEA General Safety Guide GSG-1, Classification of Radioactive Waste (2009)).

In Denmark, radioactive waste is generated from institutional applications and as a result of decommissioning of the Danish nuclear facilities, which are located at the Risø site. NORM waste is generated from activities in the oil and gas industries and to a lesser extent from production of geothermal energy. NORM waste generated from activities in these industries is stored by responsible license holders.

Danish Decommissioning is a state-owned entity responsible for operation and decommissioning of the former nuclear facilities in Denmark. As such, Danish Decommissioning stores and manages the limited amounts of radioactive waste (so called “special waste”) originating from destructive testing performed on irradiated fuel-elements during the operational period of the nuclear facilities in Denmark. Danish Decommissioning is furthermore tasked with the responsibility of collecting, characterizing and managing radioactive waste generated from institutional applications and resulting from operation and decommissioning of the nuclear facilities in Denmark. Danish Decommissioning is designated as the entity responsible for developing and implementing a disposal solution in Denmark.

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 national policy for the safe management and disposal of radioactive waste, and for the safe decommissioning of the nuclear facilities at the Risø site is defined by Parliamentary Resolution B48[4] (2003) and Parliamentary Resolution B90[5] (2018).

Parliamentary Resolution B48

Parliamentary Resolution B48 on the decommissioning of nuclear facilities at Risø Research Centre (Parliamentary Resolution B48) was adopted by The Danish Parliament on March 13, 2003. According to Parliamentary Resolution B48, the government was tasked to promote the decommissioning of the nuclear facilities at Risø Research Centre, through the activities of the state-owned entity Danish Decommissioning. The defined

[4] Parliamentary Resolution on the decommissioning of the nuclear facilities at the Risø Research Facility site
[5] Parliamentary resolution on a long-term solution for Denmark’s radioactive waste

end-state for decommissioning activities was the release the areas for unrestricted use. Pursuant to Parliamentary Resolution B48, preparations of a basis for decision for a Danish disposal facility for radioactive waste were initiated.

Parliamentary Resolution B90

Parliamentary Resolution B90 on a long-term solution for Denmark's radioactive waste (hereafter Parliamentary Resolution B90) was adopted by The Danish Parliament on May 15, 2018. The policy covers all radioactive waste generated from institutional use and operation and decommissioning of the nuclear facilities at the Risø 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 disposal facility. Parliamentary Resolution B90, chapter 4, expresses the safety objectives underpinning the resolution as a whole. Parliamentary Resolution B90 facilitates upgrades to the existing storage facilities at the Risø site through the construction of a new storage facility (NOL). In the medium to long term, geological studies to identify possible sites for a geological disposal facility in Denmark are to be conducted. Siting of the disposal facility will eventually be recommended based on analyses of geological, physical and socio-economic and safety criteria. The geological disposal facility is scheduled 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 limited amounts of radioactive waste (so called "special waste") originating from destructive testing performed on irradiated fuel-elements. The special waste comprises the most radioactive part of the inventory of radioactive waste. Following, Parliamentary Resolution B90, 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.

According to Parliamentary Resolution B90, the disposal solution could also be considered as a host for NORM waste.

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

A updated national strategy (National Programme[6]), expanding the provisions of Parliamentary Resolution B48, by including decisions in Parliamentary Resolution B90, was adopted in December 2020.

The overall structure of the strategy is described in Section 1.1 of the National Programme and is comprised by 3 technical and 3 socio-economic areas considered in Parliamentary Resolution B90 and projected over a timescale ranging from the completion of the decommissioning of the nuclear facilities until commissioning of a geological disposal facility by 2073 at the latest. The timescale is divided into short-term,

[6] National Programme for the Responsible and Safe Management of Radioactive Waste

mid-term and long-term periods, which provides the time frame for the course and completion of the main deliveries defined in the National Programme.

The technical areas are subdivided into “Waste Management”, “Geology & Siting” and “Disposal Solution” – whereas the socio-economic areas are subdivided into “Organisational Framework”, “Stakeholder Engagement” and “Finance and Costing” (Figure 1). The main areas are further divided into a number of variably interdependent deliveries, which take effect in the short term, mid term or long term, or extends over several terms.

A number of key decisions defines the programme and the design of a final disposal solution. Most importantly, Parliamentary Resolution B90 configures the programme, constraining it to a deferred solution for Denmark’s radioactive waste with the objective of long-term storage in upgraded facilities until the localisation and implementation of a geological disposal solution by 2073, at the latest. Subsidiary key deliveries and key decisions are described in the following for each of the main areas of the programme.

Waste Management

The waste management area outlines how existing and future radioactive waste is to be characterized, classified, segregated, sorted, minimized and otherwise managed (including long-term storage) in a responsible and safe way before it can be included in a disposal solution. In the short term, the focus is mainly on the construction of an upgraded storage facility and associated waste management facilities – and transfer of the waste from existing storage facilities to the upgraded storage facility. Short-term and mid-term storage and predisposal activities mainly involves characterisation and reassessment of the waste inventory in order to identify options for e.g. sorting, segregation, decay storage, volume reduction and reprocessing in a manner that ensures that further waste management as well as implementation of a disposal solution remains possible. Lastly, the outcome of the short to mid-term probing for an international solution for the so-called “special waste” is crucial for the final design of the disposal solution. The “special waste” constitutes a limited fraction of the radioactive waste in terms of mass and volume, but accounts for a significant proportion of the long lived activity in the combined inventory, and therefore places critical constraints on predisposal management and disposal options.

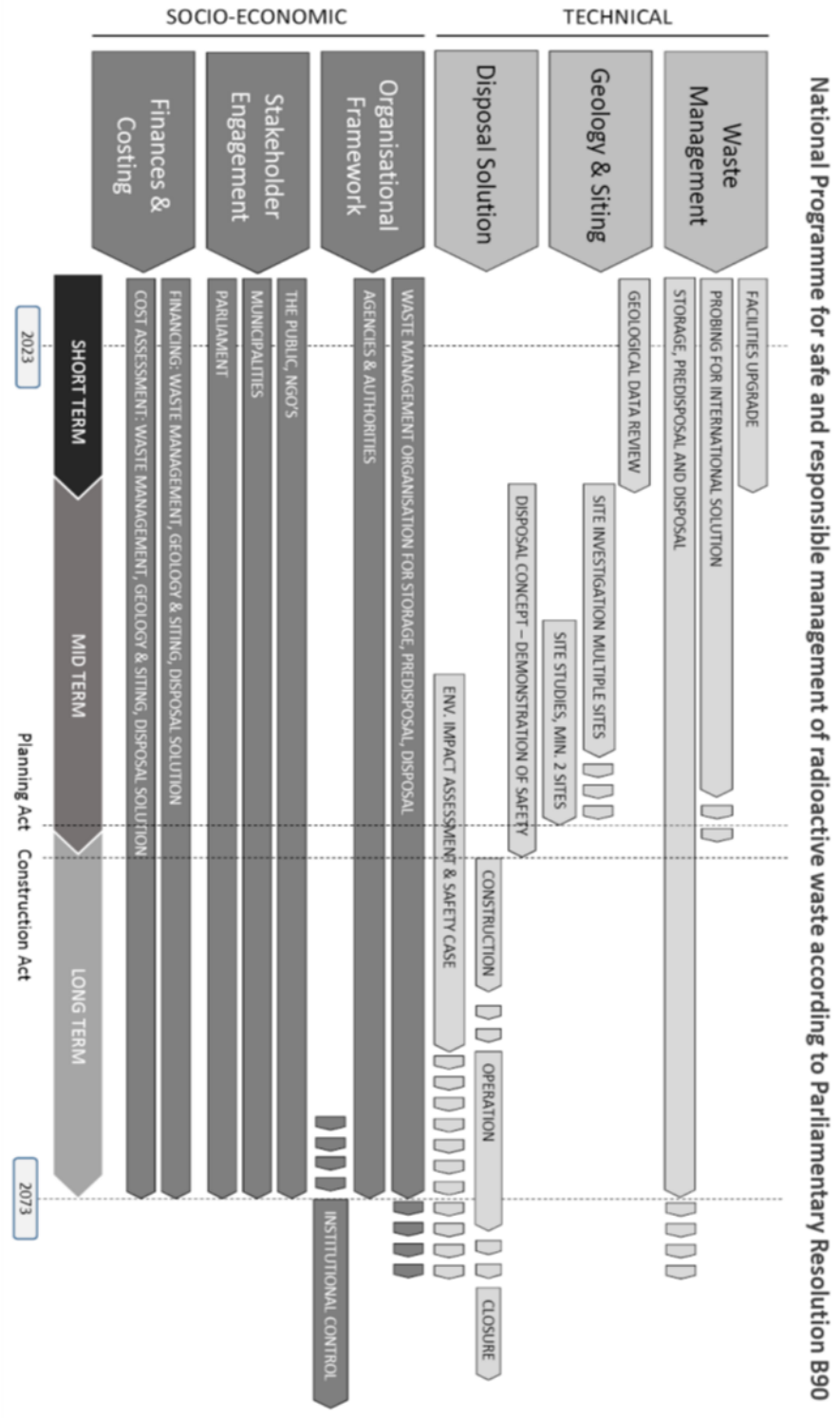

Figure 1: Structure programme areas and timeline for Danish National Programme

Geology and Siting

The Geology and Siting area consists of three successive deliveries, which are designed to identify suitable geological site(s), which in combination with a chosen disposal concept provides a safe and acceptable disposal solution for all relevant types of radioactive waste. The short-term delivery is a "geological data review" of available geological data down to a depth of 500 meters, which, together with previously conducted assessments and importantly, possible municipal partnership solutions, will form the basis for the selection of several sites to be subjected to further "site investigations, multiple sites" in the mid-term period. On the basis of these studies, two sites will be selected for so-called "site studies", i.e. further geological studies e.g. on the basis of the disposal concepts that appear particularly suitable with respect to the local geological setting and the preceding dialogue with the municipality and local stakeholders. It should be noted in this connection that the particular design of the disposal concept can take into account the possibility of separate solutions – e.g. a deep borehole in combination with a shallow gallery. If the "site studies" show that the combination of geology and concept does not provide a solution which satisfies safety criteria, the "site investigations, multiple sites" will continue in order to identify other geologically suitable sites for further "site studies".

Disposal solution

The disposal solution area outlines the development of one or more "disposal concept(s)", which may be constructed, if the design – in combination with the geological barrier systems - can successfully undergo a demonstration of safety, providing confidence that the combined barrier system of the disposal solution will meet safety requirements. The actually implemented disposal solution will be subject to an EIA[7] assessment. In order to be commissioned and go into operation, the disposal concept must acquire a license on the basis of a safety case, including a supporting safety assessment. The particular design of the disposal concept must take into account the possibility of separate solutions – e.g. boreholes and galleries – designed for specific types of radioactive waste and that such parts of the disposal facility may subsequently be closed and sealed, completing the disposal process for these waste fractions. With regard to receiving and disposing of future radioactive waste from users of radioactive material (hospitals, research labs and industry), the disposal facility must include options for receiving radioactive waste to be placed in one or more sections of the disposal facility designed for this purpose, and to be closed and sealed once filled. The planning can take into account a possible need for future extension of the facility with a proposal for acquisition of extra land for a new disposal section.

Organisational Framework

The implementation and development of a disposal solution will take place over many decades. This requires a strong organizational foundation and framework as stated in the National Programme (Page 14/68-15/68) and clearly constituted in the legislation, and

[7] Environmental impact assessment

where also the individual responsible authorities have been given clear tasks and mandates from their respective ministries. Along the entire course of the programme, the organizational framework must support a parallel development of technical and socio-economic competencies of operators as well as authorities. Only by establishing, maintaining and to some level retaining the necessary level of insight and understanding of all parts of the programme - as they develop - can effective progress, an apt process as well as a complete, transparent and straightforward communication with stakeholders – be ensured. There must therefore be mechanisms that maintain communication and cooperation between the parties involved, as well as mechanisms that ensure that the responsible ministries continuously are informed about the status, progress and barriers to this - and that responsible parties continuously take the necessary position on the state of the programme.

Stakeholder engagement

It is Parliament's explicit wish that the overall process is carried out with continuous involvement of all relevant stakeholders in a disposal solution for radioactive waste in Denmark. In addition to the statutory involvement and consultation of the public in different stages of the process, the involvement of stakeholders will include the continuation and adaptation of a contact forum in the case in line with developments, comprising a dialogue forum and communications resource at the final decided location for a disposal facility. Operation of a communications platform with access to all relevant material in the case, and with a contact person function is included in the plan for stakeholder involvement.

Finance and Costing

Financing and cost assessments of all the activities included in the entire programme e.g. waste management, geological investigations, disposal concept development, construction, operation and closure etc. are included in the basis for adoption of Parliamentary Resolution B90. The basis includes general cost analysis, cost profiles and financing considerations for the proposed long-term solution. The costs are however subject to significant uncertainty, as there is no national experience with locating, designing and constructing facilities of this nature. In addition, the time scale means that the cost profiles may change considerably, pending e.g. the design of the final disposal concept. Although it is by parliamentary resolution decided to cover the costs of the programme as a whole, there will be a need to partition funding according to the shorter-term budgeting of projects and sub-projects individually - since these can depend on variables such as e.g. geological setting, design concept, export opportunities and the development of new waste management methods. Therefore, as depicted in Figure 1, ongoing cost analysis and financing for relevant technical and socio-economic deliveries must be carried out over the lifetime of the National Programme.

Since the adoption, implementation of the National Programme has focused on the technical areas, notably on the following short-term to mid-term objectives:

- Decommissioning of the nuclear facilities at the Risø site (Technical Area: Waste Management)
- Construction of an upgraded storage facility (NOL) at the Risø site and associated waste management facilities, including transfer of waste from existing storage facilities at the Risø site to the upgraded storage facility (Technical Area: Waste Management)
- Review and identification of potential host geologies for disposal extending to depths of 500 m (Technical Area: Geology and Siting)
- Identifying possible disposal concepts incl. generic feasibility and barrier system studies (Technical Area: Disposal Solution).

Further details on progress with programme implementation are provided in Section H.

B.2. Practices for radioactive waste management

Danish Decommissioning is the main generator and responsible manager of radioactive waste in Denmark, and Danish Decommissioning also has responsibility for pre-disposal management, incl. storage of the “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 2.

Licensees may discharge radioactive waste (liquid and gaseous) if this is otherwise suited for discharge, according to the provisions in Executive Order 670/2019[8]. 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 Danish Decommissioning. Danish Decommissioning, within it remit of activities works towards reducing the amounts of radioactive waste to be disposed of. Both licensees and Danish Decommissioning 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 Danish Decommissioning may store waste up until a national disposal facility is commissioned. Consequently, all radioactive waste generated by institutional users in Denmark is eventually transferred to Danish Decommissioning. Only waste generators in the oil and gas etc. industries store radioactive waste for periods extending 1 year.

[8] Executive Order No. 670 July 1 2019 on the Use of Radioactive Substances

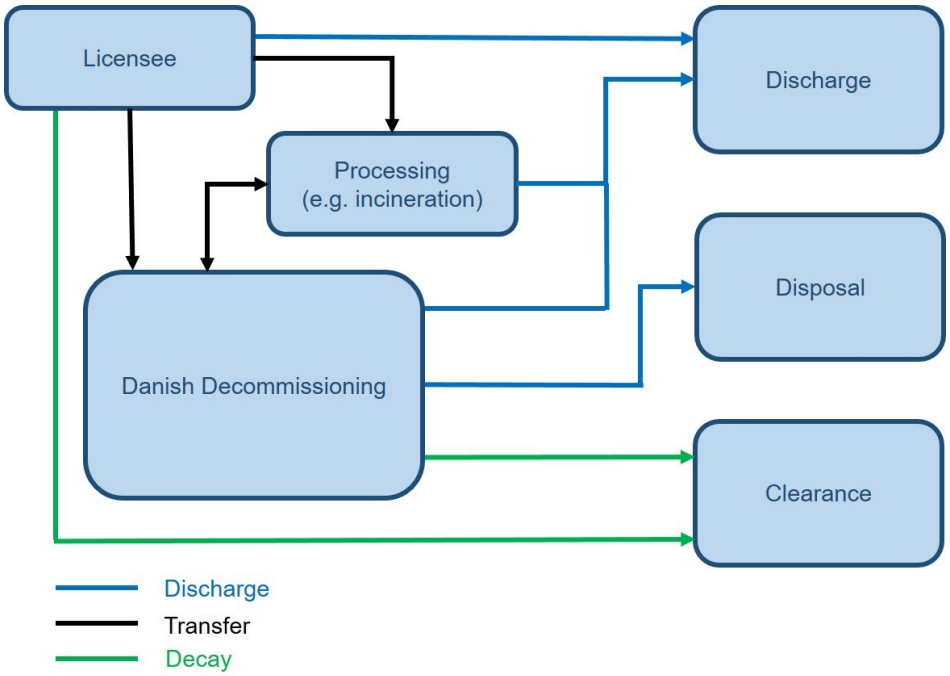

Figure 2: Generalised framework for management of radioactive waste in Denmark.

Radioactive waste (NORM waste) produced as a result of activities in oil and gas industries, as a by-product of geothermal energy production etc. are subject to the same regulatory regime as specified above, except that radioactive waste from these activities is stored at storage facilities operated by the waste-generators, awaiting development of a final management solution for these types of radioactive waste.

The largest part (65% by mass) of the Danish inventory of NORM waste is stored by Danish Decommissioning at the Risø site. The main part of this NORM waste consists of tailings from the experimental extraction of uranium carried out during the operational period of the nuclear facilities, while approximately 5 % originates from institutional NORM waste generators.

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 radioactive waste in Denmark is also covered by the legislative and regulatory system portrayed in Section E. Information on NORM waste is provided throughout the report.

Section D. Inventories and Lists

Article 32, Paragraph 2

D.1. Spent fuel management facilities

The amount of radioactive waste (so called “special waste”) originating from destructive testing performed on irradiated fuel-elements remains unchanged since last reporting in terms of volume and mass, as there are no spent fuel management facilities located in Denmark, and no processing abroad has taken place.

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

Spent Fuel	Storage facility	Material	Mass/Volume	Activity
Spent fuel from DR 1	Risø site	Solution of 20% enriched uranyl sulphate in light water	4.9 kg U 15.8 l	25.9 GBq fission products 0.4 GBq actinides
Experimentally produced and irradiated fuel of power reactor type	Risø site	Uranium oxide pellets mostly in zircalloy tube	233 kg U	484 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 2024.

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 fuel of power reactor type remains the same. Accordingly, the calculated

activities are decay corrected to the datum of 01-01-2024 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.

The inventory for the waste listed in this section is also available through the IAEA hosted "Spent Fuel and Radioactive Waste Information System" (SRIS)[9], providing information on radioactive waste inventories, national radioactive waste management programmes etc. in IAEA member states

D.2. Radioactive waste management facilities

An overview of nuclear facilities and associated buildings at the Risø site is given in Figure 3. Building numbers and their respective names are listed in Table 2.

Following inspection and approval by the nuclear regulatory authorities ultimo 2005, the Radiological Characterization Laboratory for sampling and characterisation of radiological materials from the nuclear facilities, buildings, and surroundings was commissioned.

Since, the laboratory has undergone multiple external audits of quality assurance in accordance with the DS/EN ISO 9001:2015 standard. As part of its commitment to maintaining high-quality standards, the laboratory is subject to an external audit on an annual basis. The most recent external audit took place in 2019. In addition to external audits, the laboratory conducts internal audits on a yearly basis.

As an example of the work carried out at the laboratory is, 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 for decommissioning waste upholds an independent accreditation. The accreditation was granted in 2007 by DANAK in accordance with ISO/IEC 17025:2005 and revised to ISO/IEC 17025:2017 in 2020. This accreditation was confirmed during the latest audit in May 2023. 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, from 2020 to 2023, 44.2 tons of material passed the clearance test and subsequently have been released from regulatory control by Danish Decommissioning.

Inventories of radioactive waste subject to the Convention are given in Table 3 for conditioned[10] waste and in Table 4 for unconditioned waste, respectively. Waste received

[9] IAEA Spent Fuel and Radioactive Waste Information System - Denmark
[10] The radioactive waste is conditioned for storage not for disposal.

over the last four years is presented in Table 5, which includes secondary waste (waste with a non-decommissioning origin generated at the Risø site) as well as unconditioned institutional 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). Please note in the latest report that there was an error, wherein the volume was mistakenly indicated as mass.

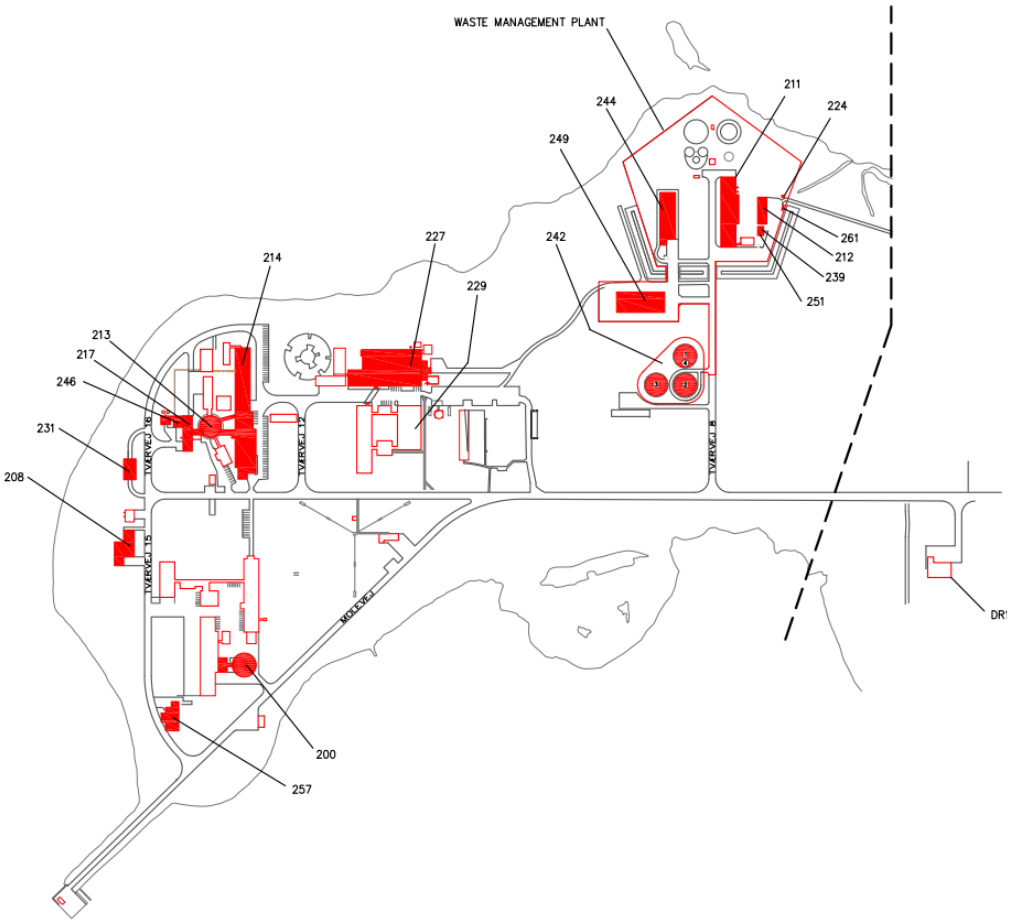

Figure 3: A map of the Risø Peninsula (Risø site). The objects marked red resemble the building managed by Danish Decommissioning. Each red building has a number attached, which corresponds to the building number in Table 2.

Building number	Danish designation	English designation
200	H-hallen (DR 2, reaktorhal)	Handling Hall (DR 2 Reactor Containment Hall)
208	Aktivt Laboratorium and Isotope laboratorium	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
231	Centralvejslager	Centralvej Storage
239	Modtagelager	Institutional Waste Storage
242	Tailings- og malmbassiner	Tailings and ore pools
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
251	Henfaldslager for eksternt affald	Decay Storage for Institutional Waste
257	Frigivelseslaboratorium	Clearance Laboratory
261	Miljøcontainer	New Storage of Radioactive Liquids

Table 2: List of buildings managed by Danish Decommissioning. The location of each building on the Risø Peninsula (Risø site) is shown in Figure 3.

Storage facility	Mass (tons)	Volume (m^3)	Activity (TBq)
Low Level Waste Storage	~1,780	~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 2024.

Storage facility	Mass (tons)	Volume (m^3)	Activity (TBq)
Drum Storage and Centralvej Storage	~162	84	489
Tailings and ore pools	4,800	3100	0.1
Intermediate Storage	2,092	1,425	194

Table 4: Inventory of unconditioned radioactive waste stored at Danish Decommissioning as of January 2024, classified as low and intermediate level waste (LLW and ILW). Please note that the inventory of the Drum Storage and Centralvej Storage does not include the spent fuel from Table 1.

Year	2020	2021	2022	2023
Secondary waste from the Risø site	3.7 tons	1.9 tons	3.9 tons	2.8 tons
Secondary waste from external waste producers	6.0 tons	4.3 tons	3.9 tons	5.5 tons

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

Since the last report, the Fuel Fabrication Facility (Building 229) has been fully decommissioned and released from regulatory control. Additionally, three new storage facilities have been commissioned: the Institutional Waste Storage (Building 239), an intermediate storage facility for waste received from external suppliers awaiting further treatment or packaging; the Decay Storage for Institutional Waste (Building 261), a storage facility for sources that might be eligible for clearance later; and the New Storage of Radioactive Liquids (Building 261), providing additional storage for liquids awaiting treatment. Also, a storage for the radioactive concentrate resulting from the treatment of radioactive water have been commissioned in Building 212.

The tailings, which were stored in two of the three pools (Building 242) are now concentrated in one pool. Following the ore, that was stored in a heap, was moved to the two vacant pools. Both the pool with the tailings and the two pools with the ore have been covered with heavy-duty tarpaulin material.

Since 2020, 30 drums containing items such as vacuum cleaner bags, compacted waste, sources from ionization smoke detectors, and various waste from DR 3 and Hot Cells have been relocated to the Low-Level Waste Storage. Additionally, two drums containing

various institutional waste have been relocated to Drum Storage, and six DD Type 2 containers have been relocated to Centralvej Storage.

The 7th National Report declared that the Intermediate Storage (Building 249) contained an activity of 234 TBq and a mass of 1,605 tons. Since 2020, an additional 63 DD Type 2 steel containers have been positioned in the Intermediate Storage, and as of January 2024 the Intermediate Storage contain 2,092 tons of radioactive waste with a total activity of 194 TBq (Table 4). The main contents of the Type 2 steel containers comprise concrete and steel from the reactor block of DR 3, experimental rigs from DR 3, parts from the primary cooling system, and ion chamber from DR 3, as well as shutter housing and plugs from the Hot Cell facility.

In January 2024, Danish Decommissioning dispatched their third shipment, containing 4.7 tons of combustible radioactive waste, to Cyclife Sweden AB. Danish Decommissioning will receive the bottom ash and filters from the combustion process. Danish Decommissioning expects to achieve a mass reduction of 90%, consistent with previous incineration campaigns. The contract with Cyclife Sweden AB still stands and once the mass of combustible radioactive waste reaches above a certain point, Danish Decommissioning will undertake a new incineration campaign.

Furthermore, Danish Decommissioning has initiated the practice of sending liquid waste with very low-level activity to a licensed incineration facility in Denmark. Currently, Danish Decommissioning has dispatched 380 plastic canisters, totalling approximately 1900 litres of liquids to the incineration facility. The activity of the resulting fly and bottom ashes from the incineration process is below exemption levels, and therefore the treatment does not result in the return of radioactive waste for Danish Decommissioning to manage.

Secondary waste generated during the decommissioning activities at the Risø site by Danish Decommissioning 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 (institutional waste) received from users of radioactive materials and radioactive sealed sources in Denmark (i.e. hospitals, research institutions, industrial applications etc.) generally vary between 2 and 10 tons per year.

The inventory for the waste listed in this section is also available through the IAEA hosted “Spent Fuel and Radioactive Waste Information System” (SRIS)[11], providing information on radioactive waste inventories, national radioactive waste management programmes etc. in IAEA member states.

[11] IAEA Spent Fuel and Radioactive Waste Information System - Denmark

D.3. Nuclear facilities under decommissioning

The decommissioning activities at the Risø site are progressing, and in the following a status is given for the completed decommissioning work as well as for the ongoing decommissioning work at the nuclear facilities. The emphasis is on the decommissioning of the Hot Cell Facility, Danish Reactor 3, and the facilities of the Waste Management Plant.

An overview of the decommissioning status for each nuclear facility at the Risø 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 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 one third of the biological shield has been removed.
Hot Cell Facility	Facility for post irradiation investigations of nuclear fuel	1989	85 % of the activity has been removed and preparation for the demolishing of the cells is ongoing.
Fuel Fabrication Plant	Fuel Fabrication Plant for DR 2 and DR 3	2002	Fully decommissioned and the building was released from regulatory control in 2023.
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, while updates to the decommissioning plan are being finalized.

Table 6: Nuclear facilities decommissioned or under decommissioning at the Risø 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) were 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 facility for large and/or heavy objects as well as other waste objects from the on-going decommissioning projects at the Risø site.

In 2019 Danish Decommissioning 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. Final approval of the decommissioning report was provided 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. Afterwards, the equipment for the dismantling of the internals was removed, this include the dismantling of the temporary Packing Hut and Manipulator Box.

Details on the following operations were presented in the Seventh National Report from Denmark to the Joint Convention:

- Remote cutting of the Reactor Aluminium Tank (RAT),
- Emptying the storage facilities – Experimental rigs
- Removal of paint by CO_2 ice blasting
- Remote of the graphite reflector
- Removal of the cast layer of lead
- Preparatory work for cutting the reactor block

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

D.3.3. Progress since last national report

Due to the Covid-19 shutdown, not as much cutting has been done as planned, but the top layer cuts have been made and individual blocks have been lifted out. During the shutdown a larger dust containment for the faces of the biological shielding of the reactor block was designed. Two dust containment units were installed (Figure 4). The dust containments minimise the risk of contamination of the DR 3 reactor hall during cutting, repositioning of the dust containment itself, service works, and changes the setup of the saw.

Figure 4: Dust containments mounted on facade 1 and 3. Ventilation ducts for the dust containments are connected to the vacuum extractors at the ground level.

The two dust containment units were installed opposite each other on facade 1 and 3 of the biological shielding block of DR 3. By the end of 2021, seven DD type 2 steel containers with six concrete blocks in each were filled (Figure 5): As the concrete is contaminated with tritium the concrete is managed as radioactive waste.

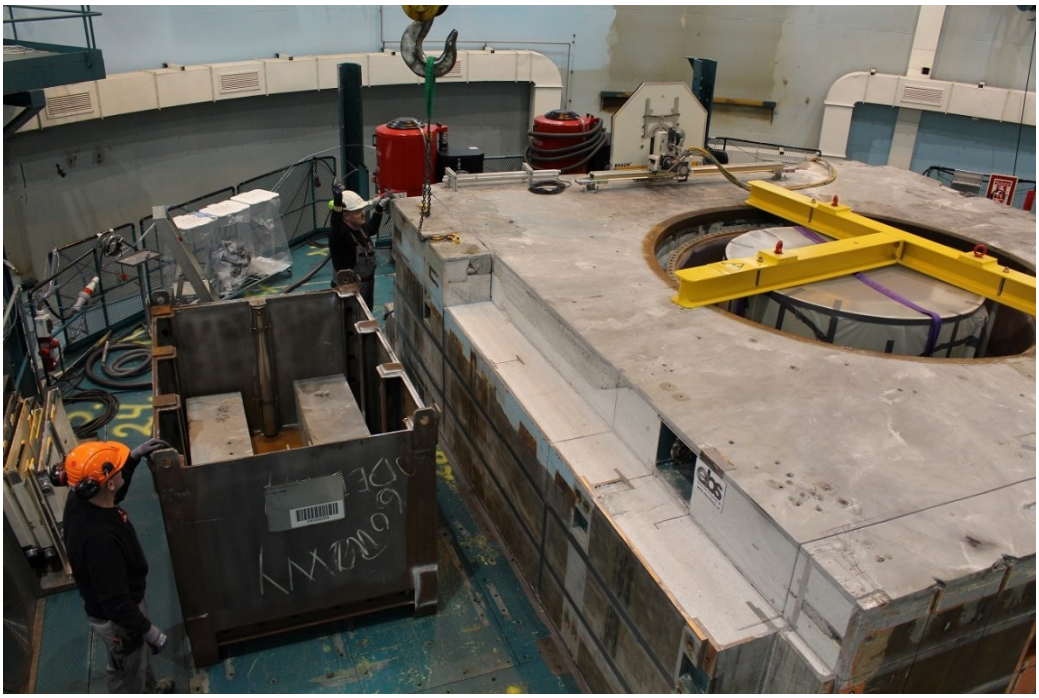

Figure 5: Lifting of one of the cut blocks to a DD type 2 steel container

The reactor steel tank was cut with circular saw together with the inner most layer of concrete. The bottom block in the middle of the nine blocks was left for radiation shielding and the rest were packed in DD type 2 steel containers. The dust containments were then moved and set up on facades 2 and 4, and from here the last parts of concrete block and the steel tank was cut. After finishing the upper most layer of the concrete block, the movable deck was lowered and the next layer of the concrete block prepared for cutting (Figure 6).

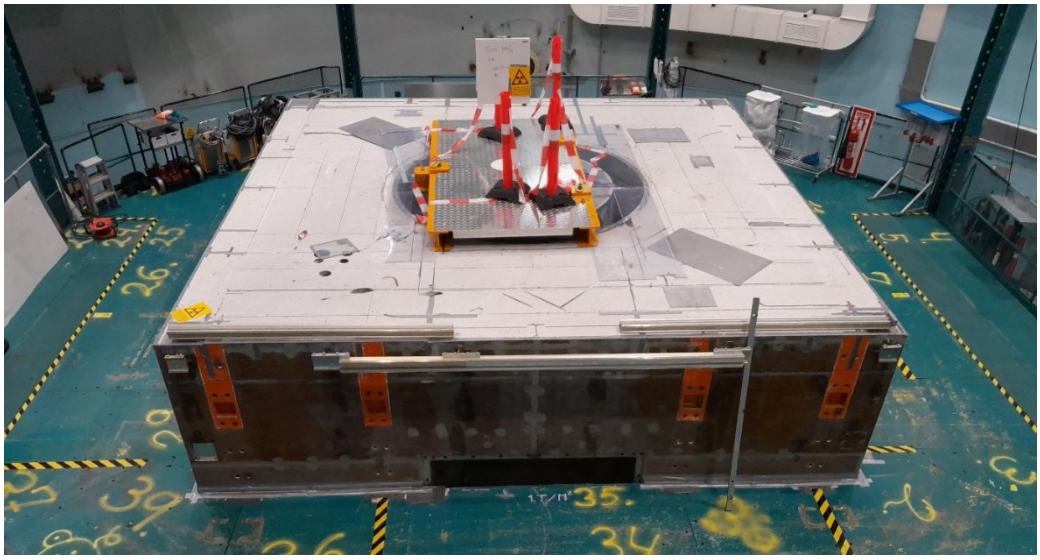

Figure 6: The moveable deck was lowered and the next level of concrete is ready for cutting.

2023 presented challenges of balancing requirements concerning conventional working environment for the air exhaust from the dust containments against requirements for radiation protection. Conventional working environment requirements stipulate that the exhaust air from the dust containments must have a direct outlet from the building. This requirement is in conflict with the capacity of the ventilation system for the reactor hall. The problem is solely related to the conventional working environment as there is no radiological concerns, since all exhaust air is HEPA 13 filtered. The solution was to recirculate the air in the dust containments (Figure 7), maintaining a slight under pressure, while only exhausting a small volume of the air to the reactor hall.

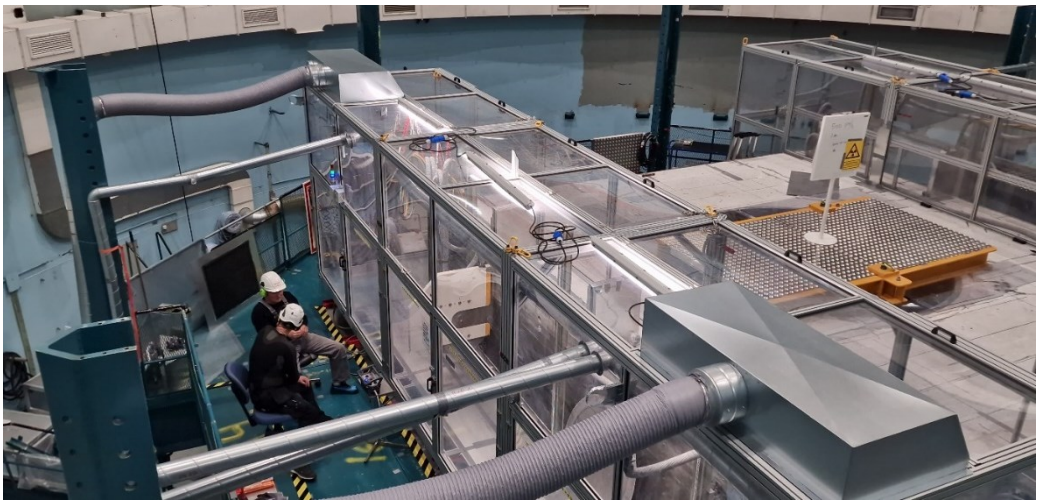

Figure 7: The new recirculation of the ventilated air in the dust compartments.

Cutting with circular saw of the concrete shielding presented challenges (Figure 8) in the form of local pockets of shot concrete and rebar within the concrete. On facade 3, the concrete is now removed almost all the way to the steel tank. Due to the above-mentioned challenges with the ventilation, cutting of the facade 1 concrete is lacking a little behind.

Figure 8: Challenges with the circular saw cutting in a mix of concrete and steel

Current status of the cutting is that one third of the concrete shielding has been cut and removed from DR 3.

Wire cutting

The circular saw cutting method resulted in slower performance than expected and tests with wire cutting were therefore carried out (Figure 9). The tests showed that wire cutting performed better when cutting a mixture of steel and concrete. In contrast to the circular saw which operates with a fixed setting, the wire cutting provides adjustable cutting settings, which speeds up the work. Using the wire cutting, required modification of the dust containments (Figure 10).

Figure 9: Testing of wire cutting

Figure 10: The modified dust compartments prepared for wire cutting at the right side of the picture.

In the modified set-up, wire cutting takes place on one facade and circular saw cutting on the opposite side. If wire cutting proves more effective, a complete change to wire cutting will be implemented.

Packing of rigs and emptying of the storage blocks

All the storage blocks and the cutting pool in the Active Handling Hall (Building 214) have been emptied.

DD had developed a shielded cutting facility placed on top of a hole in the floor in the active handling hall. The main parts of this facility was:

- Stand for the vertical handling flask (~23 tons)
- Lead shielding fixed at three sides and upwards
- One moveable lead shielded wall (to be able to maintain the band saw)
- A moveable band saw inside
- Light, cameras, ventilation and vacuum cleaner to control the dust.

This equipment used for cutting has run well and reliably. This task was fully completed in 2022. Following the decommissioning of the various handling equipment such as shielded handling flasks, viewing boxes and other shielding was initiated.

D.3.4. Hot Cell Facility

The Hot Cell Facility (Building 227) was in operation in the years 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 radioactive 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, present in the hot cells were hot spots on workbenches and floors due to the work with Co-60 radiotherapy sources. Hence, a number of Co-pellets were dropped, and not retrieved during the operation of the Hot Cell Facility.

The originally chosen method for decontamination of the hot cell-interiors using 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 and finished in January 2019. The effect of the remote blast cleaning was that approximately 85% of the activity in the cell range was removed.

Details on development of remote controlled equipment (blast cleaning and vacuuming), the use of mock-ups, test of blasting material and results of the blast cleaning campaign are presented in the Seventh National Report.

”Green Field” – Hot Cells

The original end state goal for the Hot Cell Facility was to decommission the Hot Cells Facility, preserve building including the entire cell rage and release the facility from regulatory control without restrictions, hence to *Green Field*.

However, the decommissioning strategy was changed following a study in 2019, as the study concluded that documentation of compliance with clearance criteria would be complicated and time consuming due to possible contamination within embedded pipes in the cell wall structures (Figure 11).

The new decommissioning strategy now includes the demolition of the entire cell range.

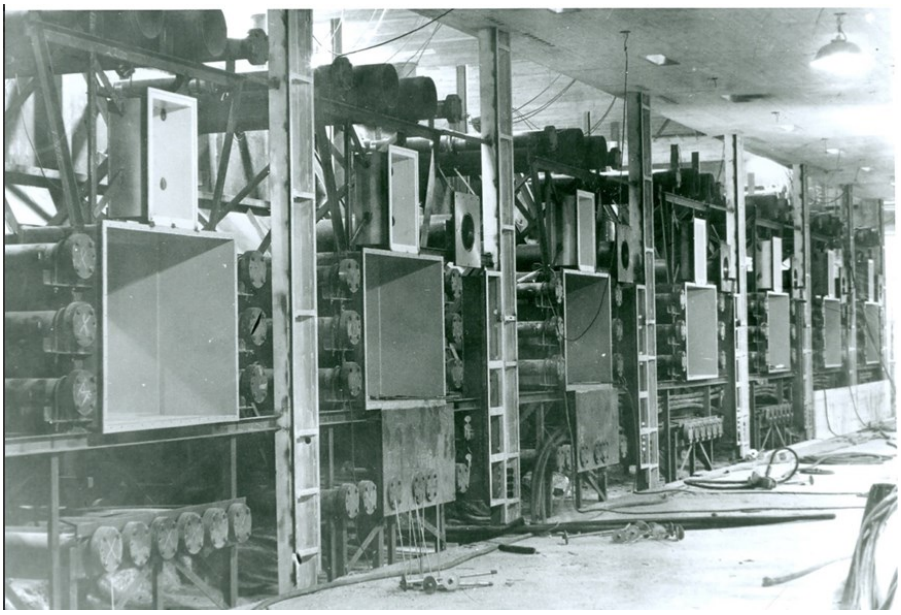

Figure 11: Picture form the construction of the Hot Cell Facility in the 1960's showing some of the now embedded cables and tubes.

Progress since last national report

Since the last report the work on Hot Cells Project have continued and can be divided into the following 4 major parts.

- Decontamination of the shutter openings (2020)
- Remote vacuum cleaning the cells following the remote blasting campaign (2021-2023)
- Removal of hotspot and equipment in Cell 1 (2023)
- Planning dismantling of the cell range (2022-2023)

Decontamination of the shutter openings

The shutter openings (Figure 12, Figure 13, and Figure 14), where the shutters originally were used to close the upper part of the cells, have undergone decontamination work using steel grit blasting. In the following, each step will be described in more detail.

Removal of dummy shutters

Dummy shutters (Figure 13), which were installed after the removal of the original 6000 kg shutters in 2016, were removed one at a time. During the removal, the dummy shutters were vacuumed for loose contamination. Subsequently, the surfaces of the dummy shutters were painted to fix any remaining contamination. Afterwards the dummy shutters were dismantled and placed on a pallet, ready for transport.

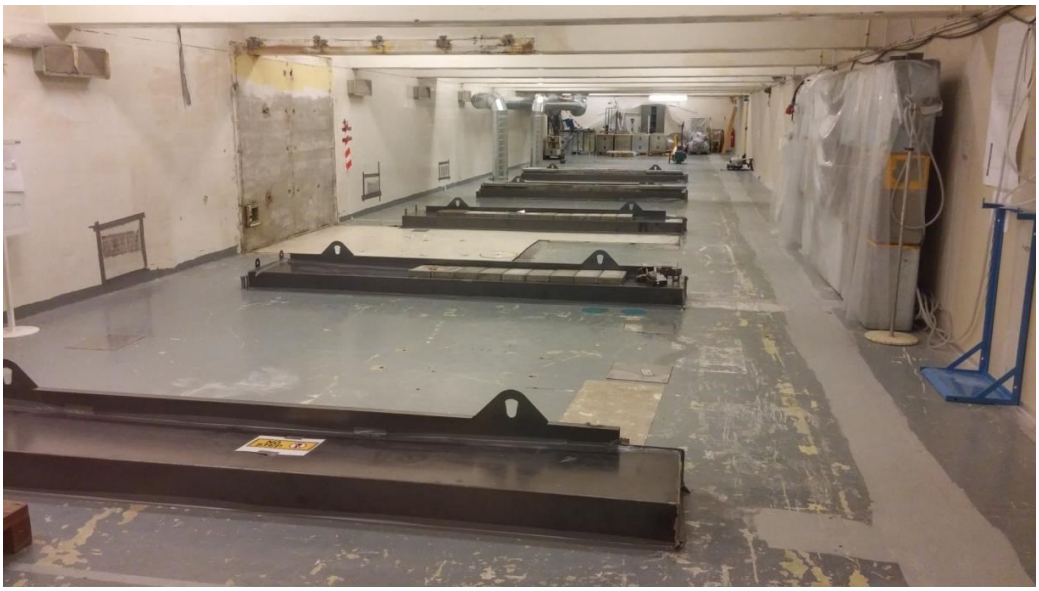

Figure 12: Dummy shutter housings with dummy shutters on the top surface of the row of hot cells, before modification.

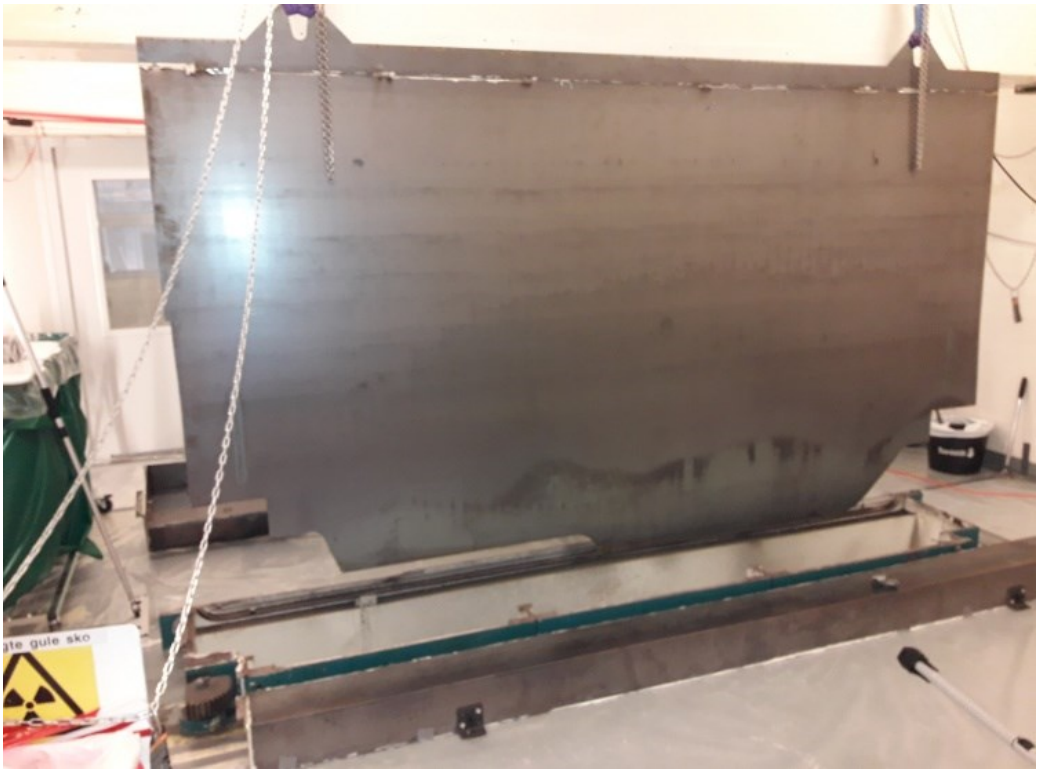

Figure 13: Dummy shutter being removed.

Figure 14: Empty shutter opening with a direct view down into a hot cell.

Modification of dummy shutter housing

When a dummy shutter was dismantled and placed on a pallet, the existing dummy shutter housing box was modified (Figure 15). After this, a new blasting cover intended to be used in the media blowing operation was installed.

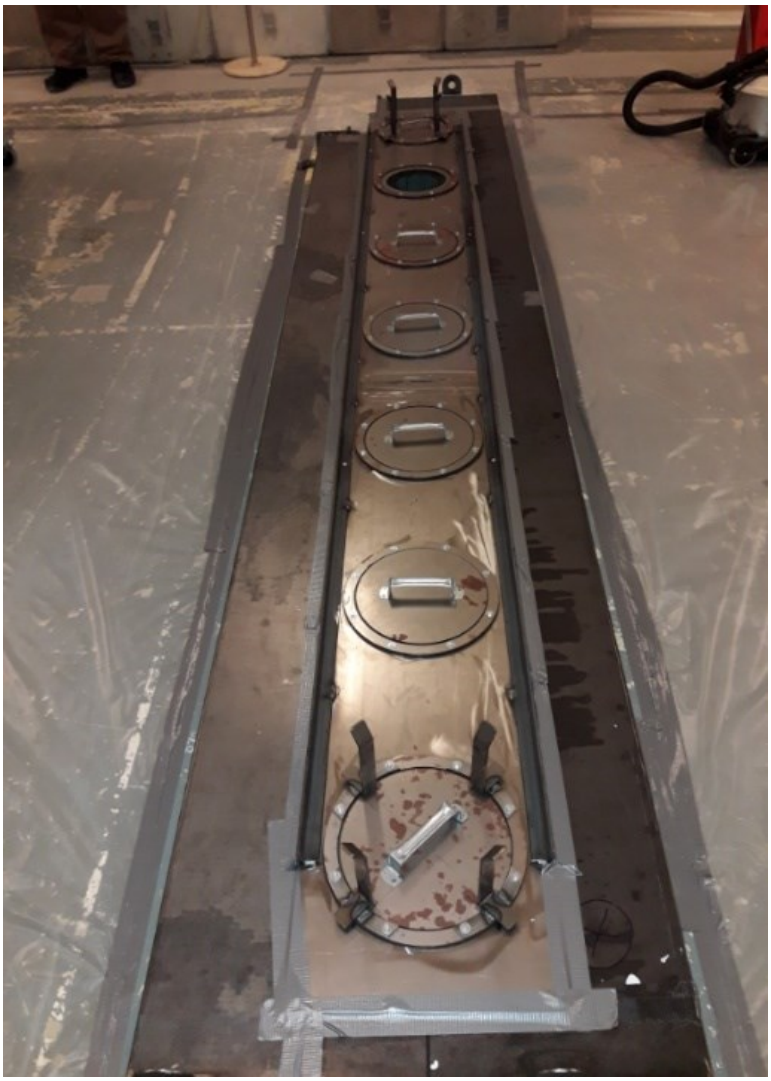

Figure 15: Dummy shutter housing after modification

Design and construction of a blasting cover

In consideration of conventional safety and to control the airflow during the steel grit blasting a blasting cover was designed, constructed and installed. Figure 16 shows the blasting cover being installed on top of the modified dummy shutter housing.

Figure 16: Blasting cover installation

Steel grit blasting

The operation took place in such a way that the cylinder with blowing nozzle was introduced through one of the outermost holes and another cylinder with a mounted camera was introduced through another hole sufficiently far from the blowing nozzle that the camera was not damaged. See Figure 17 for the complete set-up. Figure 18 show the execution of the work.

After blasting through all the shutter openings, the radiation levels in the shutter openings dropped by a factor of 2 to 4. The decontamination factors were most likely higher than shown by measurements, which may also have been affected by the contribution from the radiation level inside the cells.

Vacuum extraction of the steel grit inside all the cells

This work has been ongoing over a longer period (on/off), but the main purpose was to remove steel grit from the initial blasting and blasting of the shutter openings. During this work, and to ensure the 10,000 kg lead shielded cell doors were still able to open and close after the grit blasting, a function test of the doors was carried out. This proved to be important, as the doors initially were stuck. This was originally an identified risk, but as expected, it was possible to operate the doors after extracting steel grit from the hinges and other mechanical parts.

Figure 17: The complete setup of the steel grit blasting. The blowing nozzle is placed in the first hole and the camera in the third.

Figure 18: The operator controls the blowing nozzle and at the same time keeps an eye on the media blowing through the camera surveillance.

Removal of hotspot and equipment in Cell 1

Work inside the cells commenced in early 2023, starting with a hotspot at the primary entry to the cells (Figure 19). This hotspot was complicated to locate and remove, because it turned out to be stuck under the 10,000 kg door, but after several attempts it was removed (Figure 20). After the hotspot removal, the steel rack just inside the cell was dismantled and removed (Figure 21). The next step is to remove filter covers to establish easier access for personnel to work inside the cells. This work is planned for 2024.

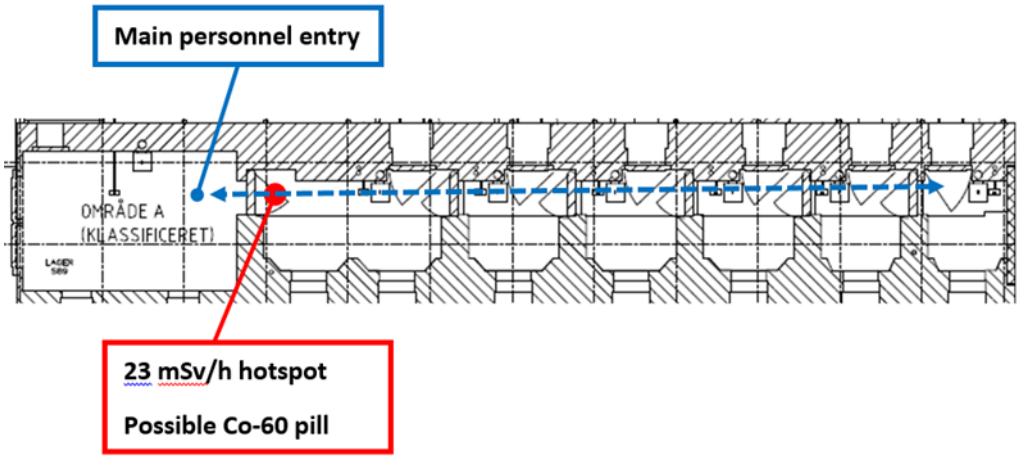

Figure 19: Hotspot location at the entry to the hot cells

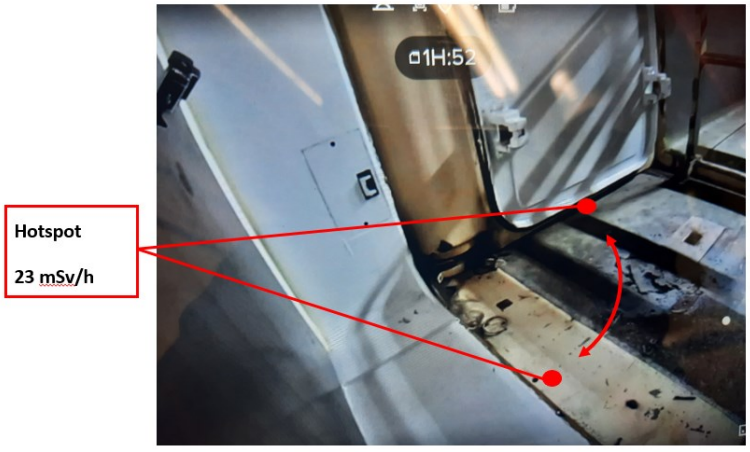

Figure 20: The hotspot was stuck under the door

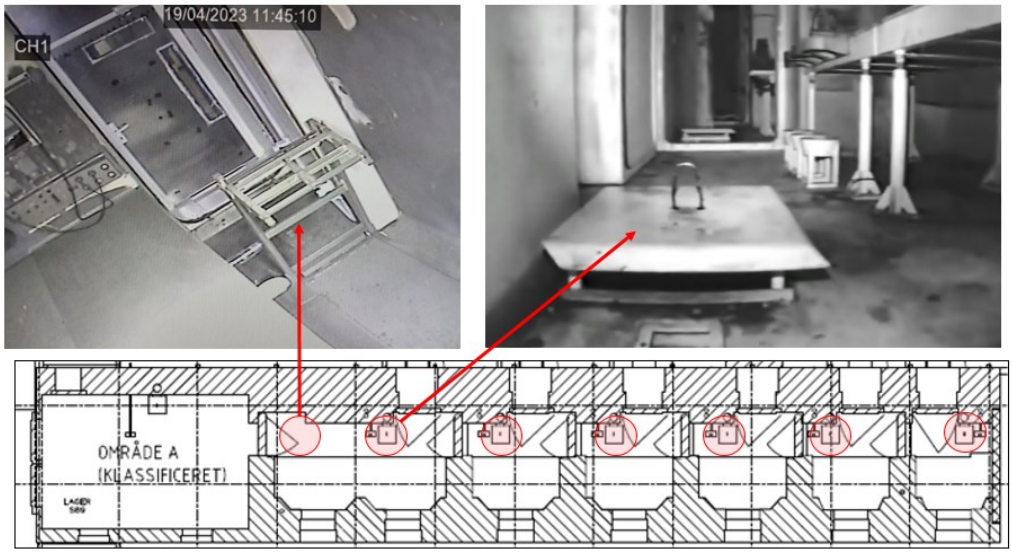

Figure 21: Steel rack and ventilation filter covers in the hot cells

Planning to demolish the cell range

The work with planning the logistics and demolishing of the entire cell range is ongoing. The demolishing will commence when the intermediate cleaning of the cells is completed. For use in this work, a digital model of the building has been made to simulate the future operations and methods (Figure 22), as well as for use in connection with the planning of building changes.

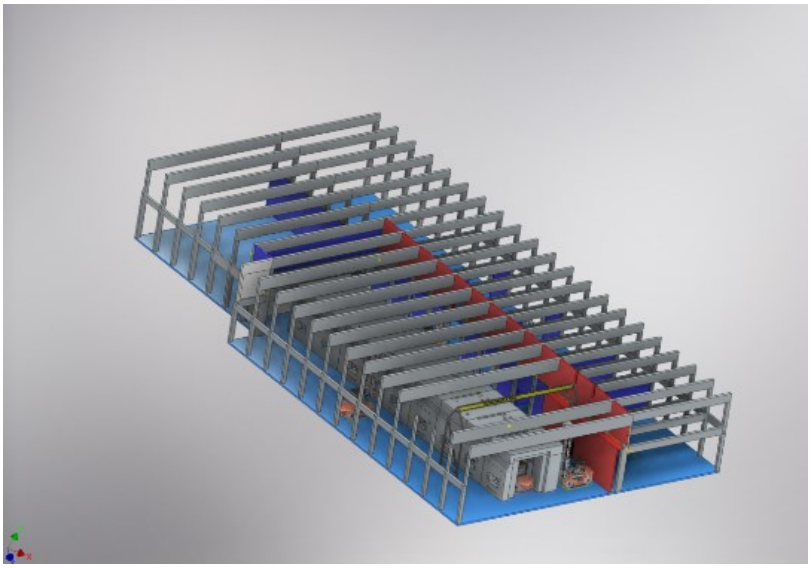

Figure 22: Digital 3D model of the building with the entire hot cell range.

D.3.5. The Fuel Fabrication Plant

From the 1960's until the year of 2002, the Fuel Fabrication Plant (Building 229) 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, which 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 (Figure 23 and Figure 24).

Figure 23: Classification by colours of the ground level before the start of decommissioning of the Fuel Fabrication Plant:

- 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 24: Classification by colours of the first floor level before the start of decommissioning of the Fuel Fabrication Plant:

- 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 23) is cleared for unrestricted use (spring of 2014).
- The contaminated **vacuum oven** (indicated by a red circle in Figure 23) is removed and has been handled as radioactive waste (2015).
- **The powder room** (designated “pulverrum” on the ground floor in Figure 23) is decontaminated and clearance measurements have been carried out (2015).
- The entire pipe work of the **drain system** was dismantled (2015).
- Three **ventilation systems** above the powder room were removed (2015).

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 appeared as dark spots on the concrete floor of the crawlspace, where leakage has occurred due to corrosion of the gutter (Figure 25). 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 25) it was decided that the final decommissioning work was put on hold until the Technical University of Denmark (DTU) had vacated the building (in 2022).

Figure 25: Crawlspace with uranium contamination in the floor (Fuel Fabrication Plant)

Development since last report

DTU vacated the building in the spring of 2022, whereby Danish Decommissioning gained control of the entire building 229 and the decommissioning work in the crawl space could be initiated. In a corridor of 1 x 21 m, up to 6 cm of the concrete floor had to be removed.

Due to the limited height in the crawl space of 70 cm, (Figure 26), there was a need to establish additional working height to facilitate the remove of the contaminated concrete layer from the ground cover. Access to the crawl space was made by removing the ground floor deck above (Figure 27).

To minimize the risk of contamination of the surrounding building mass, an enclosure was established over the opening to the crawl space to ensure (Figure 28). An environmental box with HEPA-filters was installed for collecting airborne dust and together with a vacuum extractor, also to create a lower pressure to ensure the airflow went into the basement.

Figure 26: Low ceiling basement, before removing the deck (Fuel Fabrication Plant).

Figure 27: Ground floor level with the deck above the crawl space removed (Fuel Fabrication Plant)

Figure 28: The custom-made enclosure placed over the opening in the deck over the crawl space and the connected environmental box with HEPA-filters.

The clean-up of the contamination in the floor of the crawl space was completed and the decommissioning reports (final decommissioning report and a clearance report) were submitted for approval by the nuclear regulatory authorities. On 1 May 2023, the Fuel Fabrication Plant was released from regulatory control. This means that the building may be demolished making way for the New Upgraded Storage Facility (NOL), (see details in Section H.2).

D.3.6. Waste Management Plant

A decommissioning plan was submitted to the nuclear regulatory authorities for approval in December 2018. In May 2019, Danish Decommissioning received a formal approval of the decommissioning plan from the authorities.

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 200, DR 2 Reactor Containment Hall including waste handling and packing facility
- Building 208, Radiological Characterization Laboratory and Isotope Laboratory
- Building 211, the main building of the Waste Management Plant with the old radioactive waste treatment and bituminisation facility, old active laundry, old isotope laboratory.
- Building 212, Drum Storage, Concentrate Storage and reception centre for external radioactive waste including the handling box facilities, and a separate storage for the radioactive concentrate resulting from the treatment of radioactive water.

- Building 217, DR 3 auxiliary building including the new facilities for distillation of active waste water, and active laundry, and decontamination cabinet.
- Building 224, Storage of Radioactive Liquids
- Building 231, Centralvej Storage
- Building 239, Institutional Waste Storage
- Building 242, Tailings and Ore Pools
- Building 244, Low Level Waste Storage
- Building 249, Intermediate Storage including the Buffer Storage
- Building 246, Building containing storage tanks for radioactive waste water
- Building 251, Decay Storage for Institutional Waste
- Building 257, Clearance Laboratory
- Building 261, New storage of Radioactive Liquids
- The conventional Water Treatment Plant

The first building to undergo decommissioning is the main building of the Waste Management Plant (Building 211), which contains facilities such as the old active waste water treatment (distillations), storage tanks for active water, 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 centre 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 decommissioning projects of the other nuclear facilities at the Risø site (listed in Table 6), the Waste Management Plant is unique, as some of the facilities are still in use for waste management and storage of institutional waste received from external waste producers (i.e. hospitals, industrial users etc.).

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

In the decommissioning plan, it was recognized that certain parts of Building 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 211 are 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.

As part of the preparatory work for the decommissioning of the Waste Management Plant and the continued safe management of radioactive waste, certain facilities were relocated

and commissioned to other buildings managed and operated by Danish Decommissioning as of August 2023:

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

Details on the preparatory work for decommissioning of the Building 211, including the relocation of facilities mentioned, are presented in the Seventh National Report.

Progress since last report

The decommissioning of the main building of the Waste Management Plant (Building 211) was challenged by two periods of shutdown due to Covid-19 in 2020 and 2021. During the shutdown period the number of staff was limited to a minimum for maintaining the safety of the facilities, hence no decommissioning work was carried out.

The preparatory work for the decommissioning were initiated in 2020, as facilities to remain in operation were moved to other buildings on the Risø site. Hence, the Isotope Laboratory was moved to Building 208 (Figure 29) and the distillation plant to Building 217. The latter has entailed the construction of a new tank storage for active waste water in Building 246.

The workshop in Building 211 was closed and equipment moved to Building 215.

The initial characterization of parts of Building 211 has continued as the building has been evacuated. An initial screening of the workshop and a few offices has been carried out and no contamination was found.

In the second half of 2021, the move of the laundry facility from Building 211 to building 217 is completed. By the end of 2021, the laundry facility was commissioned at the new location (Figure 30).

Figure 29. The new laboratory in building 208

Preparations for decommissioning of the Building 211 have been continuing through 2023. The subproject description of the decommissioning works and dismantling activities in the main building has been submitted to the regulatory authorities for approval.

In addition, the main decommissioning plan (project description) for the Decommissioning of the Waste Management Plant including the waste storages required revision to take into account that certain functions, such as the laundry, the active laboratory and waste water treatment services had relocated to other facilities. A final updated decommissioning plan for the Waste Management Plant is expected in 2024.

Figure 30: The new laundry facility in building 217

Uranium ore

To meet requirements from Roskilde municipality, tailings from previous uranium extraction experiments have been collected in one of the tree pools, and the uranium ore from the heaps was moved to the two other pools. Both tailings and ore have been covered with heavy-duty tarpaulin material (Figure 31). This was done during the summer 2022.

Figure 31: One of the basins with cover with heavy-duty tarpaulin material

Due to the storage of uranium ore in heaps placed directly on the ground for many decades, fluoride compounds and to a minor degree heavy metals such as arsenic and lead have been washed out and are found in concentrations exceeding the levels allowed in soil and groundwater. A preliminary mapping of contamination with fluoride from the former ore deposit storage has been prepared. The mapping forms the basis for a revised clean-up order from Roskilde municipality.

A detailed project for removal of a top layer of NaF-contaminated soil from the previous storage site has been prepared and is to be approved by Roskilde municipality. Before removal can be done the site must be released from regulatory control. This is expected to take place in 2024, and the removal of NaF-contaminated soil is expected to be carried out before end of 2024.

D.3.7. Release of land from regulatory control

The initial discussions regarding a process for the release of land on the Risø site from regulatory control were initiated in the beginning of 2015. Following this, Danish Decommissioning submitted their first draft of a plan for the release of land based on the MARSSIM methodology. The plan included a programme using in situ gamma spectrometry in combination with core-sampling and laboratory analyses.

Adoption of Parliamentary Resolution B90 provides for establishment of a new upgraded storage facility (NOL) at the Risø site. In order to satisfy the requirement in Parliamentary Resolution B48 for release of site areas for unrestricted use an updated plan taking into account the still existing facilities on site, plans for new facilities and a revised sampling and analysis strategy had to be developed.

The plan for the release of land was further developed and, in December 2019 the updated plan was submitted to the nuclear regulatory authorities. In the updated plan, in situ gamma spectrometry was abandoned due to high background contributions from existing facilities, and instead, focus placed on core-sampling and laboratory analysis of samples, still with reference to the MARSSIM methodology. Further updates and clarifications were requested by the regulatory authorities, and in 2023, an application for the release of land from regulatory control, including the results of the sampling programme was submitted to the regulatory authorities. The application is in the final stages of regulatory review.

D.4. International expertise and decommissioning

Since the last review meeting, representatives from the 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
- International Project on Decommissioning of Small Medical, Industrial and Research Facilities (MIRDEC project) organized by IAEA. Denmark hosted the 7th MIRDEC meeting in Copenhagen October 2023.
- Integrated Regulatory Review Service (IRRS) mission to Denmark in September 2021.
- IAEA regional workshop on regulatory review of decommissioning plans (consultant)
- Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) to Denmark in 2022.
- Four ARTEMIS review missions to EU member states (as reviewer and team leader)
- IAEA training course for new ARTEMIS experts (consultant)
- IAEA mission to Sweden 2022 (as reviewer)
- IAEA mission to China on site release (consultant)
- IAEA workshop on ARTEMIS guideline update workshops (consultant)
- IAEA Technical Cooperation project on drafting regulation for radioactive waste management and decommissioning (consultant).

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
- Applied Health Physics provided by Oak Ridge National Laboratory, US
- One-week Managers/CSOs Course on Criticality provided by Sandia National Laboratory, US
- 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). An ARTEMIS mission was conducted in Denmark May 2022.
- IAEA Coordinated Research Project on the development of a standardised framework for borehole disposal.
- Avfall Grund provided by Studsvik, Sweden

Section E. Legislative and Regulatory System

Article 18. Implementing measures
Article 19. Legislative and regulatory framework
Article 20. Regulatory body

The legislative, regulatory and organisational framework for safe management of radioactive waste in Denmark has remained as specified for the last reporting period, with no change in the assignment of roles and responsibilities of regulators, operators, and licence holders.

Review activities of the executive orders issued under the Radiation Protection Act were initiated in 2022, also addressing some recommendations and suggestions provided during the IRRS and ARTEMIS missions. The anticipated updates include further provisions regarding decommissioning and radioactive waste management. Updated executive orders are expected to enter into force in 2025.

The Ministry for the Interior and Health made administrative updates to the circular detailing the tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science regarding radioactive waste management and issued an updated Circular no. 9635 of 16 June 2022 on the tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science concerning responsible and safe management of radioactive waste.

The Danish Agency for Higher Education and Science revised and issued a circular (Circular no. 9261/2022) regulating tasks and responsibilities of Danish Decommissioning (licence holder), replacing previously issued circulars.

The national framework is presented in greater detail below.

Legal framework

The legal framework for radiation protection and safety as well as for responsible and safe management of radioactive waste in Denmark rests on The Radiation Protection Act[12], The Nuclear Installations Act[13], and their underlying executive orders and circulars.

[12] Act no. 23 of 15 January 2018 The Radiation Protection Act
[13] Act no. 170 16 May 1962 The Nuclear Installation Act

The Radiation Protection Act is the main instrument for transposition of Council Directive 2013/59/EURATOM (The European Basic Safety Standards). In addition to the provisions of the Council Directive, the act implements the framework and principles of The 2007 Recommendations of the International Commission on Radiological Protection, ICRP Publication 103. In covering the ICRP “exposure situations” and “exposure categories”, the act is all-inclusive in terms of facilities and activities, applying to nuclear installations as well as all stages in the management of radioactive waste. The act empowers the Danish Health Authority with all regulatory core functions such as authorization, review and assessment, inspection and enforcement.

The Nuclear Installations Act defines the concept of nuclear installations and establishes the fundamental principles for authorization; to ensure and maintain safety during commissioning, operation and decommissioning of nuclear facilities. Pursuant to the law, the Danish Health Authority under the Ministry of Health[14] and (by later amendments) the Danish Emergency Management Agency under the Ministry of Defence, constitute the nuclear regulatory authorities. The nuclear regulatory authorities are authorised to establish limits and conditions for construction, operation and decommissioning of nuclear facilities, to issue terms necessary to ensure compliance with such limits and conditions and to access nuclear facilities at any time. The nuclear regulatory authorities can demand that operations shall be stopped if stipulated limits and conditions are violated, or for reasons of safety. The nuclear installations at the Risø site, including the national storage facilities for radioactive waste, are subject to oversight and inspection by the nuclear regulatory authorities.

The nuclear regulatory authorities have established Operational Limits and Conditions for operation and decommissioning of the nuclear facilities at the Risø site, detailing specific provisions in accordance with the provisions of The Nuclear Installations Act and The Radiation Protection Act, applicable to the decommissioning and operational activities of Danish Decommissioning.

The nuclear facilities at the Risø site are thus subject to regulatory control by the Danish Health Authority and by the nuclear regulatory authorities. Regulatory control is exercised in a coordinated manner. This also applies to the new, upgraded storage facility to be established according to the provisions of Parliamentary Resolution B90. The application of The Nuclear Installations Act to the upgraded storage facility will reflect that the upgraded storage facility itself as well as the activities undertaken there, shares few similarities with nuclear installations as such.

The national legal framework comprises additional legislation in support of responsible and safe management of radioactive waste, including: The Environmental Impact

[14] Today the Ministry of Interior and Health

Assessment Act, The Nuclear Safety Act, The Health Act, The Public Information Act and The Planning Act, including relevant underlying orders.

Organisational and regulatory framework

The regulatory framework for the management of radioactive waste comprise three ministries in the main. Pursuant to the all-encompassing nature of The Radiation Protection Act, the Ministry of Interior and Health is responsible for the legal framework in relation to all facilities (also nuclear facilities) and activities involving radiation sources including management of radioactive waste. The Ministry of Interior and Health and the Ministry of Defence are responsible for the legal framework governing the administration of The Nuclear Regulatory Authorities. The Ministry of Higher Education and Science is administratively responsible (as operating entity) for the nuclear facilities in Denmark, which are all government property and for Danish Decommissioning, which is tasked as national implementer for the decisions regarding radioactive waste management according to Parliamentary Resolution B90.

The Danish Health Authority

The Danish Health Authority acts under the Ministry of Interior and Health. The main tasks include health promotion, disease treatment and prevention – the latter including radiation protection and safety. In accordance with The Radiation Protection Act, the Danish Health Authority is the national competent authority for regulating the use of radioactive substances including radioactive waste. The everyday administration of the obligations and powers of the act is delegated to the Danish Health Authority, Department for Radiation Protection. Pursuant to The Nuclear Installations Act, the Danish Health Authority and the Danish Emergency Management Agency constitute the nuclear regulatory authorities – maintaining regulatory oversight of nuclear safety, including for storage facilities where these are regarded as nuclear installations. In addition to the above described regulatory functions, the Danish Health Authority has been assigned particular responsibilities in relation to the implementation of the National Programme. These responsibilities are detailed in Circular no. 9635 of 16 June 2022.

The relevant legislation is:

1. The Radiation Protection Act (Act no. 23 of 15 January 2018 on Ionising Radiation and Radiation Protection) and the following underlying Executive Orders transpose the large majority of the EU-BSS provisions into Danish legislation:
    1.1. Executive Order no. 669 of 1 July 2019 on Ionising Radiation and Radiation Protection.
    1.2. Executive Order no. 670 of 1 July 2019 on Use of Radioactive Substances.
    1.3. Executive Order no. 672 of 1 July 2019 on Transboundary Shipments of Radioactive Waste and Spent Nuclear Fuel.
    1.4. Circular no. 9635 of 16 June 2022 on the tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science concerning responsible and safe management of radioactive waste
2. The Nuclear Installations Act (Act no. 170 of 16 May 1962 on Nuclear Installations)
    2.1. Executive Order no. 278 of 27 June 1963 on Protective Measures against Accidents at Nuclear Facilities, etc. – as changed according to Executive Order no. 502 of 10 January 1974.

2.2. 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.

The Danish Emergency Management Agency

The Danish Emergency Management Agency (DEMA) is responsible for Danish emergency preparedness and acts under the Ministry of Defence. DEMA supervises authorities and municipalities on contingency planning. Pursuant to the Nuclear Installations Act, the Danish Emergency Management Agency and the Danish Health Authority constitute the nuclear regulatory authorities.
The relevant legislation is:

1. The Nuclear Installations Act (Act no. 170 of 16 May 1962 on Nuclear Installations)
    1.1. Executive Order no. 278 of 27 June 1963 on Protective Measures against Accidents at Nuclear Facilities, etc. – as changed according to Executive Order no. 502 of 10 January 1974.
    1.2. 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.
2. The Emergency Management Act, Nuclear Preparedness §§ 5 and 24 also Chapter 7a (Consolidation Act no. 314 of 3 April 2017 on Emergency Management).
    2.1. Executive Order no. 1762 of 27 December 2016 on Security Measures for Nuclear Material and Nuclear Facilities and Drafting of Security Plans.
3. The Nuclear Safety Act (Act no. 244 of 12 May 1976 on Safety and Environmental Conditions at Nuclear Facilities, etc.) (Only § 11 and § 12 (1) is in force).

The Danish Agency for Higher Education and Science

The Agency has formal responsibility for institutions under the Ministry of Higher Education and Science, including Danish Decommissioning. The primary tasks of Danish Decommissioning are to: 1) dismantle the nuclear research facilities at Risø by 2023, in a safe, environmentally sound and economically optimal way, 2) receive, process and store radioactive waste from Danish users of radioactive material, and 3) participate in the process that lead to a long-term solution for the radioactive waste by 2073 - until then, storing the waste. The role and responsibilities of Danish Decommissioning are detailed in Circular no. 9261 of 11. March 2022. The Danish Agency for Higher Education and Science has been assigned particular responsibilities in relation to the implementation of the National Programme. These responsibilities are detailed in Circular no. 9635 of 16 June 2022.

The relevant legislation/governing instruments are:

1. Parliamentary Resolution B48, 2003 on the Decommissioning of the Nuclear Facilities at Research Station, Risø.
2. Parliamentary Resolution B90, 2018 on a Long-Term Solution for Denmark's Radioactive Waste.
3. Executive Order no. 1229 of 3 November 2015 on Departmental Changes between Ministers
4. Circular no. 9635 of 16 June 2022 on the tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science concerning responsible and safe management of radioactive waste
5. Circular no. 9261 of 11. March 2022 on Danish Decommissioning.

The Danish Environmental Protection Agency

The Danish Environmental Protection Agency is part of the Ministry of Environment, and it administers the legislation on environmental protection, which is to ensure clean air, (drinking-) water and soil and good living conditions for people, animals and nature. The Environmental Impact Assessment Act as well as the Planning Act (under the Ministry of Ecclesiastical Affairs) are relevant in the planning and siting of facilities such as nuclear facilities or a disposal facility for radioactive waste.

The relevant legislation is:

1. The Environmental Impact Assessment Act (Consolidation Act no. 4 of 3 January 2023 on Environmental Impact Assessment of Plans and Programs and of Specific Projects (EIA).
2. The Environmental Protection Act (Consolidation Act no. 48 of 12 January 2024 on Environmental Protection)

The Danish Agency for Planning and Rural Development (Ministry of Ecclesiastical Affairs)

The Danish Agency for Planning and Rural Development administers The Planning Act on involving the public in a coherent planning that combines social interests in land use, contributes to protect nature and environment, and creates a good framework for growth and development throughout the country. The Planning Act as well as the Environmental Impact Assessment Act are relevant in the planning and siting of facilities such as nuclear facilities or a disposal facility for radioactive waste.

The relevant legislation is:

1. The Planning Act (Consolidation Act no. 223 of 1 March 2024 on Planning).

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

Funding

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 Finance Act covers the operating costs of the Danish Health Authority and the Danish Emergency Management Agency through allocations to the respective ministries in charge i.e., the Ministry of Interior and Health and the Ministry of Defence, respectively. Apart from the broad specifications in the annual Finance Act there are no detailed provisions to ensure that the regulatory authorities are assured relevant competences and resources corresponding to the obligations given to the regulatory body by law.

The Constitution 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 2024 Finance Act e.g. declares the appropriation for:

- the activities of the Danish Health Authority (§ 16)
- the activities of the Danish Emergency Management Agency (§ 12)
- the Danish Agency for Institutions and Educational Grants[15] (§ 19).

[15] 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 Radiation Protection Act assigns the responsibility for radioactive waste management facilities and/or activities with the licence holder. The Nuclear Installations Act assigns responsibility for the management of radioactive waste generated from nuclear installations with the designated owner of the facility. As such, the obligations of licence holders have remained unchanged during the reporting period. The prime responsibility for the safe management of radioactive waste rests with the licence holder.

The nuclear regulatory authorities have issued Operational Limits and Conditions for Danish Decommissioning, detailing how the nuclear installations at the Risø site may be safely operated and decommissioned. As the decommissioning of the nuclear facilities at the Risø site is ongoing, the Operational Limits and Conditions are progressively updated. Latest version of the Operational Limits and Conditions is from 2022. Public versions of the Operational Limits and Conditions are available on the website of the Danish Health Authority[16].

Currently, the nuclear regulatory authorities are reviewing and updating the Operational Limits and Conditions.

Assessment and demonstration of safety

All activities related to use of radioactive materials, decommissioning of facilities for such use and associated radioactive waste management conducted by any undertaking, including Danish Decommissioning, are subject to the provisions in the Radiation Protection Act and underlying executive orders. Following these provisions, licensees are required to undertake assessments of safety, taking into account all aspects relevant to safety. Safety assessments must at all times reflect the activities undertaken by the licensee. For planned activities or facilities for the use of radioactive materials, a safety assessment must be prepared prior to the onset of activities or use of facilities. Radiation Protection legislation requires licensees to be able to document compliance with relevant legal requirements. The Danish Health Authority may specify terms to a license, including provisions for assessment and demonstration of safety.

[16] Operational Limits and Conditions for Danish Decommissioning 2020

According to The Nuclear Installations Act, any designated owner of a nuclear facility must seek approval for construction as well as operation of a nuclear facility. Prior to construction of a nuclear facility, the nuclear regulatory authorities must be presented with a preliminary safety report detailing technical properties of the facility, control and safety measures and site-specific characteristics. Prior to operation of a nuclear facility, the nuclear regulatory authorities must be presented with a final safety report providing sufficient information to facilitate a full assessment of the safety of the facility. Approval to construct or operate a nuclear facility may be given on terms. The nuclear regulatory authorities may at any time specify further requirements for reasons of safety, including provisions for assessment and demonstration of safety.

Mandate, tasks and responsibilities for Danish Decommissioning

The adoption of Parliamentary Resolution B90 extends the tasks of Danish Decommissioning to also include contributions to establishing a long-term solution for radioactive waste. In this capacity, Danish Decommissioning will take active part in processes related to planning, localisation, construction, operation and decommissioning of the planned upgraded storage facility as well as in the development of the disposal solution to be implemented by 2073 at the latest. Tasks and responsibilities for Danish Decommissioning have been elaborated through various Parliamentary Resolutions, issuance of circulars etc.

Existing facilities

Radiation Protection legislation requires Danish Decommissioning to ensure the safety of spent fuel and radioactive waste management, to uphold documentation for safety and to implement quality assurance and management systems as appropriate. For the decommissioning of the nuclear facilities at the Risø site, Danish Decommissioning is required to perform safety assessments, to elaborate plans for management of radioactive waste, and through instructions and verification processes, including radiological monitoring, to demonstrate that safety is maintained. Similar provisions are stipulated in the Operational Limits and Conditions for Danish Decommissioning.

The nuclear regulatory authorities have issued Operational Limits and Conditions for Danish Decommissioning, detailing how the nuclear installations at the Risø site may be safely operated and decommissioned. The Operational Limits and Conditions for Danish Decommissioning specifies that Danish Decommissioning has the responsibility for ensuring that operation and decommissioning of the nuclear facilities at the Risø site takes place in accordance with the conditions set in the Operational Limits and Conditions and laws and orders regarding radiation protection and nuclear security. The Operational Limits and Conditions set conditions regarding, *inter alia,* maintaining and improving safety of spent fuel and radioactive waste management, documentation for safety, quality assurance and management systems. The Operational Limits and Conditions for Danish Decommissioning further specify that the collective Safety Documentation for Danish Decommissioning must be updated minimum every 5th year. Every chapter is updated separately.

Planned facilities

Following Parliamentary Resolution B90, Danish Decommissioning is planning construction of a new upgraded storage facility (NOL) for all the radioactive waste for which Danish Decommissioning bears prime responsibility. The storage facility will be in operation until no later than 2073 when a final disposal facility for the radioactive waste will be in operation.

Since the adoption of Parliamentary Resolution B90 Danish Decommissioning's main focus has been on preparation and planning of the new upgraded storage facility. According to the resolution, the facility shall be located on the Risø peninsula. The more precise location on the peninsula has been decided, based on an overall safety assessment, an assessment of the location in relation to already existing facilities and an assessment of the geotechnical conditions on the preferred location. In parallel, the overall demands and specifications have been formulated, and a detailed project proposal formulated in close cooperation between Danish Decommissioning and the associated contractors. During the process there has been a close dialogue with the nuclear regulatory authorities and other stakeholders, both directly and through the established national and local contact fora.

After finalization of the detailed project proposal, the main focus has been on finalizing the safety assessment for the upgraded storage facility. In parallel, the documentation for obtaining the necessary approvals regarding environmental impacts (Act 973/2020) and spatial planning (Act 1157/2020) is under preparation. Simultaneously, a detailed budget has been elaborated and approval by the Financial Committee of the Danish Parliament has been obtained. When all necessary approvals are obtained, the construction site will be prepared and a public tender will be announced. Depending on approvals, it is estimated that the facility will be ready for operation by 2028.

When the upgraded storage facility is ready for operation, the radioactive waste will be transferred from the present storage facilities.

After establishment of the upgraded storage facility and transfer of the waste, the main activities will be waste management, including continued reception of waste from external users of radioactive sources, inspection and necessary handling of the stored waste and preparation of the waste for final disposal, comprising account of planning and construction of new reception and handling facilities, as well as more detailed characterization and description of especially the historical waste, where the present documentation is insufficient, A more detailed long-term waste management plan will be elaborated based on experience from international practice and dialogue with Danish Decommissioning's international panel of experts.

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

Danish Decommissioning from the Risø National Laboratory in 2003. The staff originally assigned to the decommissioning and for operating the Waste Management Plant was reassigned to Danish Decommissioning 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 accordance with the safety provisions prescribed by the Nuclear Regulatory Authorities. Continuous staff adjustments and replacements are accommodated through training courses, seminars, and more extensive classes to ensure both an adequate level of qualification as well as transfer of relevant experience from skilled members of the staff.

Until now, the main focus of Danish Decommissioning has been decommissioning. In the future, focus will change, gradually turning the organization into an organization centred on radioactive waste management, with responsibility for safe storage of the waste, and co-responsible for the process leading to disposal. In 2021, Danish Decommissioning introduced a major organisational change in order to better prepare the organisation to the new tasks.

The Danish National Programme is financed through allocations on the Financial Act:

The operating costs of Danish Decommissioning (license holder) are funded through allocations to the Ministry of Higher Education and Science.
For the tasks specified for Danish Decommissioning in Parliamentary Resolution B90, the project costs of decommissioning are financed through a reserve fund. The costs of siting, construction, operation and decommissioning of the long-term storage facility (NOL) and the disposal facility foreseen in Parliamentary Resolution B90, are financed through a second, separate reserve fund. The operating costs of both facilities are included in the frameworks of the reserve funds. For the long-term storage facility, the reserve fund will finance a 50-year operation period from 2023-2073[17]. For the disposal facility, the reserve fund will finance a 50-year operation period from 2073 to 2122.

Article 23. Quality assurance

Danish Decommissioning was certified according to ISO 9001 in June 2004. The quality assurance system at present covers the entire process of decommissioning, including all radioactive waste management steps. The system is inspected biannually by Danish Standards (DS) and is subject to a complete audit every third year. Danish Decommissioning regularly conducts internal audits as required by the standard. All audit reports are available to the Nuclear Regulatory Authorities.

[17] The operation period will be shorter as the long-term storage facility will not enter into operation before 2028 at the earliest.

IT security requirements according to ISO 27001 have been implemented since 2015.

Danish Decommissioning operates a radiological characterization laboratory for sampling and characterisation of radiological materials from the nuclear facilities, buildings and was commissioned in 2005. Since, the laboratory has undergone multiple external audits of quality assurance in accordance with the DS/EN ISO 9001:2015 standard. As part of its commitment to maintaining high-quality standards, the laboratory is subject to an external audit on an annual basis. The most recent external audit took place in 2019. In addition to external audits, the laboratory conducts internal audits on a yearly basis.

The Clearance Laboratory for decommissioning waste upholds an independent accreditation. The accreditation was granted in 2007 by DANAK in accordance with ISO/IEC 17025:2005 and revised to ISO/IEC 17025:2017 in 2020. This accreditation was confirmed during the latest audit in May 2023. The accreditation provides for the clearance of materials with no restrictions on the amount or type of decommissioning waste.

The Waste Documentation System operated by Danish Decommissioning is based on bar code identification which enables real-time spatial tracking of any registered waste item. Danish Decommissioning also applies colour-coding of waste categories, waste containers and waste routes, which has reduced the number of waste handlings as well as waste destination errors.

Article 24. Operational radiation protection

The Radiation Protection Act is all-inclusive in terms of facilities and activities, applying to nuclear installations, decommissioning as well as all stages in the management of radioactive waste. The act provides the Danish Health Authority with all regulatory core functions such as authorization, review and assessment, inspection and enforcement, and requires the license holder to provide for operational radiation protection for workers, external workers and members of the public for planned as well as unplanned activities and events. This applies to all types of facilities and activities, including decommissioning, for which the license holder must provide all the education, training, instruction and equipment (including protective equipment) needed to conduct activities in a safe manner. With respect to personnel at the contractor level, it is the responsibility of Danish Decommissioning 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.

Furthermore, Danish Decommissioning is subject to Operational Limits and Conditions, which set out operational limits 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.

F.2. Discharge

The Radiation Protection Act and underlying orders defines dose constraints to be taken into account with respect to planned discharges of radioactive substances. The general dose constraints are in accordance with the facility specific dose constraints defined in the Operational Limits and Conditions for Danish Decommissioning.

Discharges of radioactive materials from the Waste Management Plant at the Risø site are primarily liquid and originate in the radioactive waste water 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 32 and Figure 33.

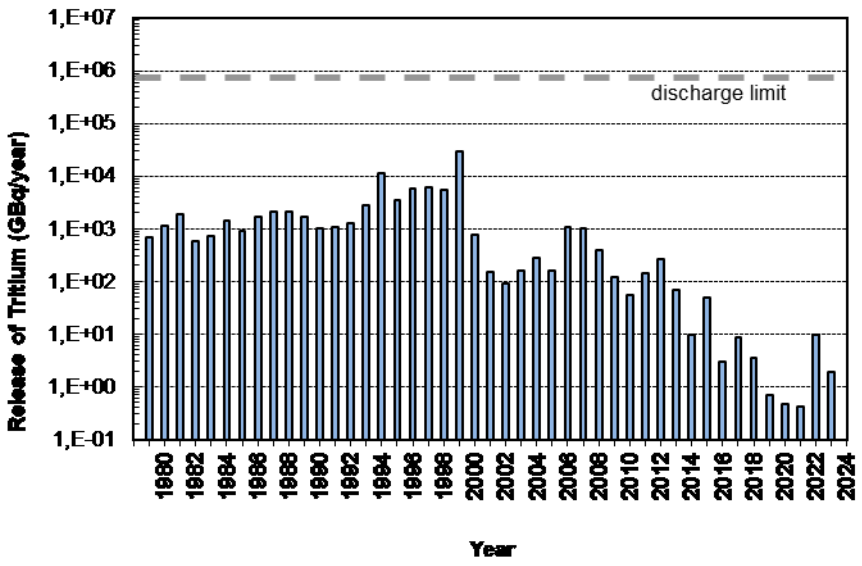

Figure 32: Annual release of tritium into Roskilde Fjord from the Waste Management Plant

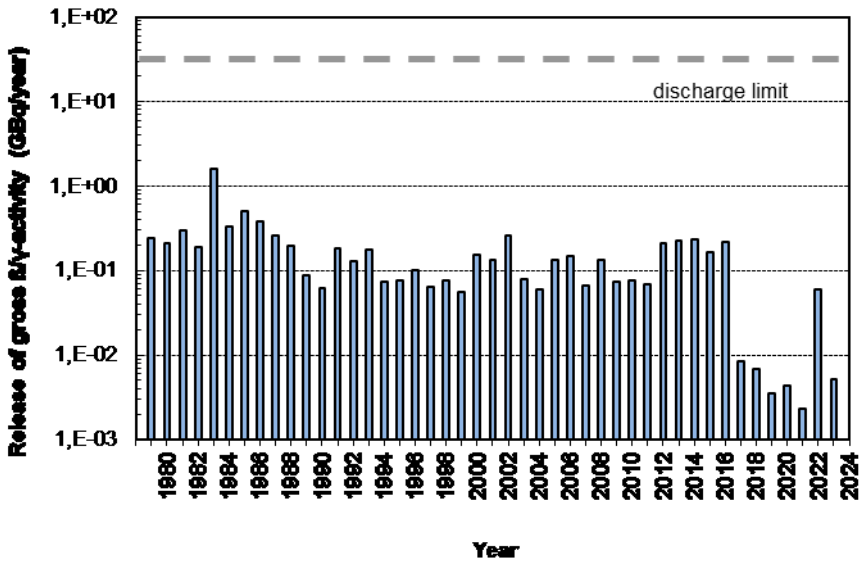

Figure 33: Annual release of gross ß/γ-activity into Roskilde Fjord from the Waste Management Plant.

Article 25. Emergency preparedness

With regard to off-site preparedness, the Danish Emergency Management Agency is responsible for preparing the overall nuclear contingency plan for Denmark and Greenland. The overall nuclear contingency plan concerns coordination and cooperation between the state authorities that are responsible for maintaining and continuing essential societal functions 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 general area of responsibility; according to the principle of sectoral responsibility, any authority responsible for a given task on a daily basis is also responsible for this task in the event of a crisis, for example a nuclear accident. The overall nuclear contingency plan aims, among other things, to provide an overview of the area of responsibilities of the authorities included in the plan as well as to provide an overview of their resources and capacities. The overall nuclear contingency plan contains, among other things, a number of templates for communication in the early phase of a nuclear accident, which the authorities can use. The authorities' decisions on implementation of emergency measures etc. is coordinated in the National Operative Staff, led by the National Police. The overall nuclear contingency plan can also be implemented in the event of a radiological accident if this is appropriate taking into account the nature of the accident. According to law, the overall national nuclear contingency plan must be revised at least every four years. The current overall nuclear contingency plan came into effect in 2022.

With regard to on-site preparedness, any operator of nuclear facilities etc. is - according to the applicable legal basis – required to prepare an on-site contingency plan. This plan is part of the conditions that the nuclear regulatory authorities must approve and supervise. This obligation currently concerns the existing storage for radioactive waste and the former research reactors, which are being decommissioned, as these facilities constitute nuclear facilities under Danish law.

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. An account of accumulated doses showed that workers at Danish Decommissioning were subject to a total collective dose slightly above 1 person-mSv. No exposure was recorded for external contractors carrying out demolition tasks.

Decommissioning of DR 2 was finalised during spring 2008. Accounted exposures show that staff from Danish Decommissioning received a collective dose of 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 Cell Facility, Fuel Fabrication Facility, and work at the Waste Management Plant

Workers at Danish Decommissioning 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 2020-2023 was less than 23,9 person-mSv, with a maximum individual dose of 2,4 mSv.

Section G. Safety of Spent Fuel Management

The Danish Parliament decided in 1985 not to include nuclear power in the Danish energy supply. Therefore, there are no plans for siting, designing, constructing or operating spent fuel management facilities. Spent fuel from the research reactors DR 2 and DR 3 was transferred to the USA according to an agreement with the US Department of Energy.

Minor amounts of spent fuel from research reactor DR 1 and radioactive waste generated from post-irradiation investigations of experimentally irradiated power reactor fuel constitute the sum of material in the Danish inventory with a nuclear fuel origin. Amounts and activities are listed in section D.1. 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 activity concentrations are less than 10^4 TBq/m^3 and heat generation from the waste in its originally designed waste packages is less than 1 kW/m^3. Storage of this material requires no provisions for 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 last 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 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 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

The provisions of The Radiation Protection Act and The Nuclear Installations Act and underlying executive orders provide the basis for protection of humans and the environment, now and in the future. Specifically, responsible licensees are required to ensure that the:

- Generation of radioactive waste is kept to the minimum practicable,
- Radioactive waste is characterized taking into account aspects of criticality, biological, chemical and other hazards that may relevant for radioactive waste management,
- Interdependencies among the different steps in radioactive waste management are taken into account, and
- Relevant dose constraints are considered for any existing or planned facility or activity. For any type of facility (including a disposal facility) a dose constraint of 0.1 mSv per year applies. After closure of a disposal facility, a dose constraint set at 0.01 mSv per year with regard to the expected development of the repository applies for all relevant time scales.

The above and further provisions to avoid predictable and undue impact burdens on future generations are furthermore presented in Parliamentary Resolution B48 and Parliamentary Resolution B90, and in the circulars issued to the Danish Health Authority, the Danish Agency for Higher Education and Science, and Danish Decommissioning.

Radioactive waste generated from decommissioning activities and radioactive waste generated from institutional activities in Denmark is stored by Danish Decommissioning. Radioactive waste storage facilities are inspected by the Danish Health Authority and 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. 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:

H.2. Developments since the Seventh National Report

Denmark's National Programme for the Responsible and Safe Management of Radioactive Waste under EU Council Directive 2011/70/EURATOM was adopted by the Ministry of Health in January 2021. The programme confirms the national strategy outlined in Parliamentary Resolution B90[18] which can be summarized thus:

1. Upgrade of the storage facilities of Danish Decommissioning at the Risø site to extend operations until a disposal facility is commissioned.
2. Localization, construction and commissioning of a disposal facility by no later than 2073.

The National Programme[19] defines the short- to mid-term objectives of activities over the next 5-10 years as follows:

1. Construction of an upgraded storage facility based on reassessed radioactive inventory and associated predisposal management options – taking into account management options for the "special waste" (spent fuel from research reactor DR1 and irradiated research fuel, cf. Section D.1).
2. Review and identification of geologies suitable for disposal down to 500m depth.
3. Identification of possible disposal concepts, including feasibility and barrier system studies.
4. Designation of most relevant disposal facility sites for detailed studies based on the outcome of the above items 1.-3.

The status of objectives 1.-4. is given in subsections H.2.1-H.2.4.

H.2.1. Construction of an upgraded storage facility at the Risø site

The project is in the final stages of the planning phase. Danish Decommissioning expects that the project can move from planning to legal tender and subsequent construction phase in 2025, pending approval of a preliminary safety report by the Minister for the Interior and Health. The nuclear regulatory authorities provide counselling and evaluation to the Minister for the Interior and Health in the approval process. Following approval by the Minister for the Interior and Health, the project will need approval of an environmental

[18] Parliamentary resolution on a long-term solution for Denmark's radioactive waste
[19] National Programme for the Responsible and Safe Management of Radioactive Waste

impact assessment by the Danish Environmental Protection Agency as well as adoption of a local plan by the Municipal Council of Roskilde Municipality.

The situation plan in Figure 34 outlines the proposed new facilities (in grey shades). Building 810 is a new storage building for radioactive waste. Building 801 is a storage for NORM waste in Danish Decommissioning's possession, primarily uranium tailings and ore. Building 800 is an access gate facility.

Danish Decommissioning plans for commissioning the storage facility in 2028, pending approval by the Minister for the Interior and Health, the Nuclear Regulatory Authorities, and a licence from the Danish Health Authority.

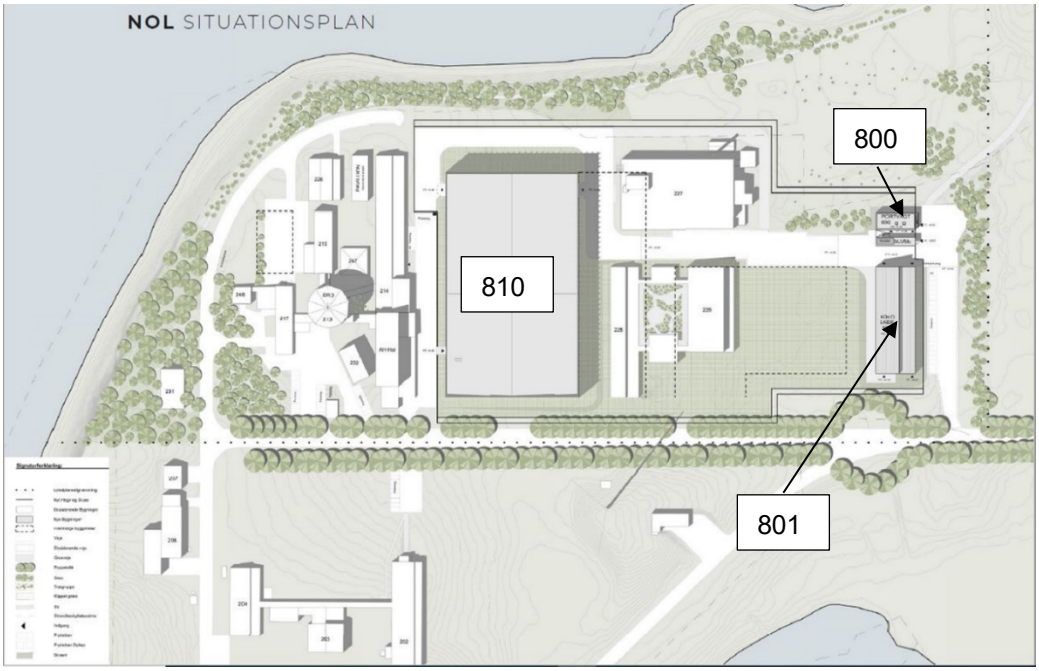

Figure 34: Situation plan (not to scale) of proposed new upgraded storage facilities (in grey shades) at the Risø site.

H.2.2. Review and identification of geologies suitable for disposal down to 500m depth

In January 2022, Geological Survey of Denmark and Greenland published an evaluation of desk studies and modelling exercises based on a review and compilation of existing data[20]. Characterisation and evaluation of geological properties and conditions at 500 meters depth has led the Survey to conclude that further in situ studies are required to establish detailed data on the subsurface properties and conditions at depths to 500 meters. The acquired data will be used as input to a safety case with the purpose of

[20] The studies are published on the homepage of GEUS

demonstrating whether the combined disposal concept of geological and engineered barriers can provide the required level of safety and performance on both the short and long term. The process to identify a disposal concept will be discussed in the following subsection.

H.2.3. Identification of possible disposal concepts, including feasibility and barrier system studies

Danish Decommissioning has been tasked with the identification of possible disposal concepts. In 2021, an overview of generic disposal concepts was presented by Danish Decommissioning along with a preliminary consideration of two relevant concepts to be further developed: 1) a deep geological facility and 2) an intermediate-depth facility in combination with a borehole. Danish Decommissioning considers the borehole concept particularly relevant for disposal of the “special waste”, given the very limited volume of this fraction of the Danish inventory. However, it is acknowledged at the same time that borehole disposal is not a proven technology and will require further consolidation through research and development.

Following the IAEA ARTEMIS review in May 2022 (cf. subsection H.2.5), Danish Decommissioning has begun the preparation of an implementation plan to cover the entire period until 2073 when commissioning of the disposal facility is due according to the Parliamentary Resolution B90 and the subsequent national strategy and national programme. The implementation plan will cover the compilation of design criteria, the site selection procedure, establishment of the knowledge basis, including necessary research, and the identification of milestones for decision making on disposal facility options, design, licensing, construction, operation, closure and post closure phase.

A first draft of the implementation plan has been discussed between Danish Decommissioning and an advisory group of international experts in September 2023. It was recommended that Danish Decommissioning should:

- develop a generic safety concept with the purpose of clarifying the criteria for site selection and for potential host rock characteristics
- define the milestones of the implementation plan more clearly in terms of deliveries/results/outcomes and link the milestones to actions in relation to processes and stakeholders
- strengthen competence requirements management to perform tasks and activities defined in the implementation plan.

Further discussions of the implementation plan took place in December 2023 between Danish Decommissioning and the Danish Health Authority, the nuclear regulatory authorities as well as Geological Survey of Denmark and Greenland. The discussions focused on the issues of defining generic waste acceptance criteria for a disposal facility concept and the current state of characterisation of the historic waste fractions, including the “special waste”.

Danish Decommissioning is currently reviewing the implementation plan in the light of these consultations in order to revise and develop the plan further.

H.2.4. Designation of most relevant disposal facility sites for detailed studies

Progress in the identification of relevant disposal facility sites is depending on the elaboration of the implementation plan, cf. subsection H.2.3. Danish Decommissioning will review and expand the conceptualization of a generic disposal facility based on the combination of an intermediate-depth facility with a borehole, cf. H.2.3.

H.2.5. ARTEMIS Mission 2022

An IAEA ARTEMIS mission took place 1-9 May 2022. The report of the ARTEMIS mission to Denmark[21] proposed seven recommendations and two suggestions:

R1: The regulatory body should establish regulatory requirements and guidance documents for the development and authorization of waste management facilities in the different stages of their life-time (siting, design, construction, operation, decommissioning or closure and post-closure, as applicable).

R2: The Government should ensure management of and control over all radioactive waste and designate waste management organizations that are obliged to accept all types of radioactive waste.

R3: The Government should update the National Programme in order to include appropriate interim targets and end states for the monitoring of programme implementation for all types of radioactive waste.

R4: In order to improve inventory data Danish Decommissioning should perform nuclide specific measurements on the individual waste packages in the course of transfer activities to a new storage facility, as appropriate.

R5: To ensure timely operation of the disposal facility the implementer should prepare a comprehensive implementation plan consistent with the National Programme.

R6: The Government should establish a compliance assurance procedure for the implementation of the National Programme.

R7: The implementer of the disposal facility should develop generic waste acceptance criteria for disposal and - as soon as a facility specific safety case is available - final waste acceptance criteria on the basis of regulatory body requirements.

S1: As soon as a comprehensive implementation plan for the disposal project is

[21] Report of the Integrated review service for radioactive waste and spent fuel management, decommissioning and remediation (ARTEMIS) mission to Denmark

available, the Government should consider updating the corresponding cost estimation and implement a procedure for periodic review and update. Risks and uncertainties should be accounted for according to the stage of the project.

S2: Danish Decommissioning should consider establishing the strategic plan for competence management according to the needs identified in the implementation plan for development of the geological disposal facility, review and regularly update it.

Actions to address findings in ARTEMIS review

The mission report has been presented to the Parliament Committees of Health and Higher Education and Research.

Similarly, the Ministry of Higher Education and Science and Danish Decommissioning initiated actions to address ARTEMIS recommendations and suggestions directed at the main implementer of the National Programme.

Danish Decommissioning in its capacity as implementer has begun activities to address the issues covered in R4, R5 and R7 as well as S1 and S2 above, cf. subsections H.2.1. and H2.3.-4. above. The activities are included as work packages in the annual target and performance plan of Danish Decommissioning. The target and performance plan is subject to approval by the Danish Agency for Higher Education and Science.

The Danish Health Authority initiated review activities of the executive orders issued under the Radiation Protection Act in 2022 with the aim of performing a general review of the legal framework, and also to address recommendations and suggestions provided during the ARTEMIS missions. Recommendation R1 and relevant recommendations provided during the IRRS mission to Denmark in 2020 may be addressed through issuance of additional executive orders. The anticipated updates for executive orders expected to enter into force in 2025 include specification of requirements regarding decommissioning and further provisions on radioactive waste management.

The Danish Health Authority is monitoring the progress with implementation of actions taken to address all recommendations and suggestions given in both the IRRS and the ARTEMIS missions.

H.2.6. Interaction with stakeholders

Interactions with stakeholders have been maintained throughout the reporting period.

Quarterly meetings have been held with Contact Forum Roskilde with emphasis put on the development of the upgraded storage facility at the Risø site.

Joint meetings have been held with the National Contact Forum and Contact Forum Roskilde in 2021 on the publication of the national programme, and in 2022 on the

publication of the characterization and evaluation of geological properties and conditions at 500 metres depth by Geological Survey of Denmark and Greenland.

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 64 applications according to Council Directive 2006/117/Euratom concerning the supervision and control of shipments of radioactive waste and spent fuel. Fifty-four applications were related to transit through Denmark, five related to transports from Sweden to Denmark, one from Finland to Denmark, and four related to transportations from Denmark to Sweden.

Section J. Disused Sealed Sources

Article 28

The regulatory framework given by The Radiation Protection Act and the underlying Executive Order No. 670/2019[22] 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, i.e., Guidance on the import and export of radioactive sources (2005) and Guidance on the management of disused radioactive sources (2018). Denmark co-signed the Code of Conduct in 2004 and the supplementary guidance documents, in 2005 and 2019 respectively.

The management of disused sealed sources is regulated through Executive Order no. 670/2019. This order provides for the requirement that a sealed source taken out of use must be returned to the producer or turned over to a licensed undertaking. Alternatively, the sealed source must be transferred to Danish Decommissioning for storage and ultimate disposal. The Danish Health Authority, Radiation Protection shall be duly notified in order to keep records and registries up to date.

In the years 2021 – 2023, Danish Decommissioning received 2211 kg of household ionizing smoke detectors and a total of 1194 disused sealed sources for further management. Of these, five sealed sources could be categorized according to IAEA Safety Guide RS-G-1.9 Categorization of Radioactive sources (2005) as category IV sources (Activity ratio (A/D) greater than 1 and lower than 10).

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.

A national data integration interface enables daily cross-checks 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). This facilitates a proactive and timely intervention by the Danish Health Authority, Radiation

[22] Executive Order on Use of Radioactive Substances

Protection in case of bankruptcy, or discontinuation for other reasons, of undertakings possessing radioactive sources.

Since the 7th review meeting, disused sealed sources have not been located in scrap yards.

Since the last report, one category II, five category IV and 1194 category V high-activity sealed sources (Table 7), for which no further use is foreseen, have been transferred to Danish Decommissioning for safe and secure management.

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. (Table 7) (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.

Security categories for high-activity sealed sources	2021	2022	2023
I	0	0	0
II and III	0	0	1
IV	0	0	5
V	223	562	409
Household Ionizing smoke detectors (kg)	1391	551	269

Table 7: Overview of number of disused sealed sources delivered to the Waste Management Facility, Danish Decommissioning in the years of 2021, 2022, and 2023.

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 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 were postponed, respectively the IRRS to August-September 2021 and ARTEMIS to May 2022.

The IRRS mission served 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, were 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. 9635 of 16 June 2022 on tasks of the Danish Health Authority and the Danish Agency for Higher Education and Science concerning responsible and safe management of radioactive waste.
- Circular no. 9261 of 11 March 2022 on Danish Decommissioning.

Operation Limits and Conditions:

Operational Limits and Conditions issued by the nuclear regulatory:

- 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 Risø site the nuclear regulatory authorities continuously update these documents. Public versions of the Operational Limits and Conditions are available on the websites of the Danish Health Authority and Danish Decommissioning.

National policy and programme:

- National Program for the Responsible and Safe Management of Radioactive Waste [23]

As a result of the adoption of Parliamentary Resolution B90, a new national policy for radioactive waste management was established and the associated strategy (National Programme) for the responsible and safe management of spent fuel and radioactive waste was established in compliance with Council Directive 2011/70/Euratom.

Latest report to the Council Directive 2011/70/Euratom:

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

The fourth report from Denmark to the Council Directive 201170/Euratom is to be submitted to the Commission by August 16 2024.

[23] National Programme for the Responsible and Safe Management of Radioactive Waste

L.2. Denmark – Overview matrix

Type of Liability	Long-term management policy	Funding of liabilities	Current practice/ facilities	Planned facilities
Spent fuel	According to B90[24], 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 fuel is stored under safe and secure conditions by DD[25].	Long-term storage facility, including management facility. Disposal facility, if efforts to find international solution proves unsuccessful.
Nuclear fuel cycle wastes	Not applicable	Not applicable	Not applicable	Not applicable
Application Wastes	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, and manages radioactive wastes generated by institutional users in Denmark.	Long-term storage facility, including management facility. Disposal facility.
Decom-missioning	Following B48[26], 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 decommissioni ng tasks at the Risø site.	Not applicable
Disused sealed sources	Return to the manufacturer or management by DD	Return to the manufacturer or transfer to DD at the cost of the licensee. DD carries other costs.	DD receives, and manages disused sealed sources, which cannot be returned to the manufacturer.	Long-term storage facility, including management facility. Disposal facility.

[24] Parliamentary Resolution B90
[25] Danish Decommissioning
[26] Parliamentary Resolution B48

Danish Health Authority
Islands Brygge 67
2300 Copehagen S
Denmark

Tel.: +45 44 54 34 54
E-mail: sis@sis.dk
Web: www.sis.dk

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

NATIONAL REPORT FROM GREENLAND

8TH REVIEW MEETING, 2025

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 third Report from the Government of Greenland prepared for the 8th Review Meeting to the Convention, 2025, 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 in Greenland.

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 7th 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 2021, the previous report, and the questions and answers can be found via the homepage for the Joint Convention[1].

In the 2021 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.

   The Danish Working Environment Authority (WEA) has drafted a new executive order regarding ionizing radiation and the working environment in Greenland. The executive order was prepared in collaboration with the Greenland Self-Government. The scope of the order includes 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), apply to both employees and self-employed. On a more general note, the provisions 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 has been set to ensure human health and safety. Methods of evaluation and calculation of radiation exposure is 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 is required. The executive order entered into force in June 2022[1].

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 planned system for online registration of radioactive waste has not yet been implemented. 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 and for monitoring purposes) 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-

[1] Bekendtgørelse om ioniserende stråling og arbejdsmiljø i Grønland (https://at.gl/da/regler/bekendtgoerelser/1099-ioniserende-straaling-arbejdsmiljoe)

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.

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. It has until now not been possible to initiate the initiative.

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. At present, there are no plans to initiate projects producing NORM waste. New legislation from December 2021 prohibits exploration of radioactive mineral resources.

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 planning to draft an executive order aligned with international IAEA standards and EU- directives for best practices.

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 has issued 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.

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 will draft an executive order detailing responsibilities for registrants and licensee if needed. The provisions will align with corresponding Danish legislation, as well as international standards for best practices.

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 has issued 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.

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.

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.

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.

Article 26. Decommissioning

Industry, medical and educational sectors

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

Section G. Safety of Spent Fuel Management

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

NORM facilities

After adoption of Inatsisartut Act No. 20 of 1 December 2021 on prohibition of preliminary investigation, research and exploitation of uranium etc. it is at present not relevant to develop concrete plans for establishing waste facilities from mining and milling of radioactive minerals in Greenland.

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.

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 Northwestern 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 may possibly 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 and due to the adoption of Inatsisartut Act No. 20 of 1 December 2021 on prohibition of preliminary investigation, research and exploitation of uranium etc., planning of such facilities is at present not relevant.

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

At present, such initiatives is not relevant.

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.

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. Further initiatives are at present not relevant.

Regulatory framework initiatives

Standards and requirements for radiation safety matters for exploration and exploitation of radioactive materials in Greenland are at present not developed further.

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, there are no projects where uranium may be produced as a by-product. The present legislation does not permit such initiatives.

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 the following amendments:

Greenland Parliament Act no. 26 of 18 December 2012,
Greenland Parliament Act no. 6 of 8 June 2014,
Greenland Parliament Act no. 16 of 3 June 2015,
Greenland Parliament Act No. 34 of 28 November 2016
Greenland Parliament Act No. 16 of 27 November 2018
Greenland Parliament Act No. 39 of 28 November 2019 (Explanatory notes).

Greenland Parliament Act No. 20 of 1 December 2021 on prohibition of preliminary investigation, research and exploitation of uranium etc.

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 process.
- The Danish Working Environment Authorityhas drafted a new executive order regarding ionizing radiation and working environment in Greenland. This was 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

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.

Danish Health Authority
Islands Brygge 67
2300 Copenhagen S
Denmark

Tel.: +45 44 54 34 54
E-mail: sis@sis.dk
Web: www.sis.dk